FTA RESEARCH

FEDERAL TRANSIT ADMINISTRATION

FTA Open Data Policy Guidelines

APRIL 2016

FTA Report No. 0095
Federal Transit Administration

PREPARED BY
Martin Catalá
Center for Urban Transportation Research
University of South Florida

U.S. Department of Transportation
Federal Transit Administration

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Federal Transit Administration
Office of Research, Demonstration and Innovation
U.S. Department of Transportation
1200 New Jersey Avenue, SE
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Metric Conversion Table

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC

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ABSTRACT

This project identifies and documents best practices from transit agencies that have implemented open data practices to improve operational efficiency and increase customer satisfaction and to provide guidance to FTA regarding measures it could take to encourage open source data to the entire transit industry. The mechanisms used to identify best practices were a conference workshop and two webinars in which expert presenters provided information, experiences, practices, and lessons learned from their unique perspectives. The results of the workshop and webinars are consolidated in this report, which is intended to serve as a guidebook for transit agencies desiring to make their data open to the public. Agencies did not report a cost-benefit analysis to justify the effort required; rather, the focus was on a shift in mindset toward liberating the data to improve customer interaction and leveraging technological advancements to extend the agencies' reach to potential customers.

EXECUTIVE SUMMARY

The Open Government Initiative establishes the goal for federal agencies to promote transparency, participation, and collaboration through systems that make government data easy to acquire, analyze, and respond to. Under this broad directive, the U.S. Department of Transportation (USDOT) is requiring each of its modal administrations to develop open data policies. The Federal Transit Administration (FTA) is seeking to fulfill this objective internally and also through working with transit agencies on greater transparency and accessibility of their data.

Open government data are having a transformative impact on the economy, the efficacy of government operations, and, ultimately, the nation's democracy by providing unprecedented, universal access to information. As with other sectors of government, adopting open data practices within the public transit industry can result in streamlined and improved data flows, increased customer satisfaction, and enhanced customer support services. Providing data in an open format also allows developers to create applications that provide customers with multiple avenues to access information, ultimately increasing the reach of the agency to existing and potential customers.

Across the U.S., agencies are working to improve information delivery to transit customers by adopting open data practices. Today, more than 150 applications use data supplied by more than 250 transit agencies in the U.S. The widespread adoption of open data practices is of significant interest to FTA, which seeks to improve operational efficiency and increase transit ridership. Therefore, the development of guidelines for agencies to share schedule and real-time information is of vital importance to FTA.

FTA sponsored this project to identify and document best practices from transit agencies that have successfully navigated the challenges of sharing data in the public domain. A secondary purpose was to provide guidance to FTA regarding measures it could take to encourage open source data to the entire transit industry. The mechanisms used to identify best practices were a conference workshop and two webinars where presenters provided information, experiences, practices, and lessons learned from their unique perspectives. The results of the workshop and webinars are consolidated in this report, which is intended to serve as a guidebook for transit agencies that wish to make their data open to the public.

Open Data and General Transit Feed Specification (GTFS)

To better understand the characteristics of open data, a clear and accepted definition is necessary. The *Open Data Handbook* produced by Open Knowledge, a non-profit open government advocacy organization, describes open data in terms of the following three characteristics:

- **Availability and Access** – the data must be available as a whole and at no more than a reasonable reproduction cost, preferably by downloading over the Internet. The data also must be available in a convenient and modifiable form.
- **Reuse and Redistribution** – the data must be provided under terms that permit reuse and redistribution, including intermixing with other datasets.
- **Universal Participation** – everyone must be able to use, reuse, and redistribute the data; there should be no discrimination against fields of endeavor or against persons or groups. For example, restrictions that would prevent commercial use or restricting use to certain purposes (e.g., for education only) are not allowed.

There are many advantages for transit agencies embracing open data practices, which extend their reach to existing and potential customers. By using widely-accepted open data formats, many large and small agencies throughout the country are able to offer software applications to customers for no additional cost. Although open data are becoming more standard, the rise of web-based and mobile transit applications is very recent.

TriMet in Portland, Oregon, and other pioneering agencies have played a vital role in advocating and leading the industry in the area of open data. In 1999, TriMet and King County Metro in Seattle, Washington, were the first agencies to begin using open data and application protocol interfaces (API) to share data. GTFS, launched by Tri-Met and Google in late 2005, is a data format comprising a series of text files that can be imported into database applications for greater manipulation and efficient querying. Collectively, these files produce a robust picture of an agency's scheduled service, including information on the location of bus stops, route alignments, schedules, calendar of services, and trips. From an innovation standpoint, the development of the GTFS data format has had a profound impact on the public transit industry. In addition to providing a platform for customers to plan transit trips using a web browser or smartphone, GTFS data have been used by software developers to create myriad smartphone and web-based applications, varying in function from service evaluation to trip planning to locating apartments near transit services.

There are other applications for GTFS data beyond supplying data to developers for repackaging and app creation. For instance, FTA has produced a simplified method to evaluate projects submitted under the New Starts and Small Starts grant program that uses a limited version of the conventional four-step travel model and replaces the traditional "coded" transit network with standard transit services data in the GTFS format. In addition, a range of analytical, service planning, and automation tools rely upon the GTFS open data infrastructure to simplify processes and enable data-driven decisionmaking, alternatives analysis, and public outreach.

Benefits of Open Data

Collectively, the conference workshop and webinar presentations yielded a number of issues that have been encountered and successes that have been achieved, as well as implications and applications for agencies, customers, and developers, and other relevant information. The presentations considered the following four perspectives, (1) legal policy, (2) agency, (3) industry, and (4) third-party developers. Although these perspectives were used at the outset of the project to distill the overlapping viewpoints of open data users and producers, the benefits of open data, as summarized below, are best explained in terms of transit customers and transit agencies.

Customers

In the transit industry, customers are the most important constituency. Not surprisingly, the open data revolution within the transit industry is focused around the needs of customers. Workshop and webinar presenters indicated that by delivering data from a back-end operation to customer-facing applications, transit agencies are able to improve customer satisfaction, become more engaged with customers, and improve the quality of service delivered.

Participants in the conference workshop and webinars noted the positive impacts, including record increases in ridership, that access to open data has had on customer satisfaction. As research has shown, the provision of wayfinding information to transit customers can improve their satisfaction and may induce higher ridership, so agencies embracing open data have an increased opportunity to influence and attract transit riders. Several presenters described how their open data policies and practices created a conduit for agency and customer interaction and, ultimately, reaped unintended benefits, including improved customer relations. Through open data activities, agencies engage customers through satisfaction surveys and by tracking application downloads and the number of times real-time data feeds are accessed. The customer input and feedback associated with open data practices orient the agency towards engaging customers and recognizing their experiences, which, ultimately, leads to a continuous improvement process.

Agencies following open data practices also are able to improve the quality of service delivered to their customers. According to the *Transit Capacity and Quality of Service Manual* (TCQSM),[1] availability of information to help customers navigate the transit system is a quality-of-service measure. The widespread availability of schedule and real-time information through applications built upon open data ensures that the agency delivers the highest quality of service to its customers. Furthermore, due to the analytical opportunities of open schedule and real-time data, customers enjoy the benefit of improved service design based on open data sources.

Agencies

Many workshop participants reported the benefits to agencies of embracing open data practices, including improved efficiencies, greater transparency, enhanced analytical capabilities, opportunities for improved service and performance analytics, and improved relationships with data stakeholders. Agencies that have embraced open data practices have discovered cost savings and efficiencies that have a direct impact on the agency's effectiveness. During times of increased ridership and reduced revenues and support, the open data activities of these agencies have improved customer experiences while reducing costs associated with customer activity. Further, the open data framework has been used to streamline data collection as well as information delivery.

Although the innovative engine of open data often relates to improved customer services and streamlined information flow, the power of open data is perhaps most apparent in the field of service analytics and visualization. Presenters shared several examples of how developers have used open data to quickly create an innovative solution to illustrate a service. For example, the availability and robust nature of GTFS data enabled the rapid evaluation and communication of the full impact of Hurricane Sandy on New York City's transit services. The same approach was used to measure and communicate to citizens the accessibility of a newly-proposed rail line in Paris within hours of the proposal's release.

Successfully Opening Your Data

Based on expert research and the experience of webinar participants, several guiding principles and techniques for transit agencies emerged. The findings summarized below are based on the insights of agencies that have successfully moved data into the open arena:

1. **Follow Best Practices** – The practices and lessons learned from agencies that are already openly sharing data were showcased and provided their practices, procedures, and experiences.. Agencies seeking to embrace open data and leverage their data to improve customer experiences should follow the examples of these agencies.
2. **Alter Your Perspective** – A fundamental mindset plays a crucial role in determining an agency's open data choices. agencies that view information and data systems as an overhead expense will seek to minimize and control costs; whereas, open data agencies will use data to improve decisionmaking and widen their influence over customer experiences. Agencies in the latter category view data systems as an asset; therefore, efforts to maintain and upgrade information and data systems are viewed as investments. Although this attitude can come from anywhere in the organization, workshop participants indicated that a leader of an organization who embraces this philosophy is vital to it becoming "data-centered." However, some participants reported that they were able to build support by illustrating how

a new approach to data could be used to power decisionmaking, increase productivity, and improve customer experiences.

3. **Become Data-Centered** – Many of the agencies participating in the webinars, workshop, and interviews view data management as a vital business practice used to improve operational efficiency and to help attract more passengers to public transit. Agencies recognize the initial and continuous efforts needed to produce and maintain open data for the agency. Many agencies that embrace open data practices do so because it is part of an ongoing business enterprise that requires updating and curation. At the core, these agencies view data as the center of an enterprise that improves decisionmaking and service delivery and bolsters the agency's profile, all while improving customer experiences.
4. **Focus on the Customer** – When viewed through the lens of customer experience, open data are akin to improving schedule design or bus stop amenities to help attract and retain customers. This customer focus is at the core of the mission of open data within the transit industry. Benefits of government transparency and accountability aside, improved performance and customer experience are the core reasons why open data are vital to a successful agency. In addition, when open data initiatives are framed as a way of improving customer experience and increasing organizational efficiency, decisionmakers at agencies often see there are more opportunities than barriers.
5. **Carry Out Successful Implementation Strategies** – Agencies that successfully share data in the public domain embrace implementation strategies to ensure that their open data practices are sustainable and effective. A commitment to open data on the part of staff and management increases the effectiveness of these strategies. Consequently, some activities are more important,, depending upon the environment and attitude of the agency and the role of open data and technology on organizational efficiency and customer satisfaction. For example, agencies in need of better management and staff leadership may develop an open data policy to help frame the agency's policies.. For agencies already enjoying the support of staff and leadership, the implementation strategies offer improved open data programs.
    - **Develop an Open Data Policy** – An open data policy ultimately serves as a roadmap for decisions an agency must make with regard to data. Several agencies have formal open data policies to guide the decisionmaking process, including procurement and technology considerations. There are many examples of governmental open data policies and guidance for agencies to follow; however, for agencies with no formal open data policies, principles and goals may easily substitute as policy documents. Sources for a step-by-step process toward an open data policy can be found in this document's appendix.

- **Use a Phased Approach through the Creation of Pilot Projects** – When leadership is skeptical and a formal open data policy are not politically palatable, agency staff may find success through pilot projects. Most typically, an agency's first efforts are to open schedule data to be used by large search engines, such as Google and Bing and to allow customers access to mobile applications. Regardless of the political environment, pilot projects can pave the way for future endeavors. Moreover, with the advent of integrated automatic passenger counters (APCs), computer-aided dispatch (CAD), and automatic vehicle location (AVL) systems, the opportunities to open and share data are becoming commonplace.
- **Engage with Data Users** – All agencies that successfully share their data have established a relationship with their data stakeholders. Agencies participating in the webinars, workshop, and interviews reported a wide spectrum of activities, including developing user agreements in concert with developers, participating and hosting regular developer meetings, and introducing challenges to the developer community such as "Best App" competitions.
- **Develop a User Agreement** – Many agencies require that data users agree to certain terms of use to protect themselves from harm for damages or injuries that may result from using or accessing the data. These limitations fall under a broad set of protections characterized by the data being offered "as is" and by not offering a warranty of accuracy. Language from sample user agreements can be found in this document's appendix.
    - *Eliminate Obstacles* – The open dialogue and interaction among workshop/webinar attendees and presenters yielded several common barriers to sharing transit data in an open arena, as well as potential strategies to remove these obstacles:
    - *Technology Barriers* – Three primary approaches were identified for resolving technological barriers. Developing the skills within the organization to create, manage, and distribute open data systems typically is employed by large- and medium-size agencies that have the information technology (IT) talent and robust database capabilities to invest in such activities. For agencies concerned with the costs of developing in-house resources, a more feasible option may be to outsource the collection, delivery, and management of open data. However, the most common solution employs a combination of outsourcing and in-house skill development.
    - *Political Barriers* – An agency's approach to open data is grounded in political realities and the agency's overall perspective regarding the role of data. When leadership is skeptical and a formal open data policy is not politically palatable, any change toward open data practices will require compelling evidence of the benefits, as well as the political will to infuse the changes into the organization. Agencies participating in the webinars, workshop, and interviews emphasized that the success of open data implementations often hinges on the support of leadership

to overcome the perceptions and apprehensions regarding open data, coupled with staff-level champions to serve on the front lines of developer relations and mitigate legal concerns through the development of user agreements.

- *Fear of Hazards* – Many agencies that do not share their data claim a fear of losing quality control through data sharing. However, these fears likely are unfounded, as no example of inconsistent data or loss of data control was identified during any of the interviews. In addition, copyright protections and liability due to data usage were identified as legal concerns that have deterred agencies from openly sharing data. However, according to expert presenters, legal and copyright protections of schedule and real-time data usually are not enforceable, as these are generally not considered to be copyrightable data formats. In rare cases when exceptions arise, certain measures such as withholding algorithm estimations can be used to remove any claims to copyright. To protect agencies from liability, mechanisms such as licensing and terms of use agreements were recommended.

Recommendations for FTA

Guided by open government principles, the federal government has instituted a broad Open Government Initiative that requires all federal agencies to adopt open data policies. Under this initiative, FTA should encourage transit agencies to embrace open data practices through three broad principles: advocacy, training, and administration requirements.. These steps will help FTA extend its commitment to open data beyond its offices and into the industry, ultimately fulfilling its commitment to open and effective government.

- **Advocacy** –To promote and guide open data practices through information-sharing, FTA could showcase the benefits of existing open data opportunities through national conferences, webinars, and research efforts for open data practices at transit agencies. In addition, there is opportunity for FTA to cultivate its existing relationship with the USDOT Intelligent Transportation Systems Joint Program Office by producing webinars emphasizing opportunities and issues relating to open data. FTA also could promote existing open data opportunities by highlighting the Data.gov website and its open data applications. Accordingly, it is also recommended that FTA improve developer access to data by creating a GTFS protocol for agencies to host and post GTFS data on the Data.gov website.
- **Training** – FTA's advocacy activities alone would be an incomplete effort, as agencies motivated by advocacy efforts inevitably will encounter barriers related to the skills and technology required to implement open data practices. Identifying training opportunities and taking advantage of existing programs would enable agencies to acquire the skills to move toward open data practices. FTA should seek to leverage existing programs at the National Transit Institute and the USDOT Intelligent Transportation Systems Joint Program Office to develop a training path for open data within the transit industry.

- **Administration** – To augment the tools available to FTA to guide the public transit industry toward embracing open data practices, FTA should consider altering its existing Master Agreement and Certifications and Assurances. A possible alteration to the Master Agreement would incorporate language suggesting ownership during or extending beyond the life of a project. Another suggested and perhaps more appropriate alteration would deal with the list of certifications and assurances with which each agency must comply—in particular, the requirements for data standards under the National ITS Architecture. This section is most appropriate for addressing open data due to the fact that schedule and real-time data typically are derived from ITS systems. Furthermore, FTA may wish to explore the possibility of requiring agencies to conform to open data commitments for all federal dollars spent on technologies producing real-time and schedule data.

SECTION 1

Framework for Open Data and Transit

Introduction

Open government data are having a transformative impact on the nation's economy, the efficacy of government operations, and, ultimately, the nation's democracy through greater transparency. The benefits of open data are realized when governments provide access to frequently-requested data and information to all interested stakeholders.[2] Open data impacts government staff workloads by reducing the time and effort to deliver and access data. Further, private interests—from businesses relying on government data to citizens improving decisionmaking—are enjoying access to public data in machine-readable formats, so that computers can import databases and other computerized data for display. Due to the magnitude and breadth of data collected by the government, the opening of federal data sources has far-reaching impacts, including fueling innovative services and products that produce value for consumers w hile having the potential to spur economic growth.[3]

Federal initiatives are driving the effort to distribute federal data in machine-readable formats to stakeholders. The centerpiece of the federal government's commitment to open data is its Data.gov website. Serving as a data portal for application developers and researchers, Data.gov provides stakeholders with unprecedented access to government data and serves as a portal for federal, state, and local government data, including geo-spatial information and tabular datasets. There are nearly 125,000 datasets and more than 200 mobile and web apps listed on the Data.gov site that rely upon open federal data, including those related to transportation. Many of the datasets can be used to support research, facilitate decisionmaking among policy makers, and improve the lives of citizens.

Figure 1-1 *Homepage of Data.gov website*

Data.gov is designed to accept data from local and state governments, which can have significant impact on communities and citizens by providing access to information. Public transportation schedule and location data are emblematic of local data resources with a direct impact on the public. Public transportation services, often the lifeblood of mobility in large urban areas and a lifeline for people without access to personal transportation, is a vital part of any community. Access to schedule and real-time data provides existing and potential customers with a direct connection to information that improves their daily lives. The importance of communicating transit schedule information is recognized in the *Transit Capacity and Quality of Service Manual* (TCQSM)[4] as a vital element of quality service delivery. Further, the National Center for Transit Research (NCTR) report "Designing Printed Transit Information Materials"[5] conveys

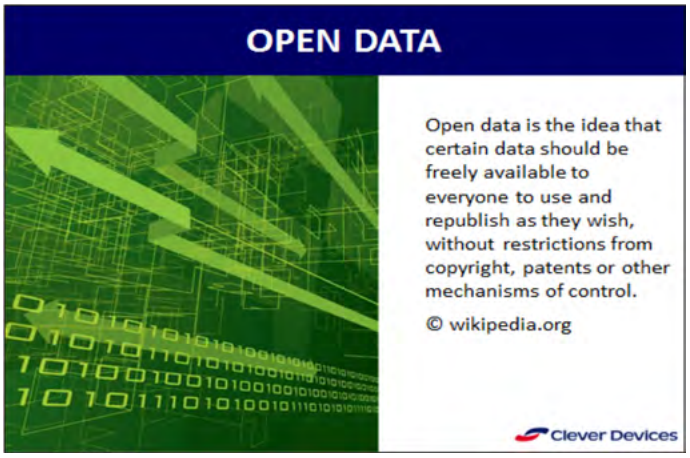
the importance of communicating this information to existing and potential passengers.

As with other sectors of government, adopting open data practices within the public transit industry can create organizational efficiency. Agencies with established open data systems have experienced savings through improved and streamlined data flows, increased customer satisfaction, and savings with customer support services such as call centers. Agencies across the U.S. are working to release schedule data to improve information delivery to transit customers by adopting open data practices. Larger metropolitan areas have the potential to benefit the most from such practices; with a larger customer base, agencies serving these areas are naturally incentivized to invest in and implement open data systems. Providing real-time and schedule data in an open format allows application developers to create applications that provide customers with multiple avenues to access information, ultimately increasing the reach of the agency and improving transit trip planning. For example, customized mobile delivery provides customers with unique and specialized information to improve the way-finding experience.

To better understand the characteristics of open data, a clear and accepted definition is necessary. The *Open Data Handbook*, produced by Open Knowledge, a non-profit open government advocacy organization, describes open data with three characteristics—availability and access, reuse and redistribution, and universal participation:[6]

- **Availability and Access** – the data must be available as a whole and at no more than a reasonable reproduction cost, preferably by downloading over the Internet. The data also must be available in a convenient and modifiable form.
- **Reuse and Redistribution** – the data must be provided under terms that permit reuse and redistribution, including the intermixing with other datasets.
- **Universal Participation** – everyone must be able to use, reuse, and redistribute the data; there should be no discrimination against fields of endeavor or persons or groups. For example, restrictions that would prevent commercial use or restricting use to certain purposes (e.g., only for education) are not allowed.

It is important to note that the description of open data is independent of the file format. All data, regardless of format and type, have the potential to be open. This is an important distinction for the transit industry, which has a long history of closed proprietary systems to help with operational activities. These systems, originally designed to help agencies track vehicles to improve dispatch and operations, typically were not available for any other use. Even within an organization, data were isolated and not used by other departments. As agencies



realized that the information from these data systems can assist with other activities and be used to help address customer needs, the movement towards expanding the use of these systems created a wealth of opportunities. These opportunities greatly expanded when documented and open data were made available to others outside the organization and set the stage for the open data movement within government and, in particular, the transit industry.

FTA's Role in Transit Open Data

The Federal Transit Administration (FTA) funded this study to identify best practices at transit agencies that make their data available to the public, including making transit system Automatic Vehicle Location (AVL) and Computer-Aided Dispatch (CAD) data available to the public.

Global positioning system (GPS) technology, originally developed by the U.S. military, became available for civilian use in the early 1990s, and since public transportation is concerned with time and space, the transit industry was a natural fit for this new technology. Initially, vendors and transit systems envisioned that GPS technology would make them more efficient and effective in their own operations. Consideration was given to enhanced customer service, but no one anticipated the Internet revolution. Today, multiple mechanisms provide customers and developers with access to transit agency data, which can be used for applications that support them in their daily lives.

For this study, the mechanisms used to identify best practices were a conference workshop and two webinars at which presenters provided information, experiences, practices, and lessons learned from their unique perspectives. The workshop and webinars took place in 2013 and 2014 and are summarized herein to provide agencies with the tools to open their data and provide them to the public. FTA also sought information on policy directives that would be acceptable to transit agencies and encourage them to open their data. Assessing the use of General Transit Feed Specification (GTFS) data by transit agencies across the U.S. will help determine the feasibility of developing a National Transit Network based on GTFS data.

SECTION
2

Transit Open Data

Introduction

Since, 1999, agencies such as King County Metro in Seattle (Washington) and TriMet in Portland (Oregon) have been using open data and application protocol interfaces (API) to share data for repackaging to improve the rider experience. The use and adoption rates of GTFS by agencies across the U.S. serve as a bellwether of open data in the transit industry (see Figure 2-1).

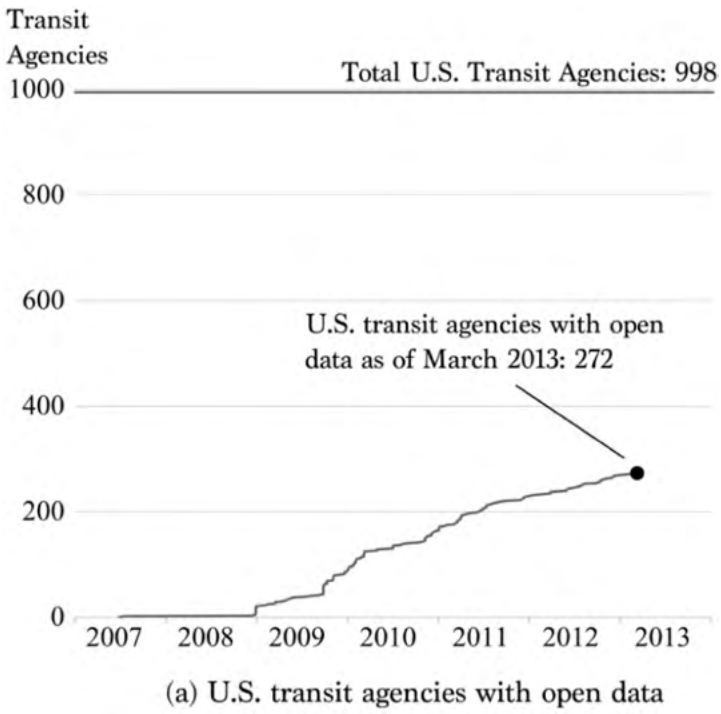


Figure 2-1
GTFS adoption rate[7]

The growth of open data has gone hand-in-hand with the growth of applications to support transit trip planning. Based on data from CityGoRound, there are more than 150 apps using data from 250+ transit agencies in the U.S. The applications developed all use open data formats and, consequently, any agency that seeks to produce open data in these widely-accepted open data formats will reap the benefits of simultaneously delivering these apps to customers. Since 2005, the number of agencies embracing open data practices has grown considerably. Figure 2-2 shows the transit open data timeline from 2005 through 2012.

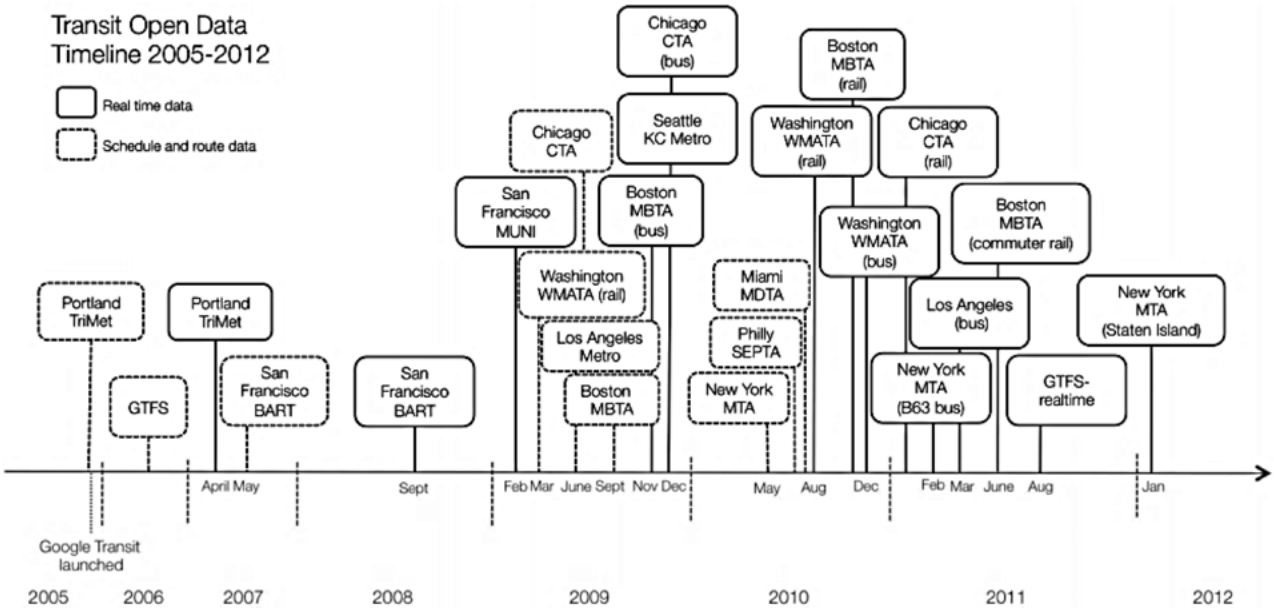


Figure 2-2 *Transit open data timeline, 2005–2012*[8]

Transit Data

It is important to recognize the myriad data that constitute "transit data." From operational information of buses to passenger loads, bus stop locations, and service area, all of these data fall under the umbrella of transit data. However, this report focuses on customer-oriented transit data—more specifically, on data that assist customers with transit trip planning activities, transit schedules, and real-time information. The release and availability of schedule and real-time data are driving significant innovation within the public transit industry, much of which can be attributed to the development of GTFS and the adoption and development of multiple real-time data formats such as Service Interface for Real Time Information (SIRI) and GTFS Real Time (GTFS-RT). Each of these data formats provides a standardized, machine-readable format for public transportation agencies to produce and share.

Real-Time Information

The development of real-time information for public transportation has had a significant impact on the transit industry. Due to the high costs of outfitting vehicles with GPS equipment and the closed information systems affiliated with real-time data systems, real-time information is slightly slower than static data. However, the increased adoption of automatic passenger counters (APCs) and the advent of open real-time standards have resulted in an increase in the use of real-time systems. The ability of agencies to use APCs to fulfill federal reporting requirements has contributed to their increased use. Many APC systems include

GPS, so agencies are leveraging that hardware to produce real-time feeds for both operational and planning purposes. Consequently, more agencies are adopting real-time information systems for both operations and customer-focused services.

This report is based on the practices and insights of agencies that have implemented or are implementing open data practices. As such, agencies were drawn to these efficiencies and practices to improve operational efficiency and increase customer satisfaction. No agency reported a cost-benefit analysis to justify the effort required; rather, the focus was on a shift in mindset toward liberating the data to improve customer interaction and leveraging technological advancements to extend the agencies' reach to potential customers.

Transit Schedule Data

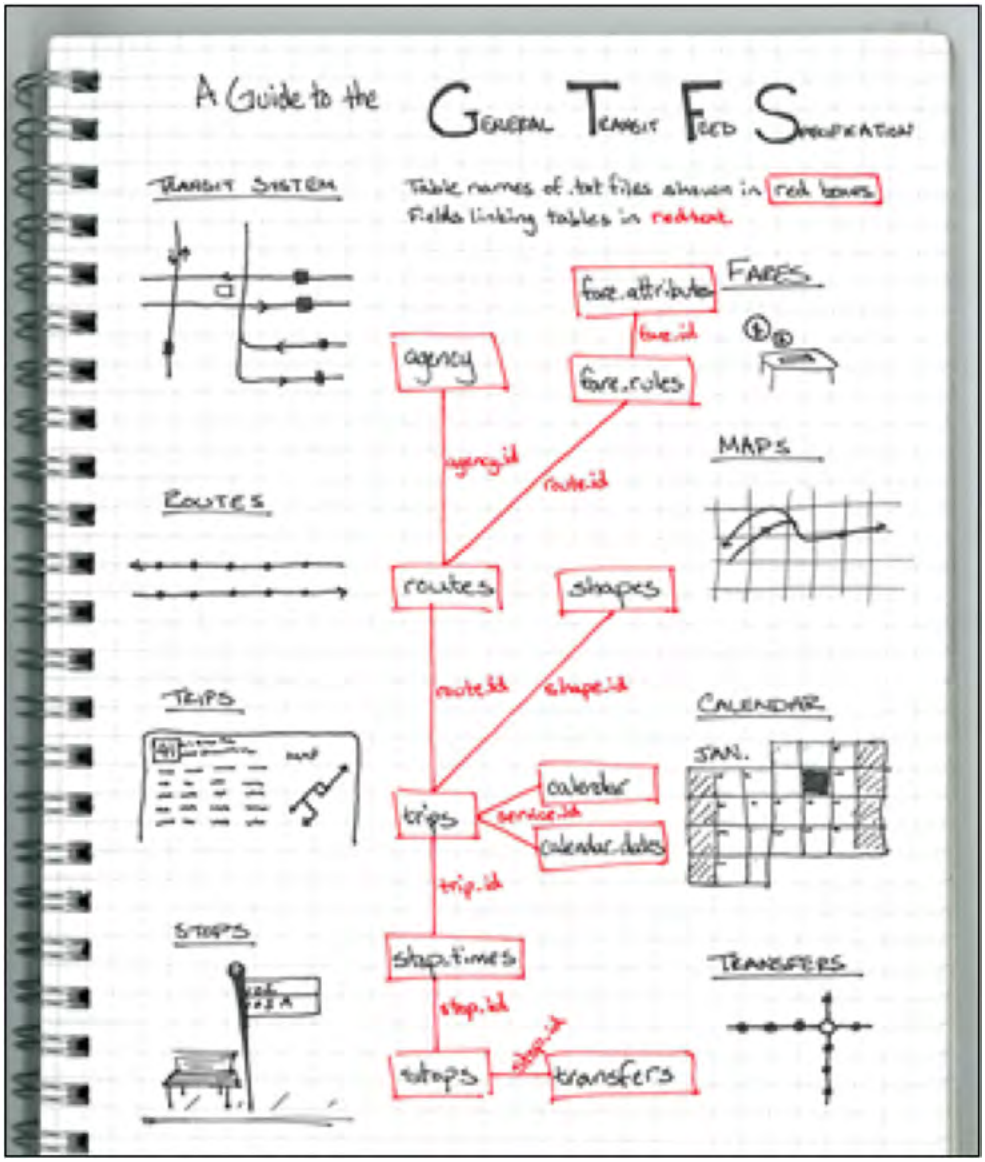
Although open data are becoming more standard, the rise of web-based and mobile transit applications is very recent. Open data has its origins in two major pioneers, Google and Tri-Met (the transit agency in Portland, Oregon), and has been boosted by the technologically-savvy demands of the Millennial generation. Bibiana McHugh, IT Manager for GIS at Tri-Met, in an article entitled "Pioneering Open Data Standards: The GTFS Story,"[9] recalled traveling in 2005 and finding it frustrating that she could not find transit information. Knowing that data were available (Tri-Met had a history of making its data available), Ms. McHugh was determined to create a directions navigation platform for transit similar to how individuals access driving directions on the web. She contacted Jeremy Faludi, who was doing work in the area of open data and knew someone at Google. Google had the same idea but realized it needed a government partner. Ultimately, Google and Tri-Met began working on a beta test, now known as GTFS, in early 2005, and launched it later that year.

The GTFS file format is made up of a series of text files that can be imported into database applications for greater manipulation and efficient querying. The text files contain information on the location of bus stops, route alignments, schedules, calendar of services, and trips. Collectively, these files produce a robust picture of an agency's scheduled service. As such, software developers have produced myriad smartphone and web-based applications that vary from service evaluation to trip planning to locating apartments near transit services. All of the innovation has grown out of the consistent and available information contained within agency GTFS data.

GTFS was designed to be as simple as possible for agencies to produce and developers to use with layers for routes, stops, and times, as illustrated in Figure 2-3. GTFS data can be static with an agency's published schedules and can be combined with real-time information if the agency possesses AVL/CAD, APC, and other technologies in its fleets.

Figure 2-3

GTFS model illustrated[10]



The development of the GTFS data format has had a profound impact on the public transit industry. Primarily, it provides a platform for all customers to plan transit trips using a web browser or smartphone. However, more specifically, it illuminates the possibilities of open data by providing a platform for stakeholders to produce more precise and useful information for transit customers and service planners. By shifting its focus to data quality, agencies have improved the information used by customers and planners alike.

One of the primary resources for agencies using GTFS data is the Google Maps website, which lists the cities covered by Google Transit and, therefore, the agencies actively participating in the Google Transit program. Participation requires the agencies to maintain and make available their GTFS file for Google

use. As of May 2014, 494 transportation providers were participating in the Google Transit Program,[11] as shown in Figure 2-4. In addition, websites such as TransiTFeeds.com, CityGoRound, and GTFS-data-exchange.com have created inventories and lists of open data. These sites seek to leverage transit data to produce mobile applications.

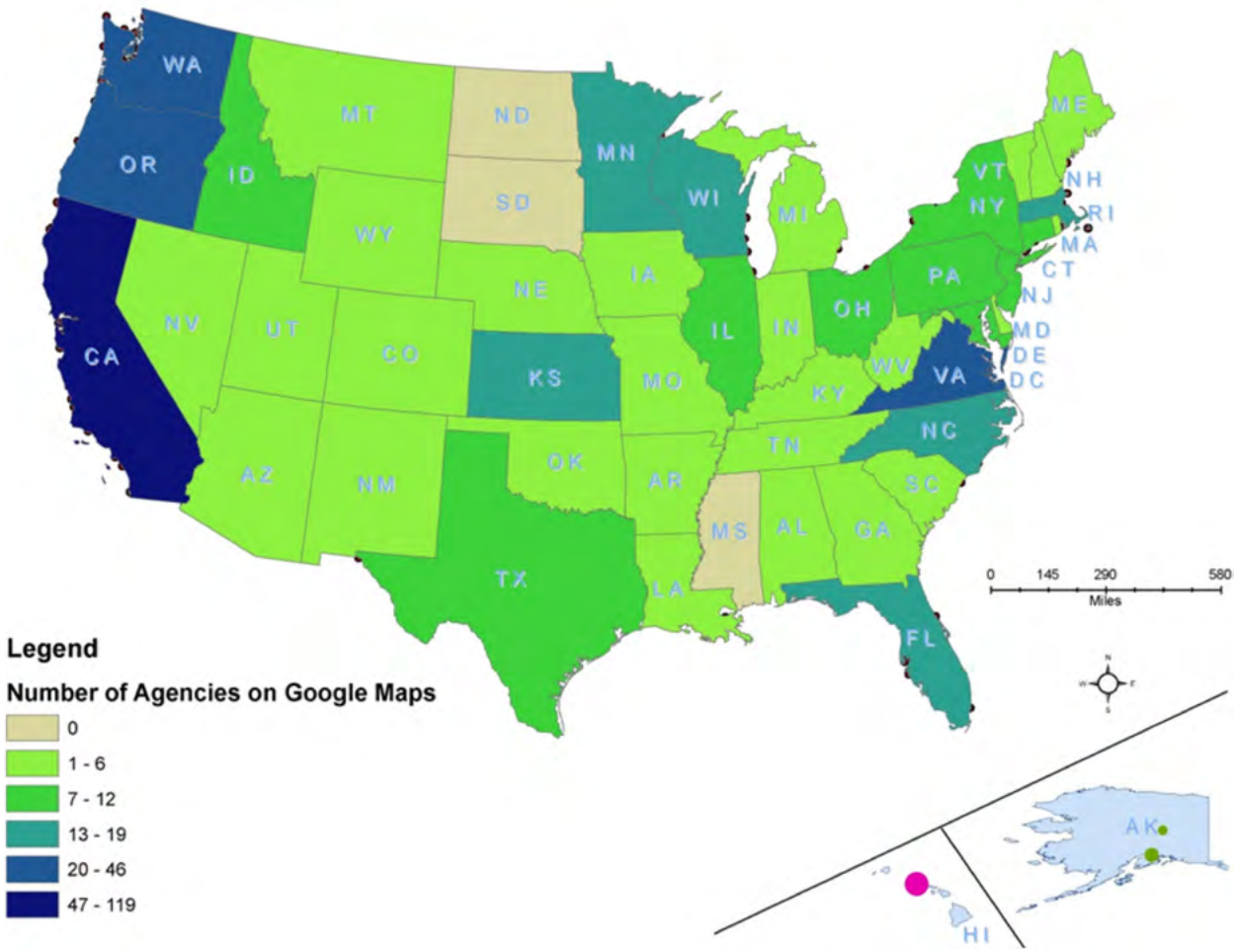


Figure 2-4 *Transit agencies on Google Maps (May 2014)*

It should be noted that the GTFS is not the only protocol that exists for organizing transit service data for sharing with the public. TransXChange is the United Kingdom's (UK) nationwide standard for exchanging bus schedules and related data and is used for the electronic registration of bus routes, the Traffic Area Network, and the exchange of bus routes with other computer systems such as journey planners and vehicle real-time tracking systems. TransXChange is part of a family of coherent transport-related XML standards that follow meta data and schema guidelines established by the UK government to encourage data interoperability and exchange between governmental departments known as GovTalk.[12]

Other Uses of GTFS Data

Applications for GTFS data beyond supplying data to developers for repackaging are noted as follows.

STOPS

FTA developed a simplified method to evaluate and rate projects submitted under the New Starts and Small Starts grant program. The Simplified Trips-on-Project Software (STOPS) application uses the GTFS data format as the coded input of transit services data. At their option, sponsors of New Starts and Small Starts projects may use simplified method to quantify the measures used by FTA to evaluate and rate projects. STOPS is a limited implementation of the conventional "four-step" travel model that replaces the standard "trip generation" and "trip distribution" steps with the Census Transportation Planning Package (CTPP) tabulations from the 2000 Census (and, soon, the American Community Survey) to describe overall travel markets. It also replaces the traditional "coded" transit network with standard transit-services data in the GTFS format. More detail is available in an overview of STOPS and its component procedures.[13]

TBEST

TBEST (Transit Boardings Estimation and Simulation Tool) represents an effort to develop a multi-faceted GIS-based modeling, planning, and analysis tool that integrates socio-economic, land-use, and transit network data into a unique platform for scenario-based transit ridership estimation and analysis. TBEST's GTFS interoperability tools take advantage of the investment that agencies and vendors have made in developing Google Transit Trip Planner-compatible files. These tools are a critical part of the use of TBEST for service planning, since they integrate current or historic operational network information directly into TBEST, saving the organization valuable time in maintaining an accurate modeling and analysis platform.[14]

OpenTripPlanner and OTP Analyst

OpenTripPlanner (OTP) provides a range of passenger information and transportation network analysis features using open street map and GTFS data to model infrastructure for finding itineraries combining transit, pedestrian, bike, and car segments. This is an open source platform for multi-modal and multi-agency journey planning and follows a client-server model, providing several map-based web interfaces and a Representational State Transfer Application Program Interface (REST API) for use by third-party applications. OTP relies on open data standards including GTFS for transit and OpenStreetMap for street networks. Launched in 2009 by a consortium of developers and organizations, the project

has attracted a thriving community of users and developers, receiving support from public agencies, startups, and transportation consultancies alike. OTP deployments now exist around the world, and OTP is also the routing engine behind several popular smartphone applications.

OTP Analyst applies OpenTripPlanner's routing engine to issues and problems in transportation planning, public policy, and the social sciences. The transit system model and optimization logic originally developed for point-to-point searches have been extended to support one-to-many and many-to-many queries in large batches, a foundation upon which have built a wide range of analytical tools enabling data-driven decisionmaking, alternatives analysis, and public outreach around service changes and infrastructure development. This functionality is built into OTP and available as part of any trip planning deployment.[15]

Time Table Publisher

Produced by TriMet in 2006, Time Table Publisher automates the process for dynamically generating printed and HTML-based timetables using the GTFS format. The application was produced to streamline the effort spent by scheduling and marketing departments in producing this information for customers. This is a single system that allows a transit agency to examine, modify, and transform raw scheduling data into easy-to-read timetables for customer information purposes. The application simplifies and accelerates the production of printed on-street schedules and web schedules, which areoften a very time-consuming and a manual process for most agencies. This system results in more accurate, current, and consistent schedule information for the customer.

TimeTablePublisher is designed to use data directly in the GTFS format, so it can be very easy for an agency to implement. In addition, it can connect to and read from other sources of data, including a database, a comma-separated text file, and XML. An easy-to-use interface and a tool that compares the changes between two service dates makes it easy to format and edit the data. As an open sources application, TimeTablePublisher is available at no cost so other transit agencies can use it and even contribute enhancements to it.[16]

Data Standards

Any data policy discussion would be incomplete without addressing the impact of data standards on open data policies and practices within the transit industry. Data standards are the rules by which data are described and recorded to help share, exchange, interface with, and understand data.[17] Data standards and open data policies and practices are interrelated.

Many of the formats discussed in this report conform to the United States Geologic Survey (USGS) definition of data standards. The public transit industry has an

adopted set of standards that are integral to the transit industry. Encompassed in the Transit Communications Interface Profiles (TCIP), the American Public Transit Association (APTA)-designed data standard, provides a standardized set of definitions of data in the transfer of transit-related data and information. The standard defines the interaction between a wide range of systems, components, devices, and platforms to ensure seamless interface between the myriad systems employed on transit vehicles. It covers information, data, and communications about fare collection, incident management, bus traffic management, on-board systems, passenger information, scheduling, and run-cutting. The data definitions can be used by vendors, transit professionals, and others to support operations, maintenance, planning, management and customer service.[18]

The TCIP standard ensures that data and information from the multiple systems can interact with other systems. Frequently, on-board technologies must work seamlessly with other systems to ensure proper operation and, ultimately, accurate information about those systems. The well-documented and vetted information and data definitions and relationships ensure that all data are interoperable and can be used by other systems.

Open data's impact on innovation and resource savings are reduced when the data do not conform to a data standard. Data released in an inconsistent and poorly-documented format require data users to expend resources to translate and reformat the data. As a consequence, open data that do not conform to a consistent, predictable, and documented format undermine the goals and principles of open data principles. The recommended practice is to ease the use of data from different systems, improve transparency, encourage innovation, and create efficient data systems that lead to cost savings.

There are times that standards alone do not make data usable, and some well-defined and widely adopted data standards do not conform to the open data principles. For example, transit schedules and maps stored in a PDF format are not as interoperable as other standardized formats. Agencies distributing transit schedules and maps in a PDF format can claim to be sharing data in an electronic and standards-based format, but they cannot claim to be offering open transit schedules and mapping data, because the PDF requires proprietary software to be read, and the process of accessing the data within the PDF is neither consistent nor machine-readable. Consequently, not all standards based data are truly "open" in nature.

Open data policies, practices, and data standards are interrelated. Data that are free and open but that do not conform to standards are not nearly as useful. Data stored in a standard that is unavailable or one that is not easily accessed or machine-readable are not nearly as open. Data that are formatted in a consistent and reliable format, stored in a format that is easily consumed by data and information technology systems, and accessible to all, are open data.

SECTION 3

Role of Millennials and Third-Party Developers

In addition to transit customers and transit agencies, third-party developers are an important open data constituency that use source data from a transit agency to create innovations. Todd Park, U.S. Chief Technology Officer, summarized the role developers have in innovation: "You take the data that's already there … just put it in a machine-readable form, and let entrepreneurs turn it into awesomeness."[19] Many think that innovation from developers is only the development of mobile apps; however, developers also use myriad operational and service data to create innovative practices in service planning, operations, and maintenance, among others. Developers are the critical link between customers and transit agencies. Transit agencies can focus on their own core means of communicating with customers, whereas, developers can create applications that serve customers in ways that the agencies cannot, which ultimately increases customer satisfaction.

> "You take the data that's already there...jujitsu it, put it in a machine-readable form, and let entrepreneurs turn it into awesomeness."
>
> Todd Park
> United States Chief Technology Officer

Not all developers are young, but many are, having grown up in the generation from which the open data movement sprang. With drastically different views of transportation from those of the generations that came before them, Millennials (those between ages 18 and 34 in 2015)[20] are transforming communities and the developments that shape them.[21] On the whole, Millennials own fewer cars and drive less than their predecessors. They would rather walk, bike, car-share, and use public transportation, and they choose to live in places that facilitate that lifestyle. Millennials have a "get it now" mentality and prefer to communicate in real time with messages and texts rather than emails. And, whereas Millennials are inclined to use transit for environmental reasons, they also are affected by staggering student loan debt that makes car ownership more out of reach. Put simply, Millennials are transforming communities and the developments that shape them.

SECTION

4

Summary of Conference Workshop and Webinars

The purpose of this study was to identify best practices in the industry to provide transit agencies with tools and means to make their data open to the public and to provide guidance to FTA regarding measures it could take to encourage open source to the entire transit industry.

To that end, a workshop was convened at the American Public Transportation Association (APTA) TransITech conference in Phoenix, Arizona, in March 2013, followed by webinars in December 2013 and August 2014. Their purpose was to have transit agencies provide best practices and lessons learned regarding their open data experience. Approximately 75 professionals attended the workshop, and the webinars drew approximately 100 listeners each, with 13 presentations by experts from the following agencies and entities:

- MBTA, Boston, MA
- Metro Transit, Madison, WI
- WMATA, Washington, DC
- Georgia Institute of Technology, Atlanta
- Center for Urban Transportation Research, University of South Florida, Tampa
- MTA, New York, NY
- Clever Devices, Woodbury, NY
- BART, San Francisco, CA
- 511, San Francisco, CA
- King County Metro, Seattle, WA
- Conveyal, Washington, DC
- The Thomas Law Firm, Washington, DC
- Lou Milrad, Toronto, Ontario, Canada

The workshop and webinar presentations highlighted numerous issues that have been faced and successes that have been achieved related to open data, as well as implications and applications for agencies, customers, and developers and other topical information relevant to the study effort. A summary of all presentations from all workshops and webinars is presented below and also can be found in the appendices.

Benefits of Open Data for Transit

The Open Government Initiative established the goal for federal agencies to promote transparency, participation, and collaboration through systems that make government data easy to acquire, analyze, and respond to. Under this broad directive, the U.S. Department of Transportation (USDOT) is requiring each of its modal administrations to develop open data policies. FTA is seeking to fulfill this objective internally and through working with transit agencies on greater transparency and accessibility of their data. This project seeks to provide guidance for transit agencies seeking to openly share schedule and real-time information, thereby removing barriers for agencies to share data with the public.

The experiences of agencies that have successfully navigated the challenges of sharing data in the public domain provide a foundation from which to base guidance. Through a collaborative presentation, workshop attendees and presenters interacted to further delineate the barriers to sharing transit data in an open arena. The presentations considered viewpoints from the following four perspectives: (1) legal policy, (2) agency, (3) industry, and (4) third-party developer. Although these perspectives were considered at the outset of the project to distill the overlap with open data users and producers, the benefits of open data are best explained from the perspectives of transit customers and transit agencies.

Transit Customers

At the most fundamental level, open data are about transparency and sharing information with the public. In the transit industry, customers are the most important constituency, and the open data revolution within the transit industry is focused around the needs of customers. By delivering data from a back-end operation to customer-facing applications, transit agencies are able to become more engaged with customers, improve customer satisfaction, and improve the quality of service delivered. Workshop and webinar presenters indicated that the motivation for open data was grounded in a desire to increase customer services while improving customer experiences and providing better tools to navigate the transit system.

Satisfaction

Participants in the workshops and webinars indicated the positive impacts of access to these data on customer satisfaction. Metro Transit in Madison, Wisconsin, experienced record increases in ridership, much of which is attributed to college students using the Metro system, which corresponded with the release of open schedule data and the availability of a real-time API.

Research supports the assertion that customer satisfaction has increased due to Metro Transit's open data policies. Transit Cooperative Research Program (TCRP) Synthesis 48, "Real-Time Bus Arrival Information Systems," indicates that agencies embraced real-time technology to improve their appearance in the community and that real-time information and improved wayfinding systems improve customer perspectives and satisfaction with transit service.[22] More recently, research on open data from TCRP revealed that agencies embraced real-time information signs to improve customer satisfaction,[23] and research in 2011 by Tang and Thakuriah[24] revealed that real-time information may increase transit ridership.

If the provision of wayfinding information to transit customers improves their satisfaction and can induce higher ridership, agencies embracing open data and, consequently, providing greater access to schedule and real-time information have an increased opportunity to influence and attract transit riders.

Customer Engagement

Open data policies and practices create a conduit for agency and customer interaction and, ultimately, reap unintended benefits, including improved customer relations. With an eye towards producing customer-oriented applications, agencies seek customer input and feedback on existing applications. Through open data activities, agencies engage customers through satisfaction surveys and by tracking application downloads and the number of times real-time data feeds are accessed. Application and customer satisfaction evaluations, application tracking, and continuous improvement processes associated with open data practices orient the agency toward engaging its customers and recognizing their experiences.

Agencies embracing open data often engage their customers in a manner that leads to a continuous improvement process, as exemplified by King County Metro (KCM) and the Massachusetts Bay Transportation Authority (MBTA). KCM, in reporting on the challenges of upgrading its system, revealed that customer needs were the foundation of its improvement processes. Using customer feedback from its open data offerings, KCM set out to improve its real-time and static data systems. The improvements to the data model used by its internal systems were guided by customer requests to accurately portray the unexpected route alignment changes that occur due to events and construction, which the current system was challenged to produce. Improvements to KCM's real-time data also include exploring dispatch system features to provide improved dynamic service alerts for both internal use and export out to the developer community. KCM's improvement efforts sought to find better information and visualizations to improve the customer experience guided by the customer engagement process of its open data offerings.

Similarly, MBTA's experience relayed how customer feedback on its previous open data releases guided the development of its integrated open data system. Built around the widely-used open data formats of GTFS, GTFS-Realtime, API, and Rich Site Summary or Really Simple Syndication (RSS), MBTA produced a newly-integrated data system to address the challenges reported by customers regarding existing data applications. MBTA efforts to improve how service alerts were produced within the organization were guided by customer complaints about inconsistencies. With more than 30,000 subscribers to its service alerts, improved detail and precision were the result of customer complaints. Due to the engagement process from its open data offerings and its customer feedback system, MBTA was able to improve its internal operations while producing better information for customers to improve their experience with MBTA services.

The selection of data and the systems to support the production of these data are directed by the needs of customers. Bay Area Rapid Transit (BART) and MTA reported how customer needs were at the center of their data offerings. The agencies sought to create data most relevant to customer wayfinding needs. The process of producing and developing these open data offerings were the result of customer feedback and engagement efforts.

BART's presentation highlighted the open data initiatives at BART in San Francisco. Since 1998, BART has been sharing data with its stakeholders, focusing on customer-oriented information to help improve the decisionmaking and experiences of transit customers. Recognizing the limited resources and the importance of sharing data with high value and their impact on its users, BART focused its open data efforts by delivering on high-impact platforms such as the Internet, mobile apps, email, and SMS alerts.

MTA's offerings and efforts were developed by reaching out to customers through its open data offerings. The selection of its real-time information systems were guided by customer needs for real-time information on arrivals, departures, and service alerts. The real-time system was developed around open data principles with an eye toward producing data for developers to create customer information applications.

Based on the collective experience of these agencies, customers enjoy the benefits of increased engagement with transit agencies through the open data arena. New and improved information systems that produce robust and reliable data are the primary derivative of the open data systems, resulting in improved rider experience based on the needs and concerns of the customers.

Improved Service Quality

Agencies following open data practices are able to improve the quality of service delivered to their customers. Primarily measured using TCQSM information-

availability metrics, agencies with open data provide this information in a near ubiquitous form when shared as open data. The TCQSM indicates that availability of information such as service schedules and arrival information to help customers navigate the transit system is a quality-of-service measure. The widespread availability of schedule and real-time information through applications built on open data ensures that the agency delivers the highest quality of service to its customers. This translates into measured benefit for the customers. Further, due to the analytical opportunities of open schedule and real-time data, customers enjoy the benefit of improved service design based on open data sources.

Transit Agencies

Public transit agencies with open data policies and practices enjoy many opportunities and benefits, including improved efficiencies, greater transparency, improved analytical capabilities, opportunities for improved service and performance analytics, and improved relationships with data stakeholders. Many presenters reported the benefits to agencies of embracing open data practices.

Improved Efficiency

Improving open data operations leads to increased organizational efficiency on many levels. Presenters all noted improvements in their organizations by embracing open data practices and formats. At the core of many open data initiatives is the commitment to customers and their evolving and changing needs. To address these changes, agencies actively embraced a continuous process to improve the data and services they produce, and multiple agencies presenting their successes with open data were in the midst of improvements to their data systems.

The commitment to continuous improvement of systems within the transit industry is not unique to agencies embracing open data. Agencies focused on customer needs and cost savings are guided by a commitment to continuous improvement. Similarly, open data practices are guided by the same commitment to improving data flows, accuracy, and information delivery to customers.

Highlighting the evolution of schedule data, Georgia Tech research[25] noted this commitment. The evolution of schedule information from printed schedules to machine-readable data typify the continuous improvement process agencies face when addressing the evolving needs of customers. The changes to schedule data also underscore the importance of schedules to agencies seeking to reach their customer base. As agencies move into electronic formats of schedules (e.g., PDFs, maps, and data), developers can produce interactive and usable schedule information for transit customers. However, many of these are produced in isolation and without the benefit of accepted data formats. Consequently, these

solutions often serve only a single transit agency and population. Nevertheless, the trend toward electronic schedules is a hallmark of the industry's commitment to continuous improvement and customer orientation, resulting in improved efficiency for agencies.

When this commitment is combined with open data practices, the improved efficiencies and cost savings are evident. This was particularly evident with Metro Transit in Wisconsin. The recipient of the 2012 Outstanding Public Transportation Award from APTA, Metro Transit had experienced cost savings in the face of record ridership. The release of Metro's schedule data, the availability of its real-time feed, and the implementation of a UPASS (student) program created a significant increase in new weekend and evening ridership. In spite of the influx of new transit riders, Metro received fewer customer calls and a reduction in the demand for printed schedules. Much of the savings has been attributed to the increased use of open data products.

With the release of customer-oriented data, many agencies face lower costs associated with customer requests. This was evident with BART in San Francisco, which has always been on the leading edge of delivering transit information to its tech-savvy population. By focusing on customer-oriented high-value data products, BART has been able to realize significant savings for itself and the City of San Francisco; in the face of increased ridership, BART's call center volumes decreased, resulting in a reduction in call center staffing. Further, improved return on investment (ROI) of existing web and data investments can be realized at an agency experiencing increased ridership as well as developer and API calls to its open data assets. BART also recognizes how the developers using its open transit data to promote its services provide a marketing boost. Also, sharing open data creates a positive perception of the agency by illustrating its commitment to government transparency. The improved reach of its services and positive public perception contribute to the growth of the agency while decreasing costs and increasing efficiency.

The benefits of open data realized by BART extended to organizational and municipal stakeholders as well. As developer applications addressed customer needs, call center volumes decreased by 21% at the City of San Francisco's 311 citizen information line, resulting in an annual $1 million cost savings. The City attributes the 311 call center volume reduction to BART's open data efforts.

Another beneficiary of BART's open data practices is the San Francisco Bay Area 511 system. Using data from multiple agencies including BART, 511 SF can continue its ongoing commitment to deliver commuting information for current and future commuters. The service is looking to create a "long-term digital blueprint" and open data exchange specification to provide a framework for data collection and dissemination among the numerous data partners in the region. By embracing open data practices, the 511 system is able to streamline access

to existing data sources and improve overall interoperability and planning to accommodate the collection of new data.

Many agencies realize efficiencies due to improved customer relations through the provision of customer-facing applications. However, open data practices can result in internal efficiencies as well. In addition to reductions in customer service calls, TriMet in Portland, Oregon, has realized staff savings by developing an open source tool to produce timetables for printed and electronic schedules. By leveraging existing open data assets, printing of the schedule timetables was reduced significantly, and the rapid deployment of timetables for web viewing resulted in significant cost savings while producing more timely electronic schedule information.

MBTA in Boston also has experienced improved efficiencies as a result of its uniform real-time information system. The new system allows developers working for MBTA to create an improved alert system that has resulted in streamlined and efficient alerts. These savings were realized once MBTA designed its user interface and data system around its open data offerings.

The open data practices of mature open data agencies illustrates the power of open data processes to organizations. For agencies with less mature records of open data such as Mexico City, the power of open data formats is clear; the framework for applications for both internal data validations and capture, as well as customer-facing applications, have been made possible by building data collection applications around an open data format. Starting with virtually no data assets, Mexico City agencies worked with Conveyal to use GTFS as a data framework for an application developed to coordinate data collection to produce a unified citywide transit data product. Using a tool developed around the GTFS data framework, the Conveyal team worked over a 6-week period with 5 operators in Mexico City and a staff of 20 to produce data for 129 routes and 5,000+ bus stops. The capacity to build the data collection application and execute the collection and validation effort was a testament to the simplicity and robustness of the GTFS data platform. By building around the open format of GTFS, the agencies enjoyed a new operational efficiency in a robust application and now have a significant data asset to support multiple activities, including engaging with developers to produce mobile and web-based applications to enhance journey planning and transit information services. Not just a map of transit infrastructure, it is a working model of transport and a framework for collaboration. Figure 4-1 illustrates a model of transit accessibility based on the data collected for Mexico City agencies.

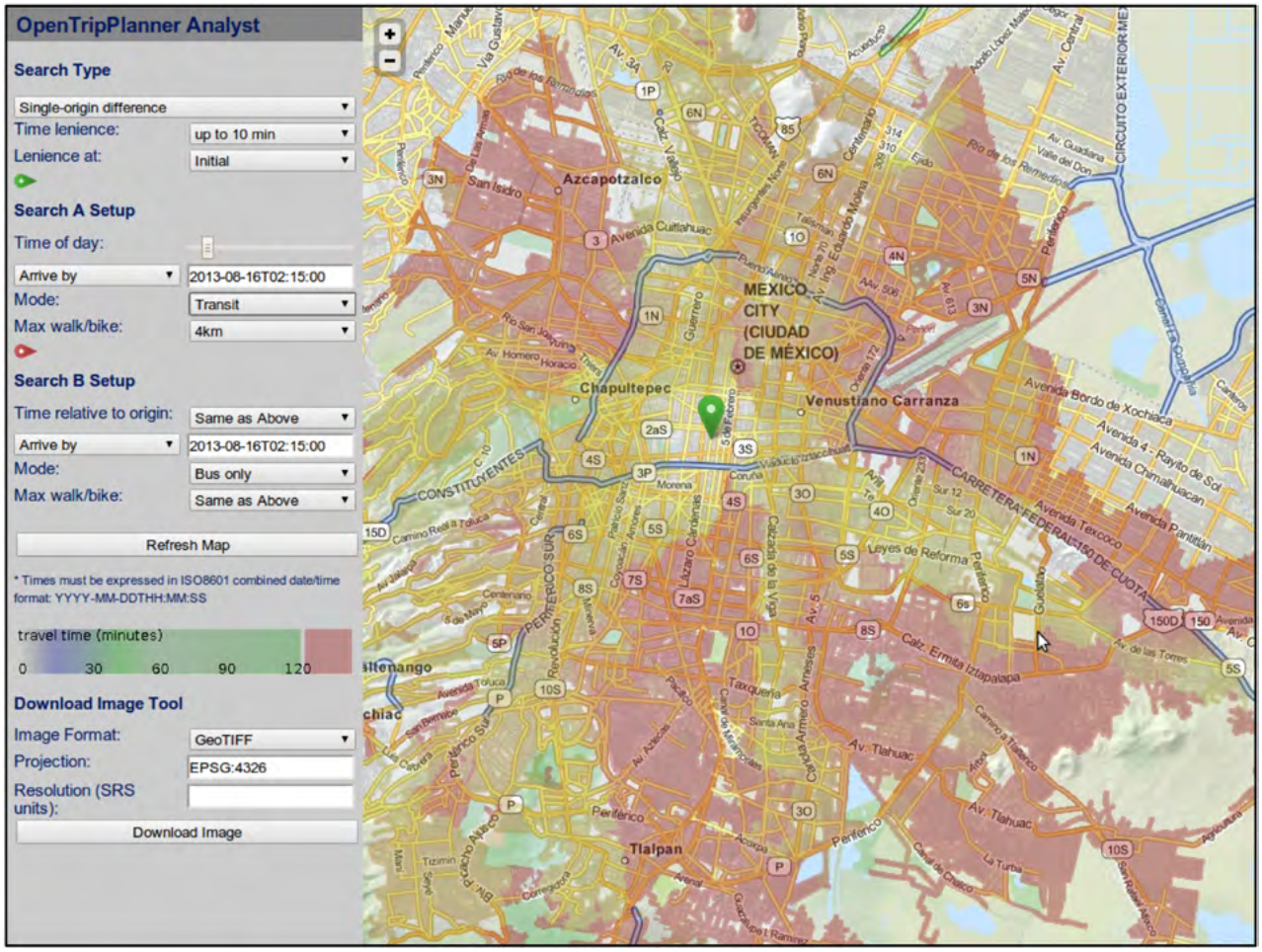


Figure 4-1 *Screenshot from OpenTripPlanner Analyst showing Mexico City transit accessibility*

Agencies that have embraced open data practices have discovered cost savings and efficiencies that have a direct impact on agency effectiveness. During times of increased ridership and reduced revenues and support, the open data activities of these agencies have improved customer experiences while reducing costs associated with customer activity. Further, the open data framework has been used to streamline data collection and information delivery. These realizations illustrate the efficiencies and savings associated with open data.

Analytics

The innovation engine of open data often relates to improved customer services and streamlined information flow. However, the innovation power of open data is most apparent in the field of service analytics. Using data originally designed for trip planning, developers have produced novel and powerful evaluation metrics.

One of the first to do this on a large scale was the Brookings Institute, which, by using an open data format, was able to demonstrate the power of uniform and widely-available data by analyzing transit access to jobs.[26] The availability of GTFS data led Brookings researchers to develop a methodology around the GTFS format to evaluate labor transit accessibility rates based on transit travel time. By relying on the GTFS data, they were able to leverage widespread open data to produce comparative analysis of the agency's service effectiveness, as indicated in Figure 4-2.

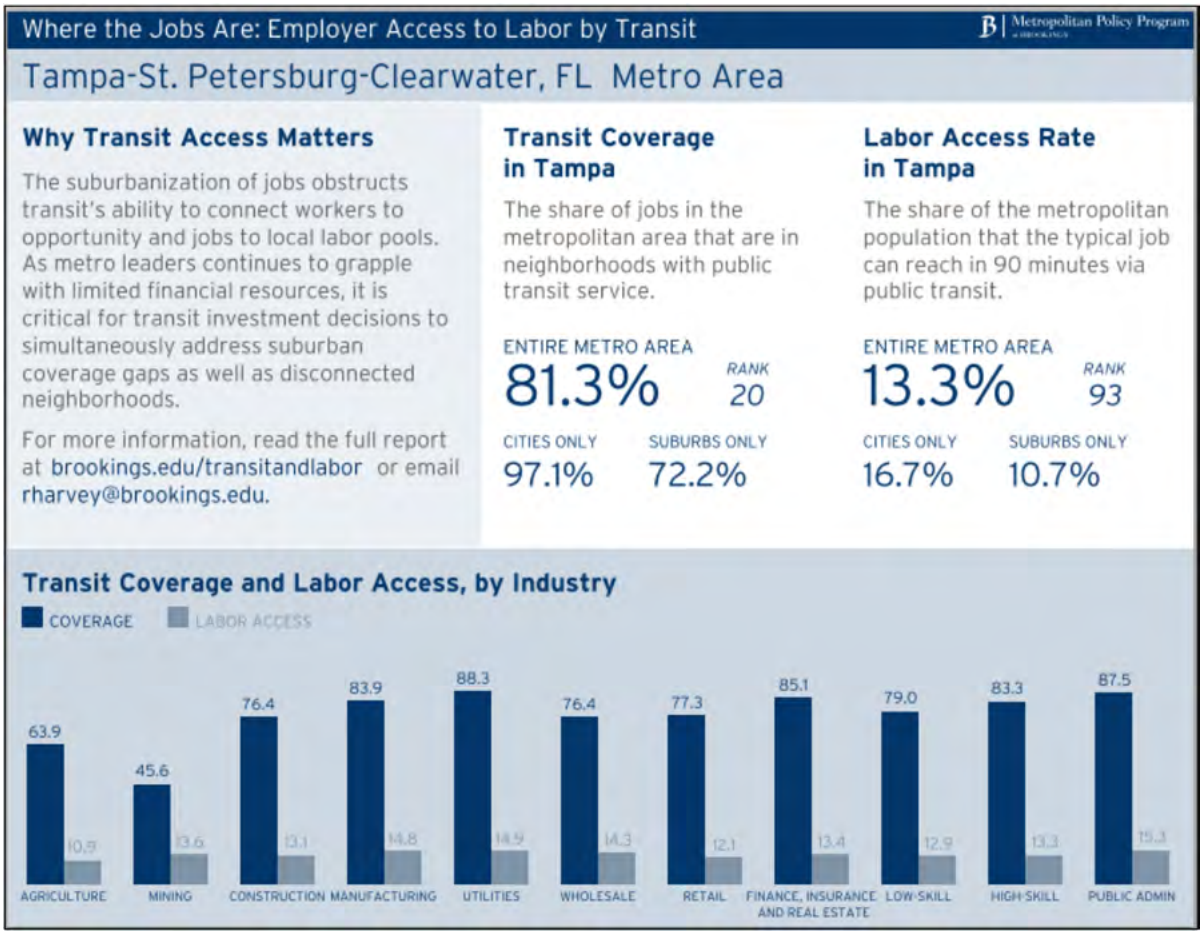


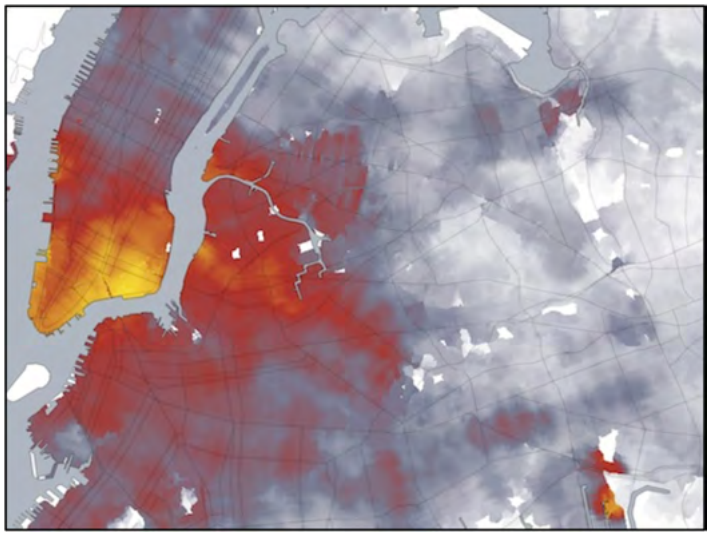
Figure 4-2 *Brookings jobs access dashboard*

The power of using the open data as a framework for public transportation modeling was evident in the aftermath of Hurricane Sandy. Using GTFS data, transit accessibility was measured to illustrate the magnitude of the storm's impact on New York City's transit services. The map in Figure 4-3 illustrates the reduction or percent change in services available to the residents of the city, with areas of bright red and yellow reflecting the regions most impacted by the storm. Given the availability and robust nature of GTFS data, a rapid evaluation of the

impact of the storm was measured and used to communicate the full impact of the hurricane.

Figure 4-3

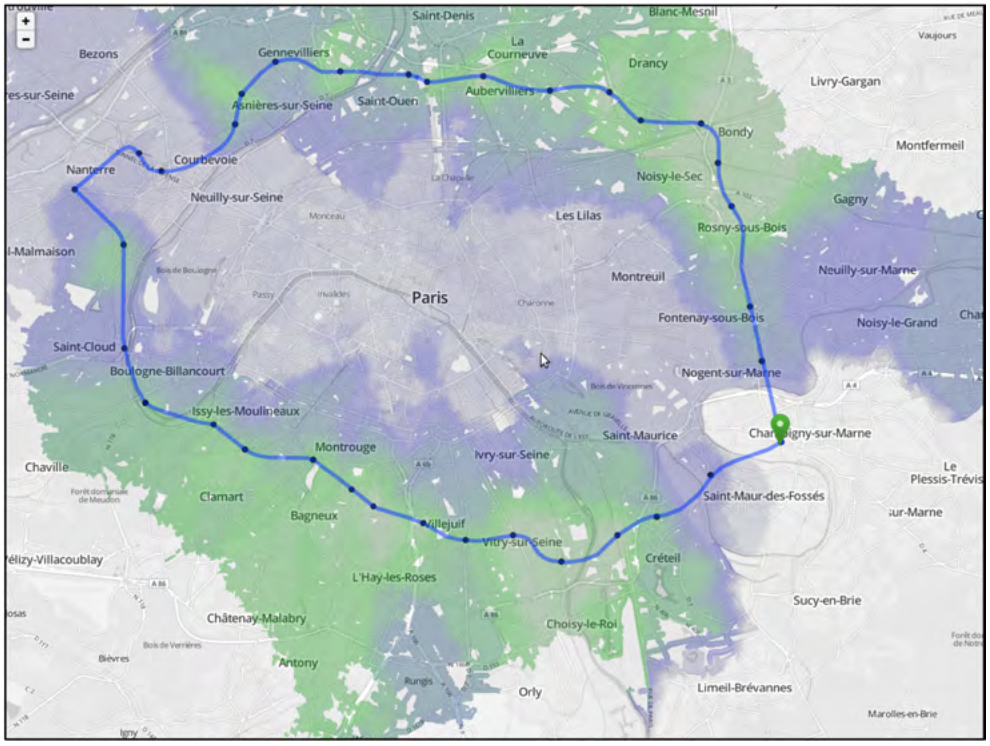
Hurricane Sandy impact on New York City services



Open schedule data also were used to leverage an analysis of a new proposed rail line in Paris, France, as shown in Figure 4-4. By building on the existing GTFS data for the city, a developer was able to add the new proposed line to the existing GTFS and conduct an accessibility analysis illustrating the impact of the new proposed route within hours of the proposal's release.

Figure 4-4

Accessibility of proposed Paris (France) rail line



Both the NYC and Paris examples illustrate the power of producing analytics and visualizations of using open data. Rapid responses to hurricane flooding and the new proposed Paris system allowed developers to quickly create an innovative solution to illustrate a service. Open data is a predictable known format that developers can innovate because of the data's clear and understood format.

The innovation of open data has launched many other initiatives, including efforts within the federal government. The Environmental Protection Agency (EPA) has used GTFS to support its SmartLocation Database, a jobs accessibility website and database to illustrate the extent and availability of jobs via public transit. The EPA's capacity to produce this dataset and offer it on a continuing basis is rooted in the availability of the data.[27]

SECTION 5

How to Successfully Open Your Data

The research and opinions expressed at the workshop and webinars by experts highlighted several guiding principles and techniques for transit agencies. The following findings are based on the insights of agencies that have successfully moved data into the open arena.

Follow Best Practices

The practices and lessons learned from agencies already openly sharing data were brought to light through the workshops, webinars, interviews, and research, producing insights into the practices, procedures, and experiences of agencies that share their data. Agencies seeking to embrace open data and leverage it to improve customer experiences should follow the examples of these agencies.

Two overarching activities guide agencies towards open data practices—(1) a fundamental attitude of embracing information and technology as an asset for enhancing organizational efficiency and improving customer experience; in the parlance of organizational change, the attitude guides the actions, and the right attitude is fundamental for any agency seeking to embrace open data, and (2) a broad range of implementation practices that open data agencies follow.

Embrace an Altered Perspective

A fundamental mindset separates agency open data choices. Agencies that view information and data systems as an overhead expense will seek to minimize and control costs, whereas open data agencies will use data to improve decisionmaking and expand the influence over customer experiences. Open data agencies view data systems as assets, and efforts to maintain and upgrade information and data systems are viewed as investments. Open data agencies begin with the benefit data brings to the organization, seeking to take advantage of how it can be used to improve decisionmaking, increase productivity, and attract customers. This attitude can lead to a "data-centered" organization that uses information to power decisionmaking and improve customer experiences.

Become Data-Centered

Many agencies participating in the webinars, workshop, and interviews consider open data to be a vital business practice used to improve internal operations and help to attract more passengers to public transit. Agencies recognize the initial and continuous efforts needed to produce and maintain open data for the agency,

a realization that serves as a barrier for agencies concerned about embracing open data and the resources required to successfully and continuously sharing service data. Many agencies that embrace open data practices do so because it is part of an ongoing business enterprise that requires updating and curation.

All workshop presented revealed ongoing and future directions of their open data efforts. KCM had upgraded its AVL systems and was in the process of upgrading its static schedule system to include calendar-based schedule data in GTFS format. MBTA's early successes laid the groundwork for the consolidation of its real-time data into a single database, with plans to integrate more changes into the system. At the core, these agencies view data as the center of an enterprise that improved decisionmaking and service delivery and bolstered the agency's profile, all while improving customer experiences.

Focus on the Customer

In conjunction with becoming a data-centered organization, agencies that participate in open data practices are focused on customer needs and satisfaction. When viewed through the lens of the customer experience, open data is akin to improving schedule design or bus stop amenities to help attract and retain customers. This customer focus is at the core of the mission of open data within the transit industry. Benefits of government transparency and accountability aside, the improved performance and experience of customers are at the core of why open data is vital to a successful agency. When open data and enterprise data systems are framed as a way of improving customer experiences and increasing organizational efficiency, agency decisionmakers often realize that the opportunities are greater than the barriers.

Implement Successful Strategies

Agencies that successfully open data employ vital actions to ensure that their open data practices are sustainable and effective, and implementation strategies operate in several environments that impact the effectiveness of these vital actions. These actions are more effective when staff and management support and assert a commitment to open data, and the absence of an organizational commitment decreases their effectiveness. Some activities are more vital, depending upon the environment and the agency's open data attitude regarding the role open data and technology has on organizational efficiency and customer satisfaction. Nevertheless, these implementation strategies help an agency move towards discovering the benefits of open data and ensure the successful implementation of open data practices. Agencies in need of management and staff leadership may develop an open data policy to help frame the agench's actions. Other options include conducting pilot studies or a phased approach towards open data efforts. For agencies that have the support of staff and

leadership, the implementation strategies guide them towards more improved open data programs.

Develop an Open Data Policy

Several agencies have formal open data policies to guide the decisionmaking process, including procurement and technology considerations. There are many examples of governmental open data policies and guidance for agencies. Although not a requirement, the development of an open data policy may help agencies without leadership guidance to move toward openness.

First, an open data policy should clearly state the agency's goal in sharing its data (i.e., enhance customer experience, improve agency transparency). The policy also should address the types of data to be used and shared by stakeholders. Included in the policy should be limitations of the data provided, including data with private/personal information or any other information that may create security and safety concerns. Ultimately, a policy serves as a roadmap for decisions the agency must make with regard to data. It will allow the principles of open data to seep into the organization and will ensure that the procurement of data and information systems will have open data provisions and opportunities. For agencies seeking to develop an open data policy, sources for a step-by-step process toward an open data policy can be found in this document's appendices.

Phased Approach – Create a Pilot Project

There are many approaches to steer an agency towards open data policies and practices. When leaders are skeptical and a formal open data policy is not politically palatable, agency staff may find success through pilot projects. Most typically, an agency's first efforts are to open schedule data to be used by the large web search engines such as Google and Bing and allow customers access to mobile applications. Regardless of the political environment, pilot projects can pave the way for future endeavors. However, with the advent of integrated automatic passenger counters (APC), computer-aided dispatch (CAD), and automatic vehicle location (AVL) systems, the opportunities to open and share data are more common.

The Pinellas Suncoast Transit Authority (PSTA) in Florida used upgrades to CAD/AVL systems as an opportunity to leverage open data practices. PSTA engaged Clever Devices to produce a real-time tracker and created an app built off the vendor-delivered API to allow customers to scan quick response (QR) codes affixed to bus stop signs to get real-time arrival data for the stop. Figure 5-1 illustrates a bus stop sign with a QR code.

Figure 5-1

Bus stop sign with QR code

The source of this perspective can come from anywhere in the organization; however, workshop presenters noted that leaders of an organization who embrace this perspective is vital; design considerations and investments are guided by leadership's view that data are an asset. Overcoming this challenged is rooted in the political realities of each agency. A wide variety of circumstances influence how agencies perceive data within the organization, and leadership changes can be a catalyst for these changes. Several agencies have been able to build support through thoughtful implementations to illustrate new operational efficiencies, costs savings, and improved customer relations due to the new approach to data within the organization. Successful agencies view data management as an operational efficiency that is vital to the running of an agency.

The decision to embrace new technologies and methods often requires compelling evidence of benefits as well as the political strength to infuse the changes into the organization. How to "sell" the idea of becoming a data-centered organization to an agency's leadership and management is addressed in later sections.

Technology Barriers

For agencies seeking to share real-time and schedule data, there are multiple approaches to resolving technological barriers. Although each of the solutions described below represents absolute solutions, blended solutions are a possibility as well. Regardless of the data being shared, the foundation of data availability must be met, and challenges to this can be resolved as described below. Three approaches to resolving these issues include developing the skills within the organization to manage, create, and distribute the data; outsourcing the responsibility for data management; or, typical of most agencies, creating a blended approach.

Skill Development

Developing skills to manage, create, and distribute the data within an organization offers an agency many advantages. Typically, agencies that develop these skills in-house are larger and have a capacity to manage the staff to produce these data. Medium-size agencies will integrate the data systems with larger information systems departments, leveraging the skills of information systems professionals to improve the operations and planning data needed to

produce GTFS and real-time data systems. Agencies that produce and manage the data using existing staff consider data to be a vital part of agency success and efficiency. These agencies invest these resources to improve decisionmaking and internal business systems. These skills also translate into other opportunities within the organization, as database and system efficiencies can produce other advantages to the organization's efficiency.

Outsourcing

Some agencies focus on the costs associated with delivering these data and the potential talent pool to develop these skills and decide to outsource the collection, delivery, and management of these datasets. This is particularly true with real-time information systems, in which integrated systems help with dispatching, passenger counters, and real-time arrival estimates. A single vendor may equip buses to produce real-time information. Although schedule information is less common, an increasing number of agencies are seeking to manage schedule data with a vendor. Web-based and desktop-based solutions are abundant for managing schedule information.

Blended Approach

The most typical example for agencies is a blended approach that combines outsourcing and in-house skill development. This leverages the opportunities of desktop solutions while preserving expertise with outside vendors and contractors. Schedule data frequently is managed using scheduling software with which agency staff become proficient and use. Commercial scheduling products frequently export to the GTFS format. Further, real-time systems can be managed by agency staff while vendors maintain the hardware to track vehicle location.

Engage with Data Users

All agencies that successfully share their data have a relationship with the data stakeholders. Following are several examples of how to create such relationships.

Competitions for Best Apps

Competitions for the best applications have been held in Boston, New York City, and Washington, DC. Although it is unclear if these competitions produce meaningful returns on investment, based on input from agencies conducting them, they are well-received and create a venue for communicating and engaging with the data-user community. However, interviews revealed that application support and development are not guaranteed, and examples of competition winners abandoning projects indicated the challenge of application competitions. Still, the competitions highlight agency effort to engage and improve customer experiences.

Create a Registry of Users

Creating a registry of users is another method used by many agencies as a way to stay in touch and engage with the user community and to create an avenue for two-way communication.

Meet with End Users

Similar to a registry, several agencies have regular meetings or mini-conferences to highlight available data and listen to what users may prefer. Some agencies reported user meetings evolving into a dialogue about data among users and producers. This environment creates a deep collaboration among the user community, the transit agency, and transit customers. The end result is a vibrant community guided by a commitment to improving public transportation services.

Develop a User Agreement

User agreements require that data users agree to terms of use to limit the agency's liability from using or accessing the data. Madison Metro Transit includes a provision for use that data are to be used to support public transit and cannot be used for nefarious purposes. Sample user agreement language can be found in this document's appendix.

Overcome Fear of Hazards

Perhaps the most powerful and least understood barrier is fear of hazards. Several factors contribute to agencies maintaining a closed data position, including loss of control over data and data quality and fear of legal hazards of open data.

Loss of Control Cover Data Quality

Agencies reported technical challenges associated with maintaining and continually producing reliable and accurate data as the biggest reason for not embracing open data principles. Several agencies pointed to concerns about loss of control over open data as justification. In one case, an agency held a steadfast position to not share its data due to the loss of quality control over schedule data, pointing to an example of inconsistency between the agency and third-party representation of a stop and route that had been discontinued but was still appearing on the developer's application. However, it was determined that the agency had not shared the most up-to-date version of its data to the developer. (In the months after the discussion, the agency opened its data to developers.)

Legal Barriers

Agencies frequently cite legal concerns related to open data. When considering the legal barriers to open data, schedule and real-time data must be considered

separately. Experts in the field presented mechanisms to protect agencies from liability and described the copyright protections of such data.

Schedule and Real-Time Data

According to presentations by experts in the fields of public transportation data and copyright laws, sanctions resulting from sharing data are not found in the research. Primary questions surrounding legal and copyright protections of schedule data were recognized as not enforceable. Schedule data are not a copyrightable data format and, as such, sharing data would not violate copyright protections of vendors that produce schedule information. Real-time data fell under the same umbrella of legal liability. However, estimated arrival time data are viewed as a work product and, consequently, cannot be shared without vendor approval or compensation to the vendor. However, these limitations can be overcome during the procurement process by requesting that data be made available through an API or in another open data format.

Terms of Use

Most agencies sharing data use licensing and terms of use agreements for use of their data. These agreements protect the agency from commercial lawsuits. The data are distributed "as is," and the developers accept any and all hazards for commercializing the data.

Copyrights

Experts in the field and studies have noted how agency schedule data are not copyrightable, and agencies should have no restrictions on distributing schedule data regardless of how they are developed or assembled.

SECTION 6

FTA Recommendations

Guided by open government principles, the federal government has instituted the broad Open Government Initiative. Recognizing the benefit of open data, this Initiative requires agencies to open their data to the public,[28] seeking to act as a catalyst for innovation by providing open data portals and issuing "grand challenges" competitions to harness the innovation of entrepreneurs and the American public. FTA can encourage transit agencies to embrace open data practices through three broad principles: advocacy, training, and administration.

Advocacy

Advocacy activities acknowledge open data opportunities through case studies, best practices, and lessons learned. By focusing on promoting open data benefits through information-sharing, FTA can play an advocacy role by highlighting the benefits of existing open data opportunities through national conferences, webinars, and research efforts for open data practices at transit agencies. Engaging with existing conferences and ongoing information-sharing events will allow FTA to guide these activities to promote open data practices and benefits.

The Transit GIS Clearinghouse, a project of the National Center for Transit Research (NCTR) at the University of South Florida, conducts the GIS in Transit Conference every two years that highlights the benefits of open data for transit agencies.[29] In past years, the conference has showcased innovative applications produced by developers using open schedule data and focused on how the public transportation industry can benefit from open data and the open source tool OpenTripPlanner.[30] In addition, the Transit GIS Clearinghouse website features multiple webinars and posts highlighting the opportunities of open data.[31,32]

FTA could cultivate its existing relationship with the USDOT's Intelligent Transportation Systems Joint Program Office by producing webinars emphasizing opportunities and issues relating to open data. Through the existing Talking Technology and Transportation (T3) program, webinars may spur agencies to move toward open data practices. Aside from the two webinars produced for this project, there are no open data and public transportation webinars within the T3 archives. FTA could encourage new webinars that focus on the opportunities of open data for public transportation providers.

Leverage Data.Gov Web Portal

FTA could seek to encourage transit agencies to leverage the Data.gov web portal to consolidate open transit data and also could promote existing open data opportunities by highlighting the Data.gov website and its open data applications. Currently, developers seeking to produce applications using transit data must engage each agency separately. An unofficial web site, GTFS-data-

exchange.com, seeks to improve developer access to data by creating a single repository of GTFS data. FTA could develop a GTFS protocol for agencies to host and post GTFS data on the Data.gov website. Currently, only three agencies store GTFS data on the Data.gov website: Staten Island Ferry Schedule, Chicago Transit Authority (CTA), and City of San Francisco (SFMTA).

Advocacy would address the motivation and benefits of open data for organizations. By highlighting and showcasing the opportunities afforded to agencies that open their data, FTA can impact agency attitudes and positions on open data.

Training

Agencies motivated by advocacy efforts inevitably will encounter technical feasibility barriers such as the lack of skills and technology required to implement open data practices. Technical training and tools would provide agencies with the capability to open data. Identifying training opportunities and taking advantage of existing programs would enable agencies to acquire the skills to move toward an open data agency.

This direction is consistent with the direction of the APTA Workforce Development Task Force and TRB's Workforce Special Report 275, which acknowledges that"… agencies require a workforce with a wider range of technical disciplines than ever before."[33] The call for agencies to embrace training and hiring in the field of information and technology systems is articulated in Mark Headd's contribution to the book *Beyond Transparency*:

> Governments need to place an emphasis on recruiting and hiring people who have experience making things. In addition, governments need to focus on developing the "maker skills" of existing employees.[34]

As many workshop participants indicated, agencies reluctant to embrace open data practices often lack the technical capacity to produce and maintain open data efforts. FTA should seek to leverage existing programs at the National Transit Institute (NTI) and the USDOT Intelligent Transportation Systems Joint Program Office to develop a training path for open data within the transit industry. This includes identifying tools that help move agencies toward open data practices. The National Rural Transit Assistance Program's (RTAP) position of encouraging agencies to embrace open data has resulted in the creation of a GTFS Builder for rural transit providers.

Administration

To augment the tools available to FTA to guide the public transit industry toward greater open data, FTA could alter its existing Master Agreement and

Certifications and Assurances. Moreover, it could require agencies to conform to open data commitments for all federal dollars spent on technologies producing real-time and schedule data. Currently, all agencies receiving money from FTA must sign and fulfill the requirements of the federal government's Master Agreement and Certifications and Assurances. FTA already places requirements for transit agency ITS activities to conform to TCIP standards. Alterations could be made under Section 20 of the Master Agreement, in which rights related to Data and Copyrights address the issue of recorded information. This addresses data collected during the project implementation. Language suggesting ownership during the life of a project could frame an open data opportunity. In this case, the subject data may address only the information acquired and produced during the term of a project. However, open data address access to information for the life of a project. Truly open data would extend beyond the life of a project.

Additional changes could deal with the list of certifications and assurances with which each agency must comply. In Group 07 (Intelligent Transportation Systems), the certification and assurances include compliance requirements for data standards under the National ITS Architecture. These standards embrace interoperability between technology systems to communicate between technologies. Interoperability technically ensures that ITS hardware and the corresponding data it produces and interprets can be communicated with other ITS systems. Although this section does not address data or the production or sharing of data, it is most appropriate for addressing open data due to the fact that schedule and real-time data typically are derived from ITS systems.

A suggested approach would be to alter the Group 07 certification to include language that encourages open data—for example, by adding the following:

> Assure that any data produced from an ITS project shall be made available to the public to promote agency transparency and encourage innovation and improve customer experiences. The data need not conform to specifications or standards but must be documented to support the interoperability with other data systems.

Conclusions

FTA has many tools at its disposal to lead the transit industry toward embracing open data. Through promotion and advocacy, FTA could alter the perspective of the industry. With a current wealth of tools at its disposal, leveraging the opportunities to illuminate and educate the industry would be a major step. Advocacy would provide a roadmap towards open data, and the tools to navigate the roadmap will require greater investment in skills in the area of information technology disciplines. By taking advantage of existing training programs, FTA-sponsored training would focus on teaching technology and data management

skills and would highlight how these skills will help move an agency toward open data practices. In addition, FTA could alter its agreements with grantees to ensure that funds in the area of technology and data are built around the principles of open data. These steps will help FTA extend its commitment to open data beyond its offices and into the industry, ultimately fulfilling its commitment to open and effective government.

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APPENDIX

A

Open Data Policies and Agreements

Examples of Open Data Policies

1. Socrata Open Data Portal Vendor

   https:/hyperlink/www.socrata.com/open-data-field-guide/

2. Collaborative Website of the Federal Government's Policy on Open Data

   https://project-open-data.cio.gov/

3. National League of Cities Open Data Policies

   http://www.nlc.org/Documents/Find%20City%20Solutions/City-Solutions-and-Applied-Research/CSAR%20Open%20Data%20Report%20FINAL.pdf

4. Open Data Guidebook

   http://opendatahandbook.org/

5. Open Data Guidance from Civic Commons Collaborative

   http://wiki.civiccommons.org/Open_Data_Guidelines/

Agencies with Reviewed Open Data Agreements

- AC Transit, CA
- AirBART, San Francisco Bay Area, CA
- Basin Transit Service, Klamath Falls, OR
- Bay Area Rapid Transit (BART), San Francisco Bay Area, CA
- Caltrain, San Francisco Bay Area, CA
- Capital Metro, Austin, TX
- Cascades East Transit, Bend and region, OR
- Cherriots, Salem, OR
- Chicago Transit Authority, Chicago, IL
- Corona Cruiser, Corona, CA
- Dallas Area Rapid Transit (DART), Dallas, TX
- Irvine Shuttle, Irvine, CA
- Island Transit, Island County, WA
- Jefferson Transit Authority, Port Townsend, WA
- Josephine Community Transit, Josephine County, OR
- Los Angeles County Metropolitan Transit Authority (LACMTA), Los Angeles, CA

- MTS, San Diego, CA
- Massachusetts Bay Transportation Authority, MA
- Metro Transit–City of Madison, Madison, WI
- Metrolink, CA
- Metropolitan Transit Authority of Harris County, Houston, TX
- Milwaukee County Transit System, Milwaukee, WI
- Orange County Transportation Authority, Orange County, CA
- Regional Transportation District, Denver, CO
- Ride Connection, Portland Metro Area, OR
- Sacramento Regional Transit, Sacramento, CA
- San Francisco Municipal Transportation Agency, San Francisco, CA
- San Joaquin Regional Transit District (RTD), Stockton, CA
- South Lane Wheels, Lane County, OR
- TAC Transportation, OR
- TheBus, Honolulu, HI
- Transit Authority of Northern Kentucky, Covington, KY
- TriMet, Portland, OR
- Trinity Transit, Trinity County, CA
- Unitrans (Davis), Davis, CA
- Utah Transit Authority, Salt Lake City, UT
- VIA Metropolitan Transit, San Antonio, TX
- Washington Metropolitan Area Transit Authority (WMATA), Washington, DC
- Woodburn Transit, Woodburn, OR

Examples of User Agreement Language

Terms and Conditions

Terms and conditions provide broad descriptions of the protections upon which the use of data are contingent. The examples below are illustrative of the variety and similarity of terms and conditions statements.

- **Massachusetts DOT** – *The Developer's License Agreement sets out the terms and conditions ("the Terms") governing your use of the information and real time and static transportation data made available by the Massachusetts Department of transportation on the "Developers Page."*
- **Metro Transit (Madison, WI)** – *City of Madison, Metro Transit, (collectively "City"), owns and maintains certain electronic data, including but not limited to, Metro Transit Tracker live tracking data and scheduled transit service data (the "Data"). City hereby grants you ("Licensee") non-exclusive, non-transferable,*

limited, and revocable rights to use, reproduce, and redistribute the Data subject to the following terms and conditions.

- **RTD (Denver, CO)** – *By your download or continuing use of the Google Transit Feed Specification ("Data") provided by the Regional Transportation District ("RTD"), you agree to this License Agreement and Terms of Use ("Agreement"), as it may be updated or modified by RTD at any time without notice and in its sole discretion. If you do not consent to be bound by this Agreement including as updated or modified, do not use or download the Data. By clicking to download the Data files, you confirm that you have read and agree to the entire Agreement.*
- **Kansas City Area Transit (KCATA) (Kansas City, MO)** – *Thank you for visiting the Google Transit Feed Page (the "Page") of the website for the Kansas City Area Transportation Authority ("Authority" or "KCATA"). By continuing use of the Page, accessing any information on the Page, or downloading or using the Google Transit Feed Data ("Data") provided herein by KCATA, you agree to this License Agreement and Terms of Use (collectively, the "Agreement"), as they may be updated or modified by KCATA at any time without notice and at KCATA's sole discretion. If you do not consent to be bound by the terms of this Agreement, including as updated or modified, you may not use the Page or download any material or Data from it. By downloading the Data, you confirm that you have read and agree to the entire Agreement.*
- **Chicago Transit Authority (CTA)** – *This Developer License Agreement and Terms of Use ("Agreement") governs the use by developers and third parties ("you") of electronic data owned and maintained by Chicago Transit Authority ("CTA," "we" or "us"), including, but not limited to, CTA Bus Tracker data, CTA Train Tracker data, transitchicago.com Alerts data, General Transit Feed Specification ("GTFS") and Scheduled Service data (collectively, "CTA Data"). CTA can change this Agreement at any time by posting a revised Agreement as CTA deems necessary. Your continued use of any CTA Data constitutes acceptance of those changes.*

The terms and conditions establish the legal framework for the rights, privileges, and obligations associated with using an agency's data. Agencies should be mindful of the positive impact of open data on customer relations; thus, the terms and conditions should set a transit-supportive tone for a long-term relationship with developers who are trying to make public transit information more accessible.

The Massachusetts DOT provides "relationship principles" with developers, highlighting several tenets that support an ongoing dialogue and recognizes third-party developers as collaborators to reach its existing and potential customers. The principles include the following:

- Respect resources.
- Succeed together.
- Expect change.

- Communication is key.
- Open, open, open.
- Legal.

License Limitations

The License and Limitations sections of agreements describe the extent, purpose, and conditions for using the transit agency's data.

- **Metro Transit (Madison, WI)** – *This License is limited to uses that utilize the Data for assisting mass transit riders or in furtherance of promoting public transportation.*
- **Oahu Transit Services (Oahu, HI)** – *You are granted a limited, revocable, non-exclusive right to use the Data , provided that no trademarks, service marks, logos or other intellectual property of OTS and/or the City may be used except in accordance with these Terms.*
- **San Francisco Municipal Transportation Authority (SFMTA) (San Francisco, CA)** – *SFMTA hereby grants Licensee a nonexclusive, limited, and revocable license to use, reproduce, and distribute data subject to the terms and conditions stated in this License Agreement. The license granted in this License Agreement shall be effective from the date of delivery of the data. During the term of this License Agreement, SFMTA shall retain all right, title and interest in the data.*
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Disclaimer and Liability

A Disclaimer and Liability section will protect an agency from liability that might arise from use of data. Agencies use the disclaimer of warranties in multiple fashions, including warranties on the data, data availability, data accuracy, and timeliness.

Warranty Disclaimer

Warranty disclaimers address the usefulness of the data. This prevents any developer from filing suit against an agency based on commercial or civil issues arising from use of the data. In essence, the data are provided "as is" and "as available," and there are no warranties on the data.

- **Bay Area Rapid Transit (BART) (San Francisco, CA)** – *Data are provided on an "as is" and "as available" basis. BART makes no representations or*

warranties of any kind, express or implied. BART disclaims all warranties, express or implied, including but not limited to implied warranties of merchantability and fitness for a particular purpose. BART and its employees, officers, directors and agents will not be liable for damages of any kind arising from the use of data including but not limited to direct, indirect, incidental, punitive and consequential damages.

- **Island Transit (Island County, WA)** – *Data are provided on an "as is" and "as available" basis. Island Transit makes no representations or warranties of any kind, express or implied. Island Transit disclaims all warranties, express or implied, including but not limited to implied warranties of merchantability and fitness for a particular purpose. Island Transit and its employees, officers, directors and agents will not be liable for damages of any kind arising from the use of data including but not limited to direct, indirect, incidental, punitive and consequential damages.*
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Indemnification

Indemnification clauses are intended to protect transit agencies from legal recourse by users of its data from claims associated with financial loss due to the use of transit data.

- **Metro Transit (Madison, WI)** – *Licensee agrees to indemnify, defend and hold harmless city, and its officers, officials, agents and employees from and against all fines, suits, proceedings, claim, suits, proceedings, claims, cause of action, demands, damages, liabilities and expenses (including liability costs and attorney fees) of any kind or of any nature whatsoever arising out of, in connection with, caused by or resulting from licensee's use of the data or products derived therefrom.*
- **Metro Transit (Los Angeles, CA)** – *You shall defend, indemnify, and hold metro and its employees, officers, and agents harmless from and against any and all liability and expense, including reasonable defense costs and legal fees, caused by your use, possession, or dissemination of the Transport Information made available from the services.*
- **RTD (Denver, CO)** – *To the extent permitted by law, you agree to indemnify, defend and hold harmless RTD and its officers, directors, and employees from and against all fines, suits, proceedings, claims, causes of action, demands, or liabilities*

of any kind or of any nature arising out of or in connection with your use of the data.

Limitation on Liability

A Limitation on Liability clause can be found in many forms and combined with other Disclaimer and Liability sections of agreements. These clauses are very similar and, in some cases, identical.

- **Metro Transit (Madison, WI)** – *Licensee agrees that city, and its employees, officers, officials and agents will not be liable for damages of any kind arising from the accuracy of or licensee's use of the data, including but not limited to, direct, indirect, incidental, punitive and consequential damages regardless of whether such damages arise based upon contract, negligence, strict liability in tort, warranty or other legal theory.*
- **BART** – *The Licensee agrees that the SFMTA and its employees, officers, directors and agents shall not be liable for damages of any kind arising from the use of data or any application that uses the data including but not limited to direct, indirect, incidental, punitive and consequential, and or special damages. The Licensee shall display or include this disclaimer in any use agreement for any application of the data created or provided by Licensee.*
- **Oahu Transit Services** – *You understand and agree that in no event will OTS be liable for any direct or indirect damages, even if OTS is aware of the possibility of such damages, including without limitation loss of profits or for any other special, consequential, exemplary, incidental or punitive damages, however caused, whether based up on contract, negligence, strict liability in tort, warranty, or any other legal theory, arising out of or related to your use of the data, the service or the site. The parties intend that this limitation should apply even if it causes any warranty to fail of its essential purpose.*

Ownership of Data

Clauses that address ownership of data preserve an agency's data, copyrights, and patents. Some agencies explicitly express copyright protections of the agency's branding and logo in separate clauses, and others combine them with ownership of data clauses.

- **Utah Transit Authority** – All materials published on the Site, including, but not limited to, trademarks, service marks, maps, schedules, departure information, fare information, photographs and illustrations (collectively, the "Content"), is the property of UTA unless otherwise indicated.
- **VIA Metropolitan Transit (San Antonio, TX)** – VIA shall at all times maintain title, ownership, rights, and interest in and to the data.
- **SFMTA** – This License is for limited use of the data as set forth herein. The SFMTA retains full title and ownership and all rights and interest in the data, and nothing in this License Agreement alienates any of those rights or interests.

- **Metro Transit (Los Angeles, CA)** – In no event shall you claim ownership of the transport Information on your website, web application or any other digital product. You shall have no rights to reproduce or use the Metro trademark in connection with the transport Information or the services.

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Copyright and branding clauses address the extent to which agency name and logos can be used. If the agency allows the use of copyrighted logos and taglines, the copyright and branding clauses prohibit the use of the logos to create the illusion that the application is an Agency created or endorsed application. The use of the copyright and branding clauses varies widely, with some agencies not addressing this issue and others articulating the limitation thoroughly.

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- **WMATA (Washington, DC)** – *WMATA trademarks and copyrighted materials, including any confusingly similar variants, may not be used in association with the data.*
- **Metropolitan Transit Authority of Harris County (Houston, TX)** – *METRO trademarks, service marks, logos, copyrighted material or other designations of source, including any confusingly similar variants, may not be used in association with data without express written permission of METRO.*
- **CTA** – *Subject to you abiding by this agreement and the CTA Trademark Guidelines for Developers (incorporated herein by reference), CTA grants you a limited, non-exclusive, non-assignable, non-transferable and revocable license and right to use the names, logos, trademarks, title treatments and art (the "CTA Brand Assets") as provided by CTA that relate to the CTA Data, including the CTA, CTA BUS TRACKER, and CTA TRAIN TRACKER word marks and the CTA Bus Tracker Logo and CTA Train Tracker Logo, for your use solely in connection with offering your application. You may not use the CTA Brand Assets or any trademarks or terms confusingly similar to CTA's trademarks in the name of your application or in any way that may suggest that CTA is affiliated with, endorses, or sponsors you or your application or that is likely to tarnish or dilute the CTA Brand Assets. You must comply with the CTA Trademark Guidelines for Developers which contain important restrictions, as well as examples of uses that are and are not acceptable.*

Severability

Severability is a term to suggest that if one part of the agreement is considered unenforceable the remainder of the agreement will remain in effect.

- **Metro Transit (Madison, WI)** – *To the extent a court of competent jurisdiction determines that any part or provision of this Agreement is unenforceable as a matter of law, such part or provision of this Agreement will be deemed*

severable and the remainder of this Agreement shall survive and remain enforceable.

- **Oahu Transit Services** – *The invalidity of any term or provision of these Terms will not affect the validity of any other provision. Waiver by OTS of strict performances of any provision of these Terms will not be a waiver of or prejudice OTS's right to require strict performance of the same provision in the future or of any other provision of these Terms.*
- **WMATA (Washington, DC)** – *Severability and Waiver: The invalidity of any term or provision of these Terms will not affect the validity of any other provision. Waiver by WMATA of strict performances of any provision of these Terms will not be a waiver of or prejudice WMATA's right to require strict performance of the same provision in the future or of any other provision of these Terms.*

APPENDIX

B

Conference Workshop and Webinars Presentation Summaries

Conference Workshop – "Open Data Policy Guidelines for Transit"

APTA TransITech Workshop Findings, March 20, 2013, Phoenix, AZ

Workshop Background

The Open Government Initiative establishes the goal for federal agencies to promote transparency, participation, and collaboration through systems that make government data easy to acquire, analyze, and respond to. Under this broad directive, USDOT is requiring each of its modal administrations to develop open data policies. FTA is seeking to fulfill this objective internally and also through working with transit agencies on greater transparency and accessibility of their data. This project seeks to provide guidance for transit agencies seeking to openly share schedule and real time information, thereby removing barriers for agencies to share data with the public.

Workshop Purpose

The purpose of the workshop was to identify characteristics of a transit agency's open data policy that would be both implementable and acceptable to agencies. The experiences of agencies that have successfully navigated the challenges of sharing data in the public domain provide a foundation from which to base guidance. Through a collaborative workshop presentation, workshop attendees interacted and questioned presenters to further delineate the barriers to sharing transit data in an open arena. The presentation considered perspectives of (1) legal policy, (2) agency, (3) industry, and (4) third-party developers. The six presenters represented a wide variety of experiences. Conclusions and outcomes are listed below.

Presentations

"Steps Toward Open Data at a Mid-Size Municipal Transit Agency" – Timothy Sobota, Transit Planner, City of Madison/Metro Transit, Madison, WI

Mr. Sobota detailed Metro Transit's schedule and real-time data history dating back to 1999. Initially starting as internal applications, many of the applications and data migrated to external customer-facing applications. Internal vehicle tracking applications supported internal operations, and fleet management became the foundation of a customer-facing web-tracking service including mobile device access. Static schedule data, stored in a schedule database, were

converted into the GTFS format. All systems and data were not initially shared with the public.

In 2010, data from the web-tracking service were extracted by developers to produce a mirror database that could be used to produce vehicle tracking apps based on the private database. Numerous apps were developed using the private real-time database and, in that same year, Metro Transit released its GTFS data to developers to use for application development. To ensure the publication and sharing of GTFS files, Metro Transit worked deliberately to ensure that procurement efforts included clarification that all data elements within a vendor's product databases were owned by the City. These efforts paved the way for a city-wide open data policy. The City also developed terms of use to protect the agency from any liability associated with using the data. These included a disclaimer of warranty; options for the City to update, alter, modify, or discontinue data sources without notice; indemnification of the City in providing data; and limitations on liability from data use. A unique element of the terms of use was that the data could be used only to assist riders or promote transit.

Mr. Sobota noted that open data has encouraged ridership growth while decreasing customer service call volumes and reducing the demand for printed schedule materials. Ridership gains with UPASS (student) customers on evening and weekends accounted for much of the gains. Metro transit received the 2012 Outstanding Public Transportation Award from APTA. The open data policy developed by the City's legal department protected the City from lawsuits. It further established a common open data framework for other City agencies to follow. The city-wide open data policy supported other data sharing efforts, such as video data and incident reports by City law enforcement and local school administration staff, which added further value to the City-wide open data policy.

"MTA's Open-Data Opportunities in 2013 and Beyond" – Ernest Tollerson, Director, Environmental Sustainability and Compliance, Metropolitan Transportation Authority, NY

Mr. Tollerson reported that MTA fully supports the GTFS-Real Time feed as a recognizable format for distributing real-time transportation information (arrivals, departures, alerts, and other pertinent information). He described the equally important benefit of open data for mass transit operators and converting the data into data visualizations and decision-support tools/apps for operations, maintenance, and other transit business processes. The agency's open data efforts have resulted in multiple applications developed for transit customers. By reaching out to users and the application development community, MTA has leveraged its open data feeds, resulting in customers finding it easier to navigate MTA's network and gaining more control over their time and everyday life activities.

"Using TCIP in the Consolidation of On-Board Equipment and Fixed End Hardware" – Jonathan Walker, P.E., Assistant Manager of Bus Engineering, WMATA, Landover, MD

Mr. Walker described a project that consolidated multiple systems to remove redundant processes and create cost savings. Using TCIP in the consolidation process created a three-year savings of $6.4 million. The implementation process built upon existing WMATA enterprise data to create a process for delivering critical information both within the agency and to external consumers. Ultimately, the consolidated systems will be installed on 1,500+ buses.

"Open Data Collection and Dissemination Standards for 511" – Nisar Ahmed, 511 Transit Information Program Coordinator, Metropolitan Transportation Commission, Oakland, CA

Mr. Ahmed identified the benefits of 511 to serve a multijurisdictional region. The Federal Communications Commission (FCC) in 1999 designated 511 as a nationwide three-digit telephone number for traveler information. The presentation addressed how 511 San Francisco Bay Area developed and maintains its multi-modal traveler information system. The 511 SF Bay Area service uses multiple communication channels including web and mobile phone apps, text messaging, and changeable message signs to disseminate its information. As a result, 511 SF Bay Area has the highest usage per capita of all 511 services. Vital to 511 SF Bay Area's success is coordinating with the program's partners, including Caltrans and the region's 30+ transit agencies. The service leverages its public transit partners' sharable static and real-time transit data to produce multi-modal trip planning and real-time transit departures. Building upon its relationships with existing partners, 511 SF Bay Area is attempting to streamline the process of assembling the multiple sources of information into the SF 511 Bay Area system by developing a regional data exchange format. It is hoped that the streamlining process and new open data exchange will also encourage greater participation in the 511 program.

Since 2002, the 511 SF Bay Area service has delivered traveler information to the San Francisco Bay area commuters. Since its inception, the 511 SF Bay Area program has continually expanded its services by adding more information with greater detail through multiple communication platforms. A hallmark of these accomplishments is thoughtful and future-oriented planning considerations. In 2013, 511 SF Bay Area continued its ongoing commitment to delivering commuting information for current and future commuters. To ensure the system is highly dependable and scalable during peak and emergency occasions, the 511 system is migrating to "cloud" based servers and databases. Further, the development of a "long-term digital blueprint" and open data exchange specification seeks to provide a framework for data collection and dissemination between the numerous data partners in the region. The exchange specification

seeks to encourage wider adoption of the 511 system by streamlining access to existing data sources and improving overall interoperability and planning to accommodate the collection of new data. The open data exchange also seeks to support external developers by creating bulk and ad-hoc data exports. The bulk export data would be scheduled service in the form of GTFS data, and the ad-hoc data exports would support real-time data requests to support the development of real time applications by third party developers.

"Open Transit Data—A Developer's Perspective" – Sean Barbeau, Ph.D., Principal Mobile Software Architect for Research and Development, University of South Florida, Tampa

Dr. Barbeau noted that open data provides opportunities for developers to support public agency missions by leveraging the private sector's ability to nimbly develop software applications. Open data is the sharing of data with external public parties, and more than 500 agencies worldwide have transit data in GTFS format. Static information cannot provide accurate vehicle trip planning and locations, and vendors are unpredictable. Some agencies shared data with Google, and when Apple dropped Google Maps, iPhone users lost transit direction. Real-time data provide estimated arrival time, vehicle positions, etc., which GTFS formats cannot.

"Experiences with Open Data: A Supplier's Perspective" – Dean Soucy, Senior Vice President for Engineering, Clever Devices, Woodbury, NY

Mr. Soucy noted that additional focus is needed to adopt a very limited set of standards for the exchange of ITS data. All adopted standards should support the creation of third-party, commercially-available protocol tools to ease development cost and time. He noted that the use of API can help leverage and liberate real-time data to share with customers. He expressed concern about licensing fees being required for access to a transit agency's data, citing that fees can range from 3–8% of the total contract value.

Webinar 1 – "Learn from the Experts: Open Data Policy Guidelines for Transit: Maximizing Real-Time and Schedule Data Use and Investments"

December 5, 2013, http://www.pcb.its.dot.gov/t3/s131205_open_data.asp

Overview

Charlene Wilder, FTA Transportation Management Specialist, presented the key objectives of the webinar and introduced the speakers. She noted that the webinar highlights experiences of transit agencies with a history of producing and sharing real-time and schedule data for their customers and private-sector third-party developers. This enables the long-term vision of moving beyond sharing data, measuring their impact, and showcasing the lessons learned and highlighting the best practices of sharing open data. Webinar participants will be exposed to the opportunities that open data provides and the challenges to overcoming technology and implementation strategies. She also conducted a real-time poll on audience understanding about the open data usage and users.

Presentations

Martin Catalá, Manager, GIS and Informatics, Center for Urban Transportation Research (CUTR), University of South Florida

Mr. Catalá noted that this webinar is part of a large project undertaken by CUTR under the direction the FTA. The goal is to capture information on agencies who are currently sharing open data and to build a guidebook for transit agencies that incorporates best practices. The FTA project is guided by four major policy areas: the legal policy framework focusing on the financial/legal liabilities that transit agencies are concerned with while sharing open data, the agency/operational framework focusing on the organizational perspective, the industry framework focusing on implementation involving technology and customer experiences, and the third-party developer and transit user area. For the study, interviews were conducted with agencies that do not share open data to incorporate their experiences into the guidebook. He welcomed feedback from webinar participants who are involved in sharing open data in transit agencies.

Dave Barker, Manager of Operations Technology, MBTA

Mr. Barker's presentation focused on MBTA Real Time, a project that integrates predictions and alerts into one platform based around GTFS. MBTA's commitment to open data was evident from the multiple open data feeds offered to developers and the user community. Early success with sharing the agency's GTFS data gave rise to multiple feeds surrounding real-time information as well

as service alerts and elevator outages. MBTA was encouraging innovation and open data to its customers, and developers produced more than 50 applications. However, all feeds were independent of each other and covered only schedules, real-time information, or alerts. Occasionally, information from the two feeds could produce contradictory information. To produce consistent information across feeds while improving data management and information flow within the agency, MBTA sought to produce a unified real-time system. For external customers, the API delivering the service information was intended to be the same; however, the system producing the service data was a single unified product that eliminated the contradictions between feeds. Further, the internal service alerts regarding commuter rail, bus transit, subway, and elevator outages were unified into a new single graphic user interface for all dispatchers within one piece of software.

Currently, MBTA has schedule data, alerts, and elevator/escalator outage information, designed and written by IBI Group for MBTA. The software uses the C# application with Microsoft SQL server, back-end on two Amazon cloud servers, based around a foundation of GTFS data, Alert GUI, with XML/JSON API, GTFS-realtime, RSS, and website subscription service. A demo showed how an alert system works and how a user and dispatcher use the information via different apps such as Google, Embark, and Proximit. The response from customers indicated that some wanted more alerts and some fewer. Overall, with more than 30,000 subscribers and positive feedback on the new web design, MBTA's customer alert system as been well received. Some of the negative feedback included complaints regarding lack of consistency in the way different internal users publish alerts, delays in getting SMS, and confusion from having too many options.

The MBTA system relies upon GTFS to serve as the foundation of the new system. Using the GTFS format, dispatchers reported service alerts consistent with the trips and stops captured in the GTFS. This consistent foundation trickled down into MBTA's API for real-time bus arrivals and schedule changes. With the development of the new real-time system, MBTA has had more than 100 developers register to use the data for application development. Some of the lessons learned by MBTA are that the GTFS base is successful and the development method works well. Future work will focus on real-time integration for subway, commuter rail, and Twitter, as well as steps to reduce message volume, improve formatting, and encourage further development.

Timothy Moore, Web Service Manager, BART

Mr. Moore's presentation highlighted the open data initiatives at BART. Since 1998, BART has been sharing data with its stakeholders, focusing on customer-oriented information to help improve the decisionmaking and experience of transit customers. Recognizing the limited resources and the importance of

sharing data with high value and impact on its users, BART focused its open data efforts by delivering on high-impact platforms such as the web, mobile apps, email, and SMS alerts. BART's efforts have resulted in significant developer and application production. He pointed out that BART's rate of app usage per rider is higher than many of the larger and successful agencies in U.S. With more than 115 apps and services, 2,700 developers in network, and 40 million API calls, BART's approach has produced significant value for its stakeholders and riders.

Mr. Moore explained how the benefits of open data are realized by BART, the developer community, and other organizational and municipal stakeholders. The open data initiative has many benefits, including developers focusing resources on customer needs rather than route and trip optimization, reduced calls to the City of San Francisco's 311 citizen information line, and BART's improved ROI on existing web and data services, staffing savings, and increased viability. Developers leveraging the data are able to focus on customer needs and app functionality. The City of San Francisco has experienced a reduction of calls to the City's 311 system by 21%, resulting in an annual $1 million cost savings. BART experienced savings, improved ROI on existing web and data services, improved customer experiences, increased awareness of services delivered, and staffing savings through reduced call center volumes. By using the trip planning and real-time data, developers avoid using resources to solve real-time arrival estimates or trip planning. By focusing on customer needs and improved functionality, developers are able to improve production time to market and ultimately the profitability of the apps.

BART has realized tangible and intangible benefits from its open data efforts. Measureable benefits include staffing reductions at the agency's call center, in spite of increased ridership, resulting in an FTE being reassigned from the call center to another position. Further, improved ROI of existing web and data investments were realized with an agency experiencing increased ridership and many developers and API calls to its open data assets. Also, BART enjoyed increased marketing and awareness resulting from many developers using transit data to promote the use of BART services, and sharing open data creates a positive perception for the agency because it illustrates its commitment to governmental transparency. The improved reach of its services and positive public perception contribute to the growth of the agency. Understanding the open data ecosystem of BART reveals that the data are provided to the developers, who are providing solutions to customers, and customers are using this solution to use the services. This ecosystem is a powerful way of providing services, and it helps BART provide services with limited resources.

Kevin Webb, Conveyal

Mr. Webb discussed how leveraging GTFS can be used to rapidly collect transit stop, route, and schedule data, evaluate the impact of storms on transit service,

and evaluate accessibility changes due to new route designs. All these examples are borne out of efforts that leverage the GTFS data format to conduct and evaluate the circumstances for each of the projects. Conveyal's experience with building and using GTFS datasets for international and domestic transit operators was highlighted. Each example illustrated how the GTFS format served as the foundation of the efforts and how the GTFS data structure can frame agency communication, planning, and transit operations. Recognizing that the GTFS serves as a data model of the transit system and is the foundation for public facing applications, it becomes clear that GTFS is a robust data platform to build upon and around. Mexico City, for example, started with virtually no data assets and illustrates the power of the GTFS data platform. GTFS served as a data framework for application developed to coordinate data collection for producing a unified, city-wide transit data product. Using a tool developed around the GTFS data framework, Mr. Webb and his team worked over a period of 6 weeks with 5 operators in Mexico City with a staff of 20 to produce data for 129 routes and 5,000+ bus stops. The capacity to build the data collection application and to execute the collection and validation effort was a testament to the simplicity and robustness of the GTFS data platform. By building around the open format of GTFS, the agencies enjoyed a new operational efficiency in a robust application. Furthermore, these agencies now have a significant data asset to support multiple activities, including engaging with developers to produce mobile and web-based applications to enhance journey planning and transit information services. Not just a map of transit infrastructure, it is a working model of transport and a framework for collaboration.

The power of using GTFS as a framework for modeling public transportation was evident after the impact of Hurricane Sandy on New York City transit services. Using GTFS data, transit accessibility was measured to illustrate the magnitude of the impact on the transit services. By measuring the population impacted by the emergency event, the magnitude of the impact on the population was easily accessed and evaluated. Given the availability and robust nature of the GTFS data, a rapid evaluation of the impact of the storm was measured and utilized to communicate the full impact of the hurricane. Paris is another illustration of how GTFS can be used to produce a meaningful evaluation of proposed service changes. Using the Paris GTFS, accessibility changes for a new route were evaluated. Building upon the GTFS data set and an open source application, OpenTripPlanner Analyst, the impact of the accessibility changes were measured. By modifying Paris's existing GTFS to include the new route, the new system could then be used to actively measure the impact the service would have on its users. A website was developed to allow users to interact with the new proposed route and understand the impact it would have on the accessibility from a user perspective.

Finally, the *Transit Capacity and Quality of Service Manual* discusses the use of GTFS in the cross-comparison between different cities in the U.S. that had released GTFS. This example was used as framework for understanding a tool that could be used to develop metrics which are complex from a data standard. GTFS provided a distribution based on frequency of service and location of stops, headways, etc. Also, future work taking place in China will use GTFS as a potential input and service quality indicator to examine comparative transportation metrics across cities.

As a closing note, Mr. Webb noted that from a public communication and internal operational perspective, GTFS is a spreading phenomenon. From a public trip planning perspective, it is now produced in well over 1,200 cities. From an internal communication perspective, it is a legally-mandated framework for performance evaluation that can be used to coordinate communications about service delivery. Overall, use of GTFS is a boon to the transit industry.

Webinar 2 – "Learn from the Experts: Open Data Policy Guidelines for Transit – Maximizing Real-Time and Schedule Data, Legalities, Evolution, Customer Perspectives, Challenges, and Economic Opportunities, Part II"

August 7, 2014, http://pcb.volpe.dot.gov/t3/s140807_open_dataII.asp

Presentations

"Open Transit Data: Evolution and Best Practices" – Dr. Kari Edison Watkins, P.E., Ph.D., Assistant Professor, Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta

Dr. Watkins' presentation relayed the findings from case studies of agencies that employ open data practices, addressing the agencies' motivation for open data and the benefits derived from embracing open data practices. After a brief background on the evolution of printed schedule data to machine-readable schedule data, Dr. Watkins underscored the importance of schedules to an agency seeking to reach its customer base. As agencies moved into electronic formats of schedules (e.g. PDF, map, and data), developers could produce interactive and usable schedule information for transit customers. These solutions, however, only serve a single transit agency and population. The advent of GTFS changed this scenario. Agencies that produced data in GTFS format enjoy the benefit of transit planning on Google Maps, and consequently, developers that created GTFS-based solutions are able to deploy the apps in different cities with GTFS data. The findings of the open data case studies she conducted were presented, as were the motivations of the agencies seeking to open their data, including improving customer services, increasing information

access riders, fostering innovative and diverse apps, creating interconnected transit trip planning, promoting transit agency transparency, and supporting equitable information access for persons with disabilities.

She also detailed the benefits of open data. Agencies have reported the rapid development that has resulted in opening agency data up to developers. Nine weeks after MBTA released its real-time data, seven applications were developed. From a desktop arrival time widget, a countdown arrival sign, and an iPhone app, the agency was able to realize significant extension of its customer reach in a variety of specialized ways. Other benefits included the ability to evaluate transit service across agencies and to provide comparable performance metrics and evaluations. These methods enhance existing performance evaluations as well as provide repeatable and comparable results for the agency. Findings from case studies that examined the best practices and lessons learned from agencies that provided open data were presented. Many agencies reported an initial hurdle of overcoming perceptions and attitudes toward open data, and some reported technical skill limitations or "technical feasibility" as well as constraints on staffing commitment and resources to deploy and maintain an open data system. Some agencies reported concerns about legal liability associated with opening data to the public and developers. Agencies embarking on open data initiatives reported concerns over technical know-how—did the organization have the staffing skills to develop and produce the data in an open format? It was clear the agencies needed to invest in and develop these skills to properly manage and deploy the data to the user community.

The case studies found that none of the legal fears associated with agency brand confusion, logo usage, and legal liabilities were experienced. Many of the barriers and legal issues surrounding open data can be covered by user agreements between the agencies and developers. The case studies did reveal patterns of success. Successful deployments required the recognition and commitment to develop the data continuously with frequent and up-to-date releases of data. Agencies reported that overcoming challenges associated with out-of-date GTFS files and continuously releasing the data ensured a smoother and consistent delivery of the data, resulting in better customer products. Another common characteristic is the role of staff-level champions and supportive strong leadership. Agency success hinged on the support of leadership to overcome the perceptions and fears of open data, coupled with staff-level champions to serve on the front lines of developer relations and mitigate legal concerns through the development of user agreements. The relationships with developers were highlighted as a vital element of successful deployment of open data. The agencies reported a wide spectrum of activities, including developing user agreements in concert with developers, participating and hosting regular developer meetings, and introducing challenges to the developer community.

The final practice noted was measuring open data performance by monitoring app development. Tracking downloads and the number of apps developed under a user agreement was a simple step to measure the extent to which data are being used by developers. Further, agencies can use the inventory of apps to identify potential gaps for disadvantaged groups that might not have access to the appropriate technology to benefit from the open data. Finally, agencies should conduct market research to better understand the technology market available to existing and potential transit users.

"Open Transit Data: Meeting Customer Needs, or Where the Data Meets the Road" – Dan Overgaard, Supervisor, Systems Development & Operations, King County Metro Transit

Mr. Overgaard relayed KCM's experiences with open data and real time information. Since 1993, KCM has used real-time information to assist with service planning, scheduling, and operations. Real-time data guided new route schedules and configurations. In 2001, the idea of moving the real-time information from a back-end operation to a customer-facing application was borne out of efforts by both KCM staff and the University of Washington (UW). A UW professor obtained access to real-time information and developed an application called Transit Tracker, which provided real-time locations of the KCM fleet. Recognizing the benefits of the information to the customers, KCM adopted the application and produced a web application reporting system. Most recently, KCM has upgraded its system and currently produces and shares GTFS real time data for developers to use. Since its inception, KCM has invested in updating the hardware and technology to produce real-time data, a continuous improvement process, particularly during these times of rapid technology advancements in the area of mobile communications and platforms. From its initial efforts to produce a customer-facing application, KCM produced myriad communication avenues to provide transit information to its customers, including sharing static schedule data in the form of GTFS data and real-time information using the GTFS real-time format.

King County Metro communication avenues include Metro's online website, an automated trip planner, Tracker (bus location and departures), Eye on Your Commute (blog updates), an interactive voice response system, transit alerts via email subscription, Twitter alerts and interaction, on-board stop announcements & displays, real-time information signs on RapidRide corridors, and static and real-time data available to third-party developers. To meet the expectations of riders accustomed to receiving accurate real-time information, KCM works hard to produce information about abnormal service conditions that are not a part of the open data format used by KCM. Abnormal operating conditions such as unexpected road closures, events, and other service interruptions are a source of complaints by KCM riders.

Mr. Overgaard illustrated the challenge of upgrading the system by describing the complexity of KCM's data system. Despite the challenges, improvements and next development steps are planned to improve the customer information delivery system. To address the planned and anticipated events that interrupt normal service, KCM will use calendar-based GTFS data to improve the accuracy of scheduled service information and plans to alter its data model to support a stop-based model to be used by all internal systems, supporting the efforts to create new ad hoc routes to accommodate unexpected route alignment changes. Improvements to real-time data include exploring dispatch system features to provide improved dynamic service alerts for both internal use and export out to the developer community. The improvements also seek to find better information visualization to improve the customer experience and to survey customers to better understand their information needs.

"Legal Protection of Transit Data"© – Larry W. Thomas, J.D., Ph.D.

Dr. Thomas, an attorney and author of a TCRP legal digest, spoke on the legal protections afforded to transit agency data under copyright laws. Case law representing the legal foundation of his copyright opinion illustrated the foundation of transit agency protections under copyright laws. In essence, data are not copyrightable, so copyright claims about transit data are not protected. Illustrating the extent of the claims, he explained how some data that are original in nature can be considered "compilations" and be subject to copyright laws. A database may be considered a compilation if it meets the three requirements of the originality test: (1) collection and assembly of pre-existing data; (2) selection, coordination, or arrangement of that data; and (3) a resulting work that is original, by virtue of the selection, coordination, or arrangement of the data contained in the work. Even then, legal protection is thin. His research determined that agencies frequently use terms of use and license agreements to restrict data access and usage. Even in cases of public records disclosure laws, there are two rulings indicating that a requester must sign an end-user agreement, effectively restricting further distribution or use of the database. In conclusion, he indicated that "thin" copyright protections may be afforded to a database deemed a compilation. Even then, however, data underlying the copyright may be extracted without violating the copyright. Further, transit agencies rely upon contracts and terms of use agreements to protect data.

"Open Data—Legal Framework & Municipal Economic Development Opportunities" – Lou Milrad, B.A., LL.B

Mr. Milrad's presentation highlighted Canadian copyright laws and the many similarities between the Canadian and U.S. systems. Many of the protections under the Canadian legal framework create an environment similar to the U.S. The foundation of the open data movement in Ontario and its municipal governments is transparency and accountability. Open data encourage open

accountability and service transparency. At each level of government in Canada, the open data movement is growing and, recently, the Canadian Federal Government, in conjunction with provincial and municipal governments, agreed to create a single license agreement for open data, providing ease for any governmental body seeking to open its data to stakeholders. The presentation also highlighted the importance of open government data to economic development. Municipal land data, such as land records and permitting and zoning data help investors in properly siting real estate investments. Among these datasets are public transit service data. When agencies make these data available, they address a pressing concern and question for investors. Open data are a driving force for economic development in Ontario. This includes public transit datasets, which play a role in real estate investment decisions. By encouraging agencies to share data with decisionmakers and investors, from the development of single license agreements to guiding agencies towards greater transparency, Ontario will enjoy job creation and economic growth.

DEFINITIONS

Application Programming Interface (API) APIis a set of routines, protocols, and tools for building software applications. An API expresses a software component in terms of its operations, inputs, outputs, and underlying types. An API defines functionalities that are independent of their respective implementations, which allows definitions and implementations to vary without compromising each other. A good API makes it easier to develop a program by providing all the building blocks. A programmer then puts the blocks together. In addition to accessing databases or computer hardware, such as hard disk drives or video cards, an API can ease the work of programming Graphical User Interface (GUI) components. For example, an API can facilitate integration of new features into existing applications (a "plug-in API"). An API also can assist otherwise distinct applications with sharing data, which can help to integrate and enhance the functionalities of the applications. APIs often come in the form of a library that includes specifications for routines, data structures, object classes, and variables. In other cases, an API is simply a specification of remote access to the data calls exposed to the API consumers. An API specification can take many forms, including an International Standard such as POSIX, vendor documentation such as the Microsoft Windows API, or the libraries of a programming language such as the Standard Template Library in C++ or the Java APIs.

Graphical User Interface (GUI), A GUIsometimes pronounced "gooey" or "jee-you-eye," is a type of interface that allows users to interact with electronic devices through graphical icons and visual indicators such as secondary notation, as opposed to text-based interfaces, typed command labels, or text navigation. GUIs were introduced in reaction to the perceived steep learning curve of command-line interfaces (CLIs), which require commands to be typed on the keyboard. The actions in a GUI are usually performed through direct manipulation of the graphical elements. In addition to computers, GUIs can be found in hand-held devices such as MP3 players, portable media players, gaming devices, and smaller household, office, and industry equipment. The term "GUI" tends not to be applied to other low-resolution types of interfaces with display resolutions such as video games and is not restricted to flat screens such as volumetric displays because the term is restricted to the scope of two-dimensional display screens able to describe generic information, in the tradition of the computer science research at the Palo Alto Research Center.

JavaScript Object Notation (JSON) JSONis a lightweight data-interchange format. It is easy for humans to read and write and also easy for machines to parse and generate. It is based on a subset of the JavaScript Programming Language, Standard ECMA-262 3rd Edition, December 1999. JSON is a text format that is completely language-independent but uses conventions that are familiar to programmers of the C-family of languages, including C, C++, C#, Java, JavaScript, Perl, Python, and many others. These properties make JSON an ideal data-interchange language. JSON is built on two structures: a collection of name/

value pairs, which, in various languages, is realized as an object, record, struct, dictionary, hash table, keyed list, or associative array, and an ordered list of values, which, in most languages, is realized as an array, vector, list, or sequence. These are universal data structures. Virtually all modern programming languages support them in one form or another. It makes sense that a data format that is interchangeable with programming languages also be based on these structures.

Rich Site Summary or Really Simple Syndication (RSS) RSSoriginally was termed an RDF Site Summary and now is often called Really Simple Syndication, uses a family of standard web feed formats to publish frequently-updated information such as blog entries, news headlines, audio, and video. An RSS document (called "feed," "web feed," or "channel") includes full or summarized text and metadata such as publishing date and author name. RSS feeds enable publishers to syndicate data automatically. A standard XML file format ensures compatibility with many different machines/ programs. RSS feeds also benefit users who want to receive timely updates from favorite websites or to aggregate data from many sites. Subscribing to a website RSS removes the need for the user to manually check the website for new content. Instead, their browser constantly monitors the site and informs the user of any updates. The browser also can be commanded to automatically download the new data for the user. Software termed "RSS reader," "aggregator," or "feed reader," which can be web-, desktop-, or mobile-device-based, present RSS feed data to users. Users subscribe to feeds either by entering a feed's Uniform Resource Locator (URI) into the reader or by clicking on the browser's feed icon. The RSS reader checks the user's feeds regularly for new information and can automatically download it, if that function is enabled.

Short Message Service (SMS) SMS is a text messaging service component of phone, web, or mobile communication systems. It uses standardized communications protocols to allow fixed line or mobile phone devices to exchange short text messages.

Extensible Markup Language (XML) XMLis a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable. It is defined by the World Wide Web Consortium's (W3C) XML 1.0 Specification and by several other related specifications, all of which are free open standards. The design goals of XML emphasize simplicity, generality, and usability across the Internet. It is a textual data format with strong support via Unicode for different human languages. Although the design of XML focuses on documents, it is widely used for the representation of arbitrary data structures, such as those used in web services. Several schema systems exist to aid in the definition of XML-based languages, and many APIs have been developed to aid the processing of XML data.

Service Interface for Real Time Information (SIRI) SIRI is an XML protocol to allow distributed computers to exchange real-time information about public transport services and vehicles. SIRI is based on the Transmodel abstract model for public transport information and comprises a general purpose model and an XML schema for public transport information. SIRI allows pairs of server computers to exchange structured real time information about schedules, vehicles, and connections, together with general informational messages related to the operation of the services. The information can be used for many different purposes, such as to provide real time departure from stop information for display on internet and mobile delivery systems, to provide real time progress information about individual vehicles, to manage the movement of buses roaming between areas covered by different servers, to manage the synchronization of guaranteed connections between fetcher and feeder services, to exchange planned and real time timetable updates, to distribute status messages about the operation of the services, and to provide performance information to operational history and other management systems. SIRI includes a number of optional capabilities. Different countries may specify a country profile of the subset of SIRI capabilities that they wish to adopt.

Transit Communications Interface Profiles (TCIP) TCIP–is an APTA Standard that provides a library of information exchange building blocks to allow transit agencies and transit suppliers to create standardized tailored interfaces. APTA TCIP is based on the earlier TCIP work performed by Institute of Transportation Engineers (ITE), American Association of State Highway and Transportation Officials (AASHTO), and National Emergency Management Agency (NEMA) and published as the NTCIP 1400-series standards. APTA TCIP extended the NTCIP Standards to include a Concept of Operations, Model Architecture, Dialog Definitions, and a rigorous, modular approach to conformance. Both the APTA TCIP development and the earlier NTCIP development were sponsored by the US DOT Intelligent Transportation Systems Joint Program Office.

TCIP provides building blocks for interfaces for several business areas, including common public transport, scheduling, passenger information, transit signal priority, control center, onboard systems, spatial referencing, and fare collection.

ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
API	Application Programming Interface
APC	Automatic Passenger Counters
APTA	American Public Transportation Association
AVL	Automatic Vehicle Location
BART	Bay Area Rapid Transit
CAD	Computer-Aided Dispatch
CDMA	Code Division Multiple Access
CLIs	Command-line Interfaces
CUTR	Center for Urban Transportation Research
CTA	Chicago Transit Authority
EPA	Environmental Protection Agency
GIS	Geography Information System
GSM	Global System for Mobile Communications
GTFS	General Transit Feed Specification
GUI	Graphical User Interface
FCC	Federal Communications Commission
FDOT	Florida Department of Transportation
FTA	Federal Transit Administration
FTE	Full Time Equivalent
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
JSON	Javascript Object Notation
KCM	King County Metro
MBTA	Massachusetts Bay Transportation Authority
MTA	Metropolitan Transportation Authority
NCTR	National Center for Transit Research
NEMA	National Emergency Management Agency
NTCIP	National Transit Communications Interface Profiles
NTI	National Transit Institute
OTP	Open Trip Planner
PSTA	Pinellas Suncoast Transit Authority
QR	Quick Response
REST API	Representational State Transfer Application Program
ROI	Return on Investment
RTAP	National Rural Transit Assistance Program
RTD	Regional Transportation District
RSS	Rich Site Summary or Really Simple Syndication
SFMTA	San Francisco Metropolitan Transit Authority
SIRI	Service Interface for Real time Information
SMS	Short Message Service
SOAP	Simple Object Access Protocol
T3	Talking Technology and Transportation
TBEST	Transit Boardings Estimation and Simulation Tool

TCIP	Transit Communications Interface Profiles
TCRP	Transit Cooperative Research Program
TCQSM	Transit Capacity and Quality of Service Manual
URI	Uniform Reform
US DOT	U.S. Department of Transportation
UTA	Utah Transit Authority
W3C	World Wide Web Consortium
XML	Extensible Markup Language

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