Phase 2 Interface Control Document (ICD)

GDOT ITS4US Deployment Project

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16. Abstract

The Georgia Department of Transportation ITS4US Deployment project, Safe Trips in a Connected Transportation Network (ST-CTN), is leveraging innovative solutions, existing deployments, and collaboration to make a positive impact using transportation technology to support safety, mobility, sustainability, and accessibility. The ST-CTN concept is comprised of an integrated set of advanced transportation technology solutions (connected vehicle, transit signal priority, machine learning, predictive analytics) to support safe and complete trips, with a focus on accessibility for those with disabilities, older adults, and those with limited English proficiency.

The Interface Control Document (ICD) describes the open interfaces implemented in the ST-CTN deployment. The ICD lists the services, their security, presentation and application layer protocols and specifications.

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Table of Contents

Revision History ..... **i**

Table of Contents ..... **iii**

1 Introduction **1**

1.1 Purpose of the Interface Control Document 1

1.2 References 1

1.3 Document Overview 2

1.4 Assumptions 3

1.5 Constraints 3

1.6 Risks 4

2 Project Overview **6**

2.1 System of Interest (SOI) 9

2.2 Functional View 11

3 Interface Description Overview **15**

3.1 Resource Objects 15

3.2 Interface Inventory 16

3.3 Interface Security by Subsystem 18

3.3.1 STM Security Approach 18

3.3.2 G-MAP Security Approach 18

3.3.3 Private and Public PMD Security Approach 19

3.3.4 Ride Gwinnett Security Approach 19

3.3.5 GCDOT TCC / PED-X Security Approach 19

3.3.6 Enhanced TSP Policy Server Security Approach 19

4 Interface Description 21
4.1 Interface Int-1 Ride Gwinnett GTFS 21
4.2 Interface Int-2 MARTA GTFS 23
4.3 Interface Int-3 Ride Gwinnett GTFS Realtime 25
4.4 Interface Int-4 MARTA GTFS Realtime 26
4.5 Interface Int-5 OpenStreetMap (OSM) 28
4.6 Interface Int-6 Network Impedance API 30
4.7 Interface Int-7 Sidewalk Sim Data 33
4.8 Interface Int-8 WAZE 35
4.9 Interface Int-9 GDOT NaviGAtor 37
4.10 Interface Int-10 Personal Safety Message (PSM) Count 39
4.11 Interface Int-11 G-MAP API 41
4.12 Interface Int-12 PED-X Actuation Request 44
4.13 Interface Int-13 Ride Request 50
4.14 Interface Int-14 Performance Measurement Dashboard (PMD) 54
4.15 Interface Int-15 PMD Data Feed 55
4.15.1 Framework PMD Data Feed 57
4.15.2 Example of PMD Data Feed 58
4.16 Interface Int-16 INS SDK 58
5 Requirements Traceability Table 61
6 Appendices 63
Appendix A. Acronyms and Abbreviation 65
Appendix B. Standards Plan 69
B.1 Standards Deployed 69
B.2 Gap in Standard Development 70
Appendix C. Document Change Log 73

List of Tables

Table 1. Referenced Documents 1
Table 2. Risk Management 4
Table 3. Critical ST-CTN Information Flow Descriptions 13
Table 4. Interface Generators and Consumers 15
Table 5. Interface Inventory 17
Table 6. Ride Gwinnett GTFS Interface 21
Table 7. MARTA GTFS Interface 23
Table 8. Ride Gwinnett GTFS Realtime Interface 25
Table 9. MARTA GTFS Realtime Interface 27

Table 10. OSM Interface 28
Table 11. Network Impedance API Interface 30
Table 12. Sidewalk Sim Data Interface 33
Table 13. WAZE Interface 35
Table 14. GDOT NaviGAtor Interface 37
Table 15. PSM Interface 39
Table 16. G-MAP API Interface 41
Table 17. PED-X Actuation Request Interface 44
Table 18. Ride Request Interface 50
Table 19. Inbound and Outbound Message Formats 52
Table 20. Agency Customizable Data Fields 53
Table 21. PMD Interface 54
Table 22. PMD Data Feed Interface 56
Table 23. INS SDK Interface 59
Table 24. Traceability Table 61
Table 25. Standards Deployed in the ST-CTN Project 69

List of Figures

Figure 1. Traveler's Complete Trip 6
Figure 2. ST-CTN High-Level Context Diagram 9
Figure 3. Functional Architecture for ST-CTN System 12
Figure 4. Ride Gwinnett GTFS Sequence Diagram 22
Figure 5. MARTA GTFS Sequence Diagram 24
Figure 6. Ride Gwinnett GTFS Realtime Sequence Diagram 26
Figure 7. MARTA GTFS Realtime Sequence Diagram 28
Figure 8. OpenStreetMap (OSM) Sequence Diagram 30
Figure 9. Network Impedance API Sequence Diagram 32
Figure 10. Sidewalk Sim Data Sequence Diagram 35
Figure 11. WAZE Sequence Diagram 37
Figure 12. GDOT NaviGAtor Sequence Diagram 39
Figure 13. Personal Safety Message (PSM) Count Sequence Diagram 41
Figure 14. G-MAP API Sequence Diagram 44
Figure 15. PED-X Actuation Request Sequence Diagram 46
Figure 16. Ride Request API Sequence Diagram 52
Figure 17. PMD Sequence Diagram 55
Figure 18. PMD Data Feed Sequence Diagram 57

1 Introduction

The Georgia Department of Transportation (GDOT) and Atlanta Regional Commission's (ARC) Safe Trips in a Connected Transportation Network (ST-CTN) project was selected by the U.S. Department of Transportation (USDOT) as a part of the ITS4US Deployment Program. The project seeks to enhance the traveler's complete trip travel experience by enhancing mobility, accessibility, reliability, and safety for system users, particularly for underserved communities, including people with disabilities, older adults, and users with limited English proficiency (LEP). This is done by leveraging innovative solutions, existing deployments and team collaboration such as integrating connected vehicle (CV) data with an open-source software-based trip planner that is used to provision web-based and mobile application user access. The trip planner will provide users with the ability to create a personalized trip plan with information regarding the navigation of physical infrastructure, the ability to resolve unexpected obstacles, and ensure users' visibility throughout the trip. The proposed deployment will provide targeted users with the ability to dynamically plan and navigate trips.

1.1 Purpose of the Interface Control Document

The Interface Control Document (ICD) describes the specifications and methods by which subsystems and components of the ST-CTN system exchange information.

This document identifies the application programming interfaces, security and communications protocols (i.e. internet protocols) that implement the exchange of information. The document audience assumes that the reader is familiar with the ST-CTN system architecture (**GDOT System Architecture Document**), internet standards and protocols, and Intelligent Transportation Systems (ITS) standards and specifications.

1.2 References

Table 1 lists the documents that were used to support the development of the ST-CTN ICD. References to these documents are identified with the acronym provided in brackets. Applicable standards are listed in **Appendix B Standards Plan**.

Table 1. Referenced Documents

ID	Referenced Documents
[CONOPS]	Atlanta Regional Commission. Deliverable Task 2 Concept of Operations. Atlanta: U.S. Department of Transportation. (2021).

ID	Referenced Documents
[SYRS]	Atlanta Regional Commission. Deliverable Task 6 System Requirements Specification. Atlanta: U.S. Department of Transportation. (2021).
[SAD]	Georgia Department of Transportation. Deliverable Task 2B System Architecture Document. Atlanta: U.S. Department of Transportation. (2023).
[SDD]	Georgia Department of Transportation. Deliverable Task 2B System Design Document. Atlanta: U.S. Department of Transportation. (2024).

1.3 Document Overview

The ICD describes the purpose of each interface between subsystems or components within the system and between the system and external systems. The document is organized as follows:

Section 1 Introduction – presents the purpose, overview, assumptions, constraints and risks associated with the interfaces deployed.

Section 2 Project Overview – describes the ST-CTN system of interest and functional architecture view that provides the context for the interface descriptions.

Section 3

Interface Description Overview – provides a summary of the interfaces, their flows and security applied by each system subsystem.

Section 4 Interface Description – detailed description of each interface Including Interface Identifier, Description, Associated System Requirement(S), Access Method / Link, Encoding Method, Interface Profile, Size, and Frequency.

Section 5 Requirements Traceability Table – a summary table of interfaces and their related requirements. The table validates that key interface requirements are met.

Section 6 Appendices – There are three appendices as follows:

> **Appendix A Acronyms and Abbreviation** – tables that list term definitions, acronyms and abbreviations.
>
> **Appendix B Standards Plan** – a plan that describes the standards that are used to deploy the system. In addition, through the design and deployment, the plan identifies areas where standard development would further support the deployment.
>
> **Appendix C Document Change Log** – Detailed changes that are made from original ICD throughout its update. *Note: since this is ICD Version 1, no changes were made from the initial version to a subsequent version.*

1.4 Assumptions

The following assumptions related to the ST-CTN system are presumed:

It is assumed that interface and security approaches will be deployed during the summer of 2024. The deployment and testing may impact and require changes to the interfaces or security approach. When there is a change in how the interface is specified in this document, an updated version will be issued, and the changes documented in **Appendix C**.

It is further assumed that data leveraged from outside sources will be maintained and of quality. Data ingested from outside sources will be reviewed and quality checked for accuracy and compliance with acceptable formatting prior to incorporating the data into the system. For example, there are several methods for encoding General Transit Feed Specification (GTFS) data. The data consumed is ingested from the Ride Gwinnett GTFS Data Manager and follows consistent encoding guidelines. On the other hand, OpenStreetMap (OSM) has less established guidelines for encoding sidewalk data and can be used in a variety of use cases. To that end, the ST-CTN team applied a consistent method for encoding sidewalk network data in OSM prior to its ingestion.

In addition, it is assumed that all user groups will be knowledgeable of how to properly use the Georgia Mobility and Accessible Planner (G-MAP) application.

1.5 Constraints

Impacts on the interfaces include the following:

- The GDOT signal system is currently under development. The new system is not expected to be thoroughly tested and deployed across the project region until at least 2025-2026. To that end, an alternative approach is being developed and implemented to address the Pedestrian Crossing Signal (PED-X) Actuation Request. A “proxy server” or gateway will be deployed to receive requests from G-MAP based on the traveler location at ten signalized intersections (with pedestrian signals and roadside units (RSU)). The gateway software will mimic the functionality of GDOT’s new traffic signal software system. This is an interim step to show how the PED-X application will work. The project will migrate the interface to the traffic signal system native application programming interface once it is fully deployed and tested in the project area.

- Since OSM is crowdsourced data where users can add and remove node identifiers (i.e., identifiers are not persistent), OSM data uploads for the STM subsystem and G-MAP application were synchronized to ensure consistency throughout the duration of the project. All future OSM updates will be handled in the same manner to ensure that the link and node identifiers are the same.

1.6 Risks

The project team managed several risks throughout Phase 2 related to interfaces. The risk description, severity and mitigation strategy (as defined in the **Phase 2 Project Management Plan**) are listed in **Table 2**, where severity is defined by the product of the probability and impact (probability * impact) to describe the calculated risk. This risk assessment approach is based on the commonly used Risk Index Priority Matrix. Severity ranges from 1 to 25 (high = 15-25, medium = 5, 8-12, low = 1-4, 6).

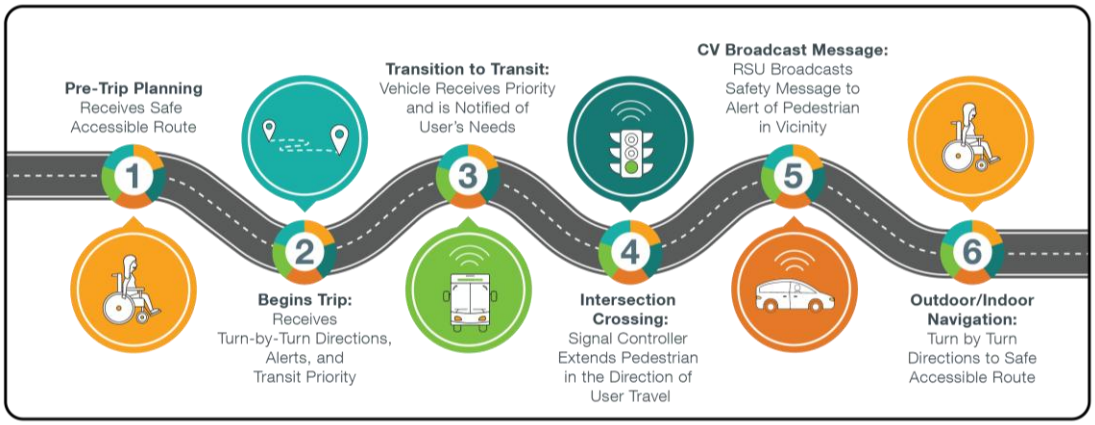
Table 2. Risk Management

Risk ID	Description	Severity	Mitigation Strategy
ICD-Risk-01	Change in external equipment and/or software that impacts information or communications exchange.	2	Any external system that is operating in degraded or failure mode will be detected, and travelers will be warned of any degradation in service.

Risk ID	Description	Severity	Mitigation Strategy
ICD-Risk-02	The PED-X application (component of the ST-CTN system described below) relies on a modified application programming interface (API) within the Qfree Kinetic platform. GDOT is migrating the MAXView/MAXTime platform to the centralized Kinetic platform. The migration is behind due to vendor delays.	6	The ST-CTN will facilitate an alternate path that gives a direct call to the controller in the event that Kinetic is not available. It will remove some functionality, but will achieve the needed outcome of placing a ped call if Kinetic is not available. The alternative architecture will provide remote ped actuation to up to 10 intersections and will be developed such that it is easily migrated to the central system for scalability during Phase 3 when Kinetic is online.
ICD-Risk-03	Due to PED-X architecture changes, a direct connection will likely be needed with Gwinnett County's central signal system. Coordination with Gwinnett County IT may take longer than anticipated.	6	The ST-CTN project team is coordinating with Gwinnett County IT to provide all information needed as soon as possible.

2 Project Overview

The ST-CTN project aims to upgrade and integrate existing technologies and services to assist underserved populations with completing their complete trip successfully, safely, and reliably. The vision of the project is to provide users complete trip functionality with directions, conditions, and status on the links between trip legs that are personalized based on the user's profile, while connecting the user to CV infrastructure to provide safer trips and more transportation network awareness. As an illustration of how the ST-CTN system will be used, transit-based trips were delineated into six segments (as depicted in **Figure 1**) to allow for easier understanding and a greater breakdown of priorities and goals.



Source: ARC, 2020

Figure 1. Traveler's Complete Trip

The delineated trip segments include the following steps and project components:

- **Step 1 Pre-Trip Planning.** The traveler plans for and receives a safe accessible route.
    - The ability to customize trip preferences based on the user's abilities.
- **Step 2 Begins Trip.** The traveler begins their trip and receives turn by turn directions, alerts, remote pedestrian activation, and can trigger transit signal priority (TSP) if the user requires additional time boarding or alighting a transit vehicle, is unable to stand for long periods, or is sensitive to weather conditions.
    - Turn by turn, shortest path, directions along pathways that meet user defined preferences.
    - Provides support services for users if they become disoriented or have issues accessing defined paths.
    - Activates TSP for buses if the user requires additional time boarding or alighting a transit vehicle, is unable to stand for long periods, or is sensitive to weather conditions.

Step 3 Transition to Transit. The traveler transitions to transit and the transit vehicle receives priority and is notified of users' needs. TSP can be triggered if the bus is running behind schedule due to a longer boarding time needed by a user.

- Provides users with transit trips that have accommodations that meet user defined preferences.
- Sends alerts to transit vehicles when users need additional time to board, navigate internally, or alight the transit vehicle.
- Remotely requests service from transit vehicles while waiting to board or alight.
- Triggers TSP if the bus is running behind schedule due to a user needing additional time to board or alight.

- **Step 4 Intersection Crossing.** When crossing a signalized intersection, the traveler indirectly interacts with the signal controller which extends the pedestrian phase in the direction of user travel.
  - Allows the user to communicate with connected intersections if they are unable to reach or press the crosswalk button.
  - Provides the user with information about the intersection crossing and adds time to the crossing if needed.

  Step 5 CV Broadcast Messages. RSUs broadcast safety messages to alert CVs of pedestrians/bicyclists in the vicinity.
  - Provides the ability for users to remotely request service from transit vehicles while waiting to board or alight.
  - Provides communications to CVs from pedestrian crossing signal systems (via RSUs) to make them aware of pedestrians crossing a roadway.
- **Step 6 Outdoor/Indoor Navigation.** The traveler is provided with turn-by-turn directions to a safe accessible route.
  - Hands-free navigation via mobile apps and/or wearables and accessible channels (haptic, voice, text).
  - Alerts and dynamic routing in response to changes in path conditions.
  - Provides the user with accessible routes into and through transit hubs within the project area.
  - Provides users with updates on the operating status of indoor infrastructure such as elevators and escalators.

There is an additional **Step 7** that is not part of the traveler's complete trip but is part of the ST-CTN system: **Reporting**. This step provides summaries of the data collected during the Complete Trip process.

System development and system integrations completed within the scope of this project will enable travelers – specifically those in the underserved community – to program and safely complete single mode or multimodal trips that are based on their abilities; improve the transition between modes by providing additional details to users and transit service operators; and suggest dynamic routing changes based on infrastructure condition and calculated delay.

The existing initiatives that are being leveraged to support the proposed ST-CTN system and those components that will be developed specifically to support ST-CTN project evaluation are defined in more detail below. The icons and colors depicted below are used throughout the document to clearly identify the critical components of ST-CTN. In some cases, partner agencies are upgrading the services within their current systems to create a more robust data set or toolset for the ST-CTN program.



OTP for G-MAP. Atlanta Rider Information and Data Evaluation System (ATL RIDES) includes an Open Source Software (OSS) multi-modal trip planning and mobile application, and a Connected Data Platform (CDP) using regional General Transit Feed Specification (GTFS) transit service data. The tool supports multi-agency context, multilingual support, and mobile app turn-by-turn directions. The OpenTripPlanner (OTP) architecture facilitates integration with additional OSS tools including a data analytics engine, call center module with APIs, and account management system. The existing ATL RIDES application will be modified and enhanced based on ST-CTN project needs and leveraged to create a new, independent application which will be differentiated as the *OTP for G-MAP* subsystem (hereafter referred to as G-MAP).



SIDEWALKSIM. SidewalkSim is an asset management system and shortest path (lowest impedance) routing tool for pedestrian pathways. Site inspections provide more detailed Americans with Disability Act (ADA) and inclusive design and condition data for use in pathway accessibility analysis. SidewalkSim identifies the best path between any two points in the pedestrian network, given the set of pathway characteristics and any user-specified needs and route penalties.



CV1K. The Atlanta region is home to one of the largest CV deployments in the United States – Regional Connected Vehicle Infrastructure Deployment Program (CV1K). CV1K is deploying interoperable CV technologies at signalized intersections throughout the Atlanta region using both Dedicated Short-Range Communications (DSRC) and Cellular Vehicle to Everything (C-V2X) technologies to deliver safety and mobility-based applications. The program provides support to configure, operate, and maintain CV infrastructure and applications, including TSP. Gwinnett County (GC) is one of the largest recipients of the first phase of this deployment.



CVTMP. GC's Connected Vehicle Technology Master Plan (CVTMP) sets out to develop and improve economic viability and quality of life, address the needs and challenges to motorized and non-motorized modes, establish guidelines for deploying technology, and have broad applicability to Gwinnett, other local jurisdictions, and across the state—to set the standard for implementing CVs. Among the high priorities is establishing a mobile accessible safety program and alternative strategies for TSP in Gwinnett County.



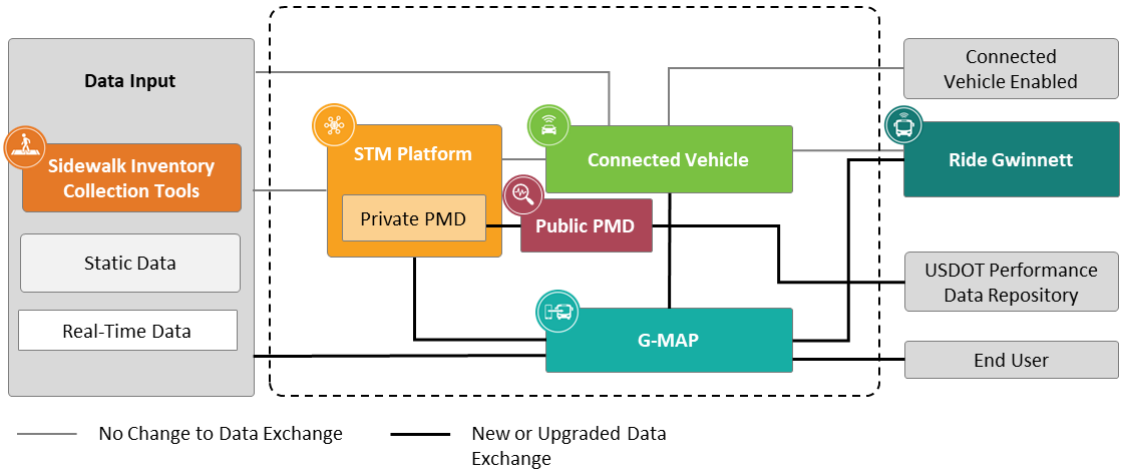
STM. The Space Time Memory (STM) platform processes traffic volume and speed data from multiple monitoring and modeling sources, tracks network performance measures, and predicts evolving route conditions using traditional and machine learning techniques. The STM projects trip trajectories through the transportation network, as network conditions change in space and time. This tool will be applied to analyze and predict performance through the multi-modal transportation network. The shortest path analysis will be applied to the combined roadway, transit, sidewalk, and shared-use path networks, allowing routing decisions to incorporate travel time, safety, and other impedances into path selection.

In addition, the ST-CTN system will include the development of a Performance Measurement Dashboard (PMD) that is not currently in use.

PMD. The PMD is a data storage and distribution tool that archives operational, survey and performance metrics of the system. The PMD is envisioned to ingest, quality check, and curate all types of data – static and dynamic, structured and unstructured, open and private datasets. The PMD will store the datasets so that they can be viewed and accessed based on user roles. The PMD will include a public PMD for the public to access open data presented on an interactive dashboard to the public.

2.1 System of Interest (SOI)

This section provides a high-level description of the proposed System of Interest (SOI). The context diagram presented in **Figure 2** illustrates the concept developed in Phase 1 and shows the interactions among the end user and subsystems. The subsystems, users, flows and their relationships are explored further in the four major architectural views presented in **Section 2.2**.



Source: GDOT, 2024

Figure 2. ST-CTN High-Level Context Diagram

The scope of the project will expand and enhance capabilities of the existing programs deployed in the project area. The programs are described as follows:

G-MAP Subsystem. Based on ATL RIDES which is being developed with the support of Federal Transit Administration's (FTA) Integrated Mobility Innovation (IMI) Grant program. The existing program provides more reliable and easier to access journey planning to all travelers making it easier to utilize the region's transit services. The ST-CTN will extend the ATL-RIDES functionality to provide additional user interaction to plan and safely complete single mode or multimodal trips that are based on their abilities; improve the transition between modes by providing additional details to users and transit service operators; suggest dynamic routing changes based on infrastructure condition and calculated delay, such as real-time transit data, work zone impacts, and impedance calculations based traffic conditions. The extended capabilities will be branded as G-MAP. It should be noted that during Phase 1, 'ATL RIDES' was used to describe the trip planning and user interface subsystem. However, the

subsystem naming convention has been refined to be described as G-MAP herein to clarify the distinct systems.

The G-MAP will include several additional functions to aid travelers in their journey. These include:

- **Ride Request –** The Ride Request application allows a transit passenger to send a stop request to an approaching transit vehicle. This application allows a transit vehicle to know that a passenger has requested a transit stop from a mobile device. The application will use the Gwinnett County Transit (GCT) Ride Request application integrated in their Computer Aided Dispatch / Automatic Vehicle Location (CAD/AVL) system as the core functionality that G-MAP uses to alert a transit operator to a traveler's presence and stop request at a transit stop.

- **Mobile Accessible Pedestrian Signal System** -- Mobile Accessible Pedestrian Signal System is an application that allows for an automated request via a center to center (C2C) information flow from G-MAP to the signal controller via a proxy server also known as the Secure Mobile Unit Gateway (SMUG) (part of the CV Subsystem) to request the pedestrian signal (PED-X) at a specific intersection crossing and extend the pedestrian walk time as needed. The PED-X signal at the intersection provides confirmation of the request.

- **Indoor Navigation** – The indoor navigation function will be enabled by the installation of waypoint and aiding transceivers to support the wayfinding and routing functions in the G-MAP mobile app. The indoor navigation beacons will be installed in the Gwinnett Justice Administration Center (GJAC) and Norcross OneStop, both facilities operated and maintained by the Gwinnett County Facilities Department.



Connected Vehicle (CV) Subsystem. The CV Subsystem is composed of the systems included as a part of the GC and GDOT CV programs. GC and GDOT are leaders in the deployment of CV infrastructure. The subsystem will leverage the current CV components deployed in the GC Connected Corridor and the GDOT CV1K projects including all the center, roadside, and vehicle components. As described in the current system, the center components consist of components located at the GDOT Traffic Management Center (TMC) and GC Transportation Control Center (TCC) – Navigator TMC, central system signal operations, Security Credential Management System (SCMS), Map Data (MAP) Server and ITS Hub connected through GDOT communications network. The GDOT communication network also consists of a SMUG that allow for information exchange between the G-MAP system and the signal controllers. The roadside components consist of traffic signal systems owned and operated by GDOT and Gwinnett County. The subsystem allows for the broadcast of pedestrian safety messages (PSMs) when pedestrians are in the vicinity or crossing at an intersection. The subsystem also provide TSP via the OBE on the transit vehicle to the signal controller via the RSE. The equipment and operations of the subsystems will not be changed in the ST-CTN project.



Space Time Memory (STM) Subsystem. The STM Platform predicts trajectories through the multimodal network based on network characteristics as congestion evolves in time and space and to provide users with more realistic estimates of commute duration, impedance value, and energy use across alternative departure times, routes, and transportation modes. The impedance-based network calculations are prepared in the STM

subsystem and include all-path networks (APN). The APN will include sidewalks and all local roads and will correspond to an updated OpenStreetMap (OSM) network employed after modifications are made to add missing pathways and remove non-pathway links to improve speed.



Performance Measurement Dashboard (PMD) Subsystem. The PMD Subsystem is a data storage and distribution tool that archives operational, survey and performance metrics of the system. The PMD is envisioned to ingest, quality check, and curate all types of data – static and dynamic, structure and unstructured, open and private datasets, store the datasets so that they can be viewed and accessed based on user roles, and provide access to and present open-based data on an interactive dashboard to the public. The PMD subsystem is comprised of private and public components where the private PMD manages and performs analytics on private data, including PII and then provides anonymized data to the public PMD. The public PMD displays the performance measures within a public facing dashboard and provides anonymized data to the USDOT Performance Data Repository.

2.2 Functional View

The Functional Viewpoint describes the functions (the 'what') and their interactions between the major subsystems and with external systems. As described in Section 1.4 of the SAD, the Functional View is the bridge between the Phase 1 concept and the Phase 2 deployment.

The Functional View focuses on the subsystems – existing and those that require expanded functionality and additional connectivity than is available within its current state. As highlighted in **Section 2.1**, the SOI includes four major subsystems (G-MAP, STM, CV, and PMD). In addition, system interfaces between SOI subsystems and with external system interfaces are described.

Critical ST-CTN data exchanges are identified by number and color in the context diagram and correspond to the exchanges described in **Table 3**. These descriptions are focused only on the scope of work required to implement the new system and information that is necessary to provide context to that work. As described in **Section 2**, there are a number of existing and on-going efforts that are being performed outside the scope of this project that are critical to the success of ST-CTN.

Figure 3 provides the ST-CTN high-level functional and information flow diagram in more detail and corresponds with the flows described in **Table 3**. The flows are further described in Section 5 of the SAD, including functional views for each subsystem within the system.

The legend below describes the objects displayed in the diagrams.

- Bold dashed boxes outline the system/subsystem of interest,
- Major subsystem components that are existing are depicted by rectangular boxes with transparent outlines,
- External system components are depicted by light grey rectangular boxes,
- People are designated with a silhouette inside of a rectangular box,
- Each subsystem is indicated by color and icon, as shown on the right.

Sidewalk Inventory Collection Tools is burnt orange

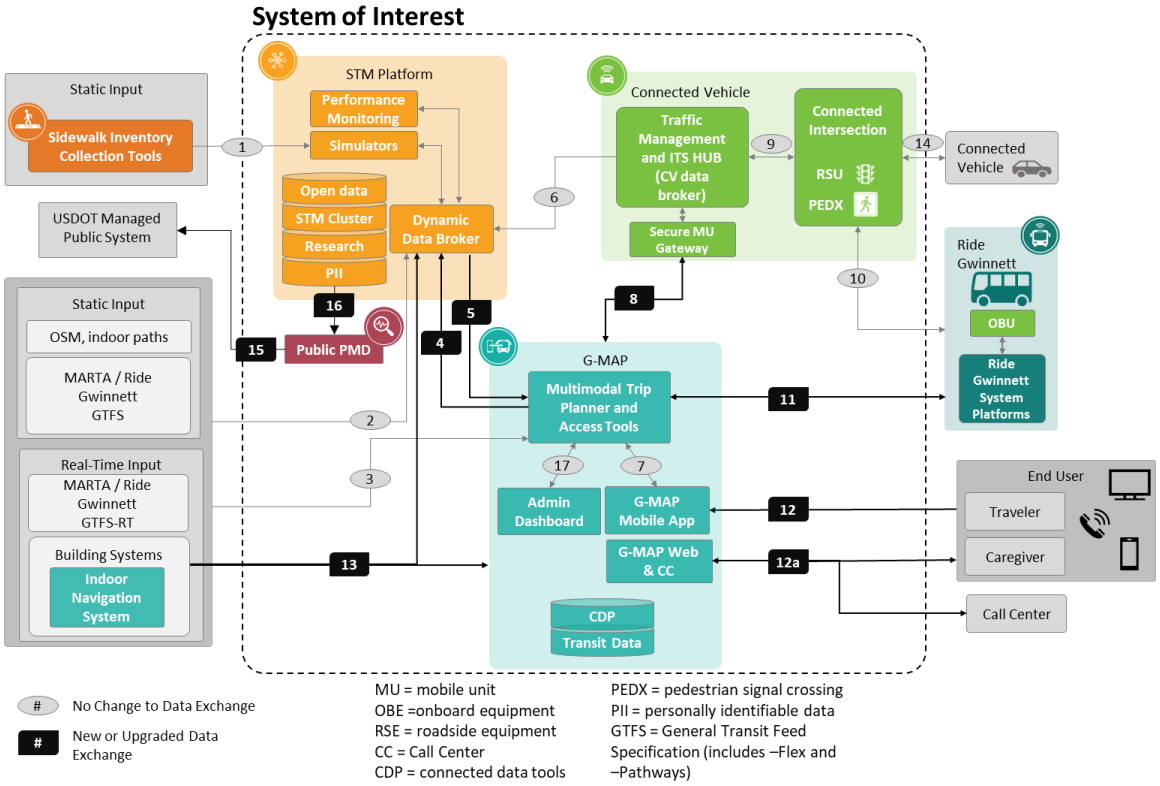
STM is peach

CV is green

OTP for G-MAP is turquoise

Gwinnett County Transit is teal

PMD is red



Source: GDOT, 2024

Figure 3. Functional Architecture for ST-CTN System

The system information flows are identified by number in the functional diagram above and described in **Table 3**. The grey oval labels indicate existing data exchanges that will be utilized with no change to the current data exchange. Black rectangular labels indicate data exchanges that will be new or upgraded to support the ST-CTN system. The information flow identifiers (column 1) in the table are used in every functional diagram in this section.

Table 3. Critical ST-CTN Information Flow Descriptions

Information Flow ID	Description	Source	Destination
1	Sidewalk inventory data, including accessibility features to the STM Platform simulators	External	STM
2	Static data from various existing sources to the STM Platform dynamic data broker	External	G-MAP, STM
3	Static and dynamic data from various existing sources to the G-MAP multimodal trip planner	External	G-MAP
4	G-MAP Mobile App logs and trip feedback	G-MAP	STM
5	STM Network Impedance API	STM	G-MAP
6	CV and Traffic Operations Messages: signal phasing and timing road characteristics, traffic data	CV	STM
7	OTP APIs and G-MAP APIs	G-MAP (trip planner)	G-MAP (channel access)
8	Mobile Accessible Pedestrian Signal System (PED-SIG)	G-MAP	CV (Secure Mobile Unit (MU) gateway)
9	CV messages includes Personal Safety Message (PSM) and other CV messages and Signal Controller monitoring and control information	CV (CV data broker)	CV (Connected Intersection)
10	TSP and other CV application messages	GCT Onboard Unit (OBU)	CV (Connected Intersection)
11	Ride Request messages	G-MAP Mobile App via G-MAP	Ride Gwinnett
12	G-MAP Mobile App APIs and Traveler exchange – profile, trip plan, settings, notifications, feedback, etc.	End user G-MAP mobile app	G-MAP Mobile App
12a	Similar data flows to Data Exchange ID 12 with restrictions on viewing and changing certain data.	End user G-MAP mobile app	Website, Call Center, Caregiver device

Information Flow ID	Description	Source	Destination
13	Dynamic information from building facilities, including beacon signals to the G-MAP Mobile App and INS vendor cloud SDK	Building System (external)	G-MAP
14	CV data	CV OBU	CV RSU
15	Project data for USDOT-managed Public System	Public PMD	USDOT Managed Public System
16	Public facing data and visualizations for reporting on system operations and performance	Private PMD (STM)	Public PMD
17	G-MAP Web Services and Traveler exchange – profile, trip plan, settings, notifications, feedback, etc. Access to functions and information depends on user role. Interface available to traveler (registered person), trusted companion, or call taker in call center.	G-MAP (trip planner)	G-MAP Admin Dashboard

3 Interface Description Overview

This section provides an overview of the GDOT ST-CTN ITS4US project interfaces, including a description of the resource objects, a complete interface inventory, and description of the security approach implemented for the interfaces by subsystem.

3.1 Resource Objects

Table 4 describes the actors who serve as data generators or consumers of the interfaces that are included in this document.

Table 4. Interface Generators and Consumers

ID	Component / Subsystem	Functional Description	Typical Role(s) (generator/consumer)
1	CV	Connected Vehicle ITS Hub stores CV data generated by the roadside units including PSM	Generator (external system)
2	GDOT TMC	This facility houses the traffic management center that supports the GDOT NaviGAtor system.	Generator (external system)
3	G-MAP	Trip Planner that provides turn-by-turn directions based on traveler's needs and preferences.	Generator and Consumer
4	G-MAP Mobile App	Mobile App that a traveler will access to provide profile needs and preferences to receive personalized trip plans.	Generator and Consumer
5	Gwinnett Transit	Gwinnet Transit produces GTFS and GTFS-realtime for fixed route transit service, as well as the on-board systems that manage the Ride Request message exchanges. In addition, Ride Gwinnett buses include Onboard Equipment (OBE) that transmit transit signal priority messages to the Roadside Equipment (RSE).	Generator (external system) Consumer (Ride Request and Enhanced TSP)
6	Indoor Navigation System (INS)	The INS includes the map update system (for the two indoor facilities) and the trip planner for indoor navigation.	Generator (external system)
7	MARTA	MARTA includes generator of GTFS and GTS-realtime for fixed route and rail transit services	Generator (external system)

ID	Component / Subsystem	Functional Description	Typical Role(s) (generator/consumer)
8	OSM	OpenStreetMap provides network information for the project areas.	Generator (external system)
9	GDOT/GC TCC	Traffic Control Center houses the operations and management of GDOT/GC traffic signal system including central communications network, traffic operations and road conditions data, and video systems.	Generator (external system)
10	Private PMD	Private performance management dashboard (data pipe and storage) for system archived data. Secure storage for private and Personally Identifiable Information (PII) datasets.	Generator / Consumer
11	Public PMD Portal	A portal that provides operational and analytic performance measures to the public.	Consumer
12	Public PMD	Public facing dashboard summarizing the performance of the ST-CTN system.	Generator / Consumer
13	Sidewalk Inventory Tool	Sidewalk Sim is a tool that collects and stores information about sidewalk accessibility measures (based on ADA compliance rules).	Generator (external system)
14	STM	Platform to support generating personalized, predictive trip planning.	Generator / Consumer
15	WAZE	A private system that collects and manages crowdsourced information about roadway traffic conditions. WAZE is represented by the 'Real-Time Data' box in Figure 2 and by the 'Real-Time Input' box in Figure 3.	Generator (external system)

3.2 Interface Inventory

Table 5 provides the list of interfaces that implement the exchange of information in the ST-CTN system.

Table 5. Interface Inventory

Interface ID	Interface Name	Generator	Consumer	Exchange Type (transaction / 1-way)	Information Std
1	GTFS – Ride Gwinnett	Gwinnett Transit	G-MAP	1-way	GTFS
2	GTFS -MARTA	MARTA	G-MAP	1-way	GTFS
3	GTFS realtime – MARTA	MARTA	G-MAP	1-way	GTFS realtime
4	GTFS realtime – Ride Gwinnett	Gwinnett Transit	G-MAP	1-way	GTFS realtime
5	OSM	OSM	STM, G-MAP	1-way	OSM
6	Network Impedance API	STM	G-MAP	Request-Response	Custom (based on OSM specification)
7	Sidewalk Sim Data	Sidewalk Inventory Tool	STM	1-way	Custom
8	WAZE	WAZE	STM	1-way	Proprietary
9	GDOT NaviGAtor	GDOT TMC	STM	1-way	Proprietary
10	PSM Count	CV	STM	1-way	Society of Automobile Engineers (SAE) J2735
11	G-MAP API	G-MAP	STM	1-way	Private
12	PED-X Actuation Request	G-MAP	GC TCC (PED-X / Kinetic)	Transaction	Custom
13	Ride Request	G-MAP	Gwinnett Transit	Transaction	Custom

Interface ID	Interface Name	Generator	Consumer	Exchange Type (transaction / 1-way)	Information Std
13a	Ride Request	G-MAP	TSP Policy Server (Enhanced TSP)	1-way	Custom
14	PMD	Private PMD	Public PMD	1-way	Custom
15	PMD Data Feed	Public PMD	Public	1-way	Custom
16	INS Software Development Kit (SDK)	INS	G-MAP Mobile App	Transaction	Proprietary

3.3 Interface Security by Subsystem

This section describes the network security protocols supported by subsystems and components. The following subsections describe the data transmission security approach of each subsystem and component.

3.3.1 STM Security Approach

The STM is hosted in a secure, access-controlled, Amazon Web Services (AWS) environment. Several of the inflowing data items such as the NaviGAtor data are pushed via scripts residing on secure Georgia Tech hosted servers to a password secured AWS-S3 bucket. Others, such as Waze data, are obtained from Waze servers with key based authentication over a HTTPS connection. The Impedance data is transmitted from the STM to the G-MAP servers via a password secured API over a HTTPS connection.

3.3.2 G-MAP Security Approach

Although generic routing functionality in G-MAP is publicly available and does not require credentials, access to user-specific preferences, including mobility profiles, favorite locations, notification settings, and trip search history is subject to authentication. A request to the G-MAP server for user preferences requires an HTTPS connection and a bearer token in the HTTP “Authorization” header. The bearer token is issued by Auth0, a platform used to verify a user’s identity, after a user enters correct credentials. The bearer token only allows querying and editing the data for one specific user and their “trusted companion”, if they have set up one.

G-MAP includes a basic reporting functionality that includes usage of the routing functionality and select user data. Files that constitute the report are uploaded using HTTPS to an Amazon Web Services S3 bucket with no public access, except the least privileges as required.

3.3.3 Private and Public PMD Security Approach

Private PMD Security Approach

G-MAP log data that is obtained from the G-MAP cloud servers is obtained from a secure AWS-S3 bucket via password authentication. The transmission of the aggregated non-PII data between the Private and Public PMDs occur similarly through a secure AWS-S3 bucket via password authentication. The Private PMD security approach is described in more detail in the Phase 2 Data Privacy Plan (DPP).

Public PMD Security Approach

No security will be applied to the interface available from the public PMD.

3.3.4 Ride Gwinnett Security Approach

To access the API, a unique authorization mechanism is required. Avail Technologies Inc. (Computer-Aided Dispatch / Automatic Vehicle Location (CAD/AVL) vendor for Ride Gwinnett) will provide the necessary details to relevant ITS4US technical partners.

3.3.5 GCDOT TCC / PED-X Security Approach

Proxy Server

The proxy server that will be deployed to support the connection between G-MAP and the Gwinnett County traffic signal system will be deployed and hosted on the Gwinnett County network. The Gwinnett County network is a secure, access-controlled environment.

G-MAP/GCDOT TCC Connection

The connection between the G-MAP application and the Gwinnett County TCC will be utilized to send pedestrian actuation requests from G-MAP to the Gwinnett County traffic signal system. Authentication for these requests will be handled through an API that will require a token to process the request.

3.3.6 Enhanced TSP Policy Server Security Approach

The TSP Policy Server uses HTTPS. The TSP Policy Server application programming interface (API) is accessed via an API Key. Only the TSP software agents, G-MAP, and trusted developers have the API key. API keys are tracked. Each system / developer gets a unique API key. No personally identifiable information is stored.

4 Interface Description

This section provides a detailed description of each interfaces implemented in the ST-CTN system. Similar information is provided for each interface including name, ID, description, associated requirements, access method / link, encoding method, profile, size, and frequency. Links and further detailed information are provided where available.

4.1 Interface Int-1 Ride Gwinnett GTFS

Table 6 describes the Int-1 Ride Gwinnett GTFS interface.

Table 6. Ride Gwinnett GTFS Interface

Interface Field	Description
Interface Name	Ride Gwinnett GTFS Static Feed
Interface ID	Int-1
Interface Description	The GTFS is a data specification that allows public transit agencies to publish their transit data in a format that can be consumed by a wide variety of software applications. Today, the GTFS data format is used by thousands of public transport providers (excerpt from gtfs.org, extracted 1/13/2023).
Associated Information Flow	Information Flow ID 2
Source / Destination	Gwinnett Transit to G-MAP
Requirement Traceability	**Requirement ID:** 3.1.0-103 **Related Requirements:** 0.0.0-232, 0.0.0-234, 0.0.0-235
Access Method / Link	• Access to this information is not publicly accessible. Data updates are available upon request.
Encoding Method	**Wrapper:** Zipped via HTTP Uniform Resource Locator (URL) • **Encoding**: Comma-Separated Values (CSV), text format

Interface Field	Description
Interface Profile	URL: Reference - General Transit Feed Specification (gtfs.org) • Ingest the following tables: ○ Agency.txt ○ Calendar_dates.txt ○ Fare_attributes.txt ○ Fare_rules.txt ○ Feed_info.txt ○ Frequencies.txt ○ Routes.txt ○ Shapes.txt ○ Stop_times.txt ○ stops.txt ○ transfers.txt ○ trips.txt
Size	Compressed – approximate 1.3 Megabyte (MB)
Frequency	Every Quarter

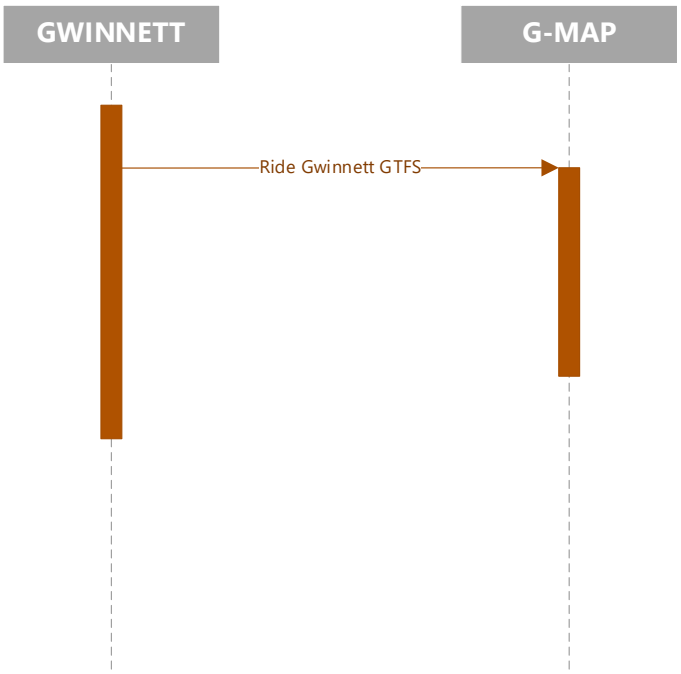


Figure 4. Ride Gwinnett GTFS Sequence Diagram

4.2 Interface Int-2 MARTA GTFS

Table 7 describes the Int-2 MARTA GTFS interface.

Table 7. MARTA GTFS Interface

Interface Field	Description
Interface Name	MARTA GTFS Static Feed
Interface ID	Int-2
Interface Description	The GTFS is a data specification that allows public transit agencies to publish their transit data in a format that can be consumed by a wide variety of software applications. Today, the GTFS data format is used by thousands of public transport providers (excerpt from gtfs.org, extracted 1/13/2023).
Associated Information Flow	Information Flow ID 2
Source / Destination	MARTA to G-MAP
Requirement Traceability	**Requirement ID:** 0.0.0-232 **Related Requirements:** 0.0.0-234, 0.0.0-235
Access Method / Link	• Access to this information is available from: https://opendata.atlantaregional.com/datasets/8c006d1f59b142469300c4e688208a2f/about or https://www.itsmarta.com/app-developer-resources.aspx • URL to access compressed file: https://www.itsmarta.com/google_transit_feed/google_transit.zip
Encoding Method	**Wrapper:** Zipped via HTTP URL • **Encoding**: CSV, text format

Interface Field	Description
Interface Profile	URL: Reference - General Transit Feed Specification (gtfs.org) • Ingest the following tables: ○ Agency.txt ○ Calendar.txt ○ Calendar_dates.txt ○ Routes.txt ○ Shapes.txt ○ Stop_times.txt ○ Stops.txt ○ Trips.txt
Size	Compressed – approximate 19 MB
Frequency	Every Quarter

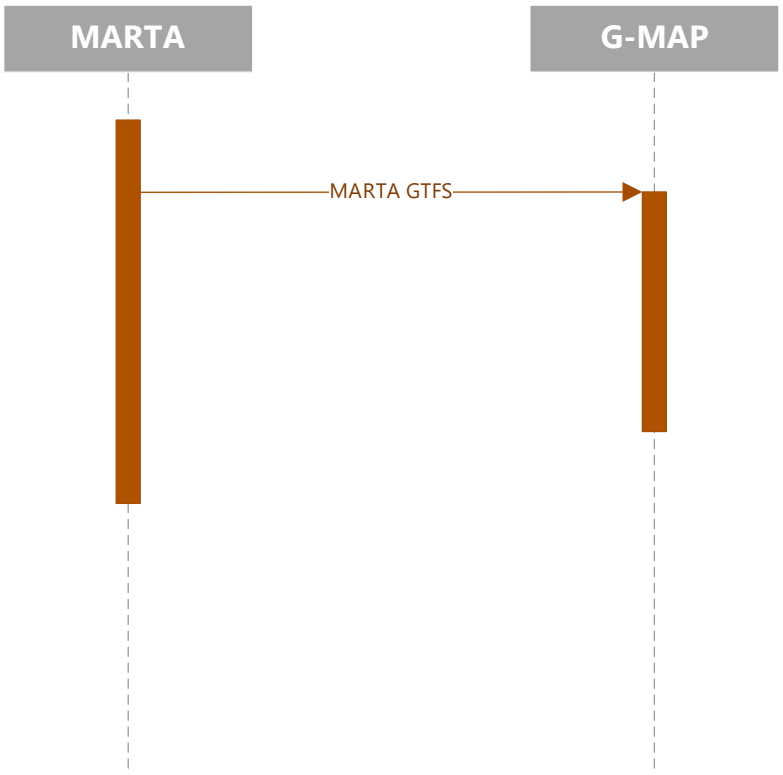


Figure 5. MARTA GTFS Sequence Diagram

4.3 Interface Int-3 Ride Gwinnett GTFS Realtime

Table 8 describes the Int-3 Ride Gwinnett GTFS Realtime interface.

Table 8. Ride Gwinnett GTFS Realtime Interface

Interface Field	Description
Interface Name	Ride Gwinnett GTFS Realtime
Interface ID	Int-3
Interface Description	Ride Gwinnett's GTFS Realtime is a feed specification that allows public transportation agencies to provide realtime updates about their fleet to application developers. It is an extension to GTFS (General Transit Feed Specification), an open data format for public transportation schedules and associated geographic information. GTFS Realtime was designed around ease of implementation, good GTFS interoperability and a focus on passenger information.
Associated Information Flow	Information Flow ID 3
Source / Destination	Ride Gwinnett to G-MAP
Requirement Traceability	**Requirement ID:** 3.1.0-104 **Related Requirements:** 0.0.0-233
Access Method / Link	• Trip Updates: https://realtimegwinnett.availtec.com/InfoPoint/GTFS-Realtime.ashx?Type=TripUpdate • Vehicle Positions: https://realtimegwinnett.availtec.com/InfoPoint/GTFS-Realtime.ashx?Type=VehiclePosition • Service Alerts: https://realtimegwinnett.availtec.com/InfoPoint/GTFS-Realtime.ashx?Type=Alert
Encoding Method	**Wrapper:** • **Encoding**: Protocol Buffer
Interface Profile	The following GTFS-realtime files are published • Trip Updates • Vehicle Positions • Service Alerts

Interface Field	Description
Size	Approximately – • Trip Updates – 16 kilobytes (kB) • Vehicle Positions – 16 kB • Trip Updates – 1,000 kB
Frequency	30 second intervals

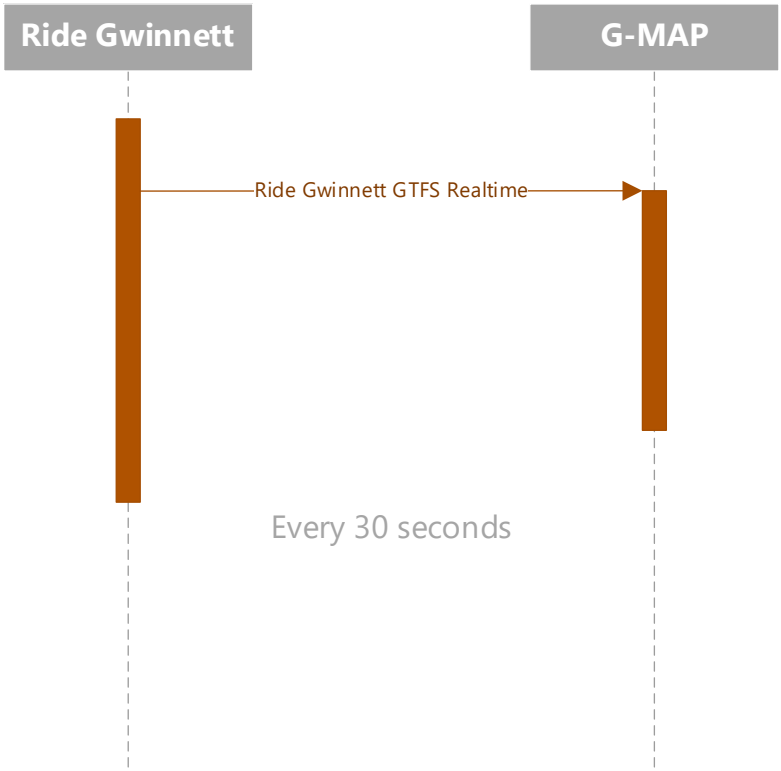


Figure 6. Ride Gwinnett GTFS Realtime Sequence Diagram

4.4 Interface Int-4 MARTA GTFS Realtime

Table 9 describes the Int-4 MARTA GTFS Realtime interface.

Table 9. MARTA GTFS Realtime Interface

Interface Field	Description
Interface Name	MARTA GTFS Realtime and MARTA Rail Realtime RESTful API
Interface ID	Int-4
Interface Description	MARTA's GTFS Realtime is a feed specification that allows public transportation agencies to provide realtime updates about their fleet to application developers. It is an extension to GTFS (General Transit Feed Specification), an open data format for public transportation schedules and associated geographic information. GTFS Realtime was designed around ease of implementation, good GTFS interoperability and a focus on passenger information. The Rail real time arrivals data feed uses a Web Service to receive a Representational State Transfer (REST) response.
Associated Information Flow	Information Flow ID 3
Source / Destination	MARTA to G-MAP
Requirement Traceability	**Requirement ID:** 0.0.0-233 **Related Requirements:** none
Access Method / Link	• Vehicle Positions: https://gtfs-rt.itsmarta.com/TMGTFSRealTimeWebService/vehicle • Trip updates: https://gtfs-rt.itsmarta.com/TMGTFSRealTimeWebService/tripupdate • Rail real time arrivals: https://developerservices.itsmarta.com:18096/railrealtimearrivals?apiKey=xxxxxxxxx (need to sign up for API key to access data)
Encoding Method	**Wrapper:** • **Encoding**: Protocol Buffer
Interface Profile	Information about the MARTA GTFS realtime can be found at https://www.itsmarta.com/app-developer-resources.aspx
Size	Actual – • Vehicle Positions – 16 kB

Interface Field	Description
	• Trip Updates – 1,000 kB
Frequency	30 second intervals

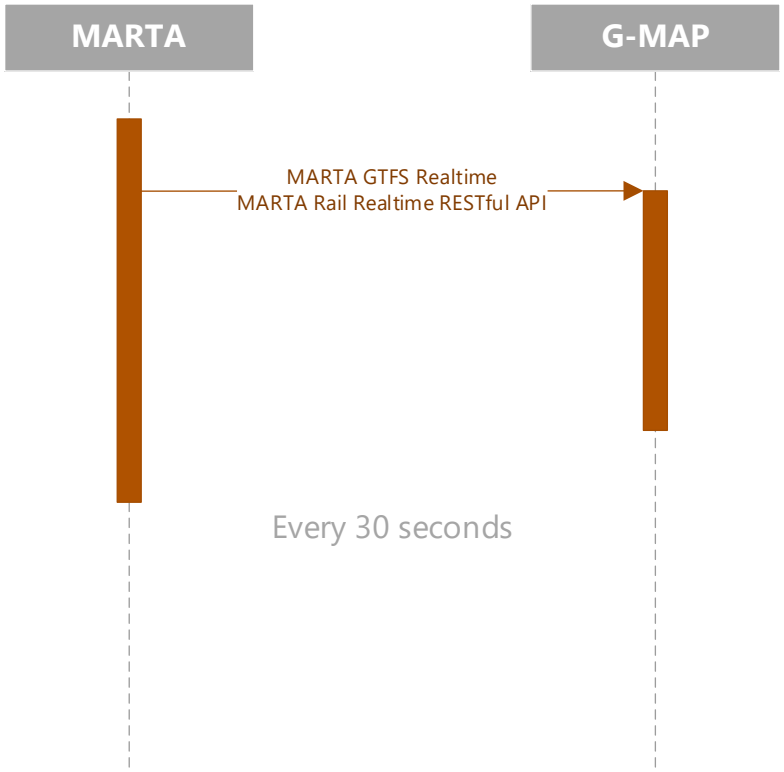


Figure 7. MARTA GTFS Realtime Sequence Diagram

4.5 Interface Int-5 OpenStreetMap (OSM)

Table 10 describes the Int-5 OpenStreetMap interface.

Table 10. OSM Interface

Interface Field	Description
Interface Name	OpenStreetMap (OSM)

Interface Field	Description
Interface ID	Int-5
Interface Description	The OSM interface provides open source base maps for the trip planning website and application. Public Right of Way (PROW) includes sidewalk and facility entrances in the project region integrated into OSM: • Public right of way data includes features and conditions of sidewalk, crosswalk, curb cuts, and walking paths • Access to transit stops and community shuttle pickup/drop off locations • Access to accessible building entrances
Associated Information Flow	Information Flow ID 2
Source / Destination	OSM to STM and G-MAP
Requirement Traceability	**Requirement ID:** 1.3.0-037 **Related Requirements:** 0.0.0-236, 1.2.0-018
Access Method / Link	Links to specific regions of Gwinnett County area in OSM: https://download.geofabrik.de/north-america/us/georgia.html or URL with information on how to access OSM area-- https://wiki.openstreetmap.org/wiki/API_v0.6#Retrieving_map_data_by_bounding_box:_GET_/api/0.6/map
Encoding Method	https://wiki.openstreetmap.org/wiki/PBF_Format
Interface Profile	Information about the OSM features and interface profile can be found at: https://wiki.openstreetmap.org/
Size	Depends on geofenced area exported
Frequency	A single download is stored. Updates to the base map will be synchronized with an STM update to ensure that the graph models are the same.

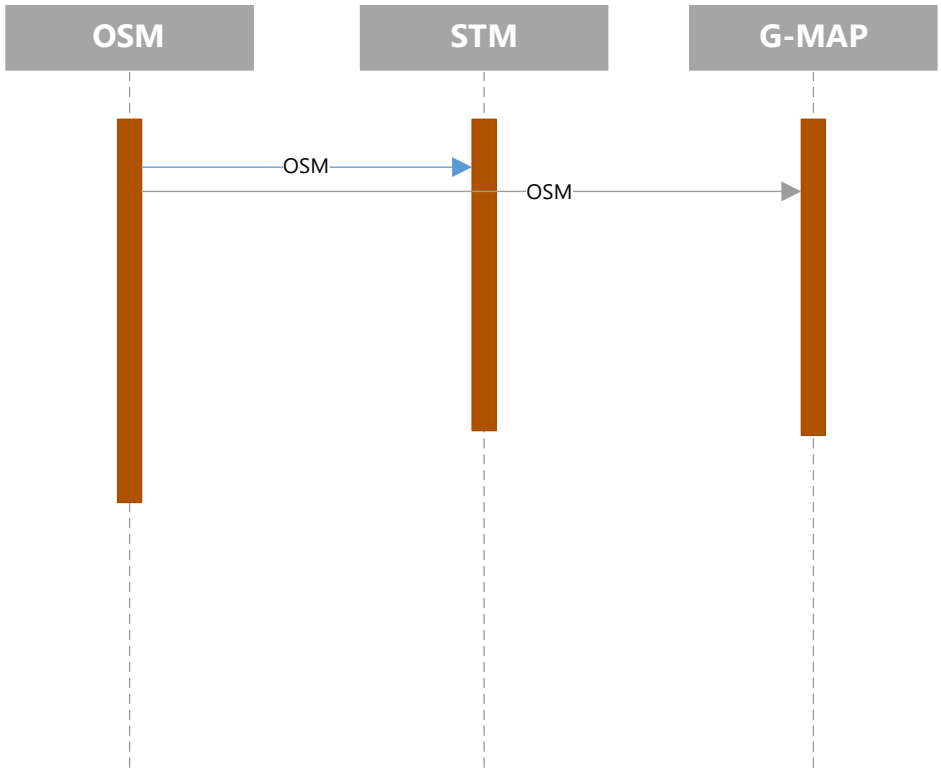


Figure 8. OpenStreetMap (OSM) Sequence Diagram

4.6 Interface Int-6 Network Impedance API

Table 11 describes the Int-6 Network Impedance API interface.

Table 11. Network Impedance API Interface

Interface Field	Description
Interface Name	Network Impedance API
Interface ID	Int-6
Interface Description	An API that incorporates network weights (impedances) to an OSM model graph database (links and nodes) that is generated by the STM Impedance Engine. Several layers of weights are included which are tailored to support travel by a variable number of mobility categories.

Interface Field	Description
Associated Information Flow	Information Flow ID 5
Source / Destination	STM to G-MAP
Requirement Traceability	**Requirement ID:** 1.3.0-034 **Related Requirements:** 1.3.0-030, 2.1.2-076, 2.1.3-077, 2.3.0-081
Access Method / Link	GET /api/impedance/gmap/export?id=*datasetid* The following error codes can be issued: • 400 (Bad Request) – If the URL parameters are not formatted correctly. • 404 (Not Found) – The provided "id" cannot be found. • 409 (Conflict) – The requested dataset is being updated and is currently unavailable. Wait and try again.
Encoding Method	**Request:** REST call (see "GET" method in Access Method/Link above). **Return:** CSV file that is formatted using link-node structure.
Interface Profile	See example below
Size	Varies depending on entire area or sub-area call, approximately 5-10 MB
Frequency	Same as Int-5 (OSM) at during Phase 2. Every 15 minutes in later months.

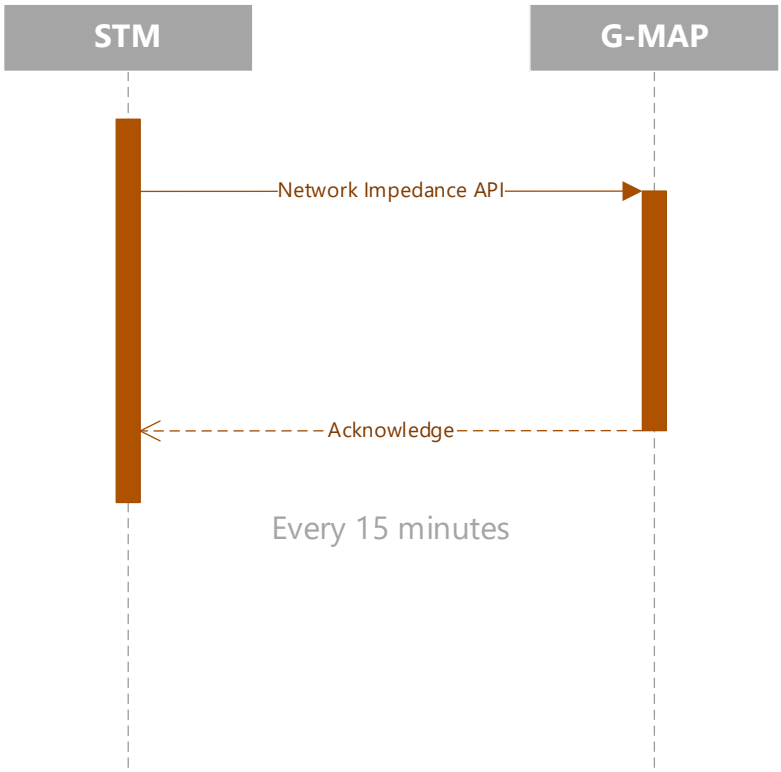


Figure 9. Network Impedance API Sequence Diagram

A user can specify a grid cell using the following datasetid (as identified in GET statement above) as a query string parameter:

Entire study area:

"area-1"

Sub-areas:

"33.8N84.4W": {"min_lat": 33.8, "max_lat": 33.9, "min_lon": -84.4, "max_lon": -84.3},
"33.9N84.4W": {"min_lat": 33.9, "max_lat": 34.0, "min_lon": -84.4, "max_lon": -84.3},
"34.0N84.4W": {"min_lat": 34.0, "max_lat": 34.1, "min_lon": -84.4, "max_lon": -84.3},
"33.8N84.3W": {"min_lat": 33.8, "max_lat": 33.9, "min_lon": -84.3, "max_lon": -84.2},
"33.9N84.3W": {"min_lat": 33.9, "max_lat": 34.0, "min_lon": -84.3, "max_lon": -84.2},
"34.0N84.3W": {"min_lat": 34.0, "max_lat": 34.1, "min_lon": -84.3, "max_lon": -84.2},
"33.8N84.2W": {"min_lat": 33.8, "max_lat": 33.9, "min_lon": -84.2, "max_lon": -84.1},
"33.8N84.1W": {"min_lat": 33.8, "max_lat": 33.9, "min_lon": -84.1, "max_lon": -84.0},
"33.9N84.2W": {"min_lat": 33.9, "max_lat": 34.0, "min_lon": -84.2, "max_lon": -84.1},
"34.0N84.2W": {"min_lat": 34.0, "max_lat": 34.1, "min_lon": -84.2, "max_lon": -84.1},
"33.9N84.1W": {"min_lat": 33.9, "max_lat": 34.0, "min_lon": -84.1, "max_lon": -84.0},
"34.0N84.1W": {"min_lat": 34.0, "max_lat": 34.1, "min_lon": -84.1, "max_lon": -84.0},
"33.9N84.0W": {"min_lat": 33.9, "max_lat": 34.0, "min_lon": -84.0, "max_lon": -83.9},
"34.0N84.0W": {"min_lat": 34.0, "max_lat": 34.1, "min_lon": -84.0, "max_lon": -83.9}

The response will be a CSV file. The header row and two rows of data is provided here as an example:

Timestamp,Upstream Node,Downstream Node,Link,None,Some,Device,WChairM,WChairE,MScooter,Vision,Vision+,Some-Vision,Device-Vision,WChairM-Vision,WChairE-Vision,MScooter-Vision,Some-Vision+,Device-Vision+,WChairM-Vision+,WChairE-Vision+,MScooter-Vision+
2023-10-01 12:00:00,8284970515,8285013518,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0
2023-10-01 12:00:00,8285013519,8285013522,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0

4.7 Interface Int-7 Sidewalk Sim Data

Table 12 describes the Int-7 Sidewalk Sim Data interface.

Table 12. Sidewalk Sim Data Interface

Interface Field	Description
Interface Name	SidewalkSim Data Feed
Interface ID	Int-7
Interface Description	The SidewalkSim data feed contains a graph (node-link) structure with sidewalk asset information including defects, ramps, curbs, curb cuts, intersection information and bus stop descriptions. The data feed contains information from sidewalk data collected during June 2023 and December 2023. Periodic updates will be performed per the operations and maintenance cycle (see *Comprehensive Operations and Maintenance Plan* (COMP)).
Associated Information Flow	Information Flow ID 1
Source / Destination	Sidewalk Inventory Tool to STM
Requirement Traceability	**Requirement ID:** 1.3.0-037 **Related Requirements:** 1.3.0-032, 1.3.0-035

Interface Field	Description
Access Method / Link	• REST API that pulls data from internal sidewalk data server
Encoding Method	CSV
Interface Profile	The CSV file includes the following information: 1. The header (first) row of the CSV file must contain columns with the "Variable Name" exactly as it appears in the defining spreadsheet. 2. All following rows must contain data in columns that align with the matching header row column. 3. The order of the columns does not matter, only that the data in each column matches the variable named in the same column in the header row. Variables include the following: • Links • Defect data • Ramp data • Curb data • Curb cut data • Crossing data • Bus stop data
Size	• Depends on scope and content of information.
Frequency	• Periodically, when change is detected or during update cycle.

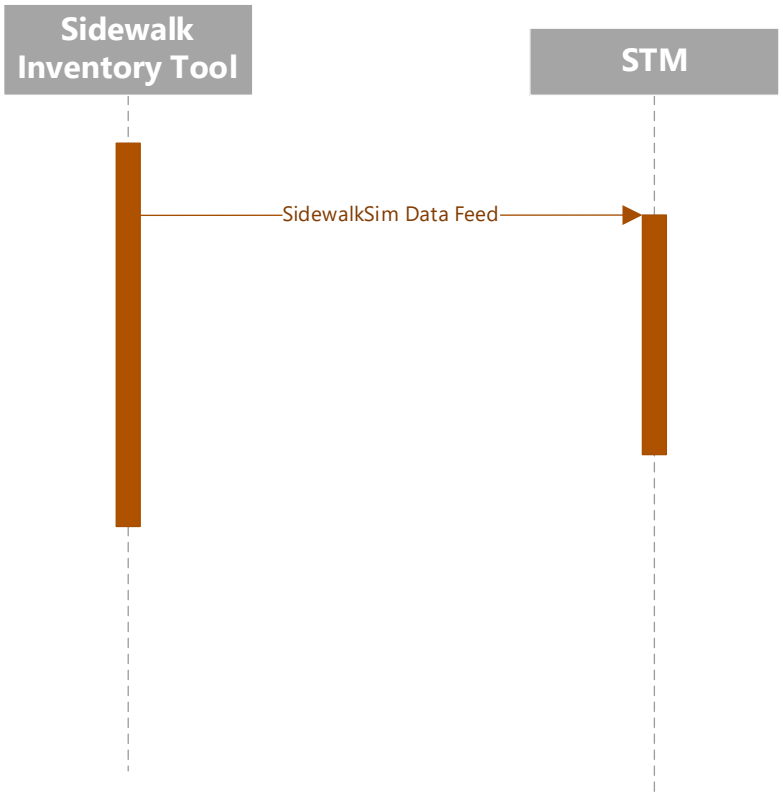


Figure 10. Sidewalk Sim Data Sequence Diagram

4.8 Interface Int-8 WAZE

Table 13 describes the Int-8 WAZE interface.

Table 13. WAZE Interface

Interface Field	Description
Interface Name	WAZE
Interface ID	Int-8
Interface Description	Geographically Encoded Objects Really Simple Syndication (GeoRSS) Cumulative Alert Data from Velocity feeds. The Waze Partner Hub data provides information about traffic jams and events that affect road conditions from drivers using Waze or from external sources.

Interface Field	Description
Associated Information Flow	Information Flow ID 3
Source / Destination	WAZE to STM
Requirement Traceability	**Requirement ID:** 6.1.0-249 **Related Requirements:** 6.1.0-150
Access Method / Link	REST API Through the WAZE Partner Hub
Encoding Method	Encoding Method: **JavaScript Object Notation (JSON)**
Interface Profile	Specifications are available from https://support.google.com/waze/partners/answer/13458165?hl=en for Alerts and Jams
Size	• About 150 KB
Frequency	At 5 minutes intervals

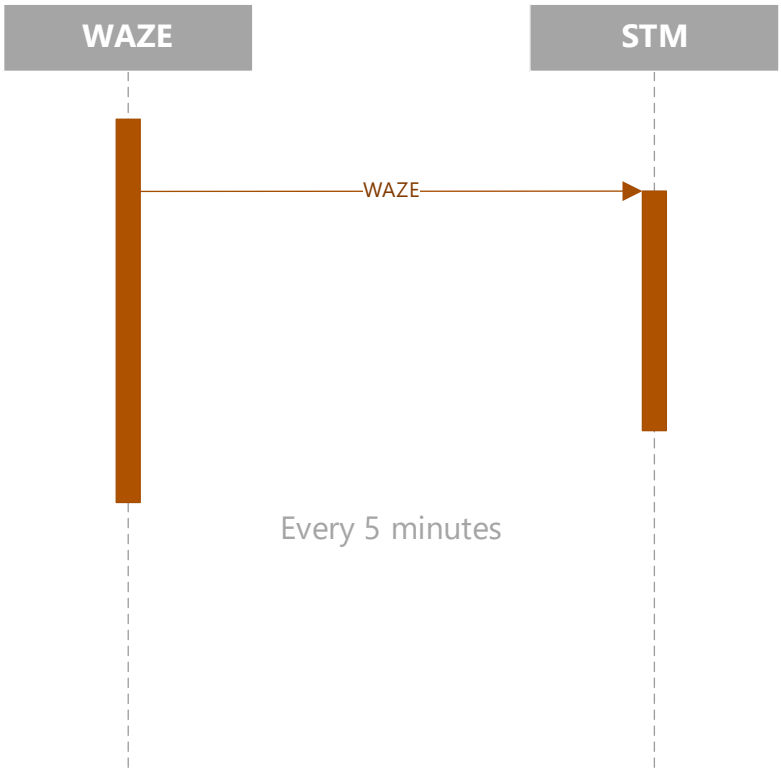


Figure 11. WAZE Sequence Diagram

4.9 Interface Int-9 GDOT NaviGAtor

Table 14 describes the Int-9 GDOT NaviGAtor interface.

Table 14. GDOT NaviGAtor Interface

Interface Field	Description
Interface Name	GDOT NaviGAtor
Interface ID	Int-9

Interface Field	Description
Interface Description	The GDOT NaviGAtor system monitors and archives data for monitored freeway and arterial links at 20-second, lane-by-lane resolution. The NaviGAtor data provides information on arterial links with intersections. NaviGAtor data will be retrieved from the GDOT NaviGAtor Structured Query Language (SQL) database server and stored as Amazon Web Services (AWS) S3 files in the CSV format. The NaviGAtor data is polled from the database at regular intervals and is initiated with an API call.
Associated Information Flow	Information Flow ID 3
Source / Destination	GDOT TMC to STM
Requirement Traceability	**Requirement ID:** 6.1.0-249 **Related Requirements:** 6.1.0-150
Access Method / Link	• Non-published URL, port, database and access method. For more information contact Bennett Foster (ARC). • REST API
Encoding Method	**Wrapper:** • SQL from GDOT Navigator SQL database server
Interface Profile	The following queries are made (i.e., Select from…): • Event_comment • Scheduled_event where modified_date >= (current time – one minute) • Unscheduled_event where modified_date >= (current time – one minute) • Event_property where property_id>=(last retrieved property_id) • device_id,detector_id,timestamp,status,CAST (volume as INT),speed,CAST (occupancy as INT), CAST(confidence as INT) from vsd_data • vsd_detector
Size	• Polled at specified dynamic rate
Frequency	5 minutes

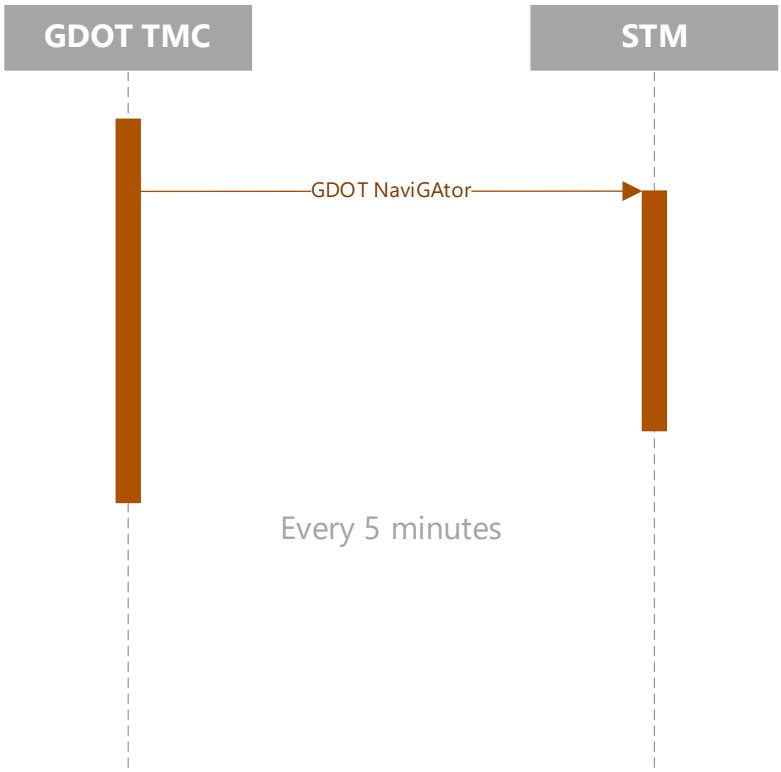


Figure 12. GDOT NaviGAtor Sequence Diagram

4.10 Interface Int-10 Personal Safety Message (PSM) Count

Table 15 describes the Int-10 Personal Safety Message interface.

Table 15. PSM Interface

Interface Field	Description
Interface Name	Personal Safety Message (PSM) count
Interface ID	Int-10
Interface Description	The interface lists all the times and sources (RSUs) that broadcast a personal safety message.

Interface Field	Description
Associated Information Flow	Information Flow ID 14
Source / Destination	CV to STM
Requirement Traceability	**Requirement ID:** 6.1.0-249 **Related Requirements:** 6.1.0-150, 6.1.0-180
Access Method / Link	Email to Private PMD from CV Data Hub
Encoding Method	Compressed CSV file
Interface Profile	The data contained in the message is an extract from the CV Data Hub. The information provided includes the following: The **header information** includes: From datetime, To datetime, Count (number of entries in file contents). The **file contents** lists each occurrence with the following entry: datetime (message broadcast), RSU ID (that broadcast the PSM)
Size	Varies
Frequency	Weekly

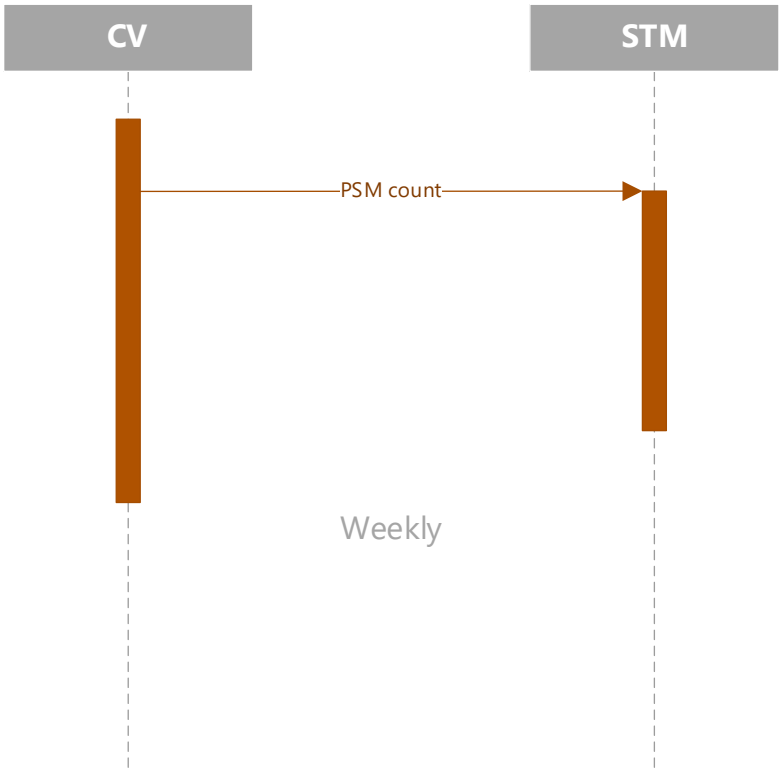


Figure 13. Personal Safety Message (PSM) Count Sequence Diagram

4.11 Interface Int-11 G-MAP API

Table 16 describes the Int-11 G-MAP API interface.

Table 16. G-MAP API Interface

Interface Field	Description
Interface Name	G-MAP API
Interface ID	Int-11

Interface Description	As users plan trips through the GMAP app, their requests will result in the generation of multiple JSON files: • TripRequest -- A trip request which contains date/time, origin and destination information, as well as a "userID" identifying the user that initiated the request. The trip request is provided to the Network Impedance API, which will generate a response containing a proposed route to their destination based on user mobility profile and impedance values. • TripSummary -- The proposed itineraries or routes (i.e. the set of directions without user trace data) for a TripRequest. The TripSummary contains a "tripRequestId" that associates the TripSummary to a TripRequest. • MonitoredTrip – A trip or itinerary with step-by-step directions that a user saves for monitoring alerts and delays, and for trusted companions to monitor someone's travel. • TrackedJourney -- As a user keeps the G-MAP mobile app for step-by-step navigation to their destination, a TrackedJourney is created that logs the user's positional trace data (latitude, longitude, speed, bearing, etc.) at frequent intervals (e.g. every five seconds); these are stored in a TrackedJourney file. The TrackedJourney data contains a "tripId" that associates it to a MonitoredTrip. • OtpUser -- Along with the collections of files associated with each trip initiated on a given day, there will be a set of OtpUser file representing each unique user that requested any form of navigation that day. Each OtpUser data model contains a user's unique ID value, their mobility profile data, and an array of their "savedLocations" data. TripRequests and MonitoredTrips can be associated to a Persona via their "userId" values. • Trip-survey-responses – referencing the monitored trip and user ID, and the push notification id. The in-app deviation survey will be collected into a CSV file . Compressed archives (zipped files) of the collection and each file will be uploaded to the G-MAP S3 bucket daily, and once per week will be processed by the Private PMD to generate performance metrics for the previous week. Each data model will have its own ZIP archive containing all the JSON or CSV files of that specific type for each day, along with an associated date stamp. File formats will appear as follows: <<YYYY-MM-DD-FileName.zip>>. For example: "2024-11-11-OtpUser.zip". The collection of the travel statistics will be named <<YYYY-MM-DD-merged,zip>>.

Interface Field	Description
Associated Information Flow	Information Flow ID 7
Source / Destination	G-MAP to STM
Requirement Traceability	**Requirement ID:** 2.1.2-075 **Related Requirements:** 2.1.2.-076, 2.3.0-081, 7.3.0-210, 7.3.0-208
Access Method / Link	Not available (contains trace data). For more information contact Bennett Foster (ARC). Note: these files will be uploaded to an S3 bucket daily
Encoding Method	Zipped file that aggregates multiple JSON encoded files
Interface Profile	The live interface format for these files may be found at https://zcl3o5i5ib.execute-api.us-east-1.amazonaws.com/prod/docs by searching for one of the desired entities listed above. The corresponding source code for these entities can be found at https://github.com/ibi-group/otp-middleware/tree/dev/src/main/java/org/opentripplanner/middleware/models.
Size	• Variable
Frequency	Uploaded daily to S3 bucket

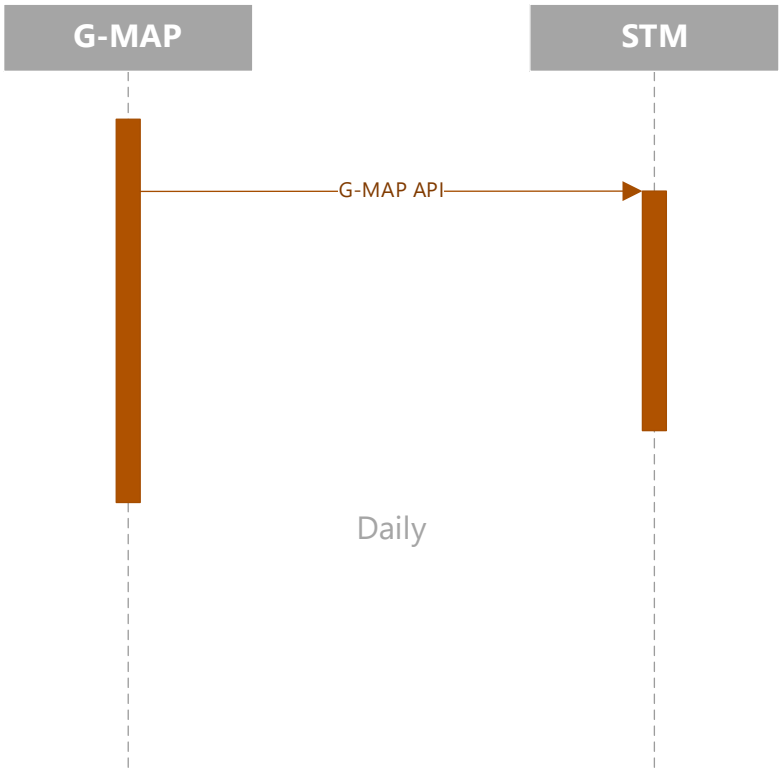


Figure 14. G-MAP API Sequence Diagram

4.12 Interface Int-12 PED-X Actuation Request

Table 17 describes the Int-12 Ped-X Actuation Request interface.

Table 17. PED-X Actuation Request Interface

Interface Field	Description
Interface Name	PED-X API
Interface ID	Int-12
Interface Description	An API that requests actuation for a pedestrian signal with extended walk time as an option. The request identifies the crosswalk (e.g., east-west) for a specific intersection. The traffic signal control system identifies the cycle time and signals the signal controller to request actuation using National Transportation Communications for ITS Protocol (NTCIP) 1202/1201.

Interface Field	Description
Associated Information Flow	Information Flow ID 8
Source / Destination	G-MAP to GC TCC (PED-X / Kinetic)
Requirement Traceability	**Requirement ID:** 4.1.0-116 **Related Requirements:** 4.1.0-115, 4.2.0-135, 2.3.0-081 Note: NTCIP Standards including 1201, 1202 and 1211 are used in the legacy traffic signal systems, but will not be replaced by this interface. These requirements include the following: 0.0.0-222, 0.0.0-223, 0.0.0-224, 4.1.0-121, 4.1.0-121, 4.10.0-132, 4.10.0-133, 4.10.0-134, 4.10.0-134
Access Method / Link	Authorization Required (not available). For more information contact Bennett Foster (ARC).
Encoding Method	REST
Interface Profile	The interface includes the following APIs Discovery APIs: • List Intersections – retrieves a list of all intersections and their descriptions wherein the user can request actuation. • Get Intersection – retrieves details of a specific intersection that a user can request actuation. • List of Crossings for Intersection – retrieves a list of crossings for a specific intersection (to actuate the direction the user travels across the intersection) • Get Specific Crossing – retrieves details of the crossing for a specific intersection The interface to request actuation is the Call Crossing API. • Call Crossing – initiates a call on a specific crossing and if the call should be extended Specifications for these APIs are described below.

Interface Field	Description
Size	1kB
Frequency	As needed

The Sequence diagram, (**Figure 15**) shows the endpoints described below. The List Intersections, get specific intersection, and get specific crossing APIs are variations of discovery services to identify the intersections and approaches that can be requested for pedestrian actuation and extended walk. They are optional if the identifiers are known to the G-MAP. The same API, appended with a "call" action is used to signal the TCC Gateway to request actuation of the signal controller from the TCC. The message to the TCC is based on the NTCIP 1201/1202 Management Information Base (MIB).

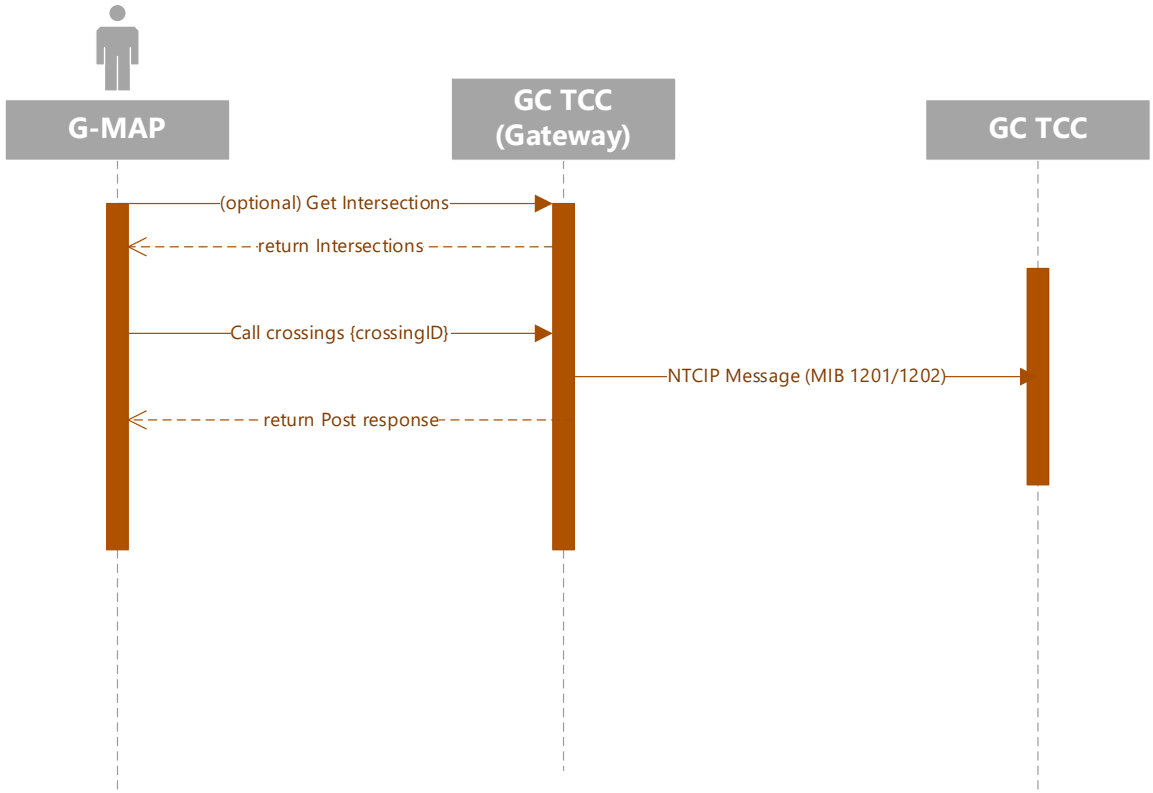


Figure 15. PED-X Actuation Request Sequence Diagram

Endpoints

1. List Intersections

- **URL**: `/intersections`
- **Method**: `GET`
- **Description**: Retrieves a list of all intersections.
- **Responses**:
  - **200 Success**: Successfully retrieved list of intersections.
  - **401 Unauthorized**: API key missing or invalid.
- **Example Response Content:** ***`GET /intersections`***

```
[
  {
    "id": "1001",
    "description": "Test Intersection 1"
  },
  {
    "id": "1002",
    "description": "Test Intersection 2"
  }
]
```

- **Intersection Record Fields:**
  - **Id**: Unique identifier for the intersection.
  - **Description**: Description of the intersection.

2. Get Intersection

- **URL**: `/intersections/{intersectionId}`
- **Method**: `GET`
- **Parameters**:
  - `intersectionId` (string, required): The identifier for the intersection.
- **Description**: Retrieves details of a specific intersection.
- **Responses**:
  - **200 Success**: Successfully retrieved intersection details.
  - **401 Unauthorized**: API key missing or invalid.
  - **404 Not Found**: Intersection ID does not exist.
- **Example Response Content:** ***`GET /intersections/1001`***

```
{
  "id": "1001",
  "description": "Test Intersection 1"
}
```

```
]
```

- **Crossing Record Fields:**
  - **Id**: Unique identifier for the crossing.
  - **Description**: Description of the crossing direction.
  - **Signal**:
    - **Walk**: Pedestrian signal is displaying a solid "Walk" sign.
    - **Clear**: Pedestrian signal is flashing a "Don't Walk" sign to clear the intersection.
    - **Stop**: Pedestrian signal is displaying a solid "Don't Walk" sign.
    - **Off**: Pedestrian signal is OFF.
  - **Calls**:
    - **Extended**: A call for a extended walk has been placed and waiting to be served.
    - **Standard**: A call for a standard walk has been placed and waiting to be served.
    - **None**: There are no calls.

4. Get Specific Crossing

- **URL**: `/intersections/{intersectionId}/crossings/{crossingIds}`
- **Method**: `GET`
- **Parameters**:
  - `intersectionId` (string, required): The identifier for the intersection.
  - `crossingIds` (string, required): The identifier for the crossing, or multiple crossing identifiers when seperated by a comma (%2C).
- **Description**: Retrieves details of specific crossings within an intersection.
- **Responses**:
  - **200 Success**: Successfully retrieved crossing details.
  - **401 Unauthorized**: API key missing or invalid.
  - **404 Not Found**: Intersection or crossing ID does not exist.
- **Example Single Crossing Response Content:** ***`GET /intersections/1001/crossings/NENW`***

```
[
  {
    "id": "NENW",
    "description": "North-East to North-West",
    "phase": 2,
    "signal": "Stop",
    "calls": "None"
  }
]
```

- **Example Multiple Crossing Response Content:** ***`GET /intersections/1001/crossings/NENW%2CSWSE`***

```
[
  {
    "id": "NENW",
    "description": "North-East to North-West",
```

```
    "phase": 2,
    "signal": "Stop",
    "calls": "None"
  },
  {
    "id": "SWSE",
    "description": "South-West to South-East",
    "phase": 6,
    "signal": "Stop",
    "calls": "None"
  }
]
```


5. Call Crossing

- **URL**: `/intersections/{intersectionId}/crossings/{crossingIds}/call`
- **Method**: `POST`
- **Parameters**:
  - `intersectionId` (string, required): The identifier for the intersection.
  - `crossingIds` (string, required): The identifier for the crossing, or multiple crossing identifiers when seperated by a comma (%2C).
  - `extended` (boolean, optional, default: `false`): Whether to call for an extended/alt walk to increase the crossing time.
- **Description**: Initiates a call on specific crossings. Can specify whether the call should be extended.
- **Responses**:
  - **200 Success**: Successfully initiated call on the crossing.
  - **401 Unauthorized**: API key missing or invalid.
  - **404 Not Found**: Intersection or crossing ID does not exist.

  Notice: The call will return only after it has been received and verified at the intersection controller, and should take about 1 second for a standard call or about 3 seconds for an extended call to return with a result.

  Notice: The signal state may not change until the intersection controller cycles to the called phase for the crossing.

- **Example Response Content - Standard Walk:** ***`POST /intersections/1001/crossings/NENW/call?extended=false`***


```
[
  {
    "id": "NENW",
    "description": "North-East to North-West",
    "phase": 2,
    "signal": "Stop",
    "calls": "Standard"
  }
]
```

- **Example Response Content - Extended Walk:** *POST /intersections/1001/crossings/NENW/call?extended=true*


```
[
  {
    "id": "NENW",
    "description": "North-East to North-West",
    "phase": 2,
    "signal": "Stop",
    "calls": "Extended"
  }
]
```


4.13 Interface Int-13 Ride Request

Table 18 describes the Int-13 Ride Request interface.

Table 18. Ride Request Interface

Interface Field	Description
Interface Name	Ride Request API
Interface ID	Int-13 and Int-13a

Interface Field	Description
Interface Description	The Ride Request interface supports communication from G-MAP (specifically the mobile app) to the Ride Gwinnett's CAD/AVL in-vehicle system (developed by Avail Technologies). This communication will initiate the sending of a message to a transit vehicle operator that they will be picking up an ADA rider while in revenue service (at a future stop). The API will handle the following Use Cases: 1. An ADA rider plans a trip and accepts the suggested route using the G-MAP mobile application. The application sends a message to the Gwinnett CAD which in turn generates and sends a message to the applicable transit vehicle's Mobile Data Terminal (MDT); notifying the operator that **an ADA rider may be at the specified stop**. 2. An ADA rider plans a trip and accepts the suggested route using the G-MAP mobile application. The application sends a message to the Gwinnett CAD which in turn generates and sends a message to the applicable transit vehicle's MDT; notifying the operator that an ADA rider may be at the specified stop. The ADA rider **cancels their trip** from inside the G-MAP app. The application sends a message to the Gwinnett CAD which in turn generates and sends a message to the applicable transit vehicle's MDT; notifying the operator that the previous message has been rescinded. In addition, the same message is forwarded to the TSP Policy Server to trigger Enhanced TSP. The message alerts the TSP Policy Server that a traveler is waiting at a pickup stop and will be traveling to a dropoff stop. During that period, the transit vehicle should be given sign priority to keep as close to schedule as possible.
Associated Information Flow	Information Flow ID 11
Source / Destination	G-MAP to Gwinnett Transit
Requirement Traceability	**Requirement ID:** 3.1.0-094, 3.1.0-096 **Related Requirements:** 3.1.0-095, 3.1.0-098, 2.3.0-081
Access Method / Link	Connection details are confidential. For more information contact Bennett Foster (ARC).
Encoding Method	JSON-formatted HTTP POST

Interface Field	Description
Interface Profile	See **Figure 16** Figure 16. Ride Request API Sequence Diagramand **Table 19** for the Inbound and Outbound messages. User customizable fields are described in **Table 20.**
Size	About 100 kBytes
Frequency	As needed

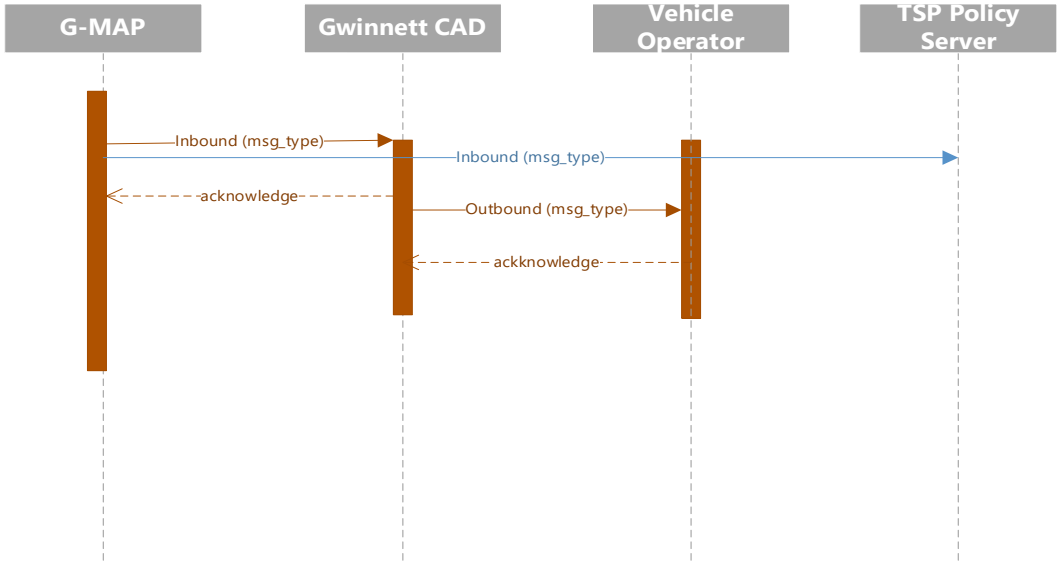


Figure 16. Ride Request API Sequence Diagram

The same Ride Request Message is sent to the TSP Policy Server to request enhanced TSP.

Table 19 provides the inbound and outbound message formats for the Ride Request API.

Table 19. Inbound and Outbound Message Formats

Field Name	Sample Value	Description
timestamp	2024-01-31T21:20:35.000Z	String, the UTC time the post was triggered in YYYY-MM-DDThh:mm:ssZ format

Field Name	Sample Value	Description
agency_id	GCT	String, identifier of the transit agency servicing the originating end-user. Comes from the agency_id field of the GTFS Schedule agency.txt file
from_route_id	10	Integer, numerical public identifier of the originating route servicing the end-user. Comes from the route_id field of the GTFS Schedule routes.txt file
from_trip_id	t532-b65-sl2	String, GTFS trip identifier of the originating trip servicing the end user. Comes from the trip_id field of the GTFS Schedule trips.txt file
from_stop_id	686	Integer, numerical external stop identifier where rider will be encountered. Comes from the stop_id field of the GTFS Schedule stops.txt file
from_arrival_time	3:54:20	String, scheduled arrival time of the bus servicing the end-user at the originating stop in hh:mm:ss format. Comes from the arrival_time field of the GTFS Schedule stop_times.txt file
to_route_id	10	Integer, numerical public identifier of the destination route servicing the end-user. Comes from the route_id field of the GTFS Schedule routes.txt file
to_trip_id	t532-b65-sl2	String, GTFS trip identifier of the destination trip servicing the end user. Comes from the trip_id field of the GTFS Schedule trips.txt file
to_stop_id	686	Integer, numerical external stop identifier where rider is expected to be offloaded. Comes from the stop_id field of the GTFS Schedule stops.txt file
to_arrival_time	3:54:20	String, scheduled arrival time of the bus servicing the end-user at the destination stop in hh:mm:ss format. Comes from the arrival_time field of the GTFS Schedule stop_times.txt file
msg_type	0	Integer, numerical identifier of the message template being requested. Value 1 indicates request while value 0 cancels request.
mobility_code	0	An enumerated value corresponding to a shared table of mobility aid codes. When value is 1, driver is alerted that the traveler needs more time. A zero (0) indicates that the traveler does not need more time.
trusted_companion	true	Boolean, flag identifying if the end user is accompanied by a trusted companion

Table 20 provides the agency customizable data fields for the Ride Request API.

Table 20. Agency Customizable Data Fields

Field Name and Enumerated Values	Customizable Descriptions
msg_type	**Customizable Template**

0	The previous notification for {From_Stop_Internet_Name} has been cancelled**
1	There will be a passenger at stop {From_Stop_Internet_Name} in need of {mobility_codes} {trusted_companion}
mobility_codes	**Customizable Text**
0	Does not need more time
1	Needs more time boarding and alighting the vehicle
trusted_companion	**Customizable Text**
True	Rider traveling with a Trusted Companion
False	Rider is traveling Alone

4.14 Interface Int-14 Performance Measurement Dashboard (PMD)

Table 21 describes the Int-14 Performance Measurement Dashboard (PMD) interface.

Table 21. PMD Interface

Interface Field	Description
Interface Name	Private to Public Performance Measurement Dashboard Interface
Interface ID	Int-14
Interface Description	Interface for transitioning data from private to public PMD
Associated Information Flow	Information Flow ID 16
Source / Destination	Private PMD to Public PMD
Requirement Traceability	**Requirement ID:** 7.3.0-219 **Related Requirements:** 7.3.0-208
Access Method / Link	• Secure API endpoint with authentication • Access method is restricted. For more information contact Bennett Foster (ARC).
Encoding Method	Compressed comma delimited file (CSV)

Interface Field	Description
Interface Profile	The CSV files will consist of the following fields: • Date • Performance Measure Name • Value
Size	• 10 KB
Frequency	Weekly

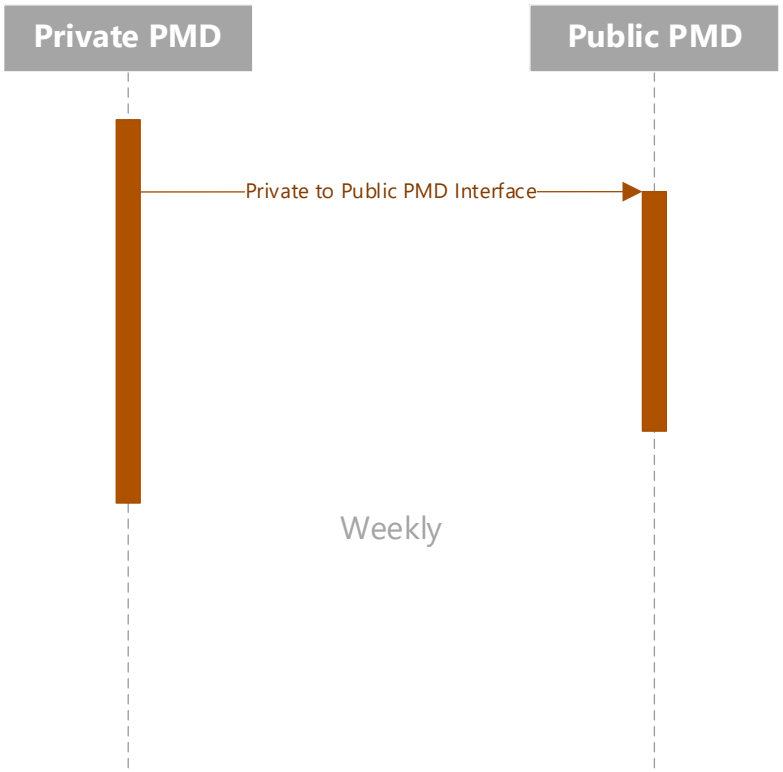


Figure 17. PMD Sequence Diagram

4.15 Interface Int-15 PMD Data Feed

Table 22 describes the Int-15 Performance Measurement Data (PMD) Feed interface. The Phase 2 Performance Measurement and Evaluation Support Plan (PMESP) provides detailed information regarding the metrics that will be used to assess the project outcomes.

Table 22. PMD Data Feed Interface

Interface Field	Description
Interface Name	Public PMD to Open Data Format Interface
Interface ID	Int-15
Interface Description	Interface for publishing PMD data in an open data format. The performance measurements and related metrics contained in the open data feed is described in the Phase 2 PMESP.
Associated Information Flow	Information Flow ID 15
Source / Destination	Public PMD to Public (access)
Requirement Traceability	**Requirement ID:** 7.3.0-209 **Related Requirements:** 2.3.0-081
Access Method / Link	Public API endpoint (URL)
Encoding Method	Compressed comma delimited file (CSV) Each compressed file name will reflect the lineage and measure information. The files will use the following naming convention: • PM-ID_<from-date>_<to-date>.zip • PM-ID_<from-date>_<to-date>_meta.csv • PM-ID_<from-date>_<to-date>_summary.csv
Interface Profile	A detailed description for each performance measure and related metric is included in the System Design Document. The framework for the CSV files includes two files – • Metadata which includes information on lineage and included metrics • Summary which contains a list of each summarized metric. The framework file formats are provided in **Section 4.15.1**. An example for each framework file is shown in **Section 4.15.2**.

Interface Field	Description
Size	Variable depending on performance measure
Frequency	As needed by the public. The data will be updated on a monthly basis.

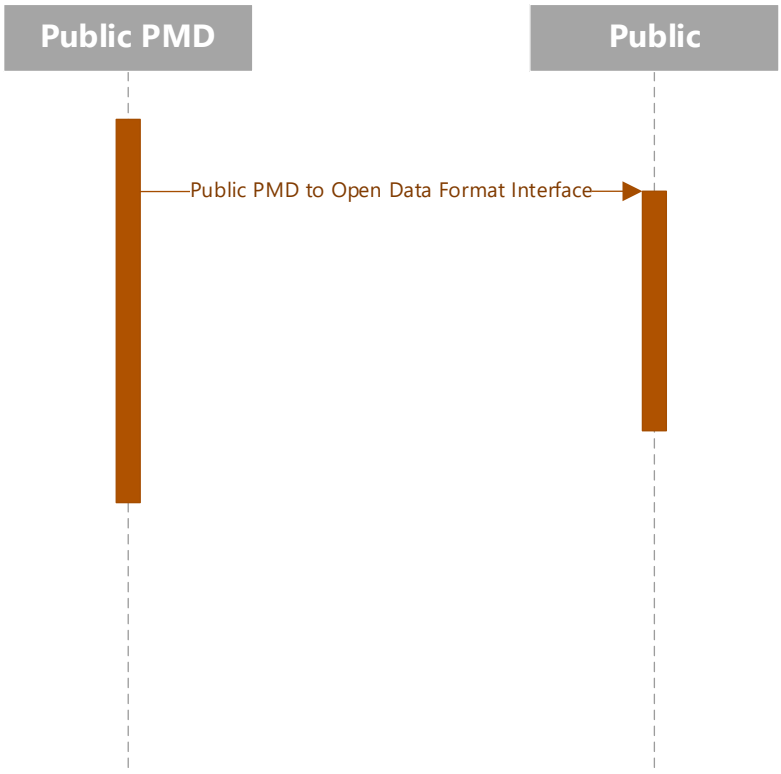


Figure 18. PMD Data Feed Sequence Diagram

4.15.1 Framework PMD Data Feed

Information on the performance measurement (PM) data are included in two files, Metadata and Summary, as described below in CSV format:

File 1 Performance Measure Metadata

- From_date (yyyymmdd), to_date, dataset_name, PM_ID, PM_name
- (multiple) PM_ID, count-type, Metric_ID, eval_question, value-type, [end_user_type]

File 2 Performance Measure Summary (for each metric)

- (multiple) PM_ID, count, metric_id, value, [end_user]

4.15.2 Example of PMD Data Feed

This example shows a monthly summary for performance measurement “CT-PM-1 Enhance the travelers’ complete trip travel experience” (described in the PMESP). Note that several metrics including CT-ME-1.2 and 1.3 are summarized over an 18 month period, so they are not included in the sample monthly data feed.

File 1: Performance Measure Metadata

20240301, 20240331, ct-pm-1, ‘enhance traveler experience’

ct-pm-1, people_no, ct-me-1.1, ‘did the ST-CTN system enhance the travelers’ complete trip travel experience’, avg_likert, end_user;

ct-pm-1, day_count, ct-me-1.6, ‘Did access to call center support through the ST-CTN system allow the travelers to better understand the application and complete future trips without having to utilize the call center’, avg_daily_volume;

ct-pm-1, trip_count, ct-me-1.8, ‘Did travelers feel greater confidence and independence during their complete trip, including transitions, with the ST-CTN system or did they deviate from the ST-CTN system complete trip recommended routes?’, percent;

The comprehensive set of metadata will be included in Summary PM file for each metric.

File 2: Summary Performance Measure

ct-pm-1, 10, ct-me-1.1, 3, ‘older adult’;

ct-pm-1, 9, ct-me-1.1, 4, ‘physical disability’;

ct-pm-1, 5, ct-me-1.1, 2, ‘low income’;

ct-pm-1, 7, ct-me-1.1, 5, ‘LEP’;

ct-pm-1, 31, ct-me-1, 4, ‘all’;

ct-pm-1, 31, ct-me-1.6, 10;

ct-pm-1, 200, ct-me-1.8, 85;

The comprehensive summary of performance measures will be available for each metric.

4.16 Interface Int-16 INS SDK

Table 23 describes the Int-16 INS SDK interface.

Table 23. INS SDK Interface

Interface Field	Description
Interface Name	Indoor Navigation System (INS) Software Development Kit (SDK)
Interface ID	Int-16
Interface Description	The INS SDK from CXApp provides services between their INS SaaS and the G-MAP mobile application through services provided by native SDKs. The services include: • Wayfinding Navigation includes services to generate turn-by-turn navigation for different abilities • Display Navigation includes services to download and display amenities, path types (walkways, elevators, escalators, stairs), labels, and destinations • Settings includes style settings for map presentation Map configuration input is supported by the CXApp administration and control portal. For more information on the INS SDK and related service contact Bennett Foster (Atlanta Regional Commission).
Associated Information Flow	Information Flow ID 13
Source / Destination	INS to G-MAP Mobile App
Requirement Traceability	**Requirement ID:** 6.2.0-196 **Related Requirements:** 6.2.0-241, 6.2.0-242, 6.1.0-152, 6.2.0-182, 6.2.0-183
Access Method / Link	Proprietary. For more information contact Bennett Foster (ARC).
Encoding Method	Proprietary
Interface Profile	The SDK and associated services are proprietary.
Size	Depends on the query

Interface Field	Description
Frequency	As needed when traveler is navigation through an indoor facility using the G-MAP mobile app.

5 Requirements Traceability Table

The interface descriptions provided in Section 4 include a reference to the comprehensive set of related requirements associated with each interface. **Table 24** provides a summary of the interface to the primary requirements traceability including the verification method which describes the process used to validate the accomplishment of the requirement. The verification methods include test, inspection, analysis or demonstration.

Table 24. Traceability Table

Interface ID / Name	Primary Requirement ID	Verification Method
Int-1 Ride Gwinnett GTFS	3.1.0-103	Inspection
Int-2 MARTA GTFS	0.0.0-232	Inspection
Int-3 Ride Gwinnett GTFS Realtime	3.1.0-104	Inspection
Int-4 MARTA GTFS Realtime	0.0.0-233	Inspection
Int-5 OSM	1.3.0-037	Inspection
Int-6 Network Impedance API	1.3.0-034	Inspection
Int-7 Sidewalk Sim Data	1.3.0-037	Inspection
Int-8 WAZE	6.1.0-249	Inspection
Int-9 GDOT NaviGAtor	6.1.0-249	Inspection
Int-10 PSM	6.1.0-249	Inspection
Int-11 G-MAP API	2.1.2-075	Inspection
Int-12 PED-X Actuation Request	4.1.0-116	Inspection
Int-13 Ride Request	3.1.0-094, 3.1.0-096	Inspection
Int-14 PMD	7.3.0-219	Inspection
Int-15 PMD Data Feed	7.3.0-209	Inspection
Int-16 INS SDK	6.2.0-196	Inspection

6 Appendices

This document includes the three following appendices:

Appendix A. Acronyms and Abbreviation provides a complete list of the acronyms and abbreviations used through the ICD.

Appendix B. Standards Plan describes the standards that are deployed as part of the ST-CTN project, as well as the gaps in standard development.

Appendix C. **Document Change Log** lists the changes made to the ICD in each version.

Appendix A. Acronyms and Abbreviation

This appendix lists the acronyms and abbreviations used throughout this document.

ADA – Americans with Disability Act

API – Application Programming Interfaces

APN – All-Path Networks

APS – Audible Pedestrian System

ARC – Atlanta Regional Commission

ATL RIDES – Atlanta Rider Information and Data Evaluation System

AVL – Automatic Vehicle Location

AWS – Amazon Web Services

C2C – Center to Center

CAD – Computer Aided Dispatch

CC – Call Center

CDP – Connected Data Platform

COMP – Comprehensive Operations and Maintenance Plan

CSV – Comma-Separated Values

CV – Connected Vehicle

CV1K – Connected Vehicle Infrastructure Deployment Program

C-V2X – Cellular Vehicle to Everything

CVTMP – Connected Vehicle Technology Master Plan

DSRC – Dedicated Short-Range Communications

FTA – Federal Transit Administration

GCT – Gwinnett County Transit

GDOT – Georgia Department of Transportation

GDPR – General Data Protection Regulation

GeoRSS – Geographically Encoded Objects Really Simple Syndication

GJAC – Gwinnett Justice Administration Center

G-MAP – Georgia Mobility and Accessible Planner

GTFS – General Transit Feed Specification

HTTPS – Hypertext Transfer Protocol Secure

ICD – Interface Control Document

IEC – International Electrotechnical Commission

IETF – Internet Engineering Task Force

IMI – Integrated Mobility Innovation

INS – Indoor Navigation System

ISO – International Organization for Standardization

ITS – Intelligent Transportation Systems

IVR – Interactive Voice Resp

JSON – JavaScript Object Notation

kB – kilobyte

LEP – Limited English Proficiency

LTE – Long Term Evolution

MAP – Map Data

MARTA – Metropolitan Atlanta Regional Transit Authority

MB – Megabyte

MDT – Mobile Data Terminal

MU – Mobile Unit

N/A – Not Available

NTCIP – National Transportation Communications for Intelligent Transportation Systems Protocol

Oauth – Open Authorization

OBE – Onboard Equipment

OBU – Onboard Unit

OSM – OpenStreetMap

OSS – Open Source Software

OTP – OpenTripPlanner

PED-SIG – Mobile Accessible Pedestrian Signal System

PED-X – Pedestrian Crossing Signal

PII – Personally Identifiable Information

PMD – Performance Measurement Dashboard

PROW – Public Right of Way

PSM – Personal Safety Message

RBAC – Role-Based Access Controls

REST – Representational State Transfer

RFC – Request for Comments

RSE – Roadside Equipment

RSU – Roadside Unit

SAD – System Architecture Document

SAE – Society of Automobile Engineers

SAML – Security Assertion Markup Language

SCMS – Security Credential Management System

SDK – Software Development Kit

SOI – System of Interest

SQL – Structured Query Language

ST-CTN – Safe Trips in a Connected Transportation Network

STM – Space Time Memory

TBD – To Be Determined

TCC – Transportation Control Center

TCP – Transmission Control Protocol

TMC – Traffic Management Center

TSP – Transit Signal Priority

URL – Uniform Resource Locator

USDOT – U.S. Department of Transportation

V2X –Vehicle to Everything

Appendix B. Standards Plan

The Standards Plan describes the standards that are deployed as part of this project, as well as where additional do not exist or are limited in their development. These gaps describe gaps in standards, open specifications, or protocols that would support and accelerate deployment.

B.1 Standards Deployed

The standards that are deployed as part of this project are listed in **Table 25.**

Table 25. Standards Deployed in the ST-CTN Project

Standard Name	URL (specification)	Standard / Protocol Type	Related Interface
BLE version 5	https://www.bluetooth.com/specifications/specs/	Communication / Equipment	Int-16
CSV	Internet Engineering Task Force (IETF) Request for Comments (RFC) 4180 Comma Separated Value Files	Data interchange	Int-1, Int-2, Int-6, Int-7, Int-9, Int-10, Int-14, Int-15
GTFS	General Transit Feed Specification https://developers.google.com/transit/site-map	Data	Int-1, Int-2
GTFS-realtime	GTFS-realtime https://developers.google.com/transit/gtfs-realtime	Data	Int-3, Int-4
HTTP	Internet Engineering Task Force (IETF) Request for Comments (RFC) 7230 Hypertext Transfer Protocol https://www.w3.org/Protocols/Specs.html#:~:text=Hypertext%20Transfer%20Protocol%20%2D%2D%20HTTP,%2C%20collaborative%2C%20hypermedia%20information%20systems	Communications	All
JSON	JavaScript Object Notation https://www.json.org/json-en.html	Data interchange	Int-8, Int-11, Int-13
OpenAPI	https://swagger.io/specification/ Also known as Swagger	Data interchange	Int-4, Int-6. Int-7, Int-9, Int-12, Int-14
OSM	OpenStreetMap specification: https://github.com/openstreetmap/ OSM data: https://www.openstreetmap.org/	Data and Data interchange	Int-5

Standard Name	URL (specification)	Standard / Protocol Type	Related Interface
Proto Buffer	Google data interchange format https://github.com/protocolbuffers/protobuf Used for GTFS realtime and OSM	Communications	Int-3, Int-4
REST	Representational State Transfer (REST) uses OpenAPI to describe REST APIs.	Architecture style (via HTTP or encoded using OpenAPI)	Int-4, Int-6. Int-7, Int-9, Int-12, Int-14
SAE J2735	V2X Communications Message Set Dictionary https://www.sae.org/standards/content/j2735set_202211/ Use cases are described in SAE J2945 Part 9 - Vulnerable Road User Safety Message Minimum Performance Requirements J2945/9_201703 https://www.sae.org/standards/content/j2945/9_201703/	Data	Will be downloaded for Performance Measurement Dashboard
Transmission Control Protocol (TCP)	Internet Engineering Task Force (IETF) Request for Comments (RFC) 9293 https://datatracker.ietf.org/doc/html/rfc9293 (published August 2020)	Communication	All
ZIP	International Organization for Standardization (ISO) / International Electrotechnical Commission (IEC) 21320-1:2015 (a subset of ZIP file format 6.3.3). Used for GTFS	Compression File format	Int-1, Int-2, Int-11, Int-15

B.2 Gap in Standard Development

There are two major gaps in interface specifications that would accelerate the deployment of this project. The two interfaces share a similar orientation; they are traveler (pedestrian) driven, real-time, geolocated requests for vulnerable road user safety services. Specifically, the gaps cover two integration elements that are being deployed. They include the Ride Request and PED-X Actuation Request.

Ride Request

The Ride Request message describes a traveler driven request to a transit operator for a fixed-route, revenue vehicle to pick them up at a bus stop. The service provides added comfort, convenience and accommodations for underserved community access to fixed-route transit. Several use cases are included in this gap:

- Traveler with accessibility challenges (including person with strollers) can inform the driver that they are waiting at a bus stop for a pickup. This will provide the driver with the

warning that the traveler may need extra time to board, may be covered by the shelter (especially during inclement weather), or that they need special services (e.g., ramp and tie-down for wheelchair).

A standard set of field descriptions and data specification for the Ride Request API would support leveraging the service across multiple transit on-board systems. There are currently no standards that support this interface.

PED-X Actuation Request

The pedestrian actuation request would benefit from developing a specialized NTCIP standard that supports the direct communication from a traveler's "mobile unit" or smart phone to a pedestrian signal request system (or an audible pedestrian system (APS)). There are significant limitations with existing standards that may be leveraged to create a specification that supports P-X use cases such as NTCIP 1211 Signal Control and Prioritization, or traffic signal control standards (NTCIP 1201/1202).

The new standard would include message exchanges similar to NTCIP 1211, however the messages require new fields and response messages. The new standard could leverage NTCIP 1211 inputs – request, update, clear, cancel, however developers would need to apply the following types of changes:

- APS strategies (these could be defined as enumerated types) including a flag to request additional walk time
- Respond with estimated walk time, walk/don't walk, countdown clock or other APS sign information including emergency preemption message (for emergency vehicles)
- Update security protocols to connect with APS
- Additional communications protocols to handle multiple communications channels (e.g., direct communications (i.e., Bluetooth, WiFi, Long Term Evolution (LTE)) or Center to Center)
    - Note: the Bluetooth method of communication with an APS is patented

Appendix C. Document Change Log

Any future interface changes will be documented in this section.

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