Phase 1 Concept of Operations (ConOps)

California Association for Coordinated Transportation ITS4US Deployment Project

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Final Report — July 16, 2021
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COMPLETE TRIP
ITS4US

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16. Abstract

This project aims to address the need for riders who use demand-responsive services, rural riders, and riders with disabilities to have equal access to the real-time trip planning technologies already available for fixed-route transit, as well as Transportation Network Companies. Fixed-route transit rider information has developed quickly in the last 15 years, but is generally limited to smartphone users in urbanized areas. General Transit Feed Specification (GTFS) data, the most common transit schedule exchange data format, does not require the inclusion of accessibility information that ensures riders with vision, mobility, hearing, and cognitive disabilities can access the transit service information.

This Concept of Operations (ConOps) for the CALACT Phase 1 ITS4US project details the current system of shared transit data in operation within the three state region of California, Oregon, and Washington, identifies deficiencies with that system and user needs which should be fulfilled, and a proposal for a new system of technology governance and maintenance that would augment the system to fulfill those user needs. The research and development that has gone into this project has been performed by a broad team of technology and transit experts in collaboration with stakeholders including transit operators and riders, and builds from the ongoing work of the community of rural and specialized transportation technology practitioners over the last decade. The ConOps is not a precise plan for how to reform the transit information system in the region, but rather a high-level concept for how such a plan should approach the problems faced by the transportation industry and a description of the needs that must be met by a new system. This ConOps will be succeeded by additional plans which will further develop the proposal into a detailed system ready to be implemented.

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1. Scope

This Concept of Operations (ConOps) for the CALACT Phase 1 ITS4US project details the current system of shared transit data in operation within the three state region of California, Oregon, and Washington, identifies deficiencies with that system and user needs which should be fulfilled, and a proposal for a new system of technology governance and maintenance that would augment the system to fulfill those user needs. The research and development for this project has been performed by a broad team of technology and transit experts in collaboration with stakeholders including transit operators and riders, and builds from the ongoing work of the community of rural and specialized transportation technology practitioners over the last decade. The ConOps is a high-level concept for how this project will make online and mobile trip planning more accessible and equitably available and a description of the needs that must be met by a new more accessible and equitable trip planning system. Additional plans will follow this ConOps which will further develop the proposal into a more detailed system and implementation plan.

The intended audience of this document is the CALACT team, including its subcontractors and stakeholder subcommittee chairs and members, as well as the USDOT program management team. Academic and practitioner stakeholders who may find this document useful are considered as well.

1.1. Project Background

The CALACT project addresses the clear need for riders who use demand-responsive services, including riders with disabilities, to have equal access to the real-time trip planning technology that is already available for urban fixed-route transit. Nearly 300 of the over 500 transit operators in California, Oregon, and Washington deliver a form of demand-responsive service.[1] Rider characteristics of these services likely differ substantially from those on fixed-route services as rural residents and people with disabilities are more likely to be low-income, unable to use fixed-route services due to disability, and/or are living in a physically isolated environment.

The demand-response systems themselves offer a lower quality of rider experience, where would-be passengers must find a transit provider that will serve their needs, call a dispatch system to plan and reserve their trip, requiring a long lead time (typically at least a day in advance), and allowing little room for flexibility. The trip planning experience of demand-response systems is further and uniquely burdened by a complex web of determining operator coverage area, for what qualifications that operator or specific service within that operator's service menu they qualify, if the operator has availability, if they need to pay and how. Unlike fixed route

[1] Numbers calculated based on internal lists of agencies and metadata provided by ODOT, WSDOT, and Caltrans.

services, which have a well-established data standard and a stable industry of third-party trip planning services, and private Transportation Network Companies (TNCs), which produce their own seamless and instantaneous booking and payments flows, demand-responsive transit lacks the technical solutions which could ease these burdens for their riders. There's no comparable desktop or smartphone experience and no other innovations which exist to untangle these webs of availability, reservations, or payments.

Most fixed route users in the three-state region have access to real-time information about transit services through any mobile device. However, very few users have that information about public demand-responsive transit, and none have that information except through custom proprietary systems implemented at a few local agencies. Further, users of fixed-route services who would like more access to details regarding the transit system accessibility features and other amenities often cannot easily find that information.

The particular underserved communities the project focuses on are people with mobility disabilities, people with vision disabilities, people with cognitive and developmental disabilities, people with hearing disabilities, older adults, low-income populations, rural residents, veterans, and people with limited English proficiency.

This project is one of five deployments of the Complete Trip - ITS4US Deployment Program, led by the ITS JPO and supported by Office of the Secretary (OST), Federal Highway Administration (FHWA), and Federal Transit Administration (FTA). These deployments were selected to showcase innovative business partnerships, technologies, and practices that promote independent mobility for all travelers regardless of location, income, or disability. The Complete Trip - ITS4US Deployment Program is carried out in three phases over five years: Concept Development (current phase), Design and Testing, and lastly Operations and Evaluation. There is a post-deployment operations and maintenance phase for an additional five years. The intended outcomes for the CALACT deployment are to improve the user experience and cost efficiency of demand responsive transit for riders at agencies throughout the Washington, Oregon, and California.

Project partner (subcontractor) organizations include:

- Oregon Department of Transportation (ODOT): Agency outreach in Oregon, member of PMT, transit directory product manager
- Washington Department of Transportation (WSDOT): Agency outreach in Washington, member of PMT, transit analysis product manager
- California Department of Transportation (Caltrans): Agency outreach in California, member of PMT, payments product manager
- Washington State Transit Association (WSTA): Support agency outreach in WA and assist with event coordination
- Trillium, an Oregon small business: Concept design, report writing and product management support
- Compiler LA, a California small business: Software systems requirements and data management lead

- Tamika L. Butler Consulting, a California small business: Internal evaluation and stakeholder engagement
- Mark Wall Associates, a California small business: Agency outreach and support for reporting and project administration
- Estolano Advisors, a California small business: Agency and stakeholder outreach support
- California Partners for Advanced Transportation Technology at UC Berkeley: Project evaluation and stakeholder safety and human use leads
- MobilityData IO, a Canadian nonprofit: Data specification development and technology readiness assessment lead
- Transit, a Canadian private corporation registered for business in the US: Technical advice on customer interface needs and development
- Navilens, a Spanish private corporation registered for business in the US: Digital accessible signage and text to speech product leads
- Google, an American public corporation (unfunded): Participation in an advisory and user testing coordination role

1.2. Acronyms and Glossary

Accessibility – Accessibility is used in this document to indicate the ability all riders—especially people with disabilities, Limited English Proficiency, or who faces other barriers to access transit—to use transit and transit technologies in a way that best supports those users' individual experiences with transit. A service or technology may be "accessible" as defined by the ADA, but may also present "accessibility barriers" which this project seeks to help riders manage, in order to make the service or technology "more accessible".

ADA - Americans with Disabilities Act

API - Application Programming Interface

B2C - Business to consumer

B2G - Business to government

BAA - Broad Agency Announcement

CA - State of California

CA PATH - California Partners for Advanced Transit and Highways

CAD/AVL – Computer-Aided Dispatch/Automatic Vehicle Location

CALACT - California Association for Coordinated Transportation

Caltrans - California Department of Transportation

CCPA - California Consumer Protection Act

CDL - Concept Development Lead

ConOps - Concept of Operations

Deep link – a deep link is a link within a mobile application which directs the user to another mobile application, rather than to a website.

Demand-responsive transit – Transit services which provide trips at a location and/or time that is requested by a rider. Generally, any transit service that is not Fixed-route is considered a type of Demand-responsive transit for the purposes of this document, including general public DAR, ADA paratransit, and other transit models.

DOT - Department of Transportation

Fixed-route transit – Transit services that provide service to the general public through vehicles which stop at designated locations (stops and stations) at designated times.

GPS – Global Positioning System

GTFS - General Transit Feed Specification

IEEE - Institute of Electrical and Electronics Engineers

IRB - Institutional Review Board

NEMT – Non-Emergency Medical Transportation

NIST 800-53 - National Institute of Standards and Technology

PII – Personally Identifiable Information

PLC - Project Leadership Committee

PML - Project Management Lead

PMO - Project Management Organization

PMP - Project Management Plan

PMT - Project Management Team

ODOT - Oregon Department of Transportation

OR - State of Oregon

OS - Operating System

SCC - System Coordination Committee

SDL - System Development Lead

SEMP - Systems Engineering Management Plan

SyRS - System Requirements Specification Document

TBD - To Be Determined

TTS – Text-to-Speech

TNC - Transportation Network Company

UI - User Interface

WA - State of Washington

WBS - Work Breakdown Structure

WSDOT - Washington State Department of Transportation

WSTA - Washington State Transportation Association

1.3. Document Overview

Section 3 of this document describes the “current system.” Section 4 provides explanations of needed changes, along with descriptions of those changes. This also includes a list of the project’s 93 user needs identified through stakeholder interviews and use case decomposition. The document then outlines the overall concept of the proposed system in Section 5. Section 6 includes operational scenarios that connect user stories within the new system to the user needs the system intends to fulfill. Lastly, a summary of impacts of the proposed system follows in Section 7, as well as an analysis of the proposed system in Section 8.

1.4. System Overview

The CALACT ITS4US project will create a system of technology infrastructure that coordinates organizations across the three-state region of California, Oregon, and Washington. The purpose of the system created through this project will be a new level of equitable technology service available to all transit operators and other rideshare providers in the region. Easy access to high quality trip planning will be more available to riders with disabilities, rural and low-income riders, those with limited-English proficiency, and veterans. These riders will be able to plan their trip, book their seat, and coordinate payment for their ride, even if that ride includes ADA paratransit, a rural dial-a-ride service, or a local community transportation non-profit serving rides to veterans. By connecting this demand-responsive trip planning into current fixed route trip planning, the full public transportation network will become available to riders from these underserved communities, and the network available to current fixed route riders will be expanded. The

combined outcome will be a seamless transit experience, at reduced cost to taxpayers and more effectively reported to the state DOTs.

Achieving this outcome will be a coordinated effort between transit agencies, DOTs, technology vendors, technical non-profits, trade associations, and technology companies. The project will augment the flow of data from transit operators to riders by developing a system of coordination between the state Departments of Transportation (DOTs) in the region, which maintains transit data quality and aggregates that data on an ongoing basis. The DOTs are the primary project sponsors and will lead a System Coordination Committee (SCC) which governs the content of procurement guidelines required and supported by each state DOT. After the initial development of GTFS data extensions by project partners, these guidelines will ensure that high-quality transit data continues to be available throughout the life of the system, which will be aggregated in a transit directory system based on official lists of transportation services maintained by each DOT. The transit directory system will provide basic information regarding transit services to all users, including riders as well as other parties such as social service agencies or employers that may need information regarding the transit available. The SCC will also administer functions to publish best practices for the development of rider applications, to coordinate accessibility, eligibility, payment, and wayfinding coordination between agencies, and to support a first-tier support desk function that helps all users interact with the directory system. The diagram below shows the proposed system components and how they interconnect. The proposed system, with additional detail and in larger font, is provided in Section 5.

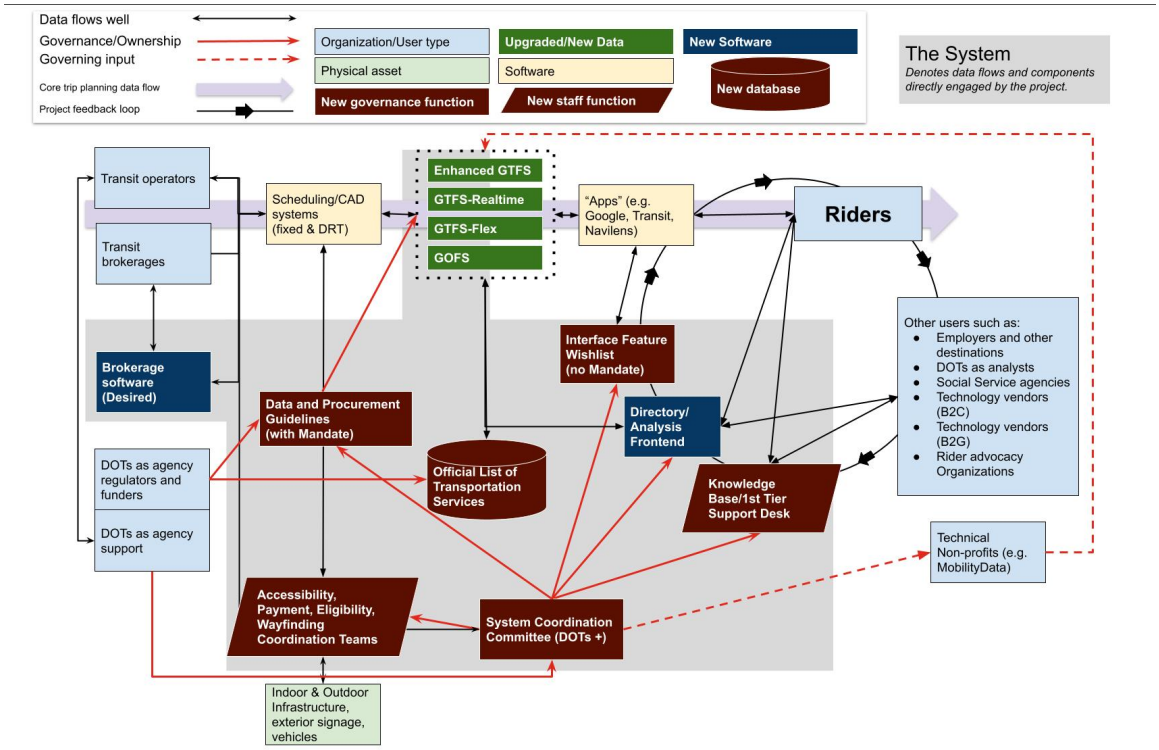

Figure 1. Proposed System Diagram (in miniature)

2. Referenced Documents

CALACT User Needs Identification and Requirements Planning report, USDOT (2021)

CALACT Needs Summary, USDOT (2021)

CALACT Stakeholder Registry and ConOps Review Panel Roster, USDOT (2021)

GTFS, gtfs.org, Github (2021).

GTFS-Flex, https://github.com/MobilityData/gtfs-flex/blob/master/spec/reference.md, Github (2021)

Fares v2, bit.ly/gtfs-fares, Google Documents (2021).

GOFS: Working group documents, MobilityData (not yet public)

IEEE Std 1362TM-1998 (R2007), IEEE Guide for Information Technology—System Definition—Concept of Operations (ConOps) Document, IEEE (2007)

3. Current System and Situation

The purpose of this section is to provide a foundational description of the current system and situation regarding transportation for underserved communities in California, Oregon, and Washington. This description is provided to help the reader understand what systems are currently in place, so that changes and updates can be effectively described in Section 4. This description focuses on the operational challenges in the current system, as well background on why the current system developed in the way it did.

3.1. Background and Scope

The current system focuses on providing static, fixed-route transit schedule information publicly for riders to plan trips. Tools and solutions employed by the current system have been aimed at making information available more easily to riders using websites, web applications, and mobile apps. However, the functionalities and the data behind them have been developed rapidly in the last 15 years. Development has largely focused on riders who are easiest to serve and perceived to be most likely to use trip planning technology, because they are savvy in the use of mobile technology and is and does not have any constraints related to vehicle types or infrastructure. The interfaces which are commonly promoted by transit agencies, such as Google Maps, Transit the app, Moovit, and others, generally do not provide detailed information about the accessibility details or cost of services, and when they do, that information is optional and contingent upon data being provided by agencies.

These tools are primarily based on General Transit Feed Specification (GTFS) data. In 2005 TriMet in Portland, OR and Google partnered to develop GTFS, originally known as the Google Transit Feed Specification, as a way of describing transit routes, stops, schedules, and fares to Google Maps. GTFS developed beyond Google Maps specifically and is now used by a wide variety of third-party software applications, both commercialized and customized. In 2010, the name was updated from Google Transit Feed Specification to General Transit Feed Specification to reflect this change.

GTFS is used widely throughout Washington, Oregon, and California to allow riders to plan trips using online trip planners and third-party applications such as Google Maps and Apple Maps. Google Maps is usually the primary motivator for an agency to invest in GTFS data. In Oregon, Washington, and California, the states support development and maintenance of GTFS data for all transit agencies throughout their state, through the Oregon Department of Transportation, Washington Department of Transportation, and the California Integrated Travel Project (Cal-ITP) respectively. While this type of state sponsorship has helped propel GTFS to its current regional ubiquity, GTFS usage is primarily managed at the agency level and its publication is not standardized. This often can result in disorganized and incohesive transit data networks at a level beyond what an individual agency can influence.

Many transit agencies (particularly larger agencies) manage and publish their own GTFS data using tools from a vendor-provided scheduling or CAD/AVL system. Smaller transit agencies may

edit data using Excel, hire a consultant, or use specialized software. Smaller transit agencies are less likely to have GTFS data than larger agencies because of the cost and effort of producing the data, and because there are not as high of expectations around online and mobile information for public services as there is among riders of larger transit agency services.

Many agencies who have Automatic Vehicle Location (AVL) and Real Time Passenger Information (RTPI) technology have also deployed the real-time extension of GTFS, GTFS-realtime, which allows agencies to publish arrival time adjustments depending on the real-time location of vehicles, as well as custom alert messages. Cal-ITP is working to bring California statewide coverage of real-time GTFS data.

Transit agencies see GTFS as primarily useful to enable traveler information tools, and directly engage with some apps like Google Maps and Transit to request that their information be shown to riders via the data they produce. Other applications such as Apple Maps and Bing Maps discover data that is published online and reach out to agencies directly. Directories including openmobilitydata.org and transit.land allow discovery of GTFS data throughout the world. Some states such as Oregon (oregon-gtfs.com) and California (https://www.camobilitymarketplace.org/provider-map) publish state directories of transit data.

DOTs and transit agencies also use GTFS data operationally and for planning and analysis. California, Oregon, and Washington all use GTFS data, often in conjunction with other datasets, to analyze access to transit, network connections, network changes, service performance, travel demand, and other aspects.

While GTFS can model some basic fare and accessibility information, little has been done to bring trip booking and payment to commercial trip planning apps, especially because those apps only include fixed-route transit information. Booking is more likely to be a necessary part of the complete trip process for demand-responsive services. Cal-ITP is involved in developing GTFS-Fares v2, a proposed extension of GTFS, particularly to use for payment validation in contactless payment systems. This work is a foundational step in the standardization of such data, but there is still a lack of a generalized in-app booking/payment tool remains.

GTFS currently includes this limited fare and accessibility information only for fixed-route transit services, so it does not encompass all types of transit available to riders. One solution for this issue has been the development of GTFS-Flex, a proposed extension that allows trip planners to display information about demand-responsive and paratransit services with flexible schedules and routes. A significant amount of GTFS-Flex data has been created for various regions in the three states, most notably for the entire state of Oregon, but coverage is far from complete. Additionally, there are very few deployments of online tools making use of flexible data. This condition has begun to be addressed at the global level by MobilityData through the GOFS (General On-demand Feed Specification) working group, which is a coordinated effort by transit agencies, TNCs, taxi companies, and regulators (including CALACT and the USDOT) to build on the GTFS-flex proposal. However, this effort and the specification which develops from that working group will need to be promoted and adopted by vendors and agencies in order to be successful.

3.2. Description of the Current System and Situation

A context diagram and description of the current system is provided on the next page:

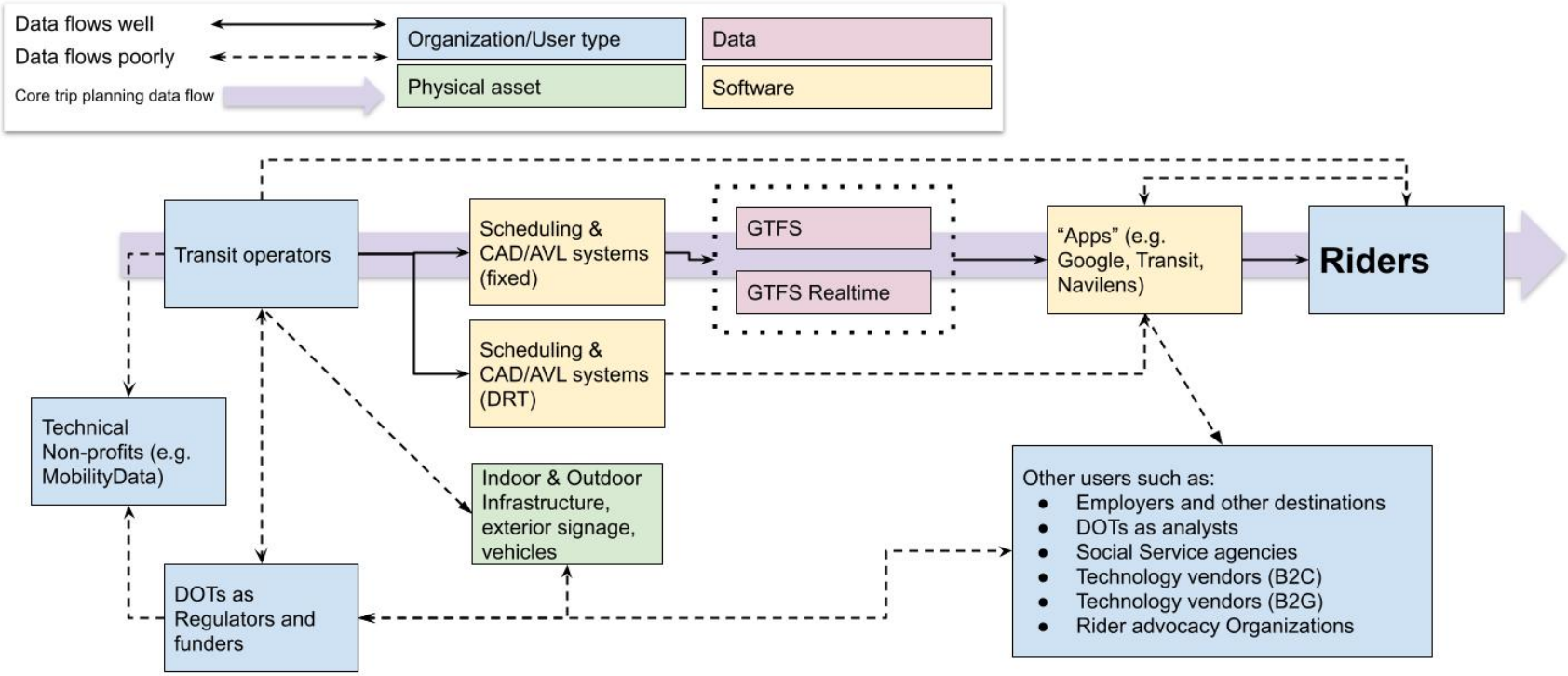

Figure 2: Diagram of the Current System

3.2.1. High-Level Description of Current System Diagram

In the current system, GTFS and GTFS Realtime can flow automatically from fixed-route scheduling and CAD/AVL systems managed by transit operators to a few different mobile apps like Google Maps. Riders can view and plan fixed-route trips using these apps and agency websites, which typically have a "Google Trip Planner widget" or custom or proprietary trip planner. The rider uses a computer or a mobile device with internet access to discover, access information, and plan fixed-route transit trips. However, there are limits to what information the current GTFS spec is able to convey, and this does not always include information that is important to riders in underserved groups.

The lack of information relevant to underserved groups is especially true for demand-responsive transportation, which often has a particular focus on offering services to riders with disabilities, veterans, older riders, and rural riders. Attempts made by agencies, DOTs, and other stakeholders to address these inequities are *ad hoc* and inconsistently applied, which have hindered the broad market adoption of more demand-responsive and accessibility-focused transit technology. Furthermore, other data flows that would be necessary to provide truly complete trip information, such as data on built environments and precise fares, are non-existent.

In general, within the current system, all data flows outside of the core flow of GTFS data from transit agencies to public rider applications through scheduling and CAD/AVL software vendors is non-standardized and inefficient. This includes the manner in which transit operators communicate with technical non-profits such as MobilityData, regulators such as DOTs, and the way in which agencies track their physical assets. There are no standardized approaches for the management of these subsystems and exchange of data between them, even though there are many commonalities between different transit agencies and regulators. Even the ways in which transit agencies communicate with riders are disorganized and often ineffective. There are few common tools for how to track rider feedback and complaints, and when staff members change at a transit agency, the way in which that agency communicates with riders often changes as well.

The ADA, section 508 of the Rehabilitation Act of 1973, and Title VI of the Civil Rights act of 1964 set out numerous requirements which together require that all riders are provided sufficient access to transit services, including information about those services. Transit agencies currently have a series of established practices for ensuring compliance with those laws, however, the specifics of how transit information should be conveyed through mobile apps and other online tools has not been specifically defined on a nation-wide basis. The result is that transit agencies may not provide the same level of access to information to all riders, and nationally, there is likely a general disparity whereby the underserved groups identified by this project do not receive equal access to transit information.

3.2.2. GTFS Production

In the current system, the static GTFS data feeds required for these tools to work are created in one of a few different ways. For some agencies, the data is created in-house by employees who create and managed their own GTFS data. Other agencies contract with specialized vendors to manage this process for them or provide software that makes the process easier. In some states (e.g. Oregon, Vermont, New York), the state DOT sponsors this type of assistance for agencies in

an attempt to encourage consistent GTFS use across the area. Where data is accurate and reasonably complete, GTFS can then also be used for analysis in areas like equity evaluations and transportation planning.

3.2.3. GTFS Governance

The GTFS data spec is subject to a governing process that includes public participation. This process includes changes to the spec and documented best practices, as well as for adding new extensions. Any additions require a producer, a consumer, and a community vote. The vote must be unanimous, or the change or addition is not approved.

There is a global non-profit which provides technical leadership for the governance of GTFS, Montreal-based MobilityData, which is a partner to the CALACT ITS4US project. Many transit agencies in the three state region, as well as each state DOT, is a member of MobilityData and contributes to the global discussion regarding GTFS and various related extensions (along with many other parties including other US-based DOTs, agencies, and ITS4US program participants and a diverse array of global actors. MobilityData does not own the GTFS data specification. Google holds ownership under an Apache Version 2.0 License. US-based governmental and transit operating agencies do not have an organized approach to coordinating feedback to MobilityData or the GTFS community.

3.2.4. Rider Behavior within Current System

Once the rider accesses the available information to plan their trip, they travel to the relevant pick-up location. It is up to the rider to independently plan for this part of their trip based on either their own research or prior experience. Accessibility features and barriers, such as curbs or hills, are not typically listed on agency websites nor documented with GTFS.

When the vehicle arrives, the rider boards and makes their payment. It is up to rider to figure out accessibility features or barriers navigating through stations and boarding the vehicle, whether through prior experience with service or own research and to have the correct fare available in an accepted payment method. Information about fares and payment processes may be available on the agency's website but may still be limited. For example, many agencies only accept cash as payment on the vehicle and may require exact change. Signs regarding policies or alerts may be posted in a manner that can be seen but not heard or heard but not seen.

Once the rider has boarded, the vehicle travels along its route and the rider alights at their preferred stop. The degree of navigational information the rider has access to while traveling varies heavily based on vehicle infrastructure, the procedures the driver follows, any disabilities the rider may have, and any physical or digital resources they may have. For example, some vehicles may be equipped to audibly announce each stop name as the vehicle arrives, while others may have maps posted.

3.2.5. Demand-Responsive Services within Current System

If a rider is instead accessing a demand-responsive service, it is very unlikely any ITS technology exists to assist them in service discovery, planning, booking, and paying for the service. The rider will generally need to seek out information of services in area on their own, using the agency website or calling the agency directly to learn about eligibility requirements and how to use the

service. This can be a difficult task, and often falls on folks who are members of underserved communities who may have an especially hard time sorting through large amounts of information.

In most current systems, riders access demand-responsive services by calling ahead to verify their eligibility and book a ride in advance. Riders may get a confirmation call, text, or email about their upcoming trip closer to pickup time. Generally, pickup times are often given as a window of time instead of a specific time. When the vehicle arrives, the rider is assisted as needed or as the specific service allows in boarding. The rider provides payment, and the rider is transported to their destination.

3.2.6. Non-rider users of GTFS data

Standardized data can often fulfill multiple purposes beyond its primary use case. The transit information GTFS and its extensions describe is no exception, as it is valuable to many non-rider users such as DOT regulators/analysts, rider advocacy organizations, technology vendors, employers and other destinations, and operators themselves. Unfortunately, that information is either locked behind applications not designed for their user needs (like trip planners), or in another system that is not easy to find or use. There do exist open repositories for data within the region, but these resources are by no means standardized or coordinated. Furthermore, these repositories usually only contain the raw GTFS files of a given transit service which are only useful to industry specialists who are GTFS-fluent. Projects like ODOT's Transit Network Explorer Tool (TNExT), which enables high-level transit service analysis at the state level, have shown the value of developing GTFS-based applications that make that data more approachable for use cases beyond trip planning.[2] Other extensions like GTFS-ride, which can describe ridership data for regulators and operators, can also serve non-rider use cases. These examples are significant milestones, but exceptions to the rule of limited transit data access and additional efforts are needed to truly change the transit data ecosystem at scale.

Another area that lacks adequate standardization and regional coordination is specifically on the operator side of demand-responsive services. Currently, agencies are unable to pool trips easily because of the different scheduling methods riders use. Additionally, there is no standardization around brokerages, a common aspect of demand-responsive transportation, particularly with social services that connect their customers to transportation services like NEMT. Brokerages are organizations who help demand-responsive transit agencies coordinate, share, and exchange trips and riders in order to help those agencies reduce costs and serve additional riders. Brokerages are sometimes a functionality of agencies themselves, sometimes a shared functionality of multiple agencies, and sometimes a separate organization, which often uses software to manage the data involved in supporting agencies.

2 See a description of how GTFS is used within ODOT transit planning through the TNExT application here: https://trilliumtransit.com/2021/02/18/an-interview-with-matthew-barnes-and-sarah-hackett-how-odot-uses-gtfs-data-for-planning-analysis/

3.3. Current System Stakeholders

The following entities are included within the Diagram of the Current System (Figure 2) as stakeholders in the operation, usage, and maintenance of the current system:

Table 1: Current System Stakeholder Descriptions and Roles

Stakeholder	Description	Role in Current System
Transit Operators	Organizations responsible for the day-to-day operation of both fixed route and demand-responsive transit.	Directly organizing and providing transportation services to rider, taking part in data standard communities as interested parties
DOTs as Regulators/Analysts	State and federal organizations responsible for legislation and regulation of a certain industry. In some cases, provides funding to transit agencies/operators.	Enforcing standards in service delivery, equity, safety, etc., funding ITS development, acting as a resource for agency's procurement efforts, liaising on behalf of technology vendors and agencies, taking part in data standard communities as interested parties
Technology Vendors (B2G)	Technology vendors providing services to government entities.	Creating tools and producing data for regulators and agencies, some of which are public-facing, taking part in data standard communities as interested parties

Stakeholder	Description	Role in Current System
Technology Vendors (B2C)	Technology vendors providing services to consumers.	Creating consumer-facing tools fueled by open data, taking part in data standard communities as interested parties
Technical Non-Profits	Not for profit organizations providing services or consulting on technical issues such as data standards.	Taking part in data standard communities as interested parties or leaders/stewards
Rider Advocacy Organizations	Organizations aimed at improving transit for transit riders and advancing rider interests.	Lobbying to legislators and taking part in data standard communities as interested parties to improve the transit experience for riders, directing social programs that directly support riders
Riders	Traveler who takes public transit. Travelers utilize buses and rail service to get from their origin to their destination.	Making use of the tools available to them to make as informed transit travel decisions as possible, serving as end-users, customers/consumers, and passengers in the transit ecosystem
Social Service Agencies	Agencies that provide services with the goal of promoting the health and well-being of individuals and families.	Directing social programs that directly support riders

Stakeholder	Description	Role in Current System
Employers and other destinations	Various types of organizations, especially those with large campuses, rely on transit to support transportation for both employees and customers.	Promotion of transit and transit information systems, feedback to agencies on needed service.
Brokerage	An organization or functionality that allows the coordination, sharing, or exchanging of rides between demand-responsive transit agencies.	Increase the operational efficiency and service quality to riders through the coordination, sharing, or exchanging of trips between demand-responsive agencies.

3.4. Support Environment

The support environment for the current system is broad and diverse, including operational processes, physical infrastructure, and software, hardware and data technologies. It is also different depending on the local context of the users. Some transit agencies and riders have complex ITS infrastructures and operate in urban environments with physical infrastructure specifically built to augment that infrastructure. Other transit agencies and riders have little technology to work with other than vehicles and commercial cell phones and operate in rural environments where even the roadway infrastructure is not up to a modern standard. Additionally, fixed route services operate with an entirely different technology stack than demand responsive services, and sometimes these technologies are combined to deploy a deviated-fixed route. The current system operates within this diverse environment, but only effectively for some users, generally those more technologically advanced and in urban settings.

Typical technologies that support the current system are

- Scheduling systems: Software that operators use to generate bus schedules, which typically produces GTFS data.
- CAD/AVL systems: “Computer-aided dispatch/automatic vehicle location” refers to on-board technology that allows dispatch centers to monitor and manage their vehicle fleet in real-time.
- GPS devices: On-board signaling hardware that produces the coordinates of a vehicle

- Telephone systems: Systems, on-board or in-office, that allow riders to call in to transportation services to request pickup
- Customer service call centers: Service for riders to call in with questions about a transportation service
- WiFi devices: On-board hardware that allows operators to conduct online functions of their services like mapping, communication, and scheduling
- Cellular networks: both riders and agencies use the cellular phone and data networks to exchange information to and from the transit vehicle and other locations.
- Consumer mobile phones, smartphones, and other computers: Riders use their own mobile devices to access SMS, websites, and native applications through cell or wifi networks.
- Station/bus stop infrastructure: Built-in accommodations for riders. This could include signage displaying traveler information
- Fare kiosks and vending machines: Stations where riders can pay for their bus fare. These may accept cash, card, contactless payment, or any combination of these methods.
- Agency websites/online documentation: Often a main informational source for fixed-route schedules
- Data validators: Programs that evaluate GTFS data for accuracy/correctness
- Transit data analysis tools: GTFS-based software that enables regulators to conduct various high-level analysis tasks of a transit network
- Online trip planning applications: Online tools in which a user can input an origin-destination pair, as well as a few other trip parameters, and return potential transit trip itineraries
- Online map interfaces: Manipulatable map display on which trip directions are overlaid in many trip planning apps.

3.5. Modes of Operation for Current System

The following table describes the different modes in which an agency operates under the current system and the outcomes under those modes. Three modes of operation are included: normal, degraded, and failure. While each case describes a different condition level and some agencies operate at normal operations sometimes, the system is degraded or failing in most places at most times by virtue of being incomplete. No consistent processes or policies are in place to remedy this situation at present due to the complexity of the system failures and number of different stakeholders involved.

Table 2: Modes of Operation Descriptions and Outcomes

Mode of Operation	Description	Outcome
Normal	The transit agency's ground-truth service has representative data used in online trip planning and other transit information tools. This representative data is up to date, accurate, and complete and is accessible to all parties that need it, whether that be regulators, developers, trip planner end users, or the agency themselves.	Riders are able to rely on accurate online information about fixed-route transit services and travel accordingly. Agencies and regulators are able to conduct analysis with good data. Rider applications are able to deliver a reliable service to their end users. The information provided to users is generally all of the information needed for a user who is familiar with the general operations of fixed-route transit and mobile applications, although does not include some specific information that may be important for some riders with disabilities.
Degraded	The transit agency has data representing service, but it is out of date, inaccurate, or incomplete. Online transit information tools therefore paint an incomplete picture of the agency's services and in some cases may contradict ground-truth (for example, a stop's location or arrival times may not match). Representative data may not be fully accessible to all parties that need it and is likely not publicly available.	Riders have access to online information regarding fixed-route services, but it may not be as helpful as it should, and in some cases, mislead them as they make travel decisions. Agencies and regulators can conduct analysis with the data, but only in broad strokes, as more granular data is less reliable. Rider applications can consume transit data but would need to mitigate the promotion of unreliable data, and therefore may not publish it.

Mode of Operation	Description	Outcome
Failure	The transit agency operates without any representative data for online transit information tools.	Riders have no access to standardized online information, so they must manage to make sense of physical and online materials to discover and plan transit trips. Agencies and regulators do not have access to schedule and service data that is clearly defined and organized in a way that makes it easy to conduct analysis. Rider applications cannot publish the agency's services, reducing their utility to end users.

3.6. Operational Policies and Constraints

The major operational constraints on the current system are lack of resources and lack of consistent information and regulation. Many agencies are offering demand-responsive services, but do not have the money, staff, or knowledge to ensure information about these services is effectively made available.

Smaller agencies, especially in rural areas, do not have the same funding that more urban agencies possess. This inequity in financial resources means that rural agencies often do not have the funds to hire someone to maintain their website, create and maintain GTFS data, effectively market their services, or consistently respond to rider questions. Rural areas are also more likely to have slow or inconsistent internet and phone services, which can make the creation and maintenance of online tools challenging and difficult for riders to access.

In addition to the lack of financial resources, there is a lack of clear and consistent information on best practices surrounding how a transit agency displays schedule information and implements service change schedules. For example, one agency may only update their schedules once every few years while another may make small, incremental changes to arrival times every two weeks. Neither extreme serves riders well. This makes it difficult to ensure that data from multiple agencies of different sizes and regions have the same quality and consistency of information and that that information translates into cohesive, publicly available data. Because demand-responsive services and rural use cases are rarely or never considered in the development of rider applications, agencies operating this type of service are further disincentivized from investing in trip planning and other customer information technology.

This inconsistency also makes it difficult for riders to effectively plan trips across multiple agencies. Although GTFS data makes it possible for third party applications to show transit data for multiple agencies, if some agencies do not have the resources to create and maintain GTFS

data, gaps will be present in the representative data of a given region. Without consistent and complete data, riders cannot get an accurate understanding of the services available to them.

The approach proposed in this ConOps would put into effect a system that would provide information to customers regarding a large number of operational policies and constraints of the transit network. However, the diversity of transit network operational policies and constraints of the system that makes it unfeasible to describe such policies and constraints here. There are some standardized policies that are mandated by the ADA or other laws. For example, the requirement that complementary paratransit service be provided within an hour of the requested travel time, or within a three-quarter mile of a fixed-route. However, these policies are often not only met but exceeded by transit agencies. Therefore, the particularities of these policies must be considered on a local level rather than generally, and be integrated into service information.

4. Justification for and Nature of Changes

The current system does not meet the needs of user groups identified in this project. This section describes these shortcomings in the current system and the impacts on certain user groups. It details the User Needs that need to be addressed and proposed changes, as well as User Needs that were considered but ultimately will not be addressed in this project.

4.1. Justification of Changes

The current system focuses primarily on fixed-route transit services, whereas most of the over 500 transit operators and other mobility providers in California, Oregon, and Washington deliver a form of demand-responsive service. Rider characteristics of these services differ substantially from those on fixed-route services as more likely to be low-income, transit-dependent, with a physically or mental disability that prevents them from using fixed-route services, and/or are living in a physically isolated/rural environment. The demand-response systems themselves offer a lower quality of rider information, where would-be passengers must first find a transit provider that will serve their needs, call a dispatch system to plan and reserve their trip, requiring a long lead time (often at least a day in advance), and allowing little room for flexibility. The trip planning experience of demand-response systems is further and uniquely burdened by a complex web of qualifications and requirements that prevent efficient use of this information. These include determining operator coverage area, determining age or disability qualifications for this operator or for a specific service within the operator's service menu, if the operator has availability, if they need to pay and how. Because these demand-responsive services are used primarily by members of the identified underserved groups, these deficiencies are disproportionately impacting these riders.

Unlike fixed route services, which have a well-established data standard and a stable industry of third-party trip planning services, demand-responsive transit lacks the technical solutions that could ease these burdens for their riders. There is no comparable desktop or smartphone experience and no other innovations that exist to untangle these webs of availability, reservations, or payments. This significant disparity denies users a simple, digital user interface to plan for demand responsive trips. Most fixed route users in the three-state region have access to real-time information about transit services through any mobile device. Very few users have such information about public demand-responsive transit, and when they do, it is through custom proprietary systems implemented at a few local agencies.

Further, fixed-route transit rider information has developed quickly in the last 15 years in a fashion that has focused investment on riders with smartphones in urbanized areas. GTFS data, which is the most common transit schedule exchange data format, does not require the inclusion of accessibility information that ensures riders with vision, mobility, hearing, and cognitive disabilities can access the transit service information. The specification and its best practices are primarily designed around urban fixed-route transit in a single language. This information divide produces mobility challenges to each of the identified underserved groups.

Specific deficiencies within the system regarding transit data, trip planning application functionality/accessibility, and the political system as a whole are identified below.

Transit data deficiencies

- Information about vehicle capacity to accommodate riders with mobility needs
- Information on rural routes and lack of web available information on rural routes because of inadequate agency funding. Rural services are more often demand-responsive or deviated-fixed routes, which are not covered by current transit rider apps.
- Metadata and cosmetic information (such as route shapes). Alternatively, existing data includes overly verbose data that prevent the easy understanding of transit service options.
- Complete and coherent representation of fare information. This is particularly important for demand-responsive transportation services that often have complex, multilateral fare, payment, and funding systems. This prevents low-income riders from budgeting effectively for their transportation.

Trip planning deficiencies

- Interfaces, including smartphone and web apps, are not designed with users in mind who either have limited dexterity, limited English proficiency, or overall limited experience in the form factor. Interfaces in general rely on written or spoken communication without quality visual information design or consideration for users with vision disabilities.
- Many abbreviations or other text within trip planner UIs cannot be read aloud. Text in this form is difficult to deliver by annunciation software like TTS.
- Information that includes clear pathway directions for ambulatory and mobility device users, informational signage at bus stops, and that displays accessible routes to and from the bus stop is not typically provided.

Market deficiencies

- Wealthier agencies can purchase more complex technical systems.
- Low-income workers with multiple jobs, childcare, without time or skills to embark on transit research projects have less time to invest in finding and learning about transit technology tools.

Justification for a new system

These deficiencies exist because the current system's market is framed around an unregulated economic transaction between operators and fixed route scheduling software vendors. These vendors create data that is then provided to third party public apps. This transfer of data is opaque to many operators who lack guidance on best practices or direct communication with end users of the mobile applications. As a result, the agencies do not have a consistent feedback loop or connection with the riders they serve. Technology is focused on the simplest rider needs and accessibility and demand-responsive transit are overlooked.

Changes need to be made to provide services fairly (to users of all abilities in all geographies) in a manner that does not disadvantage members of the specified underserved communities. At a minimum, the system needs updates to ensure that transit operators regularly publish all information that is important to riders interviewed by this project, but the goal of these changes is to ensure that *everyone* is able to access transit easily and effectively. Because the system is dispersed across so many different stakeholders and organizations, involving numerous technologies, vendors, operators, or different types in different local contexts, the proposed system must be capable of being applied locally by those different stakeholders.

4.2. Description of Desired Changes

The new system proposes changes to the current system, building on the work already done in online trip planning development. It does not replace a system, but rather adds new functionalities and improves the whole trip planning experience for all users. The desired changes aim to address the following user needs—in Section 4.2.1—in accessible trip planning, booking, and payment.

4.2.1. User Needs Breakdown

The following table lists the User Needs identified in this project, organized by User Need ID and priority (1: Essential Needs; 2: Desirable Needs; 3: Optional Needs).

User Need IDs reflect the user group which has the specified need, and whether the need has a parent need. The user group is identified by an abbreviation that follows the abbreviations in the User Groups with User Needs table below. A need which has two numerical identifiers separated with a dash (e.g. “RID-01-2 - Book in third party app”) indicates that the need is a child need to the parent need which shares the first numerical identifier (e.g. “RID-01 - Discover DR”).

Description of justifications of the priorities are as follows.

- **Essential Needs (priority = 1)** shall by provided by the new system. These needs were deemed by project partners to meet the following criteria: they are critical to the success of the project goal, which is to support the needs of the identified underserved groups within the transit information system; and the project team has the skills, capacity, and resources to put into effect a system which is very likely to successfully meet the need.
- **Desirable Needs (priority = 2)** should be provided by the new system. These needs were deemed by project partners to either not be critical to the success of the project goal even if they were very important to that success, or the project team might likely attempt to put them into effect but fail to do so.
- **Optional needs (priority = 3)** might be provided by the new system. These needs were deemed by project partners to be important but not critical to the success of the project goal, that the project team might likely attempt to put them into effect but fail to do so, or were deemed only modestly important to the success of the project.

Additional information contained in the table identifies which user groups the needs relate to.

User Groups Relating to User Needs

User Group	Abbreviation	Short Description
Transit Operators	OP	Organizations responsible for the day-to-day operation of both fixed route and demand-responsive public transit.

User Group	Abbreviation	Short Description
Local, State, and Federal regulators	REG	State and federal organizations responsible for legislation and regulation of a certain industry.
Business-to-Government Technology Vendors (B2G)	B2G	Technology vendors providing services to government entities. Specifically, vendors providing scheduling applications to transit agencies.
Business-to-Consumer Technology Vendors (B2C)	B2C	Technology vendors providing services to consumers. Specifically, vendors providing freemium or ad-based transit trip planning applications direct to consumers.
Riders/Public Transit Users	RID	Traveler who takes public transit. Travelers utilize buses and rail service to get from their origin to their destination.

Rider User Subgroups

Abbreviation	Rider User Subgroup
VT	Veteran riders
RT	Rural riders
DM	Riders with mobility disabilities
DV	Riders with vision disabilities
DH	Riders with hearing disabilities
DD	Riders with intellectual and developmental disabilities
OA	Older adult riders
LI	Low income riders
SI	Riders with other safety concerns (e.g. women, riders of color, riders with children, recently incarcerated riders)
LEP	Riders with limited English proficiency

Table 3: User Needs List - Rider Needs

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-01 - Discover DR	1	The rider needs to discover and book demand responsive trips within online/mobile trip planners so that these services are as easily accessed as fixed-route services.		X	X	X	X	X	X			
RID-01-1 - Book in advance	1	The rider needs to know how long in advance they must book the demand-responsive trip so they can plan accordingly and not miss the deadline.		X	X	X	X	X	X	X		
RID-01-3 - DR travel time	1	The rider needs to know the expected travel time for a demand-responsive trip so that they can ensure they will arrive at their destination on time.		X	X	X	X	X	X			

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-01-4 - DR wait time	1	The rider needs to know the expected wait time for a demand-responsive trip so that they can ensure they will be available at the pick up time and will make it to their destination on time.			X	X	X	X	X			
RID-01-5 - DR delay	2	The rider needs to know whether a delay in a demand-responsive service is expected, or a result of the service/ride being cancelled, so that they can decide between either waiting for the delayed vehicle or planning a new trip.			X			X				
RID-01-6 - DR origin and destination	3	The rider needs to confirm that the correct origin and destination has been acknowledged by the demand-responsive service so that they can correct any errors and know that they will be picked up and dropped off at the correct locations.		X	X	X	X	X	X		X	

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-01-7 - Book quickly	3	The rider needs to avoid long times for scheduling and confirmation, so that trips are easy to plan and do not unduly interfere with the rest of their day.		X	X			X	X			
RID-02 - Various trips	1	The rider needs to discover various plausible trips (i.e., which routes or services) which meet their needs when multiple trips are possible, regardless of the transit mode of trip or geography, so that they can pick the trip that best suits their individual needs.		X								
RID-03 - Eligibility process	1	The rider needs to know about any eligibility process they must go through in order to use the service, how to go through that process, and whether that process must be validated before use of service so that they can effectively access that service without rejection or undue delay.	X		X	X	X	X	X	X		

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-04 - Hear text annunciation	1	The rider needs to hear via text annunciation all information necessary to the trip planning and wayfinding experience without any text being garbled or incoherent so that riders with vision disabilities can get the information they need for their trips and all riders understand audio announcements.				X		X			X	X
RID-04-1 - Audio option	1	The rider needs to have access to any alerts, wayfinding directions, or service regulations posted on visible signs at stations, stops, or on board vehicles, through audio annunciation, so that riders with vision disabilities can get the information they need for their trips and all riders with proficiency in announced languages can understand audio announcements.				X					X	
RID-13 - App guidance	1	The rider needs to be able to use the trip planning system with minimal guidance or be provided with adequate guidance so they can travel with independence.						X	X	X		

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-13-1 - No experience necessary	2	The rider needs to be provided with an interface which does not require experience with similar interfaces to operate to ensure all riders, regardless of their level of technical knowledge, can use trip planning tools.						X	X	X		
RID-14 - Cost of service	1	The rider needs to be informed of the cost of the service, whether the service is free, and whether there are ways to reduce the cost of the trip and how to access those price reductions, so that the rider can spend their money effectively and know if price is going to be a barrier to accessing the service.								X		
RID-14-1 - Standard payment media	1	The rider needs to pay fares including reduced fares using a payment media that they have routine access to rather than need a special form of payment media so that they are able to understand and feel comfortable with the payment method and are only required to learn as few new systems as possible.		X						X	X	X

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-14-2 - Cost for party	3	The rider needs to know the cost and if the cost differs based on the number of people in their party, and who the other people in their party are (e.g. caregiver as opposed to friend or child) so that they can ensure the trip is affordable and have the required payment available.			X	X	X	X	X	X	X	
RID-15 - Customer service	1	The rider needs to be able to contact customer service to ask questions via both audio and text so any questions about how to use the system can be addressed.						X		X	X	
RID-16 - Communicate with driver	2	The rider needs to be able to communicate through text, audio, and visual formats at the time of trip to the driver so that they are given timely information about the rider's needs directly. This ensures the least amount of steps in the way of rider-operator information "hand-off."			X			X			X	

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-16-1 - Communicate without voice	3	The rider needs to be able to communicate to other riders and the driver if they're not able to communicate with them through voice so that they can ask questions and get to the right location.					X	X				
RID-17 - No internet	1	The rider needs information presented in ways that do not require internet or a smartphone device so that they can access their trip without these devices or if their internet service is unavailable.		X						X		
RID-17-1 - Real-time through SMS	2	The rider needs to be able to access real-time and other information through text message so that they do not have to be connected to the internet to get updates.		X				X		X	X	
RID-17-2 - Limited internet	2	The rider needs the app to (partially) function even when there is limited or no internet access so that they do not have to rely on a stable connection when making time-sensitive trip decisions.		X						X	X	

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-18 - Safety features	2	The rider needs to know about safety features and amenities available during their trip such as lights and shelters so that they can plan for a trip on which they feel both safe and comfortable		X	X	X	X	X	X		X	
RID-18-1 - Safety at waiting area	2	The rider needs to know the safety amenities at the waiting location so that they can evaluate the amenities and plan a safe trip.		X	X	X	X	X	X		X	
RID-18-2 - Station patrol	3	The rider needs to know whether security guards or officers routinely patrol the stop or station area, and if those officers are armed, so that riders can plan for their personal safety.						X		X	X	
RID-18-3 - Stops along route	3	The rider needs to know all the stops along the route so they can see what features and amenities they can or can't access at intermediate stops in order to plan for charging equipment, using the restroom, or other errands, especially at night or if the rider has a vision or mobility disability.		X						X	X	

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-18-4 - Safety at intermediate points	3	The rider needs to know the safety amenities at intermediate points along their trip so that they are safe during the entirety of their trip.			X				X		X	
RID-18-5 - Restroom locations	3	The rider needs to be shown the locations of public restrooms along the route, and know if the restrooms are gendered, multi or single-occupancy, accessible, and have baby-changing stations so that they can safely use the restroom when needed.							X	X	X	
RID-19 - Device accessible	1	The rider needs to be able to know whether each part of their trip is accessible to mobility devices and bikes so they can plan for a safe and multimodal trip.			X				X		X	

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-19-1 - Space for mobility device	1	The rider needs to tell whether there is space onboard the vehicle for their mobility device and other equipment or items they intend to bring along on their trip, and any device or luggage limits they might need to stay within, so that they know the trip they plan for ahead of time is a trip they can complete.			X				X		X	
RID-19-2 - Pathways in advance	1	The rider needs to understand the pathways they will use to get to their boarding location, between transfer points, and to their destination including possible barriers in reaching those pathways so that they can confirm the entire trip is accessible, bring the right mobility equipment if applicable, and approach stops from the appropriate pathway.			X	X					X	

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-19-3 - Loading mobility device	2	The rider needs to know whether they will be able to get their mobility device and belongings into the vehicle (as opposed to whether this equipment will fit once onboard the vehicle) so that they know the trip they plan for ahead of time is a trip they can complete.			X				X		X	
RID-19-4 - Space for mobility device real-time	2	The rider needs to know whether the spaces for mobility devices on a vehicle are already occupied, and, if so, what the wait for the next vehicle is so they can plan their travel accordingly.			X							
RID-19-5 - Bikes on board	3	The rider or group of riders needs to know whether they can bring their bike or bikes onboard the vehicle so they can plan for multimodal trips.								X	X	
RID-19-6 - Bikes on board real-time	3	The rider needs to know whether bike stowage is available onboard the vehicle at the time of the trip so they can plan for any changes affecting their multimodal travel.								X	X	

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-19-7 - Mobility device charging	3	The rider needs to know whether there is a port for mobility device charging onboard the vehicle or at the transit stop so that they can plan accordingly and have enough power to reach their destination.			X							
RID-19-8 - Bike parking	3	The rider needs to be aware whether and where bike parking is available near the transit stop so they can plan for multimodal trips.								X	X	
RID-19-9 - Trust pathway validation	3	The rider needs to trust the validation of pathway accessibility so they can plan with confidence, knowing that what they encounter on the ground is the same as what they see ahead of time.			X							
RID-20 - Diversity of interfaces	2	The rider needs to be able to give and receive information in a variety of ways so that riders of all backgrounds, abilities, and preferences can give and receive the information necessary to plan and take a successful trip.				X	X	X			X	X

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-20-1 - Preferred language	1	The rider needs to access any written text in their preferred language so transit information is communicated to everyone, regardless of their primary language.									X	X
RID-20-2 - Plain language	1	The rider needs to be provided visual and audio information which uses plain language where words are necessary so that information is accessible regardless of English proficiency.						X			X	X
RID-20-3 - Visual or text	1	The rider needs to have access to all information presented to riders in a visual or text media so that riders with hearing disabilities are able to access the information they need.					X	X			X	X
RID-21 - Talk to app	2	The rider needs to be able to talk to the phone/app to make a request for a ride through a conversational format so that services can be accessed without the dexterity/technical expertise needed to operate a smartphone app manually.				X		X	X			

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-22 - Veteran info	2	The rider needs to have access to information about services or prices geared specifically towards veterans within online and mobile trip planners so they can discover transportation services intended for a specific user population.	X									
RID-23 - Present location	2	The rider needs to know their present location along the route in audio and visual formats so they know when they are approaching their stop, can communicate with others (such as the driver), and know where they are if they need to deboard earlier than planned.				X	X	X				
RID-24 - Various notifications	2	The rider needs to be able to assign pick up and drop off notifications to different individuals, such as a caregiver, so that other people can confirm the trip has been successfully completed.						X	X			

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-25 - Safety feature hours	2	The rider needs to know the availability of businesses, buildings, services, and landmarks, and the hours of operation of these features, near waiting locations so they can plan their trip according to their needs outside of transportation.		X	X			X	X		X	
RID-26 - Know about TDD	2	The rider needs to know that Telecommunications Device for the Deaf (TDD) is an option available to them for customer service, because a rider with a hearing disability is more likely to access the service if they know it is TDD-compatible.					X					
RID-27 - Confidence in info	2	The rider needs to have confidence that the information provided is correct so that they can effectively and safely plan their trip.		X	X	X	X	X	X	X	X	

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-28 - Limit words	2	The rider needs to be provided trip planning data in a simple format that does not rely on more words than necessary or a cluttered interface which contains excessive information so that information can be found quickly and does not require a high level of English proficiency.						X			X	X
RID-29 - Info before arrival	2	The rider needs to have access to information about wayfinding signs, landmarks, and vehicle prior to arrival at the station or pick-up/drop off location so that they can look out for those features.					X	X			X	X
RID-30 - Consistent experience	2	The rider needs a consistent and predictable experience when seeking online/mobile information so that they do not need to learn a new system frequently, ensuring easier access for people with developmental disabilities or other accessibility needs.			X	X		X	X			

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-31 - Adjust preferences	2	The rider needs to be able to change their preferences for mobility equipment and baggage access needs, depending on what device they are using or what they are bringing with them, and be able to change those preferences easily while searching trips so they can choose the best trip for their specific needs.			X						X	
RID-32 - Exact stop locations	2	The rider needs very precise and accurate stop locations presented to them visually to ensure they know where to board/alight.					X	X		X	X	
RID-33 - Confirm vehicle	2	The rider needs to be able to confirm that the vehicle they are boarding is the right vehicle to serve their desired trip, so that they can avoid accidentally boarding the wrong vehicle.				X	X	X				

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-34 - Elevators in service	2	The rider needs to know whether lifts, elevators, and other automated equipment along their pathways or onboard vehicles are in operation in real time, so that they know if their trip is actually accessible at time of their trip.			X							
RID-35 - Right stop	3	The rider needs to be sure they are boarding or alighting at the right stop without seeing the area so they can complete their trip, regardless of any vision disability or time of day.				X		X				
RID-36 - Way back home	3	The rider needs to be sure they won't be caught at their destination without a way back home so they don't get stranded and can maintain their safety during their trip.		X	X	X	X	X	X	X	X	X

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-37 - Various options	3	The rider needs to be presented with a wide variety of options to accomplish their goals when they have few restrictions on their travel (ie, walking more or less, using a bike or not using a bike, etc.) so that they are offered a degree of flexibility when trip planning.									X	
RID-38 - Expect crowding	3	The rider needs to know if transit waiting zones or vehicles will likely be crowded to evaluate the safety/convenience of a given trip.			X			X			X	
RID-39 - Aware of apps	3	The rider needs to be aware of the available rider applications and their features so they can make informed choices as a consumer of software.	X	X	X	X	X	X	X	X	X	X
RID-40 - Schedule changes	3	The operator needs to inform riders regarding changes in planned schedules through a variety of media such as push notifications, SMS, or phone calls, so that all riders are aware of changes even if they don't use rider apps.						X				

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-41 - Assistive tech awareness	3	The rider needs to be aware of assistive technology applications or other services, so that they can use those applications regardless of vision, hearing, dexterity or other disabilities.			X			X	X			
RID-42 - Navigation directions	3	The rider needs to receive navigation directions in a way that doesn't presuppose they can determine which cardinal direction they are headed in, so the necessary steps to complete the trip are easily understood.				X		X				
RID-43 - Service animal	3	The rider needs to confirm that their service animal will have space on board the demand-response vehicle, so that they are able to travel with their service animal.				X		X				

Need ID	Priority	Need	RID VT	RID RT	RID DAM	RID DAV	RID DAH	RID DAD	RID DAO	RID LI	RID SI	RID LEP
RID-44 - Operator feedback	3	The rider needs to be able to provide feedback to the operator regarding the trip, such as quality of amenities, service, or driver interactions, so that preferences and knowledge of riders can be used to improve service and information about service.	X	X	X	X	X	X	X	X	X	X
RID-45 - Communicate without text	3	The rider needs to be able to communicate needs to the service without typing text or needing to spell words correctly so that typing errors, or the ability to type overall, do not impede the correctness of trip decisions, eligibility status, or level of accommodations provided.			X	X		X	X			

Table 4: User Needs List – Non-Rider Needs

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
APP-01 - Connection with customer	2	The rider application vendor needs to maintain a direct connection with their customer, the public transit rider, especially if there is a payment integration in that application, to receive feedback from the user and correct any critical issues identified by the user such as an improper charge.		X			
APP-02 - Accessibility guidance	2	The rider application vendor needs to have clear guidance on the design of an interface that is WCAG 3.0 compliant (or the applicable current standard) and which is accessible to the use of a range of assistive technologies in common use or planned to be in common use, so they can implement a user interface which meets the needs of all users.		X			

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
APP-03 - Precise user location	3	The rider application vendor needs access to the precise, real-time position and direction of the rider relative to the stop, in order to satisfy the rider needs for boarding and alighting at the correct stop.		X			
B2G-01 - Identify customers	2	The software vendor needs to identify which agencies within a region are potential customers for their services so that they can sell their services and maintain their business.			X		
B2G-02 – Assess quality	3	The software vendor needs to assess whether the agencies using their software meet data quality regulations to maintain good standing with industry partners consuming that data.			X		
MUL-01 – See full network	1	All users need to see list and map interfaces of agencies, routes, stops, and transit connections within a region to fully understand and access the transit network.	X	X	X	X	X

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
MUL-02 – Clear governance	1	The operator, regulator, software vendor, and rider application vendor need a specification and governance process that is not overly convoluted or verbose, so each can participate and feel that their needs are being heard and demonstrate the value of that process to the public.		X	X	X	X
MUL-03 – Contact information	1	All users need to be able to find contact information for various functionalities at each agency so that they can ask questions and get any other information they need.	X	X	X	X	X
MUL-04 – Two-way exchange in booking	2	The software vendor and rider application vendor need to have a method of realtime, two-way exchange between their respective systems in order to facilitate the scheduling of realistic trips which suit rider needs.		X	X		

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
MUL-05 – Real-time vehicle auditing	3	The operator and regulator need to be able to identify the location of vehicle assets in real-time to get a full picture of the transportation network in operation and confirm that service has been provided as expected.				X	X
MUL-06 – Alignment on needs	3	The operator and software vendor need to have the ability to communicate clearly about each other's needs and capacities, and be able to price services reasonably so that each party is engaged in a mutually beneficial partnership, and that that partnership can be sustained productively long term.			X	X	

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
MUL-07 – Map data	3	The operator, regulator, software vendor, and rider application vendor each need to have access to a high quality map data set with reasonably similar accuracy in order to allow them to place attributes such as stop amenities relative to the map and know the presence and status of sidewalks, curb cuts, and other accessibility features along pedestrian rights of way.		X	X	X	X
OP-01 – Integrated trip planning	1	The operator needs to provide trip planning that is integrated with other regional systems so that riders can see complete information when planning trips.				X	
OP-02 – Booking through rider apps	1	The operator needs to provide booking of trips through publicly available rider apps.				X	

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
OP-02-1 – Time of booking	1	The operator needs to define when demand-responsive trips can be booked within third-party applications and promote those requirements so riders are able to successfully book trips.				X	
OP-03 – Tech sophistication not required	1	The operator needs to be able to publish high quality data for publication in trip planning and other applications regardless of the technical sophistication and level of financial resources of the transit system so that all riders have equal access to trip planning services.				X	
OP-04 – Phone reservations	1	The operator needs to keep accepting phone reservations so that riders who cannot effectively use internet or mobile applications can access services.				X	

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
OP-05 – Changes to road network	2	The operator needs to manage the impacts of changes to the road and pedestrian network such as construction or the effects of weather on infrastructure so they can adjust their service with as minimal disruption as possible.				X	
OP-06 – Serve requests precisely	2	The operator needs to be able to serve rider requests for pickup and drop off time as closely as possible, and within the hour-window mandate of the ADA to be ADA compliant, but also to provide transportation services with competitive pickup/drop-off punctuality.				X	
OP-07 – Integrated fare payment	2	The operator needs to provide trip planning that is integrated with fare payment so that riders can easily pay for their trips without needing to have the correct payment method at the stop or on the vehicle.				X	

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
OP-08 – Different types of trips	2	The operator needs to schedule many different types of trips with the same vehicles, including trips for riders with a disability, the general public, and groups, so they can optimize service productivity and provide needed service features to riders.				X	
OP-09 – Transfer trips	2	The operator needs to transfer trips from one scheduling system to another when multiple scheduling systems are used by different subcontractors or different agencies so that scheduling information is always accurate for riders regardless of how they are accessing the information.				X	
OP-10 – Assess data quality	2	The operator needs to assess whether they are meeting data publication requirements (which will be published by the SCC) or what steps should be taken to meet those requirements so that they don't encounter regulatory issues and know that they are providing high quality information to riders.				X	

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
OP-11 – Procure software	2	The operator needs to find and procure software systems which provide for its needs so they have the best available information when deciding which tools are best for their specific case.				X	
OP-12 – Precise stop locations	2	The operator needs to provide precise stop locations through open datasets so that rider applications can help riders locate themselves relative to those stops and follow wayfinding directions.				X	
OP-13 – Notify riders of delay	2	The operator needs to notify riders of a delay in demand responsive service or of the updated time of arrival, so that the rider can know the current status of their trip and be prepared to ride.				X	
OP-14 – Caregivers and other rider DR partners	3	The operator needs to schedule trips for riders who may have other passengers along with them, such as kids or caregivers, so that the service is prepared to accommodate those travelers.				X	

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
OP-15 – Service animals	3	The operator needs to schedule trips for riders who have service animals and confirm to that there is space available for that service animal so the rider knows they will be able to travel safely.				X	
OP-16 – Communicate pathway quality	3	The operator needs to communicate to riders the completeness and quality of pathway accessibility information or information regarding the process by which that information has been validated, so that riders can trust information provided regarding pathway accessibility.				X	
OP-17 – Rider feedback	3	The operator needs to receive feedback from riders regarding their perception of trip safety so that they can adjust services as appropriate to provide safe experiences for all riders.				X	

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
REG-01 - Assess compliance	2	The regulator needs to assess whether agencies are complying with regulations regarding data quality so they can foster accurate and consistent information across an entire region.					X
REG-02 - Anonymized DR trips	3	The regulator needs to be able to archive and analyze historical (anonymized) trips to evaluate equity and transportation planning and policy decisions.					X
REG-03 - Review ridership	3	The regulator needs to be able to review ridership by stop, route, and agency so they can evaluate equity of service and make informed transportation planning and policy decisions.					X
REG-04 - Administrative contact	3	The regulator needs to be able to identify the administrative agency responsible for service so that they can make contact about issues or audits.					X

Need ID	Priority	Need	RID	B2C	B2G	OP	REG
REG-05 - Vehicle location auditing	3	The regulator needs to identify where vehicle assets are located by region and whether those vehicles are in a state of good repair to make informed funding allocation decisions.					

4.3. Changes Considered but not Included

Some of the needs considered will not be included with this project. Factors that contributed to the decision to remove user needs from the final list focused on similar criteria to determining priority. Needs that were not included were ones that were outside of the scope of the project or were determined to have very little possible impact on the identified underserved user groups. The following user needs were considered but not included in the project:

Table 5: Removed Needs with Justification

Need ID	Need	Removal Justification
23	The rider needs be able to access road condition information for the roads on which transit will operate, especially where transit is forced to use one particular highway so that they can know about potential delays or cancellations.	This information may be useful to some riders but may reflect a degraded state of realtime information being provided by the operator, cannot be directly implemented by the project, and is not likely to be specifically important to a underserved group being targeted.
28	The rider needs to be able to confirm that the vehicle and boarding process is accessible to them personally through discussion with an operator or very specific and dependable information about what accessibility means so there is a clear understanding of whether they will be able to use the service in that specific instance.	The focus of this need is the use of human validation for the specific context of the accessibility features of the planned trip. This need may be partially covered simply by having contact information for the agency, which is covered in needs 62 and 114. If it is not covered by those needs it is not likely to be improved by this project.
36	The rider needs an interface that is focused specifically on the transit information they need, rather than an interface cluttered with other non-transit information so that they can quickly access the information they need, especially for riders using screen readers.	While this is often a useful feature for some users in the current environment, it is a feature generally controlled by private app developers unrelated to the data provided to them, making it difficult to resolve through this project. Additionally there are many valid reasons why an app developer may not choose to fulfill this user need and effective approaches they can take to minimize the impacts of not fulfilling this user need.

Need ID	Need	Removal Justification
38	The rider needs a driver who is knowledgeable in the operation of accessibility equipment and patient in communication so that they can ask for and receive help when needed.	This project is not likely to be able to effect driver training, which is the likely feasible solution to this user need. While it might feasibly be useful to indicate that the driver is untrained, because that is an undesirable trip characteristic, resources should be focused on training.
54	The rider needs clear visuals utilizing elements such as colored or bolded lines that help them clearly depict the expected travel plan so that riders can understand signs regardless of their English proficiency .	While this is often a useful feature for some users in the current environment, it is a feature generally controlled by private app developers unrelated to the data provided to them, making it difficult to resolve through this project. Additionally there are many valid reasons why an app developer may not choose to fulfill this user need and effective approaches they can take to minimize the impacts of not fulfilling this user need.
64	The rider needs to be able to turn on a 'night mode' with a darker profile so visual information is legible regardless of time of day/location of the rider.	While this is often a useful feature for some users in the current environment, it is a feature generally controlled by private app developers unrelated to the data provided to them which makes it difficult to resolve through this project. Additionally, there are many valid reasons why an app developer may not choose to fulfill this user need and effective approaches they can take to minimize the impacts of not fulfilling this user need.
66	The rider needs to be able to trust staff and other riders to de-escalate dangerous situations so that riders can rely on having a safe trip.	This project is not likely to be able to effect driver training, which is the likely feasible solution to this user need. While it might feasibly be useful to indicate that the driver is untrained, because that's an undesirable trip characteristic, resources should be focused on training.
69	The rider needs to know how to avoid areas that are dark, or areas where they may be alone so that they can plan for their safety.	This need is provided for to the degree possible through information about the safety amenities at stops accounted for in other user needs.

Need ID	Need	Removal Justification
71	The rider needs to be aware of new features and capabilities without having to use each app, read news articles, or have friends in the industry so that new developments in online trip planning actually impact users who will benefit from them the most.	It is unlikely that the project will be able to notify riders of new features within applications in any organized fashion. Need 24 related to awareness of the interface is a more practical focus of the project efforts.
76	The operator needs to manage the perceptions of different riders towards one another (e.g. may have riders who request to not ride with another rider who they perceive to have poor hygiene) so that riders can all have safe access to services without facing discrimination.	Rider perceptions towards other riders are likely to be discriminatory, and should not be promoted by operators or the project. Sorting out the few cases where this need is reasonable and non-discriminatory is not plausible.
78	The operator needs to allow staff members to maintain control over how they do their jobs while implementing new technologies so that such developments do not disrupt or impede the day-to-day delivery of services.	While this is an important cultural consideration at agencies implementing new technologies, it is not feasible to address through this project.
79	The operator needs to ensure that volunteer-run services provide adequate accommodations for riders with disabilities so that people with disabilities have equal access to these services.	While this is an important cultural consideration at agencies implementing new technologies, it is not feasible to address through this project.
86	The operator needs to combine their service offerings with the service offering of other operators in the area so all services connected to the complete trip are interoperable among different agencies.	Multiple service offerings should be available in the same frontend applications, as is covered by other user needs, but it is not necessary for multiple services to be 'combined'.
94	The regulator needs to be able to connect vehicle assets to the funding sources used for their purchase to make informed funding allocations and to audit those purchases.	While tracking vehicle assets is important, an easy reference through the proposed interface to vehicle funding streams is not central to project concerns.

Need ID	Need	Removal Justification
95	The regulator needs to be able to compare the accessibility to jobs and other opportunities available to different parts of the region they regulate so they can enforce compliance to standards regarding level of service accessibility and make informed transportation planning decisions.	Accessibility analysis to jobs and other opportunities is an advanced analytical feature that should require a purpose-built application that will not be supported by this project.
96	The regulator needs to be able to assess equity of service delivery across the region they regulate so they can enforce equity compliance and make informed transportation planning decisions.	Equity analysis is an advanced analytical feature that should require a purpose-built application that will not be supported by this project.
98	The software vendor needs to maintain proprietary components of their system, such as algorithms for the optimization of schedules.	This user need is very likely to be fulfilled by the project, which is framed around the inclusion of commercial actors many of whom do and will continue to own and operate proprietary technology, however and because of that fact, it does not need to be accounted for in lower level system design.
102	The rider application vendor needs to maintain the same process and accept the same data for both discovery and transaction at every transit operator included within their app to ensure a consistent user experience and also so that the data exchange process is not overly complicated and shuts out agencies from being included in the plan/book/pay ecosystem.	This user need is very likely to be fulfilled by the project since it is framed around the inclusion of commercial actors, many of whom use a standardized process for data collection. However, it does not need to be accounted for in lower level system design and vendors may have the option of using a different approach.
106	The operator needs to easily find and procure software systems which provide for its needs so they have the best information available when choosing which tools will suit their needs.	Duplicate with User Need 103.

4.4. Assumptions and Constraints

The existing and proposed system depend on accurate, complete, and standards-based data and APIs (application programing interfaces). The outcome of having a system built around data standards proposed by the project requires that those data standards are interoperable. They must be adopted by data standard communities, (which itself likely requires both a producing and consuming entity and then a vote by the community) and ingested by trip planning applications. Ingesting these new data formats would require upgrading user-facing routing software, integrating deep link or in-app capabilities for booking, TTS (text-to-speech), among other changes to the current system. In this way, developing two essential parts of the system—data standards and the applications that use the data—naturally occur together.

APIs will also need to be developed to make these intersystem connections. To ensure the region has consistent coverage of representative data, a regional effort must be taken to gather current and accurate information, including information on service schedules, boundaries, vehicle specifications, infrastructure, eligibility, booking, fares, etc. Such an undertaking requires initial cooperation and active, ongoing participation of agencies. If any one of these parts is dysfunctional, it can jeopardize the entire system.

Transportation providers, agencies, and regulators already have a complex system of software and data pipelines. A fixed-route provider uses software for their operations in network planning and schedule development, CAD/AVL, fare system management, passenger counting, passenger-facing information and trip planning. A demand-responsive provider uses software as well to receive trip requests, schedule rides on vehicles, dispatch vehicles, and audit trips and rides. The above functions may be served by many different software from different vendors. Given the high degree of modularity of this system, adding new functions and data specifications needs to be done in a way that allows existing systems to continue to operate or be replaced without disruption to riders and high costs to agencies.

Data and API standards, best practices, and guidelines are essential for purchasing agencies to be able to foster interoperability between the systems that they purchase and implement. Implementation guidelines will be useful so that traveler-facing applications can deliver information that matches how agencies present their services. Voluntary guidelines would still allow experimentation and innovation among apps.

To enable broad access to travelers and planners, data should be available online under open licenses and in open directories. Interstate governance is needed to build a universal directory of transit data feeds for the three states, which this program is positioned to provide.

Data on the movement of vehicles is sometimes linked with data for individual person trips. A record of point-to-point demand-responsive trip may not be linked to an individual identity, but the origin or destination may be at a home, workplace, social service, which could be used to link the trip to an individual identity and even build a profile of travel behavior. Therefore, any data that could reveal travel behavior needs to be protected as a matter of user privacy.

The prevalence and availability of demand-responsive transportation will increase in the coming years as technology allows more efficient booking and routing, and expectations continue to be shaped by ride-hail in a post-pandemic world. It is expected that more demand-response services will be offered over the course of this program.

5. Concepts for the Proposed System

GTFS and the shared processes built around it are not complete and leave many needs unsatisfied, but they have been widely-adopted. GTFS is now an existing data format at hundreds of agencies in the three state region, used by all of the 100 largest agencies and most of the rest. The exact number is unknown, but perhaps most of all fixed route transit trip plans in the United States are planned using a customer interface driven by GTFS data. While public actors have a responsibility to see that the outcomes of the GTFS ecosystem are shared equitably by many riders, they also have a responsibility to work with and through the GTFS ecosystem, rather than against it. That is why the proposed system does not change the core operations of the current GTFS ecosystem, but rather supplements that operational model with minimal regulations and active public operator coordination that seek to increase the outcomes of that system for the underserved groups focused on by the ITS4US program.

5.1. Background and Scope

The goal of the system created through this project is to address the clear need for riders who use demand-responsive services and riders with disabilities to have equal access to the real-time trip planning technology that is already available for some fixed-route transit. The new system will provide equitable technology service available to all transit operators in the region and ensure that all riders are able to plan a trip, book their seat, and coordinate payment for their trip, including all ADA paratransit, rural dial-a-ride service, and local community transportation centers. This system will address the gaps in services that make the current system fully accessible only to smartphone users in urbanized areas.

5.2. Description of the Proposed System

The changes proposed for the new system are based on facilitating the finalization of proposed extensions to the GTFS data specification, new data standards related to booking integration, new open-source software applications tailored to provide easy tools for regulators and other users to analyze transit agencies and their services, and intergovernmental-coordination processes to ensure that ongoing investments effectively maintain and improve the developed data, data specifications, and software. The proposed approach defines new responsibilities for state DOTs that improve data outcomes from transit agencies and their software vendors, creates a standardized interface for reviewing key transit service information, provides a feedback loop that improves the quality and accessibility of rider interfaces on an ongoing basis, and integrates demand-responsive transportation services into the GTFS data ecosystem.

These enhancements will be carried out within the organizational context of the following proposed system, as illustrated in the diagram on the next page:

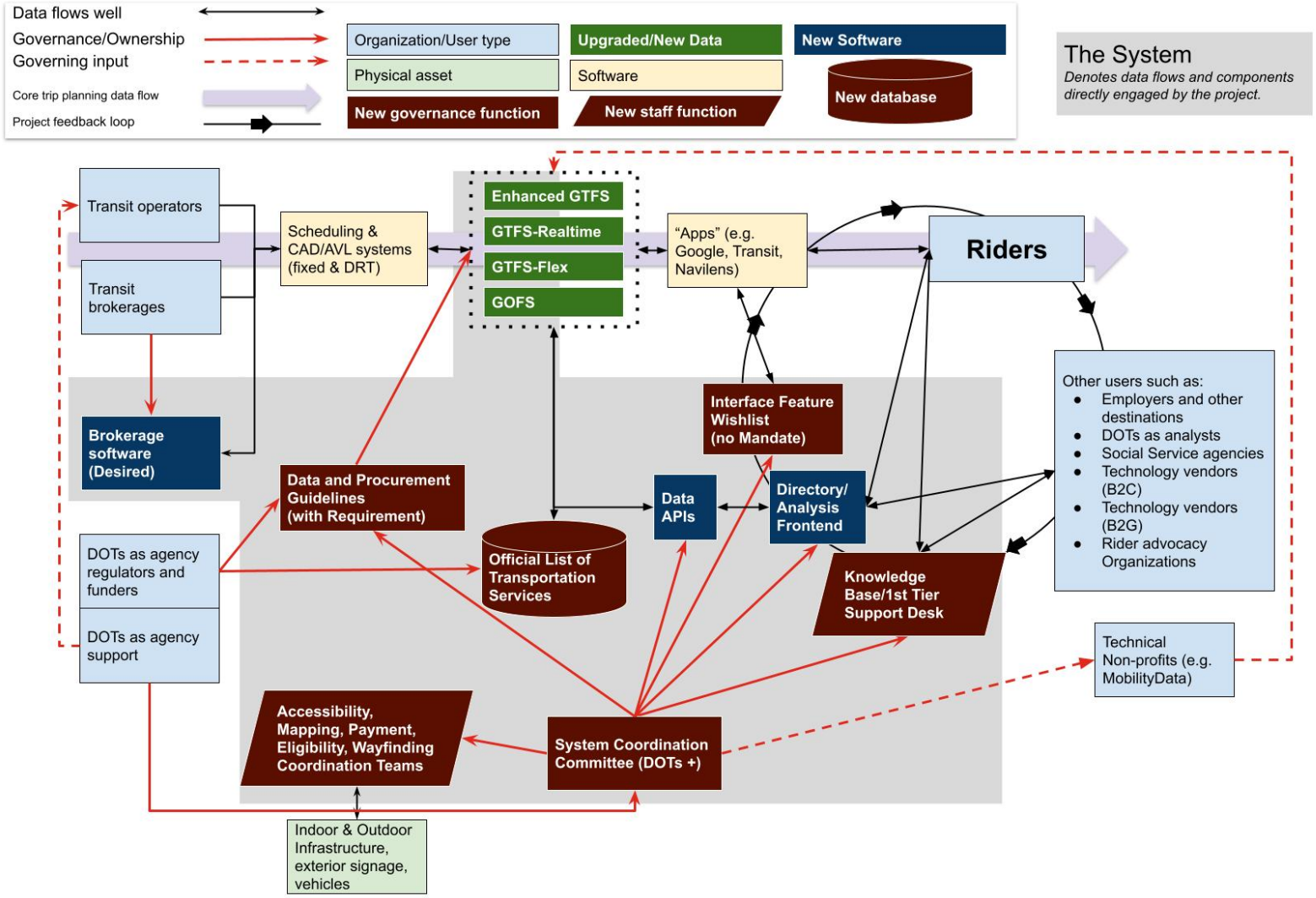

Figure 3: Proposed System Diagram

5.2.1. Sub-System Breakdown

The proposed changes seen in the Proposed System Diagram are described in the following lists of systems that will be created as an outcome of this project.

5.2.1.1 Transit Data Enhancements

These system components extend the data provided by transit agency scheduling and related systems into rider applications like Google Maps, Apple Map, Rome2Rio, and many others.

Enhanced GTFS

Complete GTFS refers to the presence of GTFS for every fixed route agency in the service area that contains data in compliance with the Pathways, Text-to-Speech, Translations, and likely Vehicles and Fares v2 extensions.

The Pathways extension describes the physical environment of a stop or station as it relates to on-foot or wheelchair navigation and accessibility.

Text-to-Speech provides screen reader applications improved notation for difficult-to-pronounce information found in a GTFS dataset (for example, a stop name like “Stop ‘n Save @ NE C. Chávez Blvd”).

The Translations extension provides text in multiple languages for information found in a GTFS dataset.

Vehicles describes the attributes and behaviors of the vehicles in operation of a bus schedule.

Lastly, Fares v2 describes complex transit fare systems, taking into account features like fare capping, zone or route-based fares, and discount groups.

With the addition of these extensions, all of the required and desired needs should be accounted for through the inclusion of that information in GTFS datasets. Rider applications such as Google Maps will be able to import that data and provide it to end users. Some of these extensions, including Pathways and Text-to-Speech, are already incorporated into the GTFS specification and could be used in applications currently. Others, such as Fares v2, are in the process of being implemented by a rider application. None, however, are widely adopted and are used by a very small number of agencies. Much of this data (Pathways, Text-to-Speech, Translations, Vehicles, and Fares v2) could be built directly by the CALACT ITS4US project with minimal need for agency effort.

GTFS Realtime

GTFS Realtime is an API specification that provides alerts regarding transit services and also allows for the update of arrival times and vehicle locations. While it is not feasible for the CALACT ITS4US project to produce arrival time or vehicle location updates, which must be calculated automatically with GPS or other location information from the vehicles, it is feasible both to produce alert information for agencies and also to encourage the adoption of GTFS Realtime. This would support the fulfillments of user needs identified in stakeholder research.

GTFS-Flex

GTFS-Flex is a proposed extension of GTFS that incorporates demand-responsive services for the purpose of service definition and trip discovery. The first large scale deployment of GTFS-Flex data launched in 2018 in Vermont, when the VTrans FTA Mod Sandbox project began publishing GTFS-Flex data for each agency in that state and incorporated the data into a statewide trip planner. GTFS-Flex v2 is an updated version of the proposed extension released in 2020 that incorporates lessons learned during that process and subsequent deployments in NW Oregon and Central California. In 2020, an additional extension synchronized with GTFS-Flex v2 was developed to describe the eligibility restrictions of transit services and is currently being enhanced through an FTA Mobility4All grant led by project partner agency ODOT. The CALACT ITS4US project with build data aligning with these proposed extensions (whichever versions are current at time of data creation process) to describe every public or private non-provide demand-responsive service within the three-state region.

GOFS

GOFS (“General On-Demand Feed Specification”) is the name given to the MobilityData working group currently convening to define a specification and roadmap to allow not only discovery, but also the booking of and payment for services in trip planning apps. GOFS would be similar to a “GTFS-Flex Realtime” specification and allow for a transactional experience for riders, who could find possible demand-responsive trips and initiate their demand and get a response from the agency. Long-term, both during the ITS4US project timeframe and after, GOFS would need to be produced by scheduling software used by the transit operator, so that an automated API could transmit real-time booking opportunities to rider applications, but booking and payment features are likely to use deep link or phone integration features which would allow GOFS to be published temporarily on a more manual basis through the CALACT ITS4US project.

Data generation detail

The figure below provides a more detailed view of the creation of exact data specifications by specific agency systems, in order to present more diagrammatic detail of this section of the proposed system which is provided at a high level in the Proposed System Diagram. Fixed route scheduling and CAD/AVL systems provided different data specifications, as do demand responsive scheduling and CAD/AVL systems (which are generally a single software system as opposed to two separate systems. Additionally, the diagram below highlights a second project feedback loop whereby the SCC improves ongoing management through learning lessons from the procurement guidelines and the technology coordination system component (more detail in the subsequent sections).

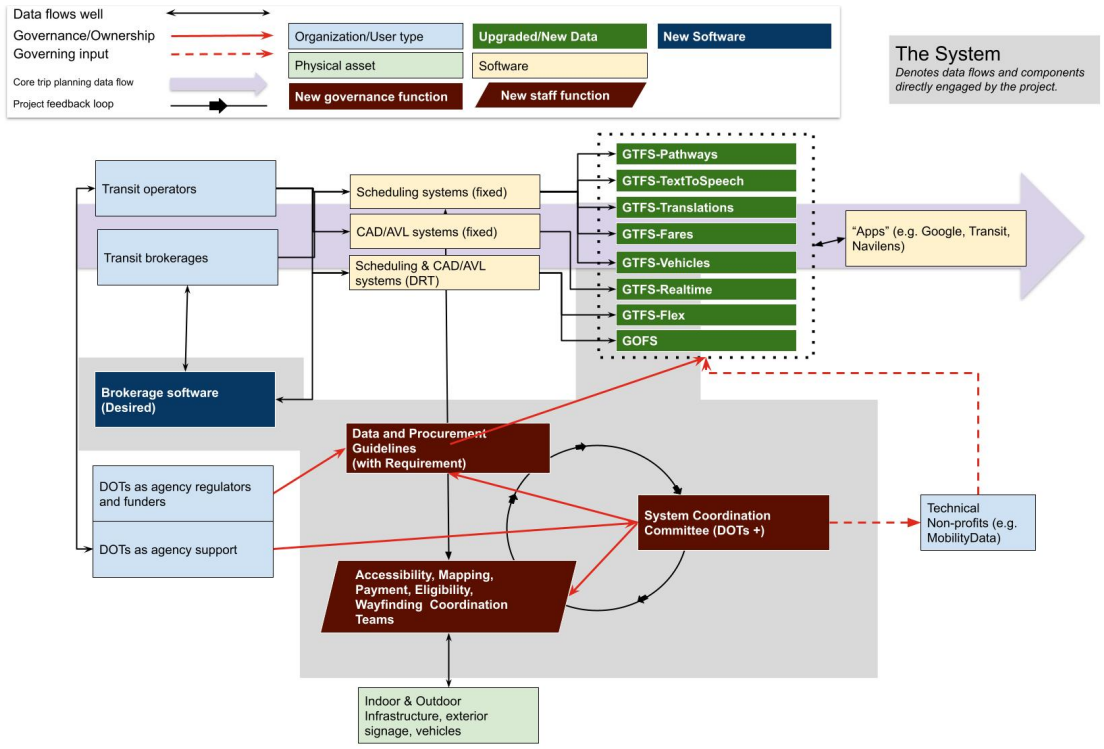

Figure 4: Data Generation Detail

5.2.1.2 New State DOT Responsibilities

New governance features put the State DOTs of the three-state region in a central position for the system approach to maintain the transit data enhancements initiated by the project.

Data and Procurement Guidelines

The CALACT ITS4US project would coordinate the development of data quality guidelines which specific the data to be provided as well as establishing a process to assess data quality. As existing standards and proposals are complex and broad, requirements to produce GTFS data must be supplemented with guidelines on how to produce quality data meeting the needs of regulators, operators, vendors, transit riders, and other stakeholders. Procurement guidelines, developed in partnership with operators to be inserted into agreements with vendors to govern data quality, would assist operators in procuring software systems that could produce the complete and accurate data required to meet data guidelines. By providing both data assistance and procurement guidelines as a resource to operators, the project can help ensure the improvement in quality of data used in third-party trip planning applications and thus improve outcomes for riders. State DOTs will be essential in encouraging agencies in their states to adopt the guidelines in their vendor agreements.

System Coordination Committee

The System Coordination Committee (SCC) is a long-term governance function that defines and evolves the advisory data and procurement guidelines to keep them practical in light of the current status of the GTFS ecosystem. During the course of the CALACT ITS4US project, this

committee would be made up of the PMT, with advice from the PLC. The SCC would hire a Project Management Organization (PMO) to implement and manage the components of the system governed by the SCC, as well as to provide training and technical support to DOTs in the development of technical capacity for their roles within the project. The SCC would continue to function after Phase 3 of the project, although whether a PMO would continue to support the SCC or if DOT representatives would assume operations will not be defined until Phase 3 after project evaluation begins. The state DOTs will be central decision-making participants in the SCC, making up the core members of a consortium approach to aligning data regulation across the three states, through commitments detailed within an MOU drafted before the end of Phase 1.

Official List of Transportation Services

To fulfill this project component, each state DOT will need to maintain a list of transportation services operating within their states. These lists must have a standardized process that can ensure a regional list of all agencies and their related GTFS feeds can be coordinated and in sync with the global list of all transit services. The Official List could take many different exact forms but must be a data product available for all users through an easily machine-readable format with proper documentation. This information may include additional fields and metadata as defined by the System Coordination Committee. Exactly which transportation services are covered may change over time, but will include at least all shared-ride public transit services, and may include additional mobility providers such as non-profits who operate transportation services for their clients, taxis, etc.

5.2.1.3 New System Coordination Committee Responsibilities

Unlike the procurement guideline implementation within internal state regulatory processes and the maintenance of an official list of transportation services, which is a function implemented at the state level, certain subcomponents of the project must be governed in a coordinated effort between the states. Thus, the SCC will be the direct administrator of the following subcomponents.

Data APIs

The Data APIs are a database and backend software application which ingests GTFS data from the GTFS data sets listed on the Official List of Transportation Services, and provides to other applications a series of APIs that expose useful data elements from the GTFS feeds as well as aggregations, calculations, and abstractions from those GTFS feeds which are useful to application developers. The Data APIs would be a software application of some shared model that allows the State DOTs to administer appropriate licensing and hosting of the application and transmit it to other state parties to allow evolution of the interface on a consistent basis and after the project using a financial model shared across the three states.

Directory/Analysis Frontend

The Directory/Analysis frontend would be a single website where all users are able to find basic transit operator data, such as contact information, a list of routes and stops, demand responsive services and their service times and areas, fares, and GTFS downloads. Additional analytical features such as custom data downloads may be available for advanced users. The directory/analysis front end would be a software application of some shared model that allows the State DOTs to administer appropriate licensing and hosting of the application and transmit it to

other state parties to allow evolution of the interface on a consistent basis and after the project using a financial model shared across the three states. One or multiple websites and servers could host the application, and those websites could be owned by the DOTs or other parties.

Knowledge Base/1st Tier Support

This knowledge base and support desk would provide basic educational resources and use the directory to provide answers to simple questions. Any user would be able to receive support regarding the right contacts for transit information in their region and assistance in using shared tools like the Data APIs and directory/analysis frontend, or commercial mobile applications such as Google Maps, Transit, Navilens, or others. The support desk would be a staffed functionality with a consistent team of technicians managing the answers to user questions and a management functionality developing business processes to do so efficiently and steward the business data gathered from users. Such data could provide for feedback to other subcomponents of the system.

Accessibility, Mapping, Payment, Eligibility, and Wayfinding Coordination

During the course of the ITS4US project, complete inter-state/inter-agency standardization of Accessibility, Mapping, Payments, Eligibility, and Wayfinding coordination is unattainable and not necessarily desirable. Each individual state and agency may continue to use local tools and policies that should still be interoperable and coordinated, along with oversight of accessibility features not governed directly by data standardization. There will be a technical team made up of project members and other staff who are responsible for long-term support of the SCC, state DOTs, and the individual transit agencies in the state define and negotiate solutions to fulfilling user needs that are not supported directly through transit data enhancements required through procurement and data maintenance approaches.

Interface Feature Wishlist

Many stakeholder interviews identified desired application features that are not fulfilled by rider-facing transit apps today. This project does not intend to design customer interfaces but will recommend that some user interface features be provided or some engineering practices be followed by app developers and revisit and update those recommendations as the project progresses. The Interface Feature Wishlist (alternate name under consideration: “Engineers’ Guide to Transit”) would be governed by the SCC and implemented by project partners consisting of public documentation directed at app developers and agencies. Both suggestions for established applications with a large number of users as well as for start-ups and custom operator applications would describe the best practices for communicating transit information to riders accessibly.

5.2.1.4 Transit Operator Software Applications

The CALACT ITS4US project does not envision developing software directly for transit operators except for a potential targeted software approach to fulfilling one important agency user need.

Brokerages (desired)

Brokerages are a desired (i.e., not required) subcomponent of the system. Transit operator users expressed a desire to save resources through better coordination of rides with neighboring

agencies. Data models exist to exchange information between demand-responsive agencies via brokerages, and could fulfill this use case, but would not be necessary for the other components of the system to fulfill their requirements. A brokerage could be a standalone feature governed through a different model than other system subcomponents. If implemented, brokerage software would be built or deployed in partnership but operated, maintained, and governed by transit operators locally. This would allow operators to benefit from open data specifications and shared development, without encroaching on local agency operations.

5.3. Stakeholders and Actors of the Proposed System

Table 6: Stakeholders and Actors of Proposed System

Stakeholder	Description	Role in Proposed System
Transit Operators	Organizations responsible for the day-to-day operation of both fixed route and demand-responsive transit.	Transit operators would continue to play the role of managing scheduling systems that provide GTFS data, and that role would be expanded within the system of interest. However, transit operations would be outside the proposed system implemented by the project.
DOTs as agency Regulators, Support, and Analysts	State organizations responsible for implementing federal and state law related to the transportation system.	DOTs play multiple roles within the proposed system. First, as regulators, they implement state-level requirements. Second, they provide technical support to the agencies they regulate and contribute to the governance of the SCC. Third, they analyze the state transportation network to identify opportunities to increase access and equity.

Stakeholder	Description	Role in Proposed System
Employers and other destinations	Employers and other organizations with large campuses with an interest in supporting efficient transportation to and from their locations.	While not participating directly in the system, this is a user group that is supported by the proposed system, as they are now able to access information on transportation services available to them more effectively.
Technology Vendors (B2G)	Technology vendors providing services to government entities. These organizations provide scheduling and CAD/AVL software directly to transit operators.	Technology vendors providing scheduling and dispatching software to transit operators are outside the system but affected by it, as they must provide data outputs from their system that align with the published guidelines.
Technology Vendors (B2C)	Technology vendors providing services to consumers. These organizations provide mobile applications direct to riders.	Technology vendors providing rider applications are outside the system but affected by it, as they are able to ingest new data outputs from the system and able to improve the accessibility of their applications based on the interface feature wishlist.
Technical Non-Profits	Not for profit organizations providing services or consulting on technical issues such as data standards. The primary organization fulfilling this role in the GTFS ecosystem is MobilityData.	Technical non-profits do not directly engage in the system but are affected by it. Feedback from state DOTs, transit operators, and riders in the three-state region are now coordinated and provided through the SCC.

Stakeholder	Description	Role in Proposed System
Rider Advocacy Organizations	Organizations aimed at improving transit for transit riders and advancing rider interests.	While not participating directly in the system, this is a user group that is supported by the proposed system as they are now able to access information on transportation services that would affect the riders for whom they advocate.
Riders	Travelers who takes public transit. Travelers utilize buses and rail service to get from their origin to their destination.	Riders do not participate in the system but are better served by the system which improves the accessibility of mobile applications they use, as well providing new interfaces.
Social Service Agencies	Agencies that provide services with the goal of promoting the health and well-being of individuals and families.	While not participating directly in the system, this is a user group that is supported by the proposed system as they are now able to access information on transportation services available to their clients.
Brokerages (Desired)	An organization or functionality that allows the coordination, sharing, or exchanging of rides between demand-responsive transit agencies.	Increase the operational efficiency and service quality to riders through the coordination, sharing, or exchanging of trips between demand-responsive agencies.

5.4. Support Environment

The support environment for the proposed system is substantively similar to the support environment for the current system described in section 3.4. The proposed system provides additional coordination of the support environment for transit operators, vendors, riders, and other

system actors, in order to improve accessibility outcomes. It does not require additional change to the support environment other than those described within the system itself.

5.5. Modes of Operations for Proposed System

The following table describes the different modes in which the proposed system would operate and the outcomes under those modes. Three modes of operation are included: normal, degraded, and failure. The proposed system is designed to increase the quality of normal operations under the current system and support more agencies in providing data under normal operations, rather than the degraded or failing operations that characterize the current system. No consistent processes or policies are in place to remedy this situation at present due to the complexity of the system failures and number of different stakeholders involved.

Table 7: Mode of Operation of Proposed System Descriptions and Outcomes

Mode of Operation	Description	Outcome
Normal	The transit agency's ground-truth service has representative data used in online trip planning and other transit information tools. This representative data is up-to-date, accurate, and complete and is accessible to all parties that need it, whether that be regulators, developers, trip planner end users, or the agencies themselves. The agency's data includes demand-responsive services as well as accessibility-focused information such as text-to-speech, pathways, and translation information.	Riders are able to rely on accurate online information about all transit services and travel accordingly. Agencies and regulators are able to conduct analysis with good data. Rider applications are able to deliver a reliable service to their end users. The information provided to users is generally all of the information needed for users of any abilities to discover and use the best trip to suit their needs.

Mode of Operation	Description	Outcome
Degraded	The transit agency has data representing services, but it is out of date, inaccurate, or incomplete. Online transit information tools therefore paint an incomplete picture of the agency's services and in some cases may contradict ground-truth (for example, a stop's location or arrival times may not match). Representative data may not be fully accessible to all parties that need it and is likely not publicly available.	Riders have access to online information regarding transit services, but it may not be as helpful as it should, and in some cases, may mislead them as they make travel decisions. Agencies and regulators can conduct analysis with the data, but only in broad strokes, as more granular data is less reliable. Rider applications can consume transit data but would need to mitigate the promotion of unreliable data, and therefore may not publish it. In degraded conditions, additional support from state DOTs and the other system subcomponents providing technical assistance are applied to help the agency improve their transit data.

Mode of Operation	Description	Outcome
Failure	The transit agency operates without any representative data for online transit information tools. In this mode of operation, there are key tools that have not been adopted by the agency, or those tools are not being utilized effectively.	Riders have no access to standardized online information, so they must manage to make sense of physical and online materials to discover and plan transit trips. Agencies and regulators do not have access to schedule and service data that is clearly defined, organized, easy to analyze. Rider applications cannot publish the agency's services, reducing their utility to end users. In failure conditions, agencies do not meet the expectations of the system and state DOT must provide assistance to provide transit data describing the operated services.
Transitory	The transit agency operates in a fashion that has certain components of the new system but has not implemented all features.	Riders have access to information available during Normal operations of the current system, and some but not all information available during Normal operations of the proposed system. Transitory operations may be different in different regions as the technologies to be deployed will vary.

5.6. Operational Policies and Constraints

The operational policies and constraints of the proposed system are substantively similar to the operational policies and constraints of the current system, but the negative effect they have on the system will have been ameliorated by the proposed system subcomponents. Other policies and constraints that limit the field of applicable solutions that can be applied in the proposed system have been accounted for in system subcomponents to support system success within those constraints. There are some new relevant policies and constraints related to the system which should be considered as they relate to the standardization of data and transit agency processes outside of the three state region of this project.

5.6.1. Better use of staff and contractor resources

Significant resources from state DOTs and agencies are dedicated in the current system to discuss and plan for how to adapt shared data resources like GTFS and related standards to the needs of multiple agencies and coordinate divergent but related projects that leverage those standards. The SCC will support more efficient use of these resources by ensuring that each state DOT and other stakeholders are aware of other ongoing projects, by providing a central venue where DOTs can coordinate other ongoing specification enhancement projects. The same resources can be used to advance transit data, but greater improvement will be realized by reduced overlap between the multiple agencies working with GTFS and other specifications.

5.6.2. Management of IT policies and capacities

In the development of shared software resources, the IT policies and capacities of different organizations involved, especially the central state DOTs must be considered. These organizations do have very distinct IT policies, capacities, and roadmaps for how those policies are expected to change over the coming years. Most of the specific IT policies in effect at these agencies are too numerous to recount here, and not necessary to consider at this stage of system design. However, the general framework of the proposed system has been designed to allow for the best management of local IT policies and reduce the risk of conflict between system design and IT policies and capacities. The distinction between the official list of transportation services, data APIs, and the directory/analysis frontend is of critical importance to this consideration. The frontend and APIs are only broadly defined, but serve the purpose of transmitting data to all machine and human users are shared across all states, whereas the official lists of transportation are state-held data products which can be managed as each state sees fit. The separation of the official lists of transportation services from data APIs and the frontend allows for the DOTs to maintain their own core data product in a form that best fits agency policies, while allowing the shared software tools that make up the frontend to be separated from that data product. The exact manner in which software would be hosted and deployed has not yet been determined and is dependent on continued research into the operational policies and capacities of state DOTs, as well as the related development and deployment of software by other organizations such as MobilityData, which may host a global transit directory which could overlap with and be integrated with the proposed statewide or regional directory.

5.6.3. New operational contraints

This project proposes to pursue the promotion of standardized data based on data specifications within the three state region of California, Oregon, and Washington, which apply to agencies outside the three state region, in some cases globally. In particular, there is a specific focus on promoting the adoption of GTFS and proposed extensions to that specification, which have not yet been officially adopted and which, if adopted, could be voluntarily complied with and used by mobile application vendors such as Google, Transit, Navilens and others. There is an existing governance process and licensing regime for the GTFS, which would be pursued by this project and by other parties, but would not necessarily result in the standardization of data according to the proposals sponsored by this project. These global conversations are an important series of

operational policies and constraints which will not be detailed in this document, but which must be considered by the project.[3]

The proposed system would also be constrained by the budgets and staffing of transit operators. While the increase in costs of software and labor for the management of software should be minimal, as a result of much information to be standardized being already captured by currently utilized software systems, there would necessarily be some increased costs at least in the short-term for software vendors which would be passed down to agencies.

Finally, this proposed system makes the assumption that other state and local governmental parties, including some partners of the project which are currently sponsoring parallel regulatory and development projects—such as Cal-ITP being pursued by Caltrans, AIM and Mobility4All grant-funded projects being pursued by ODOT, GTFS and GTFS-flex development projects being pursued by WSDOT, and the GOFS working group being pursued by MobilityData—will continue and be at least partially successful in achieving their ends. While there are a large number of projects that the proposed system relies on, this fact is understood as a strength and an opportunity rather than only a constraint and risk. The large number of parallel development projects indicates strong interest in the proposed work and a demonstration of intent to collaborate by partner and many other organizations. The proposed system would increase the coordination of these projects would could increase the efficiency of resources devoted to those projects and decrease the risk of project failures.

[3] More information regarding the GTFS governance process can be found at https://github.com/google/transit/blob/master/gtfs/CHANGES.md

6. Operational Scenarios

Below are operational scenarios that demonstrate the proposed system in action. Each follows a particular user along with supporting users as they plan a trip or use the system for another purpose.

Table 8. Scenario 1: Individual with a mobility disability who uses a mobility device is looking for a demand response service for the first time

Item	Scenario 1: Individual with a mobility disability who uses a mobility device is looking for a demand response service for the first time
Short Description	In this use case, an individual with a mobility disability who uses a mobility device discovers a dial-a-ride service in their area. They use a commercial trip planning application to plan a trip from their origin to their destination and select the option that requires the least walking. They need to discover the service name and the information they need to book the trip.
Goal	The goal of this use case is to demonstrate the discoverability of demand-response transit services on commonly used trip planning applications.
Constraints	• This user will only be searching for services relevant to their location/eligibility status. For the user to discover the appropriate service, representative data must exist, and the app of their choice must ingest and model it.
Geographic Scope	This user could be travelling anywhere within the tri-state region that has a demand-response service which meets their accessibility needs.
Actors	• Transit agency • Rider with mobility disability • Trip planning application
Preconditions	1. Data about the demand response service must be up to date and publicly available. 2. The data standard modeling these services must be accepted and used by both producers and consumers for them to appear in trip planning queries.

Item	Scenario 1: Individual with a mobility disability who uses a mobility device is looking for a demand response service for the first time
Main Flow	1. Trip planning apps ingest and model non-fixed-route services from datasets provided by an agency, DOT, non-profit, or vendor acting on behalf of one of these. 2. The data the app consumes and publishes includes information on who the service is for (ie eligibility restrictions). 3. The individual accesses the trip planning app, to which they have provided user profile information (use and type of mobility device). 4. The user searches for a trip between the start and end points. 5. The app accesses ingested datasets and checks user profile and trip parameters against them. The app returns a possible trip that matches the user's needs, as well as information about the agency providing the trip, such as name and contact information. 6. The app identifies and presents a demand response service trip that could serve the rider's needs. The user is also presented with a "book now" button, which deep links to a booking application or webpage. 7. The user clicks on the book now button to proceed with the booking process through an agency-maintained application. 8. The user is served by the demand response service following the parameters of the trip they booked with the agency originally discovered through the trip planning application.
Alternate Flow(s)	6a. The app could also provide live vehicle/trip availability through an API transmitting real-time vehicle or dispatch data from the agency. 8a. When the vehicle has not arrived at the expected time, the rider texts, calls, or checks the mobile/web application to learn that the vehicle is still on route but delayed.
Post-conditions	1. The user discovers a transit service tailored to their specific needs and is able to plan trips with that service using a booking process that is linked with the application they used.

Information Requirements	• Trip planning app must display
	  ○ Demand-responsive service
	  ○ Eligibility requirements
	  ○ Booking requirements
	  ○ Capacity for vehicle and service to accommodate the mobility device the rider uses
	  ○ Service hours
	  ○ Booking link
	  ○ Contact information for questions
	• Trip planning app needs user information on
	  ○ Pick up/drop off location
	  ○ Trip time
	  ○ Mobility device needs
	  ○ Eligibility information

Item	Scenario 1: Individual with a mobility disability who uses a mobility device is looking for a demand response service for the first time
Related User Needs	RID-01 - Discover DR RID-01-1 - Book in advance RID-01-5 - DR delay RID-01-6 - DR origin and destination RID-01-7 - Book quickly RID-03 - Eligibility process RID-15 - Customer service RID-19 - Device accessible RID-19-1 - Space for mobility device RID-27 - Confidence in info RID-33 - Confirm vehicle RID-45 - Communicate without text MUL-03 - Contact information

Table 9. Scenario 2: Person who uses a wheelchair planning a trip to work using fixed-route service near their home

Item	Scenario 2: Person who uses a wheelchair planning a trip to work using fixed-route service near their home
Short Description	In this use case, a user with a wheelchair is planning a trip to their work using the bus service near their home for the first time. They are using the agency website's embedded trip planner which forwards users to Google Maps to access information.
Goal	The goal of this use case is to illustrate pathway and vehicle accessibility information that users with mobility disabilities need to successfully plan a complete trip.
Constraints	• This user is specifically wanting to use the fixed-route bus service near their home. They are not looking to use a demand-responsive or paratransit service. • This user is planning to use this service to get to work, so their punctual arrival time is important • This user is planning to travel alone, so they need to be able to either deal with any barriers independently, know that there will be a driver or other trained person available to assist them, or know to plan an entirely different trip in the case that this is not feasible.
Geographic Scope	The information the user needs for this case is limited to their path of travel. In this scenario the user will be traveling from an urban residential area to a denser urban commercial area. They will need information about the path between their home and the bus stop, the bus stop itself, the vehicle, the bus stop they will arrive at, and the path from the bus stop to their work. This will likely include information about sidewalks and curb cuts, streets, crosswalks, and any other barriers.
Actors	• Transit Agency • Underserved Population User/Traveler • Bus operator • Manager of built environment, i.e. sidewalks, curbs, crosswalks, and signage, and data representing that infrastructure • Customer-facing trip planning tool/application
Preconditions	1. The transit agency has a website with an embedded trip planner that is able to consume and display the required information. 2. The entity creating the data has access to the information required such as the vehicle's accessibility features and information about the surrounding bus stops and pathways.

Item	Scenario 2: Person who uses a wheelchair planning a trip to work using fixed-route service near their home
	3. The company providing the mobile application has data regarding the street grid in close proximity to the bus stops in question, including accessibility features such as sidewalks, curb cuts, crosswalks, and barriers that may impact the navigation of pedestrian routes.
Main Flow	1. User accesses the transit website's trip planner to look up their possible trip 2. Transit website's trip planner directs user to a third party site that includes all necessary information about the bus route, arrival times, and information regarding the accessibility features of the stop 3. User uses the provided information to confirm that they will be able to travel from their home to the bus stop along a route that is accessible to them 4. User is able to confirm that once the bus arrives, they will be able to board. 5. User is able to confirm they have a safe space for their mobility equipment. 6. User is able to confirm that they will be able to travel from the bus stop to their work along a route that is accessible to them 7. User is able to confirm that there is an available return trip meeting these requirements at the end of their work day so that they know they will be able to get home successfully. 8. As the user begins the trip, they refer back to the application to receive a real-time update on the expected departure time of their vehicle.
Alternate Flow(s)	2. Agency's trip planner contains information with a similar user flow as the third party app, but no referral to external software is necessary. 7. User is able to confirm that while the route they are using for their initial trip will not be running at the time of their return trip, that there is an alternate accessible route they will be able to take.
Post-conditions	1. User is able to plan a complete trip that is accessible to them and completes the trip 2. User is able to determine that the route is not going to be accessible to them, so they do not take the trip and look for other options

Information Requirements	• Trip planning app/third party site must display
	  ○ Stop location and vehicle arrival times
	  ○ Specific lat/lon positions of potential barriers to a mobility device with description of those barriers
	  ○ Description of vehicle accessibility capabilities including
	  ▪ boarding/alighting
	  ▪ specifications around aisle width

Item	Scenario 2: Person who uses a wheelchair planning a trip to work using fixed-route service near their home
	▪ current availability and size of wheelchair spaces and turnaround space ▪ availability of driver to assist • Trip planning app needs user information on ○ Pick up/drop off location ○ Trip time ○ Mobility device needs
Related User Needs	RID-13 - App guidance RID-19 - Device accessible RID-19-1 - Space for mobility device RID-19-2 - Pathways in advance RID-19-3 - Loading mobility device RID-19-4 - Space for mobility device real-time RID-19-7 - Mobility device charging RID-19-9 - Trust pathway validation RID-27 - Confidence in info RID-33 - Confirm vehicle RID-34 - Elevators in service RID-39 - Aware of apps RID-40 - Schedule changes OP-03 - Tech sophistication not required MUL-03 - Contact information

Table 10. Scenario 3: A rider with a vision disability uses an agency's website to determine what times the local train stops near their house and receives alert en route to station.

Item	Scenario 3: A rider with a vision disability uses an agency's website to determine what times the local train stops near their house and receives alert en route to station.
Short Description	In this use case, the user wants to take the train that stops near their house and is using the train agency's website to look for information about when the train comes. They retrieve that time, and are walking to the station when an alert is posted by the agency that their train has been delayed
Goal	The goal of this use case is to illustrate how online information needs to be presented in a variety of ways so that it is accessible to all users.

Item	Scenario 3: A rider with a vision disability uses an agency's website to determine what times the local train stops near their house and receives alert en route to station.
Constraints	• A constraint in this use case is that the user will be accessing information using a screen reader so information must be presented in a way that is accessible without seeing the visual information presented.
Geographic Scope	This use case takes place in a suburban area where the user lives a few blocks from a train stop.
Actors	• Transit Agency • Rider with a vision disability
Preconditions	1. The agency must have a website with the information the rider is seeking presented in a way that is accessible to people using screen readers.
Main Flow	1. User accesses the agency website 2. User is able to use their screen reader program to understand information on the homepage of the website and navigate to the correct page for arrival times 3. User finds the specific stop they want to find the arrival times for. 4. User signs up for notifications regarding alerts for the service they plan to ride 5. Before reaching the train station, the user receives a text notification which explains that the train has been delayed significantly 6. The rider visits a coffee kiosk near the train station and waits for the train while enjoying a delicious beverage.
Alternate Flow(s)	4. Instead of requesting a notification,user, the user plans to check back on the website later; 5. The user looks again at the website and finds on the same page that the arrival time has been updated and a new alert is posted, stating that there has been a significant delay. 1. Instead of the agency's website and text, the user perform steps 1 through 5 using a smartphone application.
Post-conditions	1. The user is able to find the information they need in an effective and efficient way. Because an alert was posted in a way that was accessible through their user interface, they adjusted travel plans and maintained their personal comfort at the train station.

Item	Scenario 3: A rider with a vision disability uses an agency's website to determine what times the local train stops near their house and receives alert en route to station.

Information Requirements	• Transit website information for user:
	  ○ Screen reader accessible without additional unnecessary information cluttering the site
	  ○ Stop locations
	  ○ Arrival times
	  ○ Alert posted on arrival times page easily identified through page hierarchy
	• User information:
	  ○ Chooses correct stop

Related User Needs	RID-04 - Hear text annunciation RID-04-1 - Audio option RID-13 - App guidance RID-15 - Customer service RID-19 - Device accessible RID-21 - Talk to app RID-20 - Diversity of interfaces RID-27 - Confidence in info RID-28 - Limit words RID-30 - Consistent experience RID-42 - Navigation directions RID-45 - Communicate without text OP-03 - Tech sophistication not required MUL-03 - Contact information

Table 11. Scenario 4: A rider with a vision disability boards a demand responsive vehicle on a busy street and knows the right vehicle to board because the mobile application directs them to it in a line of vehicles.

Item	Scenario 4: a rider with a vision disability boards a demand responsive vehicle on a busy street and knows the right vehicle to board because the mobile application directs them to it in a line of vehicles.
Short Description	In this use case, the user has a vision disability and has booked a demand-responsive trip. The pickup location is on a busy urban street with many vehicles parked next to the sidewalk. The user is able to be directed to the exact vehicle and approach it with confidence because their mobile application knows the location of the vehicle and also can see the digital code for that vehicle through the phone camera.

Item	Scenario 4: a rider with a vision disability boards a demand responsive vehicle on a busy street and knows the right vehicle to board because the mobile application directs them to it in a line of vehicles.
Goal	The goal of this use case is to illustrate how riders need to know which vehicle to board through accessible information.
Constraints	• The rider has a service animal and will be bringing the animal with them on the trip.
Geographic Scope	This scenario takes place on a busy urban street where many vehicles are parked and either pulling in or pulling out.
Actors	• Transit operator • Rider with vision disability • Driver
Preconditions	1. The vehicle operating the demand responsive service has a code or beacon that allows communication with the mobile application. 2. The rider must have a smart phone with a working camera and internet access through either cell or wifi. 3. The vehicle must be encoded with a digital code or beacon that can direct a user to the proper vehicle.
Main Flow	1. The rider with a vision disability has booked a trip through a mobile application for a demand-responsive service, with an origin location on a busy urban street. 2. The mobile application confirms the vehicle is en route to the pickup location and provides a push notification to the rider's mobile phone identifying the expected time until pickup. 3. The vehicle arrives, and parks along a sidewalk with other vehicles both in front of and behind that vehicle. 4. The rider receives a notification that the vehicle has arrived and raises their phone to see the line of cars. 5. The phone identifies through its camera the digital code placed near the front of the vehicle, and directs the rider towards the vehicle through audio indications of direction 6. The rider announces to the driver that they are ready for their ride.
Alternate Flow(s)	
Post-conditions	1. The rider finds the vehicle and proceeds on their demand responsive trip.

Item	Scenario 4: a rider with a vision disability boards a demand responsive vehicle on a busy street and knows the right vehicle to board because the mobile application directs them to it in a line of vehicles.
Information Requirements	• The smart phone application must be aware of the codes placed on physical vehicles, and be able to connect that code to vehicle information provided in real-time by the demand responsive scheduling application • The smart phone application must be aware of the sidewalk and curb position, and potential barriers between the rider and the boarding location.
Related User Needs	RID-04 - Hear text annunciation RID-04-1 - Audio option RID-16 - Communicate with driver RID-20 - Diversity of interfaces RID-33 - Confirm vehicle RID-42 - Navigation directions RID-43 - Service animal

Table 12. Scenario 5: Person with a developmental disability wants to schedule paratransit services online to pick them up at home and drop them off at their new job.

Item	Scenario 5: Person with a developmental disability wants to schedule paratransit services online to pick them up at home and drop them off at their new job.
Short Description	In this use case, the user is a person with a disability who is using the internet to find and book a paratransit service to pick them up at home and drop them off at work. Once at work, they need to let their sister know that they made it safely.
Goal	The goal of this use case is to illustrate the types of information that needs to be available for booking paratransit trips and how that information needs to be presented in order to be accessible to a person with a developmental disability.

Item	Scenario 5: Person with a developmental disability wants to schedule paratransit services online to pick them up at home and drop them off at their new job.
Constraints	• This user is using the internet to access services. They are not calling the agency to book a ride. • This user has a developmental disability which impacts their ability to read and process information. They may be using accessibility tools like text-to-speech to understand written materials. • This user is planning to use this service to get to work, so their punctual arrival time is important • The paratransit service in this area has eligibility requirements and requirements for how far in advance the rider needs to book a trip
Geographic Scope	This scenario takes place in an urban area with reliable internet and phone connections. The distance between the rider's home and their destination is under 3 miles and is within the urban area.
Actors	• Transit Agency • Underserved Population User/Traveler • Bus operator • Customer-facing trip planning tool/application
Preconditions	1. The transit agency has adequate information about their paratransit services online that the rider is able to find the information they need to understand eligibility requirements and be approved. 2. The transit agency has an online booking option for paratransit services. 3. The rider has an internet connection and device to access the internet
Main Flow	1. User searches for paratransit services near them in a directory interface and finds the correct local transit service. 2. User locates information about the paratransit service including eligibility requirements, how to apply, and how to book a trip. Information is presented in a clear and straightforward way through text-to-speech so that the user is able to understand the materials. 3. User is able to submit the required documentation with the help of a caregiver and get approved in a timely manner to use paratransit. 4. User is able to then book a ride, confirming their pick up and drop off points and request a notification to be sent to their sister upon both pick up and drop off. 5. User receives a notification alerting them to the vehicle approaching their location 6. User is picked up within a minimal time window and dropped off in time for work. 7. A notification is sent automatically to the rider's sister to let her know the rider arrived safely.

Item	Scenario 5: Person with a developmental disability wants to schedule paratransit services online to pick them up at home and drop them off at their new job.
Alternate flow	3. Instead of submitting documentation, the eligibility verification process includes entering a small amount of personally identifiably information (PII) into a web interface, which leads to the automated verification of the rider's eligibility.
Post-conditions	1. The user arrives safely and on time for work and their sister is notified.

Information Requirements	• Paratransit service information online needs to include:
	  ○ Eligibility requirements
	  ○ How to apply and timeline
	  ○ Booking ability
	  ○ Ability to request arrival notifications
	• Paratransit service needs information on:
	  ○ Eligibility
	  ○ Pick up/drop off location
	  ○ Trip time and latest allowed arrival time
	  ○ Arrival notification request

Item	Scenario 5: Person with a developmental disability wants to schedule paratransit services online to pick them up at home and drop them off at their new job.
Related User Needs	RID-01 - Discover DR RID-01-1 - Book in advance RID-01-4 - DR wait time RID-01-5 - DR delay RID-01-6 - DR origin and destination RID-01-7 - Book quickly RID-03 - Eligibility process RID-13 - App guidance RID-13-1 - No experience necessary RID-15 - Customer service RID-16 - Communicate with driver RID-19 - Device accessible RID-20 - Diversity of interfaces RID-21 - Talk to app RID-24 - Various notifications RID-27 - Confidence in info RID-28 - Limit words RID-30 - Consistent experience RID-33 - Confirm vehicle RID-36 - Way back home RID-39 - Aware of apps RID-41 - Assistive tech awareness RID-42 - Navigation directions RID-45 - Communicate without text OP-02 - Booking through rider apps OP-03 - Tech sophistication not required OP-06 - Serve requests precisely MUL-03 - Contact information

Table 13. Scenario 6: A rider who is a veteran and currently on a low fixed-income is researching transit in her area to see what options are available for her to go to the VA Hospital in the most efficient and economical way possible.

Item	Scenario 6: A rider who is a veteran and currently on a low fixed-income is researching transit in her area to see what options are available for her to go to the VA Hospital in a nearby urban center in the most efficient and economical way possible.
Short Description	In this use case, the user is a veteran who is also low income. She is using the internet to find out what options are available to her to go to and from the VA Hospital in a nearby urban center. She is interested in services specifically for veterans, especially if there are fare discounts available. She will have a collapsible cart with her for carrying bags.

Item	Scenario 6: A rider who is a veteran and currently on a low fixed-income is researching transit in her area to see what options are available for her to go to the VA Hospital in a nearby urban center in the most efficient and economical way possible.
Goal	The goal of this use case is to illustrate the needs of veterans and low-income riders when assessing service options.
Constraints	• This user is low-income and needs to know fare information in advance to know if they will be able to have funds available for their trip, as well as what payment media will be required for the lowest cost service. • This user will have a cart with them and needs to know that they will be able to bring their cart onto the vehicle
Geographic Scope	This scenario takes place in either a rural or an urban area with good internet and phone connections.
Actors	• Transit Agency • Veteran rider on a low income • Transit operator • Customer-facing trip planning tool/application
Preconditions	1. The transit agency has adequate information about their veteran services, fares, and vehicle accessibility/storage published through appropriate data specifications 2. The transit agency has services and/or fares specifically for veterans 3. The rider has an internet connection and device to access the internet
Main Flow	1. The user uses a public mobile application to search transit services in her area. 2. The user is able to find the multiple services that meet her needs, including an intercity route and, in the local area around the hospital, both a fixed-route service that requires a fare and a veteran-specific demand-responsive service that is free but has limited capacity which doesn't suit her immediate needs. 3. The user selects the service that meets their trip requirements and is able to find the price of that service, available discounts, and information on storage availability on the vehicle. 4. The user is able to confirm that payment is accepted in at least one way that is accessible to her. 5. The user finds that space is available onboard the vehicle for her cart and begins planning for the time of her trip.

Item	Scenario 6: A rider who is a veteran and currently on a low fixed-income is researching transit in her area to see what options are available for her to go to the VA Hospital in a nearby urban center in the most efficient and economical way possible.
Alternate Flow(s)	The rider identifies that a free demand-response service will work for future shopping trips if she plans them in advance, and gets in touch with the agency to begin scheduling rides for that service.
Post-conditions	1. The user is able to find at least one trip option that works for their pick up and drop off points and budget and will accommodate a cart.

Information Requirements	• Transit service information online needs to include:
	  ○ Availability of veteran services
	  ○ Eligibility requirements
	  ○ How to apply and timeline
	  ○ Storage availability on vehicles
	  ○ Booking ability
	  ○ Fares information
	  ○ Ability to accept fares in multiple ways
	• Transit service needs information on:
	  ○ Payment preferences
	  ○ Eligibility
	  ○ Pick up/drop off location
	  ○ Trip time

Related User Needs	RID-01 - Discover DR RID-02 - Various trips RID-03 - Eligibility process RID-13 - App guidance RID-14 - Cost of service RID-14-1 - Standard payment media RID-14-2 - Cost for party RID-15 - Customer service RID-18-2 - Station patrol RID-19 - Device accessible RID-19-1 - Space for mobility device RID-19-3 - Loading mobility device RID-22 - Veteran info RID-27 - Confidence in info RID-31 - Adjust preferences RID-37 - Various options RID-38 - Expect crowding RID-39 - Aware of apps OP-02 - Booking through rider apps OP-03 - Tech sophistication not required OP-07 - Integrated fare payment MUL-01 - See full network MUL-03 - Contact information

Table 14. Scenario 7: An older rider who has a hearing disability is taking a long bus ride but realizes they need to alight early to find a restroom.

Item	Scenario 7: An older rider who has a hearing disability is taking a long bus ride but realizes they need to alight early to find a restroom.
Short Description	In this use case, the user is a person with a hearing disability who is on a long fixed-route bus ride. They realize they need to alight early to find a restroom, and must figure out if/where a restroom is available and communicate to the driver that they need to get off the bus.
Goal	The goal of this use case is to illustrate that riders need to be able to give and receive information in a variety of ways, and that riders need to understand their surroundings at every point in a trip.
Constraints	• This rider has a hearing disability and will need to give and receive information that does not rely on speaking or audio
Geographic Scope	This scenario takes place in a small urban area along a bus route. There are a variety of businesses nearby.
Actors	• Transit Agency • Older rider with a hearing disability • Bus operator
Preconditions	1. Information about locations, upcoming stops, and nearby restrooms/business is available and presented to riders in a non-audio format

Item	Scenario 7: An older rider who has a hearing disability is taking a long bus ride but realizes they need to alight early to find a restroom.
Main Flow	1. User determines that they need to deboard earlier than planned to find a restroom. 2. User is able to access information visually about where they are along the route, upcoming stops, and where restrooms are available, through the use of a mobile application which shows that information along the bus route. 3. The users identifies that if they alight from the bus, there will not be another bus on their route for a long time, but identifies another service that will let them finish their trip within a reasonable time. 4. User indicates that they wish to alight at the appropriate stop by signaling to the bus driver through the vehicle stop request tool. 5. User alights and is able to find their way to the nearest restroom using their mobile device. 6. The rider uses the mobile app to navigate to the stop for the service to finish their ride, and successfully boards.
Alternate Flow(s)	6. Instead of a fixed-route service, the ride being used to finish the trip is a microtransit service. The rider books a trip which arrives, and when the driver asks them a question, the rider communicates via a text message with the driver that they have a hearing disability and if they driver has information for them they should communicate in text.
Post-conditions	1. The rider was able to find the information they needed, alight, and find a restroom.

Information Requirements	• Transit service information on the vehicle needs to include visual information depicting:
	  ○ Where the vehicle is along the route
	  ○ What is nearby/restroom locations
	• Mobile application needs information on:
	  ○ Which stop the rider wants to alight at

Related User Needs	RID-16-1 - Communicate without voice RID-18-3 - Stops along route RID-18-5 - Restroom locations RID-19 - Device accessible RID-20 - Diversity of interfaces RID-20-3 - Visual or text RID-23 - Present location RID-25 - Safety feature hours RID-26 - Know about TTD RID-32 - Exact stop locations

Table 15. Scenario 8: A rider with limited English proficiency is navigating to the correct bus stop in a transit mall.

Item	Scenario 8: A rider with limited English proficiency is navigating to the correct bus stop in a transit mall.
Short Description	In this use case, the user who is a recent refugee who has been granted asylum prepared for their trip beforehand and has just arrived at a transit mall. There are a variety of places to wait for a variety of transit lines and they need to find the correct one for their trip.
Goal	The goal of this use case is to illustrate that transit signage needs to be clear, transit stops need to be marked so that riders of all abilities and level of English proficiency can navigate effectively, and this information needs to be integrated into transit apps in order for users to understand the signage fully.
Constraints	1. A significant constraint in this use case is that the user is physically at the transit mall and needing to find their stop. The user did some research beforehand, but is now relying on signs physically at the transit mall. 2. Another constraint is that the user has a limited English proficiency so signs need to be designed in a way that is universally understandable 3. The user's recent immigration and trauma has led them to be wary about communicating or asking questions of people, especially uniformed staff members of the station.
Geographic Scope	This scenario takes place in a small urban transit mall with multiple stops in an area for different routes in different directions, not all of which are visible from all other parts of the transit mall.
Actors	• Transit Agency • Rider with limited English proficiency • Wayfinding signs vendor • Transit operator

Item	Scenario 8: A rider with limited English proficiency is navigating to the correct bus stop in a transit mall.
Preconditions	1. The rider was able to prepare for their trip by researching the stop location beforehand and accessing information on wayfinding signs so they know what to look for now that they are at the transit mall. 2. Information about wayfinding signs was available through mobile applications for the rider to find and reference during navigation 3. Wayfinding signs present information in a way that does not require a high level of English proficiency 4. The website, maps, and mobile apps are available in multiple languages/can be translated into any language 5. Transit operators are trained to communicate clearly and patiently with folks with limited English proficiency
Main Flow	1. User researches their trip online and is able to find in their preferred language the information they need about the stop location and how to find their stop with wayfinding and vehicle signs 2. Once at the transit mall, the user is able to recognize the necessary symbols and information on wayfinding signs to navigate to the correct stop 3. When the vehicle arrives, the user is able to confirm that it is the correct vehicle before boarding based on signs on the outside of the vehicle. 4. The user is able to confirm directly with the driver that they are on the right vehicle if the user wants that confirmation.
Alternate Flow(s)	
Post-conditions	1. The rider was able to board the correct vehicle and communicate with the driver if desired.

Information Requirements	• Transit website or mobile application information for user:
	  ○ All information on the site could be translated to any language
	  ○ Stop locations
	  ○ Arrival times
	  ○ Wayfinding sign formats and meanings
	• At the transit mall
	  ○ Wayfinding signs in formats that do not require a high level of English proficiency
	• On vehicle
	  ○ Confirmation of the vehicle route and direction
	• User information:
	  ○ Pick up and destination locations
	  ○ Preferred language

Item	Scenario 8: A rider with limited English proficiency is navigating to the correct bus stop in a transit mall.
Related User Needs	RID-19-2 - Pathways in advance RID-20 - Diversity of interfaces RID-20-1 - Preferred language RID-20-2 - Plain language RID-28 - Limit words RID-29 - Info before arrival RID-32 - Exact stop locations RID-33 - Confirm vehicle RID-40 - Schedule changes RID-45 - Communicate without text

Table 16. Scenario 9: A rider in a rural area without consistent internet needs to book a trip into the closest urban area for a shopping trip.

Item	Scenario 9: A rider in a rural area without consistent internet needs to book a trip into the closest urban area for a shopping trip.
Short Description	In this use case, the user wants to book a trip to an urban location to run errands but cannot access apps or websites that require fast or consistent internet connections. The user has a mobile device that can access internet when connected to wireless, but does not have access using data. They are able to send and receive calls and text messages.
Goal	The goal of this use case is to illustrate that not all riders have consistent access to the internet, and that riders need to be able to book trips and access information in ways that do not depend on fast or consistent internet access.
Constraints	• A significant constraint in this use case is that the user does not have consistent internet access. They will need to be able to research, book, and access their trip with limited or no internet use.
Geographic Scope	This user is traveling from a low-income rural neighborhood to a small urban neighborhood several miles away.

Item	Scenario 9: A rider in a rural area without consistent internet needs to book a trip into the closest urban area for a shopping trip.
Actors	• Transit Agency • Rural low-income rider • Commercial app (possibly)
Preconditions	1. The transit agency needs to have an app or other interface that does not require constant internet connection and an ability to book trips, distribute necessary information, and answer questions by alternate means such as phone or text message. 2. The transit agency needs to be able to send alerts about delays or changes by means that do not require internet access
Main Flow	1. The user accesses the internet from their home computer to get basic information about their trip (service area and times timing) and is able to access this in a format that does not require fast or consistent internet. 2. The user is able to call or text the agency with questions and successfully complete a trip booking through these communication channels and does not have to rely on an online chat or email function. 3. There is a delay or disruption to the user's trip and the user receives a text message letting them know. The user is then able to either wait through the delay or book a different trip that meets their needs. 4. Using this information, the user is able to navigate to their pickup location at the correct time and board the vehicle.
Alternate Flow(s)	1. The user accesses a mobile trip planner that can plan their trip without a present data connection. 2. The user is able to book the trip using the trip planner app. 3. The user begins and tracks the progress of their trip offline along the planned itinerary which includes transfers and walking using a GPS enabled mobile phone. 4. The user receives a text message letting them know that there is a delay or disruption to the itinerary. 5. The user is then able to modify their itinerary for a trip that meets their needs.
Post-conditions	1. The user is able to successfully complete their trip.

Item	Scenario 9: A rider in a rural area without consistent internet needs to book a trip into the closest urban area for a shopping trip.

Information Requirements	• Transit service information:
	  ○ Online trip information that doesn't require a fast internet connection to load
	  ○ Contact information for transit agency
	  ○ Trip reservations and answer to questions by phone
	  ○ Trip updates and alerts by phone or text message
	• Transit service needs information on:
	  ○ Rider contact information (for alerts)
	  ○ Rider location and trip needs

Related User Needs	RID-01 - Discover DR RID-01-4 - DR wait time RID-01-6 - DR origin and destination RID-01-7 - Book quickly RID-13 - App guidance RID-15 - Customer service RID-17 - No internet RID-17-1 - Real-time through SMS RID-17-2 - Limited internet RID-19 - Device accessible RID-19-1 - Space for mobility device RID-19-3 - Loading mobility device RID-27 - Confidence in info RID-31 - Adjust preferences RID-36 - Way back home RID-40 - Schedule changes OP-03 - Tech sophistication not required OP-04 - Phone reservations MUL-03 - Contact information

Table 17. Scenario 10: A rider who is a victim of stalking is planning a trip home from work at night using transit and their bike.

Item	Scenario 10: A rider who is a victim of stalking is planning a trip home from work at night using transit and their bike.
Short Description	In this use case, the user is a victim of stalking and has significant safety concerns. They are planning a trip home from their workplace at night and evaluating which options are the safest for them. They have their bike with them and are looking at all options available that use transit and their bike.

Item	Scenario 10: A rider who is a victim of stalking is planning a trip home from work at night using transit and their bike.
Goal	The goal of this use case is to illustrate rider safety concerns and interest in multimodal trips. Riders need to be presented with information about safety amenities and options for their trip so that they can make informed choices that work best for them.
Constraints	• This user is traveling with a bike, so they will need to confirm that they are able to bring their bike on any vehicle they are taking or can safely store their bike before boarding. • This user has personal constraints around safety that may impact locations where they do or do not feel comfortable as well as wanting to know if there will be lights, other people around, or other safety amenities.
Geographic Scope	In this scenario the user is traveling from an urban commercial area to a suburban residential area at night.
Actors	• Transit Agency • Rider with safety concerns and a bicycle • Vehicle operator • Commercial app (possibly)
Preconditions	1. Information is available online regarding multimodal trip planning and bike accommodations 2. Information is available about safety information such as amenities near stops and information on likely number of people near stops
Main Flow	1. User researches trip options online and it able to find either the agency's website or a third party trip planning application 2. User is able to discover multiple trip options using a combination of biking and riding transit 3. User is able to see information on safety accommodations such as lighting at boarding, transfer, and alighting stops in each potential trip, as well as whether there is space for bikes on board vehicles 4. User picks an option based on their specific safety needs and bike needs 5. User is able to safely complete their chosen trip.
Alternate Flow(s)	
Post-conditions	1. The user safely completes the trip of their choice.

Item	Scenario 10: A rider who is a victim of stalking is planning a trip home from work at night using transit and their bike.

Information Requirements	• Transit service information:
	  ○ Data on bike storage and accommodations
	  ○ Data on safety amenities
	  ○ Ability to trip plan multimodal trips using transit and a bike
	• Transit service needs information on:
	  ○ Rider location
	  ○ That the rider is bringing a bike

Related User Needs	RID-01 - Discover DR RID-02 - Various trips RID-15 - Customer service RID-18 - Safety features RID-18-1 - Safety at waiting area RID-18-2 - Station patrol RID-18-3 - Stops along route RID-18-4 - Safety at intermediate points RID-19 - Device accessible RID-19-5 - Bikes on board RID-19-6 - Bikes on board real-time RID-19-8 - Bike parking RID-27 - Confidence in info RID-33 - Confirm vehicle RID-35 - Right stop RID-36 - Way back home RID-37 - Various options RID-38 - Expect crowding RID-39 - Aware of apps MUL-03 - Contact information

Table 18. Scenario 11: A state DOT analyst is supporting a social service agency in identifying the transportation services available in a new operational region and their service parameters.

Item	Scenario 11: A state DOT analyst is supporting a social service agency in identifying the transportation services available in a new operational region and their service parameters.
Short Description	In this use case, a state DOT analyst is researching services available in an area and their eligibility requirements so that they can present that information to a local social service agency.

Item	Scenario 11: A state DOT analyst is supporting a social service agency in identifying the transportation services available in a new operational region and their service parameters.
Goal	The goal of this use case is to illustrate how important it is for transit information to be easily accessible and what kinds of information a state analyst might need.
Constraints	• A constraint in this use case is that the analyst is only searching in one geographic area
Geographic Scope	This scenario involves a geographic area surrounding a social service agency which may include rural, suburban, and urban areas.
Actors	• DOT analyst • Social services agency • Transit agencies • Third party commercial transit apps
Preconditions	1. Information about available services and eligibility requirements are available online in a complete and accurate way
Main Flow	1. Analyst accesses the DOT's directory of transit agencies in the area 2. Analyst is then able to use this list to identify available services and find more information on each service 3. Analyst has questions regarding details of agency's services, and is able to look up the administrative contact information for the agency in order to get those questions answered. 4. Analyst compiles information on each available service, booking requirements, fares, and applicable eligibility requirements
Alternate Flow(s)	
Post-conditions	Analyst is able to provide the Social Services agency with a complete report on transit options in their area.
Information Requirements	• DOT-maintained directory of transit agencies in the area • Data on booking requirements, eligibility, and fares

Item	Scenario 11: A state DOT analyst is supporting a social service agency in identifying the transportation services available in a new operational region and their service parameters.
Related User Needs	OP-01 - Integrated trip planning REG-03 - Review ridership REG-04 - Administrative contact MUL-01 - See full network MUL-03 - Contact information

Table 19. Scenario 12: A small demand response operator is transitioning to a new scheduling system.

Item	Scenario 12: A small demand response operator is transitioning to a new scheduling system.
Short Description	In this use case, small demand responsive transit operator of different types of general public and eligibility restricted service in a rural county is purchasing a new scheduling system to manage the scheduling of trips on their transit service.
Goal	The goal of this use case is to illustrate how procurement guidelines and state support will ease the process of vendor selection and software implementation, and result in improved technology access for riders without undue burden on transit operators.
Constraints	• A constraint of the use case is that the size of the operator means both the operator capacity for procurement and the number of vendors and level of vendor interest is relatively low, so an extensive and complicated procurement process to identify the right vendor is not feasible.
Geographic Scope	This use case takes place in a rural or small urban setting, but research and communication happens online and is not location dependent.
Actors	• Small rural transit operator • B2G software vendor • State DOT acting as agency support

Item	Scenario 12: A small demand response operator is transitioning to a new scheduling system.
Constraints	1. The transit operator serves diverse riders through multiple services and must be able to accommodate multiple use cases within software, such as deviated-fixed and eligibility-restricted demand-response. 2. The operator also needs to exchange some trips with a local taxi company which has an overlapping service area.
Preconditions	1. Procurement guidelines have been placed within the funding agreement between the transit operator and the State DOT, necessitating that the transit operator participate in a state data program or purchase a scheduling system capable of producing the appropriate standardized data formats.
Main Flow	1. Transit operator reviews state guidelines indicating the requirements of the scheduling software they want to purchased. 2. Transit operator contacts state DOT for technical assistance and receives a proposed scope of work to include in an RFP, as well as a list of vendors that are known to meet the guidelines. 3. Transit operator publishes an RFP including the proposed scope of work and receives multiple responses within budget. 4. Software vendor and DOT supports the transit operator through implementation, and helps the operator integrate the published data from their system into the state data system. 5. Software vendor and DOT are both able to use their standard data quality assurance processes to confirm that the agency is successfully publishing GTFS data as required.
Alternate Flow(s)	State DOT could use a group purchase arrangement allowing the operator to forgo an RFP and purchase directly from a list of vendors at pre-negotiated prices.
Post-conditions	1. The transit operator implements new scheduling software which complies with the data guidelines, and integrates that data into the data APIs and directory/analysis front end as well as into mobile applications such as Google Maps, while still accepting phone reservations and other desired customer endpoints and internal processes.
Information Requirements	• Transit operator must provide local operation constraints, and information such as size of fleet and staff in order to allow appropriate pricing by vendor.

Item	Scenario 12: A small demand response operator is transitioning to a new scheduling system.
Related User Needs	OP-02 - Booking through rider apps OP-04 - Phone reservations OP-08 - Different types of trips OP-09 - Transfer trips OP-10 - Assess data quality OP-11 - Procure software REG-03 - Review ridership B2G-02 - Assess quality MUL-04 - Two-way exchange in booking MUL-06 - Alignment on needs

Table 20. Scenario 13: A rider advocacy group is working with a specialized transportation provider to present an analysis to the DOT and legislature regarding the need for investment in underserved communities.

Item	Scenario 13: A rider advocacy group is working with a specialized transportation provider to present an analysis to the DOT and legislature regarding the need for investment in underserved communities.
Short Description	In this use case, a rider advocacy group that works with specialized transportation operators around a state is teaming with a particular operator to make the case that fixed route and demand responsive transit services must be expanded through additional state financial resources in order to provide a level of service adequate to rider needs and equitable with other regions.
Goal	The goal of this use case is to illustrate how the directory/analysis frontend can provide information regarding specialized transportation services, and used to present analyses on the accessibility of transit in a region.
Constraints	• The capability of providing complete analyses of the transportation network in a region will depend on all transportation services being included within the directory, including services operated through contractors to a larger specialized operator. • Additionally, accessibility of a transportation network may depend on mapping information regarding curb cuts and other infrastructure not controlled by the transit agency.

Item	Scenario 13: A rider advocacy group is working with a specialized transportation provider to present an analysis to the DOT and legislature regarding the need for investment in underserved communities.
Geographic Scope	The geographic scope of this use case is primarily within a large region including some urban, suburban, and rural areas, but also refers to areas outside the region for comparison.
Actors	• Rider Advocacy group • Specialized transportation operator
Preconditions	1. All transportation services within the three-state project region have been incorporated into the directory/analysis frontend, so that any comparable areas can be referred to in the analysis.
Main Flow	1. Rider advocacy group identifies area of analysis, in collaboration with specialized transportation operator, as well as areas for comparison 2. Rider advocacy group downloads needed data from the directory analysis front end, such as number of services and vehicles available and frequency and stop locations of fixed route services 3. Rider advocacy group downloads comparison data from other areas 4. Rider advocacy group performs analysis defining level of service in area of concern compared to other areas in the state 5. Rider advocacy group and specialized transportation operator prepare and present analysis to state DOT demonstrating unmet needs and level of funding needed to bring the service up to a level equitable with other regions.
Alternate Flow(s)	
Post-conditions	1. The advocacy group and operator demonstrate the level of funding needed to the state DOT to provide adequate services in the region.
Information Requirements	• All transportation services must be available through the data APIs and directory/analysis front end. • The rider advocacy group must have access to mapping data allowing them to analyze the transportation services in light of infrastructure information.
Related User Needs	REG-02 - Anonymized DR trips REG-05 - Vehicle location auditing MUL-07 - Map data

Table 21. Scenario 14: A vendor is calculating the potential return on investment from building a new software product for the transit market

Item	Scenario 14: A vendor is calculating the potential return on investment from building a new software product for the transit market
Short Description	In this use case, a software vendor is considering making an investment in a new software feature and wants to calculate the expected return on their investment possible by selling that feature to transportation services within a region.
Goal	The goal of this use case is to illustrate how vendors will be able to use the new directory/analysis interface to better plan for business expansion, and thereby provide services to transit agencies more efficiently.
Constraints	• This use case will be constrained by the presence of full and complete data for the three state region being available through the directory/analysis frontend.
Geographic Scope	The geographic scope of this use case is the entire three state region of Washington, Oregon, and California.
Actors	• B2G software vendor
Preconditions	1. All transportation services within the region have been incorporated into the directory/analysis frontend.
Main Flow	1. Vendor queries the data APIs or directory/analysis frontend for the number of agencies, vehicles, and or bus stops within the region depending on the exact technology being planned for. 2. Vendor performs worst case/base case/best case analysis on an expansion plan for their product sales, and compares expected revenue and expenses to planned investment.
Alternate Flow(s)	3. As an additional step, because there is an interest by the state DOT in the planned investment, the vendor applies for a project and receives a grant to fund part of the development, in exchange for the funded portions being open source technology.

Item	Scenario 14: A vendor is calculating the potential return on investment from building a new software product for the transit market
Post-conditions	1. The vendor can demonstrate the return on investment expected by investing in a new technology and selling it to agencies in the three state region.
Information Requirements	• All transportation services must be available through the data APIs and directory/analysis front end.
Related User Needs	B2G-01 - Identify customers MUL-06 - Alignment on needs

Table 22. Scenario 15: A state DOT is trying to add additional depth of information on mobility devices to the GTFS specification

Item	Scenario 15: A state DOT is trying to add additional depth of information on mobility devices to the GTFS specification
Short Description	In this use case, the state DOT sees the need to represent a new mobility device-related piece of information to travelers and needs an extension of GTFS to relay this additional piece of information.
Goal	The goal of this use case is to illustrate how DOTs or other parties interested in further standardization can leverage the data standardization process to meet traveler needs.
Constraints	This use case will be constrained by the fact that the standard is governance is dependent on consensus of stakeholders reaching beyond the three state area. The use case will also be constrained by the readiness of agencies and vendors to adopt new specification extensions.
Geographic Scope	The geographic scope of this use case is the entire three state region of Washington, Oregon, and California.

Item	Scenario 15: A state DOT is trying to add additional depth of information on mobility devices to the GTFS specification
Actors	• State DOT • System Coordination Committee • Technical non-profit • Rider App Developer
Preconditions	The state DOT will need to have a GTFS producing agency and GTFS consuming app ready to implement their addition to the GTFS specification.
Main Flow	1. State DOT collects needs from riders. 2. State DOT brings their needs to the System Coordination Committee. 3. The State DOT/Committee confirms the interest the of GTFS producing agency and GTFS consuming app, and reviews the compliance of agencies and vendors to the current spec, to gauge feasibility of further extensions to accommodate required use cases. 4. State DOT/Committee approaches Technical non-profit with needs. Technical non-profit helps the DOT/Committee understand any overlap with other standardization efforts. 5. Technical non-profit suggests Spec Extension as a standardization solution. 6. The State DOT, Producer, Consumer as well as the greater GTFS community review solution and come to agreement. 7. The Producer and Consumer implement the spec. 8. The Spec Extension is voted on by the community. 9. The Spec Extension is added to the Data APIs and Directory/Analysis Frontend and added into the data adoption tools, Procurement guidelines.
Alternate Flow(s)	8. Some members of the global GTFS community provide the feedback that the information being added is specific to the US context, and the vote for inclusion within the spec does not pass. However, the State DOT, SCC, and Technical non-profit agree that there is sufficient need to warrant an unofficial spec extension.
Post-conditions	The State DOT can show that riders are now able to access the additional piece of information to ease their travel.
Information Requirements	• Stakeholders must understand GTFS and its governance process.
Related User Needs	REG-01 - Assess compliance MUL-02 - Clear governance

7. Summary of Impacts

The purpose of this section is to describe the impacts of the proposed new system on all stakeholders affected by the system. This includes the impacts on users, developers, maintainers, and other involved agencies and organizations. This section describes how the transition period will impact users and stakeholders, including needs for users transitioning from the current system to the new system, and give a description of the impact of these changes on each involved agency and organization.

7.1. Operational Impacts

The purpose of this section is to describe the operational impacts of the proposed new system on users and maintainers of the system. Users will adapt to some new processes and have new data sources available. Maintaining organizations will incorporate new data sources (e.g. GTFS data extensions), using new tools, which will introduce new operational risks.

7.1.1. Changes for riders

The system is focused on meeting the described user needs for riders and generally there will be minimal changes to the processes riders use in order to find transit information. Rather, there will be an improvement of the information provided to allow those riders to answer the questions they need to before and during their trip. The proposed system does offer some new tools and major features to riders that may allow new processes and operational expectations. First, the inclusion of demand-responsive transportation, which is generally absent from customer-facing mobile applications today, will mean that some users who only ride demand response transit will have entirely new tools to use. These tools will be new options, but current processes involving phone communication will remain. Second, the integration of booking and related payment capabilities to mobile apps such as Google Maps, Transit, and Navilens may require some adjusted processes for how the rider manages their account with some transportation services. At times riders may need to provide information to applications not owned by the agency and not part of the system or provide information to agencies or the SCC-managed support desk about the third-party services they used. These new features will require that riders consider and review the potential privacy and other impacts of new tools and make informed decisions regarding the use of those services.

7.1.2. Changes for other end users

The directory/analysis front end and knowledge base/support desk will provide new tools for riders as well as other users to discover trips and answer other questions they have about transit services. This will be a more significant change for other end users such as social service agencies, rider advocacy organizations, vendors doing market research, campuses like employers or hospitals, and DOTs in their analysis role, because unlike riders those users do not have applications designed for their use cases today so they will need to adopt entirely new operational processes. A new interface providing easy access to both high-level and detailed

information regarding transit services will allow new operations at different organizations to integrate standardized data into their processes. In most cases this will allow for the improvement of current processes to simplify the retrieval of information used to support clients or analyze transportation services for decision-making purposes. In other cases, new data sets will allow for entirely new or substantively revised processes. For example, an employer or university may incorporate stop locations and frequency analysis or demand-responsive transportation options into their workflow. This will require establishing new policies for how that data is incorporated into analyses as well as introduce new operational risks in the case of performing data retrieval processes incorrectly or in case of inaccurate data.

7.1.3. Changes for regulators

State DOTs will see a variety of operational changes that streamline and improve downstream processes at those agencies, but also require the standardization of upstream processes that organize data. Additionally, there will be new necessary functionalities related to transit operator technical support that will be required in order to encourage those operators to meet new regulatory expectations. In requiring that transit agencies with constrained budgets adopt new technology systems and publish data that is not published in standardized formats today, it will be necessary for DOTs to provide quality technical support to operators to be sure that they understand the requirements and processes necessary. The management of standard data products such as the official list of transportation services will necessitate the development of business processes through existing staff resources, which will require new staff skills and training as described in section 7.2. DOTs will also need to establish processes for the implementation of SCC policy decisions into their operations and for contributing to the governance of that body.

7.1.4. Changes for transit operators

Transit operators will begin using new technologies provided by software vendors for the purposes of scheduling and dispatching. Some of the changes to those software systems will not affect transit operations. The output of data in standardized formats will not require new processes where some form of that data is already published. This could include even some agency demand responsive service operations not changing substantially, as some riders may already be using apps to book trips automatically and the use of a public application such as Google Maps instead of the current app may have very little impact on the operator. In cases where demand responsive booking is not offered, new automation will require the development of business processes to manage new booking options. New operational processes also need to be defined for the management of information that is may not be collected under the current system, for example with regard to the amenities available at transit stops or the specifications of vehicle accessibility features. The changes for transit operators would be more intense if the desirable brokerage system subcomponent is included in development. Brokerage features will increase the number of parties involved in scheduling trips and the likelihood of schedules needing to be adjusted based on changes in capacity. These factors will increase the staffing and training needed to manage demand responsive scheduling software, and necessitate more automation of notifications and other customer relations features.

7.1.5. Changes for vendors

Vendors will be expected to incorporate a variety of new features into their software systems, which will require the adaptation of business processes currently in effect to ensure that these new features are delivered successfully. In many cases, these changes will clarify the relationship and needs of transit operators and reduce the burden of current processes where those needs are not clear. The focus on providing standardized data through open APIs may reduce the need for operations regarding publishing custom data formats or UIs and allow for improved operations. Neither scheduling or dispatch software vendors providing applications to transit operators, or mobile application vendors incorporating new transit data and displaying information to riders will be expected to institute processes that deviate substantially from their current operations over the long-term. Rather, vendors will be expected to improve the quality of their current business processes to incorporate new data and features related to core operational functions of their applications. Some important data transfers will take place that may involve user data or data derived from user data, and some of this data may be PII. Some vendors, especially those involved in booking and payment features, may need to establish new operational processes for the secure management of PII and policies for data sharing with other organizations.

7.2. Organizational Impacts

The CALACT ITS4US project will create a system with significant impacts on the responsibilities of state DOTs, transit agencies, and vendors operating within the three-state region. These responsibilities will require time and effort by all parties, but the costs of these responsibilities will be eased by the investments made directly through the project, which will increase coordination to reduce the expenses of system maintenance and reduce the inefficiencies experienced in the current system. The project team believes that the net effects on organizations will be to improve their efficiency and capacity to provide for desired outcomes, and that the maintenance requirements represent a healthy evolution of the organizations to more effective business structures rather than increased costs.

7.2.1. State DOTS

State DOTs, each of which is a partner to the project, will take on new responsibilities while also receiving new tools to make their current work more efficient. The State DOTs become the organizations primarily responsible for many of the features of the new system. During the course of the CALACT ITS4US project, these responsibilities will be fulfilled by project activities. After the duration of the project, these responsibilities will be ongoing activities of the DOTs which effectively support other DOT activities, but would require dedicated ongoing staffing and funding to maintain. DOT responsibilities will be defined by high-level outcomes and each DOT will likely take different operational paths to accomplish the outcomes coordinated through the System Coordination Committee..

- **Official list of transportation agencies**: The Official list of Transportation Agencies would be a new data product maintained by each DOT and they would be the responsible for maintaining them. This activity would be performed by staff assigned to the project during the term of the ITS4US program. After the duration of the program, a new staff or contractor responsibility would be defined to ensure that the list remained up to date, although this position would likely be less than a full FTE, except perhaps in California. The new position

would require training and new skills to collaborate with other state DOTs and transit agency partners as well as organize information gathered in the central database.

- **System Coordination Committee**: The System Coordination Committee would be fulfilled by the PMT with the advice of the PLC during the course of the project and would continue under a new governance plan after the project. DOTs would be central participants and require ongoing staff commitment to participate in system governance. Because this staff role would replace current coordination efforts that are less productive, they would not add substantial staff burden, but would yield increased alignment on administrative roadmaps which would allow for ongoing cost savings in other staff and contractor functionalities.

- **Procurement Guidelines**: State DOTs will issue official procurement guidelines for transit agencies hiring technology vendors to produce and maintain GTFS. These guidelines will specify the features and GTFS extensions software vendors must be equipped to publish and maintain in order to be considered a compliant vendor. These procurement guidelines will be required for all agencies receiving DOT funding, for example by being placed as a clause within funding agreements. These guidelines will be written with assistance from the System Coordination Committee, minimizing the additional staff burden on DOTs.

- **Interface Feature Wishlist**: The Interface Feature Wishlist will be governed by the System Coordination Committee, maintained by the PMO during the course of the ITS4US project. It will serve as a resource for transit app developers updated based on feedback from riders, social service agencies, and rider advocacy organizations..

- **Knowledge Base/1st Tier Support Desk Teams**: The Knowledge Base/1st Tier Support Desk will be governed by the System Coordination Committee and require staffing, perhaps within DOTs, to help direct individuals to the correct information. This increase in staffing should be minimal, because the support given should include fairly cursory information, and users will be directed to their local agency for ongoing and in-depth questions. During the course of the ITS4US project any staffing would be provided by the PMO or otherwise be funded work of the project.

- **Accessibility, Payment, Eligibility, Wayfinding Coordination Teams**: These teams will be overseen by the System Coordination Committee, managed by the PMO. Teams will be comprised of experts in their specific areas and will coordinate directly with vendors providing relevant materials and services to make specific recommendations. To the degree that DOTs participate directly in the Coordination Teams through the ITS4US project, like the System Coordination Committee, these staff roles would replace current coordination efforts that are less productive. They would not add substantial staff burden and will yield increased alignment on administrative roadmaps that would allow for ongoing cost savings in other staff and contractor functionalities.

- **Directory/Analysis Frontend**: This new feature would be governed by DOTs through the System Coordination Committee. DOT responsibilities for the maintenance of the directory frontend would be minimal, as the directory will managed by the PMO during the course of the ITS4US project and as most maintenance would take place by agencies through the maintenance of GTFS data. Staff training would be required in the use of the Directory/Analysis Frontend to retrieve transit service information; this additional capability would positively impact DOT operations and training would be supported by the PMO.

7.2.2. Transit Operators

Transit operators will have some new responsibilities within the new system while also receiving support and guidance from state DOTs that decreases the burden of those responsibilities, and new tools from software vendors that increase the effectiveness of their software applications.

- **Official list of transportation agencies**: Transit agencies will have a minimal responsibility to report certain key information regarding their GTFS data feeds and agency contact changes to the state DOT, but these will not require new staff or training.

- **System Coordination Committee**: Some transit agencies may be represented on the System Coordination Committee, but this would be voluntary and replace or align with current coordination activities.

- **Procurement Guidelines**: The procurement guidelines implemented by state DOTs would place new requirements on transit operators, by requiring that they purchase and maintain software systems that provide certain features not standard in these applications today. However, these procurement guidelines would also clarify the expectations for such systems, and with accompanying resources to assist in the procurement process, would ease the purchase of transit technology. Ultimately, the selection of technology would be easier and require less training to perform effectively.

- **Scheduling/CAD systems:** Transit agencies will need to maintain some data as part of operating scheduling/CAD software, but procurement/data guidelines will ease this burden. The operators will also be responsible for working with other parties to ensure that data outputs of the scheduling and CAD AVL systems meet data requirements. These requirements will be supported through training and support by and through DOTs and the vendors, and may complement or in the long term streamline reporting processes for NTD and other regulatory procedures.

- **Rider applications:** These would provide new tools that would improve rider-facing information but might also require new marketing responsibilities. Those new responsibilities would be eased by the 1st tier support desk.

- **Directory/Analysis Frontend**: This will be a new tool agencies can use to easily understand other transit services within their region or shared operational area. Transit agencies would bear the responsibility of ensuring their GTFS data, which would be posted to this directory, is up-to-date so other agencies have access to correct information and can conduct accurate analysis.

- **Brokerage (Desired)**: Transit operators will often be responsible for the organizational aspects of transit brokerages, but already fulfill this responsibility in the current system. Taking on organization of a brokerage would not be required of agencies, but would be a pre-requisite of some organization where the desired software would be used.

7.2.3. Technology vendors (B2G)

Technology vendors engaged in selling scheduling and dispatching software to transit operators

- **System Coordination Committee**: Technology vendors may be included as stakeholders on the system coordination committee.

- **Procurement Guidelines**: Vendors will need to follow these procurement guidelines when selling products to agencies.

- **Scheduling/CAD Systems:** B2G vendors will provide the software that makes up scheduling/CAD systems used by agencies (following required data/procurement guidelines).

- **Directory/Analysis Frontend**: The origin point for much of the directory data will be that which was produced through B2G vendors' scheduling/CAD software, so vendors will need to ensure that data meets the DOTs' standard of data quality and completeness for this system.

- **Brokerage (Desired)**: In order the brokerage subcomponent to be used, vendors would need to allow that software to access their APIs and book trips to the vendor software similar to other third-party rider-facing applications.

7.2.4. Technology vendors (B2C)

Technology vendors engaged in providing applications to end users

- **System Coordination Committee**: Technology vendors may be included as stakeholders on the system coordination committee.

- **Interface Feature Wishlist**: This is non-required, but B2C vendors will be a key part of the feedback loop that includes the wishlist. Vendors have the opportunity to upgrade and/or build new tools that meet market expectations catalogued here.

- **Rider applications**: B2C vendors will be the entities building new transit data into their apps propelled by these changes in the market. More than one major B2C technology vendor is a partner of this project and have committed to integrating these changes to rider-facing applications.

- **Directory/Analysis Frontend**: Vendors will be able to discover transit services to represent in their applications through this tool. This directory may also serve as the "fetch" location for much of an application's transit data repository.

7.3. Impacts During Development

Table 23: Impacts During Development

Stakeholder	Responsibilities	Disruptions	Opportunities
DOTs	DOTs serve a primary role in project governance. Staff members will need to contribute to and review project decision making outcomes.	DOTs will be establishing new processes and altering existing processes requiring changes in staffing and responsibilities.	DOTs will be able to decrease the cost of some operations.

Stakeholder	Responsibilities	Disruptions	Opportunities
Operators	The operators have the new responsibility to maintain software systems with enhanced capabilities but are supported in that effort, especially in the considerable upfront work to define elements like pathways, text-to-speech, and stop amenities. In some cases, this would be a responsibility which would require new staffing, and in others, additional staff training.	Operators will experience moderate disruption, as agencies in sponsored deployments will receive appropriate resources to manage the deployment and non-compliant vendor systems will be replaced through standard procurement cycles and processes. New responsibilities will require staff training and business process changes that may cause disruption.	Higher quality customer service tools will present the opportunity to improve relationships with customers. New software tools will also present the opportunity to decrease labor costs.

Stakeholder	Responsibilities	Disruptions	Opportunities
Vendors	Vendors will bear the primary responsibility for implementing new software features, but these responsibilities will be in line with current business processes.	New features will result in new staffing responsibilities and customer service requirements, as well as new operational risks for vendors.	Vendors who adapt quickly to the enhanced standardization approach will have a significant commercial opportunity to capture resources which would be spent on new software systems.
Riders	Riders will not see new responsibilities other than the responsibility to manage and consider the impacts of adopting new technologies.	New disruptions should be minimal for riders, as new technologies will be integrated into current trip planning platforms. New data flows should improve and increase the consistency of tools riders already use.	Riders will see the new opportunities of enhanced accessibility features and the ability to discover and book demand-responsive trips in public trip planning apps.

Stakeholder	Responsibilities	Disruptions	Opportunities
Other users	Other end users will not experience new responsibilities other than considering the impacts to their operations of adopting new tools.	Because these other users do not currently have appropriate user interfaces to meet their needs, they would experience only minimal disruption in integrating new, more functional tools into their processes.	Other end users would have the opportunity to integrate new tools into current business processes for increased efficiency and to leverage new data sets for processes that cannot be performed within the current system.

8. Analysis of the Proposed Systems

The goals of the CALACT ITS4US project focus on changing how the market for public transit rider information work through providing new types of standardized data. If project budgets were unlimited, there would be a variety of technology options available to fulfill those goals. Granted the scale of the budget, the project has identified the potential governance approaches available to alter the market through minimal regulations and coordination. Direct development of software applications being reserved for those few functionalities where the software can most easily be developed, and the costs most easily shared between diverse organizations and where governance processes are insufficient to fulfill user needs. This section analyzes the proposed approach in light of the benefits, limitations, and disadvantages of the approach, as well as alternative approaches.

8.1. Analysis of the Proposed System

The proposed system is designed to change the operations of the greatest number of entities possible while investing the smallest reasonable direct investment into the system. Additional investments could be made to better ensure the success of the system or increase the speed of transition to the new system for additional agencies beyond those included in pilot deployments. The proposed system is designed to easily allow additional investments to further support project objectives.

The proposed system focuses on adjusting the governance structure of the current system, which has only loose and ad hoc governance. Transportation services across the three-state region together make up a single transportation network that leverage on but are separate from the roadway transportation network. Transportation services are distinct from transportation infrastructure such as roadways in that transportation services do not require that travelers bring their own vehicle. Rather they provide transportation vehicles in shared ride services that provides a more accessible mobility network at lower overall system costs compared to the roadway network as infrastructure for privately owned vehicles. However, even though the network that is made of transportation services provides an alternative network which is more accessible, unlike the roadway network there is only limited cooperative governance of the information systems that describe how that network can be used. Instead, individual agencies, including very small and poorly funded rural transportation services, are left to create their own passenger information systems with few shared resources.

The development and proliferation of GTFS has demonstrated that shared resources are both desired by agencies and also powerful in providing improved customer experience. Like many other businesses, transit information has increasingly been provided through mobile devices during the last decade. GTFS—a shared resource for describing fixed route transit—has been central to this evolution and has yielded investments from numerous existing businesses and created entirely new businesses. But demand responsive transportation services, rural services, riders with disabilities, and other underserved groups have been partially or wholly left out of that evolution. Many needs of riders, agencies, DOTs, vendors and other users have not been fulfilled.

The CALACT ITS4S project proposes that a collaborative governance system that coordinates technical investments from the players across it is the best approach to improving the current system and meeting previously unmet user needs.

8.1.1. System Benefits

The major benefit of the proposed system approach is it redirects current system costs to increase efficiency. This is plausible because there are significant known inefficiencies in the current system. As shown in the current system diagram in Section 3.2, there are many data connections within the current system that do not function or function poorly. Because data is unstandardized or even uncollected, many system actors are operating with poor information. Transit agencies cannot easily procure software because the optimal software solution to address their needs is difficult to identify. Many users (DOTs, social service agencies, vendors, employers, and rider advocacy groups) who want to see and analyze transit information cannot find it easily, because there are no common user or application interfaces. DOTs in their regulatory role spend significant resources duplicating various data efforts and re-collecting core operator information like points of contact or demand response service areas because that information is not stored for easy accessibility.

By creating a system for data creation and maintenance, which shares the responsibilities of system maintenance across operators, vendors, and regulators, the proposed system coordinates currently inefficient activities. If successful, the result would be enhanced information for users, specifically the groups of underserved users identified by this project and institutional users such as the DOTs in their analysis role and rider advocacy groups, without long-term increased costs.

8.1.2. System Limitations

The proposed system is limited primarily by three factors: 1) the ability of state DOTs to foster changes in agency and vendor activity through regulatory process changes, 2) the capacity of defined technical coordination functions to keep pace with changing technology and communicate with agencies and vendors, and 3) the willingness of rider applications to follow suggestions of the interface feature wishlist and incorporate new data.

The DOTs take core responsibility in this project for enacting the procurement guidelines that are central to the ongoing maintenance of the GTFS data enhancements that must continue in order for the proposed system to function. Much of the information that would be required through these guidelines is already captured by agencies and their vendors,. The software and process investments necessary at different agencies and vendors would range from very small to very significant. Because some significant changes would be needed, it is possible that those agencies and vendors simply would not comply which would put the DOTs in the difficult position of needing to enforce requirements (which is generally not feasible) or accept non-compliance. This limitation is managed by the proposed system through additional DOT support for agencies and vendors, through the careful application of requirements which are reasonable and desired by most system users, and in potentially through funding for transit operators who are unable to purchase or use software effectively.

The defined governance process itself will require substantial ongoing maintenance. New accessibility issues will arise, and some system issues like eligibility verification, payment

standardization, and wayfinding can only be partially addressed by the project. These issues and adaptation to future events and market trends will require governance communications to continue, and also require technical coordination functions as identified in the proposed system diagram. This technical coordination will be difficult and time-consuming work that requires both communication skills and an understanding of the system. Only so much technical coordination will be possible at any given time, and some user needs will need to be actively prioritized over others.

Finally, the proposed system is partially contingent on investments being made by private sector actors operating rider applications that cannot be required to make those investments, including partners to the project other rider application vendors. These application vendors are encouraged to make investments in displaying more accessible trips, but based on the proposed system and current legal framework, may choose not to.

8.1.3. System Disadvantages

The primary disadvantage of the proposed system is that risks of complete system failure are relatively high as compared to other approaches. Because the proposed approach would leverage governance processes and include both suggested and required best practices communicated to other parties, it is possible that those other parties will fail to adopt the proposed best practices. If adoption is not widespread, the proposed system may completely fail and not produce many software artifacts of use to later systems. Focusing more resources on developing software applications could yield solutions that are more likely to impact a smaller number of users and a smaller number of use cases, and those software applications would be available for future projects even if this alternative approach still failed to fulfill the user needs identified in this ConOps. However, such technologies focused on specific localized contexts would be less replicable and considerably more expensive to scale. The project has determined that a governance approach, while it introduces greater risk of proposed system failure, also offers much greater opportunities for system success.

8.1.4. System Performance Measurement

The proposed system would put into place a new transit data governance approach to ensure that the GTFS published by transit agencies provides for the needs of riders with disabilities, older riders, low-income riders, rural riders, LEP riders, and riders with other safety concerns. Further, the governance system would provide tools and resources to allow all users to access this data and look up information regarding transit systems, and to support the development of rider applications by private party which put that data to use.

These high-level goals imply three different general approaches to measuring the performance of the system:

- Is there more GTFS data published, which complies with the accessibility-focused enhancements fostered by this project?

- Are users able to successfully answer their questions regarding transit services by using the tools and resources provided by the project?

- Do third-party application developers implement the accessibility features suggested by the project?

These general performance measurements will be broken down into a series of precise performance metrics, to be detailed in the Performance Measurement and Evaluation Support Plan. The data sources to be used by the project will be itemized in the Data Management Plan. Generally, data for the use in performance measurement will be drawn from

- The Directory Analysis Frontend and 1st Tier Support Desk: these tools and resources sponsored by the project will create user analytics and communications data sets that can be used to evaluate the amount of data created and how it is accessed by users

- Data sources developed in collaboration with transit operators: transit operators at deployment sites will have access to their riders and the capacity to request rider feedback through surveys, as well as provide data to the project such as rider feedback and complaints, or operational metrics such as number of riders

- Data sources provided by software vendors: both B2G and B2C software vendors will have access to data from their users which may support the measurement of project performance. These data sets will need to be discussed with and licensed from third-parties who own that data.

8.2. Alternatives and Trade-offs Considered

The CALACT ITS4US project considered a number of alternative system sub components that could have been deployed to solve for the user needs identified through the stakeholder engagement.

Demand responsive scheduling software

User needs confirmed that riders and operators both wanted to book trips automatically through public mobile applications, although operators identified some concerns regarding the functionality expected to fulfill that user need. The original CALACT ITS4US project proposal suggested that these user needs could be fulfilled by developing demand-responsive scheduling software for use by small transit agencies that are not generally served by the vendor market and model the real-time booking functionalities required. User research indicated that there were more vendors than expected both willing to work with smaller agencies of only 2-10 vehicles, and more vendor willingness to adopt standardized exchange specifications necessary to allow for third party booking. If a software application were developed the number of agencies that could be covered was small and the risks of development being unsuccessful or overbudget were comparatively high. Thus, the project selected a governance approach focused on mandating vendor compliance with open data standards.

Brokerage software requirement

The original CALACT ITS4US project proposal did not identify brokerages as a target system for enhancement. However, agency users identified this system as in important need from their perspective, in order to increase the efficiency of their operations. A system approach was considered that would have made the development of a brokerage software application a

required component of the system, potentially integrated with open source demand responsive scheduling or a standalone system, because there could be efficiencies in combining the booking of passenger trips with the exchange of trips with other agencies. However, the brokerage system does not meet a user need identified by the underserved groups of riders identified by the ITS4US program, even if increased operator efficiency would improve overall service for riders. Additionally, the proposed system could operate without brokerage software, and such software could be added in after the launch of other system components without disrupting those other components. For these reasons, the project determined to introduce this system subcomponent as desired but not required for a successful deployment.

Customer service instead of first tier support

Many users identified that their needs regarding asking basic questions or identifying proper points of contact were unfulfilled. This included representatives from underserved groups wanting to ask questions conversationally (i.e., not have to use an application user interface) as well as included some users being unaware that mobile user interfaces for transit information were available. The original concept identified in the CALACT ITS4US proposal was to develop shared customer service tools that agencies could use together, to increase the efficiency of customer service, but user research indicated that some customer service needs were very basic, and that knowing who to contact for customer service was a primary issue. Providing full customer service can be expensive, and some agencies have already made extensive investments in such platforms that should be leveraged rather than superseded. These investigations led the project to reframe the customer service subcomponent as a “first tier support” or “knowledge base” component which is meant to work in parallel to the directory frontend and direct users to the customer service and user interface tools best for them where those tools exist.

Eligibility and payments technology investments

The CALACT ITS4US considered integrating statewide eligibility verification systems and payment platforms to allow for a fully automated plan, book, and pay experience for riders of eligibility-restricted services. Operator and vendor users agreed that the goal was right, but that achieving that goal directly through near term investments was not practical. Riders also agreed with the goal but saw it as a long-term need rather than a high-priority short-term need. Eligibility policies and verification processes and systems are complex and politically fraught. The payments market is orders of magnitude larger than the transit market and major changes are currently taking place regarding contactless payment cards. The California Integrated Travel Project (Cal-ITP), working in collaboration with the CALACT ITS4US program, is investing significant resources in creating scalable technologies to address these user needs, and during the course of the ITS4US project more will be known about the success of those initiatives. The ITS4US project will invest in the GTFS extensions that provide better descriptions of eligibility restrictions and payment options, in order to allow for more basic and replicable plan, book, and pay applications while planning to incorporate more advanced applications as they become available

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