

Mobility for All Pilot Project

GTFS-eligibilities and GTFS-capabilities



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TABLE OF CONTENTS

ACKNOWLEDGEMENTS	1
EXECUTIVE SUMMARY	4
BACKGROUND.....	6
PROJECT DESCRIPTION AND SCOPE.....	7
BACKGROUND ON DATA STANDARDS, GTFS, AND GTFS EXTENSIONS	10
<i>General Transit Feed Specification (GTFS)</i>	10
PARTNERSHIPS AND STAKEHOLDER INPUT	13
PROJECT OUTCOMES	13
<i>The Introduction of the Concept of Uniform Resource Name (URN)</i>	14
<i>Project Webinar</i>	15
<i>ODOT GitHub Pages: GTFS-eligibilities and GTFS-capabilities</i>	16
PERFORMANCE MEASURES	17
LESSONS LEARNED	18
ONGOING OPPORTUNITIES – SUSTAINABILITY – NEXT STEPS.....	19
<i>Expert Panel input on GTFS-eligibilities</i>	20
<i>Expert Panel input on GTFS-capabilities</i>	21
EFFECTS OF COVID-19.....	23
CONCLUSION.....	23
APPENDICES.....	25
<i>Glossary</i>	25
<i>Additional Technical Advisors on the Project</i>	27
<i>Related Projects</i>	28

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The ODOT's Public Transportation Division and Full Path Transit Technology guided the project, with insights and expertise provided by the project's Expert Panel and Technical Working Group.

OREGON DEPARTMENT OF TRANSPORTATION – PUBLIC TRANSPORTATION DIVISION

Sarah Hackett, Project Lead
Public Transportation Network Coordinator

Karyn Criswell, Administrator
Public Transportation Division

Jennifer Sellers
*Rail Operations and Statewide Multimodal
Network Manager*

Marsha Hoskins
Policy and Implementation Manager

Frank Thomas
Program Manager - Statewide Transit Network

Matthew Barnes
*Program Manager - Statewide Transit Network
(retired)*

FULL PATH TRANSIT TECHNOLOGY

Kevin Chambers and Lara Bjork



EXPERT PANEL / TECHNICAL WORKING GROUP

211 LA

CALACT (California Association for Coordinated Transportation)

Cambridge Systematics

Schweiger Consulting

Central Florida Regional Transportation Authority (LYNX) Compiler LA

AARP Public Policy Institute

DemandTrans

US Department of Veterans Affairs

FlexDanmark (formerly) and Danish GeoTech Agency

Hopelink

IBI Group

Interline Technologies

Jarvus

King County Metro Transit

Metropolitan Transportation Commission (San Francisco Area CA)

Minnesota Department of Transportation

MobilityData

NADTC (National Aging and Disability Transportation Center)

National Rural Transit Assistance Program

NEORide

ODOT Office of Civil Rights

Oregon Commission for the Blind

Oregon State Independent Living Council

Ride Connection

Routematch by Uber

Shared Use Mobility Center

Taskar Center for Accessible Technology, Paul G. Allen School of Computer Science, University of Washington

Tillamook County Transportation District

David Serby

Thomas Craig

Paul Sorenson and Raphael Barcham

Carol Schweiger

William (John) Slot and Norm Hickling

Vyki Englert

Jana Lynott

Roger Teal

Pat Sheehan

Niels Larsen

Staci Sahoo

Santosh Mishra

Drew Dara-Adams

Julia Schaumburg

Michael Rimion

Nisar Ahmed

Elliott McFadden and Alex Stoiaken

Timothée Millet and Cristhian Hellion

Steve Yaffe

Robin Phillips Nancy Doherty, and Marcy Jaffe

Katherine Conrad

Carroll Cottingham

Malinda Carlson

Brooke Wilson

Alex Page

Daisy Wall

Al Benedict

Anat Caspi

Doug Pilant and Cathy Bond

EXPERT PANEL / TECHNICAL WORKING GROUP (cont.)

Token Transit	Ekaterina Kuznetsova
Tompkins County (NY) Department of Social Services	Dwight Mengel
Transit App	Andrew Salzberg
Trillium Solutions	Weston Shippy
Washington Department of Transportation	Ian Wesley

EXECUTIVE SUMMARY

Under a grant from the Federal Transit Administration's (FTA's) Mobility for All Pilot Program (M4A), the Oregon Department of Transportation (ODOT) sought to fill a pressing need for standardized and computer-readable data that describes rider eligibility (characteristics that qualify a rider to use a specialized transportation service) and service capability (ability to meet rider needs).

Over the last decade, ODOT and Oregon transit providers have made substantial investments in the General Transit Feed Specification (GTFS) and related software tools. As a result, most Oregonians can use applications (apps) and websites (such as Google Maps) to plan trips on approximately 60 fixed route transit services in the state. GTFS-flex is an extension of GTFS that has the capacity to represent demand-responsive transit. These kinds of specialized transit services typically provide services for categories of passengers whose needs are not met by fixed route services, such as seniors, people with disabilities, veterans, and low-income populations, and in some rural areas where no frequent service is not provided.

ODOT recently began working to create and maintain GTFS-flex data statewide. However, GTFS-flex in its current form is incomplete; unlike GTFS, GTFS-flex does not contain critical information about passenger eligibility, trip purpose eligibility, and transit service capabilities.

Discovering available demand-responsive services is typically challenging, requiring the rider to check on multiple websites, make calls, etc., to find out what services are available and whether they qualify to use them. There are no opportunities for riders to get web or app explanations of these services. Other ways for riders to discover these options are needed. The project goal was to expand transit data standards to improve depiction of specialized transit services, targeting these missing elements, and make progress on standardized and computer-readable data for demand-responsive transit services.

The goals of this project are particularly important for ODOT because they address Strategy 4.1C of the [Oregon Public Transportation Plan \(OPTP\)](#): *Identify and address technological barriers that inhibit or prevent people, especially the transportation disadvantaged, from accessing information regarding public transportation services or providers.* In addition, this work supports ODOT's 2021-2023 Strategic Action Plan outcomes, particularly: *Improving equitable access to active and public transportation.*

To accomplish this work, ODOT contracted with Full Path Transit Technology (Full Path). One of the initial tasks was to conduct research to find any completed and in-process efforts to define and describe work toward this purpose to make sure that ODOT's work did not duplicate existing work. Although there is a great deal of standardized transit data available through GTFS, as well as several proposed and active "extensions" to GTFS that expand its utility for complex transportation data, the research indicated that there were no existing efforts to address data standards relating to rider eligibility and service capability.

ODOT and Full Path saw the importance of having the project consult with experts in the fields of human services transportation, disability advocacy, public transportation service provision, data standards development, and transit-related software development to provide input and guidance to this project overall. Full Path solicited members for an Expert Panel and also created a subgroup – the Technical Working Group – to address the detailed technical work of developing the proposed standards. Oregon transit agencies and data experts, along with U.S. and international experts, participated.

Since the project's budget and timeline required focusing on an achievable result, ODOT limited the scope to the discovery stage of the demand-responsive trip lifecycle, rather than addressing subsequent stages such as registration and booking for these services. (ODOT's involvement in the CalACT "Trip Planning for All" ITS4US project is expected to make progress toward these goals.)

Another key decision was to emphasize the importance of being able to create this type of data feed easily rather than attempting to ensure that such data was complete and exact. For example, ODOT, Full Path, and the Expert Panel determined that it was more important for the initial version of GTFS-capabilities to provide service level information, rather than detailed information about every vehicle in their fleet. Similarly, there was agreement to emphasize flexibility in describing eligibility categories rather than limiting them with strict definitions. These choices were due to various factors, including: the project timeline, the need to get industry acceptance and adoption of the proposals, and the variation in types of transit vehicles used for demand-responsive services (cars, vans, cutaways, etc.).

An important outcome of the project is a proposal for GTFS-eligibilities that introduces Universal Resource Names (URNs) as a structured way of developing unique identifiers for eligibility categories. In addition, some parts of the project work have already been absorbed into MobilityData's General On-Demand Feed Specification (GOFs) project.

The proposals also pointed to a larger institutional need – the world of transit is increasingly overlapping with human services and medical services. These services should clearly be prioritized for inclusion in GTFS, and such organizations, and persons with mobility challenges, should participate in standards processes.

Because this project was intended to be a "solid first step" in the development of GTFS-eligibilities and GTFS-capabilities, the following are opportunities the project identified to continue this work:

- support cross-institutional conversations to develop agreement on common goals and processes;
- ensure inclusive engagement with riders during development of applications that use the proposed standards;
- ensure inclusive governance for the standards to ensure they meet the public interest;
- engage people and agencies from throughout the world, to expand the United States focus of the project;
- secure sustained funding for data production and consumption;
- secure ongoing development and support of URNs as a concept that is new to the transit world;
- develop ability to track real-time information about seating area configuration changes through GTFS-capabilities; and
- support for translating these proposals into multiple languages.

One aspiration of this project is to influence the national adoption of GTFS-flex by transit providers, State DOTs, software vendors, and others. This could include adoption of GTFS-flex by [Google Maps](#), [Apple Maps](#), [Transit App](#), and open trip planners adding eligibility and capability information, as well as demand-responsive service travel options, to free trip planning software. Such actions could transition these websites, applications, and related tools to be universal trip planners. All of the project proposals have been created using open source standards, to be used by any state or region in the United States.

BACKGROUND

ODOT has spent over 10 years investing in transit data standards and related software: first General Transit Feed Specification (GTFS), then GTFS-ride (ridership), and most recently, GTFS-flex (designed to enable trip planning for demand-responsive or paratransit services).

GTFS-flex is a proposed extension to GTFS that has the capacity to represent demand-responsive services, especially for trip planning, and ODOT is already working to create and maintain such data across the state. However, GTFS-flex, in its current form, is incomplete since it does not contain critical information about passenger and trip purpose eligibility, and the capabilities of transit services.

Some of the challenges to access to specialized forms of public transportation do not exist with general public transit. In some cases, a person's individual characteristics (e.g., age, disability status, residence, employment, or registration in a particular program) may determine whether they qualify for a particular transportation option. In other cases, the transportation provider will have varying abilities to meet the needs of riders (e.g., mobility devices, assistance animal, companion seating). These situations are complex; some of the challenges include:

- Discovering specialized services is often labor-intensive, and the burden typically falls on riders to figure out what options exist and whether they qualify for a specific type of transportation,
- Providers of public transportation find it difficult to share information about the full range of their services with the public, especially for specialized services, and
- The tools that are necessary to understand how eligibility and service capability factors affect different populations' mobility are not available to planners, policymakers, and researchers.

The Mobility for All (M4A) Pilot Program grant provided an opportune next step in ODOT's efforts to improve standardized transit data, especially those focusing on issues related to demand-responsive services. ODOT's goal was to look beyond fixed route and the general public transit data that are widely available for Oregon transit services to develop ways to improve data that describes other types of public transportation (e.g., ADA paratransit and veterans' service). For these, service levels are typically beyond what general public transit provides. This project allowed ODOT and Full Path to develop proposed extensions to GTFS and GTFS-flex that could support a standardized data foundation for all public transportation riders.

PROJECT DESCRIPTION AND SCOPE

The M4A grant provided an opportunity for ODOT to fill a pressing need for standardized and computer-readable data. ODOT contracted with Full Path with the goal of developing two proposed extensions to standardize demand-responsive transit data: GTFS-eligibilities and GTFS-capabilities. Both target the need to describe standardized public transit services in a computer-readable format. In addition, both need to be able to connect to the existing data models and standards in GTFS and GTFS-flex, including information about routes, trips, booking times, etc., and need to be created and shared in a tabular (.csv) format.

The proposed **eligibilities** extension describes the constraints related to access to demand-responsive services, focuses on the narrowed or specific service (less access than general public transit), and addresses the need to handle access rules and membership requirements created by each transit service and/or the jurisdiction providing the service. This includes making sure it is possible to capture the complexity of eligibilities as they exist today, and to also provide a path to simplify and coordinate how eligibilities are managed at a regional level or higher level.

Rider eligibility: Rider characteristics that qualify a rider to use a service in question (including but not limited to age of 65 or over, mobility-related disability, veteran status, female, or qualified paratransit user).

The proposed **capabilities** extension describes service features that can respond to rider needs, focuses on expanding service beyond those provided to ambulatory riders, and defines the spatial, mechanical, or human resources of the transit service. This includes the ability to provide service-level information – what can the service offer – not the detailed information about each vehicle used for the service. It also describes the potential accommodations that can be available for different kinds of riders.

Service capability: The ability of the transit service to meet riders' physical needs and the extent of the assistance available (including, but not limited to, door-to-door, door-through-door and stretcher, mobility device, and bariatric transport capabilities).

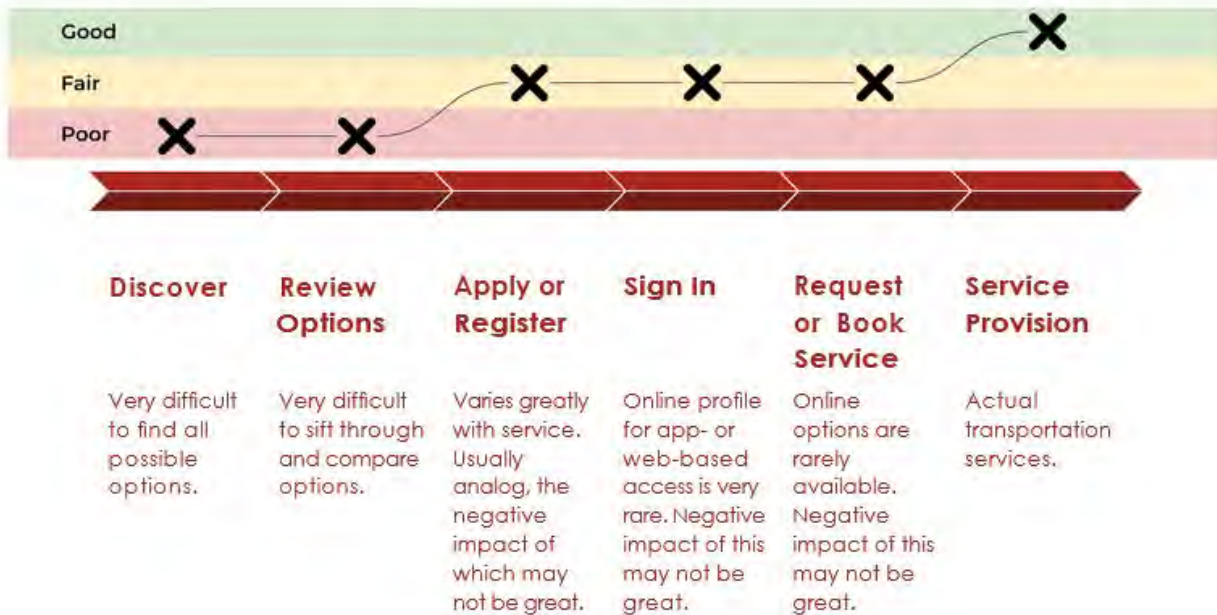
For both the eligibility and capability proposals, designing the common cases can be easy, but the processes need to ensure that cases that are more complex can also be represented.

Developing these proposals required review of the typical trip lifecycle for demand-responsive transportation services:

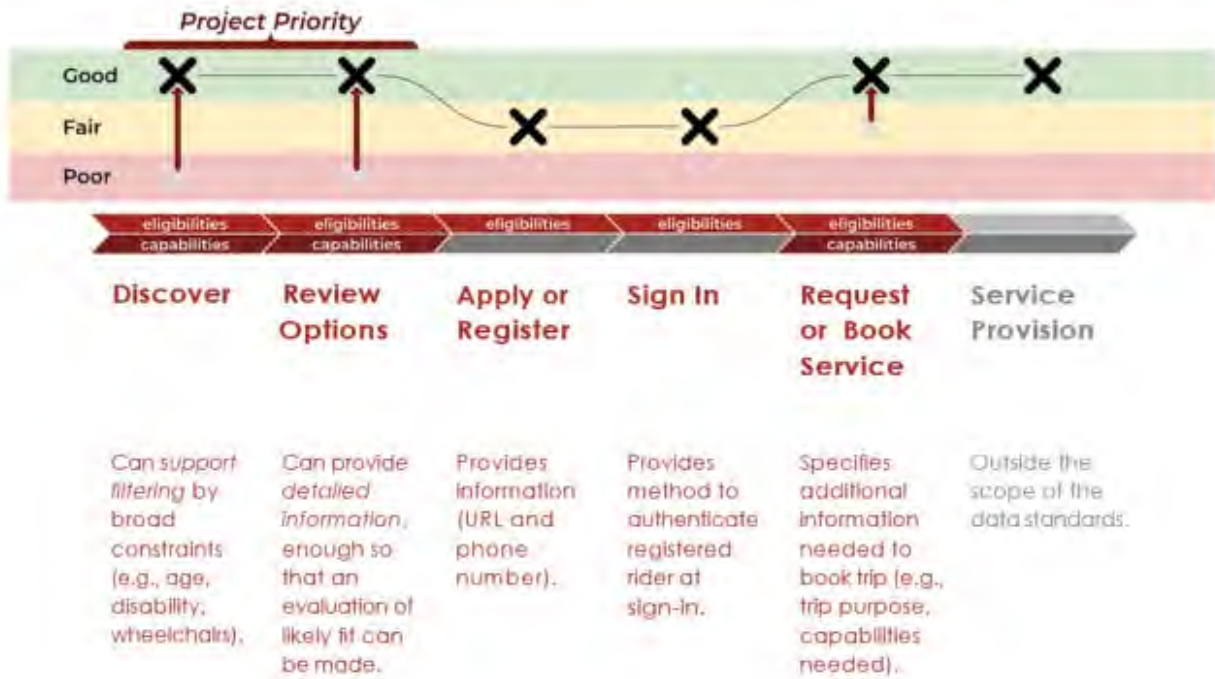
The typical trip lifecycle for demand-responsive services:



The trip lifecycle for a sample user – current experience and conditions:



The aspirational and improved user experience that can result from this M4A project:



BACKGROUND ON DATA STANDARDS, GTFS, AND GTFS EXTENSIONS

GENERAL TRANSIT FEED SPECIFICATION (GTFS)

The General Transit Feed Specification (GTFS) is a data specification that allows public transit agencies to publish their transit data in a format that a [variety of software applications](#) can consume.

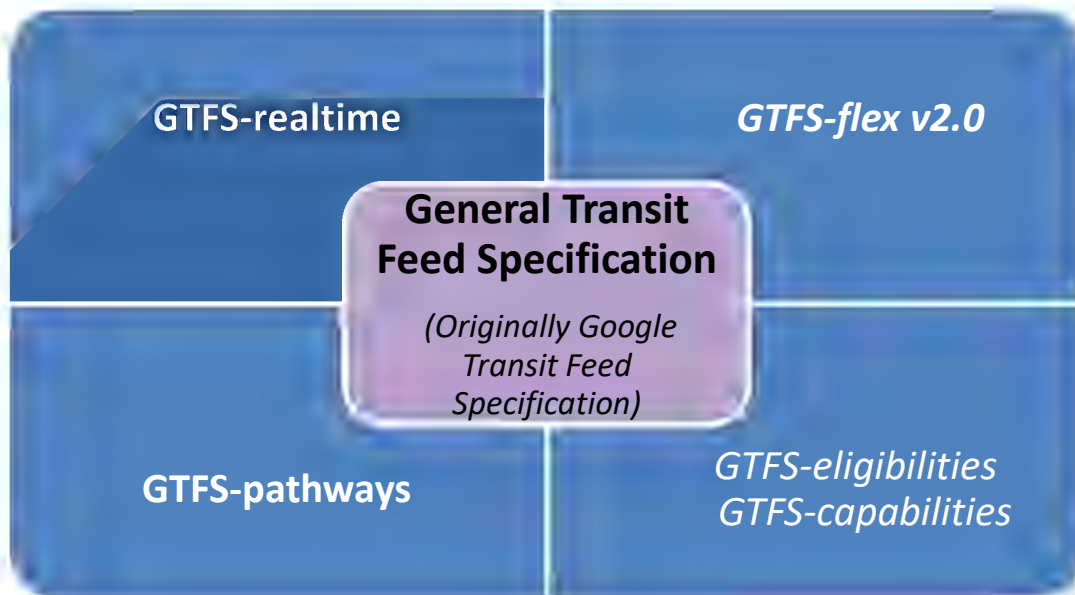
GTFS: How to make public transit data universally accessible

TriMet (Tri-County Metropolitan Transportation District of Oregon) is the public agency that operates mass transit in the Portland, Oregon metropolitan area. In 2005, TriMet worked with Google to format their transit data into an easily maintainable and consumable format that could be imported into Google Maps, creating a transit data format originally known as the Google Transit Feed Specification¹ (GTFS). Today, thousands of public transportation providers use the GTFS data format; it is the first data standard for describing transit services to gain wide acceptance in the United States. GTFS is the reason that transit data appears in trip planning apps.

Among public transportation data formats, GTFS stands out because it was conceived as a way to meet specific, practical needs in communicating service information to passengers, not as an exhaustive vocabulary for managing operational details. It is designed to be relatively simple to create and read, for both people and machines. Even organizations that work internally with highly detailed data using standards like [NeTEx](#) (the Network Timetable Exchange), have found GTFS useful as a way to publish data in consumer applications for wider consumption.

Currently, GTFS has a [static component](#) that contains schedule, fare, and geographic transit information and a [real-time component](#) that contains arrival predictions, vehicle positions, and service advisories. It can tell a rider whether a bus, train, or ferry is scheduled to stop at a given location at a particular time, which is essential for trip planning. Such data is used by a variety of third-party software applications for many different purposes, including trip planning, timetable creation, mobile data, data visualization, accessibility, analysis tools for planning, and real-time information systems. GTFS can provide clear and accurate static information about fixed schedules, routes, and stops.

¹ In 2010, the GTFS format name was changed to the General Transit Feed Specification to accurately represent its use in many different applications outside of Google products.



GTFS Static

This is the common format for the basic level of GTFS and is based on fixed route transit services -- those that run on a predetermined schedule, on specific routes, with posted timetables and designated stops to pick up and drop off passengers.

Typical GTFS feeds will include many of the following fields:

agency.txt	the transit agency providing the service
stops.txt	locations where vehicles pick up or drop off riders
routes.txt	the transit agency routes that make up the service
trips.txt	the sequence of two or more stops occurring during a specific period
stop_times.txt	times that a vehicle arrives at and/or departs from stops each trip
calendar.txt	dates of service using a weekly schedule, with start and stop dates
calendar_dates.txt	exceptions to the services defined in calendar.txt
fare_attributes.txt	fare information for the service routes
fare_rules.txt	rules that apply to the fares
shapes.txt	route alignments that map vehicle route alignments (GIS)
frequencies.txt	headway (the time between trips)
transfers.txt	rules for making connections at transfer points between routes
pathways.txt	descriptions of physical and visual accessibility inside a station
levels.txt	description of the levels of a station
feed_info.txt	dataset metadata, including the publisher, version, expiration info
attributions.txt	dataset attributions

GTFS Best Practices

These are the recommended practices that guide descriptions of public transportation services in the GTFS format. These practices were developed through the [GTFS Best Practices working group](#), with membership representing data consumers, data producers, app developers, transit providers, industry consultants, and other industry experts.

Without coordinated best practices, various GTFS-consuming applications could create requirements and expectations in an uncoordinated way, leading to diverging datasets and less interoperability. Before the release of these Best Practices, there was much greater ambiguity and disagreement about what constituted uniform and accurate GTFS data.

GTFS Best Practices objectives include:

- Improving end-user customer experience in public transportation apps,
- Supporting broad data interoperability to make it easier for software developers to deploy and scale applications, products, and services, and
- Facilitating the use of GTFS in various application categories (beyond its original focus on trip planning).

Currently, GTFS Best Practices guidance includes:

- [Dataset Publishing and General Practices](#) - related to the overall structure of the GTFS dataset and to the manner in which they are published
- [Practice Recommendations Organized by File](#) - to facilitate mapping practices to the official GTFS reference
- [Practice Recommendations Organized by Case](#) – practices for specific cases, such as loop routes, may need to be applied across several files and fields

PARTNERSHIPS AND STAKEHOLDER INPUT

ODOT and Full Path engaged with experts in the fields of human services transportation, disability advocacy, public transportation, data standards development, and transit-related software development to provide input and guidance on this project. The project was designed to be a collaborative effort with input from representatives who are subject matter experts representing the interests of seniors, people with disabilities, veterans, and low-income populations, as well as software designers, transit providers, and higher education researchers. Full Path assembled an Expert Panel, and a subgroup, a Technical Working Group.

There were seven meetings. Three of the meetings included members of both the Expert Panel and the Technical Working Group. The other four meetings were discussions among the members of the Technical Working Group. The project considered and incorporated the perspectives and recommendations provided by all of these experts. (Membership list on pages 2 – 3.)

PROJECT OUTCOMES

Building on previous work on data standards, the project considered GTFIS-fares (related to categories of riders) for eligibilities and GTFIS-vehicle categories, GTFIS-vehicle allocations, and GTFIS-seats for capabilities.

Service attributes were important considerations for GTFIS-eligibilities, including:

- Minimum or maximum **age** constraint (already included in rider categories proposal)
- **Basic other eligibility** constraint (riders with disabilities, other)
- Allowable **trip purposes** (medical, shopping, education, work)
- **Eligibility** verification (checked at booking and/or at boarding)
- **Registration** (how and where) for the service (URL/website address, phone number)
- Eligibility determination **appeal** (where) (URL/website address, phone number)

The project considered additional service attributes, including:

- For human capabilities:
 - Enumerated **service levels** (curb-to-curb, door-to-door, door-through-door, hand-to-hand)
 - **Driver training** (a driver has or has not received required training)
- For vehicle/mechanical capabilities
 - Presence and required use of **seat belts**
 - **Lift** presence, dimensions, and lifting capacity
 - **Ramp** presence, width
 - **Narrowest width** for accommodating the travel of a mobility device (including the doorway)
 - Number of **stretchers** that can be accommodated

The project also introduced the concept of mobility device space – the features and attributes of mobility devices that need to be considered for demand-responsive service vehicles. These included:

- Enumerated **securement methods** (no equipment, rider-operated equipment, driver-operated equipment)
- Enumerated **location** (near the front door, near the rear door, near the rear of the vehicle, accessed by a separate door or lift)
- Space **dimensions** (width, length)
- Vehicle capacity **effect** (number of seats stowed, approximate number of standing riders displaced)

The project also considered ways to address associate mobility device spaces with bookable seats (GTFS-seats proposal) that could describe how seats and mobility device spaces interact.

THE INTRODUCTION OF THE CONCEPT OF UNIFORM RESOURCE NAME (URN)

The project included research into efforts outside the realm of transportation that could offer support for the development of GTFS-eligibilities and GTFS-capabilities extensions. This resulted in a recommendation for the use of Uniform Resource Names (URNs). These are a type of Uniform Resource Identifier (URI) - similar to a Uniform Resource Locator (URL) that identifies a website.

Uniform Resource Names (URNs) are described by the Internet Engineering Task Force [IETF RFC 8141](#) as persistent, location-independent resource identifiers. They can provide globally unique names, achieved through nested namespaces, can have clear structure rules that allow for relatively easy creation of new names, and are intended to be a unique human-readable identifier, not a description. (URN descriptions are also included in the proposal). The project proposes URNs be used for eligibility, trip purpose, and legal compliance purposes.

This recommendation is the most noteworthy element of this proposed extensions project because it attempts to address a significant challenge of describing specialized transportation: how to standardize a range of services that are highly diverse and complex. URNs, using the structures provided by LEX (see bullet below), provide a robust method for uniquely naming eligibilities, trip purposes, and legal compliance. At the same time, URNs provide an opportunity to reduce complexity and facilitate coordination among providers through a process whereby providers in a region agree to common eligibilities and trip purposes, common URNs for naming them, and using those URNs across all of their GTFS feeds. The proposed format is: *urn:gtfs:{entity type}:{nested jurisdictions}:{organization}:{entity name}*. (See examples of the URN format, and examples, in the blue box on page 15.)

Hypothetical Examples of Use of URNs

Eligibilities — three versions of veterans:

- urn:gtfs:eligibility:us:va:veteran
- urn:gtfs:eligibility:us;oregon:odva:veteran
- urn:gtfs:eligibility:us;oregon:ride.connection:2021.veteran

Trip purposes — recreation and three versions of medical

- urn:gtfs:trip.purpose:us;oregon;org:ride.connection:recreation;non-specific
- urn:gtfs:trip.purpose:us;oregon;org:ride.connection:medical;non-specific
- urn:gtfs:trip.purpose:us;oregon;org:ride.connection:medical;cancer.treatment
- urn:gtfs:trip.purpose:us;oregon;org:ride.connection:medical;dialysis

Compliance — based on the “LEX” proposed standard for sources of law

- urn:gtfs:compliance:us:federal:session.law:1990-07-26;pl.101-336,104.stat.327
(citation to Americans with Disabilities Act)

Two other standards and data formats were used in the development of the proposed extensions:

- [LEX](#) (Sources of Law), also from the Internet Engineering Task Force (IETF). LEX is a proposed URN namespace for sources of law (e.g., local code, state statutes, federal laws and regulations). This format provides a concise method for creating jurisdictional namespaces within a URN, allowing each name to be unique and also human-readable.
- The [User Guide](#) for the 2017 National Household Travel Survey (NHTS) (page 38) includes a list of standardized trip purposes that can be used to describe trip purposes.

PROJECT WEBINAR

On August 25, 2021, Full Path presented a webinar on the project and its proposals. Oregon transit agencies were invited to the presentation, as were members of the Expert Panel and Technical Working Group, along with the broader communications list. In addition, ODOT and Full Path staff publicized the webinar through social media and industry contacts. The [recording](#) is posted on ODOT’s YouTube channel.

ODOT GITHUB PAGES: GTFS-ELIGIBILITIES AND GTFS-CAPABILITIES

GitHub is a repository web hosting service where millions of developers shape the future of software in a collaborative manner. Across the world, ideas are posted to pages where the open source community can read, recommend, and comment on software and technology proposals. ODOT has used GitHub for repositories of transit software analysis tools and other proposed GTFS extensions.

This project produced two new GitHub pages: [GTFS-eligibilities](#) and [GTFS-capabilities](#). Both will serve as the project landing page for comment and future development of these proposals.

ODOT also created a website that describes the project, the proposed extensions, and provides links to other ODOT GTFS efforts @ [GTFSpecs.org](https://gtfspecs.org).

PERFORMANCE MEASURES

ODOT staff worked with Steve Yaffe, NADTC, to develop four performance measures to serve as targets and to evaluate the success of the work. In general, these measured stakeholder involvement, providing an assurance that the project would receive input from a diverse group of stakeholders and updates on the results of the project. This role was to use them as both proxies for interest in addressing need for standardized and computer-readable data to describe rider eligibility (characteristics that qualify a rider to use a specialized transportation service) and service capability (ability to meet rider needs).

ODOT M4A Project Performance Measures		
Activity	Target	Performance (as of 09/2021)
a) Signed agreement with contractor	December 2020	Finalized December 10, 2020
b) Project communication and outreach: Advisory Group members (renamed Expert Panel)	20 people	34 people
c) Membership of project communication and outreach email list, not including advisory group members	75 people	136 people
d) Webinar views	150 views	62 locations viewed the webinar live (103 had registered) As of September 28, 2021, the posted recording of the webinar has an additional 55 views.

LESSONS LEARNED

Expectations need to be realistic

Similar to other grant-funded projects, this effort required ODOT and Full Path consider the amount of work that could be accomplished in the available budget and time. The breadth of this project easily could have expanded into other aspects of the trip lifecycle – addressing real-time information needs for seating configurations and exploring other important issues raised by the Expert Panel. Similarly, it was necessary to set a geographic scope for this effort. GTFS and its extensions are used in countries around the world, and the proposed standards address issues that are part of transportation considerations globally. However, aside from Montréal-based MobilityData representatives and one participant in Denmark, advisory group members were all in the United States. To consider worldwide variations adequately would have required outreach and resources beyond the scope of this grant project. Ongoing work on these proposed GTFS extensions will benefit from engagement with agencies on an international scale.

The advisory group process is both valuable and challenging

The project would not have been possible without the involvement of the Expert Panel and Technical Working Group members. The collective knowledge and input of the members provided real-life examples that helped shape and refine the final proposals. It was especially valuable to have the Technical Working Group, a subset of the larger Expert Panel that dug deep into the technical elements of the proposals. A primary benefit of this working group was having members with expertise in the structure of the GTFS, resulting in proposals that align with GTFS conventions. Having these insights early in the standards' lifecycle is likely to speed up their development and adoption considerably.

The larger Expert Panel also included members who do not typically work directly in building new technologies - instead, they interact with the “finished products” or have an operational perspective from their work with agencies that support people who use specialized transportation. For some members, their daily work was very removed from direct experience or work related to transportation technology, but their participation provided valuable perspectives and real life examples. The process could get sidetracked trying to address technical issues or bogged down with all of the perspectives of the very diverse group. As with the project as a whole, keeping members expectations clear and realistic was helpful, especially given their varied backgrounds.

The formation of the Expert Panel was an iterative process. As new members joined, Full Path asked for suggestions as to others who should be invited. Full Path was generally able to follow up on these suggestions and recruit additional members. However, some members recommended that the Expert Panel include transit riders or rider advocates. The project did not allow the time or scope to truly recruit and involve a cohort of demand-response riders. Instead, the project had to rely on the Expert Panel members to use their exposure to and experience with such riders to inform their comments. It is clear that when applications are developed to use these proposed extensions, app developers and other stakeholders will need to involve riders of specialized transit services more directly in their design research and testing.

There was also concern about whether the Expert Panel had adequate representation from transit software companies and transport network companies (TNCs) such as Uber and Lyft. Full Path was not successful in getting representatives of these types of companies to participate in this project, but both ODOT and Full Path believe that the project could have been improved with their perspectives and involvement. Since the proposed extensions will need continued refinement before they are accepted as data standards, there will be future opportunities, outside this project, for input from transit software companies and TNCs.

Connecting to broader conversations is vital

ODOT made an important decision in developing the contract for this effort – the requirement that Full Path coordinate with MobilityData’s GOFs project in the development of the GTFS-eligibilities and GTFS-capabilities proposals. This coordination involved staff from this M4A project serving on the MobilityData advisory group and visa versa, plus additional discussion of how the two projects related. As a result, MobilityData has selected elements of these proposed standards to incorporate into their development of the GOFs data standard. Early engagement with MobilityData helped this project form meaningful connections with the larger standards development ecosystem.

Equity considerations were embedded into the project.

This continues ODOT’s ongoing work to support the accessibility and usefulness of transit services through open data and address equity goals laid out in the [Oregon Public Transportation Plan](#). This was possible by involving staff and consultants from other state DOTs (California, Minnesota, and Washington) and many other public entities, along with representatives from groups that directly accountable for equity (in comparison with private sector, investor-driven representatives).

ONGOING OPPORTUNITIES – SUSTAINABILITY – NEXT STEPS

The stakeholders / subject matter experts advising on this project had a shared interest in the success of the project and in ensuring that these efforts were sustained after the grant period. They identified the need to find at least one data producer (e.g., a transit agency to generate the data) and one data consumer (e.g., a commercial trip planning website or app) to adopt the standards. Another effort to ensure sustainability was creation of the tools needed by service providers (transit agencies) to maintain data over time, as service and eligibility requirements change, especially those providers that have limited computer/ IT capacity or infrastructure.

Stakeholders were also interested in defining a longer-term goal to guide development of the data standards.

The Expert Panel committed to ensuring the project’s success and specifically interested in ensuring project benefits for veterans, low-income individuals, older adults, and people with disabilities (including, but not limited to, blind and visually impaired people). Their aspirations for this project included equitable transit planning, equitable transportation access, and improving data standards to make service discovery easier for riders, agencies, and software developers. They also valued learning about each other’s projects and work.

Project stakeholders also wanted to define a longer-term goal to guide further development and use of these proposed data standards. Some of the opportunities that have been discussed include:

- The potential to incorporate project results in other related ODOT projects that, if funded and implemented, can build on these eligibilities and capabilities proposals.
- The likelihood that when these extensions are fully developed, parties not involved in the project will find out about it, and use it and adapt it to their needs (based on the history of other GTFS extensions).
- The participation of MobilityData in this project and the linkages of the proposed extensions to their work on the General On-demand Feed Specification (GOFs). With these open communications, the project will benefit from MobilityData's involvement and interest in the proposed standards, and their role in developing tooling for new extensions. As new extensions to GTFS are approved, MobilityData can use their GTFS validator to verify that data is being correctly produced (created) and consumed (posted).
- The CalACT "Trip Planning for All" ITS4US project, with its focus on demand-responsive services.

EXPERT PANEL INPUT ON GTFS-ELIGIBILITIES

Take-aways from the Expert Panel:

- The landscape of relevant eligibilities is highly complex, with considerable variety across providers. A core challenge for GTFS-eligibilities is determining what level of detail to support. Additionally, the group discussed whether the proposed standards should focus on the world, as it exists, or whether they should be tied to efforts to encourage agencies to simplify and align their requirements.
- Ensuring data privacy for riders was not addressed since the project focused on the discovery portion of a trip lifecycle, leaving no method for storing or accessing individual information. The focus was on making it possible to find out what specialized transportation services exist, not in sharing personal information of riders. As further work is done on demand-responsive booking and determination of qualification for services, there will be a need for authentication. However, issues surrounding data privacy were outside the scope of this project. Other projects, especially the GOFs project that are addressing the entire trip lifecycle, will include these considerations.
- The project included only limited discussion of registration for demand-responsive services, with fields for a related URL and phone number as well as a text description of how to register, if required. Consistent with the project's focus on discovery, the project did not fully address a one-stop registration process, though this would be an option for future efforts.
- Whether eligibility for service decisions are made by computers (artificial intelligence / AI) or humans, transparency about how to dispute a determination of eligibility is important. There was general agreement by the Expert Panel that the data feed producer (the transit provider) would adjudicate such determinations for its services. As an initial solution, the proposed

standard includes fields for contacts through a website or by phone if a rider wants to dispute determination of eligibility for a service.

- Eligibility rules can have multiple criteria that require complex descriptions. For example, an agency may have a rule that defines eligibility as a person who is 65 or older, is disabled, or is both a student and 18 or younger. The proposed eligibility extensions address this complexity by using a URN to provide a unique identifier for each eligibility factor. Expert Panel members recommended incorporating “not” operators in the eligibility logic, to account for cases such as when a rider is eligible if they are disabled and are not a resident of Benton County or a rider is eligible for a given service if they are not paratransit eligible.
- URNs will describe eligibility criteria, but agencies/jurisdictions would still have discretion in applying such criteria. For example, agencies are often flexible in their application of their own income criteria. As a new convention within the GTFS, URNs are certain to bring up questions about how agencies apply their criteria. An initial set of best practices, recommended as part of the GTFS-eligibilities draft, could address ongoing revision to such criteria.

EXPERT PANEL INPUT ON GTFS-CAPABILITIES

Take aways from the Expert Panel:

- Because demand-responsive services can use a variety of vehicles for a specific service, the complexity of how vehicles are deployed must be addressed. Such work can involve describing the type of vehicle expected for a specific service or for a particular trip.
- The Expert Panel noted the important difference between describing service-level capability (can any vehicle in the service accept a stretcher) vs. vehicle-level capability (does this vehicle have this capability).
- One recommendation is that agencies have a choice about the level of detail presented. At the most general level, an agency might provide information that a particular vehicle type (e.g., a vehicle with a bariatric lift) is part of the available pool of vehicles for this service, without specifying its availability at a particular time or place. Considerations about the level of effort to produce an accurate data feed, and the ability to maintain that level of detail accurately will need to be balanced.
- Future efforts, especially those that aim to offer real-time information about vehicle-by-vehicle capabilities, would be valuable to riders.
- The Expert Panel helped determine which fields and data elements were the most important based on research into similar standards and professional experiences of contributors. These included: the presence or absence of a ramp; ramp width if present; presence or absence of a lift; lift width, length, and weight capacity, if present; space dimensions available for a mobility device; and a description of how the use of a mobility device space would affect

other seating and standing room. The proposed extensions are not intended to be final - additional items should be added as the standard matures.

The project also identified the following ongoing efforts that could further the work from this project:

MobilityData – GTFS-eligibilities

Along with their staff participation in this project through the Expert Panel and Technical Working Group, MobilityData offers the opportunity to create linkages through the organization's effort on GOFS. Because of their governance of GTFS (beginning in early 2019) MobilityData offers substantial opportunities to maintain the efforts to create GTFS-eligibilities and, to a lesser immediate extent, GTFS-capabilities. They have expressed an interest in the opportunities presented by these proposed standards and have an open process for developing the necessary tooling for new extensions. As new extensions to GTFS are approved, MobilityData will make updates to their GTFS validator (typically within six months). The organization also has an accompanying grading scheme for any new elements that cannot be validated in an automated way through the tool.

FlexDanmark – GTFS-capabilities

The nationwide software company in Denmark, owned by five regional public transportation agencies, supports IT for FlexTrafik. This service connects and leverages more than 550 transportation providers, providing an innovative demand-driven transportation network that targets older adults, people with disabilities, and rural residents. Their main goals are customer satisfaction and service efficiency. More than 5.7 million trips are provided each year, averaging on-time performance of 95 percent. Developing the associated data standard was challenging, but FlexDanmark now provides an example of real-time tracking of vehicle-level capability. If GTFS-capabilities are pursued and able to provide real-time information, it will be important to be able to account for seating area configuration changes that may be required, as users of different mobility devices enter and exit the vehicle. The current proposal was not able to pursue this level of development.

Some other opportunities to further this work include:

New Institutional Connections: This project will have implications for stakeholders that are already part of the GTFS ecosystem (e.g., transit agencies, State DOTs). This work can also influence stakeholders that are new to GTFS - human service agencies, mobility managers, policymakers, users/riders who want to have a voice in how these tools are applied to enhance their services, and healthcare systems. The institutional challenges (i.e., connecting different institutional cultures) may be more significant than technological ones, and so future efforts to develop buy-in among newcomers may benefit from long-term and strategic planning.

Many providers of demand-responsive providers are typically very small organizations that are not currently providing data in a machine-readable form. A thoughtful engagement approach will be needed to help these providers understand the benefits of providing their data and the requirements of maintaining it over time.

Inclusive Rider Engagement: As rider-facing apps are developed using these standards, inclusive rider engagement is essential. This kind of engagement is consistent with principles of good UX/UI design processes and therefore will be a familiar requirement for app developers. Most importantly, this level of engagement reflects a commitment to equity and respect for the people who will be using the resulting applications.

Inclusive Governance: Entities that are accountable to the public need to be present at the governance level. Involving public agencies at all levels is important in order for equity and interoperability to be given proper weight. It is important that transit experts in countries outside the United States need to review and consider these proposals so that the standards can have the widest relevance.

Sustained Funding: Funding for both data production and data consumption is necessary for the concerted effort that will be required to achieve the same level of momentum and support that the core GTFS enjoys. This funding should involve public and private sector commitments. Public sector involvement can help drive accountability for equitable investment.

Ongoing URN Development/Support: Because the proposed use of URNs is new to the GTFS world, there are several associated opportunities and needs.

- This project includes best practices for URN development. Ideally, a URN “library” will be developed with examples to demonstrate trip purpose, eligibility, and compliance.
- As use of URNs grows, mapping of terms to make it clear how a local characteristic relates to a state, national, or international one is recommended. Developing globally unique identifiers has been a long-standing challenge for GTFS, and using URNs could help advance discussions between data producers and data consumers regarding opportunities to consolidate categories.
- Even with thorough documentation about creating URNs, hands-on assistance would be valuable to organizations wanting to create GTFS-eligibilities feeds. Funding for resources and guidance could build capacity among specialized transportation providers.

EFFECTS OF COVID-19

Fortunately, the COVID-19 pandemic did not negatively affect this project. ODOT project staff were able to meet with Full Path staff remotely to plan the project and deliverables. Teleconferencing also allowed the Expert Panel and Technical Working Group to meet without regard to location. Ultimately, this allowed participants from Oregon, across the U.S., and those located internationally, to participate in these virtual meetings without time or travel limitations.

CONCLUSION

Early in the project, it was clear that the data standards community would welcome advancements in data standards to address eligibility and service capability. The project was successful in proposing GTFS extensions that can describe specialized public transportation services. These GTFS extensions include the introduction of using URNs as a way to capture local detail and nuances with a unique description to help address a complex issue that has long been a barrier to the field’s progress. URNs

also offer a tool for coordinating among agencies and providers at any level. The proposed data extensions also offer considerable flexibility and can be implemented at different levels of complexity and detail. This type of flexibility is especially important given the substantial variation among the technology systems and capacities of demand-responsive services across the United States. Although the proposed standards are still many steps away from being adopted into the core GTFS standard, this project has advanced them considerably and positioned them to be refined and adopted.

ODOT sees the results of this project as a solid first step in the development of GTFS-eligibilities and GTFS-capabilities, and a process to enable their future use. ODOT, Full Path, and the Expert Panel identified several next steps and opportunities. The next steps and opportunities include:

- 1) supporting cross-institutional conversations to develop agreement on common goals and processes,
- 2) engaging riders inclusively during the development of applications that use the proposed standards,
- 3) developing inclusive governance for the standards for entities that are accountable to the public interest,
- 4) engaging people and agencies from throughout the world (to get beyond the United States focus of this project),
- 5) sustaining funding for data production and consumption,
- 6) developing and supporting around URNs as a concept that is new to the transit world,
- 7) developing the ability to track real-time information about seating area configuration changes through GTFS-capabilities, and
- 8) supporting translation of these proposals into multiple languages.

APPENDICES

GLOSSARY

DATA STANDARDS

GTFS: The [General Transit Feed Specification](#) is the de facto data standard for describing and presenting fixed route transit services to the general public. Since its creation in 2005 by Google (originally called the Google Transit Feed Specification), the GTFS has matured and is now used for transit services across the globe. In addition to describing static schedules, it has been expanded to provide the ability to convey real-time vehicle location information and estimated arrival times. In addition, GTFS-flex and GTFS-pathways (a representation of the area around a station). Since April 2019, the specification has been maintained under the governance of [MobilityData](#), based in Montréal, Canada. Substantial changes to GTFS are made by means of [proposing extensions](#), which are then voted upon by a [community process](#).

GTFS-flex

The [proposed extension](#), now in its second major revision, adds the ability describe various forms of demand-responsive services, including route deviation, point-to-zone, point deviation, and hail-and-ride services. Since most specialized services that would benefit from the eligibilities and capabilities extensions are also demand-responsive in nature, this extension is highly complementary to the current project.

GTFS-seats

This [proposed extension](#) allows public transportation agencies to describe seating capacity in vehicles, provide information about the amenities of individual seats, and integrate other standards to allow riders to book specific seats. (The proposed GTFS-capabilities extension would add the ability to identify unique seats that are displaced by the use of a mobility device space.)

GTFS-vehicles

This [proposed extension](#) allows for detailed information about the vehicles an agency uses for the service. (The proposed GTFS-capabilities extension builds on the work of this work by adding fields related to the accessibility of categories of vehicles.)

GTFS-fares

This [proposed extension](#) is in its second major revision. It enables transit agencies to describe complex fare structures, fare instruments, and related data points related to payment for public transportation services. (The proposed GTFS-eligibilities extension builds on this work by adding categories of riders to a GTFS-fares file.)

GOSF (General On-Demand Feed Specification) Despite the name, the GOSF is more accurately a project spearheaded by MobilityData, than a specification. The project is currently in an initial closed-door process. ODOT representatives are participating in order to help ensure that the needs of a broad variety of forms of public transportation are included in the development process. The project's objective is to expand the capabilities of the GTFS with respect to on-demand mobility services, building on the work of GTFS-flex and other proposed extensions with the addition of real-time features. MobilityData has said that it intends to include elements of both of the proposal of this project, GTFS-eligibilities and GTFS-capabilities, in its proposals.

OTHER RELEVANT TERMS

Americans with Disabilities Act of 1990 (ADA) – Federal civil rights law that ensures persons with disabilities get equal opportunity to fully participate in society, the ability to live independently, and the ability to be economically sufficient. In particular, this law requires transit agencies to provide paratransit services (demand-responsive) to individuals that cannot use fixed route service because of a functional disability, and the requirement may be met through deviated fixed route services.

Demand-Responsive / Dial-a-Ride Service / Paratransit – Form of public transportation where vehicles operate in response to passenger travel needs, typically implemented by passengers contacting a transit operator, who then dispatches a vehicle to transport the passenger. These services are characterized by flexible routing and scheduling of relatively small vehicles to provide door-to-door or point-to-point transportation at the request of the passenger or their agent.

Fixed Route Service – Public transportation services provided on a repetitive, fixed schedule on a specific route, most often with designated stops to pick up and drop off passengers.

Public Transportation – The operation of a vehicle that provides general or special service to the public on a regular and continuing basis (consistent with [49 U.S.C. Chapter 53](#).) It is typically a service that is available to any person upon payment of the fare (if a fare is charged) and which cannot be reserved for the private or exclusive use of one individual or group. "Public," in this sense refers to the access to the service, not to the ownership of the system providing the service.

ADDITIONAL TECHNICAL ADVISORS ON THE PROJECT

Aaron Antrim	CEO & Founder, Trillium Solutions
Sean Barbeau	Principal Mobile Software Architect for R&D, Center for Urban Transportation Research, University of South Florida
Sherrone Blasi	Director, Statewide Veteran Services Program, Oregon Department of Veterans Affairs
Kelly Brown	Community Information Officer, Interface Children and Family Services (CA)
Anat Caspi	Director, Taskar Center for Accessible Technology, Paul G. Allen School of Computer Science, University of Washington
Thomas Craig	System Development Lead, California Association for Coordinated Transportation (CALACT) ITS4US Project
Vyki Englert	Principal, Compiler.LA
Dan Hermann	CEO, 211info
Tanya Kellam	2-1-1 Resource Special Projects Manager, Interface Children and Family Services (CA)
Timothée Millet	Senior Data Modeler, MobilityData
Santosh Mishra	Associate Director – Practice Lead, Transportation Engineering, IBI Group
Mike Rimion	Innovative Mobility Lead, King County Metro
Staci Sahoo	Director of Mobility Management, Hopelink
Andrew Salzberg	Head of Policy, Transit App
Carol Schweiger	President, Schweiger Consulting
David Serby	Project Manager, 211 LA County
Paul Sorenson	Senior Software Manager, Cambridge Systematics
Roger Teal	President, DemandTrans Solutions
Andreas Tryti	Entur

RELATED PROJECTS

Research performed as part of this project found other efforts that were of interest but did not directly contribute to the project. The following may be relevant to data standards supporting specialized public transportation services:

- The [ENTUR OpenTripPlanner](#) is an active fork of the OpenTripPlanner codebase which includes the ability to consume GTFS-flex data.
- The Pennsylvania Department of Transportation is building an online eligibility application system for local agencies. This system, expected to roll out late 2021, will accommodate local variations in eligibility.
- [Mobility Services for All Americans](#) project in Boulder, Colorado.
- Cambridge Systematics' [OneClick VTCLI project](#).
- [211 Los Angeles County Taxonomy](#), a proprietary structuring of social services (including transportation) for use in information and referral software systems. While this taxonomy may have been useful, this project did not use it because of its proprietary nature.
- The [Southern Minnesota MaaS Platform Project](#), funded by Minnesota DOT and FTA [Accelerating Innovative Mobility \(AIM\)](#) grant program.
- The CalACT "Trip Planning for All" project, funded by [USDOT's Complete Trip ITS4US grant program](#) includes project partners include DOTs from California, Oregon, and Washington. The project goal is to change the GTFS ecosystem to support transportation for riders with disabilities, rural riders, low-income riders, and other riders who are not well served by the current offerings of GTFS-based websites and apps.
- The Metropolitan Transportation Commission (San Francisco–Bay Area) is working on a regional mobility data platform, with the goal of providing data services for door-through-door trip planning. They have also implemented a means-based transit fare program through Clipper, the regional fare payment card.
- North Carolina DOT also received a 2020 M4A grant for a pilot project with for ICPTA (Inter-County Public Transportation Authority), which serves Pasquotank, Perquimans, Camden, Chowan, and Currituck Counties) to integrate demand-responsive transportation software with NCCARE360, a statewide health provider network.
- The ["Framework for Older Adult Mobility Factors,"](#) in a recent AARP publication provides an inventory of elements that affect mobility for older adults.
- [The Eligibility APIs Initiative](#), an initiative of the U.S. General Services Administration. Although this does not specifically apply to mobility and is not readily transferable to GTFS, it provides a valuable example of an attempt to create standardization ([article](#)).
- [California Integrated Travel Project](#) is working on fare eligibility.