Mobility Management Technology

Requested by
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Table of Contents

Executive Summary

Background

Caltrans is responsible for administering Federal Transit Administration grant funds for the Section 5310 Program, which helps local agencies provide transportation to elderly people and those with disabilities. These funds can now be used to implement mobility management projects, which leverage multimodal partnerships and technology to enhance service options and effectiveness. To help these mobility management projects be successful, Caltrans is interested in identifying the most effective technology solutions available so that it can recommend them to local agencies. Recent case studies on mobility management projects have highlighted the cost savings and other benefits that can be achieved when the right technology and practices are implemented together.

To assist with this information need, CTC & Associates:

- Reviewed the available literature on mobility management software (including trip scheduling, service coordination among agencies and modes, and coordination of multiple services within an agency).
- Interviewed local agencies regarding their experiences using mobility management software, including successes and challenges.

Summary of Findings

Transit Organization Interviews

- For paratransit scheduling, two of the interviewed agencies use Trapeze PASS, one RouteMatch, one StrataGen, and one Mobilitat Easy Rides. The leading vendors in this area are Trapeze and RouteMatch. Trapeze offers comprehensive packages that include an array of other mobility management technologies.
- Staff at the Transit Authority of River City (TARC) in Louisville, Kentucky, offered a detailed account of the agency's experience with Trapeze, which has been generally positive. TARC staff spoke highly of Trapeze customer service, but noted that implementation is complicated and requires close collaboration with the vendor.
- The Regional Transportation District (RTD) in Denver uses RouteMatch for its ADA service but developed custom software years ago for its Call-n-Ride service, which is open to the public. RTD found that the capabilities of the off-the-shelf software options available at the time were too limited for the on-demand response required by the Call-n-Ride. See Appendix A for a presentation on Denver's Call-n-Ride.
- The San Francisco Municipal Transportation Agency is working with City Innovate to pilot an innovative mobility management system that can be expanded to cities nationwide.

Related Resources

- A 2009 report from an Idaho metropolitan planning organization provides a comprehensive review of mobility management technologies. The report gives an overview of technology types (automatic passenger counters, automatic vehicle location, fare collection, intelligent transportation systems, paratransit scheduling, service coordination, and traveler communication systems) and available vendors.

- As the mobility management software industry matures, the standardization of data for use by application developers is of growing importance. A 2013 report from the Transit Cooperative Research Program (TCRP) addresses this issue.
- A TCRP project anticipated to begin later this year seeks to create open-standard software specifications for demand-responsive transportation (DRT) transactions including real-time service discovery, trip booking, trip accomplishment, third-party billing, and reporting.
- A 2015 Florida DOT study reviewed the use of mobility management technologies by Florida paratransit providers. The study found that 50 percent used RouteMatch or CTS Software systems for scheduling, 36 percent used Trapeze PASS and 14 percent used other systems, such as StrataGen and Ecolane.

Gaps in Findings

- We found little in the literature that spoke to the relative merits of different vendors for mobility management technologies.
- Interviewees for this Preliminary Investigation could not always speak directly or comprehensively to the challenges and benefits of mobility management technologies, especially in comparison to other systems.

Next Steps

Moving forward, Caltrans could consider:

- Following up with James Sackor of TARC's paratransit contractor, First Transit, which has experience with RouteMatch in comparison to Trapeze.
- Reviewing U.S. DOT's April 2016 mobility management webinar. (See page 6 of this Preliminary Investigation.)
- Contacting City Innovate, which in the next few months will have more information on the mobility management system it plans to pilot in San Francisco.

Detailed Findings

Mobility Management Software Vendors

Based on our literature review, the most common mobility management software vendors are:

- RouteMatch: http://www.routematch.com/
- Trapeze: http://www.trapezegroup.com/demand-response-scheduling-dispatching-solution
- StrataGen: http://stratagen.com/
- Ecolane: http://www.ecolane.com/

Other vendors include:

- CTS Software: http://www.cts-software.com/
- EnGraph: http://engraph.com/
- HB Software Solutions: http://www.hbssonline.com/
- Logic Transport: http://www.thelogictransport.com/
- Logic Tree: http://www.logictree.com/
- Mobilitat Easy Rides: http://www.mobilitat.com/
- RideExpress: http://www.rideexpress.com/
- Shah Software: http://www.shahsoftware.com/
- TripSpark: http://www.tripspark.com/
- Unified Dispatch: http://www.unified-dispatch.com/

Transit Organization Interviews

To gather information about transit organizations' use of mobility management software, CTC conducted phone interviews with representatives of the following organizations:

- Transit Authority of River City (TARC)—Louisville, Kentucky
- Regional Transportation District (RTD)—Denver
- Pace—Chicago area
- Suburban Mobility Authority for Regional Transportation (SMART)—Detroit
- Tompkins Consolidated Area Transit (TCAT)—Ithaca and Tompkins County, New York
- City Innovate—San Francisco
- COAST/Council on Aging & Human Services—rural Washington and Idaho

Transit Authority of River City (TARC)—Louisville, Kentucky

TARC website: https://www.ridetarc.org/
Interviewees:

- Priscilla Rao, Director, TARC3 Paratransit & Customer Service, 502-213-3245, prao@ridetarc.org.
- Isis Phillips, Trapeze Software Support Analyst, 502-213-3207, iphillips@ridetarc.org.

Priscilla Rao
TARC uses Trapeze PASS for its services, and does not coordinate with other agencies. TARC has two contractors: First Transit, which connects with TARC through its own Trapeze PASS software; and Yellow Cab, which receives trip manifests from TARC via Citrix connection but isn't integrated with Trapeze to receive all trip data automatically. Instead, Yellow Cab staff manually enter data. TARC is currently working with Yellow Cab's software company (DDS) and Trapeze to fully integrate them using the Trapeze Trip Broker module. Rao referred us to Isis Phillips, TARC's Trapeze software support analyst, for more information.

Isis Phillips
TARC uses Trapeze PASS for both paratransit services and fixed-route bus services. According to Phillips, the strength of Trapeze is its versatility: for TARC, it can be used for just about every transit-related function except for some billing, all in one package. TARC primarily uses it for scheduling, but other functions include managing performance data (including the timeliness of trips completed by contractors), reporting, and handling complaints. The software also manages TARC's data for the National Transit Database.

While it comes with some great features, like all software Trapeze has both positives and negatives. One positive is Trapeze's customer service; the company is currently helping TARC with an upgrade. TARC has a strong relationship with Trapeze, and using the software successfully requires building such a relationship.

TARC allows users to book trips via a Web-based interface or the phone, but it is also developing a mobile app. Phillips noted that many customers prefer to call or have caretakers call rather than use more complicated technologies.

TARC will soon test a Trapeze feature that allows coordination between fixed-route services and paratransit. This feature provides the route and time of travel for a fixed-route vehicle and then coordinates with a paratransit trip.

The Trapeze upgrade process has been a challenge for TARC, requiring significant collaboration with Trapeze's small customer service team. But overall, Trapeze customer service is good, and there are numerous resources for obtaining information on the product, including an online forum for transit agencies using Trapeze.

TARC has used Trapeze for 15 years, and before that used RouteMatch. Phillips was unable to comment on RouteMatch, but referred us to James Sackor (502-994-6670, james.sackor@firstgroup.com) of TARC's paratransit contractor, First Transit, which has experience with both RouteMatch and Trapeze. We were unable to reach Sackor within the scope of this Preliminary Investigation.

Related Resources:

- American Public Transit Association (APTA) profile of TARC's mobility management efforts: http://www.apta.com/resources/hottopics/mobility/profiles/Pages/Louisville.aspx

Regional Transportation District (RTD)—Denver

RTD website: http://www.rtd-denver.com/
Interviewee: Jeff Becker, Senior Manager of Service Development, 303-299-2148, jeff.becker@rtd-denver.com.

RTD includes metro area bus and rail and two kinds of paratransit services: ADA complementary service for those with disabilities, and a Call-n-Ride that is open to the public. RTD uses RouteMatch software for the ADA service and a custom software solution for the Call-n-Ride.

Years ago, RTD looked at RouteMatch and other vendors for the Call-n-Ride, but these applications didn't have suitable features, including the ability for customers to call with as little as two hours notice rather than a day ahead. There were other necessary configurations, such as checkpoints and zones, that the vendors didn't support at the time. Becker noted that software packages have undergone a lot of development since that time, and said Trapeze and RouteMatch are the leaders in this area.

The ADA service requires the use of reservationists for callers, whereas the Call-n-Ride is completely automated (like Lyft and Uber) and can be booked by mobile app. With no need for dispatchers, the Call-n-Ride is a quarter of the cost of the ADA service.

For details on Denver's Call-n-Ride, see Appendix A for a presentation Becker delivered to a U.S. DOT workshop in May 2016. Slide 14 includes information on costs.

Challenges using scheduling software include figuring out a configuration; there are many different configurations depending on the services to be provided. Further, using a vendor locks an agency into that vendor and to paying annual support fees. The industry is standardizing data interchange in ways that give agencies more options (similar to Google Transit). Agencies can develop custom applications using these data sets, or take advantage of the many third-party applications that use them. Becker recommended that agencies require their vendors to use the new data standards, which also helps with interoperability and coordination within the agency and with other agencies. Ultimately, the primary challenge is how to put together multiple technologies and make them work together well.

Becker presented a case study during a U.S. DOT webinar on mobility management in April 2016. A recording of the webinar is available at https://www.pcb.its.dot.gov/t3/s160414_Mobility_Options.asp; Becker's presentation slides are available at https://www.pcb.its.dot.gov/t3/s160414/s160414_Mobility_Options_presentation_Becker.pdf.

Related Resources:

- APTA profile of RTD's mobility management efforts: http://www.apta.com/resources/hottopics/mobility/profiles/Pages/Denver.aspx

Pace—Chicago area

Pace website: http://www.pacebus.com/
Interviewee: Thomas (T.J.) Ross, Executive Director, 847-228-2301, t.j.ross@pacebus.com.

Pace has used Trapeze for more than 20 years and has no experience with other software packages. Because Pace provides all the ADA services throughout the Northeast Illinois region (including Chicago), there are no coordination issues with external agencies. Agencies and municipalities that buy services from Pace set their own rules for coordinating their services, and Pace manages these services within Trapeze. These services include fixed-route vehicles and paratransit.

Pace is moving toward a centralized call-taking reservation model for the region (which has a population of 8 million). Pace uses a number of different contractors to provide services, and through its centralized systems assigns the work in a way that meets ADA requirements and minimizes costs.

Ross declined to comment on whether he recommends Trapeze, but he noted that the software will only save money if agencies reform their procedures to be consistent with it. Otherwise staff will continue to use processes and record-keeping methods that fall outside of the software system and duplicate its data. Trapeze has helped Pace improve its productivity and deliver its services under budget.

Related Resources:

- APTA profile of Pace's mobility management efforts: http://www.apta.com/resources/hottopics/mobility/profiles/Pages/Pace.aspx

Suburban Mobility Authority for Regional Transportation (SMART)—Detroit

SMART website: https://www.smartbus.org/
Interviewee: Mel Evans, Manager of Information of Technology, 248-419-7910, mevans@smartbus.org.

SMART upgraded its automatic vehicle location (AVL) system in 2011. The system now provides much more information on ridership—which service is being used at which times—so that it's possible to reallocate resources as necessary. The new system also makes it possible to provide riders with a mobile app that shows where buses are on a map and when they reach their stops. SMART's AVL vendor is Clever Devices.

The use of AVL has been a challenge in the sense of the complexity of implementation, as well as "technology overload" for staff. But SMART is very happy with it, and it is helping to improve service.

For paratransit scheduling, SMART uses StrataGen and has used it for several years, but is exploring the possibility of switching to a new product. Evans said StrataGen has been very helpful for scheduling, and other alternatives seem to be very expensive. But he said it may be possible to leverage better use of time and resources with newer software that works well with

other advances in technologies—for instance, the ability to use a tablet in buses instead of a mobile data computer.

Related Resources:

- APTA profile of Detroit's mobility management efforts: http://www.apta.com/resources/hottopics/mobility/Documents/Business-Case-for-Mobility-Management.pdf (pages 4 to 5).

Tompkins Consolidated Area Transit (TCAT)—Ithaca and Tompkins County, New York

TCAT website: http://www.tcatbus.com/ride/
Interviewee: Dwight Mengel, Chief Transportation Planner, Tompkins County Department of Social Services, 607-274-5605, dwight.mengel@dfa.state.ny.us.

TCAT provides a number of services, including fixed-route buses, paratransit services for both ADA and non-ADA users, subsidized taxi services, and contracted ridesharing through ZimRide, Ithaca Carshare, and several other services. There is no centralized dispatch for these services, although there is a community mobility education portal pointing users to them: http://ccetompkins.org/community/way2go. TCAT also has a trip planner developed in 1999 by Cornell University students (http://tcat.nextinsight.com/), but there is no central planner connecting modes. TCAT buses have used GPS since 2000; this is tied into the fare system but not used for transmission of data or for operational use.

Mengel is interested in developing local, open-source apps that will document and mitigate trip failure by providing a layered response (for instance, documenting when a taxi fails to pick up a client and providing an alternate service).

TCAT is currently engaged in two major ITS projects. The first is working on real-time passenger information and a Google Transit feed that app developers can use. Avail Technologies is the vendor. The second (not yet at the procurement stage) is a demand response system for picking up individuals at home. TCAT is interested in what QRyde (http://www.qryde.com/) is doing in this area; Mengel noted that they seem to be affordable and have a Web-based trip management system that can be used for on-demand response services.

See Tompkins County Coordinated Transportation Planning (http://www.tccoordinatedplan.org/) for projects being evaluated by TCAT.

Related Resources:

- APTA profile of TCAT's mobility management efforts: http://www.apta.com/resources/hottopics/mobility/profiles/Pages/IthacaandTompkinsCounty.aspx

City Innovate—San Francisco

San Francisco Municipal Transportation Agency (SFMTA) website: https://www.sfmta.com/
City Innovate website: http://cityinnovate.org/
Interviewee: Gert Christen, Director of Technology, 650-441-6299, gert@cityinnovate.org. Referred by: Timothy Papandreou, Director, Office of Innovation, San Francisco Municipal Transportation Agency, 415-297-8493, timothy.papandreou@sfmta.com.

SFMTA referred us to City Innovate, which was founded two years ago to solve the shared technology problems of cities trying to provide mobility on demand. City Innovate intends to work with SFMTA to implement its solution, the San Francisco Mobility On Demand Project, as a pilot in San Francisco but with a view to expanding to other cities. This product will integrate various modes and provide apps that make it possible to book a multimodal trip (including bikesharing, carsharing and transit) through the San Francisco area using one interface. City Innovate will have more information on this project in late 2016.

Related Resources:

- APTA profile of SFMTA's mobility management efforts: http://www.apta.com/resources/hottopics/mobility/profiles/Pages/SFMTA.aspx

COAST/Council on Aging & Human Services—Rural Washington and Idaho

COAST website: http://www.coa-hs.org/
Interviewee: Suzanne Seigneur, Transportation Director, 509-397-2935, sseigneurcoast@gmail.com.

COAST uses Mobilitat Easy Rides, which Seigneur described as being lower in cost and having fewer features than other paratransit scheduling software. Seigneur is a new transportation director and wasn't able to speak to the quality of the software. This is the only software COAST uses, and the organization is not yet automated in any other way.

Related Resources:

- APTA profile of COAST's mobility management efforts: http://www.apta.com/resources/hottopics/mobility/profiles/Pages/COAST.aspx

Related Resources

National Guidance and Research

American Public Transportation Association
http://www.apta.com/Pages/default.aspx
This site includes numerous resources related to mobility management, including several links to case studies of transit organizations engaged in mobility management:

- Making the Business Case for Mobility Management
  http://www.apta.com/resources/hottopics/mobility/Pages/MakingtheBusinessCase.aspx

- "The Business Case for Mobility Management," white paper, Jon Burkhardt and Jim McLary, undated.
  http://www.apta.com/resources/hottopics/mobility/Documents/Business-Case-for-Mobility-Management.pdf

- Mobility Management Profiles (agency case studies)
  http://www.apta.com/resources/hottopics/mobility/profiles/Pages/default.aspx

U.S. DOT Accessible Transportation Technologies Research Initiative
http://its.dot.gov/attri/
From the home page:

> The Accessible Transportation Technologies Research Initiative (ATTRI) is a joint U.S. Department of Transportation (USDOT) initiative, co-led by the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), with support from the Intelligent Transportation Systems (ITS) Joint Program Office (JPO) and other Federal partners. ATTRI conducts research to improve the mobility of travelers with disabilities through the use of ITS and other advanced technologies. ATTRI leads the research, development, and implementation of transformative technologies, solutions, applications, or systems for people of all abilities to effectively plan their personal and independent travel. ATTRI will enhance the capability of travelers to reliably and safely execute independent travel. ATTRI will identify, develop, and deploy new transformative technologies, applications or systems, along with supporting policies and institutional guidance, to address mobility challenges of all travelers, in particular, travelers with disabilities.

Innovative Operating Strategies for Paratransit Services, Final Report, Transit IDEA Program, November 2013.
http://onlinepubs.trb.org/Onlinepubs/IDEA/FinalReports/Transit/Transit73.pdf
This project explores strategies for operating ADA paratransit services. From the abstract:

> This project had two stages. In the first stage, the authors proposed three new policies allowing providers to serve a given zone to pick up out-of-zone passengers that are in need of their return trip to this zone. Among these new polices, two of them base the customer assignment decisions on the relative distance between pick-up and drop-off locations. The research team developed new algorithms that incorporate the proposed strategies into the scheduling and developed simulation models that replicate the paratransit operations. The authors completed the development of the static and dynamic model and validated them with simulated schematic cases. In the second stage of the project, they evaluated the effects of implementing their proposed operation strategies using a simulation platform they developed and real demand data collected from Houston, Los Angeles and Boston.

Simulations were first performed assuming Manhattan distances and then using real network distances calculated with ArcGIS geocoding and network analyst software to carefully replicate real operations. Simulation results showed that, without sacrificing customers' level of service, the best policy can significantly reduce the inefficient empty trip miles by up to 23%. As a result, it can save up to 6.6% assigned vehicles, lower the total mileage by 9% and improving the passenger trips per revenue hour by 7.8%, indicating a significant saving in operation cost and improvement in productivity by adopting the proposed policy while maintaining a reasonable level of service quality. The authors expect that the implementation of the operation strategies will have these noticeable benefits: maintain a zoning structure for easier overall management and better reliability; reduce the empty trip miles to lower operating costs; and improve the passenger trips per revenue hour; and allow cross-zonal customers to book both legs of their round-trip ride with the same provider, for an improved level of service. The simulation model developed here can be served as a powerful and effective platform to test and evaluate different paratransit operation policies.

Standardizing Data for Mobility Management, Transit Cooperative Research Program (TCRP) Web-Only Document 62, 2013.
http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_w62.pdf
From the abstract:

This research was conducted to assess the exchange of (computer based) data between transportation providers, brokers, customers and human service agencies for successful mobility management undertakings. The goal of this research is to identify opportunities for the standardization of data relevant to mobility management systems, focusing on realistically achievable objectives that can be attained in the near-term, including possible specifications, and which can also contribute to more ambitious outcomes over a longer time frame. This research examined the types of data that are used in technologies that are part of mobility management systems as well as the environment in which these software systems function. The recommendations address: 1) where data standards will provide value for mobility managers; 2) the specific data and related protocols needed for improved functionality; and 3) guidelines for procurement specifications for agencies purchasing new technology for mobility management. This report presents the research findings and conclusions. It includes a survey of both private vendors of scheduling and dispatch software and a range of transportation agencies considered to be on the advance edge of standardized data and/or are Veterans Transportation and Community Living Initiative (VTCLI) grantees.

Related Resource:

"Human Services Transportation Data Standardization and Interoperability," U.S. DOT webinar presentation, Lawrence Harman, Bridgewater University, April 2016. Presentation description: "A report on a year-long effort by the FTA to build on the Transit Cooperative Research Program (TCRP) project 'Standardizing Data for Mobility Management' to create consensus on an approach to open data exchange (interoperability)."

- Presentation slides: https://www.pcb.its.dot.gov/t3/s160414/s160414_Mobility_Options_presentation_Harman.pdf
- Webinar recording: https://www.pcb.its.dot.gov/t3/s160414_Mobility_Options.asp

Developing Regional Mobility Management Centers, Final Report, Jon E. Burkhardt, Westat, in conjunction with Mobilitat Inc., Project 50, Transit IDEA Program, October 2012.
http://onlinepubs.trb.org/Onlinepubs/IDEA/FinalReports/Transit/Transit50.pdf
Abstract:

The purpose of this Innovations Deserving Exploratory Analysis (IDEA) project was to carry out the initial phase of what the author proposes to be a multi-phase program to develop innovative low-cost management protocols and software that mobility management call centers can use to better organize, coordinate, schedule, dispatch, and monitor service programs which use transportation as one component of their service delivery strategy. These functions can be integrated with an array of Transportation Demand Management (TDM) strategies to significantly reduce trip costs. This "strategic mix" of transportation solutions has the potential to increase transit and ridership and generate new revenue streams for the transit and paratransit industry, particularly from payers of health and human services. The innovation that is the focus of this project is the development of management protocols and software packages that make transit and paratransit services more attractive to other partners, including health care providers, in coordinated community transportation operations. This project examined the potential of the organization and coordination of these activities to be accomplished through a unified regional mobility management call center that accepts customer service requests and efficiently assigns transportation or other resources to meet those requests.

Research in Progress

Development of Open Data Standards for Demand Responsive Transportation Transactions, Transit Cooperative Research Program (TCRP) project G-16. The details of this project are currently being scoped by the project panel.
http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4120
From the project description:

The objective of this research is to organize private, public, and academic stakeholders to create open standard software specifications for [demand-responsive transportation (DRT)] transactions including real-time service discovery, trip booking, trip accomplishment, third-party billing, and reporting. The proposed research may include a review of historic public domain projects that provide open standards for dial-a-ride transportation (DART) in the U.S.; current efforts at promoting open data standards within the U.S., Europe, and similar global initiatives; creation of a working group for DRT open standards development; the development of DRT open standards for presentation to the transit industry standards granting body; revision of draft standards, as necessary; publication of the final approved DRT open data standards; and presentation to international standards organizations, as appropriate.

Related Research and Resources

"Improving Performance and Productivity: Technology Impacts on Paratransit Services in Florida," Nevine Labib Georggi, *TRB 95th Annual Meeting Compendium of Papers,* Paper #16-4207, 2016.
Abstract at http://trid.trb.org/view/1393577
Abstract:

> This paper discusses the impacts of various technologies applied to paratransit services to increase operational efficiencies to provide quality transit service, even with funding limitations and increasing demand for paratransit. This paper defines paratransit services as complementary Americans with Disabilities Act services and door-to-door services including those provided by Community Transportation Coordinators. This paper summarizes the findings of an online survey conducted in February 2015 as part of a study that investigated the impacts of applying technologies in paratransit, in particular: reservation, scheduling, and dispatching software, mobile data terminals, global positioning systems, automatic vehicle location, advanced telephone systems, and vehicle security cameras. The performance measures studied included system productivity (passengers served per revenue hours), on-time performance, reduction of no-shows, driver performance, and customer satisfaction. Respondents rated security camera systems as providing the most 'bang for the buck'. The most cited technologies affecting customer satisfaction were mobile data terminals (60%) and vehicle security cameras (59%). On-time performance was most impacted by mobile data terminal deployments (64%) followed by scheduling software (63%). Since many agencies deployed technologies a few months prior to the survey rendering assessment of return on investment premature, a follow-up survey is recommended. A national survey is also recommended to collect data and develop means to analyze the benefit/cost from deploying the different technologies.

Technology Application Among Florida Community Transportation Coordinators, Florida Department of Transportation, 2015.
http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_TD/FDOT-BDV26-977-06-rpt.pdf
From the abstract:

> This report will help agencies apply effective practices that have been successful in solving challenges with the application of new innovative technologies that are available to the industry. An online survey of paratransit providers in Florida and visits to seven sites were conducted to gather case examples and lessons learned from the deployment of reservation, scheduling, and dispatching software; mobile data computers or terminals; global positioning systems; automatic vehicle location; advanced telephone systems; and vehicle security cameras. Practical lessons learned can inform agencies seeking to deploy similar technologies in the areas of vendor selection, system selection, and transitioning. The study recommends a follow-up survey because a majority of agencies deployed these technologies only a few months prior to the survey and interviews, rendering assessment of the return on investment premature.

The report covers the following types of technology:

- Reservation, scheduling and dispatching software.
- Mobile data terminal communication.
- Global positioning systems (GPS).

- Automatic vehicle location (AVL).
- Advanced telephone systems.
- Vehicle security cameras.

For scheduling, the study found that 50 percent of respondents used systems from RouteMatch or CTS Software, 36 percent used Trapeze, and 14 percent used other systems, such as StrataGen and Ecolane (see page 13 of the report). Forty-three percent of agencies using scheduling software reported a significant or moderate impact on labor costs (page 15), 55 percent a significant or moderate impact on customer satisfaction (page 16), and 63 percent a significant or moderate impact on on-time performance (page 17). The report includes similar statistics for other types of technology.

See Chapter 4 for case examples and lessons learned based on site visits to agencies, with extensive information on technologies used, lessons learned, and costs and benefits.

The report includes the following lessons learned concerning vendor selection for paratransit scheduling software (excerpted from page viii):

- Vendors should be able to provide references, and agencies should take the time to interview these references. Building upon the research presented in this report, peer agencies should be asked about their experiences with vendor technical support, training, and availability via phone or in person and their timely responsiveness to issues/challenges that come up during transition from old to new system, updates, and customer service beyond the transition. A vendor's timely response to peer agencies is a good indication of its availability.
- Hands-on training provided by the vendor is key to the success of transitioning to new systems. Agencies should make sure many opportunities are provided for training of staff and operators. In addition, agencies should set up train-the-trainer sessions so staff are confident in training new operators on the system even after transitioning is completed. Agencies can make sure that the contract includes training and/or online educational sessions for their staff.

"RouteMatch: Tour Reveals Customer-Driven Approach," *Georgia Transit Tour 2014*, pages 26-29, Community Transportation Association, December 2014.
http://web1.ctaa.org/webmodules/webarticles/articlefiles/GeorgiaTransitDay1.pdf
This article profiles RouteMatch as a company, including its integration with smartphones and reputation for customer service.

Kent, Ohio, Traveler Management Coordination Center (TMCC), Portage Area Regional Transportation Authority, Federal Transit Administration report, March 2014.
http://ntl.bts.gov/lib/55000/55500/55546/FTA_Report_No._0063.pdf
This report describes the development of a travel management coordination center with the assistance of Trapeze. The report includes a discussion of system functional requirements and software. See pages 55 to 72 for an overview of Trapeze Community Connect that includes a step-by-step process example with screenshots.

Louisville Region Demonstration of Travel Management Coordination Center: System Pre-Deployment Preparation, Transit Authority of River City, Federal Transit Administration report, March 2013.
https://www.transit.dot.gov/sites/fta.dot.gov/files/FTA_Report_No._0040.pdf
Abstract:

> The purpose of the Greater Louisville Region Demonstration of Travel Management Coordination Center (TMCC): System Pre-Deployment Preparation grant was to further phased implementation of the region's TMCC design by focusing on two major components. One component was "Travel Management Information Integration" to design and build integrations with phone systems to improve customer service. Tasks chosen were to improve and increase ways customers can interact with the TMCC and to improve service efficiency. Activities centered on testing an interactive voice response (IVR) system, including automated "day-before reminder" and "10-minute alert" calls to a volunteer group of paratransit customers. The other major component was "Coordination Model Enhancement." The intent was to develop new procedures and/or streamline existing processes to improve efficiency and the ability of the TMCC to manage multiple transportation providers and funding sources. Activities included optimizing use of existing Trapeze PASS software by obtaining consulting services to identify issues and increase staff knowledge of the software programs' functions and features. Evaluation tools included surveys, performance monitoring, and customer and staff feedback. Pre-deployment results indicate that implementation of these changes can improve customer satisfaction, service efficiency, and the ability to coordinate services.

"Applying Fixed Route Principles to Improve Paratransit Runcutting," Keith Forstall, Trapeze, *2012 Bus & Paratransit Conference,* 2012.
Abstract at http://trid.trb.org/view/1224918
Presentation slides:
http://www.apta.com/mc/bus/previous/2012/presentations/Presentations/Applying-Fixed-Route-Principles-to-Improve-Paratransit-Runcutting.pdf
This presentation by Trapeze staff describes the use of Trapeze for runcutting, in which vehicle runs and driver assignments are restructured so that as many trips as possible can be generated with the least wasted capacity.

From the abstract:

> Trapeze has introduced software that allows users of its paratransit scheduling software to perform an automated runcut. This allows the user to do in minutes what previously took hours or even days to perform. The approach taken with this technology combines automation of the steps that require large amounts of number crunching with user freedom to step in and make manual choices at key decision points along the way. Although a key benefit of the technology is its capability to mine historical data, it is conceivable that other sites with some third party scheduling software might nonetheless want to be able to enjoy the benefits of automated runcutting. The software has been designed to make this feasible as a future enhancement, either on a standalone basis or possibly even supported by a standard public interface.

Evolution of Intelligent Transportation Systems for Mobility Management and Coordination Serving California's Rural Frontier, Modoc County Transportation Commission, Federal Transit Administration report, January 2012.
http://ntl.bts.gov/lib/55000/55400/55492/FTA_Report_No._0006.pdf
Abstract:

This report documents the evolution, development, and lessons learned while attempting to identify, modify, and deploy Intelligent Transportation System (ITS) and advanced technology tools to facilitate coordination of public transit and social (human) service transportation and mobility management in a "one stop shop" located in Modoc County (northeast), California. The report summarizes planning and coordination efforts; shares challenges, lessons learned, and outcomes; and concludes by identifying some issues and structural obstacles that diminish usability and impede transfer of functional ITS tools for purposes of data collection, management, and reporting.

Technology in Mobility Management: Coordinating and Improving Services in Southwest Idaho, Compass Community Planning Association of Southwest Idaho, September 2009.
http://www.compassidaho.org/documents/prodserv/reports/TechonolyReportFINAL_Sep2009.pdf
This report provides a comprehensive inventory of technologies for mobility management, and lists vendors for these technologies. Categories of technology include:

- Automatic passenger counters
- Automatic vehicle location
- Fare collection
- Intelligent transportation systems
- Paratransit scheduling
- Service coordination
- Traveler communication systems

Vendors for paratransit scheduling include:

- RouteMatch
- Mobilitat
- Trapeze
- RideExpress
- RouteLogic
- Ontira
- Mentor Engineering
- Logic Tree
- Logic Transport
- IE Logistics
- Ecolane
- CTS Software

RouteMatch and Trapeze products also include automatic vehicle location and service coordination.

Operational Test for the Implementation of Advanced Technologies in Rural Transit Service, Eastern Carolina Council, Federal Transit Administration report, May 2009.
https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/OperationalTest_Implementation_of_Advanced_Technologies_Rural_Transit_Service_%28FinalReport%29.pdf
This project evaluated the feasibility of using RouteMatch transit management software in eastern North Carolina "with the goals of increasing efficiency, lowering operating costs, improving customer service, and encouraging trip coordination between transit agencies." The report includes a performance evaluation, as well as a survey and follow-up interviews with Eastern Carolina Council staff. Findings include:

- Several factors led to the staff not using RouteMatch's features for creating more efficient schedules and routes, including staff turnover, lack of training, and time spent troubleshooting software problems. Further, "Early attempts to use the optimized scheduling features were generally met with disappointment" because of inaccuracies in suggested routes and estimated route times (see page 6 of the report).
- Transit managers were not impressed with RouteMatch's module for trip coordination between transit agencies (page 7).
- RouteMatch did seem to have better data management features than previously used software, with advanced querying and reporting functionality that improve decision making (page 9).

The report concludes that "inaccurate and incomplete street centerline data" was the biggest obstacle to using RouteMatch.

"An Evaluation of RouteMatch Software in the Billings, MT, Special Transit System," *Journal of the Transportation Research Forum*, David Kack and Deepu Philip, Volume 47, Issue 3, pages 45-60, 2008.
http://ageconsearch.umn.edu/bitstream/206962/2/2111-4166-1-PB.pdf
This project evaluated the use of RouteMatch for scheduling and dispatching at the Billings MET Special Transit system. The paper concludes that (see page 45):

> MET Special Transit operations were slightly more efficient after the software was installed, evidenced by an increase in rides per hour and rides per mile. A slight increase in efficiency will lead to the break-even point where the software will begin to pay for itself. Surveys of dispatcher and driver attitudes showed that dispatchers believed that the RouteMatch software helped them accomplish their tasks better than the previously-used software, while drivers preferred the manifests provided by the old software.

See page 49 of the paper for a chart of the differences in rides per mile and rides per hour before and after use of RouteMatch, and page 53 for charts comparing pickup times.

Improving Capacity Planning for Demand-Responsive Paratransit Services, University of Minnesota, Minnesota Department of Transportation, April 2008.
http://www.lrrb.org/media/reports/200809.pdf
This report describes an optimization of Trapeze to improve the efficiency of paratransit operations in Minneapolis and St. Paul, Minnesota.

"Implementing ITS at New York City for Para-Transit Service," *15th World Congress on Intelligent Transport Systems and ITS America's 2008 Annual Meeting,* 2008.
Abstract at http://trid.trb.org/view/902807
Abstract:

This paper describes the 2007 improvements made by New York City Transit (NYCT) to its Adept system, which schedules up to 22,500 para-transit trips on weekdays. Municipalities offer heavily subsidized door-to-door transit service for the elderly and handicapped that are unable to use the fixed-route bus system, as mandated by the Americans with Disabilities Act. Adept is StrataGen's automatic scheduling & dispatching system. However, there are often changes on the day of service, due to changes in the trip set and to unpredictable traffic conditions. The 2007 improvements features an intelligent transportation system (ITS) Automatic Vehicle Location and Monitoring (AVLM) project to equip all vehicles with automatic vehicle location and mobile data computers (AVL/MDC). This system enables Adept to be automatically updated with the actual world state in real-time, thus freeing dispatchers to take corrective action based on accurate data, and to communicate manifest changes to drivers in real-time. The authors report AVLM project status and enhancements to the Adept system that have been able to maintain responsiveness in light of the unprecedented volume of ITS information flow associated with dispatching a large number of trips. They conclude that this ITS paradigm is providing automation and accuracy to save dispatchers and drivers time and effort in the fluid, dynamic application of para-transit dispatching for NYCT, the largest such operation in the world.

Chattanooga SmartBus Project: Final Phase II Evaluation Report, Science Applications International Corporation (SAIC), U.S. Department of Transportation, Research and Innovative Technology Administration, June 2008.
http://ntl.bts.gov/lib/30000/30500/30587/14431.pdf
Abstract:

This report presents the results of Phase II of the national evaluation of the Chattanooga Area Regional Transportation Authority's (CARTA's) SmartBus Project. The SmartBus Project is a comprehensive transit ITS program for the city of Chattanooga, Tennessee. It involves deployment of a wide array of transit ITS technologies including: data warehousing and reporting software to accumulate data from different CARTA applications and provide reports to support CARTA operations; new operations management software to support fixed-route scheduling and demand response scheduling and dispatch; ticket vending machines for the Incline Railway; a remote diagnostics maintenance system; various on-board systems (mobile data computers, computer-aided dispatch/automated vehicle location software, a covert alarm, automated passenger counters, and a next stop automated announcement system); and new fareboxes, a revenue management system, and a multi-modal transit/parking smart card electronic fare payment system. The goal of the evaluation is to determine the impacts of these technologies in performing daily functions such as operations, scheduling, service planning, and maintenance, and to gather and document any lessons learned by the project team throughout the process of the deployment and operation of the technologies. This report discusses impacts to date of the technologies that have been in place for at least 1 year. It is important to note that the full impacts of many of the technologies are not expected to be realized until the onboard systems are in place and integrated with the existing technologies, and that those later impacts will be documented in the Phase III report. The evaluation involved a series of interviews with various CARTA staff, as well as gathering data on various performance measures including transit ridership, on-time performance, and on the road failures. The results of the study indicate that the ticket vending machines for the Incline Railway have helped CARTA access to make better

business decisions about the Incline service; the data warehousing and reporting software has allowed for more rapid preparation of a variety of reports, has resulted in efficiencies in operations, and has made it possible to answer complex business decisions more quickly; the fixed route scheduling software has allowed CARTA to provide the same level of service with lower operating costs; and the paratransit scheduling and dispatch management software has increased efficiency in terms of passengers per vehicle-hour while it has not reduced the time required to issue invoices or improved the on-time performance.

"Improving Employee Workflow at WMATA by Automating Transit Operations," Tony Ricciardi and Kevin Gilfoyle, *2006 Bus and Paratransit Conference*, 2006.
Abstract at http://trid.trb.org/view/793115
This paper describes the implementation of Trapeze at the Washington Metropolitan Area Transit Authority (WMATA). From the abstract:

> The solution includes modules for bid configuration, automated bidding, daily dispatch, timekeeping, workforce management, and vehicle and yard management. WMATA elected to follow a phased approach in implementing the system and pursued a 'train the trainer' strategy as a key element of the implementation plan. Lessons learned from the implementation process are shared in the paper. In general, employees at WMATA are seeing the benefits of the new system. Overall, the turnaround to address and resolve problems is faster and easier. Managers are also noticing greater accuracy from the pick data to the daily dispatch data due to a reduction in manual processes. Information that employees access through the new system is also more consistent because data management is centralized and all users access it using the same software. Beyond these generalized results, more specific results have been observed in various functional areas, including bidding, daily dispatch, long-range work planning, payroll preparation, and workforce management. These results are described at length in the paper. Next steps for WMATA include implementing a vehicle management component for the system, and investigating other systems that can be integrated to extend the functionality of the Trapeze solution.

Contacts

CTC contacted the individuals below to gather information for this investigation.

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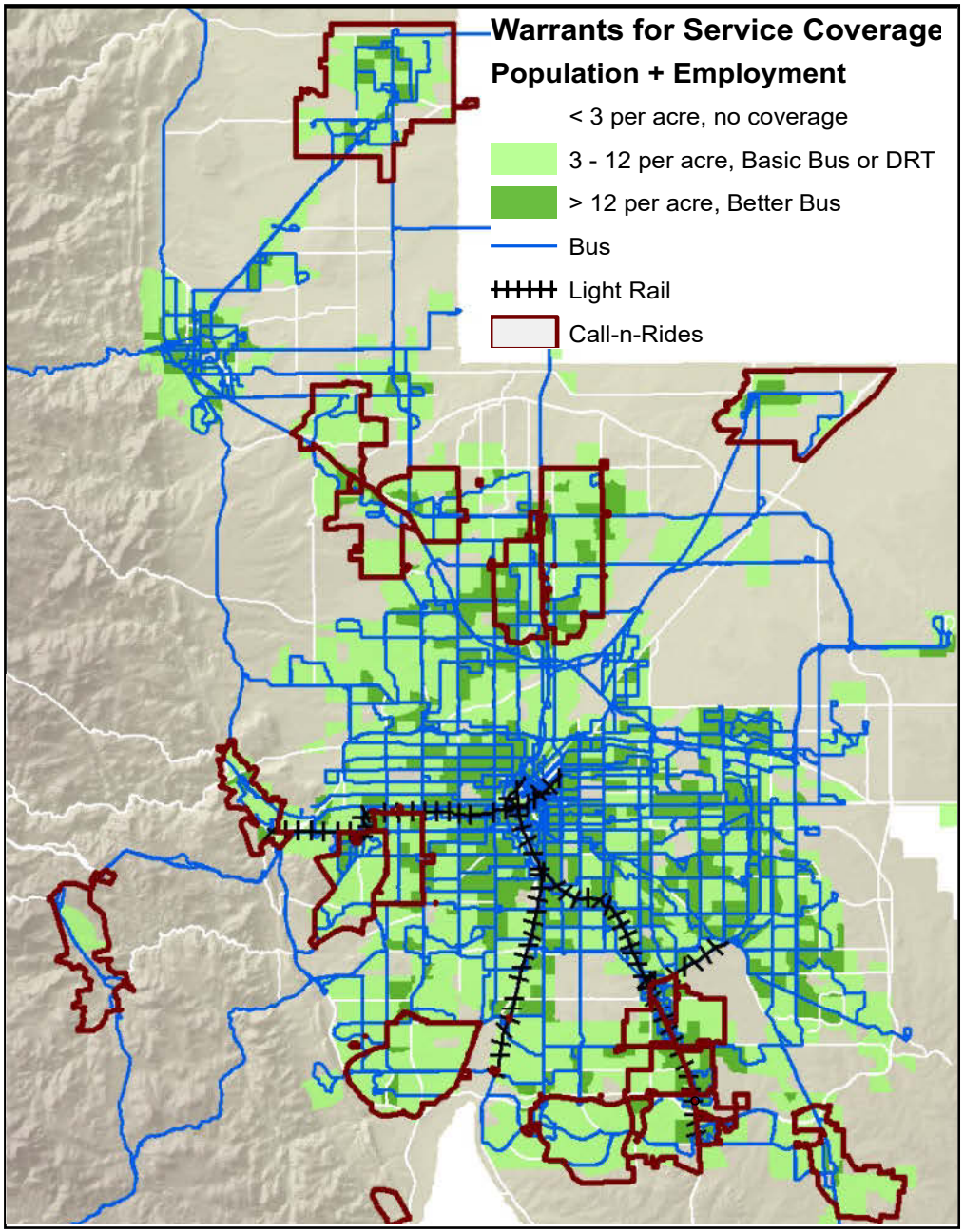
General Public Demand Response Transit (DRT)
Call-n-Ride

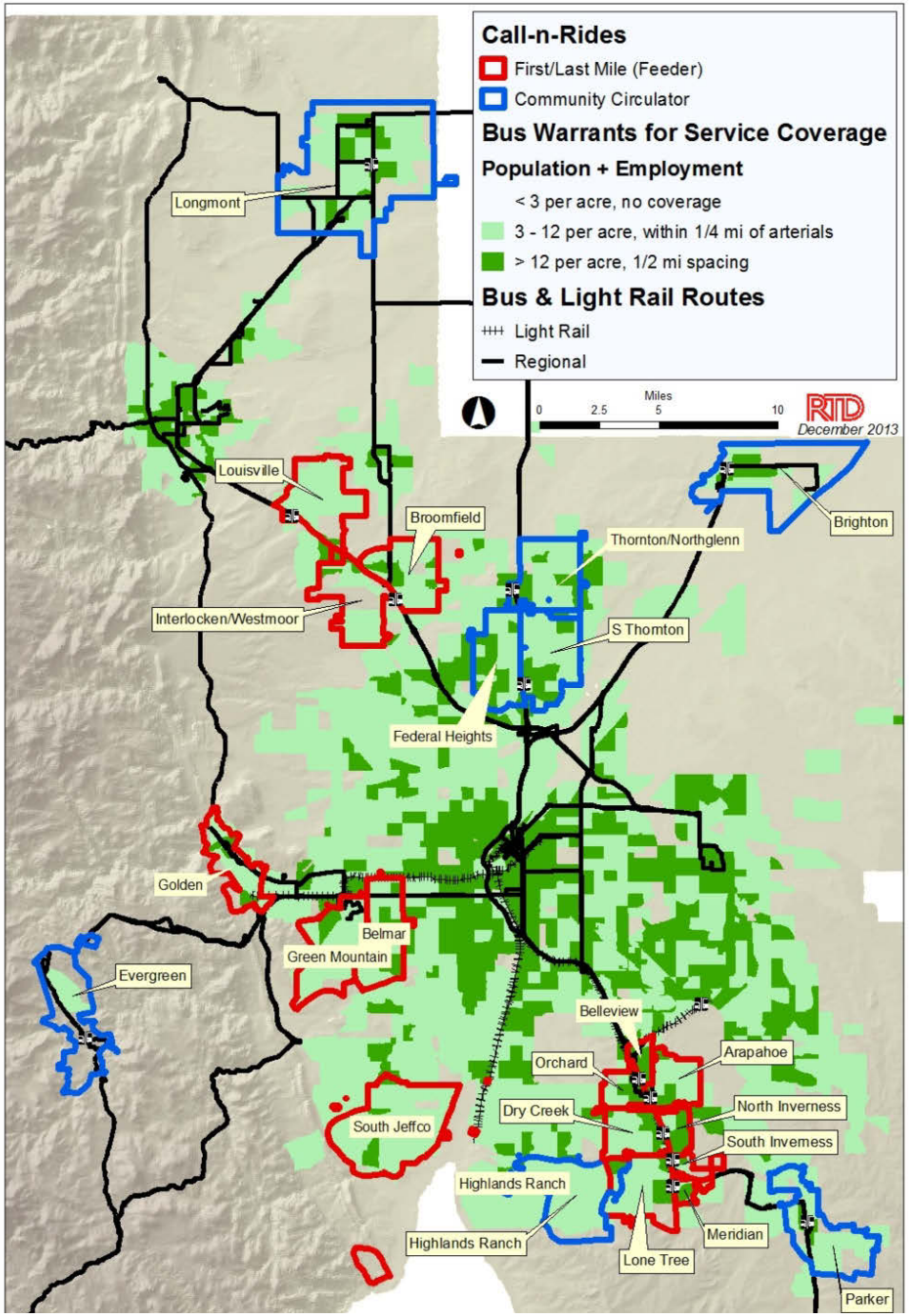
USDOT Workshop
May, 2016

A. Jeff Becker
jeff.becker@rtd-denver.com
Regional Transportation District
Denver, CO

RTD Mission: Provide cost-effective service throughout the District. … But, one size does not fit all.



Two Primary Markets: Community-Based & First/Last Mile



15 are First/Last Mile Configuration

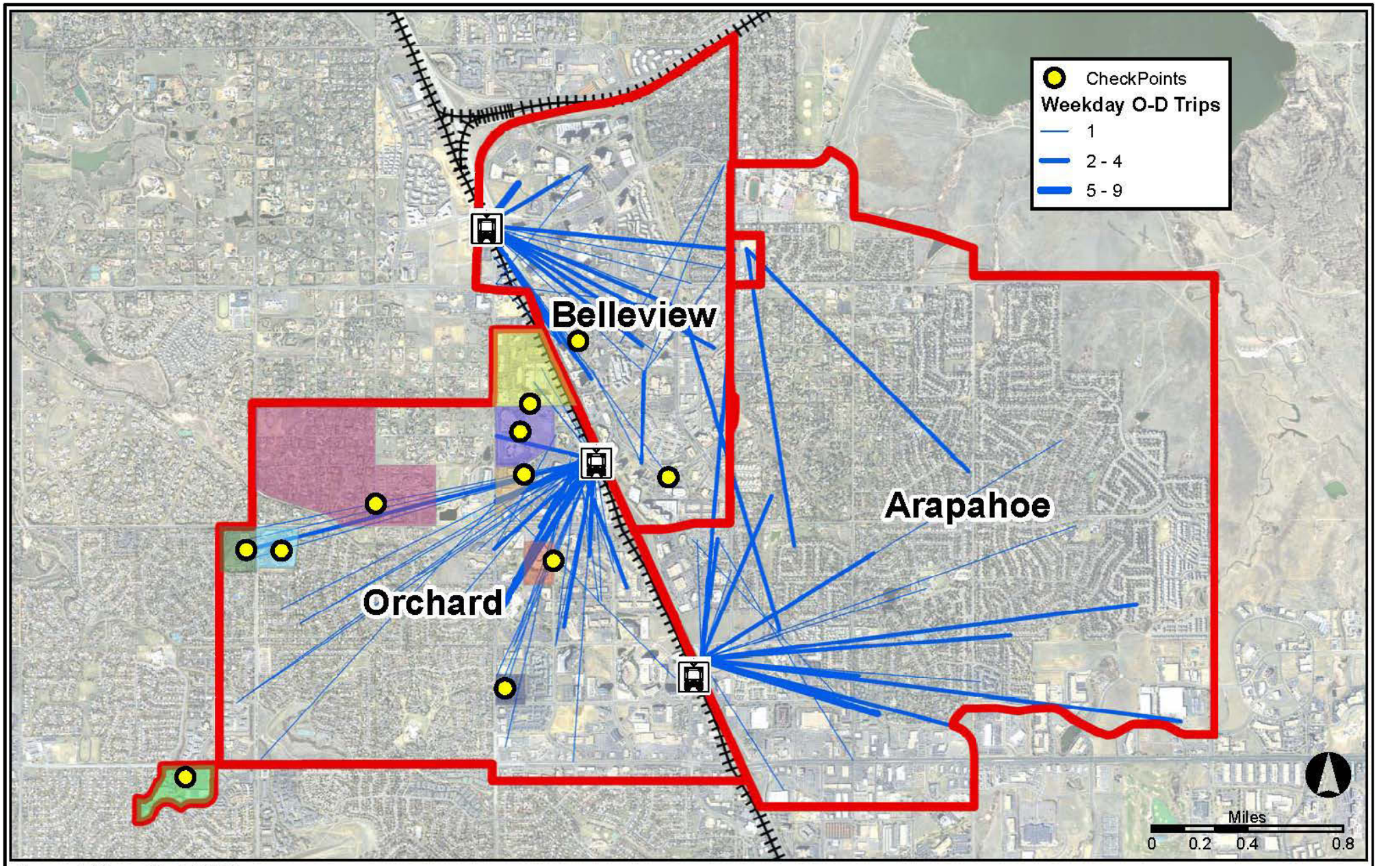
Regular commute - 4

Reverse commute - 7

Balanced commute (44%-56% split) - 4

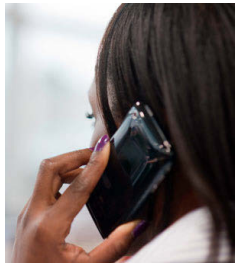
Call-n-Ride	Description	Sq Mi	Pop+Emp / Acre	Peak Vehices	Weekday Riders	Riders / Hour	Trip Ends at Station
Arapahoe	**Office, residential**	**4.66**	**9.17**	**1**	**40**	**2.9**	**83%**
Belleview	**Office, some residential**	**1.52**	**42.96**	**2**	**68**	**3.5**	**85%**
Belmar	Older suburban, Town Center, residential	7.66	9.33	2	28	1.4	43%
Broomfield	Rresidential, mixed use, school	7.49	8.32	1	54	4.0	28%
Dry Creek	Office, residential	5.21	13.03	1	56	4.2	82%
Golden	Residential, Main Street, government, college	5.50	6.98	3	269	7.3	89%
Green Mountain	New suburban, Federal Center, office	8.85	8.42	3	121	3.6	81%
Interlocken	Office campuses, residential, regional mall	8.05	6.95	1	64	3.9	92%
N Inverness	Office campuses	2.22	16.38	3	224	8.8	98%
S Inverness	Office campuses	1.46	9.53	2	112	5.7	99%
Lone Tree	Residential, offices, regional mall	7.52	9.24	1	48	3.5	75%
Louisville	Older residential, Main Street, offices	8.77	6.34	1	55	3.3	58%
Meridian	Office campuses	1.14	13.08	2	157	7.5	98%
Orchard	**Offices, residential**	**2.92**	**17.44**	**2**	**91**	**4.7**	**91%**
South Jeffco	Residential, offices	16.33	7.43	4	132	2.9	82%
Median		5.50	9.17	2	68	3.9	83%
Average		6.27	8.84	2	104	4.5	79%

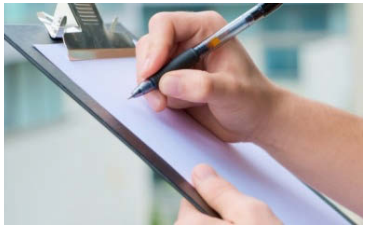
Service Configuration



Evolution of DRT & Technology
Early Years

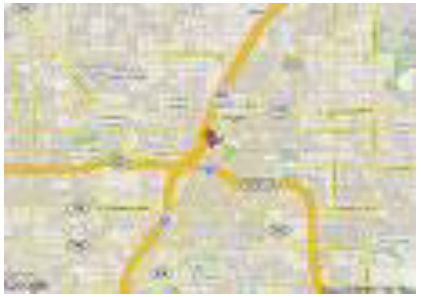
- 1960/70s – MIT, Haddonfield, NJ
- 1970s – Initiated GP DRT with central dispatch
- 1980s – Cell phones rapidly emerge
- Decentralize for driver/customer-centric service delivery
- 1980s/90s – Customers call directly to driver who uses clipboard and map





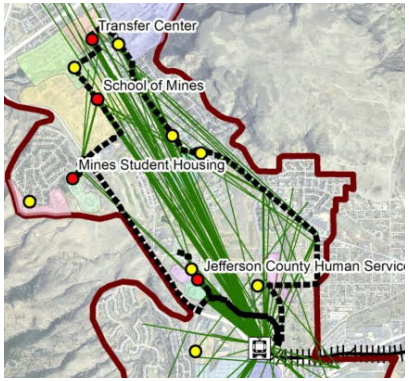
Evolution of DRT & Technology
21st Century Technology

- Mobile Internet, smart phones
- Platforms & apps, e.g., Google Maps, GPS, IVR, VOIP, SaS, Web hosting
- Ability to assemble platforms & applications
- Remote support



Evolution of DRT & Technology
21st Century - DRT service expands

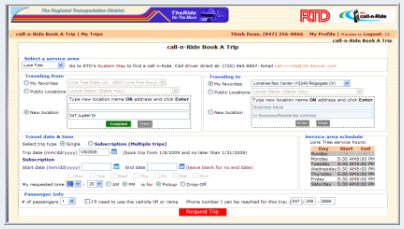
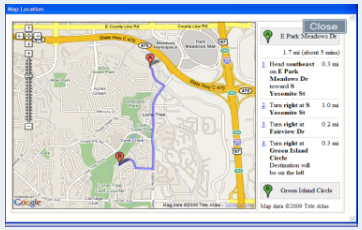
- ADA → Open public
- Configuration is more complex
- Cell phone & clipboard does not scale
- Drivers' effectiveness varies considerably



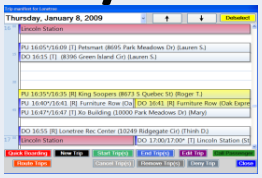
Motivation: Business Needs & Technology

- Improve **customer service**: booking & ETAs.
- Improve **driver reliability**, consistency & support.
- **Automate** to enable service configurations, promote productivity and keep booking, scheduling & dispatching costs low.
- **Streamline** back office reporting, real-time supervision; facilitate service planning
- Use **standard**, interoperable technologies; enable coordination & partnerships.

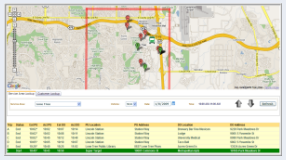
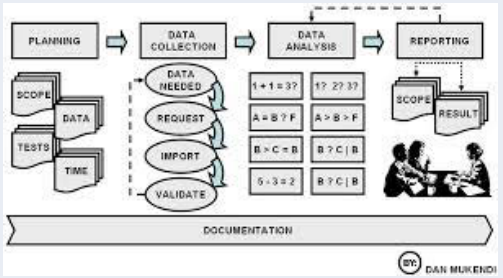
Technologies for DRT (RTD Denver)

Function	Technology Approach
Trip Booking 	• Mobile application via cell phone to driver • Web application via customer or agent • IVR, voice recognition systems • Call center
Customer Notifications 	• Voice message • Text message (SMS) • E-mail • IVR, voice recognition systems
Scheduling & Routing 	• Automated algorithms support service configurations • Server/Cloud platform • Mobile application (full function) • Geo-services: Web application, GIS

Technologies for DRT (RTD Denver)

Function	Technology Approach
Mobile Computing 	•Touch screen tablet computer • Smartphone •Apps: map, navigation
Data Communication	• Cellular data card
Automatic Vehicle Location (AVL)	• GPS • Cell phone
Driver Communications 	• Cell phone • Voice Over internet Protocol (VOIP): Skype • Instant Messaging • Voice radio (drivers & supervisors)
Data/Fare Capture 	• Mobile application interface • Electronic vehicle interface • Electronic fare system

Technologies for DRT (RTD Denver)

Function	Technology Approach
Supervision & Dispatching 	•Console: real-time data and map •Driver self-dispatch: spontaneous boardings; moving trips • Central dispatching
Data Storage, Analysis & Accounting 	• Server database: SQL Server • Data-driven automatic updates of key system parameters and travel times • Transaction logs • Reports & queries • GIS analysis • Business Intelligence software

Technology Development

- What are the business needs?
- Define functional requirements.
- Inform yourself.
- Purchase or develop?
- Proof of concept – basic functionalities.
- Deploy, test, evaluate.
- Add functionality – Incremental development.
- Partner with developer/vendors.

RTD CnR Technology Costs

- Items: application, server (web hosting), mobile tablets, wireless & messaging, tech support, enhancements
- ~3% of total operating costs (1/4 of our ADA cost)
- Average annual cost = $9,100 per service area *or* $4,800 per vehicle

Guidelines For Successful Deployment

- Assess travel patterns. How should the service be configured?
- Assess—specify—what you hope to gain from the technology.
- Dedicate management & technical support resources.
- Don’t skimp on setup and training. Specify expectations & customization.
- Observe, acknowledge and address customer & driver behavior.
- Inform yourself about and address technical issues.

Tech Costs

- 3% of total operating cost (about ¼ ADA)
- $9,100 average annual cost per service area
- or $4,800 per vehicle

Item	Each	Annualized	All Call-n-Rides
MobilityDR Development cost in 2010	$300,000	$30,000	$30,000
Server & MS SQL License	$12,000	$3,000	$3,000
MobilityDR Enhancements		$70,000	$70,000
Tablet Computer & Accessories per vehicle	$3,500	$875	$36,750
Wireless Data & Skype per vehicle		$500	$21,000
SMS and Voice Messaging per server/app		$1,700	$1,700
Tech Support per vehicle		$300	$12,600
Tech Support per service area		$600	$13,200
Tech Support per server/app		$12,000	$12,000
Total Technology: 42 vehicles in 22 service areas			$200,250
Total Operations/Admin Vehicle Hours & Cost	$70	91,000	$6,370,000