

MAT v1.1

Task 6 Multimodal and Accessible Travel (MAT) White Paper



Multimodal and Accessible White Paper on Reservations, Scheduling, and Dispatching



Multimodal and Accessible Travel Standards and Vulnerable Road User Cybersecurity Support Project

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1. Introduction

1.1 Problem Statement

The purpose of this white paper is to research and document previous work associated with reservations, scheduling and dispatching (RSD) as it relates to the development of multimodal and accessible travel standards for vulnerable road users. This white paper is supplemented with four additional white papers discussing (1) Automated Eligibility; (2) Vulnerable Road Users (VRUs), (3) PROW, and (4) Cybersecurity for Vulnerable Road Users. These white papers describe downstream applications, standards, gaps in the standards and stakeholder groups who may contribute to the development or extension of existing standards.

The topic of RSD emerged as a major gap in data collection and modeling based on the Multimodal and Accessible Travel Standards Assessment (MATSA) and subsequent project review and use case development in this ITE Cybersecurity and VRU Project (Task 3.1 Multimodal and Accessible Travel Use Case Review Gaps and Task 3.2 Multimodal and Accessible Travel Use Cases Use Cases). The gaps in standards for reservations, scheduling, and dispatching exist primarily because the transit software industry is inundated with proprietary systems. Further, funding is significantly lacking to complete the development and demonstration of standards that are in process, such as those described in this white paper. RSD data is missing from national data repositories, and inconsistent and incomplete if available.

1.2 Scope

The scope of this white paper is to identify the gaps in research related to data standards, specifications, and Application Programming Interfaces (APIs) focused on RSD. The paper includes a list of gaps in standards, key stakeholders and organizations developing related standards, stakeholders who are generating data, using the data, and developing tools that support RSD data.

1.3 Audience

The eligibility white paper is intended to inform key stakeholders contributing to the development of multimodal accessible travel (MAT) for vulnerable road users (VRU).

VRUs may consist of pedestrians, cyclists, or micro-mobility device users, such as individuals riding scooters.

1.4 Document Organization

This white paper is organized into four sections:

- Section 1: Introduction
- Section 2: RSD Application Programming Interfaces (APIs) Research and Existing Standards and Specifications - Summary of literature related to RSD standards, specifications, and research activities related to eligibility standards and its uses. The literature search was not comprehensive; rather a selection of papers that were published in the most recent past that demonstrates the type of ongoing research and specification development currently underway. In addition, several researchers and specification developers were interviewed to understand current efforts.

- Section 3: Current Projects and Systems that use RSD APIs – identifies existing systems and projects that use RSD standards and specifications.
- Section 4: Stakeholders - Stakeholders who inform standard development including the following:
 - Researchers
 - Applications developers needing the standard
 - Standard developers
 - Organizations collecting data
- Section 5: Issues and Standards Gaps – issues associated with RSD data standards and specifications, and gaps in the existing standards and specifications
- Section 6: Conclusions

2. Reservations, Scheduling and Dispatching (RSD) Application Programming Interfaces (APIs) Research, and Existing Standards and Specifications

Based on the results of Task 3.1, use cases related to gaps in Multimodal and Accessible Travel (MAT) standards were described in Task 3.2, including those associated with transit reservations, scheduling, and dispatching. Further, in describing the use cases, standards related to reservations, scheduling, and dispatching were identified.

The purpose of this white paper is to further describe the current research, standards, and specifications that cover transit reservations, scheduling, and dispatching processes related to multimodal and accessible travel. Also, this white paper identifies the gaps in the standards and specifications described in this paper.

2.1 Research

To date, there is limited research related to existing reservations, scheduling, and dispatching APIs, standards, and specifications. However, the research identified several items of note as described in the following subsections.

2.1.1 MTM Transit Link Platform

MTM, a nationwide non-emergency medical transportation (NEMT) broker, integrated three routing, scheduling, and dispatching platforms (RoutingBox, CTS TripMaster and RouteGenie) using an API-based approach.¹ This integration is being piloted with Widerange Transportation in the Chicago metro area.² The MTM software is proprietary.

2.1.2 TranWare

TranWare is a software vendor that provides automated reservations, scheduling, optimization, dispatching, global positioning system (GPS) tracking, reconciliation, and billing. The back-office software and mobile apps support fixed- and flex-route management including a comprehensive customer database, detailed trip history and flexible reporting.³ TranWare's Vendor API allows paratransit and other transportation agencies to send trips to a vehicle fleet automatically. Advanced functions allow these transportation providers to control the relevant aspects of their passengers and reservations, obtain a current overview of active vehicles, as well as route, vehicle, and driver details. External agencies can use the software to receive vehicle and trip status updates as trips are serviced.⁴

2.1.3 RouteShout

The Fairbanks North Star Borough Bus System is a small urban transit system that has a fixed route annual ridership of 550,000 as well as 21,000 registered riders for their demand response service, which provides seniors, riders with disabilities, and veterans with transportation services.⁵ The transit system deployed RouteMatch (now TripSpark) scheduling software for both fixed-route and paratransit,

including a RouteShout smartphone app for bus arrivals tracking; notifications and automated call-outs to remind demand response riders of their trips; and a customer web portal for demand response riders to book and manage their trip reservations. RouteShout provides an open API and uses General Transit Feed Specification (GTFS) feeds, allowing the agency to easily open up the platform for development of other transit applications.⁶

2.2 Standards

The Operational Data Standard (ODS) being developed by the California Integrated Travel Project (Cal-ITP) is an open standard for describing scheduled (i.e., fixed route) transit operations. ODS leverages the existing GTFS and extends it to include information about personnel and non-revenue service (deadheading). These concepts are necessary for transit operators to be able to run a fixed-route/scheduled service.⁷ ODS v1.0.0 was adopted by the ODS Working Group on May 3, 2022.

ODS aims to describe data intended for internal use within the operating agency. The overall goal of ODS is to make internal operations run more smoothly, particularly when moving data from resource planning tools (scheduling drivers and vehicles to routes) to systems used for daily operations, such as computer-aided dispatch (CAD)/automatic vehicle location (AVL) systems.

As mentioned above, ODS relies on GTFS data, which describes a large share of what is needed, including detailed route, stop, and stop time data. ODS adds what is missing: personnel schedules (called “runs”), vehicle non-service travel time to and from the route (known as “deadheading”), and other behind-the-scenes data points, such as bus garage locations.

When planning tools produce both the GTFS and ODS data sets according to the specifications, CAD/AVL tools designed to accept those same formats will be able to import the data with minimal error or need for staff to manually correct it.⁸

2.3 Specifications

2.3.1 Transactional Data Specifications (TDS)

The Transit Cooperative Research Program (TCRP) *Research Report 210: Development of Transactional Data Specifications for Demand-Responsive Transportation* describes transactional data specifications (TDS) for demand-responsive transportation (DRT) to facilitate interactions among the software systems that manage these services. The TDS accomplishes two objectives, as follows:

- Establishes a common language for software systems to communicate transactional data—all pertinent DRT trip details, such as origin and destination of the traveler and time of the requested pickup or delivery—with each other to accomplish DRT trips from the beginning to the end of the trip lifecycle; and
- Provides a recommended technical approach for how data communication will occur among the interoperating computer systems. Public transportation agencies, DRT service providers, and technology providers can use the products of this report to improve DRT services.

Cities, planning agencies, and health-care organizations will benefit from the adoption of TDS as a means of fostering the cost-effective evolution and growth of DRT services.⁹ The use of TDS is described in Section 3.1.

2.3.2 General Transit Feed Specification (GTFS)-Flex

GTFS-Flex is a proposed extension to GTFS that adds the capability to model various DRT services to GTFS, which currently only models fixed-route public transportation. GTFS-Flex covers DRT, deviated fixed routes and on-demand transportation (e.g., microtransit) services for the purpose of discovering these services in trip planning. GTFS-Flex is now produced for over 100 transit services and provides flexible transit trip plans through GTFS Maps and OpenTripPlanner^{1,10}. The most current version of this extension is GTFS-Flex v2 and it is maintained by MobilityData.

GTFS-Flex v2 includes the following components:

- GTFS-FlexibleTrips describes flexible services that operate according to a schedule, but will, on request, during scheduled service, perform certain actions to suit the needs of individual riders, such as deviating to a requested address or going to one of a number of predefined stops.
- GTFS-BookingRules provides booking information for rider-requested services using GTFS-FlexibleTrips, such as how far in advance booking should occur or a phone number that should be called in order to make reservations.¹¹

According to Patel, R.K. et al. (2022)¹², the GTFS-BookingRules specification extension, or a similar transactional standard, could provide information about services available in the very near term (next few minutes or hours) through an application programming interface (API).

As of March 2023, GTFS-Flex is considered provisional and has not been adopted formally.

2.3.3 GTFS-Eligibilities and GTFS-Capabilities

Two other applicable GTFS extensions are GTFS-Eligibilities and GTFS-Capabilities, and are under development. These extensions will describe the parameters that can determine access to specific transit services, particularly specialized transportation services. GTFS-eligibilities describes an individual's characteristics (e.g., age, disability status, residence, employment, or registration in a program) that may affect their access to specialized transportation services. GTFS-capabilities will describe a transportation provider's ability to meet a specific rider's needs (e.g., whether the provider offers services such as door-to-door service, door-through-door service, stretcher service, mobility device accommodation, and bariatric capability).

These are summarized as follows:

- GTFS-Eligibilities will provide a way for scheduling systems that use data from rider accounts to determine whether or not a trip is eligible based on the user account information. The proposed fields include the following:
 - Common attributes associated with rider accounts such as age, gender, company affiliation, trip purposes, and assistance levels provided.

¹ OpenTripPlanner (OTP) is an open source software application which ingests GTFS and OpenStreetMap (OSM) data to create trip itineraries. These trip itineraries are available through an API and can be used by mobile applications and web applications to display possible trips to riders.

- Customizable authentications of locally-defined attributes and statuses. Custom eligibilities are provided, as well as a way to understand how the custom eligibility can be authenticated.
- GTFS-Capabilities describes the additional capabilities that a service may be able to provide to serve people with disabilities and those who have mobility devices.
 - Information about services available to a rider from an individual, such as a driver or other agency-provided human resource.
 - Vehicle information, described by the (further extended) [GTFS-VehicleCategories](#) specification. See also the [GTFS-seats](#) draft extension.
 - Describing vehicle amenities related to mobility devices, and how boarding with those devices affects vehicle capacity for other riders and devices.

2.3.4 General on-demand Feed Specification (GOFS)¹³

MobilityData is leading a working group to standardize the representation of on-demand services and to set guidelines to manage rider-facing transactional data. The GOFS project enables a wide range of use cases, the most important of which is to improve trip planning in mobility applications. The main purpose of GOFS is to provide improved information for travelers when discovering demand-response services. Initially, four key features are being prioritized: service discoverability, service description, real-time service description, and booking (via deep linking) along with pricing information. The GOFS project is extending GTFS to include on-demand reservation capabilities. To that end, the following existing proposals will be used for the use cases of the GOFS project:

- GTFS-Flex v2
- GTFS-FareData
- GTFS-VehicleCategories
- GTFS-RiderCategories
- Files from the GTFS-Capabilities and GTFS-Eligibilities project

As of May 2021, the GOFS working group decided that GTFS-Flex and GOFS will consolidate into a single extension for GTFS. However, as of March 2023, there is no funding for the GOFS project, so the specification development is not moving forward.

2.3.5 GOFS-lite¹⁴

The General On-Demand Format Specification lite (GOFS-lite) allows on-demand service providers to define their service in a lightweight format that can be consumed by transport applications in an interoperable way.

GOFS-lite, as an offshoot of the GOFS project, defines a lightweight format for purely on-demand transport services to provide information about their offering, much like GTFS exists for fixed-route public transit and the General Bikeshare Feed Specification (GBFS) exists for bikeshare, shared e-scooters, carshare, and other free-floating, self-service options. GOFS-lite is intended to have as much common ground as possible with GTFS and GBFS when the context allows it.

GOFS-lite supports on-demand services as follows:

- Without fixed routes
- Operated from zone to zone
- Available to anyone
- Can be ordered in real time

Examples of supported services include: ridehailing (for transportation network companies like Uber or Lyft), on-demand microtransit and paratransit.

Unsupported services include fixed or flexible public transit services where a schedule is defined (GTFS and GTFS-Flex support those use cases).

Future GOFS-lite extensions may support the following on-demand services:

- Operated from curb-to-curb, stop-to-stop, or door-to-door
- Providing private and/or shared trips
- Can be booked in advance

GOFS-lite is a work in progress, and there are currently important missing functionalities like pricing and travel time estimations.

2.3.6 General Bikeshare Feed Specification (GBFS)¹⁵

The General Bikeshare Feed Specification (GBFS) is an open data standard for shared mobility. GBFS makes real-time data feeds available online in a uniform format with an emphasis on findability. GBFS makes information publicly available online; therefore, information that is personally identifiable is not currently and will not become part of the core specification.

GBFS was created in 2014 with collaboration from the public and private sector, and nonprofit shared mobility system owners and operators, application developers, and technology vendors. The development of v1.0 is fully endorsed, supported and hosted by the North American Bikeshare and Scootershare Association (NABSA). In 2019, NABSA chose MobilityData to govern and facilitate the improvement of GBFS. MobilityData hosts a GBFS Resource Center¹⁶.

GBFS is intended as a specification for real-time, read-only data; any data being written back into individual shared mobility systems are excluded.

An example of using bikeshare data in trip planning, GBFS data for MoGO Bikeshare in the Detroit (Michigan) area is incorporated into the Commuter Connect trip planner.

3. Current Projects and Systems that Use Reservations, Scheduling, and Dispatching APIs

As mentioned briefly at the beginning of this white paper, the primary reason for gaps in standards and specifications associated with transit reservations, scheduling, and dispatching is that this system functionality is provided mostly in proprietary software. While there are several open software products that include this functionality (e.g., RideSheet, Ride Pilot) that are described in this section, they have been deployed in a very limited number of agencies. Further, standardizing this functionality has not been a priority in the transit industry in general. This section provides information about both open and proprietary RSD software, which is representative of the status of the industry as of the date of this white paper.

3.1 Rural Lake County, OR (TDS and RideSheet)¹⁷

Lake County, Oregon is located in a rural area (larger than Massachusetts) with no taxi, Uber, or Lyft service. The only demand-responsive transportation is provided by two local nonprofits—Inner Court Family Center (ICFC) and Lake County Senior Center Association. They have overlapping territories and many of the same clients. In 2020, they became the first two providers anywhere in the United States to commit to a collaboration that relies on the TDS.

RideSheet was developed by Full Path Transit Technology as an open scheduling platform that these two non-profit organizations are using to coordinate their services. This new tool uses the TDS to format their trip data, then exchanges it online using Google Sheets (a free cloud-based spreadsheet) to maximize the number and convenience of the rides the two nonprofits can offer. Thus, these two agencies can assign and coordinate rides without emailing or calling each other.

Because RideSheet is based on the TDS and was designed to be easy to use, the Lake County example is highly replicable. RideSheet is simple scheduling software and is suitable for small providers. Also, it can be used by software developers to verify that they have successfully programmed more sophisticated scheduling software to adhere to RideSheet’s uniform API specifications, which are based on the TDS.

Some initial technical support is needed to launch a new TDS-based network, but both the code for RideSheet and the API created for Lake County are now being offered free through open-source licenses for any interested programmer or provider to use or customize. Information about RideSheet and its use can be found at <https://github.com/full-path/ridesheet>.

3.2 VTrans and Maine DOT

The Vermont Agency of Transportation (VTrans), along with several partners, developed the data and software tools that enable rural and demand-responsive transportation to be discovered in trip

planners, similar to how fixed-route transit providers could already be discovered.¹⁸ Three key technology innovations were developed and implemented within the Go! Vermont trip planner:

- GTFS-Flex data was specified and developed for public transit providers in Vermont. A database containing the descriptions of all possible trips that could be served by Vermont public transit, including flexible services was developed.
- OpenTripPlanner (OTP) was adapted to search and visualize flexible trip plans based on the aforementioned GTFS-Flex data. This included the discovery of any possible future demand-responsive trips. Once the trip is discovered, the traveler needs to reserve the requested trip in coordination with the agency(ies) providing the trip.²
- After the initial definition of GTFS-Flex, VTrans et al worked with MobilityData, constituting the GTFS-Flex v2 specification that is now being used in the industry. Further, OTP code enhancements were merged into OTP 1.4.

Further, now the Go! Vermont trip planner shows both a GTFS-Flex option with Green Mountain Transit's Dial-A-Ride service, as well as their microtransit options with MyRide by GMT (the white-labeled microtransit service in Montpelier, VT).

After this groundbreaking work in VT, MaineDOT's GO MAINE contractor demonstrated the use of GTFS-Flex for Western Maine Transportation Services in Farmington, ME. For a particular route/option on the trip planner in this area, there are more detailed directions and instructions for booking a ride. Another enhancement for this area is that individuals can download and purchase passes in an app if desired. (Mobile ticketing is currently only available via an iOS app, but this capability is being added to the Android app as well.)

3.3 RidePilot

RidePilot is a web-based transportation scheduling and reporting system with an easy-to-use interface and underlying database designed for small and medium-sized agencies. As an open-source solution, the source code for the RidePilot platform is open to the public. Further, RidePilot can be integrated with web-based trip planning tools through an API. This seamless integration allows customers to review itinerary options before selecting and requesting a service.¹⁹

RidePilot is summarized in Table 1.

² GOFS will allow direct reservations for an on-demand trip with the transportation provider(s) in the future.

Table 1. RidePilot Characteristics²⁰

Characteristic	Details
Description	<p>Scheduling system for door-to-door service including:</p> <ul style="list-style-type: none"> • Ability to setup and automatically schedule recurring runs and trips • Tracking and generating federally-required reports • CAD/AVL component with a driver app that can be loaded onto Android tablets or phones <p><i>Note: does not address fixed route transit</i></p>
Users/ Audience	<p>Very small demand-responsive operators may have previously relied on cumbersome tracking methods involving spreadsheets, whiteboards, or index cards</p>
Ease of Adoption	<ul style="list-style-type: none"> • Moderate hosting, configuration effort • Requires some training for operator staff • Lightweight CAD/AVL can be implemented with Android device
Potential Value	<ul style="list-style-type: none"> • System is designed to be centrally administered by a larger agency on behalf of many providers • Supports more efficient and competitive offerings by small operators

3.4 Transport Operator Mobility-as-a-service Provider (TOMP) API

The Ministry of Infrastructure and Water Management in the Netherlands has been developing a standard-based Application Programming Interface (API) from Transport Operators (TO) to or from Mobility as a Service (MaaS) Providers (MP) since 2018. It allows participating agencies and companies to communicate about planning, booking, execution, support, general information and payments of multimodal trips. Using the TOMP API enhances the interoperability between parties in the MaaS ecosystem. Since 2020 the TOMP-WG working group has been moved to become an open source foundation with an international scope.²¹

3.5 USDOT Projects

USDOT Projects cover the following four initiatives:

- Mobility on Demand (MOD) Sandbox Demonstration Projects,
- Accelerating Innovative Mobility (AIM) Projects,
- Integrated Mobility Innovation (IMI) Projects, and
- Enhancing Mobility Innovation (EMI) Projects.

Descriptions of these projects may be found at www.transit.dot.gov/IMI.

3.5.1 Mobility on Demand Sandbox Demonstration Projects

One of the MOD Sandbox projects, the Adaptive Mobility with Reliability and Efficiency (AMORE) project in Tucson, AZ, tested operating a flexible transit service for commuting and for providing first-/last-mile connections to fixed transit routes. One goal of the AMORE project was to combine the flexibility of a

Transportation Network Company (TNC) with the efficiency of a fixed-route transit service by grouping customers traveling in similar patterns and allowing quicker connections to the core transit system than the existing neighborhood fixed route. The pilot service was a combination of microtransit and demand-response services. Pre-scheduled trip requests were assigned to vehicles provided by transportation service provider (TSP) - minimizing both user travel cost and service provider operating costs. Multiple pick-up and drop-off requests were pooled together.

One unique part of this pilot was ensuring the TSP. As part of the insurance package, Zendrive provided a software product that was integrated with the AMORE driver app to measure five key driving behaviors:

- Hard stops – coming to an abrupt or sudden stop (“slamming on the brakes”)
- JackRabbit Starts – accelerating suddenly and quickly from a stop
- Speeding – driving faster than the posted speed limit
- Phone use – using a phone to call, text, or manually engage with apps while driving
- Hard turns – driving too fast to safely turn the vehicle

Zendrive’s software was integrated into the app via an Application Programming Interface (API) and communicated directly with its servers. No passenger information was provided to Zendrive; it knew only if a passenger was in the vehicle or if the driver was en route to pick up a passenger—driver behavior was not monitored during periods when they were off duty. Note that there is no Personally Identifiable Information (PII) for passengers, nor are there corresponding addresses. Clearly, this is a valuable resource. Knowing that a driver has not used a phone while operating the vehicle or that their driving style matches program standards is very important. Long term, it will be useful and appears to be the future of smart insurance.²²

3.5.2 Accelerating Innovative Mobility Projects

There are several AIM projects that include reservations, scheduling or dispatching elements as follows:²³

- The Guam Regional Transit Authority (GRTA) KOKO Birds AIM for the Future Freedom of Mobility on the Patriotic Route project will provide innovative and inclusive Mobility on Demand (MOD) public transportation services to connect citizens and military personnel of rural, southwestern villages and the U.S. Naval Base Guam (NBG) to the island’s commercial centers. The service will provide these areas with innovative and inclusive access for residents of three rural communities (Agat, Santa Rita, Piti) and NBG to Hagatna through southern Dededo, the island’s primary commercial, employment, (Opportunity Zone), and healthcare areas. In providing the new MOD services, GRTA will lease eight ADA-accessible vehicles for operations, provide customer-focused access to service through advanced technology, create a newly-branded service, and provide customers with “complete trip concierge” services. GRTA will use RouteMatch’s Mobility Platform technology to provide innovative on-demand customer trip scheduling, service management, and trip concierge and payment services through a new GRTA mobile app and existing website.
- Prairie Hills Transit (PHT), based in Spearfish, South Dakota, and serving 15 rural communities in western SD, will implement a new real-time dispatching and scheduling system for its paratransit and Americans with Disabilities Act (ADA) operation that reduces data latency, so vehicle location

updates are conducted in near-zero latency, enabling the use of artificial intelligence (AI) and machine learning techniques to make real-time dispatching decisions automatically. The dispatch system upgrade will allow PHT to monitor its vehicles in near-instant time and be able to expand automated control of dispatch to its entire geographical area and all of its services. The real-time updates will allow riders near-instant information about their ride and notifications via text messages or on maps on their smartphones.

- The Delaware, Dubuque, and Jackson County Regional Transit Authority (RTA) in northeast Iowa proposes to leverage technology via a password-protected portal to help improve coordination among local agency and community partners when scheduling trips for clients. This will allow for shared costs, ultimately lowering costs and reducing wait time for clients. Agencies will be able to schedule more trips than in the past, expanding local service availability to the general public. Local officials will demonstrate improved RTA service availability to the public and agency partners with a redesigned website. Displaying RTA's peak and off-peak times will enable all clients and caregivers to schedule appointments so their trips fit into RTA's services, and agency partners will have the ability to schedule appointments during RTA's off-peak times, reducing wait time for their clients.

Since these projects were announced on August 27, 2020 (FY20 funds), there are no results available yet. AIM grant projects were initiated in 2021. However, these projects should be monitored for any relevant work regarding reservations, scheduling and/or dispatching.

3.5.3 Integrated Mobility Innovation (IMI) Projects

There are several IMI projects that include reservations, scheduling or dispatching elements as follows:²⁴

- The Matanuska-Susitna (Mat-Su) Borough in Alaska will purchase a commercial 'software as a service' centralized mobility management system to centralize dispatch, fleet management, call-taking, and mobility payment integration functions for multiple transportation provider types using a single, online platform. The system will demonstrate the effectiveness of multiple transit and human services transportation providers in a rural area, where traditional transit service is largely cost-prohibitive. This one call/one click system may assign trips to the lowest-cost eligible provider and allow riders flexible request and payment options to improve the rider's Complete Trip experience. With all major providers using the same software, data collection is streamlined and leads to consistent reporting formats, encouraging collaboration among providers and creating transparency to existing and potential funders, government agencies, and the Mat-Su community.
- In the Northeast Minnesota Arrowhead Region, a linkage for first/last mile travel options connecting rural populations to multiple public transit systems will be developed and demonstrated and a business model for a nonprofit community-based transportation program will be created. The project includes developing scalable technologies to enhance the rider experience and promote accessibility options through a Mobility as a Service (MaaS) passenger app, driver app, and volunteer "scheduled/on demand" app. Also, a MaaS dispatcher platform, ride booking platform, and online booking platform to provide fast and reliable transportation will be developed. The envisioned platform will provide consumers with a multimodal portal to facilitate trip planning, ride information, pricing, and direct booking options and will serve as an automated platform to connect ride requests with available transportation options. It will provide accessible, affordable transportation options, access to various payment methods, and a community resource guide to

assist consumers in reaching a level of self-sufficiency that will allow them to remain productive members of their communities.

- The Arlington, Texas RAPID project will combine the City's expertise with on-demand rideshare and [automated vehicle] AV testing to demonstrate the integration of a shared, dynamically-routed Level 4 AV fleet into an existing public rideshare transit system. River North Transit LLC will continue to provide the rideshare service and May Mobility, Inc. will provide the AV technology and fleet. This project will create a one-stop-shop for mobility needs in the service area concentrated around the University of Texas at Arlington's (UTA's) campus, providing a seamless trip planning, booking, and payment experience across modes.
- Wake County, North Carolina will provide a unique opportunity to address the growing trend in rapidly-growing urban areas where lower-income populations are having to move outside the urban core due to gentrification, thus pushing them away from regularly-available public transit services. Instead of a first/last mile approach, this project will investigate a "first five-mile/last five-mile" approach to connect to more distant transit services for rural areas. A new microtransit service model will allow for a portion of paratransit vehicles to be stationed in closer proximity to the zone, making the service more available, with minimal advanced reservation requirements (potentially within a goal of two-hour notice).
- The Independent Transportation Network (ITN[®]), a nonprofit enterprise founded in Portland, Maine as a model for community-based, nonprofit transportation service designed to meet the mobility needs of older or visually-impaired people, will use ITNRides™ software and donated algorithms to support a large national system affordable to small and rural communities. The resulting business model and corporate structure offers maximum flexibility and adaptability to each community, yet remaining unified on the same software platform. This two-year project will work with rural communities in Maine, Kentucky, and California to test the market sensitive, consumer-oriented Mobility on Demand ITN model, currently operating successfully in urbanized areas in 12 states in lower-density rural communities. Further, the ITNRides™ software will provide effective routing and scheduling algorithms, helping rural communities increase access to transportation through efficient use of volunteer and community resources.
- Crawford Area Transportation Authority (CATA) in Pennsylvania will create the Rural Integrated Payments Program which will enable CATA to integrate ticketing and payments across paratransit and fixed-route service, thereby creating a more cohesive rider experience and enabling the agency to encourage intermodal travel. The project will provide an integrated method of scheduling, booking, and purchasing flex and fixed-route services and will provide the data required to fully understand the collective needs of CATA riders.
- Service in Baldwin County, Alabama will apply MOD to a new, rural setting, demonstrating it at a larger scale and operating multiple MOD services under a simpler and fully integrated platform. For rural areas, the service will expand standard on-demand offerings and practice by offering a service fully scoped for rural mobility. The County expects to receive the benefits of MOD through this project, enabling customers to easily plan, book, and pay for trips that meet their schedule through a consumer-facing mobile app.

Since these projects were announced on March 16, 2020 (FY19 funds), there are no results available yet. IMI grant projects were initiated in 2021. However, these projects should be monitored for any relevant work regarding reservations, scheduling, and/or dispatching.

3.5.4 Enhancing Mobility Innovation Projects

One of the categories of Enhancing Mobility Innovation (EMI) projects is software solutions. This category includes projects that support the development of software solutions that facilitate integrated demand-response public transportation that dispatches transit vehicles through riders' mobile devices or other means.²⁵ Two projects in this category are as follows²⁶:

- Metropolitan Transportation Commission (MTC) in San Francisco, will receive funding to develop a new software application that facilitates end-to-end demand responsive transit trip planning and reservations so users can request, confirm, and pay for a trip that encompasses multiple service providers across jurisdictions, and service providers can confirm and coordinate trip segments.
- NEOride, a designated Council of Government (COG) representing 18 mass transit agencies in Ohio, Kentucky, Michigan, and Arkansas, will receive funding to develop software solutions that facilitate integrated demand-response public transportation. The project will test a solution to enable real-time open data exchange for demand response software using Transactional Data Standard (TDS). The demonstration will enable various client management and scheduling software to share customer profile and eligibility information, trip requests and booking confirmations, provider and vehicle information, and trip performance status.

Since these projects were announced on August 10, 2022 (FY21 funds), there are no results available to date. EMI grant projects were initiated in 2021. However, these projects should be monitored for any relevant work regarding reservations, scheduling, and/or dispatching.

4. Stakeholders

The following stakeholder groups can play a critical role in addressing standards and specifications gaps in the reservations, scheduling, and dispatching area.

4.1 Advocacy groups

The following end-use stakeholder groups would be most helpful in addressing the gaps in reservations, scheduling, and dispatching standards and specifications.

- American Public Health Association
- Center for Health Progress
- Center for Neighborhood Technology
- National Aging and Disability Transportation Center (NADTC)
- National Alliance of Public Transportation Advocates
- Transportation for America

4.2 Transportation Organizations and Trade Associations

The following transportation organizations and trade associations would be most helpful in addressing the gaps in reservations, scheduling, and dispatching standards and specifications.

- AARP
- American Association of State Highway and Transportation Officials (AASHTO) Shared Mobility/Mobility on Demand/Mobility as a Service Inter-Committee Working Group
- American Public Transportation Association (APTA)
- Association of Commuter Transportation (ACT)
- Community Transportation Association of America (CTAA)
- Mineta Transportation Institute
- National Association of City Transportation Officials (NACTO)
- North American Bikeshare Association (NABSA)
- National Rural Transit Assistance Program (RTAP)
- Shared-Use Mobility Center (SUMC)
- Transportation Research Board (TRB)

4.3 Community, Consortium, Nonprofit, and Trade Associations

- California Integrated Travel Project (Cal-ITP)
- ITS America / Mobility on Demand (MOD) Committee
- Mobility as a Service (MaaS) Alliance
- Mobility Data Collaborative (SAE Industry Technologies Consortia)

4.4 Standards Development Organizations (SDOs)

- International SDOs:
 - International Organization for Standardization (ISO) Technical Committee 204 Working Group 8
 - European Committee for Standardisation (CEN) Technical Committee 278 Working Group 3
 - SAE International (including the Mobility Data Collaborative)

- National SDOs:
 - Institute of Transportation Engineers (ITE)
 - National Electrical Manufacturers Association (NEMA)
 - Rehabilitation Engineering and Assistive Technology Society of North America (RESNA)
- Consensus-based SDOs:
 - MobilityData (nonprofit that facilitates development and stakeholder engagement on several mobility data standards)
 - Open Mobility Foundation

4.5 USDOT programs

- Federal Transit Administration (FTA) Office of Research, Demonstration, and Innovation
- USDOT ITS Joint Program Office

4.6 Commercial Product Developers/Vendors

- | | |
|--|-----------------------|
| • AlphaRoute | • Route Genie |
| • Cambridge Systematics (software is Ride Pilot) | • Routing Box |
| • Clever Devices (scheduling software is MAIOR) | • SAFR Care |
| • CTS Software (Tripmaster) | • Schedule Viewer |
| • DDS Wireless (Stratagen software) | • Shah Software |
| • DemandTrans | • Spare Labs |
| • Downtowner | • Spedsta |
| • Ecolane | • Syncromatics |
| • Enghouse | • TaxiMobility |
| • Engraph Software (ParaPlan software) | • The Routing Company |
| • Full Path (RideSheet software) | • TransitExec |
| • GIRO | • Transloc |
| • Innovations in Transportation (INIT) | • Trapeze / TripSpark |
| • IT Curves | • TSS Paratransit |
| • Kevadiya | • Urban Mobility |
| • Kinetik | • Vi |
| • Liftango | |
| • MediTrans | |
| • MJM (EzTransport®) | |
| • Mobility Route | |
| • Moovit | |
| • MTM | |
| • NEMT Cloud Dispatch | |
| • NEMT Platform | |
| • NEMT Pulse | |
| • Passio Technologies | |
| • QRyde (by HBSS) | |
| • RideCo | |

5. Issues and Standards Gaps

The primary reason for gaps in standards and specifications associated with transit reservations, scheduling, and dispatching is that this system functionality is provided mostly in proprietary software. While there are several open software products that include this functionality (e.g., RideSheet, Ride Pilot) they have been deployed in a very limited number of agencies. Further, standardizing this functionality has not been a priority in the transit industry in general. Many agencies claim that they take reservations, prepare schedules, and facilitate dispatching in unique ways; the basic functionality is the same across transit agencies that provide fixed-route, paratransit, and microtransit services. Finally, there are several efforts to standardize these processes, but they are being conducted by non-traditional standards development organizations such as MobilityData and Cal-ITP. Funding is critical for these non-traditional SDOs to spearhead development. As of March 2023, several standards development efforts mentioned earlier in this paper have been halted because of a lack of funding.

In terms of specific standards gaps, there is a lack of standards or specifications that govern the processes associated with reservations, scheduling, and dispatching which are essential to transit operations. For example, while Cal-ITP ODS is a start to standardize this functionality, the industry needs to support adopting it. Regarding ODS development, Cal-ITP staff brought representatives from almost every scheduling and CAD/AVL company working in North America together to provide input.

Vendor development of the features of ODS that will produce and consume data is the next step in this standard's development. The way that vendors prioritize including the standard in their product roadmaps is to have it written into a request for proposals (RFP). Cal-ITP is seeking grant funding to bring together a transit agency and scheduling and CAD/AVL vendors to test compliance with the standard. This type of test case could be the fastest way to get the standard working in the real world.²⁷

6. Conclusions

The gaps in standards for reservations, scheduling, and dispatching exist primarily because the transit software industry is inundated with proprietary systems. Further, funding is significantly lacking to complete the development and demonstration of standards that are in process, such as GTFS-Flex and GOFS. USDOT has the opportunity to support standards development and deployment in this area through convening the stakeholders to agree to the specific elements needed for full-featured standards in reservations, scheduling, and dispatching, and providing funding to complete and demonstrate the use of these standards.

As done in this White Paper, the USDOT should continue to highlight easy to replicate, low-cost systems such as Lake County, Oregon's RideSheet. This will help smaller transportation systems update and improve their archaic and cumbersome RSD systems.

7. Acronyms

ADA	Americans with Disabilities Act
AIM	Accelerating Innovative Mobility
API	Application programming interface
AVL	Automatic vehicle location
CAD	Computer-aided dispatch
Cal-ITP	California Integrated Travel Project
CATA	Crawford Area Transportation Authority
CDT	California Department of Technology
COG	Council of Government
DRT	Demand-responsive transportation
EMI	Enhancing Mobility Innovation
GBFS	General Bikeshare Feed Specification
GOFS	General on-demand Feed Specification
GPS	Global positioning system
GRTA	Guam Regional Transit Authority
GTFS	General Transit Feed Specification
HSTD	Human Service Transportation Delivery
IMI	Integrated Mobility Innovation
ITN [®]	Independent Transportation Network
ITS	Intelligent Transportation Systems
MaaS	Mobility as a Service
MAT	Multimodal and Accessible Travel
MOD	Mobility on Demand
MST	Monterey-Salinas Transit
MTC	Metropolitan Transportation Commission
NABSA	North American Bikeshare Association
NEMT	Non-emergency medical transportation
ODS	Operational Data Standard
OTP	OpenTripPlanner
PHT	Prairie Hills Transit
RFP	Request for Proposals
RTA	Regional Transit Authority
RTD	Regional Transportation District
SDO	Standard Development Organization
TCRP	Transit Cooperative Research Program
TDS	Transactional Data Specifications
TNC	Transportation Network Company
TOMP	Transport Operators (TO) to or from [Mobility as a Service] MaaS Providers (MP)

TSP	Transportation service provider
USDOT	United States Department of Transportation
UTA	University of Texas at Arlington
VTrans	Vermont Agency of Transportation

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