Efficient Deployment of Advanced Public Transit Systems (EDAPTS)

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The California Center for Innovative Transportation works with researchers, practitioners, and industry to implement transportation research and innovation, including products and services that improve the efficiency, safety, and security of the transportation system.
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The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California. This report does not constitute a standard, specification, or regulation.

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THE EDAPTS APPROACH

FINAL REPORT

SEPTEMBER 2009

Prepared for:

CALTRANS DIVISION OF RESEARCH AND INNOVATION

CALTRANS DIVISION OF MASS TRANSPORTATION

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EXECUTIVE SUMMARY

In May of 2007, CCIT started Phase 1 of a 3-Phase program aimed at turning the outcomes of “Efficient Deployment of Advanced Public Transit Systems” (EDAPTS) research and development into a readily-available set of resources to help public transit agencies across California implement Advanced Public Transportation Systems (APTS). Consistent with Caltrans’ Division of Research and Innovation’s (DRI) terminology for research conduct, the program was nicknamed “EDAPTS Stage 5 deployment.” It includes, in phase 3, the commercial deployment of EDAPTS on a public transit property to be determined.

As Phase 1 of the EDAPTS Stage 5 deployment comes to an end, the CCIT team submitted a draft proposal for the next phase. Caltrans Division of Research and Innovation (DRI) has decided not to proceed with the next phase. So, this final report highlights our key activities and deliverables to date.

The original proposal identifies the goals of the three work phases as follows:

“The first phase of the project will focus on formulating and enhancing existing knowledge and expertise of EDAPTS in a manner that can be optimally comprehended by the industry. The subsequent Phase 2 will seek to definitely establish procurement sources for EDAPTS and cover the definition and preparation of the FOT\(^1\). It therefore involves identifying a transit partner willing to participate and equip its fleet with EDAPTS, as well as the funding sources to finance the deployment and O&M. The final Phase 3 of the EDAPTS Stage 5 deployment will consist of the implementation, operations and evaluation of the EDAPTS FOT.”

As stated in the original proposal, CCIT’s efforts in Phase 1 have been focused on creating a complete body of knowledge on EDAPTS available from a decade of research and development work. This also required that we clearly define what EDAPTS was to become as a ‘deployed product.’

The first section of this document presents the vision for EDAPTS. In the second section, the tools and other deliverables developed in Phase I of EDAPTS are described.

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\(^1\) Final Operational Test, referring to a commercial deployment in Phase 3.
THE EDAPTS VISION

EDAPTS has been defined as an APPROACH available to transit agencies to implement APTS. This approach offers A SET OF TOOLS aimed at easing and accelerating implementation of APTS systems that meet certain TECHNICAL AND ECONOMIC STANDARDS.

Formally, EDAPTS is a set of hands-on and analytic tools, recommended procurement methodology, and information that facilitates implementation of APTS for small urban and rural transit providers. EDAPTS outlines procurement options, provides useful information on funding sources, and advocates open source designs and open interface protocols.

The GOALS OF EDAPTS consist of the following:

- Assist small urban and rural agencies in the identification of ITS solutions (i.e., APTS systems) that meet their specific needs;
- Promote the use and incorporation of non-proprietary subsystem interfaces that facilitate future expansion;
- Advocate system performance trade-offs that significantly reduce life-cycle costs but do not adversely impact the intended usefulness of the deployed system to the procuring agency.

As part of CCIT’s efforts in Phase I, we conducted an analysis of the barriers faced by small and rural public transit operators in the implementation of APTS, we have identified three key topics for which tools have been developed or foundation for the development of tools have been completed:

1. **PROJECT FUNDING** – We aim to help transit agencies identify and obtain funding that they can apply to APTS implementation and operations. This may be done by providing information on existing programs, or by creating new channels.

2. **TECHNICAL ASSISTANCE** – More often than not, small urban and rural transit agencies need outside resources and technical help in order to plan, specify, procure, integrate, operate and maintain information technology projects. The tools developed through EDAPTS Stage 5 activities will assist the transit agencies in the pre-procurement and implementation phases of EDAPTS.

3. **TECHNOLOGY SOURCING** – EDAPTS makes some definite assumptions about the typical needs and means of small and rural transit agencies, and therefore aims to point to the most adequate solutions and products that meet certain technical and economic standards. Stage 5 activities will result in a short list of EDAPTS partners and suppliers of APTS.

The tools offered as part of EDAPTS should include guiding documents, case studies and best practices, technical specifications, software, and possibly, dedicated state-funded consulting and
engineering services and/or designated project funds. Some of these tools have been developed as original products of Caltrans-funded research and deployment efforts including relevant resources available from federal and other sources.

CCIT’s Phase I recommendations include that, beyond the timeline of Stage 5 activities, Caltrans’ Division of Mass Transportation (DMT) should coordinate the assistance offered to transit agencies as part of EDAPTS through their regular annual process of selecting transit agency proposals for funding. The next section describes the tools and other deliverables that have been developed, and the potential mechanisms for their delivery to transit agencies.

### SUMMARY OF EDAPTS PHASE I DELIVERABLES

The success of the EDAPTS approach, which will be measured by the number of agencies that adopt it, hinges in part on our ability to effectively communicate its benefits to both transit operators and technology providers, and to disseminate the tools it makes available. To this end, we have determined that a key channel for both the promotion and the delivery of the EDAPTS tools will be a website.

The website should be a portal for prospective EDAPTS adopters (i.e., transit agencies) and technology suppliers. It should highlight the merits of EDAPTS approach and provide instructions on how to get started. It should also serve as a one-stop shop for all of the associated resources such as downloadable documents and software, external links and relevant contact information. In our assessment, the development of the website should be an important next step in the deployment of the EDAPTS approach.

As part of the Phase I, we have concentrated on designing an initial set of EDAPTS tools that complement those already developed by Cal Poly San Luis Obispo and Cal Poly Pomona. Those tools are intended as dynamic and should be updated on a continued basis. The EDAPTS tools should gradually incorporate new knowledge and insights drawn from our institutional progress in establishing the EDAPTS approach as a mainstream initiative.

The following sections describe the EDAPTS tools and documents at the end of CCIT’s activities in Phase I.

### THE EDAPTS APPROACH: AN OVERVIEW

This document is intended as a first read for prospective EDAPTS adopters or suppliers. It addresses a wide audience of practitioners at various organizational levels, and seeks to be concise and simple. Its goal is to describe EDAPTS and how transit agencies can benefit from it.

**PHASE 1 STATUS:** final document completed in March 2009 (Appendix A).

**RECOMMENDED SUBSEQUENT ACTIVITIES:** limited updating as modifications are identified.
THE EDATPS APPROACH: DEFINING PROJECT NEEDS

This document guides a transit agency through the process of collecting the needs and expectations of stakeholders before implementing an APTS project. It provides common operational scenarios to help agencies formulate the outcome of EDAPTS for their community, and a framework for developing their own scenarios.

PHASE 1 STATUS: Document finalized in March 2009 (Appendix B).

RECOMMENDED SUBSEQUENT ACTIVITIES: The document’s content should be updated as further deployments occur, reflecting lessons learned as EDAPTS is refined.

THE EDAPTS APPROACH: FUNDING MECHANISM

This document highlights funding sources at the federal, state and local level for APTS implementation. While most agencies are well aware of the funding streams available to them, this document helps transit agencies shape their thinking to recognize the opportunities they have to purchase technology with their federal, state and local dollars. Eventually, we recommend that EDAPTS be tied to specific funding mechanisms under state purview.

PHASE 1 STATUS: finalized document in March 2009 (Appendix C).

RECOMMENDED SUBSEQUENT ACTIVITIES: The document’s content should be updated to reflect future changes in transportation funding and lessons learned from the Final Operational Test (FOT) of EDAPTS.

THE EDAPTS APPROACH: ASSESSING COSTS AND BENEFITS

A benefit assessment tool and a cost assessment tool have been developed using spreadsheets. This effort is a generalization of the cost-benefit analysis of the EDAPTS implementation for SLO Transit conducted by Cal Poly Pomona. It offers useful information for other agencies to estimate the cost and benefits of APTS technology that they are considering. These tools will help the agencies that want to be able to roughly estimate the likely costs and benefits before investing substantial efforts into the EDAPTS approach during the pre-implementation phase.

PHASE 1 STATUS: Tools finalized in March 2009 (Appendix D).

RECOMMENDED SUBSEQUENT ACTIVITIES: Continued research on costs and benefits of APTS technologies are needed to keep these tools updated. We also recommend development of a dynamic online decision-support tool.

THE EDAPTS APPROACH: TECHNOLOGY SOURCING

A list of potential EDAPTS vendors has been developed. This list of suppliers takes a comprehensive view of the APTS technology offering in the current market place for small urban and rural transit agencies. It lists vendors and highlights their product range and the services
they provide. Ultimately, we recommend that this list be tied with the technical and economic standards to be defined for EDAPTS approach so that it becomes a buying guide for transit agencies. Further activities to improve EDAPTS approach could include pre-qualifying vendors for EDAPTS procurement.

**PHASE 1 STATUS:** Document finalized in March 2009 (Appendix E).

**RECOMMENDED SUBSEQUENT ACTIVITIES:** Continued collaboration with DMT to develop a pre-qualified suppliers list is warranted.

**THE EDAPTS APPROACH: MARKET ASSESSMENT**

This effort identified the characteristics of the target transit agencies in California, identified the need for APTS in smaller transit agencies of varying sizes, gathered knowledge on transit agencies’ perceptions of innovative technology applications on their environment, and identified the barriers to the implementation of APTS. These were achieved by conducting face-to-face interviews, on-line surveys, and a focus group discussion. Additionally, a list of qualified potential adopters of EDAPTS in California has been established, which may be used as an EDAPTS marketing pool or used by potential APTS suppliers to estimate the size of their market.

**PHASE 1 STATUS:** Finalized document in March 2009 (Appendix F).

**RECOMMENDED SUBSEQUENT ACTIVITIES:** The list of potential EDAPTS adaptors (transit agencies) needs limited updating as APTS implementations occur over the years ahead at these agencies.

**THE EDAPTS APPROACH: TECHNOLOGY TRANSFER**

This effort identified the potential technology transfer modalities based on the open source software and hardware developed by Cal Poly SLO during the research and development stages of EDAPTS. Cal Poly SLO developed a memorandum with the results of this assessment under a sub-contract with CCIT to explore and formalize the transfer of EDAPTS resources.

**PHASE 1 STATUS:** a final draft memo submitted in January 2010 (Appendix G).

**RECOMMENDED SUBSEQUENT ACTIVITIES:** None.

**EDAPTS SPECIFICATIONS GENERATOR (CAL POLY SAN LUIS OBISPO)**

This is both a complete matrix and a companion software program that can automatically produce generic specifications from a list of user needs. As such, this tool directly follows the project needs document in the sequence of implementation of EDAPTS. It enables agencies to rapidly put together an extremely solid bidding document for procuring APTS products and services. This tool has been available for fixed route systems and was modified to include
specifications for demand response systems in Phase I. A modified draft final version of the specifications generator was made available in January 2010.

**PHASE I STATUS:** Tool to be finalized in March 2010 (Appendix H).

**RECOMMENDED SUBSEQUENT ACTIVITIES:** limited updating of the specifications as new standards and APTS systems are adopted.

The following section details additional recommendations for EDAPTS approach. CCIT expects the development of these recommended additional tools will help mainstreaming of EDAPTS approach.

### ADDITIONAL TOOLS RECOMMENDED FOR DEVELOPMENT

The following two tools are identified as important resources for the successful mainstreaming of EDAPTS.

### THE EDAPTS APPROACH: PROJECT IMPLEMENTATION

This document’s goal should be to serve as a guide to EDAPTS implementation project managers. It will describe the sequence of implementation of EDAPTS and hit on best practices in major project areas such as project planning, vendor selection, systems interoperability, user and community outreach, training and organizational change. Best practices will be drawn from lessons learned with the San Luis Obispo and Cal Poly Pomona implementations, as well as other existing sources at the state and national level.

### EDAPTS WEBSITE

As indicated earlier, the EDAPTS website should be the primary mechanism to deliver updated information on the EDAPTS approach to potential adopters. The EDAPTS website should be designed for small urban and rural transit agencies to easily utilize the following tools to effectively implement EDAPTS:

- An introductory slideshow of EDAPTS approach and a roadmap for EDAPTS implementation;
- Online interactive worksheets to identify stakeholders, define the project needs and match their needs to pre-defined customizable operational scenarios;
- Online portal for transit funding sources for APTS deployments and highlighted funding sources specific to EDAPTS;
- A dynamic online tool that estimates cost and benefits based on transit agency characteristics;
- Online list of pre-qualified suppliers with links to their product descriptions;
- Online repository of open-source EDAPTS resources;
- An online specifications generator tool to streamline EDAPTS procurement.
CONCLUSION

In this final report, we have outlined the tools that have been developed and recommendations that we deem are required to turn the EDAPTS vision into a tangible possibility for small and rural transit agencies statewide. However, none of this can realistically be accomplished without dedicated resources. Small transit agencies may not be the most sophisticated institutions, but their managers are very knowledgeable and resourceful: if all they needed today in order to implement technology that enables better on-time performance and informing passengers was hard-to-come-by information, they would easily get past that hurdle. In fact, a number of government and professional organizations are already providing plenty of information, and we can count on APTS vendors to explain the benefits of their technology to prospective buyers.

EDAPTS represents an opportunity to invest efficiently into technology that will make public transit more attractive and better serve passengers. It is ultimately up to Caltrans and the State of California to seize that opportunity by embracing it as an initiative and devoting adequate resources to it. Until this happens, EDAPTS approach development can continue, but we can hardly reach out to transit agencies and concretely propose the EDAPTS approach. Our efforts to date have taught us that we may get some initial interest, but we are necessarily limited by the resources including funding we can offer. We therefore see it as a crucial task to work with EDAPTS stakeholders, primarily Caltrans Division of Mass Transportation and Federal Transit Administration and get institutional buy-in.
The EDAPTS Approach: An Overview
Do these problems sound familiar?

• A platoon of buses operating on the same route arrives unintentionally at the same stop at the same time—reducing the efficiency of your bus service and irritating passengers.

• A bus fails and the driver lets dispatch know that his bus has gone out of service. But dispatch has no way to alert passengers waiting for this twice-a-day service on a rural road.

• As you’ve added a new route and additional buses, manually compiling your weekly or monthly performance reports has become increasingly time-consuming and burdensome.

You know there are tools out there to help solve some of these problems, but you don’t know which ones might solve your problems or whether or not they are affordable.

If so, help is on the way. Although your system may be smaller than transit systems in New York, Chicago, or Los Angeles, California, there’s no reason you shouldn’t have access to some of the same new technologies. Tools to keep your system running on time, are available at a reasonable cost and can help you keep your passengers happy.
The **EDAPTS Approach** is a set of *analytic tools*, a *recommended procurement methodology*, and *information* that facilitates implementation of Advanced Public Transportation Systems (APTS) for small urban and rural transit providers.

EDAPTS is an on-going joint effort between California Department of Transportation, UC Berkeley’s California Center for Innovative Transportation (CCIT), California Polytechnic State University San Luis Obispo, and California State Polytechnic University Pomona.

The **EDAPTS Approach:**

- provides useful information on locating and identifying funding sources.

- helps you identify the needs of those people most affected by a change in your transportation service—whether they are passengers, dispatchers, drivers, or transit organizations—and locate technology to meet those needs.

- allows you to distinguish between those systems you want and those you actually need.

- advocates open source designs and open interface protocols, so you can expand your technology later if needed.

- guides you through the procurement process with software that generates engineering specifications and a list of APTS suppliers.

- helps you make system performance trade-offs to reduce life-cycle costs that do not adversely affect the intended usefulness of the deployed system.

The **EDAPTS Approach** *helps* you deploy APTS more efficiently and at a lower life-cycle cost.
…to implement APTS

The **EDAPTS Approach** can help you find APTS technologies to:

- Improve schedule adherence
- Respond better to changes in service needs if paratransit services are provided
- Make public transit a viable alternative to driving
- Reduce emergency response times
- Provide streamlined and more efficient scheduling
- Automate data collection and reporting to reduce time spent manually entering passenger information.
- Generate reports easily.
- Improve the transit experience through real-time monitoring of routes, incidents, driver and passenger needs

The **EDAPTS motto is**: *Buy only the APTS you can afford and really need now, but buy adaptable solutions that can grow as you and your needs change.*
Getting APTS to work for you

• Every stakeholder, from passenger to transit operator, will benefit from APTS implementation using the EDAPTS approach.

• APTS technology will provide better schedule adherence. Vehicle operators will know when to depart from each vehicle stop. Real-time information will allow passengers to gauge arrival times and transit agencies to continuously be aware of drivers’ needs.

• To implement APTS for your transit system, EDAPTS provides resources and guidance throughout the process of technology procurement.

• The following diagram outlines the EDAPTS process. Keep in mind that there are resources and tools to help you through each stage.
Use the step-by-step processes of EDAPTS Approach

1. Define your needs
2. Estimate costs and benefits
3. Find funding
4. Procure a system
5. Implement the system
6. Training and outreach
7. Operations and Maintenance
8. Evaluation

The following scenarios show a “day in the life” of a transit system with APTS and illustrate some of the ways APTS can benefit you and your community.
Morning start-up

7:30am 7:45am 8:00am 8:15am

EVENT 1
Joe finishes breakfast and checks his local transit website to see if his bus will be on time. It should arrive at his stop in 35 minutes.

EVENT 2
Mira arrives at the bus depot for her morning route. She walks out to the bus, turns it on, and inspects it. On the Mobile Data Terminal (MDT) screen she logs in by selecting her name and entering the current odometer reading.

EVENT 3
Sean, the transit agency dispatcher/manager, has powered up his dispatching console and monitors the system map and fleet status table.

Joe walks to the bus stop and looks at the dynamic message sign.

ARRIVALS
Rte 55 04 min
Rte 22L 12 min

When the bus reaches 5mph the MDT display shows only the current time to avoid distracting Mira from her driving. When Mira arrives at the first stop, the MDT displays her location and counts down to departure time.

Joe runs next door for a cup of coffee and makes it back in time to board the bus.

At her next stop the MDT records her location and the time. She sees Joe at this stop and picks him up.

The system map updates bus locations every minute. The fleet status table updates whenever a bus operator arrives, stops or takes a break at a stop along the route.
Get the APTS Solution for “Morning start-up”

- **Transit website**: The transit website allows passengers to access traveler information from their homes or offices. A website is one option for distributing traveler information.
- **Dynamic message sign**: Dynamic message signs bring schedule changes directly from the dispatcher to the passenger.
- **Mobile Data Terminal (MDT)**: An on-board data information system. The MDT stores route information, logs driver and vehicle information, and displays a countdown to departure.
- **Dispatching Console**: Some key features of the dispatching console include:
  - Fleet status table- easy to read table that displays the status of each bus
  - System map- displays the location of each vehicle in the fleet on a map
  - Physical equipment (computer(s))- houses and displays the dispatching software.
Daily Operations

9:30am 9:40am 9:50am 10:00am

EVENT 1
Sarah, a student at the local community college, is walking and late for class. She calls the transit hotline and learns that a bus will arrive at a stop close to her current location in 10 minutes.

EVENT 2
Mira needs a restroom break but her next scheduled break is in 1 hour. She radios in a request to take a break at the Sunny St. bus stop, which she will approach in 15 minutes.

EVENT 3
Fred, driving Route 7, gets a cell phone call. His wife is going to the hospital to deliver their first baby! He uses his two-way radio to contact dispatch and request a substitute driver.

Roy receives Sean’s call and heads to the stop. The dynamic message sign at the stop indicates that the bus will arrive in 2 minutes. Fred logs out and Roy logs in. The MDT shows the next stop and when to start.
Get the APTS Solution for “Daily Operations”

- **Transit hotline:** This is just one way to communicate with your passengers.
- **Dispatching software:** “On Break” display allows seamless communication between drivers and dispatchers.
- **Dynamic message signs:** For relative low per-unit cost, dynamic message signs bring schedule changes directly from the dispatcher to the passenger.
Demand Responsive Transit

11:00am 11:15am 11:30am 11:45am

Passengers

Linda, an elderly resident, needs to make an unexpected trip to the doctor. She calls the automated demand-response hotline and selects “1” to schedule round-trip service.

Drivers

She speaks her start and end address and punches in the time and date of pickup. She receives an automated voice confirmation the shuttle will pick her up at 12:30pm the same day.

Dispatcher

Sean sees Linda’s request come through the automated phone system on his dispatching console and assigns a driver and a wheelchair accessible van to her trip.

Jerry, one of two demand-response drivers is finishing up another trip when he gets a radio call from Sean about Linda’s trip. He says he should be able to make it in time and agrees to take on the trip.

Once his last trip is complete Jerry heads to Linda’s home. The MDT logs his previous and current trip time and distance.

Drivers

Once 12 11 10 9 8 7 6 5 4 3 2 1
• **Automated phone system:** Voice-recognition technology, demand-response hotline, and automated voice confirmation are all functions of the traveler information system.

• **Dispatching Console:** With real-time information and dispatching console, scheduling demand responsive transportation is made easier. Some key features of dispatching software include:
  
  – System map- displays the location of each vehicle in the fleet on a map allowing you to choose the closest vehicle for the next scheduled pickup.
  
  – Physical equipment (computer(s)) - houses and displays the dispatching software.
**Unplanned Events**

**EVENT 1**
One particular passenger is harassing the driver and other passengers, making it uncomfortable for those on board.

- Luis asks the passenger to exit the bus. When the passenger does not exit and the situation escalates, he presses the Emergency button near his leg.
- Luis receives a radio call from Sean and answers a coded question to confirm the situation. Based on his response, the appropriate emergency response person arrives quickly and takes care of the situation.
- Sean is alerted to the emergency via audio-visual alarms on the dispatch console. The bus is put into “tracking mode” and its GPS location is reported every 15 seconds. An on-screen dialog walks Sean through the proper response sequence.
- Sean confirms that there is an actual emergency. He notifies the police and continues to track the bus location closely until the situation has been resolved.

**EVENT 2**
Mira, who is almost finished with her shift, radios in a mechanical error. She waits at the Pleasant St. stop because she is nervous about continuing to drive.

- After chatting with Mira on the radio Sean decides to take the bus out of service. He checks the fleet status table on the dispatching console, chooses an available bus to replace the bad one, and calls a tow truck for Mira’s bus.
- A substitute driver takes out another bus to Mira’s location. He selects the bus stop from the MDT and is directed on where to go. Mira logs out of the other bus and gets a ride back to the office with the tow truck.
- Sean then has an available driver in the office bring out the new bus to Mira. He generates an automated incident report once the substitute driver has replaced the driver and the bus.

Passengers on Mira’s bus are kept informed of the situation. Most wait for the replacement bus to arrive, since it will be only a few minutes. Dynamic message signs at other stops are updated with the delay.
Get the APTS Solution for “Unplanned Events”

- **Emergency notification system:** Swift communication and response is critical in any emergency.
- **Fleet status table:** Information at a glance. Just one of the many benefits of having information centralized.
- **Automated incident report:** because the system has recorded every message and action associated with the incident, it can run the relevant reports if this optional element is deployed.
Sean decides to run reports from the dispatching console for information on the shopping center routes. He clicks on Ride Report and chooses daily, monthly and yearly passenger loading and delay reports.

EVENT 1
A new shopping center has opened but the buses serving the area only arrive once an hour. Passengers form long queues waiting for the bus, especially in the afternoons and on weekends. One passenger calls to request more frequent service.

EVENT 2
Throughout the day, Jeff enjoys having the new MDT on his bus coordinate departure times - He no longer worries about maintaining proper spacing with other buses on the same route.

He presses a passenger counter button on the MDT each time a rider boards. This helps with reporting and route maintenance. He used to record this information manually with pencil and paper.

He also checks for service requests posted on the local website and through phone calls. The route to the shopping center is consistently over-capacity, and there is high demand for more frequent service.

Sean navigates to Schedule Maintenance and selects the “ADJUST” button. The system provides a recommended new bus schedule based on the patterns of delay and passenger load of buses on that route.

He selects the revised schedule and prints it for review at the next Board meeting. He will propose these changes to the routes, which, when ready, will be easily updated using the dispatching console.
Get the APTS Solution for “Schedule and Maintenance”

- **Ride Report**: Capacity information is aggregated with passenger requests from the Web and phone to create accurate information so agencies can respond appropriately and quickly.

- **Mobile Data Terminal (MDT)**: Another key feature of this system is that can automatically suggest departure times to keep buses well spaced and records passenger loading information.

- **Passenger Counter Button**: The button is linked to the MDT, so manual data entry is no longer needed.

- **Schedule Maintenance**: The system allows you to update the bus schedule as ridership demand changes.
Passengers boarding Luis’ bus are having problems using their smart transit cards. They have to swipe their cards several times before it is registered.

Luis, after finishing his route, reports to dispatch that the magnetic card reader was having some small problems during the day.

Sean calls the qualified dispatching vendor of the card reader, who has a contract to assist with maintenance. The vendor is able to walk Sean through the mechanics of fixing the reader.
Get the APTS Solution for “Vendor Support”

- **Electronic payment systems:** End your system’s reliance on cash transactions.
- **Qualified EDAPTS vendors:** When you make a big investment decision, you want to lower your risk any way you can. EDAPTS will have a pre-qualified list of vendors according to a specific set of technical and customer service criteria when the Final Operational Test is successfully completed.
End of day tasks... & a bright EDAPTS future!

5:10pm 5:30pm 5:45pm 6:00pm

EVENT 1
Sarah is getting ready to leave the office for the day and gets a text message on her cell phone indicating the arrival of the next bus home. Instead of waiting in the rain, she leaves the office to catch the bus right when it arrives!

EVENT 2
At the last stop of his 8-hour shift, Jeff drives the bus to the fueling station at the lot. The MDT determines that the shift is over using its standard clock and GPS, and records the deadhead miles.

While refueling, Jeff selects the “Fueling” function on the MDT and enters in the number of gallons filled and the bus’ odometer reading. This information is logged and kept for monthly reports.

At the bus lot, before leaving for the day, he selects “End Shift” from the MDT and is logged out of the system.

EVENT 3
In a neighboring city, a transit manager has seen how well EDAPTS works and is interested in purchasing certain components of the system. He navigates to the EDAPTS website and fills out information about his agency.

The web application determines the product package that best fits his agency’s needs, possible funding sources, and a list of certified vendors with contact information that can sell him the products and help implement the solution.
Get the APTS Solution for “End of day tasks”

- **Mobile Data Terminal (MDT):** Clock, GPS, fuel information, a logging system, and more, means drivers spend more time driving and less time on administrative tasks.
- **EDAPTS website:** A one-stop source for product information, certified vendors, funding sources, and smart solutions designed specifically for small and rural transit operators.
EDAPTS

For more information please visit
http://www.calccit.org/projects/EDAPTS.html
The EDAPTS Approach: Defining Project Needs

EDAPTS

Partners: Caltrans, California Center for Innovative Transportation, California State Polytechnic University at Pomona, California Polytechnic State University at San Luis Obispo

EDAPTS: The Efficient Deployment of Advanced Public Transportation Systems
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<td>APC</td>
<td>Automated Passenger Counter</td>
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<td>GPS</td>
<td>Global Positioning System</td>
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<td>MDT</td>
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<td>MPO</td>
<td>Metropolitan Planning Organization</td>
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</table>
OVERVIEW

The purpose of this guide is to help transit agencies begin to envision Advanced Public Transportation Systems (APTS) for their transit systems. Mostly, this involves defining the agency’s needs using a set of simple well-defined steps that are done before well before any hardware or software is purchased.

The approach that is used in this guide is called EDAPTS and it stands for Efficient Deployment of Advanced Public Transportation Systems. It was developed especially for rural and small urban transit agencies to help meet their specific needs and challenges. These challenges include lack of funding, procurement options, and technical assistance. In response to this, EDAPTS offers a procurement methodology and a set of tools that help transit agencies achieve low-cost and long-term APTS solutions for their transportation needs. The EDAPTS approach offers resources and tools to assist at various stages in the procurement process. This process and associated resources are described in detail in the section called The EDAPTS Approach.

Also included is a guide that will introduce APTS and help a transit agency determine which, if any, systems are needed. This ensures that money and time are not spent on unneeded changes to a transit system.

The first section will help a transit agency become familiar with APTS. It includes a list of the benefits of APTS and describes recommended APTS components. These components are focused on increasing efficiency and improving the transit experience for passengers.

Because EDAPTS advocates lower life-cycle costs, an accurate needs assessment is critical to avoid spending valuable resources on unneeded features, systems and equipment. To assist with this, a step-by-step guide is included to help assess needs. The needs assessment guide has three steps. The first step is to identify and consult stakeholders. Once stakeholders are engaged, focus groups and surveys are used to determine their specific transportation needs and expectations regarding transportation improvements. Resources to facilitate this process are provided in the appendices. Overall, this guide helps transit agencies identify the needs of the community, the APTS that can address those needs, and the resulting benefits. Finally, the guide helps a transit agency communicate this information to decision-makers through the development of operational scenarios.
THE EDAPTS APPROACH

The expanding array of Advanced Public Transportation System (APTS) technologies is constantly improving the performance of public transportation systems around the nation. As the cost of technologies decrease, these solutions are no longer limited solely to large transit systems, but are now seriously considered for use in small urban and rural environments.

The main reasons for the limited use of APTS technology in small urban and rural areas are the lack of discretionary resources for deployment, accessible procurement options and on-going technical assistance. These three problems make up the legs of the three-legged stool approach to APTS deployment. Successful deployment depends on each of these three elements. Through conversations with smaller transit agencies, some specific problems were discovered. For instance, it is often the case that these agencies have lower fare box collections, limited access to funding sources for new and better technology, and lack in-house personnel with the necessary skills for technical support required for APTS deployment.

In response to these challenges, a group of researchers and engineers has developed the Efficient Deployment of Advanced Transportation Systems (EDAPTS) approach that guides small urban and rural transit agencies through the process of acquiring APTS.

BACKGROUND

In 1998, the Federal Transit Administration (FTA) and the California Department of Transportation (Caltrans) teamed up with California Polytechnic State University at San Luis Obispo (Cal Poly SLO) and the City of San Luis Obispo Transit (SLO Transit) to investigate ways to make APTS more affordable for the small transit operator and to provide lower cost system growth and enhancements over time.

In 2007 Caltrans asked the California Center for Innovative Transportation (CCIT), along with Cal Poly SLO and California State Polytechnic University at Pomona (Cal Poly Pomona) to compile a comprehensive body of knowledge that could be utilized by any small urban or rural transit agency to deploy APTS more efficiently and at a lower life-cycle cost. The result of this research is the EDAPTS approach.

DESCRIPTION OF THE EDAPTS APPROACH

EDAPTS is a set of analytic tools, a recommended procurement methodology, and information that facilitates implementation of APTS for small urban and rural transit providers. EDAPTS outlines procurement options, provides useful information on funding sources, and advocates open source designs and open interface protocols. Implementing APTS in a transit system is an exciting, yet challenging, process. By using the EDAPTS methodology and the tools provided, a transit agency can implement the technologies it needs at a lower life-cycle cost. Overall, the EDAPTS motto is: Buy only what you can afford and really need now, but buy adaptable solutions that can grow as you and your needs change.
More specifically, lower life-cycle costs are achieved by adhering to these principles:

1. Build APTS systems that meet specific transit needs. This means distinguishing between those systems that are desired and those that are required.
2. Promote the use and incorporation of non-proprietary subsystem interfaces that facilitate future expansion.
3. Make system performance trade-offs that significantly reduce life-cycle costs but do not adversely impact the intended usefulness of the deployed system.

THE EDAPTS PROCESS

EDAPTS outlines a process of obtaining APTS technology, as shown in the diagram on the next page. This is a comprehensive process, guiding a transit agency from pre-implementation through implementation to general operations and maintenance of the system. These steps are:

- **DEFINE YOUR NEEDS:** This step guides a transit agency through identifying stakeholders and collecting the needs and expectations of stakeholders before implementing an APTS project. This process also involves developing common operational scenarios to help formulate the benefits of APTS for a community.

- **ESTIMATE THE COSTS AND BENEFITS:** This process helps to estimate the costs and benefits of APTS that is needed during the pre-implementation phase. A tool that estimates cost and benefits based on transit agency characteristics is available.

- **FIND FUNDING:** This process involves identifying one or more potential grant programs or funding sources at the federal, state and local level for APTS implementation. A list of potential funding sources and possibly even a specific funding mechanism under State purview will be made available.

- **PROCURE THE TECHNOLOGY:** This process helps a transit agency procure APTS that is currently needed while making sure it can be expanded incrementally at a low life-cycle cost. A dynamic tool to develop the technical specifications and a data format standard along with a list of pre-qualified suppliers will be made available.

- **IMPLEMENT THE SYSTEM:** This is the actual implementation of the procured APTS through the processes described above. The supplier of the APTS is typically responsible for this process in close coordination with the transit agency.

- **TRAIN EMPLOYEES AND TRANSIT USERS:** Employees who use the APTS need to be trained to effectively utilize the enhanced system capabilities and transit riders need to be made aware of the system enhancements. This process helps you through the initial time period after implementation.

- **OPERATE AND MAINTAIN:** APTS solutions need continued up-keep and maintenance for reliable performance. An agency needs to identify a funding stream to meet this need. An APTS supplier can be hired for this service or the agency may choose to do this themselves.
• **EVALUATE:** Evaluating deployed APTS solutions is critical to justify investment to stakeholders and funding entities. This helps facilitate trust and acceptance of the system and enable future expansion of APTS.

**The EDAPTS Process**

1. Define your needs
2. Estimate costs and benefits
3. Find funding
4. Procure a system
5. Implement the system
6. Training and outreach
7. Operations and Maintenance
8. Evaluation

**FOR MORE INFORMATION ON THE EDAPTS APPROACH**

Go to the EDAPTS website located at [http://www.calccit.org/projects/EDAPTS.html](http://www.calccit.org/projects/EDAPTS.html)

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GETTING STARTED

The overall purpose of the guide is to assess a transit agency’s need, if any, for APTS. The critical first step in doing this is to become familiar with APTS technology. This helps answer the question, “Why consider APTS?” In response to this question, the first section details the benefits of APTS including some unique benefits to rural and small urban transit agencies. One goal of the guide is to help a transit manager or operator start to envision the ways that APTS can improve his/her transit system.

The next section of the guide begins a process of assessing a transit agency’s needs through stakeholder identification and needs analysis. To begin, it is crucial to correctly identify stakeholders, or groups of people that use, work, and/or interact with the transit system. Lessons learned from previous deployments have shown that this is an important step. By correctly identifying stakeholders, a shared understanding of the goals of the transit improvements is achieved. The second step is to communicate with stakeholders and find out what they need from their transit system. There are resources and suggestions to help facilitate this step. The third step is to connect the needs of stakeholders to available APTS components and describe system benefits through operational scenarios. This process is important for reducing the risk of schedule and cost excesses and increasing the likelihood that the implementation meets users’ needs.

1. Overview of APTS Benefits
2. Identify Stakeholders
3. Needs Assessment
4. Develop Operational Scenarios
AN INTRODUCTION TO ADVANCED PUBLIC TRANSPORTATION SYSTEMS (APTS)

Providing public transit service to small urban and rural communities involves a unique set of needs. For instance, users are often faced with uncertainty when trying to catch a bus that may only come once every hour to a rural bus stop. At the same time, the small transit system operator typically struggles to maintain schedules and has to deal with elevated safety concerns for drivers and passengers when buses are on long headway sections of a route, especially in remote areas. Advanced Public Transportation Systems (APTS) have been developed and deployed in large-scale transit properties as a means of increasing the efficiency and safety of transit services, as well as offering users easy access to real-time travel information.

OVERVIEW OF THE BENEFITS OF APTS

Every stakeholder, from passenger to transit operator, will benefit from APTS implementation using the EDAPTS approach. APTS technology provides more on-time arrivals and better time keeping so vehicle operators know when to depart from each vehicle stop. Real-time monitoring allows passengers to gauge arrival times and transit agencies to be continuously aware of drivers’ and passengers’ needs.

A list of benefits is provided below for easy reference.

- Due to real-time bus arrival times passengers no longer have to wait for the bus.
- On-line trip planning gives passengers the ability to use public transportation more effectively.
- Improved schedule adherence.
- Better response to changes in service needs if paratransit services are provided.
- Improved impression of public transit as a viable alternative to driving.
- Improved emergency response times.
- Streamlined and more efficient scheduling.
- Automated data collection and reporting which reduces time spent manually entering passenger information into a database. Also, transit managers can generate reports easily.
- Real-time monitoring of routes, incidents, driver and passenger needs.

Major components of the recommended APTS systems generally include the Vehicle On-Board Systems, Dynamic Roadside Information Displays, Central Transit Management Systems, Roadside Data Communications Systems, and Traveler Information Systems (see the following diagram for examples). As a quick reference, components of these systems are described in detail in Appendix I of this document.
APTS COMPONENTS

Dispatching software

Roadside sign display using solar power

Traveler information services

Central site software

AVL System with GPS

MDT

Emergency actuator

Wireless (radio) data communication
These systems were investigated as part of the EDAPTS research effort. Appendix I also briefly looks at other APTS applications that may have the potential to improve the operations of small urban and rural public transportation systems. Small urban or rural transit agencies can customize APTS deployment by using one or more of the components described. In some cases, it may be necessary to look at a broader list of APTS technologies to address new or unique problems and needs.

Now that there is an understanding of what is possible with regard to APTS, the following section begins the needs assessment process with stakeholder identification.
IDENTIFYING STAKEHOLDERS

The first step is to identify all people and entities that have a stake in the operation of your transit properties. These stakeholders includes passengers, drivers, dispatchers, and managers, at a minimum. Table 1 provides a summary of the process of identifying these stakeholders. Appendix II is a sample worksheet that can also be used to help identify stakeholders.

Table 1 Identifying Stakeholders

<table>
<thead>
<tr>
<th>Objectives</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>▪ Identify high-level end-users, implementers and regulators whose needs should be understood and addressed by your project.</td>
<td></td>
</tr>
<tr>
<td>▪ Improve continuity between planning and implementation by understanding who needs to be involved in each phase of the project.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sources of information</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Affected transit agencies, partners, and associated local government organizational charts.</td>
<td></td>
</tr>
<tr>
<td>▪ Typical transit system users based on agency records, surveys and other sources.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key activities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Identify individual stakeholders and groups that are affected by changes in the transit system</td>
<td></td>
</tr>
<tr>
<td>▪ Generate a list of representatives for each entity.</td>
<td></td>
</tr>
<tr>
<td>▪ Briefly describe and document roles and responsibilities of each stakeholder.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ A comprehensive list of stakeholders and documented agreements on their roles and responsibilities for the project.</td>
<td></td>
</tr>
<tr>
<td>▪ Consolidation of stakeholders into groups linked by common interests and attributes, such as the traveling public, public agencies and private organizations.</td>
<td></td>
</tr>
</tbody>
</table>

The remainder of this section outlines a sample set of typical stakeholders for a typical APTS deployment. This section can be useful in identifying the stakeholders that should be contacted and considered as participants in selection of APTS components.

The major stakeholder groups are:

1. Public transportation passengers
2. Public/ government agencies

The following list is a collection of potential groups that may be considered. Some may not be relevant to specific transit systems; others may need to be modified for a particular transit organization’s list.
### EXAMPLE STAKEHOLDERS

#### PUBLIC TRANSPORTATION PASSENGERS

**FIXED ROUTE PASSENGERS** - Riders using services where vehicles run on regular, pre-designated, pre-scheduled routes. This group needs representation for the frequent riders as well as infrequent riders and visitors to the area.

**PARATRANSIT PASSENGERS** - Riders using on-demand transit services (i.e. paratransit). The users of these services must be represented if you provide this type of service. If voluntary representatives are not forthcoming, you should actively seek involvement from qualified representatives. This is an important stakeholder with special needs, many of them covered by the Americans with Disabilities Act. For more information on accessibility requirements see [http://www.dot.gov/citizen_services/disability/disability.html](http://www.dot.gov/citizen_services/disability/disability.html).

#### PUBLIC/GOVERNMENT AGENCIES

**FEDERAL ENTITIES:**

- United States Department of Transportation (USDOT)
- Federal Highway Administration (FHWA)
- Federal Transit Administration (FTA)

**STATE AND REGIONAL ENTITIES:**

- California Department of Transportation (Caltrans)
- Metropolitan Planning Organization (MPO)
- Regional Transportation Agency (RTA)
  - County Commissions, County Councils and Transportation Congestion Management Agencies
  - Transit District Board of Directors

**LOCAL ENTITIES:**

- Transit Authority in the City Government
- Department of Public Works
- City / County Council
- City / County Planning Department
### OPERATING AGENCIES AND OTHER SERVICE PROVIDERS:

- **Transit Service Provider** *(could be public or private)*: The agency that is responsible for the day-to-day operations of the public transportation system. Including:
  - Maintenance staff who are responsible for vehicles and APTS
  - Management staff who are responsible for meeting the reporting requirements and administering the day-to-day activities of the agency
  - Operators who drive the vehicles
  - Dispatchers who are responsible for the coordination of vehicles and compliance to fleet schedules

### FIRST RESPONDERS:

- **Transit Police or Public Law Enforcement**: The agency responsible for law enforcement on the transit vehicles or at transit facilities (bus stops, stations, etc.)

- **Emergency and Medical Services (EMS) Personnel**: The agencies that will be called upon to resolve emergency and medical situations
ASSESSING NEEDS

The next step in the EDAPTS approach is to assess the needs of identified stakeholders and stakeholder groups. The needs identification and analysis will only be successful if the stakeholders are engaged in this process. This typically involves actively seeking representation from each of the stakeholder groups.

Once the representatives of the stakeholder groups are identified, their needs can be determined through either individual interactions or group discussions. Appendix III and IV are worksheets that can be given to stakeholders to help assess their needs. The worksheet in Appendix III is directed at users/riders and Appendix IV is directed at dispatchers, managers and drivers. Table 2 is a summary of the needs assessment process.

Table 2 Performing Needs Assessment

<table>
<thead>
<tr>
<th>Objectives</th>
<th>▪ High-level identification of APTS needs in terms that all stakeholders can understand ▪ Improved continuity between planning and deployment by identifying the most important needs for each of the stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sources of information</td>
<td>▪ Stakeholder lists ▪ Needs assessment worksheets (see Appendices III and IV)</td>
</tr>
<tr>
<td>Key activities</td>
<td>▪ Define, prioritize and get approval on the needs for each stakeholder group. Signature approval by responsible individuals or corporate management is preferred.</td>
</tr>
<tr>
<td>Results</td>
<td>▪ A comprehensive, prioritized list of stakeholder issues and needs</td>
</tr>
</tbody>
</table>

Some examples are provided below to help you get started.

EXAMPLE NEEDS

NEEDS OF THE TRAVELING PUBLIC

- PUBLIC TRANSPORTATION PASSENGERS
  - Improved Confidence in Vehicle Arrivals and Departures at Stops and Transfer Points

Schedule adherence is important for all transit users. However, in small urban and rural areas it is very common for transit systems to have headways of 30 minutes or longer, making this parameter even more important to those users. Early departures or late arrivals clearly reduce the confidence among users in the viability of public transportation and discourage new users from relying on it as their primary mode of travel.
• **Accurate Transit Schedules**

The transit system should have reliable and readily accessible published timetables. Accurate timetables allow passengers to properly time their arrival at a stop and closely match their travel needs to the arrival of a specific transit vehicle.

• **Accessible Real-time Vehicle Arrival Information**

Disseminating real-time vehicle arrival information to users for all periods of the day when service is available provides additional benefits over published schedules and give a heightened comfort factor to users. Passengers may make informed decisions regarding whether to wait at a stop, use the available time for other tasks, seek alternate transportation, or walk to their destinations.

• **Online Schedule Information**

The proliferation of computers, cellular phones, personal digital assistants (PDAs) and similar wireless technologies has resulted in an increasing number of transit users that have anywhere/anytime access to travel-related information. Therefore, transit schedules and real-time arrival information can be posted online, further enhancing the ability of passengers to adjust their travel schedules and reduce waiting time.

• **Simple Online/Phone Systems For Making Demand Responsive Transit Requests**

Demand responsive transit systems allows passengers to access information and make transportation requests in a number of easy ways. These can include requests over the phone or using Internet-based applications. Using these technologies, passengers can enter their demand responsive transit requests through an online form or even through an automated voice menu using the telephone.

**NEEDS OF PUBLIC/GOVERNMENT AGENCIES**

• **GOVERNMENT ENTITIES**

  • **Efficient Transportation System through Better Transit Services**

Competitive alternate modes of transportation make the entire transportation system (including highways, freeways and street networks) more efficient and effective. All government entities responsible for transportation systems in the nation are interested in using APTS technologies to make transit a truly competitive alternate mode of transportation.

  • **Improved Reporting Accuracy**

Automatically generated reports, using real-time (or near real-time) information on performance, ridership and revenues improves the accuracy of transit service reports. These reports and data assist regulatory agencies in efficiently allocating funding, and facilitate the mandatory reporting required by the Federal Transit Administration (FTA). Furthermore, information derived from an APTS solution can be used to improve transit services and positively affect regional planning efforts. They may facilitate access to additional funds for transit investments. Long-term data provides a “target rich” environment when assessing transit system performance over time.
• OPERATING AGENCIES

• Simple Mechanism to Improve Schedule Adherence

Providing drivers with ready access to route and schedule performance information facilitates better schedule adherence. Improved schedule adherence greatly improves the transit user’s confidence that buses will arrive on schedule.

• Automated Logging of Information

Current small urban and rural transit systems often rely heavily on drivers to collect various system and operational data by hand. This frequently requires additional effort when drivers start and end their services, run their routes, board passengers, and fuel their vehicles. In some cases, it may even require additional personnel. Implementing automated data collection tools relieves the workload of drivers, improve the collection of data and minimize the need for temporary staffing in this area.

• Improved Security and Safety

Transit vehicle operators and passengers benefit from a safer transportation experience if there is a method to easily and discreetly send a request for emergency assistance when there is a serious threat or dangerous situation on board the transit vehicle.

• Enhanced Fleet Management Capabilities

By knowing real-time information regarding the current location of all fleet vehicles through technologies like Automatic Vehicle Location System (AVL), dispatchers and operators are able to manage fleets of transit vehicles more efficiently. This information helps them better coordinate mechanical service calls, substitute transit vehicles in the event of malfunctions, replace drivers, and respond to requests for information. Dispatchers have a better understanding of current vehicle operations with respect to travel time, travel speed, vehicle spacing, and schedule adherence. AVL also allows dispatchers to respond more accurately and quickly to emergency situations.

• Ability to Ensure More Appropriately Spaced Bus Arrivals at Stops

An unintentional platoon of closely spaced transit vehicles operating on the same route and arriving at the same stops in close proximity significantly reduces the overall efficiency of bus service. APTS can help transit vehicles maintain assigned schedules, proper spacing and consistent headways to improve route efficiency and reduce bottlenecks.

• Easily Generated Performance Reports

Typically, transit providers must produce various reports detailing daily, weekly, monthly, quarterly or annual operations. They benefit from systems that automate this tedious and labor-intensive reporting task. Many of the newer APTS solutions can be instructed to automatically generate these reports to meet the specific reporting needs of the agency.
**FIRST RESPONDER NEEDS**

- **Improved Response to “Mayday” Requests**

  When drivers request emergency assistance, a system enabling dispatchers to alert local emergency providers with accurate vehicle location information is a crucial element of a prompt response.

  AVL applications enable emergency responders to locate affected vehicles with minimal delay. Wireless communication technologies make it simpler for operators and dispatchers to coordinate safety issues with the police department, fire department and emergency responders.
DEVELOPING OPERATIONAL SCENARIOS

A good way to communicate benefits to decision-makers is to create operational scenarios that describe how stakeholders will use APTS and the benefits they will receive. Operational scenarios are important in the final APTS design by showing how the parts of the system work together as a whole to improve the transit experience for various stakeholders. They can also serve as the basis for developing user manuals and acceptance test plans for the system. Finally, the scenarios are useful tools for vendors to verify that the APTS system design they propose satisfy the stakeholder needs and expectations, both now and in the future.

Defining stakeholders’ needs and developing operational scenarios is a small, but important, step in the Federal Highway Administration (FHWA) Systems Engineering process. This process is important for reducing the risk of schedule and cost excesses and increasing the likelihood that implementation meets user’s needs. Adherence to this process is also necessary when certain funding sources are used.


Table 3 provides a summary of the process of developing operational scenarios.

Table 3. Developing Operational Scenarios

| Objectives | ▪ High-level overview of how stakeholders interact with the new APTS system  
|            | ▪ Clear understanding of the benefits of APTS through improved passenger, driver, and transit agency experiences |
| Sources of information | ▪ Stakeholder list  
|            | ▪ Needs assessment  
|            | ▪ Broad stakeholder input (through surveys, direct feedback, etc.)  
|            | ▪ APTS components descriptions |
| Key activities | ▪ Using sample scenario tables to show how an APTS system improves the transit experience for your agency, drivers, passengers and any other stakeholders.  
|            | ▪ Note the benefits that each stakeholder receive.  
|            | ▪ Link each scenario to a list of the APTS components needed for that scenario (see The EDAPTS Approach: an overview, for an example of how to present these scenarios). |
| Results | ▪ A set of clearly defined scenarios, user benefits, and APTS components needed (see following example scenario tables). |

The following sample scenarios show how an APTS works during typical daily operation. Using a sample list of potential stakeholders, operational scenarios are presented to describe how the trip experiences of each group improve following an APTS implementation. It is important to note that transit agencies may choose part (i.e., one or more) of the APTS systems included in the EDAPTS approach that meet their unique needs.
SAMPLE SCENARIOS

In this section, a template for the creation of scenarios is provided, followed by a set of sample scenarios from the perspectives of passengers, drivers, and dispatch personnel. While the following scenarios often involve multiple stakeholders, they are organized based on which stakeholder is the main actor.

SCENARIO TEMPLATE: FOR TRANSIT AGENCY USE

<table>
<thead>
<tr>
<th>SCENARIO A</th>
<th>Describe the experience stakeholder(s) will have with some part of an APTS system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit</td>
<td>Describe how this scenario improves the stakeholder experience</td>
</tr>
<tr>
<td>Stakeholders involved</td>
<td>List all stakeholders involved in the scenario</td>
</tr>
<tr>
<td>EDAPTS elements needed</td>
<td>List the components or APTS technologies required for this scenario</td>
</tr>
</tbody>
</table>

PASSENGER SCENARIOS

<table>
<thead>
<tr>
<th>SCENARIO 1A</th>
<th>A passenger walks to a bus stop and sees that the bus will not arrive for 4 minutes. He or she has time for a quick cup of coffee.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit</td>
<td>Provides real-time information to waiting passengers giving them peace of mind as well as an opportunity to make better use of wait time. Passengers are more satisfied with the quality of service provided.</td>
</tr>
</tbody>
</table>
| Stakeholders involved | Passenger  
Bus Driver  
Transit Manager |
| APTS components needed | Dynamic Roadside Information Sign  
Advanced Vehicle Location (AVL)  
Dispatching Software  
Mobile Data Terminal (MDT)  
Wireless Data Communication |
### SCENARIO 1B

A passenger wants to know when the next bus is expected to arrive at his/her regular stop. The passenger accesses information via internet or telephone. The information displays that the bus will arrive in 20 minutes allowing plenty of time for the passenger to walk to the bus stop.

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Passenger minimizes wait time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Decreases passenger stress</td>
</tr>
<tr>
<td>Stakeholders involved</td>
<td>Passenger</td>
</tr>
<tr>
<td>APTS components needed</td>
<td>Dispatching Software</td>
</tr>
<tr>
<td></td>
<td>Advanced Vehicle Location (AVL)</td>
</tr>
<tr>
<td></td>
<td>Mobile Data Terminal (MDT)</td>
</tr>
<tr>
<td></td>
<td>Wireless Data Communication</td>
</tr>
<tr>
<td></td>
<td>Public Website and/or Automated Phone Systems</td>
</tr>
</tbody>
</table>

### SCENARIO 1C

A passenger does not have exact change for the bus fare. The passenger is able to purchase a fare/pass using the electronic payment system at the bus stop before the bus arrives.

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Reduces boarding time because money is not exchanged while boarding the bus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduces labor associated with counting and collecting money</td>
</tr>
<tr>
<td></td>
<td>Improves customer experience</td>
</tr>
<tr>
<td>Stakeholders involved</td>
<td>Passenger</td>
</tr>
<tr>
<td></td>
<td>Driver</td>
</tr>
<tr>
<td></td>
<td>Dispatcher</td>
</tr>
<tr>
<td>APTS components needed</td>
<td>Electronic Payment System (EPS)</td>
</tr>
<tr>
<td></td>
<td>Mobile Data Terminal (MDT)</td>
</tr>
</tbody>
</table>
## DRIVER SCENARIOS

<table>
<thead>
<tr>
<th>SCENARIO 2A</th>
<th>A driver arrives at a stop. The MDT displays the bus stop location to the driver and automatically counts down the time until scheduled departure from the stop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit</td>
<td>Improved schedule adherence Drivers feel more comfortable and relaxed due to automatic countdown Passengers benefit from buses that are on-time</td>
</tr>
<tr>
<td>Stakeholders involved</td>
<td>Driver Dispatcher Passenger</td>
</tr>
<tr>
<td>APTS components needed</td>
<td>Mobile Data Terminal (MDT) Dispatching Software Central Site Software Automatic Vehicle Location (AVL) Wireless Data Communication</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SCENARIO 2B</th>
<th>A driver arrives for his/her shift. The MDT screen allows the driver to log in with his/her name and the bus’ odometer reading.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit</td>
<td>Decreased labor needed to input driver logs and bus mileage data Eases the production of operational reports These reports can help: • Fulfill funding requirements • Assist with future scheduling • Improve efficiency • Justify budget changes</td>
</tr>
<tr>
<td>Stakeholders involved</td>
<td>Driver Dispatcher Transit Manager</td>
</tr>
<tr>
<td>APTS components needed</td>
<td>Mobile Data Terminal (MDT) Dispatching Software Central Site Software</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SCENARIO 2C</th>
<th>A driver notices a disruptive passenger on board the bus and feels as though the situation is about to become dangerous. The driver discretely presses the emergency actuator, alerting central dispatch. The dispatcher can coordinate with emergency responders by providing accurate real-time location information.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit</td>
<td>Allows discrete communication when radio communication is not possible Improves emergency response time due to location information</td>
</tr>
</tbody>
</table>
| Stakeholders involved | Driver  
|                      | Passenger  
|                      | Dispatcher  

**APTS components needed**
- Emergency Actuator  
- Dispatching Software  
- Central Site Software  
- Automatic Vehicle Location (AVL)  
- Mobile Data Terminal (MDT)  

| SCENARIO 2D | A driver arrives at a stop; the automatic passenger counter (APC) counts passengers as they board and get off the bus.  

| Benefit | Reduces drivers’ workload and stress  
|         | Drivers can focus on passenger needs and safety  
|         | Decreased manpower for ridership counts  

| Stakeholders involved | Driver  
| APTS components needed | Automatic Passenger Counter (APC)  
|                        | Mobile Data Terminal (MDT)  
|                        | Wireless Data Communication  
|                        | Central Site Software  

**DISPATCH PERSONNEL AND TRANSIT MANAGERS**

| SCENARIO 3A | Dispatch personnel and transportation managers use mileage data, arrival and departure times, and driver information to generate reports.  

| Benefit | These reports can help:  
|         | • Fulfill funding requirements  
|         | • Assist with future scheduling  
|         | • Improve efficiency  
|         | • Justify budget changes  

| Stakeholders involved | Passenger  
|                      | Driver  
|                      | Dispatcher  
|                      | Transit Manager  
|                      | Regulatory body  

| APTS components needed | Automatic Vehicle Location (AVL)  
|                       | Mobile Data Terminal (MDT)  
|                       | Central Site Software  
|                       | Dispatching Software  

By choosing from the above list of operational scenarios and customizing them to meet your specific needs, the benefits of the improvements you envision can be easily communicated to community members and decision-makers. These operational scenarios are also displayed in picture form in Appendix V. Depending on what format is most comfortable, these can easily be made into a slideshow to present to decision-makers.
CONCLUSION

This guide helps a transit agency navigate the first steps toward APTS procurement. These steps include:

- **Getting familiar with APTS:** Find out ways that APTS can work for you! Many small urban and rural transit agencies have not considered using APTS technologies because of funding, procurement and technical challenges. These technologies, though, offer unique benefits to small urban and rural transit agencies. Some important benefits include real-time arrival notification for buses that may only come once or twice per hour and an emergency notification system that helps protect drivers and passengers on routes in remote areas.

- **Identifying Stakeholders:** Get people involved! Receiving input from many people and groups takes a lot of time, but it is an investment in the future success of the APTS deployment. When people get involved in the visioning process they have “buy-in” and the community can start to share a common understanding of the goals of the system changes.

- **Assessing Needs:** What is needed? This is a basic, yet critical, question to ask. Keeping APTS deployment low cost is essential and the first way to do this is through an accurate needs assessment. This will ensure that money and time is not wasted on needless systems. Also important, is prioritizing these needs. It may be that not all of the system improvements can be accomplished at once, so keeping a list of priorities is a good way to make long-term improvements.

- **Developing Operational Scenarios:** Communicate the benefits of APTS! While transit managers and operators may agree on what systems to implement, it is often the case that an external body, such as a city council or regional planning board, has to be convinced. One way to do this is with operational scenarios. These scenarios demonstrate the ways in which APTS functions and the benefits that are received by each stakeholder. They should be easy to understand, making it a good way to present system improvements to decision-makers.

There are many tools and resources located in this document for getting started with APTS procurement. For more information and technical assistance, please contact the California Center for Innovative Transportation by email at ccitdesk@calccit.org or by phone at 510-642-4522.
APPENDIX I: RECOMMENDED APTS SYSTEMS

This is a quick reference that describes various APTS components that can increase efficiency of transit operations, improve passengers’ experience, and improve reliability and safety for rural and small urban transit systems. This information is an important reference when deciding which, if any, improvements to implement.

**VEHICLE ON-BOARD SYSTEM**

Vehicle On-Board components include the equipment and software elements installed in a transit vehicle. These may include:

1. **MOBILE DATA TERMINAL (MDT)** – the device that allows the driver to access schedule adherence status, collects passenger-boarding counts, records time of day and route being driven, etc. The MDT is connected to other elements of the Vehicle On-board System and to the Central Transit Management System via on-board communication links.

2. **EMERGENCY ACTUATOR** – the device used by drivers to send an emergency message to the dispatcher/manager. A button is typically installed near the driver’s seat so the driver can press it without alerting anyone on the transit vehicle.

3. **ON-BOARD AUDIO ANNUNCIATOR** – the device that automates the announcement of stops and other information to passengers while onboard the vehicle.

4. **ELECTRONIC PAYMENT SYSTEM (PASS/FARE MEDIA READER)** – the device that reads and validates passes and other electronic fare payment (EFP) media.

5. **ON-BOARD ELECTRONIC SIGN** – one or more electronic signs that display dynamic messages to passengers within the vehicle.

6. **AUTOMATIC PASSENGER COUNTER (APC)** – the device that automatically counts passengers boarding the vehicle. It may also count passengers getting off the vehicle.

**ROADSIDE SYSTEM**

These are APTS components installed along transit routes or at vehicle stops. The roadside system typically includes an electronic, remotely-controlled display that presents information regarding estimated time of arrival of buses to passengers waiting at transit stops. These may include:

1. **DYNAMIC ROADSIDE INFORMATION DISPLAY (DRID)** – the device providing real-time information regarding vehicle arrival, based on transit vehicle progress along route.

2. **SOLAR POWER SOURCE** – an autonomous power option for the DRID to allow mounting at remote stops where AC line voltage is not available.
CENTRAL SYSTEMS

The Central Transit Management System components generally include Central Site Software that allows communication among the various APTS components. It may also include an Advanced Transit Management System (ATMS). ATMS are consoles that display vehicle location information and help transit dispatch personnel and system managers conduct effective real-time management of the transit system. These consoles can provide assistance in data collecting and storing (e.g., boarding counts and ridership information), driver information management, statistical analysis, and preparation of various operational reports.

1. **TRANSIT VEHICLE TRACKING** – powered by Automatic Vehicle Location (AVL) systems, this is a key component allowing transit agencies to monitor the location of vehicles. The location data may be used to determine schedule adherence and update the transit system’s schedule in real-time. Information regarding bus location and time is collected and displayed using the AVL and Central Site Software.

2. **DISPATCHING SOFTWARE** – the interactive software that provides a Graphical User Interface (GUI) for transit dispatchers and managers. It allows dispatchers and managers to communicate with and manage the vehicles and roadside displays. The capabilities provided by this software typically include real-time vehicle location, fleet management, schedule adherence displays, and emergency management.

3. **CENTRAL SITE SOFTWARE** – the software that runs at a fixed, central location to receive, transmit, store, and facilitate the exchange of data between other components. It typically communicates with on-board and roadside components. It also collects, stores, and retrieves real-time system data for the analysis of schedule adherence and provides Application Programming Interfaces (APIs) to dispatching software.

TRAVELER INFORMATION SYSTEM

Transit operators may choose to provide real-time information to travelers. Information can come in many forms and allows passengers to make better decisions regarding their travel plans.

1. **TRAVELER INFORMATION SERVICES** – This disseminates information on fixed bus schedules, real-time bus arrivals at specific stops, and passenger load status using the Internet, telephone, individual personal digital assistants (PDAs), text messaging service, etc.

DATA COMMUNICATIONS

The data communication system needs wireless capability to allow communication between the vehicle’s on-board system and central dispatch. In some limited instances, wired communication may be used. The information typically transferred includes bus location, stop arrival and departure times, boarding information, etc.

1. **WIRELESS DATA COMMUNICATION** – data transmission via radio, Wi-Fi, cellular, or other means, to provide the communication links among different components. This may require a wireless data communication system in the vehicles as well as a roadside wireless infrastructure.

2. **WIRED COMMUNICATION** – data transmitted between the roadside display and central dispatch may use existing telecommunications infrastructure to transmit data.
The components listed above are a set of recommended APTS technology. While there are many systems listed, it is not an exhaustive list. When customizing a unique APTS, additional systems may be needed to better fit a transit agency’s specific needs. Information about additional APTS can be found at http://www.itsoverview.its.dot.gov/TM.asp.
Stakeholder Assessment Worksheet

The following worksheet is designed to help you identify the stakeholders that interact with your specific transit system.

Traveling Public

1. How many people reside in your service area? ______________

2. Do you have a fixed route bus system? Yes_____ No_____ (if no, please skip to #5)

3. How many fixed route riders do you have in an average month? ______________

4. Are there specific groups that are serviced by the fixed route system (i.e. a university students or hospital patients)? If so please list them below.

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

5. Do you have a demand response system? Yes_____ No_____ (if no, please skip to next section – Operating Agencies)

6. How many demand response riders do you have in an average month? ______________

7. Are there specific groups that are serviced by the demand response system? If so please list them below.

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Operating Agencies

1. Who is responsible for day to day operations of your transit system (could include public agencies or private entities under contract)?

____________________________________________________________________________
____________________________________________________________________________

____________________________________________________________________________
2. Locally, which of the following groups are involved in your transit system planning, operations and maintenance:

☐ Transit authority in the city government
   Name of the transit authority _________________________

☐ Department of Public Works

☐ City Council

☐ County Commission/Council

☐ City Planning Department

☐ County Planning Department

---

**Other Agencies**

1. Do you have transit police or do you rely solely on public law enforcement to respond to non-medical emergencies?

☐ Transit Police Force ________________________________

☐ Public Law Enforcement ______________________________

2. How do you receive technical support?

☐ External contract with a consultant organization _________________________

☐ On-going service contract with original vendor ____________________________

☐ I have internal technical support

3. Do you have any external funding? ____________

4. If yes, where does this transportation funding come from (e.g. FTA, Caltrans, Earmarks, etc)?
   List all of your sources.

-------------------------------------------------------------------------------------

All of the entities identified above are the stakeholders of your transit system!
Needs Assessment Worksheet

This worksheet is designed to capture input from passengers and end users.

Please answer the following questions to the best of your ability

1. I use public transportation
   a) Very often
   b) Somewhat often
   c) Rarely
   d) Never

2. I use a dial-a-ride or demand response bus
   a) yes
   b) no

3. I ride a fixed route bus
   a) yes
   b) no

4. Why do you choose to use public transportation?
   a) Public transportation is convenient
   b) I do not own a car
   c) cost of driving is too expensive
   d) Other (please specify)____________________________
5. On a daily basis what causes the greatest inconvenience? (Please mark the level of inconvenience in the boxes next to the statements)

<table>
<thead>
<tr>
<th></th>
<th>Very inconvenient</th>
<th>Inconvenient</th>
<th>Somewhat inconvenient</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buses that do not arrive on-time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not knowing when the bus will arrive at the bus stop</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The line to get on the bus is long and moves slowly</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I’m on the bus I’m not sure which stop is next</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following section is designed to help you prioritize between different technologies that could improve your transit experience. It is important to keep in mind your specific needs when responding to the options. To complete this section read both option 1 and option 2 and indicate which option you prefer by checking the box next to it.

<table>
<thead>
<tr>
<th></th>
<th>Option 1 “I would rather...”</th>
<th></th>
<th>Option 2 “Or...”</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Have real-time bus arrival information</td>
<td>![ ]</td>
<td>![ ]</td>
<td>Have electronic payment capability</td>
<td>![ ]</td>
</tr>
<tr>
<td>Have electronic payment capability</td>
<td>![ ]</td>
<td>![ ]</td>
<td>Have automatic passenger counting</td>
<td>![ ]</td>
</tr>
<tr>
<td>Have automatic passenger counting</td>
<td>![ ]</td>
<td>![ ]</td>
<td>Have real-time bus arrival information</td>
<td>![ ]</td>
</tr>
<tr>
<td>Receive bus arrival information from a website</td>
<td>![ ]</td>
<td>![ ]</td>
<td>Receive bus arrival information from a text message</td>
<td>![ ]</td>
</tr>
<tr>
<td>Receive bus arrival information from a text message</td>
<td>![ ]</td>
<td>![ ]</td>
<td>Receive bus arrival information from a sign at the bus stop</td>
<td>![ ]</td>
</tr>
<tr>
<td>Receive bus arrival information from a sign at the bus stop</td>
<td>![ ]</td>
<td>![ ]</td>
<td>Receive bus arrival information from a website</td>
<td>![ ]</td>
</tr>
<tr>
<td>Have next stop information displayed on a sign in the bus</td>
<td>![ ]</td>
<td>![ ]</td>
<td>Have an automatic annuciator that announces the next stop on the bus</td>
<td>![ ]</td>
</tr>
</tbody>
</table>
6. Please use the space to indicate any improvements you’d like see to your transit system

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
APPENDIX IV: NEEDS ASSESSMENT WORKSHEET- TRANSIT PERSONEL

Needs Assessment Worksheet

The worksheet is designed to capture input from those people that work for/with your transit system.

Please answer the following questions to the best of your ability

1. How long have you worked for the transit agency/authority?
   a) 0-2 years
   b) 2-5 years
   c) 5-10 years
   d) 10 years or more

2. I am a
   a) bus driver
   b) transit manager
   c) dispatcher
   d) technical staff
   e) maintenance staff
   f) emergency personnel
   g) Other (please specify): __________________________

3. Our transit system has
   a) fixed route bus system
   b) demand response vehicles
   c) both demand response and fixed route systems
   d) Other (please specify): _________________________

4. Do you use the transit system?
   a) yes
   b) no

5. If yes, then why do you choose to use public transportation?
   a) Public transportation is convenient
   b) I do not own a car
   c) cost of driving is too expensive
   d) Other (please specify): __________________________
6. While you are at your job what causes the greatest inconvenience? *(please mark the level of inconvenience in the boxes next to the statements)*

<table>
<thead>
<tr>
<th>Statement</th>
<th>Very inconvenient</th>
<th>Inconvenient</th>
<th>Somewhat inconvenient</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keeping buses on-time and evenly spaces</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recording the number of passengers as they board the bus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stressful situations involving unruly passengers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inputting ridership data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Writing reports</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trying to schedule new routes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managing unexpected breaks for drivers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managing cash from bus fares</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other <em>(please specify)_</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Please use the space to indicate any improvements you’d like see to your transit system

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
**APPENDIX V: OPERATIONAL SCENARIOS THROUGH PICTURES AND GRAPHICS**

### Morning start-up

**7:30am**
- **EVENT 1**
  - Joe finishes breakfast and checks his local transit website to see if his bus will be on time. It should arrive at his stop in 35 minutes.

**7:45am**
- **EVENT 2**
  - Mira arrives at the bus depot for her morning route. She walks out to the bus, turns it on, and inspects it. On the Mobile Data Terminal (MDT) screen she logs in by selecting her name and entering the current odometer reading.

**8:00am**
- **EVENT 3**
  - Sean, the transit agency dispatcher/manager, has powered up his dispatching console and monitors the system map and fleet status table.

**8:15am**
- **EVENT 1**
  - Joe walks to the bus stop and looks at the dynamic message sign.
- **EVENT 2**
  - When the bus reaches 5mph the MDT display shows only the current time to avoid distracting Mira from her driving.
  - When Mira arrives at the first stop, the MDT displays her location and counts down to departure time.
  - Before leaving the lot she confirms her assigned route on the MDT. The MDT uses Global Positioning System (GPS) to log the date, time, and bus location, and the information is sent to Central Dispatch. She heads in the direction of her first stop.
  - The system map updates bus locations every minute. The fleet status table updates whenever a bus operator arrives, stops or takes a break at a stop along the route.

**ARRIVALS**
- Rte 55 04 min
- Rte 22L 12 min

**ROUTE OPERATOR STATUS LAST STOP NEXT STOP**
- 55  Mira S.  On route Rose Garden Collins
- 22L  Luis R.  On break Kellogg W. City Hall
- 07  Fred C.  On route Prince St. 4th St.
- 01  Jeff Z.  On route Main St. State St.
Daily Operations

9:30am 9:40am 9:50am 10:00am

**EVENT 1**
Sarah, a student at the local community college, is walking and late for class. She calls the transit hotline and learns that a bus will arrive at a stop close to her current location in 10 minutes.

**EVENT 2**
Mira needs a restroom break but her next scheduled break is in 1 hour. She radios in a request to take a break at the Sunny St. bus stop, which she will approach in 15 minutes.

**EVENT 3**
Fred, driving Route 7, gets a cell phone call. His wife is going to the hospital to deliver their first baby! He uses his two-way radio to contact dispatch and request a substitute driver.

Sean receives the break request on his dispatching console and accepts the request.

Mira uses the MDT to update the status of her bus to “On Break,” then gets off the bus to use the restroom.

Eight minutes later she resumes her route.

Sean sees Mira’s “On Break” message. The message signs at other stops on the route are updated to reflect this slight delay.

Sean answers the radio communication, sees the current location of the bus on his monitor, and looks up a list of available substitute drivers.

Sean tells Roy, an available substitute, to meet the bus at the Grand Ave. stop in 10 minutes.

Roy receives Sean’s call and heads to the stop. The dynamic message sign at the stop indicates that the bus will arrive in 2 minutes. Fred logs out and Roy logs in. The MDT shows the next stop and when to start.

She walks to the stop, catches the bus, and is on time for class.

Passengers

Drivers

Dispatcher
Demand Responsive Transit

Linda, an elderly resident, needs to make an unexpected trip to the doctor. She calls the automated demand-response hotline and selects “1” to schedule round-trip service.

She speaks her start and end address and punches in the time and date of pickup. She receives an automated voice confirmation the shuttle will pick her up at 12:30pm the same day.

Jerry, one of two demand-response drivers is finishing up another trip when he gets a radio call from Sean about Linda's trip. He says he should be able to make it in time and agrees to take on the trip.

Once his last trip is complete Jerry heads to Linda’s home. The MDT logs his previous and current trip time and distance.

Sean sees Linda’s request come through the automated phone system on his dispatching console and assigns a driver and a wheelchair accessible van to her trip.
EVENT 1
One particular passenger is harassing the driver and other passengers, making it uncomfortable for those on board.

Luis asks the passenger to exit the bus. When the passenger does not exit and the situation escalates, he presses the Emergency button near his leg.

Sean is alerted to the emergency via audio-visual alarms on the dispatch console. The bus is put into “tracking mode” and its GPS location is reported every 15 seconds. An on-screen dialog walks Sean through the proper response sequence.

Luis receives a radio call from Sean and answers a coded question to confirm the situation. Based on his response, the appropriate emergency response person arrives quickly and takes care of the situation.

EVENT 2
Mira, who is almost finished with her shift, radios in a mechanical error. She waits at the Pleasant St. stop because she is nervous about continuing to drive.

A substitute driver takes out another bus to Mira’s location. He selects the bus stop from the MDT and is directed on where to go. Mira logs out of the other bus and gets a ride back to the office with the tow truck.

After chatting with Mira on the radio, Sean decides to take the bus out of service. He checks the fleet status table on the dispatching console, chooses an available bus to replace the bad one, and calls a tow truck for Mira’s bus.

Sean then has an available driver in the office bring out the new bus to Mira. He generates an automated incident report once the substitute driver has replaced the driver and the bus.

Passengers on Mira’s bus are kept informed of the situation. Most wait for the replacement bus to arrive, since it will be only a few minutes. Dynamic message signs at other stops are updated with the delay.

Unplanned Events

1:00pm
- One particular passenger is harassing the driver and other passengers, making it uncomfortable for those on board.

1:15pm
- Luis asks the passenger to exit the bus. When the passenger does not exit and the situation escalates, he presses the Emergency button near his leg.

1:30pm
- Sean is alerted to the emergency via audio-visual alarms on the dispatch console. The bus is put into “tracking mode” and its GPS location is reported every 15 seconds. An on-screen dialog walks Sean through the proper response sequence.

1:45pm
- Luis receives a radio call from Sean and answers a coded question to confirm the situation. Based on his response, the appropriate emergency response person arrives quickly and takes care of the situation.

- Mira, who is almost finished with her shift, radios in a mechanical error. She waits at the Pleasant St. stop because she is nervous about continuing to drive.

- A substitute driver takes out another bus to Mira’s location. He selects the bus stop from the MDT and is directed on where to go. Mira logs out of the other bus and gets a ride back to the office with the tow truck.

- After chatting with Mira on the radio, Sean decides to take the bus out of service. He checks the fleet status table on the dispatching console, chooses an available bus to replace the bad one, and calls a tow truck for Mira’s bus.

- Sean then has an available driver in the office bring out the new bus to Mira. He generates an automated incident report once the substitute driver has replaced the driver and the bus.

- Passengers on Mira’s bus are kept informed of the situation. Most wait for the replacement bus to arrive, since it will be only a few minutes. Dynamic message signs at other stops are updated with the delay.
Sean decides to run reports from the dispatching console for information on the shopping center routes. He clicks on Ride Report and chooses daily, monthly and yearly passenger loading and delay reports.

**EVENT 1**
A new shopping center has opened but the buses serving the area only arrive once an hour. Passengers form long queues waiting for the bus, especially in the afternoons and on weekends. One passenger calls to request more frequent service.

**EVENT 2**
Throughout the day, Jeff enjoys having the new MDT on his bus coordinate departure times. He no longer worries about maintaining proper spacing with other buses on the same route. He presses a passenger counter button on the MDT each time a rider boards. This helps with reporting and route maintenance. He used to record this information manually with pencil and paper.

He also checks for service requests posted on the local website and through phone calls. The route to the shopping center is consistently over-capacity, and there is high demand for more frequent service.

Sean navigates to Schedule Maintenance and selects the “ADJUST” button. The system provides a recommended new bus schedule based on the patterns of delay and passenger load of buses on that route.

He selects the revised schedule and prints it for review at the next Board meeting. He will propose these changes to the routes, which, when ready, will be easily updated using the dispatching console.
Luis, after finishing his route, reports to dispatch that the magnetic card reader was having some small problems during the day.

Sean calls the qualified dispatching vendor of the card reader, who has a contract to assist with maintenance. The vendor is able to walk Sean through the mechanics of fixing the reader.

Passengers boarding Luis’ bus are having problems using their smart transit cards. They have to swipe their cards several times before it is registered.
End of day tasks... & a bright EDAPTS future!

**EVENT 1**
Sarah is getting ready to leave the office for the day and gets a text message on her cell phone indicating the arrival of the next bus home. Instead of waiting in the rain, she leaves the office to catch the bus right when it arrives.

**EVENT 2**
At the last stop of his 8-hour shift, Jeff drives the bus to the fueling station at the lot. The MDT determines that the shift is over using its standard clock and GPS, and records the deadhead miles.

While refueling, Jeff selects the “Fueling” function on the MDT and enters in the number of gallons filled and the bus’ odometer reading. This information is logged and kept for monthly reports.

At the bus lot, before leaving for the day, he selects “End Shift” from the MDT and is logged out of the system.

**EVENT 3**
In a neighboring city, a transit manager has seen how well EDAPTS works and is interested in purchasing certain components of the system. He navigates to the EDAPTS website and fills out information about his agency.

The web application determines the product package that best fits his agency’s needs, possible funding sources, and a list of certified vendors with contact information that can sell him the products and help implement the solution.

End of day tasks... & a bright EDAPTS future!

<table>
<thead>
<tr>
<th>5:10pm</th>
<th>5:30pm</th>
<th>5:45pm</th>
<th>6:00pm</th>
</tr>
</thead>
</table>

**Passengers**

**Drivers**

**Dispatcher**
MEMORANDUM

THE EDAPTS APPROACH: FUNDING MECHANISM

DECEMBER 2008

PREPARED FOR: CALIFORNIA DEPARTMENT OF TRANSPORTATION

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OVERVIEW

As an ongoing project, the Efficient Deployment of Advanced Public Transportation Systems (EDAPTS) seeks to help small urban and rural transit agencies implement innovative technologies that can improve their daily transit operations and management.

EDAPTS is an Approach that effectively guides small urban and rural transit agencies through the process of acquiring Advanced Public Transportation System (APTS). EDAPTS approach offers a procurement methodology and a set of tools that facilitate the implementation of APTS specifically for small urban and rural transit providers. The principle of the EDAPTS approach is to “buy only what you can afford and really need now, but buy adaptable solutions that can grow as you and your needs change.” For more information about EDAPTS approach, please see The EDAPTS Approach: Defining Project Needs.

The EDAPTS approach offers resources and tools to assist small urban and rural transit agencies at various processes of APTS implementation as described in the diagram. One critical process is to obtain funding for the implementation.

The direct audiences of this memo are current and future team members of EDAPTS project, as well as the decision makers in California Department of Transportation (Caltrans) or other entities. However, the main body of the memo can be easily converted to satisfy transit agencies’ needs. For instance, the proposed EDAPTS Website can present a lot of information in the memo as a comprehensive online funding resource tool. Small urban and rural transit agencies will be able to browse technology related funding sources based on their own characteristics and needs.

Within the context of helping small urban and rural transit agencies identify funding for APTS implementation and operations, the memo is organized as follows:
PURPOSE OF FUNDING SOURCE INVESTIGATION

As the Market Assessment memo determined, the most significant barriers to APTS implementation faced by small urban and rural transit agencies are the lack of funding, staffing, and technical skills. Therefore, the funding source investigation explores resources that specifically focus on helping small transit agencies identify feasible funding sources that they should consider for offsetting capital and operational costs of APTS implementation.

The purpose of this funding research is to investigate funding sources at the federal, state and local levels for APTS implementation. It also highlights more suitable funding sources from the small urban and rural transit agencies’ perspective. This information helps lay the groundwork for the Final Operational Test (FOT) in the final phases of the EDAPTS project and provides helpful insight for the possible future establishment of an EDAPTS-specific funding mechanism at the state or regional level.

In order to gain a clear understanding of the funding mechanism for technology deployments, the following tasks have been undertaken.

- First, a variety of funding sources for public transportation, at federal, state, and local levels have been reviewed and categorized. Some innovative funding means (e.g. public-private partnerships) are also included.

- Among the public transportation funding sources reviewed, sources that can be used for APTS implementation and operations are summarized in the attached reference document. (Please see Exhibit I: APTS Related Funding Sources for more information).

- Based on the characteristics of the identified funding sources and typical characteristics of small transit providers, some funding sources are more suitable for small transit APTS implementation and operations. These are filtered and highlighted in the attached reference document. (Please see Exhibit I: APTS Related Funding Sources for more information).

- The project team also researched the funding application process for the State of California. This has been summarized for small transit providers in a clear, but compact, “How to Apply” guide in the attached reference document (Please see EXHIBIT II: Funding Application Process for more information).

- Additionally, an initial version of an APTS related funding resource guide for small urban and rural transit agencies is presented in a separate document The EDAPTS Approach: Funding Mechanism (1st edition).

While most agencies are well aware of the funding streams available to them, we aim to shape their thinking to recognize the opportunities they have to purchase technology with different sources of funding that are already available to them. Our goal is that EDAPTS can be tied to a specific funding mechanism under state purview, a topic that would be addressed in subsequent iterations of the funding resources guide.

This memo will be updated to reflect future changes in the authorized funding mechanisms for transportation, as driven by changes in State and Federal legislation. Changes will also be made based on the lessons learned from the future phases of the EDAPTS project, for example, the Final Operational Test.
SUMMARY FINDINGS

As an important step in the EDAPTS approach, this funding memo documents funding sources for small urban and rural transit agencies for potential APTS implementation and operations. The following is a summary list of findings:

- Overall, there are a variety of funding opportunities available to public transportation agencies, including small urban and rural transit agencies. Funding opportunities can come from federal, state, local, or even private entities. Almost all the funding sources have time constraints, either for the application process or for funding availability. Different grant programs have different requirements for eligibility, e.g., maximum federal share, minimum fare-box recovery rate, etc.

- No existing funding sources from either public or private entities exclusively support innovative technology implementation and operations in the public transportation field. The current practice in APTS implementation and operations is to seek funding support from the same sources as general capital and operations funding for transit systems.

- The reality of funding APTS implementation from existing sources has put more pressure on transit agencies, especially smaller ones, because technology related funding has to compete with the ongoing service needs, vehicle procurement, and other capital and operational needs of a transit system.

- Many transit boards and managers place a lower priority on APTS implementation compared to general operations and capital funding needs, even though they are looking into innovative APTS to improve the ongoing performance and productivity of their transit services. This causes a funding scarcity for technology solutions and results in less APTS implementation.

- In the “Highlighted Funding Sources section”, a number of funding sources have been identified as more suitable for APTS implementation and operations. Most of the selected funding sources support both capital investments and operating costs for technology deployment, and a majority of them are suitable for both fixed-route and demand-responsive transit services.

- A brief “How to Apply” guide is provided for small urban and rural transit agencies in Exhibit II. It provides a quick review on the process of submitting a public transportation related funding application in California.

RECOMMENDATIONS

The EDAPTS team makes the following recommendations:

- Considering the fact that there are not any existing funding sources exclusively supporting technology implementation and operations, and given that the funding application process is very competitive and very complex, we recommend that EDAPTS be tied to a specific funding mechanism under the State purview.

- Involve California Association for Coordinated Transportation (CalACT) in the funding support process for small urban and rural transit systems. This involvement is ideal because CalACT is a statewide, non-profit
organization that represents the interests of small, rural, and specialized transportation providers in California. CalACT is mainly funded using the federal grant program – rural transit assistance program (RTAP). Most of smaller transit agencies in the EDAPTS market assessment study indicate that they like the idea of teaming up with other agencies to deploy APTS technology. Utilizing help from CalACT to identify suitable funding mechanisms could significantly reduce staff time and effort for small transit agencies during APTS procurement cycles.

- It is crucial to market EDAPTS to small urban and rural transit agencies with useful and systematic information and tools, such as *The EDAPTS Approach: Overview, The EDAPTS Approach: Defining Your Needs, EDAPTS Website*, etc., to help agencies:
  
  o Understand the real benefits of lower cost APTS technology solutions;
  
  o Identify their specific technology needs based on the operational needs of their own transit system;
  
  o Present their system needs and the benefits of potential technology solutions effectively to their decision makers and others.

By doing this, transit boards/managers will be motivated to perceive technology as a higher priority so that they can improve the efficiency and performance of their transit system at an affordable cost.
EXHIBIT I: APTS RELATED FUNDING SOURCES

Generally, public transportation is funded from federal, state, and local taxes, fees and assessments. However, transit agencies also are able to receive and utilize funds from private investment\(^1\) sources. Although there are a variety of funding sources available, there are still important reasons to specifically investigate technology related funding sources\(^2\), especially for small transit agencies. As indicated by researchers and practitioners\(^3\):

- It is typically hard for small urban and rural transit agencies to seek funding for APTS implementation and operations, because funding sources suitable for technology are the same sources for operations and capital funding. Therefore, APTS needs must compete with the ongoing service, vehicle, and other capital needs of a transit system.

- At the same time, because of funding scarcity, many transit boards and managers tend to perceive technology needs as secondary to operations and capital funding needs.

Considering these factors, the EDAPTS approach includes an investigation of technology related funding as an important task in helping small and rural transit agencies with APTS implementation and operations.

Research has highlighted funding sources that small urban and rural transit agencies can best utilize to deploy innovative technologies and these are summarized in the following sections. References are also listed to guide readers to more detailed information about these funding opportunities.

GENERAL FUNDING SOURCES RELATED TO APTS

Funding sources related to public transportation at different jurisdiction levels are generally described in this section. Specifically, sources that can be linked to possible APTS implementation and operations for small urban and rural transit providers are highlighted.

FEDERAL LEVEL FUNDING SOURCES

Typically, there is financial support for public transportation at the federal level. The Internal Revenue Service (IRS) collects the federal fuel excise tax, part of which is designated for transit usages. Current legislation supporting federal fuel tax allocation is the SAFE, ACCOUNTABLE, FLEXIBLE, EFFICIENT TRANSPORTATION EQUITY ACT: A LEGACY FOR USERS (SAFETEA-LU), providing $286.4 billion in guaranteed funding for federal surface transportation programs over five years through FY 2009, including $52.6 billion for federal transit programs.

The Federal Transit Administration (FTA) of the U.S. Department of Transportation (USDOT), is the entity that administers and allocates these federal fuel tax revenues to regional agencies and local transit providers. One major way FTA helps support public transportation is by issuing grants to eligible recipients for planning, vehicle purchases, facility construction, operations, and other purposes. In these grant programs, FTA apportions funds

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\(^1\) Transportation Funding in California. California Department of Transportation. 2007.

\(^2\) Here, technology related funding sources are referred as any transit funding sources that are eligible for technology investment or maintenance.

\(^3\) TCRP Report 76 (Chapter 4). Federal Transit Administration. 2002.
according to formulas and/or earmarks. FTA offers the on-line Transportation Electronic Award Management (TEAM) system for application and management of grants.

Generally, FTA grants are only available to public bodies (i.e. states, cities, towns, regional governments, transit authorities, etc.) with the legal authority to receive and dispense federal funds. The recipients of these grants are held responsible for managing their projects in accordance with federal requirements. FTA conducts on-going oversight reviews to ensure that these requirements are met.

Considering possible usages related to APTS implementation and operations for small urban and rural transit agencies, a list of grant programs sponsored by the FTA is included in the Appendix I: Federal Level Funding Sources. Each grant program is referred to by name and by a number that correlates to the section number of Title 49 of the United States Code.

It should be noted that many of these federal grant programs have their own allocation and matching mechanisms, and often include a minimum requirement on local share percentage. These requirements should be carefully considered when applying for any specific funding source.

For more information, please see:
Appendix I: Federal Level Funding Sources;
http://www.fta.dot.gov/grants_financing.html;

STATE AND LOCAL LEVEL FUNDING SOURCES

State and local funds are two other major sources that may include support for capital investment and operational assistance of public transportation. Generally, taxes and fees are the chief revenue sources for state and local transit funds. As previously noted, state and local funds may be mandatory prerequisites for utilizing federal level transit funds.

Since many “state level” funds are actually collected on behalf of local jurisdictions, we will discuss both state and local level funding sources in the same section. These state funds are typically assigned back to the local level based on the proportion of population, land area, or number of registered vehicles in the areas being served.

In California, the California Transportation Commission (CTC) and Caltrans’ Division of Mass Transportation (DMT) are the two major state government entities administrating and allocating state level transit funds. Additionally, Metropolitan Planning Organizations (MPOs) and Regional Transportation Planning Agencies (RTPAs) are also responsible for planning, coordinating and administering funds for regional transportation systems, including public transportation.

A detailed discussion of the state and local level funding sources is provided in Appendix II: State and Local Level Funding Sources. Again, features that might be tied to possible APTS implementation and operations are marked. Examples of typical fund sources include the ¼ percent of the state sales tax designated as a Local Transportation Fund (LTF), proposition bonds at the state level, local sales tax measures, and local transit fares.

For more information, please see:
Appendix II: State and Local Level Funding Sources;
http://www.dot.ca.gov/hq/MassTrans/.
OTHER ALTERNATIVE FUNDING SOURCES

There are many possible alternative funding sources that transit providers can use to fund technology related implementation and operations. These sources exist at federal, state, local level, or even private entities. Some approaches include approval as a FTA Demonstration Project; participating in the Flexed Federal Highway Administration Program, utilizing unique local funding sources, and establishing public-private partnerships. For instance, small transit agencies can often partner with local businesses who can provide revenue through the purchase of specific services, sponsorships, advertising, or donations.

However, these funding sources tend to be more competitive compared to standardized grant programs. They may not be traditionally used for transit projects, and may require more staff time and resources to pursue them as alternative funding sources. All these factors make alternative funding sources challenging for most small urban and rural transit agencies. Therefore, the involvement of higher tier entities, such as Caltrans DMT, MPOs, or RTPAs, to “team up” with a group of small urban and rural transit agencies who have similar technology needs, might be an effective, efficient and beneficial solution for finding small transit technology funding.

For more information, please see:

HIGHLIGHTED FUNDING SOURCES RELATED TO APTS

Obtaining funding is still one of the most significant barriers faced by small transit agencies in implementing and operating APTS. This is because:

- There is a lack of technology specific funding sources for transit systems. As mentioned before, funding for technology implementation commonly comes from the same sources as operations and capital funding, and has to compete with all the ongoing needs of a transit system.

- Without outside resources and support, small transit agencies typically lack the internal staffing, time and resources to research a long list of funding sources, seek innovative ways to finance their technology needs and they are simply unable to package and administer multiple funding sources simultaneously.

Therefore, it is very helpful for small transit agencies to have a short list of funding sources that are connected to APTS implementation and operations. In the following section, funding sources that are more suitable for technology deployment are filtered and highlighted based on characteristics of the different funding sources and the characteristics of small urban and rural transit systems. For each of these funding sources, the major characteristics that might be important to these transit agencies are pointed out. The following chart shows the highlighted funding sources.
Whenever possible, we have clearly identified funds that are available for specific purposes (i.e., capital, operating, and maintenance cost). Also, many small transit agencies operate both fixed route and demand responsive transit services, so funding sources that can be specifically used for demand responsive transit services are identified. These types of services have additional funding sources available to them due to their distinctive service characteristics.

With regard to these highlighted funding sources, input from other interested parties (e.g., the EDAPTS project team, public transportation practitioners from Caltrans DMT, or transit providers themselves) will help shape future iterations of this funding document. As a strategy, CCIT believes that is important to consider the establishment of an EDAPTS-specific funding mechanism at the state or regional level to facilitate future APTS deployments for small urban and rural transit systems.

**FEDERAL GRANT PROGRAM – TITLE 49 UNITED STATES CODE**

**FEDERAL GRANT PROGRAM – SECTION 5311 RURAL AND SMALL URBAN AREAS**

Title 49 of the US Code, Section 5311 is a federal grant program that specifically assists small urban and rural areas in their public transportation services. Through this federal grant program, funds are apportioned to every state using a statutory formula. Major factors of the statutory formula include the non-urbanized population and land area of the states. Major characteristics of this 5311 grant program, from the small transit agencies’ perspective and within the context of APTS implementation and operations, are listed as follows:

- Specifically targets small urban and rural transit providers – The main objective of this program is to support public transportation in areas with a population less than 50,000.
- Suitable for both capital investment and operating costs – Funds may be used for capital, operating, and administrative purposes.
- Suitable for both fixed-route and demand-responsive transit services.
- State and/or local shares are required:
  - For **capital** and **project administration**, the maximum Federal share is **80 percent**.
  - For **operating assistance**, the maximum Federal share is **50 percent** of the net operating costs.
  - Projects that meet the requirements of the **Americans with Disabilities Act (ADA)**, the Clean Air Act, or bicycle access projects, may be funded at a **90 percent** Federal match.

- Special opportunities for rural intercity bus service – It is required that states must spend 15 percent of the apportionment to support rural intercity bus service unless the Governor certifies, after consultation with affected intercity bus providers that the intercity bus needs of the state are adequately met.

- Eligible Recipients – state transportation agencies, local/regional public bodies, Indian tribes, non-profit organizations, and public transit agencies.

*For more information, please see:*
  
  Appendix I;  
  [http://www.fta.dot.gov/funding/grants/grants_financing_3555.html](http://www.fta.dot.gov/funding/grants/grants_financing_3555.html);

### FEDERAL GRANT PROGRAMS – SECTION 5310 & 5317

Title 49 of the US Code, Section 5310 and 5317 are specific federal grant programs that provide funding to states for meeting the transportation needs of human services (e.g., the elderly and persons with disabilities). With respect to APTS, these funding programs can be utilized for technology implementation and operations among demand-responsive transit services, since technology could significantly improve their efficiency.

*For more information, please see:*
  
  Appendix I;
  [http://www.fta.dot.gov/funding/grants/grants_financing_3556.html](http://www.fta.dot.gov/funding/grants/grants_financing_3556.html);

### STATE FUND – LOCAL TRANSPORTATION FUND

In California, the 1971 Transportation Development Act (TDA) earmarked ¾ percent of the state sales tax for a wide variety of transportation programs, including public transportation and transit services. Accordingly, a Local Transportation Fund (LTF) was created in each county to receive the money. According to the 2005 Survey of State Funding for Public Transportation⁴, LTF has been the primary source of state transit funds in California. Important features and requirements related to technology deployment in small transit environments are listed as follows:

- Established by the 1971 Transportation Development Act (TDA). More flexible than federal level grants but less flexible than local level funds.

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⁴ Department of Transportation (DOT) and Bureau of Transportation Statistics (BTS). Survey of State Funding for Public Transportation. 2005.
Suitable for both capital investments and operating expenditures – LTF can be more effectively used for operating assistance than federal funds since federal grants are generally designed to be used for capital investments rather than operating costs.

Suitable for both fixed-route and demand-responsive transit services.

Provides leverage for federal funds that require a minimum state/local share.

Requires minimum fare-box ratios and local support to qualify for funding:

- A transit agency must maintain a ratio of fare revenues to operating cost at least equal to the ratio it had during 1978/79, or a minimum of 10 percent if the agency is in a non-urbanized area, whichever is greater.

- For service that is provided for elderly and handicapped persons, the RTPA may adopt by resolution any performance criteria, local match requirement, or fare recovery ratio it desires.

Mandated Public Participation - Public participation is a key component of TDA. Activities of public participation include having public meetings and establishing Social Service Transportation Advisory Councils (SSTACs), to hear concerns, discuss transportation needs, and make project approval decisions.

Eligible Recipients – state and regional transportation agencies, local public bodies, public transit agencies.

For more information, please see:
Appendix II;

STATE FUND – STATE TRANSIT ASSISTANCE FUND AND PUBLIC TRANSPORTATION ACCOUNT

Another major source of funding for public transportation provided by TDA is the State Transit Assistance (STA) fund, which, is derived from the statewide sales tax on gasoline and diesel fuel. STA funds are appropriated by the California legislature to the State Controllers office. For some cases, STA funds are also referred as Public Transportation Account (PTA).

STA funds share the same features and requirements as LTF when small transit agencies want to utilize them for APTS implementation and operating purposes.

For more information, please see:
Appendix II;

LOCAL FUND – FARE REVENUES

For small urban and rural transit agencies, fare revenues are relatively small when compared to overall expenditures. However, they play a very important role in the overall funding and financing for public transportation systems. Since major state public transportation funds, LTF or STA funds require a minimum fare-
box recovery rate, they can affect the agency’s eligibility to meet the state/local match for most federal level grant programs. Therefore, most small transit agencies need to maintain, if not improve, their fare-box recovery rates.

Based on our survey of small urban and rural transit agencies, most (about 90%) met the 10% recovery rate requirement to qualify for LTF or STA funds. However, for the remaining ten percent, proactive action is required to find alternate funding solutions when applying for state and federal level funds. For example, they could try to raise local support money to meet the ratio or they could apply for exemptions if their services are mainly provided to individuals covered by the Americans with Disabilities Act (ADA) or other special categories.

**LOCAL FUND – LOCAL SALES TAX MEASURES**

In California, counties are authorized to adopt up to 1% sales tax increase for transportation programs, subject to voter approval. According to Caltrans, nineteen counties have approved sales tax measures for transportation and four transit authorities have approved permanent local tax measures in 2007.

Due to the maximum flexibility of funds provided at the local level, these funds might be more suitable for small transit agencies to target for lower cost APTS implementation and operations. These funds are suitable for both capital investment and operating costs, and can cover both fixed-route and demand-responsive transit services needs.

*For more information, please see:*  
[http://www.leginfo.ca.gov/const/article_13B](http://www.leginfo.ca.gov/const/article_13B) for Article XIIIIB of the State Constitution, which provides the authority and requirements for the imposition of local sales tax measures subject to voter approval.
EXHIBIT II: FUNDING APPLICATION PROCESS

Oftentimes, applying for public transportation funding is a complex and time-consuming process. It costs significant staff time, requires considerable effort and must be done by individuals having knowledge of the funding sources to be accessed. The following section will help small urban and rural transit providers navigate the funding application processes with a clear, but compact, “How to Apply” guide.

ENTITIES INVOLVED

Before looking at the detailed funding application process, it is helpful to understand all the entities that might be involved in the overall funding application process:

- Federal Transit Administration (FTA) – In most instances, small urban and rural transit agencies don’t need to have direct interaction with FTA. This is because most federal level grant programs that are suitable for small transit agencies are directly administrated by state level transportation agencies. In California, this function is provided by Caltrans.

- California Transportation Commission (CTC) – CTC consists of nine members appointed by the Governor, One of its primary responsibilities is to program and allocate funds for transit improvements throughout California.

- Division of Mass Transportation (DMT) at Caltrans – DMT’s primary responsibility is the administration of state and federal grant programs that provide funding for operating assistance and capital improvements. There are designated personnel in both Caltrans Headquarters and Caltrans District offices to help transit agencies find and apply for funding.

- Metropolitan Planning Organizations (MPO) and Regional Transportation Planning Agencies (RTPA) – are responsible for assisting transit agencies find and apply for funding and have increased knowledge of regional opportunities.

- Local transit agencies – are the applicants and receivers of funds based on their current and future needs of transit services.

- California Association for Coordinated Transportation (CalACT) – CalACT is a statewide, non-profit organization that represents the interests of small, rural, and specialized transportation providers in California. It is mainly funded using the federal grant program through the rural transit assistance program. Small urban and rural transit agencies should consider approaching CalACT for help and information on funding issues.

For more information, please see:
http://www.catc.ca.gov/mission.htm;
http://www.dot.ca.gov/hq/MassTrans/AboutUs.htm;
http://www.calact.org/.
FUNDING APPLICATION PROCESS

Generally, local transit agencies play the most important role in the funding application process, because most funding requests are initiated at the local level. At the same time, help and support from other entities is very important in preparing a successful funding application. As the Caltrans’ transit funding handbook indicates, the funding request process includes:

- The city, county or local transit agencies submit the request through the Regional Transportation Planning Agencies (RTPA) or Metropolitan Planning Organizations (MPO).
- The RTPA/MPO then forwards the request to relevant Caltrans’ District Office.
- The District staff works closely with the RTPA/MPO and requesting agency to ensure the completeness and accuracy of the request.
- The request is then forwarded to Caltrans Headquarters for final review by Division of Mass Transportation staff. Different program offices review specific requests, so it would be in the requesting agencies’ best interest to clearly specify which assistance program(s) they are targeting.
- If additional information is needed, Caltrans Headquarters will inform the Caltrans District Office of the information needed. Caltrans District Office will then work with the RTPA/MPO and the requesting agency to provide the information needed.
- If the request is found to be complete, it will be forwarded to the CTC for inclusion on the Commission’s Agenda for approval.

It is important to note that the whole request/application process may take significant amount of time (i.e. a year or more). Local agencies should properly plan and prioritize their transit projects in advance, considering the time and effort needed for approval of their request. Furthermore, an agency must have an executed Master Agreement with Caltrans prior to requesting State funds for a transit project (please see Caltrans’ Transit Funding Handbook for more information).

For more information, please see:
APPENDIX I: FEDERAL LEVEL FUNDING SOURCES

A major way FTA helps communities support public transportation is by issuing funding grants to eligible recipients for planning, vehicle purchases, facility construction, operations, and other transportation related purposes. FTA currently administers this financial assistance using funds made available through SAFETEA-LU5, a federal act that was signed into law in August 2005. Each year Congress provides an annual appropriation to fund the programs specified in SAFETEA-LU. Upon receiving this appropriation, FTA apportions and allocates these funds according to formulas and earmarks.

Generally, FTA funds are available only to designated recipients. These must be public bodies (i.e. states, cities, towns, regional governments, transit authorities, etc.) with the legal authority to receive and dispense federal funds. The recipients of these grants are responsible for managing their projects in accordance with federal requirements. FTA conducts oversight reviews to ensure that these requirements are met.

A list of major grant programs sponsored by the FTA is included with this document. Each grant program is referred to by name and by a number that correlates to the section number of Title 49 of the United States Code. In addition, FTA offers the on-line Transportation Electronic Award Management (TEAM) system6 for application and management of grants.

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5 On August 10, 2005, President Bush signed the SAFE, ACCOUNTABLE, FLEXIBLE, EFFICIENT TRANSPORTATION EQUITY ACT: A LEGACY FOR USERS (SAFETEA-LU), providing $286.4 billion in guaranteed funding for federal surface transportation programs over five years through FY 2009, including $52.6 billion for federal transit programs – a 46% increase over transit funding guaranteed in TEA-21.

### Federal Level Public Transportation Grant Programs and their Potential Usages on EDAPTS Deployment

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<th>SECTION NUMBER</th>
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<th>DESCRIPTION</th>
<th>DOLLAR AMOUNT</th>
<th>ALLOCATION AND MATCHING MECHANISM</th>
<th>APPROPRIATE FOR EDAPTS?</th>
</tr>
</thead>
</table>
| 5303, 5304, 5305 8 | Metropolitan & Statewide Planning | Support cooperative, continuous, and comprehensive planning for making transportation investment decisions in metropolitan areas and statewide.                                                                 | -- US FY08 (est.) $107M 9 | -- Formula  
-- Metropolitan planning organizations (MPO) and state departments of transportation are eligible recipients  
-- The federal share is 80 percent and the local share is 20 percent | These are not actually and practically available to small and rural transit. However, EDAPTS may possibly be introduced in the metropolitan or statewide transportation planning process.                                                                                                                                                                                                                                                                                                                   |
| 5307            | Large Urban Cities | Available to urbanized areas and to Governors for transit capital and operating assistance in urbanized areas and for transportation related planning. An urbanized area is an incorporated area with a population of 50,000 or more that is designated as such by the U.S. Department of Commerce, Bureau of the Census. | -- US FY08 (est.) $3,872M | -- Formula  
-- Division of Mass Transportation (DMT) is designated recipient responsibilities for small urbanized areas (UZAs 10 pop. under 200,000); otherwise MPO | This is not actually and practically available to small and rural transit. However, EDAPTS may possibly apply this program for capital investment of bus and bus-related activities, such as replacement of buses, overhaul of buses, rebuilding of buses, crime prevention and security equipment, and construction of maintenance and passenger facilities, if with a population of 50,000 or more 11.                                                                                                                                                                                                                                                       |

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8 5303 – Metropolitan Planning; 5304 – Statewide Planning; 5305 – Planning Programs.


10 UZA – Urbanized Area

11 Note: All preventive maintenance and some Americans with Disabilities Act complementary paratransit service are considered capital costs.
Federal Level Public Transportation Grant Programs and their Potential Usages on EDAPTS Deployment

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<tr>
<td>5309, 5318</td>
<td>Bus and Bus Facilities</td>
<td>The Bus and Bus-Related Facilities program provides capital assistance for new and replacement buses and related equipment and facilities.</td>
<td>-- US FY08 (est.) $928M</td>
<td>The Secretary has the discretion to allocate funds, although Congress fully earmarks all available funding.</td>
<td>YES. Purchase buses for fleet and service expansion, acquisition of replacement vehicles, bus rebuilds, bus preventive maintenance, passenger amenities (shelters and signs), equipment (mobile radio units, supervisory vehicles, fare boxes, computers).</td>
</tr>
<tr>
<td>5310</td>
<td>Transportation for Elderly Persons and Persons with Disabilities</td>
<td>Provide formula funding to States for the purpose of assisting private nonprofit groups in meeting the transportation needs of the elderly and persons with disabilities when the transportation service provided is unavailable, insufficient, or inappropriate to meeting these needs.</td>
<td>-- US FY08 (est.) $127M</td>
<td>-- Formula</td>
<td>YES (given the following conditions). The EDAPTS system can possibly improve the service of Demand Responsive Transit.</td>
</tr>
</tbody>
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</table>
| 5311           | Rural and Small Urban Areas | Provides formula funding to states for the purpose of supporting public transportation in population areas of **less than 50,000**. Funds may be used for capital, operating, and administrative purposes. | -- US FY08 (est.) $438M  
-- California FY06 $14.6M | -- Formula  
-- DMT is the delegated grantee  
-- 75% Regional Apportionment (distributed to non-urban areas based on population through Transportation Planning Agencies (TPA), deadline - December 31st of each year)  
-- 15% Intercity Bus Program (apportioned to the Intercity Bus Program (FTA 5311(f))).  
-- 10% State Administrative Expenses (distributed to administer both the 5311 & 5311(f) grant funding programs) | YES. EDAPTS can 1) enhance the access of people in non-urbanized areas to health care, shopping, education, employment, public services, and recreation; 2) assist in the maintenance, development, improvement, and use of public transportation systems in rural and small urban areas. |
| 5311(b) | Rural Transit Assistance Program | The Rural Transit Assistance Program (49 U.S.C. 5311(b)) assists in the design and implementation of training and technical assistance projects and other support services tailored to meet the needs of transit operators in non-urbanized areas. | -- 2% of 5311 | -- Administrative formula  
-- DMT administers the California State RTAP program through a contract currently with the California Association for Coordinated Transportation (CalACT), a private non-profit association of transit providers serving the needs of the non-urbanized areas of California. | YES (given the following conditions). In non-urbanized areas, EDAPTS may get training, technical assistance, and research and related support activities through CalACT. |
| 5311(c) | Public Transportation on Indian Reservations | Provide public transportation on Indian reservations through a set aside of Other-Than-Urbanized Area Program funds for direct grants to Indian Tribes. | -- US FY08 (est.) $12M | NA | YES, if EDAPTS concepts are implemented for the benefit of Indian tribes. |

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| Note 2 | http://www.dot.ca.gov/hq/MassTrans/5311.html |
| Note 3 | These two are not consistence within the FTA website. |
| Note 4 | http://www.dot.ca.gov/hq/MassTrans/Rtap.html |
### Federal Level Public Transportation Grant Programs and their Potential Usages on EDAPTS Deployment

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<tr>
<td>5311(f)</td>
<td>Non-Urbanized Area Intercity Bus Program</td>
<td>Promotes intercity transit in the non-urbanized areas of the state</td>
<td>-- California FY08 (est.) $2.9M</td>
<td>NA</td>
<td>YES (given the following conditions). The EDAPTS system can possibly be deployed for intercity transit.</td>
</tr>
<tr>
<td>5314</td>
<td>National Research &amp; Technology Program</td>
<td>The National Research and Technology Program (49 U.S.C. 5314(b)) responds to industry needs by supporting increased transit ridership, security readiness, and effective planning and oversight of major capital investments.</td>
<td>-- US FY04 $31.5M</td>
<td>NA</td>
<td>YES (given the following conditions). EDAPTS can possibly promote development of innovative transit technologies, safety and security research and technical assistance, fundamental data collection and analysis of transit industry performance, policy studies, transportation planning techniques, customer service quality, etc.</td>
</tr>
<tr>
<td>5316</td>
<td>Job Access and Reverse Commute Program</td>
<td>JARC was established as part of TEA-21 to address the unique transportation challenges faced by welfare recipients and low-income persons seeking to get and keep jobs.</td>
<td>-- US FY08 (est.) $156M</td>
<td>-- Annual competitive application process conducted by recipient (state DOT or 5307 entities17)</td>
<td>Yes. The EDAPTS system can be used to help low-income people gain access to jobs.</td>
</tr>
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## Federal Level Public Transportation Grant Programs and their Potential Usages on EDAPTS Deployment

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<td>5317</td>
<td>New Freedom Program</td>
<td>New Freedom Program is a new program authorized in SAFETEA-LU to support NEW public transportation services and alternatives beyond those required by the Americans with Disabilities Act (ADA) of 1990 (42 U.S.C. 12101 et. seq.).</td>
<td>-- US FY08 (est.) $87.5M</td>
<td>capital projects and 50 percent for operations projects.</td>
<td>YES. A new EDAPTS system can improve the service for individuals with disabilities.</td>
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<td></td>
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<td>-- California FY08 (est.) $3.2M</td>
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<td></td>
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<td></td>
<td>-- California FY08 (est.) $1.3M</td>
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<tr>
<td>5320</td>
<td>Alternative Transportation in Parks and Public Lands</td>
<td>The program funds capital and planning expenses for alternative transportation systems such as shuttle buses and bicycle trails in national parks and public lands.</td>
<td>-- US FY08 (est.) $25M</td>
<td>NA</td>
<td>YES (given the following conditions). EDAPTS can be possibly deployed in national parks and public lands.</td>
</tr>
<tr>
<td>TEA-21 5505</td>
<td>University Transportation Centers Program</td>
<td>Grants for university transportation research (49 U.S.C. 5505) are awarded to non-profit institutions of higher learning by the Research and Special Programs Administration (RSPA) using funds appropriated to FTA. This program focuses on the transfer of knowledge relevant to national, state, and local issues, and builds professional capacity of the transportation workforce.</td>
<td>-- US FY04 $6M&lt;sup&gt;18&lt;/sup&gt;</td>
<td>The Federal share is 50 percent.</td>
<td>YES (given the following conditions). EDAPTS might be qualified for this if universities/researchers can develop a standardized “EDAPTS Deployment Training” course for general or specific training of EDAPTS.</td>
</tr>
</tbody>
</table>

<sup>18</sup> [http://www.fta.dot.gov/funding/grants/grants_financing_3547.html#funding](http://www.fta.dot.gov/funding/grants/grants_financing_3547.html#funding)
## Federal Level Public Transportation Grant Programs and their Potential Usages on EDAPTS Deployment

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<td></td>
<td>Flexible Funding for Highway and Transit</td>
<td>Flexible funds include Federal Highway Administration (FHWA) Surface Transportation Program (STP) funds, Congestion Mitigation and Air Quality Improvement Program (CMAQ), and Federal Transit Administration (FTA) Urban Formula Funds. When FHWA funds are transferred to FTA they are transferred to one of the following three programs: -- Urbanized Area Formula Program (5307); -- Nonurbanized Area Formula Program (Section 5311 program); -- Elderly and Persons with Disabilities Program (Section 5310 program).</td>
<td>NA</td>
<td>Formula</td>
<td>Yes. The program funds can be used for a variety of transit improvements, which EDAPTS can achieve. In detail, EDAPTS can use the funds to purchase buses, install advanced technology fare collection systems, and increase ridership (to reduce congestion).</td>
</tr>
</tbody>
</table>
APPENDIX II: STATE AND LOCAL LEVEL FUNDING SOURCES

STATE AND LOCAL LEVEL TRANSIT FUNDS IN GENERAL

In addition to federal funds and fare revenues, state and local funds are used to support capital investment and operational assistance in public transportation. In some cases, state and local funds are mandatory prerequisites for utilizing federal level transit funds. This occurs when there is a grant requirement for a minimum contribution share from state or local funds.

Generally, taxes and fees are the chief sources of state and local transit funds. For example, Vuchic\(^\text{19}\), in his book “Urban Transit Operations, Planning, and Economics”, has listed three categories of taxes and charges that can be dedicated for transit use:

- Transportation user taxes and charges: e.g., fuel and motor vehicle taxes, parking tax, tools and area entry fees;
- Economic benefit-related taxes and charges: e.g., employer payroll or occupational tax, real estate value increment tax;
- Broad-based taxes: e.g., retail sales tax; personal income tax; property (ad valorem) tax;
- Other sources: e.g., excise taxes, etc.

In reality, different cities, counties, states, and transportation districts may have differing combinations of taxes and fees to fund transit services. According to the 2005 Survey of State Funding for Public Transportation\(^\text{20}\), among all 50 states and the District of Columbia (DC),

- The most utilized sources for transit funding were the general fund (used by 19 states), gas taxes (used by 15 states), motor vehicle/rental car sales taxes (used by 9 states), bond proceeds (used by 8 states), registration/license/title fees (used by 8 states), and general sales tax (used by 7 states).
- Twenty-seven states reported that they used other sources for funding such as state highway funds, trust funds, miscellaneous revenues, fees, taxes, lottery funds, tolls, or other types of assessments. Eight of these 27 states relied solely (100% of transit dollars) on these miscellaneous revenue sources.
- However, four reported no state funding for transit was available.

State and local transit funds can typically be used for capital investments, operating assistance, a combination of the two, or other aspects. The 2005 Survey of State Funding for Public Transportation\(^\text{21}\) also showed us that, of those programs (47) providing state transit funding:

\(^{19}\) Urban Transit Operations, Planning, and Economics – Vukan R. Vuchic – Page 413 – Sources of local and state funds for transit
\(^{20}\) Department of Transportation (DOT) and Bureau of Transportation Statistics (BTS). Survey of State Funding for Public Transportation. 2005.
\(^{21}\) Department of Transportation (DOT) and Bureau of Transportation Statistics (BTS). Survey of State Funding for Public Transportation. 2005.
- 66% reported a specific funding allocation for capital expenditures;
- 64% reported a specific funding allocation for operating expenditures;
- 60% reported funding amounts that could be used for either capital or operating expenditures;
- 30% reported funding for planning, training, studies, or other miscellaneous activities.

### STATE LEVEL TRANSIT FUNDS IN CALIFORNIA

California Transportation Commission (CTC) and California Department of Transportation (Caltrans)’ Division of Mass Transportation (DMT) are the two major governmental offices administering and allocating state level transit funds in California. To be more specific, CTC consists of nine members appointed by the Governor, and one of its responsibilities is to program and allocate funds for transit improvements throughout California\(^\text{22}\). The primary responsibility of DMT is the administration of State and Federal Grant Programs that provide funding for operating assistance and capital improvement of public transportation projects\(^\text{23}\).

However, local transit agencies also play an important role in the transit funds application process, because a typical funding request will be initiated at the local level. As the Caltrans’ transit funding handbook listed, the general funding request process includes\(^\text{24}\):

- The city, county or transit agencies submit the request through the Regional Transportation Planning Agencies (RTPA) or Metropolitan Planning Organizations (MPO).
- The RTPA/MPO then forwards the request to associated Caltrans’ District offices.
- The District staff works closely with the RTPA/MPO and requestor to ensure the completeness and accuracy of the request.
- The request is then forwarded to Caltrans Headquarters for final review. Different program offices will only review the corresponding requests, so it would be local agencies’ responsibility to specify which program(s) they are targeting for.
- If additional information is needed, Caltrans Headquarters will inform Caltrans District office in a timely manner.
- If the request is found to be complete, it will be forwarded to the CTC for inclusion on the Commission’s Agenda for approval.

It is important to note that the whole request/application process may take significant amount of time (i.e. one year or more). Local agencies should properly plan and prioritize their transit projects in advance, considering the time and effort needed for approval of their request. Furthermore, an agency must have an

\(^{22}\) [http://www.catc.ca.gov/mission.htm](http://www.catc.ca.gov/mission.htm)
\(^{23}\) [http://www.dot.ca.gov/hr/MassTrans/AboutUs.htm](http://www.dot.ca.gov/hr/MassTrans/AboutUs.htm)
executed Master Agreement with Caltrans prior to requesting State funds for a transit project (please see Caltrans’ Transit Funding Handbook for more information)\textsuperscript{25}.

According to several literature resources (e.g., web resources\textsuperscript{26}, transit funding handbook, Caltrans reports) there is neither a clear nor conclusive answer on which state transit funding programs to use for transit improvement and, in particular, for EDAPTS compliant systems. Therefore, here we list all state funding programs that could be possibly used for transit improvement, as well as their suitability for EDAPTS, based on our best knowledge.

\textsuperscript{25} Caltrans. The Transit Funding Handbook. 2001.
\textsuperscript{26} \url{http://www.dot.ca.gov/hq/MassTrans/} & \url{http://www.catc.ca.gov/programs/}
### State Level Public Transportation Funds and their Potential Usages on EDAPTS Deployment

#### Transportation Development Act (TDA) – general

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<td>-- The Transportation Development Act (TDA) was enacted in 1971 by the California legislatures to improve existing public transportation services and encourage regional transportation coordination. -- TDA provides two major sources of funding for public transportation: the Local Transportation Fund (LTF) and the State Transit Assistance fund (STA). -- The TDA funds a wide variety of transportation programs, including planning and program activities, pedestrian and bicycle facilities, community transit services, public transportation, and bus and rail projects. -- Providing certain conditions are met, counties with a population under 500,000 (according to the 1970 federal census) may also use the LTF for local streets and roads, construction and maintenance. -- The STA fund can only be used for transportation planning and mass transportation purposes. -- Public participation is a key component of TDA, where public hearing process is used to identify unmet transit needs. -- To ensure program compliance, fiscal and performance audits will be conducted.</td>
<td>-- California FY03 $1.3 billion&lt;sup&gt;28&lt;/sup&gt;</td>
<td>NA</td>
<td>See the following two rows for more detail.</td>
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<td>TDA – Local Transportation Fund (LTF)</td>
<td>-- Local Transportation Fund (LTF) is derived from a ¼ percent of the general sales tax collected statewide. -- According to the 2005 Survey of State Funding for Public Transportation, LTF has been the primary source of state transit funds in California.</td>
<td>-- ¼ cent of the general sales tax -- California FY03 $1.2B</td>
<td>Based on sales tax collected in each county, the State Board of Equalization returns the general sales tax revenues to each county’s LTF. <strong>As a result, LTF is often characterized as “local” rather than state funds.</strong></td>
<td>YES. See the row of Transportation Development Act for more detail.</td>
</tr>
<tr>
<td>TDA – State Transit Assistance fund (STA)</td>
<td>-- State Transit Assistance fund (STA) is derived from the statewide sales tax on gasoline and diesel fuel. -- Sometime it is also known as Public Transportation Account (PTA).</td>
<td>-- California FY08 (est.) $225M²⁹</td>
<td>50% of STA funds are allocated according to population and 50% are allocated according to operator revenues from the prior fiscal year.</td>
<td>YES. See the row of Transportation Development Act for more detail.</td>
</tr>
<tr>
<td>State Transportation Improvement Program (STIP)³⁰</td>
<td>-- The STIP is a multi-year capital improvement program of transportation projects on and off the State Highway System, funded with revenues from the State Highway Account and other funding sources.</td>
<td>-- California FY08 (est.) $75M (public transportation purpose)</td>
<td>CTC will review transit agencies’ application, and then approve if qualified. Local government/transit agencies must have the Master Agreement to receive/reimburse project related money.</td>
<td>YES. EDAPTS can use STIP funds for capital investment, and operating assistance purposes. But the local agencies need to work closely with their RTPA/MPO and Caltrans District in order to file the application to CTC beforehand.</td>
</tr>
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</table>

³⁰ [http://www.dot.ca.gov/hq/transprog/ocip/ocip_org.htm](http://www.dot.ca.gov/hq/transprog/ocip/ocip_org.htm)
## State Level Public Transportation Funds and their Potential Usages on EDAPTS Deployment

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<td>Traffic Congestion Relief Program (TCRP) &lt;sup&gt;31&lt;/sup&gt;</td>
<td>-- TCRP provides funding for transportation projects that would relieve congestion, connect transportation systems, and provide for better goods movement.</td>
<td>-- California FY07 $4.9M&lt;sup&gt;32&lt;/sup&gt;</td>
<td>CTC will review transit agencies’ application, and then approve if qualified. Local government/transit agencies must have the Master Agreement to receive/reimburse project related money.</td>
<td>YES. EDAPTS can use TCRP funds for capital investment, and operating assistance purpose, since it can reduce the traffic congestion by promoting transit ridership. But the local agencies need to work closely with their RTPA/MPO and Caltrans District for filing the application to CTC beforehand.</td>
</tr>
<tr>
<td>Proposition 1B - Transportation Bond Program (Prop 1B) &lt;sup&gt;33&lt;/sup&gt;</td>
<td>-- The Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006, approved by the voters as Proposition 1B on November 7, 2006, provides funding for specified purposes, including various transportation related purposes.</td>
<td>-- California $19.925 billion (for 10 years)</td>
<td>NA</td>
<td>YES. See the following rows for more detail.</td>
</tr>
</tbody>
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<sup>31</sup> [http://dot.ca.gov/hq/transprog/ocip/tcrp.htm](http://dot.ca.gov/hq/transprog/ocip/tcrp.htm)


<sup>33</sup> [http://dot.ca.gov/hq/transprog/ibond.htm](http://dot.ca.gov/hq/transprog/ibond.htm)
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<td>Prop 1B – STIP Augmentation / Transportation Facilities Account (TFA)$^{34}$</td>
<td>-- Prop 1B authorized $2 billion in general obligation bond proceeds to be available for projects in the State Transportation Improvement Program (STIP) to augment funds otherwise available for the STIP from other sources. -- Under the Bond Act, the funds shall be deposited in the newly created Transportation Facilities Account (TFA) and shall be available, upon appropriation by the Legislature, in the same manner as other STIP funds.</td>
<td>-- California $2 billion (for 10 years)</td>
<td>See the row of STIP for more detail.</td>
<td>YES. See the row of STIP for more detail.</td>
</tr>
<tr>
<td>Prop 1B – Public Transportation Modernization, Improvement, and Service Enhancement Account (PTMISEA)$^{35}$</td>
<td>-- Authorized by Prop 1B, PTMISEA is a new program comprised of $3.6 billion dollars available to transit operators over a ten-year period. -- Funds are to be used for Public Transportation Modernization, Improvement and Service Enhancements that can include upgrading transit fleets or expanding service to increase ridership and therefore reduce emissions and energy use by reducing the number of single occupancy trips.</td>
<td>-- California $3.6 billion (for 10 years)</td>
<td>The $3.6 billion is to be distributed by formula, based on population and fare-box revenue, to transit operators for capital projects.</td>
<td>YES. EDAPTS can use PTMISEA funds for capital investment$^{36}$, such as equipment purchase, bus fleet expansion.</td>
</tr>
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</table>

$^{34}$ [http://www.dot.ca.gov/hq/MassTrans/Proposition-1B.html](http://www.dot.ca.gov/hq/MassTrans/Proposition-1B.html)
$^{35}$ [http://www.dot.ca.gov/hq/transprog/ocip/ocip_org.htm](http://www.dot.ca.gov/hq/transprog/ocip/ocip_org.htm)
$^{36}$ Note: Eligible project of PTMISEA funds should be capital project (or a minimum operable segment of a project) only.
State Level Public Transportation Funds and their Potential Usages on EDAPTS Deployment

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<tr>
<td>Prop 1B – Local Street and Road, Congestion Relief, and Traffic Safety Account of 2006 37</td>
<td>Funds shall be used for improvements to transportation facilities that will assist in reducing local traffic congestion and further deterioration, improving traffic flows, or increasing traffic safety that may include, but not be limited to, street and highway pavement maintenance, rehabilitation, installation, construction and reconstruction of necessary associated facilities such as drainage and traffic control devices, or the maintenance, rehabilitation, installation, construction and reconstruction of facilities that expand rider ship on transit systems, safety projects to reduce fatalities, or as a local match to obtain state or federal transportation funds for similar purposes.</td>
<td>$2 billion (for 10 years)38</td>
<td>Funds will be allocated, upon appropriation by the Legislature, by formula as specified in Proposition 1B (50% to counties and 50% to cities): 75% of funds apportioned to counties are based on the number of vehicles registered in the county relative to all counties in the State, and 25% are based on number of county maintained road miles relative to all county maintained road miles in the State; Funds apportioned to cities are based on total population of the city in relation to all cities in the State (minimum $400,000 to each city).</td>
<td>YES. EDAPTS can help reduce traffic congestion, potentially expand ridership on transit systems, etc.</td>
</tr>
</tbody>
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37 http://svdtsucp.dot.ca.gov:8084/bondacc/MainMenuAction.do?%3F&page=localstreet
38 http://www.dot.ca.gov/hq/transprog/ibond/Prop_1B_Text.pdf
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<tr>
<td>Proposition 91 – Transportation Funding (Initiative Constitutional Amendment and Statute)39</td>
<td>-- Authorized by Proposition 91 (or currently Proposition 1A), the state intents to ensure those imposed various taxes and fees on motor vehicle fuels and the operation of motor vehicles to be used for supporting transportation program. -- It covers several programs, such as Article XIX Revenues – Fuel Taxes and Motor Vehicle Fees, Sales Tax on Gasoline and Diesel. The later contains two sub-programs: Public Transportation Account (PTA) and Transportation Investment Fund (TIF).</td>
<td>NA</td>
<td>NA</td>
<td>YES. EDAPTS may possibly get financial support from the PTA funds.</td>
</tr>
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</table>

LOCAL LEVEL TRANSIT FUNDS IN CALIFORNIA

Fare revenues play a very important roll in the overall funding and financing of public transportation systems, although, for small urban and rural transit agencies, fare revenues are relatively small when compared to overall expenditures. Second, from local sales tax revenues (see previous section for more details on possible taxes and fees), each local government could allocate substantial funding for transportation improvement, especially for public transportation. As mentioned in above Table, one of the major revenues for local government is the Local Transportation Fund (LTF), which is generated from statewide ¾ percent sales tax and designated only for transportation purpose. Furthermore, local governments have the option of levying an additional local sales tax, upon approval by two-thirds of the voters, for local transportation uses. According to the Legislative Analyst’s Office (LAO) statistic40, there are 19 counties in California who currently impose a local optional sales tax for transportation.

Local level transit funds generally have fewer restrictions in terms of the detailed usage, which means most of local transit funds should be eligible for EDAPTS purpose. However, local transit agencies should work closely with associated RTPA/MPO and Caltrans District for the available local transit funds, and the appropriate application process of local transit funds.

The EDAPTS Approach: Funding Mechanism
The **EDAPTS Approach** is a set of **analytic tools**, a **recommended procurement methodology**, and **information** that facilitates implementation of Advanced Public Transportation Systems (APTS) for small urban and rural transit providers.

EDAPTS is an on-going joint effort between California Department of Transportation, UC Berkeley’s California Center for Innovative Transportation (CCIT), California Polytechnic State University San Luis Obispo, and California Polytechnic State University Pomona.

The **EDAPTS Approach helps** you deploy APTS more efficiently and at a lower life-cycle cost.
What do you need to know, before browsing The EDAPTS Approach: Funding Mechanism?

- Do you know about APTS costs and benefits? If not, please browse *The EDAPTS Approach: Estimate Costs and Benefits* tool.
- Do you know about your APTS needs? If not, please browse *The EDAPTS Approach: Define Project Needs* tool.
- Do you know about The EDAPTS Approach? If not, please browse *The EDAPTS Approach: An Overview* tool.
- If you want to know APTS related funding mechanism? Please keep browsing this tool!
**Funding Application Process – Entities Involved**

**Local transit agencies** – You! The applicants and receivers of public transit funds based on your current and future needs for your transit system.

**Federal Transit Administration (FTA)** – In most instances, you don’t need to have direct interaction with FTA, since most federal level grant programs suitable for small transit agencies are directly administrated by state and/or regional level transportation agencies.

**California Transportation Commission (CTC)** – CTC consists of nine members, all appointed by the Governor. One of its responsibilities is to program and allocate funds for transit improvements throughout California. Typically, you don’t need to have direct interaction with CTC.

**Division of Mass Transportation (DMT)** at California Department of Transportation (Caltrans) – DMT’s primary responsibility is the administration of State and Federal Grant Programs that provide funding for operating assistance and capital improvements. There are designated personnel in both Caltrans Headquarters and Caltrans District offices who can help you find and apply for funding.

**Metropolitan Planning Organizations (MPO) and Regional Transportation Planning Agencies (RTPA)** – These are the primary organizations responsible for assisting you in finding and applying for funding.

**California Association for Coordinated Transportation (CalACT)** – CalACT is a statewide, non-profit organization that represents the interests of small, rural, and specialized transportation providers in California. It is possible for you to approach CalACT and seek help on funding issues.

**California Transit Association** – It is a non-profit statewide organization that retains all of California’s largest urban transit operators, as well as dozens of agencies in suburban and rural areas. It is possibly a good resource for you to seek help on funding.

*Information specific to State of California.*

For more information, please see:
http://www.catc.ca.gov/mission.htm;
http://www.dot.ca.gov/hq/MassTrans/AboutUs.htm;
http://www.calact.org/;
http://www.caltrans.org/.
California Funding Application Process*

- The city, county or transit agencies submit the request through the Regional Transportation Planning Agencies (RTPA) or Metropolitan Planning Organizations (MPO).

- The RTPA/MPO then forwards the request to associated Caltrans’ District offices.

- The District staff works closely with the RTPA/MPO and requestor to ensure the completeness and accuracy of the request.

- The request is forwarded to Caltrans Headquarters for final review. Different program offices review specific requests, so requesting agency should specify which funding program(s) they are targeting.

- If additional information is needed, Caltrans Headquarters will inform the approving Caltrans District office.

- If the request is complete, it is forwarded to the CTC for inclusion on approval.

NOTE: The funding request/application process may take substantial time (i.e. one year or more). Plan and prioritize your transit projects well in advance. You must have an executed Master Agreement with Caltrans prior to requesting State funds for a transit project (please see Caltrans’ Transit Funding Handbook for more information).

For more information, please see:

* Information specific to State of California.
**EDAPTS**

*What to apply for?*

Based on characteristics of different funding sources and features of small transit providers, funding sources* that are more suitable for APTS implementation and operations are shown in the following chart.

<table>
<thead>
<tr>
<th>Federal Level</th>
<th>State Level</th>
<th>Local Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>For both Fixed-Route and Demand-Responsive Transit Services</td>
<td>LTF</td>
<td>Fare Revenues</td>
</tr>
<tr>
<td></td>
<td>STA/PTA</td>
<td>Local Sales Tax Measures</td>
</tr>
<tr>
<td>For Demand-Responsive Transit Services only</td>
<td>5311</td>
<td>5310</td>
</tr>
<tr>
<td></td>
<td>5317</td>
<td></td>
</tr>
</tbody>
</table>

For more funding sources, please refer to the comprehensive list of funding sources in the EDAPTS Approach package.

* Information specific to State of California.
What to apply for? – federal level grant programs

Section 5311 – Rural and Small Urban Areas

- Specifically target small urban and rural transit providers – The main objective of this program is to support public transportation in areas with a population less than 50,000.
- Suitable for both capital investment and operating cost – Funds may be used for capital, operating, and administrative purposes.
- Suitable for both fixed-route and demand-responsive transit services.

- State and/or local shares are required. The maximum Federal share for capital / project administration is 80 percent. For operating assistance the maximum is 50 percent. (Projects that meet the requirements of the Americans with Disabilities Act (ADA), the Clean Air Act, or bicycle access projects, may be qualified for funding at a 90 percent Federal match).

- Special opportunity for rural intercity bus service – States must spend 15 percent of the apportionment to support rural intercity bus service unless the Governor certifies, after consultation with affected intercity bus providers, that the intercity bus needs of the state are already being adequately met.

- Eligible Recipients – state transportation agencies, local/regional public bodies, Indian tribes, non-profit organizations, and public transit agencies.

SECTION 5310 & 5317

There are also specific federal grant programs that provide funding to states for the purpose of meeting the transportation needs of human services, e.g., the elderly and persons with disabilities. With respect to APTS, these funding programs can be utilized for technology implementation and operations among demand-responsive transit services, since technology could significantly improve their efficiency.

For more information, please see:
http://www.fta.dot.gov/funding/grants/grants_financing_3555.html;
http://www.dot.ca.gov/hq/MassTrans/5311.html;
http://www.fta.dot.gov/funding/grants/grants_financing_3556.html;
What to apply for? – state level funds*

Local Transportation Fund (LTF) & State Transit Assistance (STA)** fund

- Established by the 1971 Transportation Development Act (TDA). Primary source of state transit funds in California. More flexible than federal level grants but less flexible than local level funds.

- Suitable for both capital investments and operating expenditures – May be better used for operating assistance, since federal grants are generally more favorable for capital investment use.

- Suitable for both fixed-route and demand-responsive transit services.

- They play an important role by satisfying federal fund match requirements for state/local share.

- Require minimum fare-box ratios and local support requirements to qualify for funding:
  - A transit agency must maintain a ratio of fare revenues to operating cost at least equal to the ratio it had during 1978/79, or 10 percent if the agency is in a non-urbanized area, whichever is greater.
  - A transit agency must maintain a ratio of fare revenues plus local support to operating cost greater than the ratio it had during 1978/79 if its ratio was greater than 10 percent in a non-urbanized area.
  - For service that is provided for elderly and handicapped persons, the RTPA may adopt by resolution any performance criteria, local match requirement, or fare recovery ratio it desires.

- Mandated Public Participation - Public participation is a key requirement of TDA. Public participation includes having public meetings and establishing Social Service Transportation Advisory Councils (SSTACs) to hear concerns, discuss transportation needs, and make project approval decisions.

- Eligible Recipients – state and regional transportation agencies, local public bodies, public transit agencies.

* Information specific to State of California.

** STA funds may be referred to as Public Transportation Account (PTA).

What to apply for? – local level funds*

Local Sales Measures

• In California, counties are authorized to adopt up to 1% sales tax increase for transportation programs, subject to voter approval. Nineteen counties have approved sales tax measures for transportation, and four transit authorities have approved permanent local tax measures, as of 2007.

• Since maximum flexibility in fund use is at the local level, these funds might be better suited for APTS projects at small urban and rural transit agencies. In this case, funds can be used for both capital investment and operating costs at both fixed-route and demand-responsive transit services.

For more information, please see:
http://www.leginfo.ca.gov/const/article_13B for Article XIII-B of the State Constitution, which provides the authority and requirements for the imposition of local sales tax measures subject to voter approval.

Fare Revenues

• Although fare revenues might be relatively small when compared to overall expenditures, they play a very important roll in the overall funding/financing process.

• The major state public transportation fund sources (LTF and STA) require a minimum fare-box recovery rate, and can affect your access to the state/local match funds needed for the federal level grant programs.

• You need to maintain and, if possible, improve your fare-box recovery rates. For example, if your fare-box recovery rate is less than the 10% minimum, you could try to raise local support money to meet the requirement. You can also consider applying for exemptions if you serve individuals covered under the Americans with Disabilities Act (ADA) or other special categories.

* Information specific to State of California.
EDAPTS

For more information please visit
http://www.dot.ca.gov/hq/MassTrans/index.html
http://www.calccit.org/projects/EDAPTS.html
**Benefits Tool**

The *Benefits Tool* Excel file helps you to customize the benefits of Advanced Public Transportation Systems (APTS) to your transit system.

**Instructions**

**Step 1:** Open the *Benefits Tool* Excel file. If you see a MACRO popup, please select “Enable” it. These are due to a version compatibility issue of the Microsoft Office Excel.

**Step 2:** Click on the *Questionnaire* tab located at the bottom of the screen. Fill out those orange color cells located in Column B, which collect information about your transit system, and APTS systems that you would like to include in your system. If you need a reminder about what each system component is, simply click the component name and you will be taken to the description.

**Step 3:** Click on the *Core System Benefits* tab and the *Additional System Benefits* tab for information regarding benefits of APTS to your transit system.

Additionally, the *Benefits by Category* tab provides you with detailed benefits calculation methodology and formula; the *System Descriptions* tab contains definitions of different components of Advanced Public Transportation Systems (APTS); and the *Measures of Performance* tab lists measures of performance that is used in the previous EDAPTS benefit/cost evaluation, which you may use for your own benefit assessment.

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**Cost Tool**

The *Cost Tool* Excel file helps you to customize the cost of Advanced Public Transportation Systems (APTS) to your transit system.

**Instructions**

**Step 1:** Open the *Cost Tool* Excel file. If you see a MACRO popup, please select “Enable” it. This is due to a version compatibility issue of the Microsoft Office Excel.

**Step 2:** Click on the *User Input Data* tab located at the bottom of the screen. Fill out those orange color cells located in Column C, which collect information about your transit system, and APTS systems that you would like to include in your system. If you need a reminder about what each system component is, simply click the component name and you will be taken to the description.

**Step 3:** Click on the *Output* tab for information regarding Cost of APTS to your transit system.

Additionally, the *Cost Data* tab provides you with detailed cost information by various APTS components; and the *System Descriptions* tab contains definitions of different components of Advanced Public Transportation Systems (APTS).
**EDAPTS**

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**Vendor vs. EDAPTS Function**

The Vendor vs. EDAPTS Function Excel file displays vendor information for various components of Advanced Public Transportation Systems (APTS).

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**Instructions**

**Step 1:** Open the *Vendor vs. EDAPTS Function* Excel file. If you see a MACRO popup, please “Enable” it. It is due to a version compatibility issue of the Microsoft Office Excel.

**Step 2:** Click on the *System Components* tab located at the bottom of the screen. Locate the components you are interested in. Components are displayed in the orange row at the top of the page (see the example picture below for more information). If you need a reminder about what each component is, simply click the component name in the orange band and you will be taken to the description.

**Step 3:** Filter the list so that you can view vendors that supply the components you are interested in. For example: if you are interested in Mobile Data Terminal (MDT), click the drop-down arrow, select "X" for Text Filters, and then click OK. Vendors that supply MDTs will be filtered to the top of the list.

**Step 4:** Next find vendor contact information located in the *Vendor Contact Information* tab. Contact information includes websites (when available) and can be accessed by clicking on the web address, if you are connected to the internet.

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*This example picture was generated in the version of Microsoft Office Excel 2007. If you are using a different version of Excel, the display of worksheet in your computer may slightly different from what’s been shown here.*
MEMORANDUM

MARKET ASSESSMENT FOR EDAPTS

OCTOBER 2008

PREPARED FOR: CALIFORNIA DEPARTMENT OF TRANSPORTATION

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OVERVIEW

As an ongoing project, the Efficient Deployment of Advanced Public Transportation Systems (EDAPTS) seeks to help small urban and rural transit agencies implement innovative technologies that can improve their daily transit operations and management. Previous stages of the EDAPTS project are listed as follows:

- In 1998, the Federal Transit Administration (FTA) and the California Department of Transportation (Caltrans) teamed up with California Polytechnic State University at San Luis Obispo (Cal Poly SLO) and the City of San Luis Obispo Transit (SLO Transit) to investigate ways to make APTS more affordable for the small transit operator and to provide lower cost system growth and enhancements over time.

- In 2007, Caltrans asked the California Center for Innovative Transportation (CCIT), along with Cal Poly SLO and California Polytechnic State University at Pomona (Cal Poly Pomona) to compile a comprehensive body of knowledge that could be utilized by any small urban or rural transit agency to deploy APTS more efficiently and at a lower life-cycle cost. The project includes research, testing, and deployment.

The CCIT project team has defined EDAPTS as an Approach that effectively guides small urban and rural transit agencies through the process of acquiring Advanced Public Transportation System (APTS). So, the concept of EDAPTS is not an individual APTS, but rather a procurement methodology and a set of tools that facilitate the implementation of APTS specifically for small urban and rural transit providers. The key principle of the EDAPTS approach is to “buy only what you can afford and really need now, but buy adaptable solutions that can grow as you and your needs change.” For more information about EDAPTS approach, please see The EDAPTS Approach: Defining Project Needs.

The EDAPTS approach offers resources and tools to assist small urban and rural transit agencies at various stages in the APTS procurement process. At the same time, it’s very useful to conduct market assessment for EDAPTS, which validates the need of continuing EDAPTS project and exposes the issues we need to address in the EDAPTS project. Corresponding research findings and recommendations are documented in this Market Assessment for EDAPTS memo.

Note that the direct audience of the memo is made up of current and future team members of EDAPTS project, as well as high level decision makers in California Department of Transportation (Caltrans) or other entities. However, results and findings from the market assessment study can also be used by other parties. For instance, the list of potential adopters of EDAPTS in California might be used by potential suppliers to estimate the size of their market based on their own attributes (e.g., cost, manufacturing ability, distributing ability, etc.). The memo is organized as follows:
OBJECTIVES AND METHODOLOGY

The objective of this market assessment is to investigate the target market for EDAPTS. Specifically, we sought to

- identify the characteristics of the target market
- identify the need for APTS in smaller markets of varying sizes
- learn transit agencies’ perceptions of innovative technology applications on their transit environments
- identify the barriers to the implementation of APTS.
- establish a list of qualified potential adopters of EDAPTS in California.

In order to gain a clear understanding of the EDAPTS market, the CCIT project team utilized several survey techniques: face-to-face interviews, a focus group, and online surveys.

- Face-to-face interviews with smaller transit providers were used to gain a broad understanding of their basic characteristics, needs, barriers, and their interest in APTS technologies. Please see EXHIBIT 1: FACE-TO-FACE INTERVIEWS for more details.

- A technology-related survey was developed by the research team and administered through an online survey distribution mechanism. The two main objectives of the online technology survey were 1) gain more insight into transit agencies’ opinions about APTS technologies; and 2) identify a group of small transit providers who would be willing to participate in a follow-up focus group discussion. Please see EXHIBIT 2: ONLINE SURVEY AND FOCUS GROUP DISCUSSION for more details.

- A focus group discussion was held via teleconference. The open discussion allowed the research team to gather direct input from small transit providers in terms of technology implementation, related barriers, and their concerns about EDAPTS project. Please see EXHIBIT 2: ONLINE SURVEY AND FOCUS GROUP DISCUSSION for more details.
Additionally, the research team compiled a list of transit agencies in California for EDAPTS marketing purposes. The project team developed the list by aggregating information from several sources. Multiple approaches were then used to verify and update the list, including: transit agencies’ annual reports, the Internet, email contact, phone contact, etc. Please see EXHIBIT 3: CALIFORNIA TRANSIT AGENCY LIST FOR EDAPTS MARKETING for more details.

The deliverable for this task is this market assessment memo, which documents the project team’s findings.

**SUMMARY FINDINGS**

The following findings/issues were discovered through analysis of the face-to-face interviews, online surveys, focus group discussion, and assembly of the transit agency list:

**CHARACTERISTICS OF THE TARGET MARKET**

- Most small transit agencies operate both fixed routes and demand-responsive transit service; therefore, it is important for a successful and efficient EDAPTS project to consider both types of operations.

- Study results imply that there are generally more small urban transit providers than rural ones, which could be one factor for EDAPTS to take into account when prioritizing the procurement and commercialization strategies.

- Financially, a large portion of studied transit agencies, including smaller ones, have reached 10% of fare-box recovery rate (fare revenue/operating expense), which is a requirement to receive most of the federal and state level funding sources. However, few agencies maintained a fare-box recovery rate over 40%, indicating that a majority of transit providers heavily rely on outside financial support for their daily transit service.

**TRANSIT AGENCIES’ PERCEPTIONS OF TECHNOLOGY AND THEIR NEEDS FOR APTS**

- Most of the transit agencies are looking into innovative APTS application to improve the performance and productivity of their transit services, as well as to minimize administrative-related workload (e.g., automated report generating).

- A wide range of technology components have been implemented at small and rural California transit agencies. There is a general trend of an increasing technology implementation rate associated with the increasing fleet size of transit agencies.

- Almost all types of APTS technologies are of great interest to transit agencies, especially to smaller transit agencies. Even those that have already implemented some APTS technologies are still interested in beginning or continuing implementation of more technologies.

- Few agencies had heard of the EDAPTS project but most of them were interested in possible deployment activities if they could observe demonstrated benefits at other agencies. Concerning the EDAPTS deployment structure, agencies are mostly interested in a flexible system that they can mold to fit their needs.
• Agencies noted the importance of integrating existing technology components in any new system.

BARRIERS AND ISSUES TO THE IMPLEMENTATION OF APTS

• The most significant barriers to APTS implementation are not the lack of interest but rather the lack of funding, staffing, and technical skills. Therefore, the project team found that the funding- and technical-support aspects of EDAPTS are critical to its acceptance and success.

• A few agencies stated their disappointment in some of the APTS technologies because of either its inefficient performance or its lack of cost-effectiveness. Similarly, some agencies mentioned they were “tired” of so many surveys, emails, phone calls, and studies; rather, they were expecting tools/systems they can use right away.

• The APTS technologies market is currently booming, and at the same time transit agencies are eager for them. During the term of the EDAPTS market assessment, the research team has experienced the case that small transit agencies could not wait for solutions from EDAPTS but have already implemented a variety of APTS technologies on their own.

• Most of the agencies like the idea of teaming up with other agencies to deploy APTS technologies. They also stated that a great benefit would be for a Caltrans project team to analyze and provide an assessment on an agency’s current ITS conditions to see if and how EDAPTS could help them.

RECOMMENDATIONS

Given that the key findings noted in this memo strongly indicate a market eager to access EDAPTS, CCIT makes the following recommendations:

• Provide small urban and rural transit agencies with effective guides through the process of acquiring APTS, which is proposed as the EDAPTS Approach by CCIT team. The concept of EDAPTS approach is not an individual APTS, but rather a procurement methodology and a set of tools that facilitate the implementation of APTS specifically for small urban and rural transit providers.

• Establish innovative ways to interact with small transit agencies, instead of tedious surveys, emails, phone calls, meetings. For instance, utilize channels like Internet to communicate and share information with transit agencies.

• Market EDAPTS approach in the form of the EDAPTS website described in CCIT’s EDAPTS Phase 1 Overview and Accomplishments memo. A user-friendly, web-based approach CCIT is advocating presents highly relevant content to its audience while addressing the need for technical and funding support and the flexibility to serve a variety of dynamic technological and market needs.

• Promote the EDAPTS website through multimedia outreach that uses the marketing list assembled for this task.

• When marketing EDAPTS approach, “lower life-cycle cost” should be one of the most important aspects highlighted. The EDAPTS website could provide small transit agencies with tools that estimate costs and benefits of APTS implementation based on features of their own transit service.
• Considering the prevailing characteristics of small transit agencies, those with both fixed-route and demand-responsive services are preferred candidates for the Final Operational Test (FOT).

• It’s also useful to demonstrate success and lesson learned from SLO, Pomona, and future deployments, since transit agencies are very interested in deployment activities.

• Features and needs from transit agencies with different fare-box recovery rates should be taken into account in the EDAPTS approach of funding investigation, since some funding sources require a minimum fare-box recovery rate.

• Enhance the institutional collaboration among Caltrans, MPO, RTPA, CalACT to provide seamless and efficient support for transit agencies. For example, continuously construct, update and maintain the comprehensive database of all transit agencies in California.

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1 MPO – Metropolitan Planning Organizations; RTPA – Regional Transportation Planning Agencies; CalACT – California Association for Coordinated Transportation.
EXHIBIT 1: FACE-TO-FACE INTERVIEWS

METHODOLOGY

We conducted face-to-face interviews with smaller transit providers to learn agencies’ basic characteristics, needs, challenges, and interest in APTS technologies. Although there is existing research on related issues, the CCIT project team determined that direct interaction with the EDAPTS target market would result in information that is more current and more tailored to our research.

California Association for Coordinated Transportation (CalACT) is a statewide, non-profit organization that represents the interests of small, rural, and specialized transportation providers in California. The project team took advantage of the CalACT 2007 Spring Conference and Expo (April 24th-27th, 2007) to administer a survey to small group of transit providers in face-to-face interviews. The group had representatives (e.g., transit managers) from five agencies, the majority of which were smaller transit providers.

Four other agencies completed the same survey online via CCIT’s website.

For detailed survey questionnaire, please see Attachment 1.

RESULTS

Table 1-1 contains a brief summary of the survey results.
<table>
<thead>
<tr>
<th>Name of Transit Agency</th>
<th>Characteristics of Transit Agency</th>
<th>Future Needs</th>
<th>Issues</th>
<th>Expectations of APTS Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mendocino Transit Authority</td>
<td>- small agency</td>
<td>- improve the efficiency of its systems (for example, improve performance,</td>
<td>- previously installed dispatching software for demand-responsive transit but was disappointed by its inefficient performance, and has stopped using it</td>
<td>- extremely interested in ITS technology</td>
</tr>
<tr>
<td></td>
<td>- annual ridership = 430,000</td>
<td>reporting, productivity)</td>
<td></td>
<td>- eager to be a pilot case for EDAPTS deployment</td>
</tr>
<tr>
<td></td>
<td>- fixed routes = 12 buses; demand-responsive transit = 16 buses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Napa County Transportation and Planning Agency</td>
<td>- fixed routes annual ridership = 780,000; demand-responsive transit annual ridership = 35,000; total of 39 buses</td>
<td>- benefit from new technologies</td>
<td>- lack of adequate funding (they would be interested in very low cost technologies)</td>
<td>- has installed some ITS technologies but is still interested in new ones like AVL and Automated Traveler Information System</td>
</tr>
<tr>
<td></td>
<td>- urban agency</td>
<td>- be more efficient (in operations and reporting) and facilitate cash handling</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- annual ridership = 2,600,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- operate both fixed routes and demand-responsive transit services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Santa Rosa City Bus</td>
<td>- small-urban agency</td>
<td>- improve efficiency, dispatching, performance, and reporting</td>
<td>- lack of in-house staffing</td>
<td>- interested in implementing ITS technologies and recently hired a consultant for it</td>
</tr>
<tr>
<td></td>
<td>- fixed routes = 42 buses; demand-responsive transit = 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of Fairfield</td>
<td>- small-urban agency</td>
<td>- improve efficiency and performance and provide better information to</td>
<td>- lack of adequate staff</td>
<td>- believe ITS technologies will be beneficial to their operations</td>
</tr>
<tr>
<td></td>
<td>- fixed routes = 42 buses; demand-responsive transit = 8</td>
<td>customers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1-1. Summary of Face-to-Face Interviews
<table>
<thead>
<tr>
<th>Name of Transit Agency</th>
<th>Characteristics of Transit Agency</th>
<th>Future Needs</th>
<th>Issues</th>
<th>Expectations of APTS Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Elk Grove</td>
<td>- small-urban agency&lt;br&gt;- fixed routes = 77 buses; demand-responsive transit = 6 buses</td>
<td>- improve performance and enhance safety</td>
<td>- lack of funding and staff</td>
<td>N/A</td>
</tr>
<tr>
<td>Stanislaus Regional Transit</td>
<td>- rural agency&lt;br&gt;- fixed routes = 9 buses (213,599 riders/year); demand-responsive transit = 9 buses (37,698 riders/year)</td>
<td>- improve operation performance and productivity&lt;br&gt;- facilitate reporting and record keeping</td>
<td>- lack of in-house staffing&lt;br&gt;- lack of reliable products available on the market</td>
<td>- have not implemented ITS technologies</td>
</tr>
<tr>
<td>Paratransit, Inc.</td>
<td>- transit organization</td>
<td>- improve operation performance and productivity&lt;br&gt;- more effective dispatching, scheduling and better maintenance tracking</td>
<td>- already implemented a lot of technologies but lack the funding to install Drive Cam</td>
<td>N/A</td>
</tr>
<tr>
<td>Gold Country Telecare</td>
<td>- demand responsive transit only (17 buses)&lt;br&gt;- annual ridership = 65,000</td>
<td>- interested in improving scheduling productivity and general efficiency</td>
<td>- believe that implementing technologies is too costly and requires too much effort</td>
<td>- interested in GPS/AVL systems</td>
</tr>
<tr>
<td>Lift Line Specialized Transportation/CTSA</td>
<td>- small agency&lt;br&gt;- fixed routes = 7 buses (20,930 riders/year); demand-responsive transit = 11 buses (57,075 riders/year)</td>
<td>- a more accurate reporting and record-keeping system&lt;br&gt;- provide greater accessibility and more useful traveler information</td>
<td>- find it hard to successfully implement technologies with their limited staff and funding</td>
<td>- have implemented many ITS technologies and are eager to deploy an easier system for tracking and dispatching</td>
</tr>
</tbody>
</table>
FINDINGS

Although there were only nine responses finally collected from the face-to-face interviews, some trends and common needs can be observed.

- **Characteristics of Transit Agency** – Most of the small transit agencies in the survey operate both fixed routes and demand responsive transit; therefore, it is important for a successful and efficient EDAPTS project to consider both types of operations.

- **Future Needs** – Most of the transit agencies stated that improving operational performance and productivity are their primary needs. Other needs also include facilitating reporting and record keeping as well as improving scheduling productivity.

- **Barriers** – The most significant barrier to APTS implementation is not the lack of interest but rather the lack of funding and staffing. Another key difficulty is in finding appropriate solutions, an obstacle that can be overcome using EDAPTS. Some of the agencies showed their disappointment with some of the technologies that had implemented because of either inefficient performance or lack of cost-effectiveness.

- **Expectations of APTS Technologies** – One-third of the agencies have already implemented some ITS technologies but most of them are still interested in beginning or continuing implementation of more ITS technologies. GPS/AVL systems, operational systems, and the Advanced Traveler Information System are particularly attractive to these agencies.

- **Other Trends** – None of the agencies had heard of EDAPTS but most of them were interested in possible deployment activities if they could observe demonstrated benefits at other agencies. Agencies are mostly interested in a flexible deployment structure that they can mold to fit their needs. All of the agencies like the idea of teaming up with other agencies to deploy ITS technologies.
EXHIBIT 2: ONLINE SURVEY AND FOCUS GROUP DISCUSSION

METHODOLOGY

The CCIT project team developed and deployed an online survey and arranged a follow-up focus group discussion. There were two main objectives of the survey:

1) Gain more insight into EDAPTS based on transit agencies’ opinions about APTS technologies;

2) Identify a group of small transit providers who would be willing to participate in a follow-up focus group discussion.

The online survey was conducted from July to August 2007. A short questionnaire, focusing on transit agencies’ opinion of APTS technologies, was first developed and posted through “Zoomerang” web survey engine/software tools. Then, the survey link was distributed to a number of transit managers/planners, most of whom work for small urban and rural transit agencies. The online survey results were further analyzed and used for the focus group discussion. For detailed survey questionnaire, please see Attachment 2.

The focus group discussion was conducted via teleconference on September 12th, 2007. It yielded informative feedback on technology implementation, related barriers, and agencies’ concerns about the EDAPTS project.

RESULTS AND FINDINGS OF ONLINE SURVEY

Forty-eight respondents filled out the online survey over two-months. Of those respondents, 27 transit agencies indicated their interests in participating in the focus group teleconference with Caltrans and CCIT. Most of them are small urban and rural transit agencies (please see following analysis for more detail). However, among all the responses, only 32 of them completed required questions, and only 25 of them provided fleet size information of their transit services. Therefore, the statistics analysis of the survey data CCIT conducted was based on those 25 completed responses with fleet size information.

TRANSIT AGENCY CHARACTERISTICS

The project team identified fleet size as a key characteristic of transit service. Additionally, two types of operations were considered: number of fixed-route transit vehicles and number of demand-responsive transit vehicles.

A majority of our sampled 25 agencies (85%) are operating a transit service with less than 50 buses total.

TECHNOLOGY NEEDS

The project team used fleet size in its analysis of technology. We divided transit agencies into five categories (as shown in Table 2-1).

2 http://www.zoomerang.com/
Table 2-1. Categories of Fleet Size

<table>
<thead>
<tr>
<th>Categories of Fleet Size</th>
<th>1-10</th>
<th>11-20</th>
<th>21-50</th>
<th>51-100</th>
<th>&gt;100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count of Survey Respondents</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**Technology Question 1 (Q1):** What types of technologies has your agency already implemented? (A list was provided; see Figure 2-1.)

Not surprisingly, a significant portion of larger transit agencies (fleet size >50) in the survey has already implemented many types of technologies. Conversely, only a minimal portion of smaller transit agencies has implemented listed technologies. For instance, only 4 out of 21 (about 19%) small transit agencies have implemented Mobile Data Terminals (MDT) in their fleet; however, 75% of larger transit agencies have done so. Additionally, results show a trend of an increasing rate of technology implementation associated with an increasing fleet size. Using Computer Aided Dispatch (CAD) technology as an example, 0%, 28.6%, 37.5%, 50%, and 50% respectively of respondents have implemented this technology for respective fleet size categories. Figure 2-1 shows the summary results collected from completed responses.

![Figure 2-1. Summary Results to Q1: Technology Already Implemented](image)

**Technology question 2 (Q2):** What types of technologies would your agency be interested in implementing? (A list was provided; see Figure 2-2.)

The project team found that almost all types of APTS technologies are of great interest to transit agencies, especially to smaller transit agencies. Compared to other categories, transit agencies with a fleet size of 21-50 are the most proactive group, considering almost all types of technology implementation. This indicates that at a fleet
size of 21, agencies cross a line where new technology becomes more of an imperative, i.e., it changes from a want to a need. Summary results to Q2 are presented in Figure 2-2.

![Bar Chart: Summary Results to Q2: Technology of Interest]

**Figure 2-2. Summary Results to Q2: Technology of Interest**

**BARRIERS**

**Technology Question 3 (Q3):** What are the barriers, if any, that generally prevent your agency from implementing Intelligent Transportation Systems technologies? (Based on existing research, three possible answers were provided to this question: funding; lack of staffing and/or technical skills; and technology sourcing and procurement. "Others" was also provided as an option.)

Notably, 100% of respondents claimed funding as a major barrier to implement APTS technologies. Lack of staffing and technical skills are significant barriers, according to 68% of the survey respondents. Unexpectedly, fewer respondents (24%) stated “technology sourcing and procurement” as a significant barrier for technology implementation. These results demonstrate that the EDAPTS project must pay attention not only to technology procurement itself, but also help identify related funding sources and provide technical support for smaller transit providers. Figure 2-3 illustrates the summary results to Q3.
RESULTS AND FINDINGS OF FOCUS GROUP DISCUSSION

CCIT and Caltrans hosted the focus group discussion by teleconference on September 12, 2007. Seven small transit providers participated in the discussion: Del Norte Local Transportation Commission, El Dorado County Transit Authority, Fresno County Rural Transit Agency, Gold Coast Transit, San Benito Local Transportation Authority, Yolo County Transportation District, and Yuba-Sutter Transit Authority. A review of the survey results was followed by an open discussion. Questions and comments included the following:

- A wide range of technology components has been implemented at various agencies.
- Many agencies identified the lack of staff or expertise to analyze data as an issue they face.
- Some transit providers have very limited staff, so they have to hire contractors for all operation services and would like to avoid the need to continue to hire new contractors for every part of their operations.
- Some agencies noted the issue of integrating existing technology components in their system. For instance, currently it is difficult to extract data and run reports because of this lack of integration. Also, one common question was whether technologies from EDAPTS would interface with any existing technology that may already be in use at a transit agency.
- One agency noted that the high turnover rate of contract employees has led to difficulties implementing technology due to high monetary and time costs and time for training. Agencies would prefer access to professional knowledge without having to pay someone onsite. For example, use an internet-based AVL, which is hosted remotely.
- A great benefit would be for CCIT and Caltrans to analyze and provide an assessment of an agency’s current ITS conditions to see if EDAPTS could help them.
EXHIBIT 3: CALIFORNIA TRANSIT AGENCY LIST FOR EDAPTS MARKETING

METHODOLOGY

As one of the major deliverables of this EDAPTS market assessment task, the CCIT research team developed a list of California transit agencies for EDAPTS marketing purposes. The list was compiled from several sources, such as Federal Transit Administration’s (FTAs) National Transit Database (NTD), California Department of Transportation (Caltrans), Metropolitan Planning organizations (MPOs), Regional Transportation Planning Agencies (RTPAs), and California Association for Coordinated Transportation (CalAct). The project team have developed, updated, verified, and aggregated different fields and records. We also collected relevant statistics about the agencies listed, including operating cost, fare revenue, service area, service population, type of transit service, number of fixed-route transit vehicles, number of demand-responsive transit vehicles, etc.

This marketing list will help Caltrans identify potential EDAPTS adopters for both Final Operational Test (FOT) stage and full deployment. Additionally, the list would share similar findings and issues for technology implementation, if it comprises transit providers with similar attributes as sampled transit agencies in Face-to-Face interview and online survey.

RESULTS AND FINDINGS

Approximately 100 California transit agencies are on the list. For a spreadsheet containing the marketing list, please see the Excel file in the deliverable package. Transit agencies with fleet size between 5 and 100 are highlighted in the list, which would be best targeting market for EDAPTS. Note that only completed cases are included in the following parameter analysis.

Table 3-1 shows brief descriptive statistics of the agencies’ characteristics. Although many of the parameters have a wide range (from minimum to maximum value), our list mainly comprises small transit agencies (see Table 3-2 for more details).
Table 3-1. Descriptive Statistics of Different Parameters Collected in Transit Agency List

<table>
<thead>
<tr>
<th>Parameters of Transit Agency</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Fixed-Route Transit Vehicles</td>
<td>92</td>
<td>1</td>
<td>338</td>
</tr>
<tr>
<td>Number of Demand-Responsive Transit Vehicles</td>
<td>102</td>
<td>1</td>
<td>76</td>
</tr>
<tr>
<td>Number of Total Transit Vehicles</td>
<td>128</td>
<td>1</td>
<td>414</td>
</tr>
<tr>
<td>Total Operating Expense ($)</td>
<td>77</td>
<td>54,838</td>
<td>129,261,916</td>
</tr>
<tr>
<td>Fare Revenue ($)</td>
<td>76</td>
<td>8,300</td>
<td>21,971,914</td>
</tr>
<tr>
<td>Fare-box Recovery Rate (Expense/Revenue)</td>
<td>75</td>
<td>1%</td>
<td>65%</td>
</tr>
<tr>
<td>Service Area (Sq. miles)</td>
<td>115</td>
<td>1</td>
<td>8,141</td>
</tr>
<tr>
<td>Service Area Population</td>
<td>116</td>
<td>1,879</td>
<td>1,515,836</td>
</tr>
<tr>
<td>People to Area Ratio (Population Density)</td>
<td>113</td>
<td>2.40</td>
<td>29,166.67</td>
</tr>
</tbody>
</table>

Table 3-2. Distribution of Total Fleet Size (N=128)

<table>
<thead>
<tr>
<th>Categories of Total Fleet Size</th>
<th>1-10</th>
<th>11-20</th>
<th>21-50</th>
<th>51-100</th>
<th>&gt;100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Total Transit Vehicles (%)</td>
<td>32%</td>
<td>24%</td>
<td>25%</td>
<td>12%</td>
<td>7%</td>
</tr>
</tbody>
</table>

FLEET SIZE OF TRANSIT AGENCY

Fleet size, one of the key characteristics of a transit service, was collected in the process of constructing the transit agency list. Two types of transit operations were considered: number of fixed-route transit vehicles and number of demand-responsive transit vehicles. Figure 3-1 illustrates the relationship between fixed-route and demand-responsive transit in the agencies we studied. Above all, among 128 transit agencies containing fleet-size information, a majority (about 81%) are operating a transit service with less than 50 buses total, another verification that our list comprises mainly small transit agencies.
Figure 3-1. Fixed-Route and Demand-Responsive Transit Agencies

**TYPE OF TRANSIT AGENCY**

Public transit agencies are generally categorized into three groups: urban, small urban, and rural transit providers. These categories were used to develop the transit agency list. Among the 87 transit agencies where this information was available, a large segment (64%) fall into the small urban transit agency category. This could be one factor to take into account when prioritizing the procurement and deployment options for the EDAPTS.

**FARE-BOX RECOVERY RATE**

Fare-box recovery rate is one of most crucial parameters in measuring the performance and efficiency of a public transportation system. As an access restriction to most of federal- and state-level funding resources, the minimum fare-box recovery rate of a transit provider is required to be at least 10%.

Figure 3-2 presents the frequency histogram of fare-box recovery rate. Out of 75 agencies that provided cost/revenue information, 84% have reached the 10% funding requirement mark. Only 8% maintained a fare-box recovery rate over 40%, indicating that majority of transit providers heavily rely on outside financial support for their daily transit service. Under these circumstances, the EDAPTS can help small transit providers in a more systematic way, i.e., not only technologies themselves but also realistic procurement support, including the funding aspect.

---

3 The fare-box recovery rate is calculated by dividing fare revenue by total operating expense.
Figure 3.2. Frequency Histogram of Fare-Box Recovery Rate
Opinion survey about EDAPTS

Efficient Deployment of Advanced Public Transportation Systems

General information:

1) • Name of the agency: .................................................................
   o Small-urban agency
   o Rural agency

• Your position: .............................................................................

<table>
<thead>
<tr>
<th>Fixed routes</th>
<th>Demand Responsive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of buses:</td>
<td>..................</td>
</tr>
<tr>
<td>Number of routes;</td>
<td>..................</td>
</tr>
<tr>
<td>Number of bus stops:</td>
<td>..................</td>
</tr>
<tr>
<td>Annual Ridership:</td>
<td>..................</td>
</tr>
</tbody>
</table>

• Who is/are your typical rider(s)? .............................................

Needs:

2) • Please rank your needs by order of priority:
   ♦ More accurate, easier reporting and record keeping (i.e. passengers counts, O.D data)
   ♦ Safer, more accurate cash handling
   ♦ Improved operation, performance, and productivity
   ♦ More effective maintenance tracking
   ♦ More effective dispatching
   ♦ Improved scheduling productivity (i.e. optimized schedule based on operational data)
   ♦ Enhanced transit safety for driver and passenger
   ♦ More accessibility and more useful customer information
   ♦ Others: ..................................................................................
3) • Has your agency ever conducted a survey of riders and/or drivers’ attitude towards new technologies?
   o Yes
   o No

→ If it has, what were the results in brief?

→ If it hasn’t, do you feel it would be a prerequisite before you implement new technologies?
   o Yes
   o No

ITS Technologies:

4) • Has your agency deployed ITS (Intelligent Transportation Systems) / APTS (Advanced Public Transportation Systems) technologies?
   o Yes
   o No

→ If it has, what kind of technologies have been deployed? (please specify the provider)

What are the benefits?

5) • What are the main barriers to ITS implementation in your agency?
   o Lack of interest / don’t see benefits
   o Interest in ITS Technologies, but there are too many problems in implementing these technologies. Please rank those problems:
      ♦ Operational and organizational challenges
      ♦ Cannot find solutions that fit your needs
      ♦ Initial effort and cost involved in assessing technologies
      ♦ Lack of adequate funding
      ♦ Lack of staffing / in-house skills and expertise
      ♦ Others:

6) • What kind of ITS Technologies, if any, is your agency interested in at the moment?
   o Operational Software and Computer Aided Dispatching Systems
   o Automated Demand Responsive Transit
Electronic Fare Payment Systems
Automatic Passenger Counter
Wireless Communications (voice or digital)
Mayday System
Advanced Traveler Information System
  □ On-line
  □ Vocal (phone)
  □ At the bus-stop
  □ En-route
GPS Automated Vehicle Location
Others: ........................................................................................................

Funding:

7) • Is there a part of your agency’s budget dedicated to operational improvement and ITS Technologies?
   o   Yes
    → What is its order of magnitude (per year, per bus, per route...)? .............
   o   No

8) • Where would your agency look for more funding if it wanted to implement a new ITS project?
   □ Federal grant
   □ State
   □ Local government
   □ Others: ........................................................................................................

About EDAPTS:

EDAPTS is a project aimed at implementing ITS technologies in small-urban or rural transit properties at a low cost and with system performance trade-offs.

9) • Have you heard about EDAPTS (Efficient Deployment of Advanced Public Transportation Systems)?
   o   Yes
→ Please summarize what EDAPTS means to you: ..............................
   o No

10) • If you were to look at the costs and benefits of EDAPTS, which is more relevant?
   o Being able to observe demonstrated benefits in other agencies
   o Conducting a prospective study of expected benefits in your agency

11) • If you were planning to deploy EDAPTS, would you prefer?
   o a flexible system that you can arrange to fit your needs exactly
   o a less flexible system, but less expensive and easier to install

12) • Would your agency implement EDAPTS?
   o on the whole network
   o only on key routes

13) • Can you think of environmental constraints and objectives in your area of operations that would either help or slow the deployment of EDAPTS?
   o Urban landscaping and signage ordinance requirements
   o Eco-friendly policies
   o Others: ...........................................................

14) • Is it significant to you that the conceptual framework of EDAPTS is based on standards such as FHWA’s National ITS Architecture Guidelines to ensure uniformity and compatibility with other systems?
   o Yes
   o No

15) • Would you be concerned about using open-source software and/or having your data be hosted by a contractor?
   o Yes
   o No

16) • When it comes to technologies decisions, does your agency have specific partners (e.g. vendors, consultants, system integrators)?
   o Yes
   → If it does, please specify who they are: ........................................
17) In order to implement new technologies cheaper and more easily, would your agency consider teaming up with other agencies (i.e. joint procurement, joint project structure...)?

- Yes
- No

18) How soon would you be willing to implement EDAPTS?

19) Any suggestions?
ATTACHMENT 2 – SURVEY QUESTIONNAIRE

1: What types of technologies has your agency **already implemented** (check all that apply)?
   - Advanced telephone systems such as Interactive Voice Response (IVR)
   - Automatic Vehicle Location (AVL)
   - Computer Aided Dispatch (CAD)
   - Electronic Fare Payment
   - Fleet Management
   - Geographic Information Systems (GIS)
   - Mobile Data Terminals (MDT)
   - Passenger Counters
   - Reservations and Scheduling
   - Transit User Information
   - Variable Message Signs
   - Web-based systems
   - Wireless Communications
   - None of the above
   - Other, please specify: .............................

2. What types of technologies would your agency be **interested in implementing** (check all that apply)?
   - Advanced telephone systems such as Interactive Voice Response (IVR)
   - Automatic Vehicle Location (AVL)
   - Computer Aided Dispatch (CAD)
   - Electronic Fare Payment
   - Fleet Management
   - Geographic Information Systems (GIS)
   - Mobile Data Terminals (MDT)
• Passenger Counters
• Reservations and Scheduling
• Transit User Information
• Variable Message Signs
• Web-based systems
• Wireless Communications
• None of the above
• Other, please specify: ___________________________

3. What types of technologies is your agency **NOT** interested in implementing at this stage (check all that apply)?

• Advanced telephone systems such as Interactive Voice Response (IVR)
• Automatic Vehicle Location (AVL)
• Computer Aided Dispatch (CAD)
• Electronic Fare Payment
• Fleet Management
• Geographic Information Systems (GIS)
• Mobile Data Terminals (MDT)
• Passenger Counters
• Reservations and Scheduling
• Transit User Information
• Variable Message Signs
• Web-based systems
• Wireless Communications
• None of the above
• Other, please specify: ___________________________

4. What are the barriers, if any, that generally prevent your agency from implementing Intelligent Transportation Systems technologies (check all that apply)?
• Funding
• Lack of staffing and/or technical skills
• Technology sourcing and procurement
• None of the above
• Other, please specify: ........................................

5. Would you be interested in participating in a conference call in August with Caltrans and CCIT to discuss your agency’s needs and the barriers you face in implementing technology?

• Yes
• No

6. Agency Name: .........................

Address 1: .................................

Address 2: .................................

City: ..............Zip Code: ...........

Contact Person: .........................

E-mail Address: .........................

Phone Number: .........................

7. How many buses does your agency operate on fixed routes? ..............................

How many buses does your agency operate on demand-responsive transit? ......................
MEMORANDUM

THE EDAPTS APPROACH: TECHNOLOGY TRANSFER

DECEMBER 2009

PREPARED FOR:
CALIFORNIA DEPARTMENT OF TRANSPORTATION
DIVISION OF RESEARCH AND INNOVATION

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EDAPTS: Efficient Deployment of Advanced Public Transportation Systems

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<tr>
<td>APC</td>
<td>Automated Passenger Counter</td>
</tr>
<tr>
<td>APTS</td>
<td>Advanced Public Transportation Systems</td>
</tr>
<tr>
<td>ATMS</td>
<td>Advanced Transit Management System</td>
</tr>
<tr>
<td>AVL</td>
<td>Automatic Vehicle Location System</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer Aided Dispatch</td>
</tr>
<tr>
<td>Cal Poly Pomona</td>
<td>California Polytechnic State University, Pomona</td>
</tr>
<tr>
<td>Cal Poly SLO</td>
<td>California Polytechnic State University, San Luis Obispo</td>
</tr>
<tr>
<td>Caltrans</td>
<td>California Department of Transportation</td>
</tr>
<tr>
<td>CCIT</td>
<td>California Center for Innovative Transportation</td>
</tr>
<tr>
<td>EMS</td>
<td>Emergency Medical Services</td>
</tr>
<tr>
<td>EPS</td>
<td>Electronic Payment Systems</td>
</tr>
<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
</tr>
<tr>
<td>FTA</td>
<td>Federal Transit Administration</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>MDT</td>
<td>Mobile Data Terminal</td>
</tr>
<tr>
<td>MPO</td>
<td>Metropolitan Planning Organization</td>
</tr>
<tr>
<td>RID</td>
<td>Roadside Information Display</td>
</tr>
<tr>
<td>RTA</td>
<td>Regional Transportation Agency</td>
</tr>
<tr>
<td>SLO Transit</td>
<td>City of San Luis Obispo Transit Agency</td>
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</tbody>
</table>
OVERVIEW

As an ongoing project, the Efficient Deployment of Advanced Public Transportation Systems (EDAPTS) seeks to help small urban and rural transit agencies implement innovative technologies that can improve their daily transit operations and management. Previous stages of the EDAPTS project are listed as follows:

- In 1998, the Federal Transit Administration (FTA) and the California Department of Transportation (Caltrans) teamed up with California Polytechnic State University at San Luis Obispo (Cal Poly SLO) and the City of San Luis Obispo Transit (SLO Transit) to investigate ways to make APTS more affordable for the small transit operator and to provide lower cost system growth and enhancements over time.

- In 2007, Caltrans asked the California Center for Innovative Transportation (CCIT), along with Cal Poly SLO and California Polytechnic State University at Pomona (Cal Poly Pomona) to compile a comprehensive body of knowledge that could be utilized by any small urban or rural transit agency to deploy APTS more efficiently and at a lower life-cycle cost. The project includes research, testing, and deployment.

The CCIT project team has defined EDAPTS as an Approach that effectively guides small urban and rural transit agencies through the process of acquiring Advanced Public Transportation System (APTS). So, the concept of EDAPTS is not an individual APTS, but rather a procurement methodology and a set of tools that facilitate the implementation of APTS specifically for small urban and rural transit providers. The key principle of the EDAPTS approach is to “buy only what you can afford and really need now, but buy adaptable solutions that can grow as you and your needs change.” For more information about EDAPTS approach, please see *The EDAPTS Approach: Defining Project Needs*.

The EDAPTS approach offers resources and tools to assist small urban and rural transit agencies at various stages in the APTS procurement process. At the same time, the EDAPTS team is assessing the potential for the transfer of technological resources that have been created through the EDAPTS efforts over the last decade. A documentation of this assessment as well as a summary of the tech transfer activities to date is presented in this *Technology Transfer Memo*.

Note that the direct audience of the memo is made up of current and future team members of EDAPTS project, as well as high level decision makers in California Department of Transportation (Caltrans) or other entities. However, results and findings from these tech transfer efforts can also be used by other parties.
THE EDAPTS APPROACH

The expanding array of Advanced Public Transportation System (APTS) technologies is constantly improving the performance of public transportation systems around the nation. As the cost of these technologies decrease, these solutions are no longer limited solely to large transit systems, but are now seriously considered for use in small urban and rural environments.

The main reasons for the limited use of APTS technology in small urban and rural areas are the lack of discretionary resources for deployment, accessible procurement options and on-going technical assistance. These three problems make up the legs of the three-legged stool approach to APTS deployment. Successful deployment depends on each of these three elements. Through conversations with smaller transit agencies, some specific problems were discovered. For instance, it is often the case that these agencies have lower fare box collections, limited access to funding sources for new and better technology, and lack in-house personnel with the necessary skills for technical support required for APTS deployment.

In response to these challenges, a group of researchers and engineers has developed the Efficient Deployment of Advanced Transportation Systems (EDAPTS). EDAPTS is an approach that guides small urban and rural transit agencies through the process of acquiring APTS.

BACKGROUND

In 1998, the Federal Transit Administration (FTA) and the California Department of Transportation (Caltrans) teamed up with California Polytechnic State University at San Luis Obispo (Cal Poly SLO) and the City of San Luis Obispo Transit (SLO Transit) to investigate ways to make APTS more affordable for the small transit operator and to provide lower cost system growth and enhancements over time.

In 2007 Caltrans asked the California Center for Innovative Transportation (CCIT), along with Cal Poly SLO and California Polytechnic State University at Pomona (Cal Poly Pomona) to compile a comprehensive body of knowledge that could be utilized by any small urban or rural transit agency to deploy APTS more efficiently and at a lower life-cycle cost. The result of this research is the EDAPTS approach.

DESCRIPTION OF THE EDAPTS APPROACH

EDAPTS is a set of hands-on and analytic tools, recommended procurement methodology, and information that facilitates implementation of APTS for small urban and rural transit providers. EDAPTS outlines procurement options, provides useful information on funding sources, and advocates open source designs and open interface protocols. Implementing APTS in a transit system is an exciting, yet challenging, process. By using the EDAPTS
methodology and the tools provided, a transit agency can implement the technologies it needs at a lower life-cycle cost. Overall, the EDAPTS motto is: 
*Buy only what you can afford and really need now, but buy adaptable solutions that can grow as you and your needs change.*

More specifically, lower life-cycle costs are achieved by adhering to these principles:

1. Build APTS systems that meet specific transit needs. This means distinguishing between those systems that are desired and those that are required.
2. Promote the use and incorporation of non-proprietary subsystem interfaces that facilitate future expansion.
3. Make system performance trade-offs that significantly reduce life-cycle costs but do not adversely impact the intended usefulness of the deployed system.

**THE EDAPTS PROCESS**

EDAPTS outlines a process of obtaining APTS technology, as shown in the diagram below. This is a comprehensive process, guiding a transit agency from pre-implementation through implementation to general operations and maintenance of the system. These stages are:

- **DEFINE YOUR NEEDS:** This process guides a transit agency through identifying stakeholders and collecting the needs and expectations of stakeholders before implementing an APTS project. This process also involves developing common operational scenarios to help formulate the benefits of APTS for a community.

- **ESTIMATE THE COSTS AND BENEFITS:** This process helps to estimate the costs and benefits of APTS that is needed during the pre-implementation phase. A tool that estimates cost and benefits based on transit agency characteristics will be made available.

- **FIND FUNDING:** This process involves identifying one or more potential grant programs or funding sources at the federal, state and local level for APTS implementation. A list of potential funding sources and possibly a specific funding mechanism under the state purview will be available.

- **PROCUREMENT:** This process helps a transit agency procure APTS that is currently needed while making sure it can be expanded incrementally at a low life-cycle cost. A dynamic tool to develop the technical specifications and a data format standard along with a list of pre-qualified suppliers will be made available.

- **SYSTEM IMPLEMENTATION:** This is the actual implementation of the procured APTS through the processes described above. It is expected that the supplier of the APTS will be responsible for this process in close coordination with the transit agency.

- **TRAINING AND OUTREACH:** Employees who use the APTS will need to be trained to effectively utilize the enhanced system capabilities and transit riders will need to be made aware of the system enhancements. This process will help you through the initial time period after implementation.
• **OPERATIONS AND MAINTENANCE**: APTS needs continued up-keep and maintenance for reliable performance. An agency needs to identify a funding stream to meet this need. An APTS supplier can be hired for this service or a transit agency may choose to do this themselves.

• **EVALUATION**: Evaluating APTS is critical to justify investment to stakeholders as well funding entities. This will help facilitate trust and acceptance of the system and enable future expansion of APTS.

**The EDAPTS Process**

**FOR MORE INFORMATION ON THE EDAPTS APPROACH**

Go to the EDAPTS website located at  

Or contact a member of the project team listed below.

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RESOURCES DEVELOPED

Many resources have arisen out of EDAPTS research that are of significant value to entities such as city and regional transit operators, service providers, and transit management system vendors who are interested in deploying an APTS system. These resources are not only helpful for those wishing to procure an EDAPTS system, but also offer significant insights and potential assistance for non-EDAPTS APTS procurements as well.

Various EDAPTS resources have been developed to date, including the original EDAPTS system which is still operational in San Luis Obispo, a cost-benefit analysis of EDAPTS, and an EDAPTS Performance Specification. The original EDAPTS system consists of hardware and software elements for dispatch, buses, and bus stops. The cost-benefit analysis and performance specification were completed as joint projects by Cal Poly San Luis Obispo and Cal Poly Pomona.

COST-BENEFIT EVALUATION OF EDAPTS

This study determines a full benefit/cost evaluation of the EDAPTS system installed in San Luis Obispo, and the accompanying technical report provides a detailed description of the methodologies and procedures used, as well as the research findings resulting from the evaluation effort. Through use of this report, transit properties can better understand how low-cost ITS solutions can improve their operations, and potential integrators will have a clear picture of the performance of an EDAPTS-derived ITS solution.

A literature review of previous Advanced Public Transportation Systems (APTSs) cost/benefit studies revealed that very few APTS evaluation studies measured benefits and costs in dollars, which is believed to be due to the lack of effective methods for placing dollar values on benefits that are not easily quantified. Quantifying benefits in dollar values requires creative assumptions and stated preference surveys. The review found that contingent valuation methods, as compared to hedonic pricing methods, showed high potential in quantifying the benefits of the SLO Transit EDAPTS ITS system. From this, an innovative evaluation method was developed to quantify the intangible benefits of the San Luis EDAPTS system. This stated preference evaluation method uses the principle of willingness-to-pay to provide an aggregate measure of what surveyed passengers are willing to forego to obtain a given ITS service feature. Using a passenger questionnaire, a boarding time survey, and interviews with SLO Transit drivers and administrators, the research team estimated the various benefits the SLO Transit EDAPTS system.

Using the identified cost items as the guideline for data collection, the project collected cost data (in dollars) from a survey of typical prices of the various components used in the design of the SLO Transit EDAPTS system. The survey included online price checks, visits to local retail establishments and calls to manufacturers and vendors of specialized items. The “best” prices of individual subcomponents were compiled for inclusion in the cost data. Labor time estimates were based on the times spent previously and in other ongoing EDAPTS projects in the installation of EDAPTS components and software programs.
On this basis, a benefit/cost (B/C) ratio analysis was performed. A sensitivity analysis of B/C ratios was also performed, considering different discount rates and assumed service lives of the EDAPTS system. The method used in this research is a slight variation of the traditional method of matching the total of a series of discounted benefits to the total of a series of discounted costs. Instead, total capital costs were annualized and added to annual operating and maintenance costs in current dollars. The annual benefits were then compared with annualized costs to derive ratios of annual benefit to annual costs.

<table>
<thead>
<tr>
<th>Sensitivity Analysis of Benefit/Cost Ratios</th>
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<tr>
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</tr>
<tr>
<td><strong>Including Consumer Surplus</strong></td>
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<tr>
<td>5% Discount Rate</td>
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<tr>
<td>7% Discount Rate</td>
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<tr>
<td>10% Discount Rate</td>
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<tr>
<td><strong>Excluding Consumer Surplus</strong></td>
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<td>5% Discount Rate</td>
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<tr>
<td>7% Discount Rate</td>
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<tr>
<td>10% Discount Rate</td>
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</table>

The report details a compelling economic justification for deployment of EDAPTS ITS solutions, with the minimum benefit cost ratios approaching four to one, depending upon factors such as inclusion of consumer surplus into the benefits and the service life of the installed system. The most conservative B/C ratio analysis excludes consumer surplus as benefits and shows B/C ratios of approximately 3.9 to 5.7. This indicates in general that every dollar invested in the San Luis Obispo EDAPTS system resulted in at least four dollars of benefits to the constituent groups. Considering consumer surplus as benefits makes the B/C ratios increase to between 4.8 and 7.0. These findings confirm that the EDAPTS ITS technologies indeed are a low-cost, easily deployed, economically sound ITS solution for small/medium transit agencies.

**EDAPTS PERFORMANCE SPECIFICATION**

The EDAPTS Performance Specification was created as part of the formalized specification of EDAPTS to assist its widespread deployment and commercial adoption. This technical report provides potential private industry partners with the elements necessary to justify the business case for this system. The stated goal of the project was to develop performance-based specifications for the EDAPTS Smart Transit System using a generalized method. Such specifications allow system integrators to supply, develop, or procure hardware and data communications subsystems to mate with existing open-source released EDAPTS software.

The Specification was developed using industry best practices, identifying all unique EDAPTS elements and determining performance-based metrics for each element. Messaging between elements was documented, and a standard created to ensure interoperability between parts procured from future EDAPTS vendors. The
Performance Specification and the Data-Formatting Standard are of interest to both system procurers and suppliers.

Tools created as part of this Specification include:

- A detailed set of tables containing all aspects of the performance specifications, including inter-table relationships. These tables are referred to as the EDAPTS Performance Specification Tables.
- The EDAPTS Performance Specification Generator software program with accompanying sample output in the form of an EDAPTS Performance Specification.
- Version 1.0 of the EDAPTS Data Formatting Standard. This document provides data-formatting details for all EDAPTS inter-component communications.
- A user’s guide for the EDAPTS performance specification tables and the software program.

Specifications are generated using the EDAPTS Performance Specification Generator, a wizard-driven automated software tool that allows a user to select the system functionality they desire for their EDAPTS system, input parameters specific to their transit system, and automatically generate a cleanly formatted performance specification document. The EDAPTS Performance Specification Generator software program was developed using the Java programming language due to Java’s powerful graphical user interface (GUI) programming and cross-platform portability attributes, and uses a Microsoft Access database due to its widespread use and availability among expected users of the Specification Generator.

An end-user, system procurer, or other interested party may use the tool to create a highly customized specification report based upon the desired system functionality. This report can be used as a guide in creating a request for proposal or bid, and is also suitable for direct attachment to such a document. The tool is also capable of generating system verification worksheets for all selected functionality, which can then be utilized to verify a procured system has been correctly installed and meets all requirements.
The EDAPTS Data Formatting Standard was compiled to document EDAPTS inter-component data communications. During the specification process the concept of components and elements was developed to differentiate between different types of hardware subsystems used in an EDAPTS installation. EDAPTS Components are considered to be any hardware or software portions of the EDAPTS system that are interchangeable with replacement components having the same performance specifications. Components are made up of Elements, and Elements are not necessarily interchangeable.

The EDAPTS Data Formatting Standard uses Extensible Markup Language (XML) to represent EDAPTS data formats due to its widespread acceptability, flexibility and ease of use, and its readiness to be directly converted into actual data objects. While it does not utilize Transit Communications Interface Profiles (TCIP), the EDAPTS Data Formatting Standard is modeled on the original TCIP standard as it was created through a broad-based transit property consensus, and the original EDAPTS system in San Luis Obispo was developed using and is based upon TCIP. TCIP has demonstrated itself to EDAPTS researchers over the life of EDAPTS to be comprehensive and well thought out, typically providing a structure that supports desired system modifications and extensions – a primary objective of EDAPTS.

The EDAPTS Performance Specification User’s Guide was written to tie all aspects of the listed tools together. This guide contains documentation of the EDAPTS Performance Specification Tables and detailed instructions for using the EDAPTS Performance Specification Generator software application. The EDAPTS Performance Specification and associated Specification Generator tool can be obtained from http://itrans.calpoly.edu/EDAPTS.
EDAPTS 1.0 SYSTEM HARDWARE

Mobile data terminal and Dynamic Roadside Information Displays were developed as part of the original EDAPTS project. These hardware designs utilized as many commercially off the shelf available subsystems as possible in conjunction with the custom-developed open-source software discussed below.

MOBILE DATA TERMINALS

The EDAPTS Mobile Data Terminal (MDT) is a compact computing platform that resides in the driver’s compartment and performs different functions to aid in operating the bus, including logging in the driver at the beginning of the shift, collecting and logging passenger ID card swipes, providing the driver information regarding arrivals at stops, schedule adherence performance, and the amount of time until departure scheduled departure. A prototype Mobile Data Terminal was developed for use in the San Luis Obispo deployment, and has the following features:

- A GPS receiver.
- An x86-based PC-104 computer running the Linux operating system.
- A 4-line by 16-character alpha-numeric display with 16-key keypad.
- A heavy-duty aluminum case with adjustable mount and internal cooling fan.
- A driver’s emergency button installed in a hidden location.
- A printed circuit board for interconnecting all components and internal subassemblies.

The unit easily fits within the driver’s compartment and interfaces via RS-232 with a radio modem and a magnetic swipe card reader, which is used to record Cal Poly ID card swipes upon boarding. The EDAPTS MDT was built from commercially available subassemblies, with custom ribbon-cable wiring harnesses and a printed circuit board used to provide electrical interconnections.
**DYNAMIC ROADSIDE INFORMATION DISPLAYS**

The Dynamic Roadside Information Displays (or Smart Transit Signs as it was termed in the San Luis Obispo deployment) are electronic, remotely controlled displays that present information regarding estimated time of arrival of buses to passengers waiting at bus stops. A prototype Smart Transit Sign was developed for use in the San Luis Obispo deployment, and consists of a display with two ten-character rows of three inch alpha-numeric characters made from high contrast flip dots housed in a vandal and weather-resistant enclosure. The signs are compliant with the Americans with Disabilities Act (ADA), and readable from approximately one hundred and fifty feet. The signs are solar and battery powered, controlled via a wireless pager system, and are capable of operating for up to 20 days of inclement weather. These displays provide “real-time” information based upon bus progress along route. Each sign displays minutes until arrival for buses arriving at stops and are also capable of displaying periodically repeating text banners.

**Smart Transit Sign**

![Smart Transit Sign Image]

**EDAPTS 1.0 SOURCE CODE**

A set of software was developed and assembled for the prototype deployment of EDAPTS in San Luis Obispo. This software included:

- Server processes for receiving collected vehicle data, processing report queries, and dissemination of traveler information to dynamic messaging signs and internet-based web terminals.

- Software client to provide dispatchers and managers with vehicle location, schedule adherence, on-time performance reporting, and ridership reporting.

- On-board software to report stop arrivals and schedule adherence to drivers, collect ridership information and validate passenger cards upon boarding, handle on-board emergencies, and communicate with the central-site server.
Dynamic sign software to process vehicle location updates provided by the central-site server and display bus arrival information to riders at stops.

This software developed for this deployment was designed using the National ITS Architecture and TCIP specifications. Data flows throughout the system make use of National Architecture Process Specifications (PSPECS), which group transit management functionalities into pre-defined dataflows and data objects. The software objects derived from the TCIP specifications were used to contain the data being collected and utilized within the system. The software objects derived from the PSPECS were used to handle the flow of data within the software. These PSPEC objects communicated via method calls (like functions and subroutines), passing the TCIP objects between each other.

The software utilizes both the C++ and Java programming languages, which provide programmers with the ability to develop software that is heavily based in an object oriented design. The software has been released into the public domain under the Lesser General Public License (L-GPL). The L-GPL is an open-source license, and is structured so that the original released software elements will remain open-source, but future add-ons and extensions can be made either open-source or proprietary at the discretion of the author. It is hoped that transit properties and commercial entities can pick up the EDAPTS system in its current state and refine it for wide-spread deployment. The open source system is licensed through Cal Poly State University Corporation, and copies of the source code may be downloaded from [http://itrans.calpoly.edu/EDAPTS](http://itrans.calpoly.edu/EDAPTS).

### CENTRAL SITE SERVER

The Central Site Server is a Java-based set of processes that collects data transmitted by the on-board Mobile Data Terminal, stores the collected data into a Sybase SQL database for later retrieval, assembles schedule adherence and ridership reports for viewing through the ATRMS dispatch client, and imports and maintains a valid ridership list which is relayed to the Mobile Data Terminal for validation upon boarding. It consists of the following components:

- **Process Manager:** Manages all processes running on the central site server or servers. Provides database interaction.
- **Coordinator:** Coordinates the running processes on a per server basis.
- **Radio Communicator:** Process for communication with the Mobile Data Terminal to receive schedule adherence and ridership information, and transmission of updates.
- **Paging Communicator:** Process for transmission of updates to the Smart Transit Signs.
- **Poly Card:** Component that requests a maintains a list of Cal Poly riders for on-board validation
- **Log Viewer:** A tool for viewing and analyzing central server output and error logs
- **Watchdog:** A process which runs on a remote computer to verify server operation and functionality
**ATRMS CLIENT SOFTWARE**

The Advanced Transit Management Software is the client interface to the EDAPTS central site server, and provides the link to managing the Mobile Data Terminals and Smart Transit Signs installed for use with the system. It is a Java-based client allowing it to run from multiple platforms including Windows, Macintosh, and Linux, and provides the dispatch or management user with:

- Vehicle location on route in both graphical and tabular formats
- Vehicle schedule adherence reporting
- Ridership reporting
- Emergency management
- Mobile Data Terminal and Smart Transit Sign management
- Statistical schedule adherence and ridership reporting

**ATRMS Client**

![ATRMS Client Image](image)

**ON-BOARD AND ROADSIDE SOFTWARE**

The Mobile Data Terminal runs from custom-tailored embedded Linux platform with a 2.4 Linux kernel. The use of this platform allows use of standardized open-source development tools, and provides great flexibility for future format or configuration changes, such as the inclusion of interfaces like 802.11 wireless networking. The MDT software itself is C++ based, and provides the following functionality:

- Display of schedule adherence to drivers with countdown to departure at stops
– Validation of rider ID card swipes
– Relay of schedule adherence and rider boarding data to dispatch via wireless communications
– On-board emergency signaling to dispatch
– Stop survey mode for addition of new or changed stops to the system
– Maintenance terminal for downloading of collected data and uploading of configuration changes or software updates

The Smart Transit Signs operate from an Assembly codebase, and is coded for the Motorola 68HC11 microcontroller. Using knowledge of the transit system’s routes, it calculates vehicle arrival time to a given stop based upon updates provided by the central server via wireless updates. Pre-determined banner messages can also be displayed upon signaling from a dispatcher using the ATRMS client. The signs also run an exerciser cycle, which displays a series of maintenance patterns on the Sign at regular intervals to ensure correct operation of the flip-dots used in the display.

EDAPTS 1.0 FINAL REPORT

A wealth of valuable information can be gleaned from the development and implementation of the prototype deployment of EDAPTS in San Luis Obispo. The findings from this installation along with discussions of various implementation and deployment issues are covered in detail in the final report for Caltrans project #65A0061 – “Efficient Deployment of Advanced Public Transportation Systems, Phase 2: EDAPTS, A Smart Transit System for Small Transit Agencies”. This comprehensive report can be downloaded from http://itrans.calpoly.edu/EDAPTS.

Topics covered include:

– Development of a Concept of Operations (CONOPS) to fully understand stakeholder needs and determine the appropriate implementation.
– Discussion of the implementation of the Transit Communications Interface Protocols (TCIP) and the mapping of system features to the National ITS Architecture.
– Design, fabrication, implementation, and installation of the hardware and software required to operate an EDAPTS AVL system.
– Discussion of areas of issue encountered during development, including correct geo-referencing of stop-points, real-time stop-detection with on-board systems, and emergency management issues.
– Overviews of the wireless communications methods used for the system and the issues encountered during implementation and deployment.
– Lessons learned, including implementation of TCIP, approaches to finding solutions to technical problems, understanding and managing stakeholder needs and requirements, and understanding the impact of an installed system upon its users.
COMMERCIAL TEST DEPLOYMENT IN POMONA

The Bronco Express EDAPTS Stage 5 Test Deployment demonstration project at California State Polytechnic University, Pomona sought to determine if the EDAPTS concepts for procuring and deploying low cost Intelligent Transportation Systems (ITS) could be optimized for small transit agencies and successfully transitioned to the commercial marketplace. The project created a series of documents useful for the procurement, deployment, and evaluation of a deployed APTS system. These documents are useful for both future EDAPTS deployments and installation of other APTS systems.

PROCUREMENT DOCUMENTATION

All procurement documentation assembled during the Pomona deployment has been bundled together into the Cal Poly Pomona EDAPTS Test Deployment Procurement Documentation Package, which can be online at http://www.path.berkeley.edu/PATH/Publications/PDF/PRR/2009/PRR-2009-05.pdf. The report documents the system procurement process, utilizing the EDAPTS procurement approach and methodology to create a set of requirements for the desired system, and includes both pre-procurement evaluation and definition of requirements, as well as the creation of a Request for Proposal to solicit bids.

Appendices to this report package include the Cal Poly Pomona EDAPTS Test Deployment Operations Descriptions, which describes the user features, operational needs and performance parameters considered during the procurement, and summarizes the results of the stakeholder workshops and assessment of operational scenarios performed to understand system user needs. The finalized and distributed EDAPTS Request for Proposal for Cal Poly Pomona is also included and may of use as a template or model for future procurements. This RFP builds upon the desired system user needs to provide detailed requirements for the intended usage of the system, a work schedule with deliverables and due dates, and the criteria for received proposal evaluation.

Also attached is the Cal Poly Pomona Test Deployment EDAPTS System Requirements and Performance Specification created using the EDAPTS Performance Specification Generator tool, which details system-wide requirements and requirements specific to components and elements within each subsystem of the desired system. The procurement team found these specifications useful in guiding them and the winning contractor during procurement and installation of the system.

DEPLOYMENT DOCUMENTATION

A comprehensive report entitled the Cal Poly Pomona Test Deployment System Installation and Technical Review Report details deployment process, from installation to system verification and validation processes for the Pomona system. It describes a number of critical system deployment activities after the RFP system supplier selection phase was completed, walks the reader through the process of creating good verification tests from the system performance requirements and providing a methodology that can be replicated by a transit property or
consultant, and demonstrates use of validation test procedures on the installed Pomona system. It can be found online at http://www.path.berkeley.edu/PATH/Publications/PDF/PWP/2009/PWP-2009-08.pdf.

The report provides small transit properties considering an APTS deployment with a detailed look at the installation, test, and operation of the installed system. It presents a set of insightful information on how an APTS solution is installed and tested, as well as how the system functions in real life. This can be of help to them as they try to grasp the complexity of an APTS solution and identify the necessary steps associated with their installation and test. Verification is performed using the test plan and procedures to verify the installed subsystems and functionality against the requirements of the Request for Proposal, and validation is performed using the Operations Description.

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**FINAL REPORT**

The final report of the Cal Poly Test Deployment builds upon the procurement and deployment documentation, and provides an overview of the entire project from procurement and installation to verification and validation. It focuses on collecting and summarizing all previous reports in this project, providing insights, recommendations and documenting the lessons learned during the demonstration.

The report summarizes the procurement process and explains its use of a modified version of the Federal Highway Administration (FHWA) Systems Engineering “V-model”. This modified V-model helped the research team and the stakeholders coalesce with a clear understanding of expectations of what the procured system needed to do. The EDAPTS procurement process used by Bronco Express demonstrated a practical procurement and bidding methodology useful to small and medium transit agencies when acquiring ITS solutions. The report also summarizes procedures that are effective in installing and testing lower-cost ITS systems and provides a practical methodology for verifying and validating them. Outcomes of using that methodology on the installed Bronco Express system are discussed and then compared with the results of the user needs and the performance specifications requested in the Bronco Express EDAPTS RFP.

Finally, it provides a detailed discussion on the effectiveness of using the EDAPTS approach for the procurement, installation, and operation of the Bronco Express EDAPTS system. This discussion concludes with a summary of lessons learned during the demonstration and recommendations for possible future enhancement of the EDAPTS approach to help assure the efficient procurement and deployment of APTS solutions in a small transit environment.
The EDAPTS 1.0 Mobile Data Terminals are prototype hardware which was built with a combination of off the shelf subsystems, e.g. motherboard, GPS receiver, and some custom elements, e.g. the case and a printed circuit board. Advantages of the EDAPTS 1.0 MDT include:

- Complete flexibility with respect to the software application which can run on it; it utilizes Linux operating system and presents a completely open architecture to the software developer
- It is extensible from a hardware port perspective; additional ports can be added through stack-on bus card connectors
- It is largely built from off-the-shelf subsystems, ensuring long-term maintainability and hence operability
- It is housed in a heavy-duty steel case and is well suited for installation in harsh transit vehicle operating environments
- It is extremely reliable, demonstrating this throughout years of operational service at SLO Transit.

The EDAPTS 1.0 MDT has several internal modules which are no longer commercially available. The x86 CPU, originally produced by WinSystems is no longer in production. WinSystems makes a newer CPU board which is pin and form-factor compatible, making it a potential drop-in replacement. The EDAPTS 1.0 MDT GPS receiver, originally produced by Motorola, is no longer in production, and hence a replacement must be found. The data format (NMEA) and physical interface (RS-232) utilized by this GPS receiver are standardized. It is anticipated that a replacement GPS receiver, which is protocol and interface compatible, can likely be found. The physical configuration, e.g. chip and pin layout, would likely be different.

The EDAPTS 1.0 MDT driver’s display and keypad are both still commercially available. It should be noted that although these two devices have worked with virtually no failures over the life of the project, they have limitations. The display is a bit small, requiring the driver to look carefully to read the information being presented. The keypad is similar to a telephone keypad, hence has limited ability for direct entry of anything other than numeric characters.

Another limitation of the EDAPTS 1.0 MDT is its limited ability for system administration; system technicians must manually plug a serial communications cable into the back of the MDT, start an application on a laptop, and then execute a series of keystrokes on the MDT while it is booting up to initiate data communications with the MDT. Upon completion of these steps, maintenance personnel may then browse the MDT file system, upload new
executables, or download various operational data logs. This process is time consuming and inefficient; updating files or retrieving data logs from a fleet of 14 buses takes one technician approximately three hours.

The vehicle-to-base station communications scheme utilized in EDAPTS 1.0 is still well suited for small transit properties and transit properties in rural areas where cellular data coverage may not be available. This communications scheme, which utilized radio modems in conjunction with a trunked, repeater-based radio system, has advantages which include potentially lower cost and the opportunity for satisfactory coverage in rural areas. Additionally, this communications scheme can be easily configured in various ways to best fit the needs of a transit property. First, the system can be configured for operation in a data-only capacity, allowing maximum throughput since the communications link need not be shared with voice communications traffic. This is advantageous because the system could potentially be initially configured for data and voice sharing the same channel, then reconfigured at a later date to be data only if data throughput needs change.

Another advantage to this data communications scheme is that data message delivery, e.g. vehicle position updates, can be adjusted to range from no guarantee of delivery requiring minimal communications resources to guaranteed delivery, which requires more resources. It is worth emphasizing the advantage of workable radio communications coverage in remote areas. The system, as installed in San Luis Obispo County, demonstrated itself to provide many opportunities for communicating a packet of data in some of the most remote parts of the county, where no cellular communications coverage exists, providing the opportunity for APTS deployment where it might not otherwise be possible. It is worth noting that this vehicle-to-base station communications link is of sufficiently low bandwidth that it will not support any remote administration of the MDT to any degree; files such as new executables are difficult at best to transfer from bases station to vehicle across a trunked radio network.

### DYNAMIC ROADSIDE INFORMATION DISPLAY

The EDAPTS 1.0 "Smart Transit Signs" have demonstrated themselves to be one of the strongest and most appealing elements of the original deployment, having worked well over the life of the system deployment. These signs have the highest potential for technology transfer of all aspects of the EDAPTS 1.0 system. The solar power design and has shown the ability to work well throughout all parts of the year in Central California, demonstrating the reliability of the design, and its potential for technology transfer. The vandal and weather-resistance of the sign has also been demonstrated, making the sign design well suited for a variety of application areas. The sign's flip-dot displays have also demonstrated themselves to be accurate and easy to read during daylight and when general area lighting is available during hours of darkness.

One limitation of the EDAPTS 1.0 signs are that they are somewhat tedious to assemble and deploy, due to the fact that they are constructed from a variety of COTS assemblies and that they were designed with limited resources as part of a research project. Future implementers of these signs should strive to reduce the weight of the sign, but this may be difficult to do while maintaining sufficient solar panel and display size. The availability of lower power components due to technology advances may make this transition easier.

The EDAPTS 1.0 signs utilize a commercial paging network to provide periodic vehicle location updates to the signs. This communications strategy has become outmoded due the general trend to move away from paging in
the advent of cellular phone communications. Other disadvantages to this data communications strategy are an extremely low baud rate and the inability to have guaranteed message delivery. The lack of guaranteed message delivery can cause some messages to get lost, reducing the accuracy of vehicle arrival time estimates displayed to the public. This paging-based data communications system is an applicable system solution where other communications schemes may not work due to lack of coverage over the service area. Of course, any system designer must ascertain the current and future availability of paging service.

The designs for the Smart Transit Sign and sign mounting post are available for download at the EDAPTS website http://itrans.calpoly.edu/EDAPTS.

**EDAPTS 1.0 SOFTWARE & SOURCE CODE**

The EDAPTS 1.0 dispatch software, which includes the Central Site Server, ATRMS Consoles, and the MDT software have both demonstrated reliability of implemented features during their seven years of use in San Luis Obispo Transit. This software exhibited flexibility with the addition of a student ridership validation feature as an add-on part way into the life of the system. This major feature addition demonstrated the extensible nature of the EDAPTS software architecture; new features are mapped from the National ITS architecture to the software process specifications, where appropriate code modules are added.

The custom-assembled distribution of GNU Linux created for use with the EDAPTS 1.0 MDT provides an extremely compact, low-resource base from which to build upon. The steps taken in its creation are detailed in the EDAPTS Phase II final report, permitting adaptation to other hardware architectures. It is also readily extensible both in terms of kernel and base system to allow addition of new hardware and devices.

The MDT software is written in C++ and the Central Server and ATRMS consoles are written in Java. These software packages were comprehensively designed around the National ITS Architecture and an early release of TCIP. The combination of these two design constraints has led to software implementation which is unwieldy to maintain and modify, albeit functionally complete and is extensible. This software presents a dichotomy of sorts; its significant flexibility aids in its extensibility, but this comes at the high price of being a complicated system to work on. As such, its applicability for reuse in future EDAPTS implementations may be limited.

The EDAPTS 1.0 sign software is written in assembly language, and hence is difficult at best to maintain and modify. The EDAPTS 1.0 sign software does contain a well thought-out approach to controlling the various resources within the sign, including features such as battery level monitoring, the estimation minutes until arrival of vehicles at stops with vehicle reports only originating from the system once per stop, power saving controls to electrically shut off some elements of the sign between display updates, and low-level control of the flip-dot displays. This software is not considered to have good potential for technology transfer from a direct application standpoint. The internal architecture and functionality of this software can provide an excellent algorithmic and functional basis for many aspects of sign control.
DEPLOYMENT SUPPORT

EDAPTS PERFORMANCE SPECIFICATION & DATA FORMATTING STANDARD

The Performance-Based Specification of EDAPTS was developed to promote industry adoption of the EDAPTS transit management system, and facilitate its deployment through comprehensive definition of the required performance of all EDAPTS elements. As such it has strong potential for technology transfer and can be used directly by potential vendor or suppliers to develop EDAPTS-conformant solutions or parts. The associated Data Formatting Standard builds up that specification by including communications data-formatting at the component level, providing a clean and unambiguous framework for EDAPTS component development and deployment. The Performance Specification Generator Tool can easily walk an interested party through creating customized performance specifications for a potential deployment.

DEPLOYMENT SUPPORT DOCUMENTS

The deployment support documents created during the Cal Poly Pomona Commercial Test Deployment represent an invaluable resource for both system procurers and suppliers alike and can be directly transferred. The Procurement Documentation Package provides methodologies for evaluating operational needs and requirements, and offers insights into the procurement process. It also serves as a guide with examples for those interested in creating their own APTS request for proposal package. The Deployment Documentation Package provides methodologies for verifying that the identified performance requirements have been met by the system supplier, and validating that the operational requirements have been achieved. The package includes evaluation worksheet templates, and serves as an example for verification and validation with the completed results of testing.
**TECH TRANSFER ACTIVITIES**

**COVALUATE**

The EDAPTS team met with Covaluate regarding the potential developing an EDAPTS 2.0 system which would be utilized by transit properties using a service-based business model. Covaluate expressed interest in developing the software aspects of EDAPTS 2.0 but indicated that they would like to find a hardware supplier/integrator to take care of all system installation and hardware maintenance work.

**ROUTEMATCH INC.**

Cal Poly EDAPTS researchers engaged RouteMatch corporation regarding their potential utilization of EDAPTS 1.0 hardware and software in future system deployments. RouteMatch indicated that they would be happy to interface to various system components by writing software-based data format translation modules, effectively translating any streams between EDAPTS 1.0 components and RouteMatch components into XML files with specified data formats.

**SYNCHROMATICS**

Syncromatics, the system supplier for the Bronco Express EDAPTS deployment at Cal Poly Pomona, was presented with the EDAPTS 1.0 release and associated documentation. Syncromatics deployed the Bronco Express system their proprietary system design, not utilizing any aspects of EDAPTS 1.0. This outcome was not unexpected as the Pomona EDAPTS test deployment budget was not sufficient for a system supplier to perform needed modifications and/or reimplementation of EDAPTS 1.0 system designs and software elements.
SUMMARY & RECOMMENDATIONS (CCIT & CPSLO)

MOBILE DATA TERMINAL AND ON-BOARD EQUIPMENT RECOMMENDATIONS

The EDAPTS 1.0 MDT should be used as a template for future on-board system designs, attaining increased performance while maintaining an open-architecture system which is flexible and extensible.

Specific improvements envisioned for the on-board equipment include:

1. A single-board solution
2. Up to six serial communications ports
3. Several digital I/O ports
4. Wireless Local Area Networking e.g. 802.11G
5. Wide area cellular data communications capability
6. An enhanced driver’s display with a larger touch screen, allowing easier reading and entry of information by the driver
7. A more compact package with few wires required to route through the driver’s compartment.

The existing MDT has all of the right pieces, they just require updating. Advantages will include dramatically increased processing power and likely reduced cost due to advances in electrical and computer engineering products, and higher levels of component integration at the present time as compared to the equipment available in 1998, when the EDAPTS 1.0 MDT was designed. Design attributes of a future EDAPTS MDT should include: simplicity of construction, extensibility of features, rugged construction, and ease of maintenance. Incorporating these aspects into the design of future MDTs has the potential to provide a low cost MDT which meets the needs of the transit industry. A potential EDAPTS system vendor should take advantage of the EDAPTS 1.0 design in conjunction with these aforementioned design attributes in the formulation of a new piece of on-board hardware.

As with the original EDAPTS MDT, the EDAPTS 1.0 MDT software can provide a good template for the future implementation of EDAPTS MDT 2.0 software. Use of this software as a template will help to ensure that the new software is comprehensive and extensible in its design. Specific recommendations for this future MDT software are:

1. Remove the constraint of mapping software functionality to the National ITS Architecture
2. Modify data objects to be conformant with a current version of Transit Communications Interface Profiles (TCIP)
3. Allow software development design freedom in all areas except for the requirement that all external interfaces are comply with TCIP
4. Ensure that any software application is functionally extensible to support APTS functionality which extend beyond the immediate needs of any given system slated for an EDAPTS 2.0 deployment
5. Be of an open architecture
Wireless data communications technology and its associated marketplace have changed dramatically since the development of EDAPTS in the late 1990s. Future EDAPTS implementations should be designed to take advantage of cellular data communications as well as other wide area communications schemes, such as the trunked radio data communications system utilized in EDAPTS 1.0. Being capable of utilizing either of these data communications technologies will provide the EDAPTS 2.0 MDT to be deployed into a variety of radio communications environments, effectively leveraging the best-fit communications system into an effective communications link between the vehicle and the base station.

Wireless local area networking, suitable for in-yard communications to transit vehicles, should be strongly considered as part of the EDAPTS 2.0 on-board equipment package. Such systems provide the ability for a system technician or administrator to easily "visit" each bus in a fleet to perform updates and download log files, etc., from all buses from within the confines of the maintenance and dispatch facility. Such a feature might not seem too important at the onset of system deployment, but can be extremely useful in the advent of deployment of advanced features such as on-board stop annunciation, maintenance of large passenger pass lists, etc.

**DYNAMIC ROADSIDE INFORMATION DISPLAY RECOMMENDATIONS**

EDAPTS 2.0 signs should be designed to be quick to assemble, install, test, and update. The data communications link to the signs should be revised to take advantage of either cellular data technology or other wide-area data transmission options. Selection of a new communications network should take into account useful functionality such as guaranteed message delivery, the ability to poll signs for diagnostic data, and the ability use support remote administration of the sign, allowing for remote updates to system timetables and software executables.

System designers should also consider modifying the sign system architecture from one of using broadcast updates with general vehicle location information applicable to multiple signs to sign-specific updates, where the estimated arrival time of vehicles at each stop is calculated for each sign and sent to specified signs. The former, where generalized broadcast messages were sent to all signs in the system, requiring each sign to calculate arrival times, may be impractical and unnecessary to cellular data communications architectures and throughput availability respectively.

Another consideration future sign designers might consider is the mounting of the solar panel on top of the sign. The configuration of EDAPTS 1.0 signs was such that the solar panel was fixed in a horizontal position, making it nearly invisible to a casual observer looking at it from the ground, making it advantageous from a vandalism perspective; if vandals don't know the panel exists, they are pretty unlikely to attempt to deface or destroy it. Modifying the solar panel mounting configuration to be non-horizontal or mounted on a different pole can have several advantages, including: a larger panel can be used, increasing the power generating capacity of the sign, the panel being aimed more directly at the sun, also improving power generating capacity also, and lastly, the potential to mount the sign on a different post, which may increase the potential locations a sign may be mounted if the solar panel can be mounted where sun exposure is available.
The EDAPTS 1.0 sign software should be rewritten in a higher level language such as C, allowing developers and system maintainers to work at higher level's of abstraction, simplifying software development, modification and troubleshooting.

The EDAPTS 1.0 signs utilize a commercial paging network to provide periodic vehicle location updates to the signs. This communications strategy has become outmoded due the general trend to move away from paging in the advent of cellular phone communications. Other disadvantages to this data communications strategy are an extremely low baud rate and the inability to have guaranteed message delivery. The lack of guaranteed message delivery can cause some messages to get lost, reducing the accuracy of vehicle arrival time estimates displayed to the public.

## EDAPTS SOFTWARE

EDAPTS Central Server, ATRMS Dispatch Client software, the MDT software, and the sign software should all be utilized as an intermediate point for the development of an EDAPTS 2.0 system. Although these software implementations are complete in their functionality, they are not ready for "primetime" deployment in additional transit properties. The organizational structure of EDAPTS 1.0, where distributed processes are heavily utilized, has merit. However, significant streamlining is necessary so that EDAPTS 2.0 software systems are not unnecessarily burdened by higher-level system requirements such as the National ITS Architecture. EDAPTS 1.0 attempted to create a client-agnostic system through the use of Java and the JVM. These efforts need to be continued in EDAPTS 2.0, except that the system should be client-agnostic at the user level, where any user with a standards compliant web browser can utilize the system.

All EDAPTS 2.0 software should be written to adhere to TCIP for all interfaces with outside elements, increasing the opportunity for EDAPTS system elements to be treated as commodities. All other software implementation details should be left to the software developer, allowing them to make design decisions based on system performance, ease of development and maintenance, and available hardware platforms.

EDAPTS 2.0 databases should be implemented so that system backups will be completed at regular intervals with minimal disturbance and distress to the system user.

All EDAPTS 2.0 software should be simple in their configuration; all required configuration details required to set up and operate the system should be within the knowledge realm of a transit manager or transit operations specialist. Other low-level technical details, such as computer networking configuration settings should be auto configuring and not require input from the system user. In short, the system should be easy to configure and operate by any person with general transit knowledge and specific institutional knowledge of their own transit property.

EDAPTS 2.0 sign software should be written in a high-level language, allowing for the abstracting low-level software functionality into easy to deal with functional elements. Such an approach will simplify software implementation and maintenance.
EDAPTS 2.0 software should be designed in a manner which allows seamless integration of different forms of wireless networking technologies with minimal effort, permitting incorporation of new technologies as they become available or cost-effective.

EDAPTS 2.0 software should be designed with data integrity as a key system requirement; all application data entering the system, which can include vehicle position updates, transit schedules, driver logins, passenger pass information presented at boarding, passenger counts and loading information, and driver’s emergency button activations, should be maintained in such a fashion to ensure its accuracy when it utilized at the time of its generation as well as in the future when it is incorporated into various system reports.

Future EDAPTS 2.0 software should be released under either the General Public License (GPL) or the Lesser General Public License (LGPL), maintaining the general EDAPTS precepts of open interfaces and an open architecture.

Lastly, EDAPTS 2.0 software should be designed to support incremental deployment as system requirements, resources, and transit staff capabilities evolve.
This tool is available as a separate zip file submitted along with this final report. The figure below shows the initial screen of this tool when installed and run.