System Design and Architecture for the IDTO Prototype

Phase I Demonstration Site (Columbus)

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1 Overview

This document builds on the previously submitted software requirements and architecture for the Phase 1 Prototype demonstration, and defines the design and architecture that implements the functions included for the Integrated Dynamic Transit Operations (IDTO) Prototype and each partner; the interfaces between the traveler, the various partner systems and evaluation teams, and the interfaces and components internal to the core IDTO Prototype component (aka the Travel Management Coordination Center). The document is organized as follows:

Section 2: System of Interest defines the relationship between the various components that make up the IDTO Prototype and introduces the reader to each of these functional components.

Section 3: Use Case Models articulates the system use cases between the various components of the IDTO Prototype.

Section 4: Interfaces details each of the interfaces between the various services providers and the IDTO Prototype which are encompassed in the Phase 1 demonstration.

Section 5: Data Model and Schema provides the details of the underlying entity-relation model, including the data dictionary, primary/foreign key relationship, and other constraints.

The attached appendix lists the structure and content of all the expected messages of the interfaces described in Section 4.

2 System of Interest

The IDTO Phase 1 demonstration site will be conducted in Columbus, OH. The Battelle Team that will be conducting this demonstration include the Central Ohio Transit Agency (COTA) and the Ohio State University (OSU) Transportation and Traffic Management Department, which operates the Campus Area Bus System (CABS) and will soon be deploying TaxiCABS, the on-campus demand-response capability. Additionally, Zimride, a nationally recognized service provider for rideshare capabilities, will roll out their dynamic rideshare service in the Columbus area. Finally, Capital Transportation, a Columbus-based private-sector transportation provider that operates a demand/response shuttle service at the Defense Supply Center Columbus (DSCC) military base will also be incorporated.

The IDTO Prototype, which encompasses the Travel Management Coordination Center (TMCC), as described herein, as well as the mobile applications and data collection associated with the various evaluation efforts associated with this effort. COTA's participation includes support of the T-CONNECT application by allowing for onboard equipment upgrades, as well as integration with their dispatching operations. The OSU-operated CABS, with its available AVL systems, will provide incoming connections to allow for protected transfers with the connecting COTA service. TaxiCABS will provide the demand/response component of T-DISP capability, and Capital Transportation, like CABS, will support the demonstration of T-CONNECT at a separate, high demand location in Columbus. Finally, Zimride will provide the D-RIDE capability. Table 2-1 summarizes these partners, their role and the associated applications.

Table 2-1. Columbus Demonstration Site Partner Roles

Partner	Service	Role	Application Area		
			T-CONNECT	T-DISP	D-RIDE
COTA	Fixed Route / Schedule	T-CONNECT Provider	X		
OSU CABS	Fixed Route / Schedule	T-CONNECT Feeder	X		
OSU TaxiCABS	Demand / Response	T-DISP Provider		X	
Capital Transportation	Private Demand / Response Provider	T-CONNECT Feeder	X		
Zimride	Rideshare Enabler	Rideshare Provider			X
Battelle	IDTO Prototype	System Integrator	X	X	X

Source: Battelle

The relationship between each of the entities (partners) that will be integrated in the Phase 1 demonstration is shown in Figure 2-1. The IDTO Prototype. In the center is located the 'IDTO Prototype', or as also identified, the TMCC. The IDTO Prototype serves as the conduit through which most of the traveler interactions take place. In the Phase 1 implementation, not all interactions required for a traveler's trip are mediated by the IDTO Prototype. For example, although the IDTO Traveler service will offer options for certain Demand/Response Providers, the responsibility to schedule that portion of the trip is outside the scope of the Phase 1 implementation and is instead handled by the traveler through other, existing portals for those services. Notice to that some of the interface arrows are bi-directional, while others are uni-directional. This directionality represents the type of dialog the underlying systems of the two respective parties are expected to maintain.

The remainder of this section describes the high-level description of the roles and responsibilities of each of the components in the IDTO Prototype.

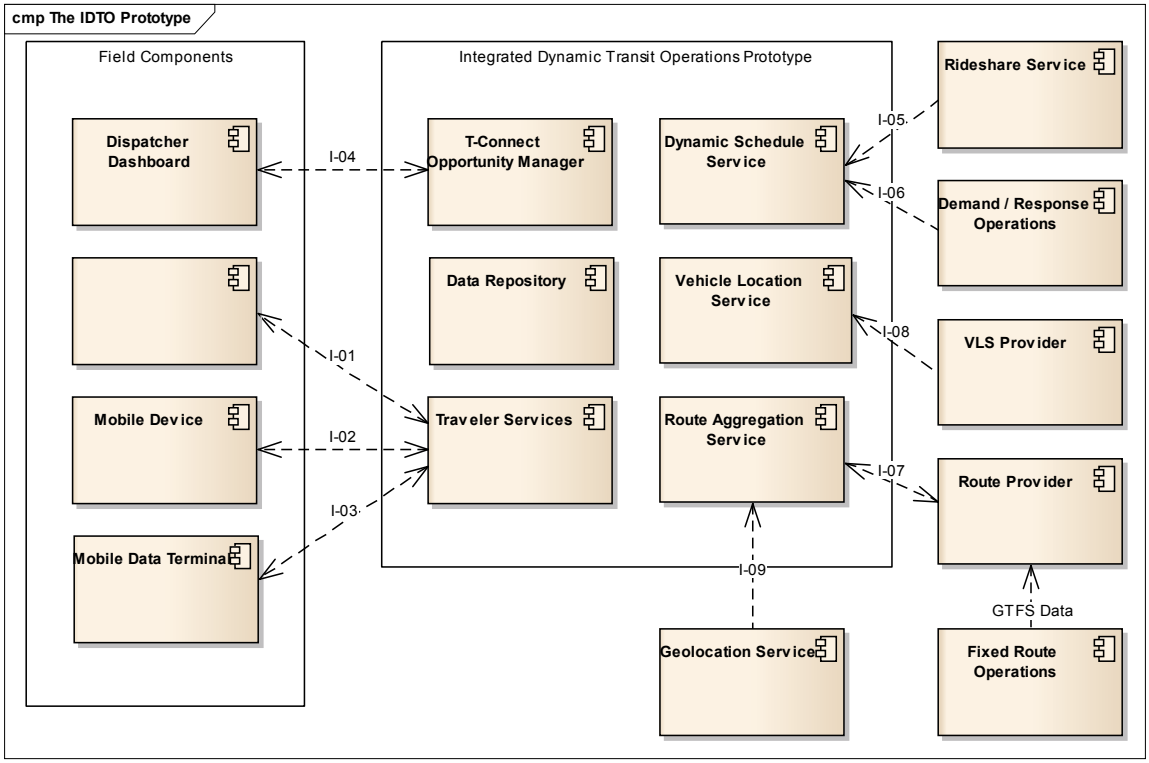

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Figure 2-1. The IDTO Prototype

2.1 Dispatcher Dashboard

The Dispatcher Dashboard is the communication link between the IDTO Prototype and the Fixed Route / T-Connect Provider's operations manager. The dashboard displays T-Connect requests to the Provider's operations manager and provides the means for the operations manager to confirm or reject requests and relay that information back to the T-Connect Opportunity Manager within the IDTO Prototype. For the Phase I portion of this effort, the responsibility of relaying the status of the T-Connect request to a bus driver lies with the operations manager.

2.2 Web Browser

The IDTO user utilizes a standard web browser to perform many of the interactions with the IDTO Prototype, including creating an account, editing profile information, scheduling and maintaining trips. If the user is running the web browser on a device with location services enabled, even the progress of an active trip can be monitored.

In particular, the IDTO web applications will be tested against Microsoft's Internet Explorer 8 browser , however Apple’s Safari, Google’s Chrome, and Mozilla's Firefox are all expected to provide suitable results as well.

2.3 Mobile Device

The primary means for a traveler to communicate with the IDTO prototype and the centerpiece of the Phase I effort is the IDTO Mobile Application residing on the traveler's mobile device.

The Phase I Demonstration of the IDTO mobile application will be implemented for both the Android and iOS platforms only.

2.4 Mobile Data Terminal

The Mobile Data Terminal enables a bus driver to interact with the IDTO Prototype. Not all buses will be equipped with an MDT. For the Phase I effort, the vehicles for only a private Demand/Response Provider will be so equipped. For those vehicles, however, the MDT will not only dynamically track the location of the vehicle, but will also allow a driver the ability to trigger a T-Connect on behalf of a traveler when the traveler's active trip is in jeopardy of missing a connection to a subsequent fixed route provider's service.

2.5 T-Connect Opportunity Manager

The T-CONNECT Opportunity Manager, or TOM, is the main component of the T-CONNECT system for IDTO. The goal of T-CONNECT is to improve rider satisfaction and reduce expected trip time for travelers by increasing the probability of automatic intermodal or intra-modal connections. T-CONNECT

will protect transfers between both transit (e.g., bus, subway and commuter rail) and non-transit (e.g., shared ride modes) modes, and facilitates coordination between multiple agencies to accomplish the tasks. The TOM monitors trips scheduled by IDTO riders for T-CONNECT opportunities and automatically requests a T-CONNECT when the possibility of missing a transfer occurs. These trips are retrieved from the Data Repository, including the trip's scheduled departure time, the trip's steps, including transit authority name, Transit Vehicle Route Number, departure time, departure stop location, arrival time, and arrival stop location.

For purpose on the prototype demonstration, all T-CONNECT requests and responses are logged to the Data Repository.

The TOM enables the IDTO prototype to notify the traveler of the status of a T-CONNECT request throughout the course of the protected trip. The T-CONNECTION status is sent using notification methods on the traveler's mobile device including real-time status updates for that T-CONNECTION.

2.6 Data Repository

The IDTO Prototype utilizes both dynamic and static data in order to facilitate the functions it provides. All data is persisted, i.e. stored permanently, via the data repository. The repository manages the database and data-cache.

2.7 Traveler Services

In order to facilitate the interaction of the IDTO Backend System with the User facing components (mobile apps and web sites), the IDTO Prototype system will employ two web based interfaces. A RESTful Web Service will be deployed to provide a data interface allowing mobile apps to send and receive data to the IDTO Backend System. A second component will be the IDTO Web Server which will host the Traveler web portal.

The IDTO Web Service is a RESTful interface providing the needed functionality for the User facing mobile apps to send and receive the data needed to fulfill the traveler’s needs. All interaction with the IDTO Backend System will be performed through the interfaces provided by this web service. Activities supported include:

- User account registration
- Account management
- Travel option searches
- Trip selection
- Saved trip review/cancel
- Trip Status notification
- On-trip confirmation

Data interchange by this web service will utilize the JavaScript Object Notation (JSON), a lightweight, human readable format for transferring data in a platform agnostic manner.

The IDTO Web Server serves as the component which hosts the Traveler Web Portal. While the primary use case for the system is that the Traveler will interact with the system via a mobile app, a web site is also planned which will allow the Traveler to interact with the IDTO Prototype system from any internet enabled computer or device. This Traveler Web Portal will include many of the same features available via the mobile app. By supplying a web site, the traveler can plan future travel needs, review their existing planned trips and update their account profile outside of the mobile app. This allows those travelers without smartphones or mobile internet devices to also participate in the IDTO Prototype demonstration.

2.8 Vehicle Location Service

The Vehicle Location Service (VLS) is responsible for integrating vehicle location information from a variety of external sources in a variety of forms with the traveler's active trips. This real-time location information is necessary for the TOM to determine exactly when a connection is in jeopardy, necessitating a protecting T-Connect to be issued.

2.9 Route Aggregation Service

The Route Aggregation Service (RAS) is the component responsible for abstracting the task of assembling the various legs of a given trip. The RAS is called by the IDTO web service (IWS) which provides the trip details such as start-time and location, destination location, and travel mode(s).

The RAS will abstract the various route providers. Given trip information, the RAS coordinates the relevant route providers and returns one or more potential trip routes to the IWS.

2.10 Geolocation Service

The Route Provider locates available trips based on the starting and ending geographic location (Latitude and Longitude coordinates). Most travelers will be planning their trips based on street addresses. The Geolocation Service is used to translate the addresses entered by a Traveler into the corresponding geographic location needed by the Route Provider.

2.11 Rideshare Service

The Rideshare Service is a component external to the IDTO Prototype which provides available route alternatives on a dynamic basis. Only traveler's previously subscribed to the Rideshare service will have these route alternatives presented to them during trip scheduling. Rideshare is presently only expected to fulfil an entire trip request for the traveler, however, as the prototype progresses and rideshare is adopted, this may be revisited in order to consider trips which include both rideshare and other transportation means.

2.12 Demand / Response Operations

This external component is the source of scheduling information for the Demand / Response Provider used by the IDTO Prototype. Data exchange is initiated by the IDTO Prototype as needed.

2.13 VLS Provider

This external component provides dynamic vehicle location data to the IDTO Prototype, enabling it to determine when traveler transfers are in jeopardy and thus requiring a T-Connect to be requested.

2.14 Route Provider

A Route Provider is a specific implementation of a routing service. The initial routing services will include COTA, CABS, TaxiCABS, and Zimride. A routing service is considered to be either a static service (COTA, CABS: both requiring General Transit Feed Specification (GTFS) route data) or a dynamic service (TaxiCABS, Zimride). Route Providers are used by the Route Aggregation Service when assembling the components of a trip.

2.15 Fixed Route Operations

This external component is the source of GTFS data for a Fixed Route Provider. Ideally the provider pushes updated GTFS data to the IDTO Prototype as their published routes change, typically on a quarterly or semi-annual basis. However, for expediency of the Phase 1 Implementation, the GTFS data exchange may be controlled by the IDTO Prototype, minimizing the impact on the external systems involved.

GTFS is a common format for public transportation schedules and associated geographic information. GTFS "feeds" allow public transit agencies to publish their transit data and allow applications such as the IDTO Prototype to consume that data in an interoperable way.

The IDTO Prototype receives schedules via GTFS feeds from all of its Fixed Route Providers, Incoming and Private Incoming, as well as the T-Connect Provider.

3 Phase I Demonstration Site

The IDTO Phase 1 demonstration site will be conducted in Columbus, OH. The transportation providers and their respective role in the demonstration include the Central Ohio Transit Agency (COTA) as the Fixed Route / T-Connect Provider; The Ohio State University (OSU) Transportation and Traffic Management Department, which operates both the Campus Area Bus System (CABS) as the Incoming Fixed Route Provider and TaxiCABS, as a demand/response service; Zimride, a nationally recognized service provider for rideshare capabilities, is the Rideshare Provider. Finally, Capital Transportation, a Columbus-based private-sector transportation provider also serves as an incoming service provider.

3.1 Central Ohio Transit Authority (COTA)

COTA operates a fixed-route service in the Columbus and the surrounding central Ohio community. Under the scenario described herein, the COTA fixed-service routes, particularly those that serve the OSU campus area and DSCC will be expanded to support the T-CONNECT application and will allow for these requests to be made to the various buses serving the demonstration area.

COTA supports the T-CONNECT application by integration with their dispatching operations.

3.2 Capital Transportation

Capital Transportation is a Columbus-based private-sector transportation provider that performs contract demand-response services at various locations including the Defense Supply Center Columbus (DSCC). Capital Transportation performs several runs daily at the DSCC location, carrying passengers between the base's three main entrances and various locations on the base. Capital Transportation will be provided with an on-board capability to request and confirm T-CONNECT connections with adjacent COTA fixed routes.

3.3 The Ohio State University Transportation and Traffic Management Department

The Ohio State University operates a fixed-route / fixed-schedule transit system known as CABS which serves the Central Campus academic core as well as remote residential, parking, and off-campus locations. The current fleet of buses is equipped with real-time AVL capabilities, which will be leveraged for this demonstration. The OSU-operated CABS, with its available AVL systems, allows incoming connections to provide for protected transfers with the connecting COTA service.

In addition to this fixed-route CABS service, OSU is in the final stages of deploying a new demand-response service called TaxiCABS. Scheduled to be operational in late-

2013, TaxiCABS will provide service to the Central Campus area, as well as neighborhoods adjacent to the campus. The IDTO Prototype will integrate with both the fixed-route CABS system, as well as the new TaxiCABS service as part of the IDTO Prototype demonstration.

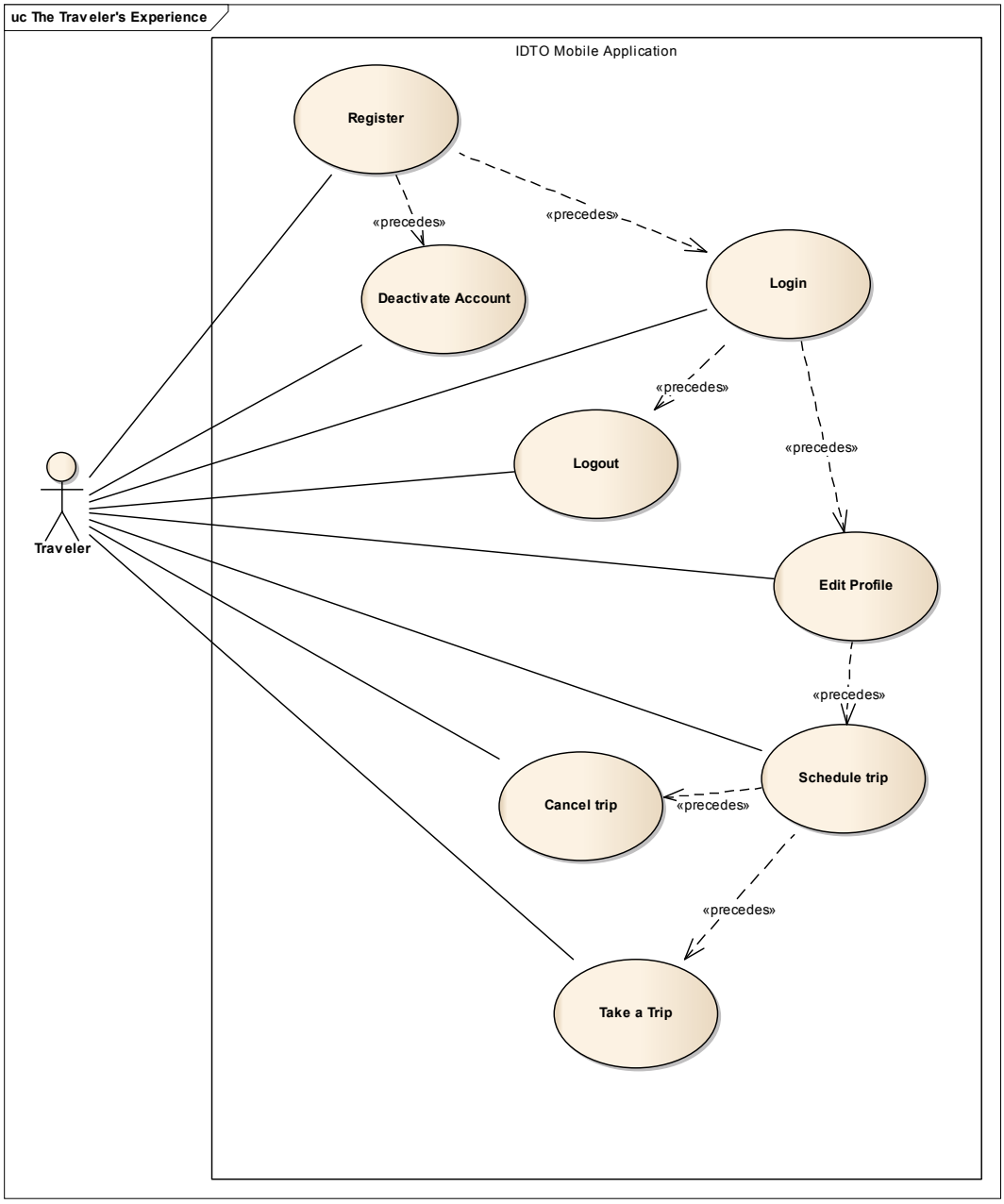
3.4 Zimride

Zimride will serve as the D-RIDE provider, a capability that they presently offer in a number of campus and urbanized areas throughout the country. Through the use of social-networking tools, Zimride enables the matching of drivers and riders for both ad-hoc and pre-planned trips. The IDTO Prototype will make dynamic rideshare options available to partcipants through the IDTO application.

4 Use Case Model

4.1 Traveler Experience

The following use cases, as shown in Figure 4-1, describe the interactions of the traveler with the IDTO Prototype. Most of the interactions can be made using either the IDTO mobile application on the traveler's mobile device, or through the IDTO web site, using a standard browser.



Source: Battelle

Figure 4-1. The Traveler's Experience

4.1.1 Register

Before a traveler can interact with the IDTO prototype, he must first register an email address on the system. The steps for registering an email address and mockups for the related mobile application screens are described here.

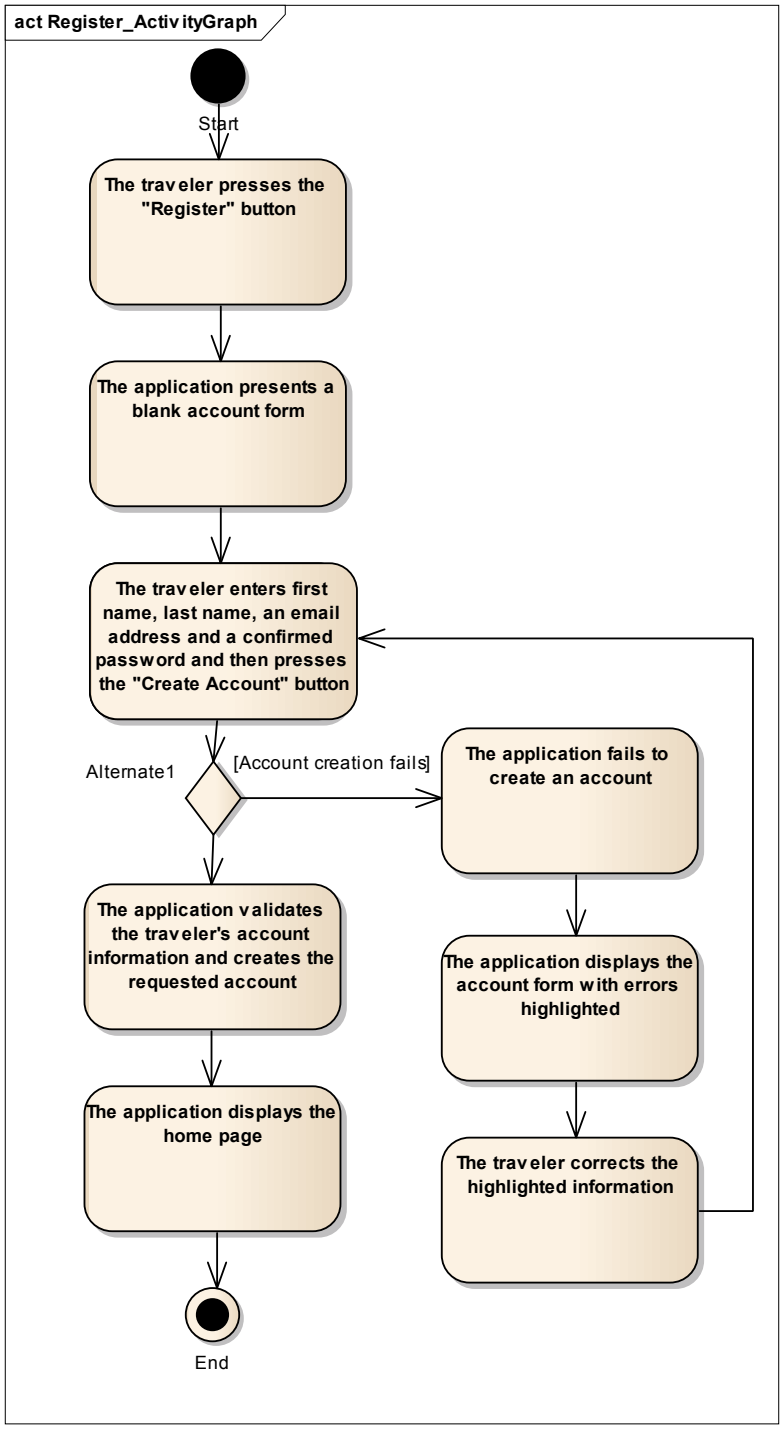


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Figure 4-2. Register_ActivityGraph

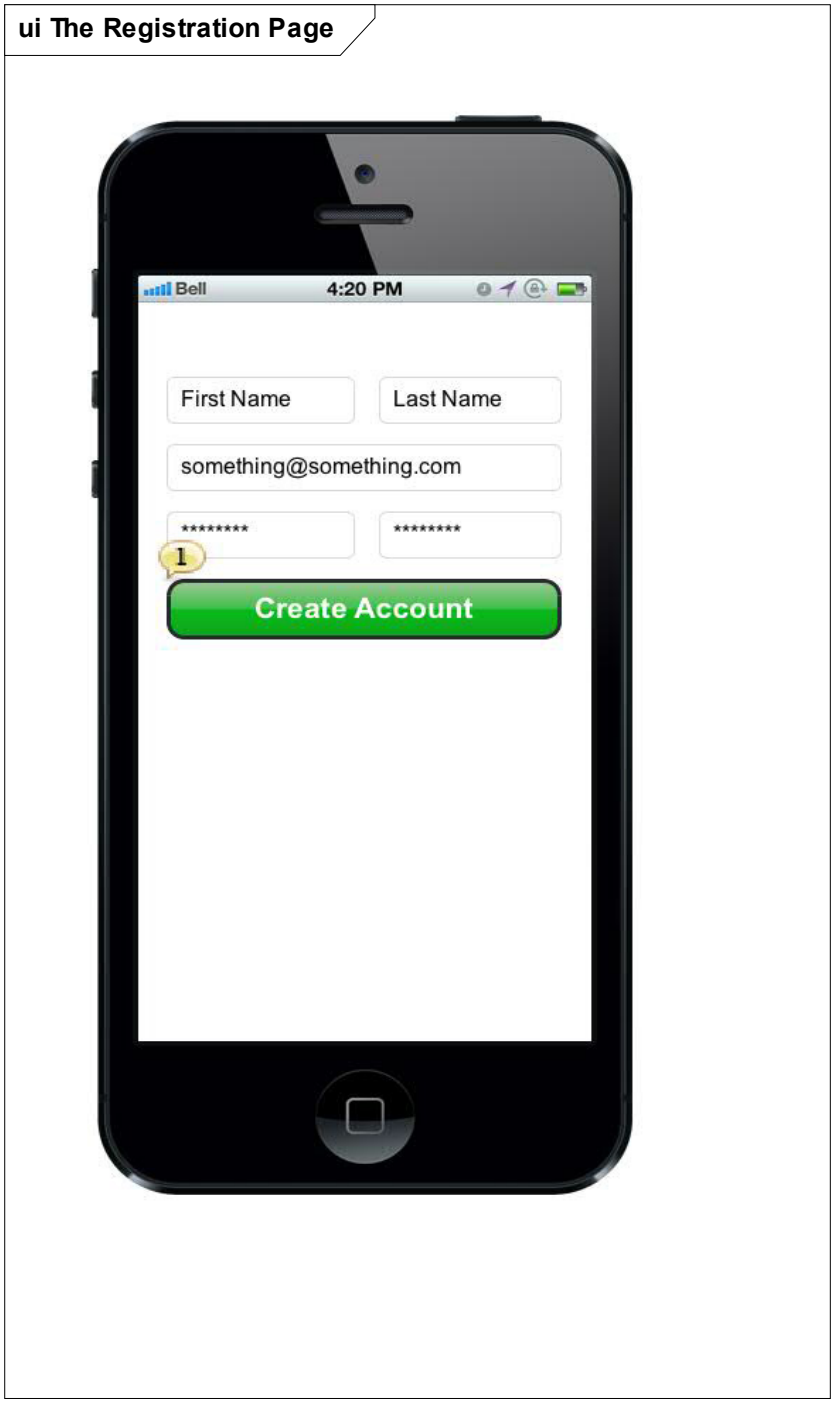

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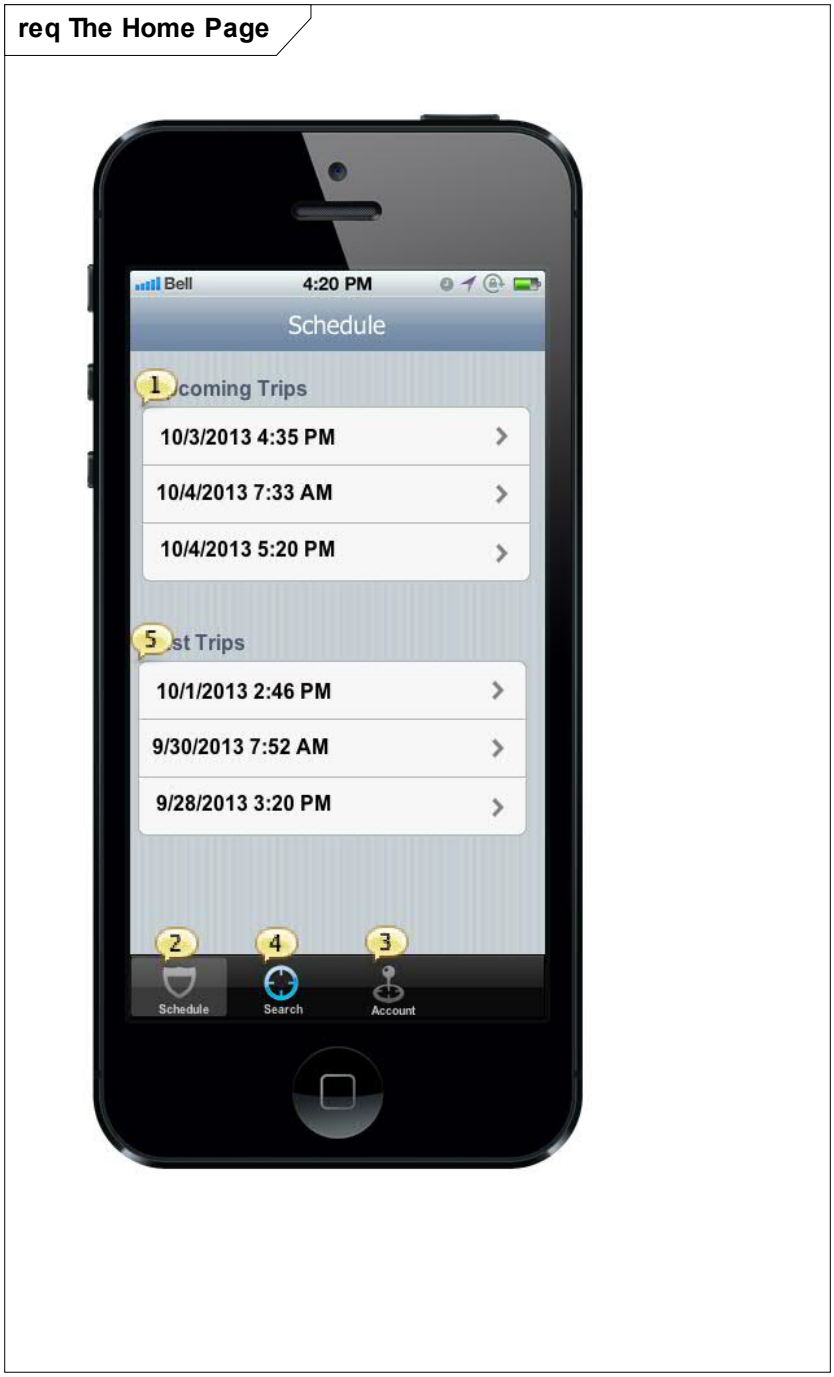
Figure 4-3. The Registration Page



Source: Battelle

Figure 4-4. The Home Page

4.1.1.1 Register

Basic Path

Basic Path:

[1] The traveler presses the "Register" button(Figure 4-6). [2] The application presents a blank account form(Figure 4-3). [3] The traveler enters first name, last name, an email address and a confirmed password and then presses the "Create Account" button. [4] The application validates the traveler's account information and creates the requested account. [5] The application displays the home page(Figure 4-4).

Alternate Paths

Account creation fails:

(at [4])

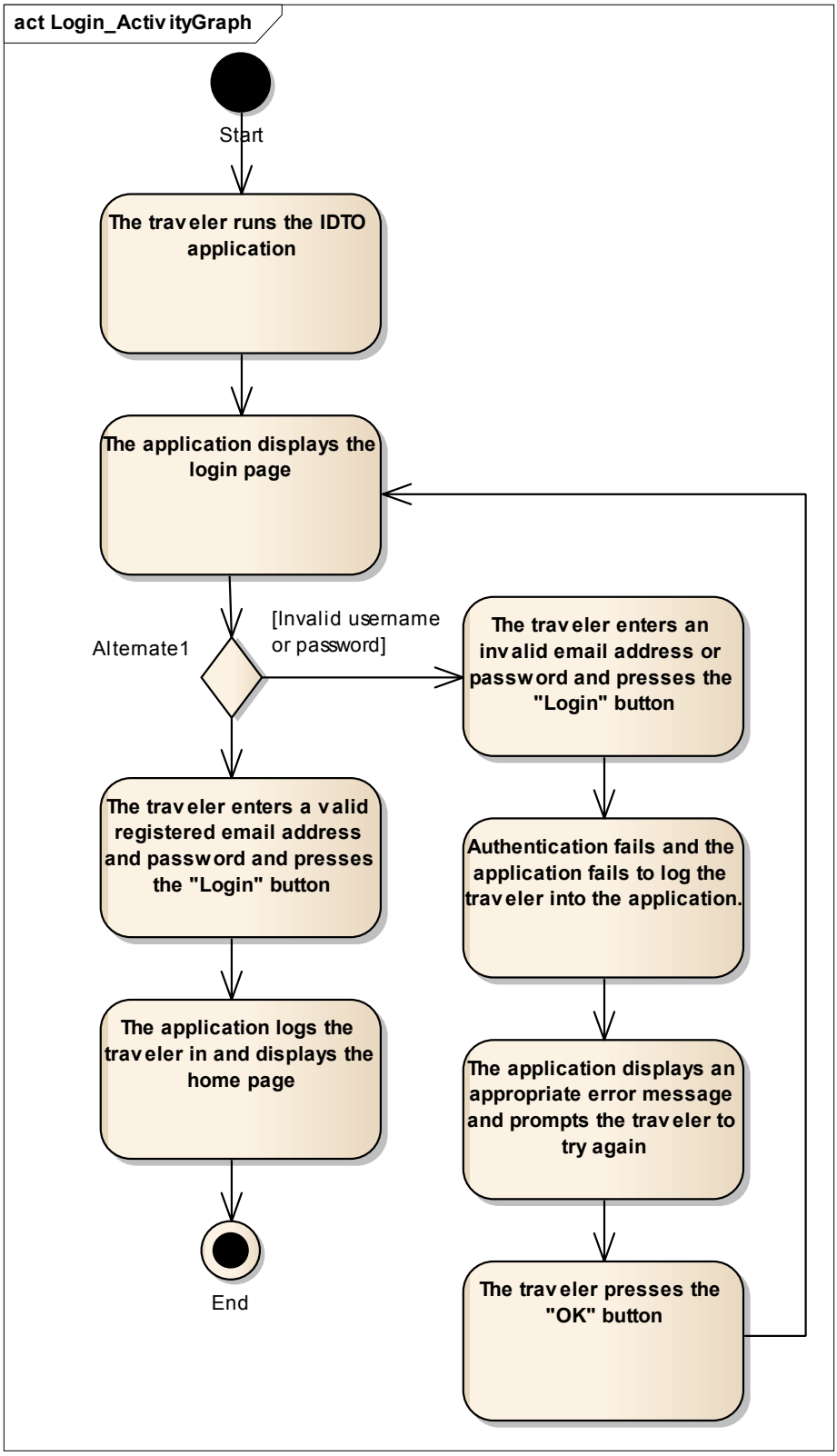
The application fails to create an account. The application displays the account form with errors highlighted. The traveler corrects the highlighted information.

Pre-condition

The traveler is not logged in to the IDTO mobile application

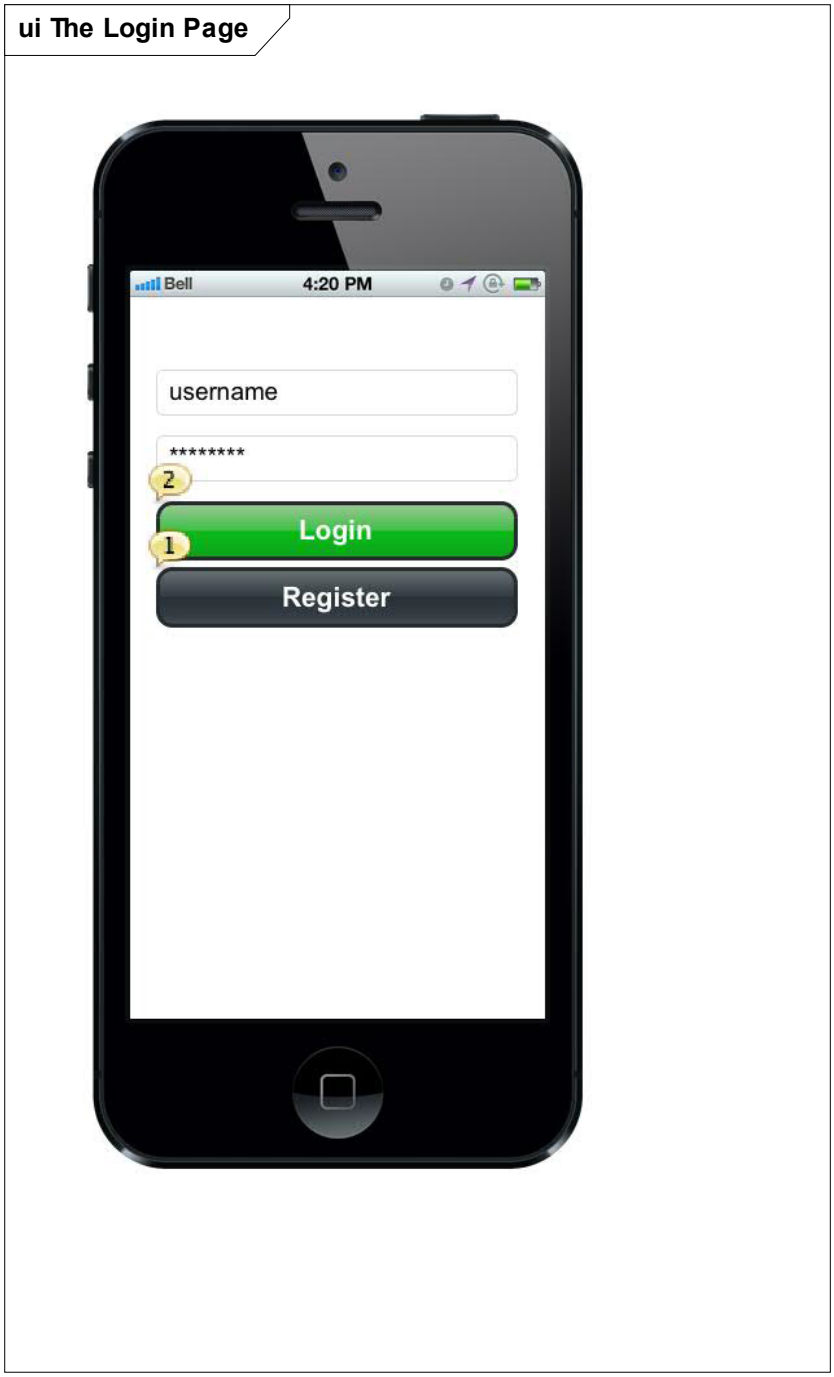
4.1.2 Login

Once an account is created, the traveler can run the mobile application and login.



Source: Battelle

Figure 4-5. Login_ActivityGraph



Source: Battelle

Figure 4-6. The Login Page

4.1.2.1 Login

Basic Path

Basic Path:

[1] The traveler runs the IDTO application. [2] The application displays the login page(Figure 4-6). [3] The traveler enters a valid registered email address and password and presses the "Login" button. [4] The application logs the traveler in and displays the home page(Figure 4-6).

Alternate Paths

Saved credentials:

The application logs the traveler in using saved credentials.

Invalid username or password:

(at [3])

The traveler enters an invalid email address or password and presses the "Login" button. Authentication fails and the application fails to log the traveler into the application. The application displays an appropriate error message and prompts the traveler to try again. The traveler presses the "OK" button.

Exceptions

Exit application:

The traveler quits the IDTO mobile application.

Login Fails:

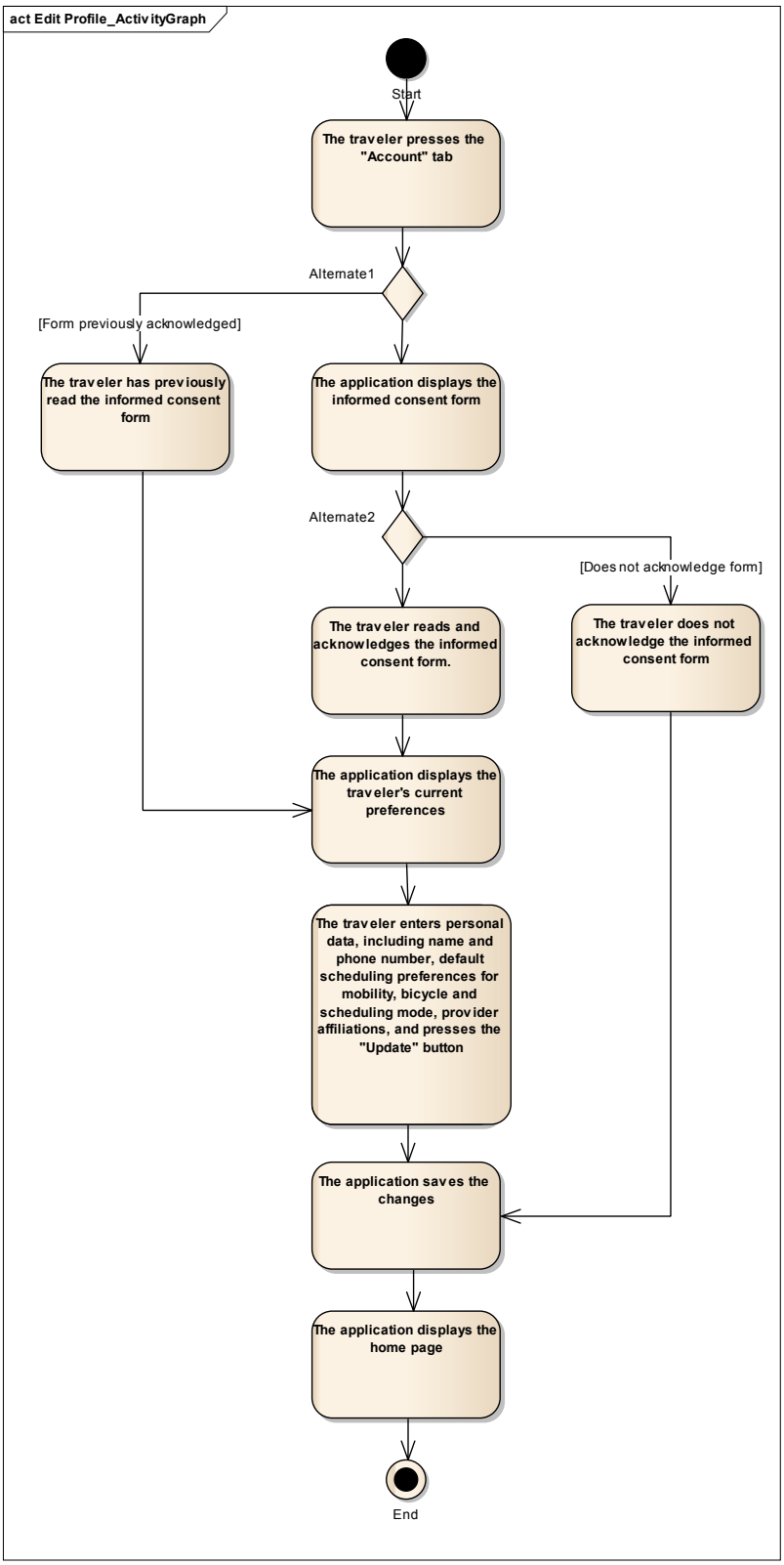
The Traveler enters an invalid email address or password for the third time. The application displays an appropriate error message.

Pre-condition

The traveler is not logged in to the IDTO mobile application

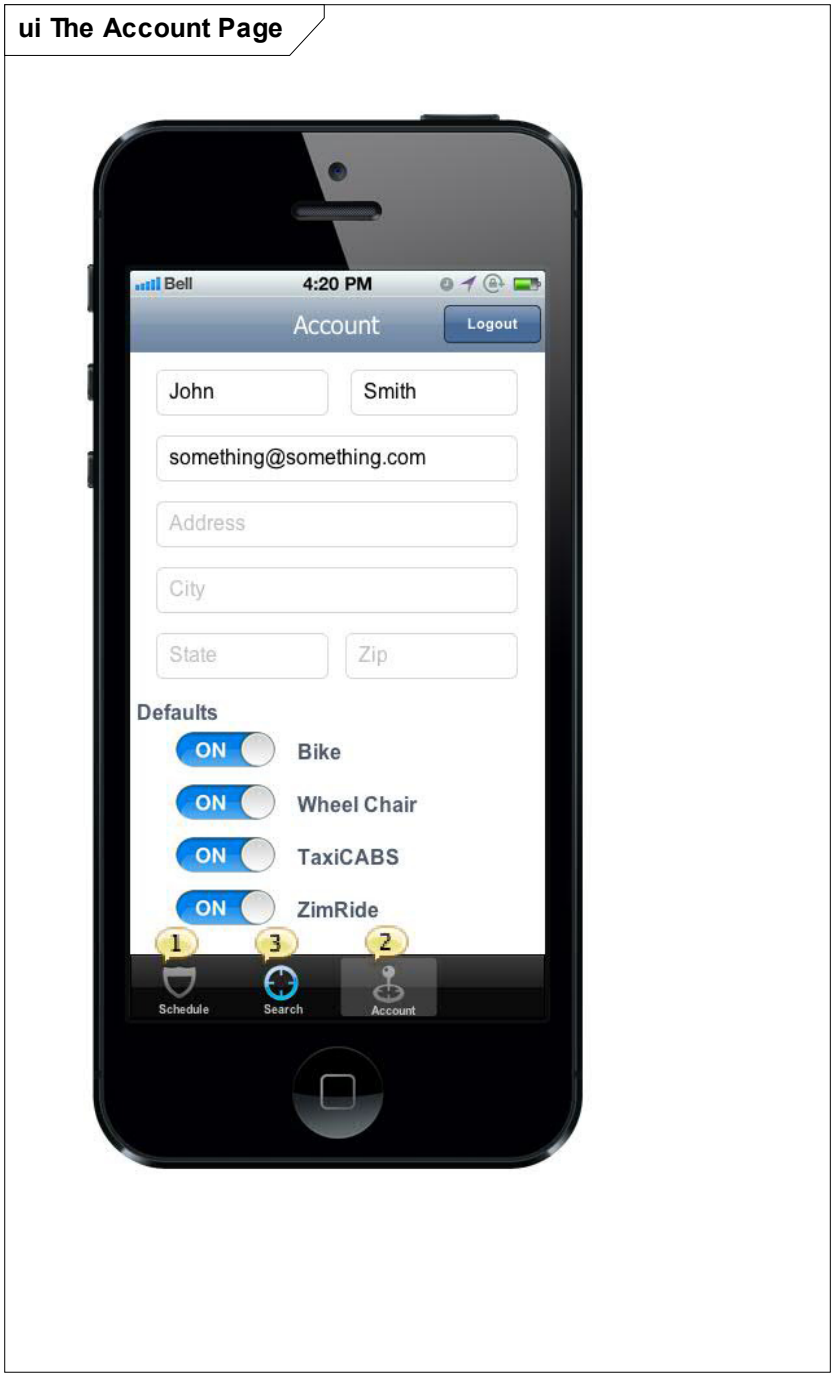
4.1.3 Edit Profile

Once the traveler has created an account and logged into the mobile application, he is able to set a number of preferences in his profile. These preferences tailor the traveler's experience to their personal situation.



Source: Battelle

Figure 4-7. Edit Profile_ActivityGraph



Source: Battelle

Figure 4-8. The Account Page

4.1.3.1 Edit Profile

Basic Path

Basic Path:

[1] The traveler presses the "Account" tab (Figure 4-8). [2] The application displays the informed consent form. [3] The traveler reads and acknowledges the informed consent form. [4] The application displays the traveler's current preferences. [5] The traveler enters personal data, including name and phone number, default scheduling preferences for mobility, bicycle and scheduling mode, provider affiliations, and presses the "Update" button. [6] The application saves the changes. [7] The application displays the home page.

Alternate Paths

Finished editing profile:

Does not acknowledge form:

(at [3])

The traveler does not acknowledge the informed consent form.

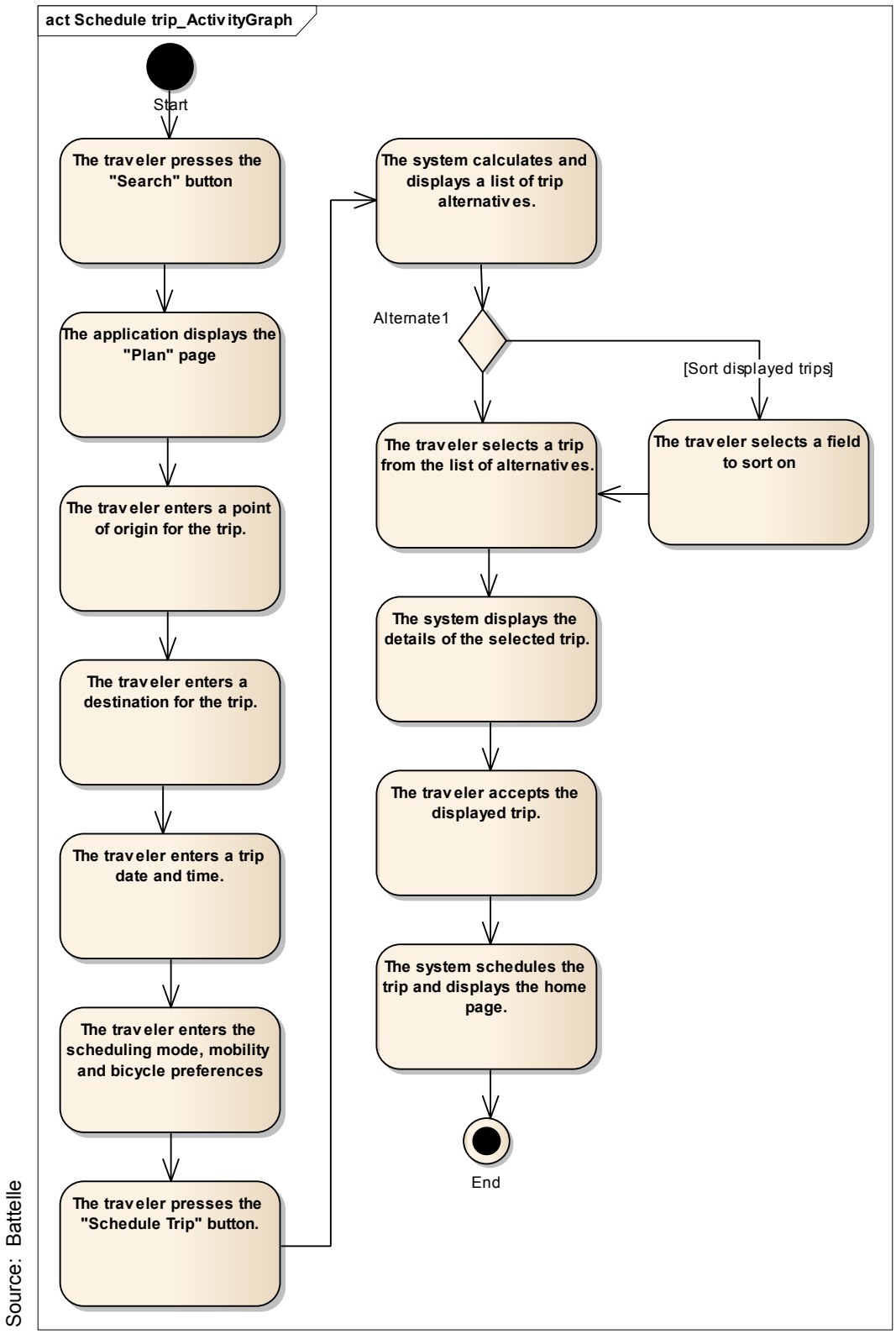
Form previously acknowledged:

(at [2])

The traveler has previously read the informed consent form.

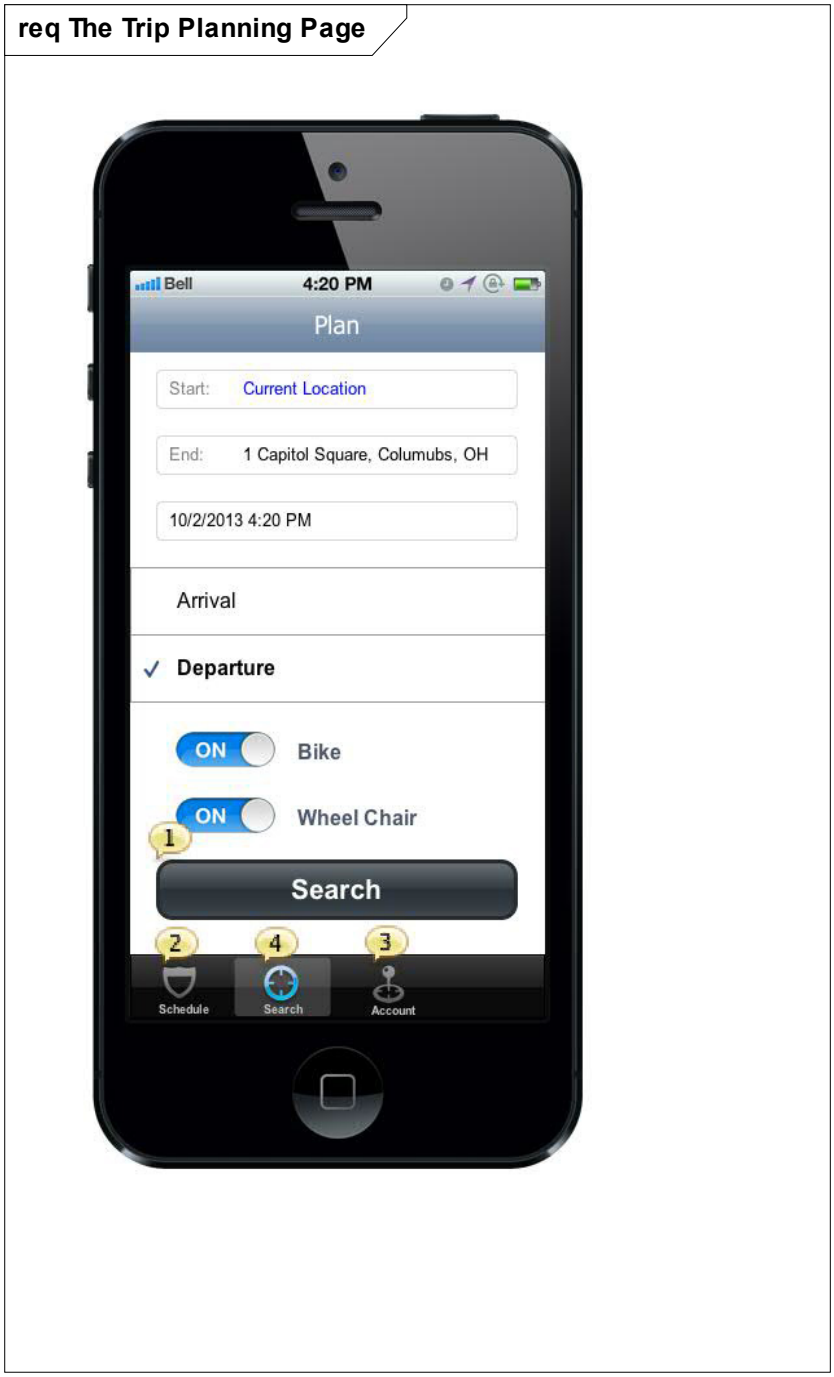
4.1.4 Plan Trip

Once the traveler's preferences are set, he is ready to plan a trip. The traveler's preferences help determine what trip providers are available to the traveler, as well as making the planning process more efficient.



Source: Battelle

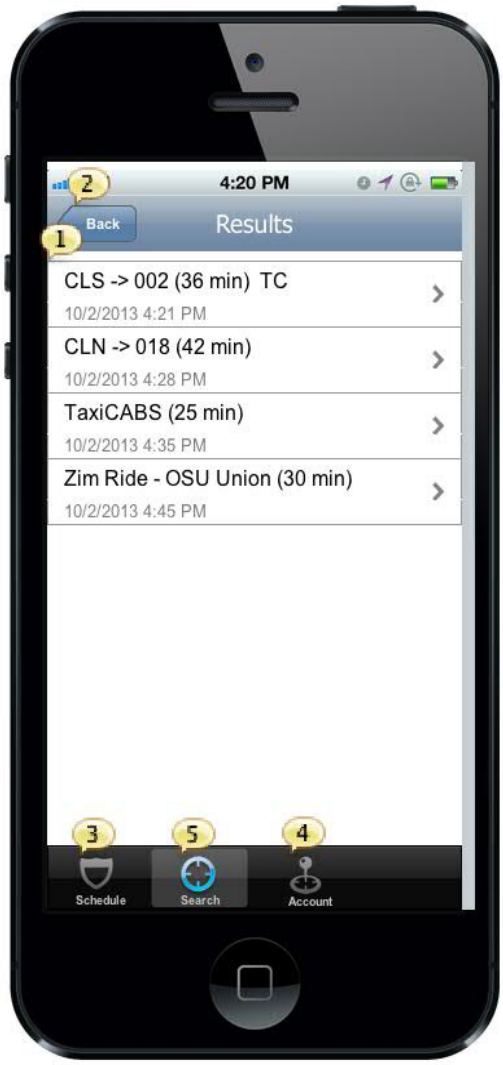
Figure 4-9. Schedule trip_ActivityGraph



Source: Battelle

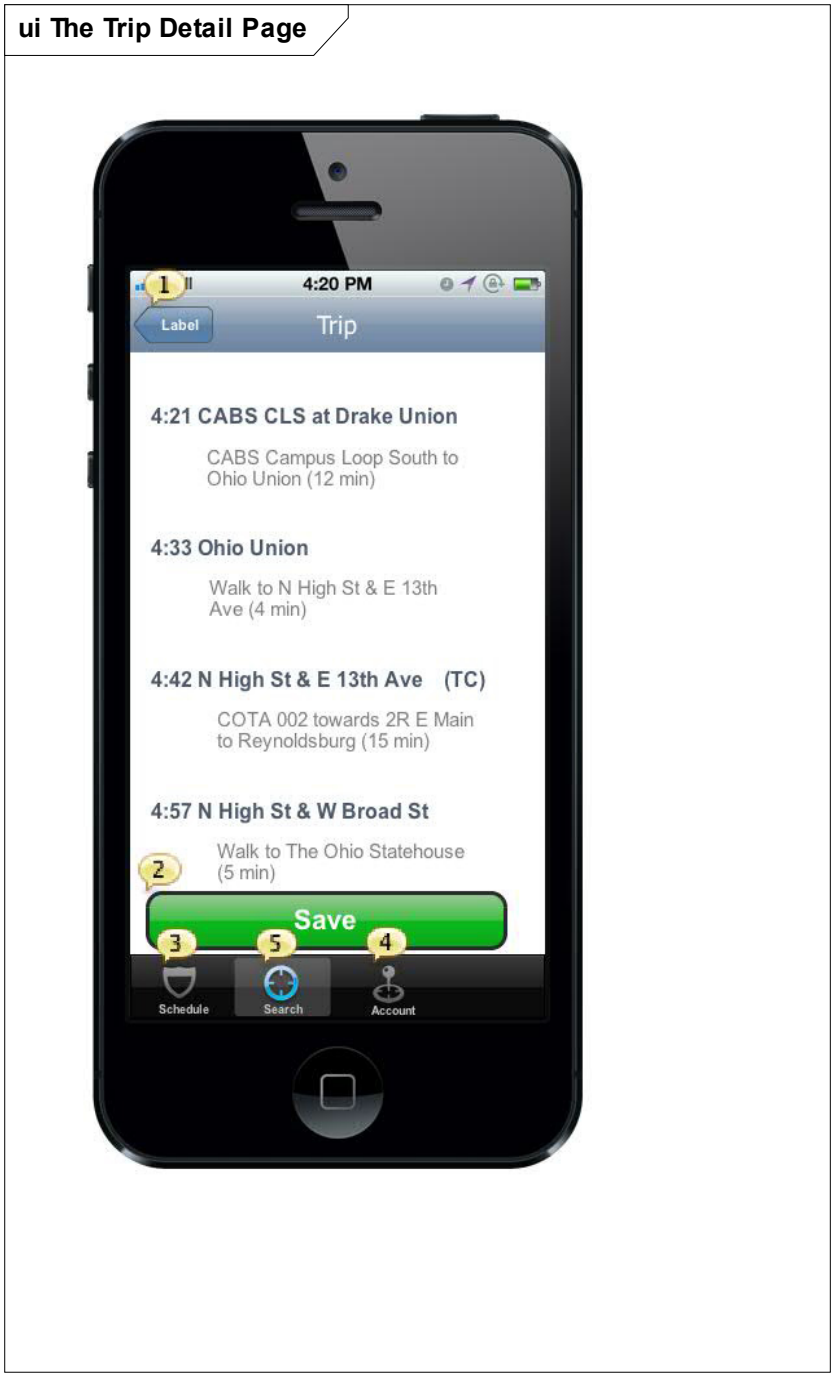
Figure 4-10. The Trip Planning Page

ui The Results Page



Source: Battelle

Figure 4-11. The Results Page



Source: Battelle

Figure 4-12. The Trip Detail Page

4.1.4.1 Schedule trip

This is the Schedule Trip description.

Basic Path

Basic Path:

[1] The traveler presses the "Search" button. [2] The application displays the "Plan" page (Figure 4-10). [3] The traveler enters a point of origin for the trip. [4] The traveler enters a destination for the trip. [5] The traveler enters a trip date and time. [6] The traveler enters the scheduling mode, mobility and bicycle preferences. [7] The traveler presses the "Schedule Trip" button. [8] The system calculates and displays a list of trip alternatives (Figure 4-11). [9] The traveler selects a trip from the list of alternatives. [10] The system displays the details of the selected trip (Figure 4-12). [11] The traveler accepts the displayed trip. [12] The system schedules the trip and displays the home page.

Alternate Paths

Alternate1:

Previously entered destination:

The traveler selects a destination from a list of previously entered locations.

Current location is the destination:

The user selects the current location as the destination.

Previously entered point of origin:

The traveler selects a point of origin from a list of previously entered locations.

Current location is the point of origin:

The user selects the current location as the point of origin.

Select a scheduling mode:

The traveler selects a scheduling mode.

Sort displayed trips:

(at [9])

The traveler selects a field to sort on.

Select a mobility preference:

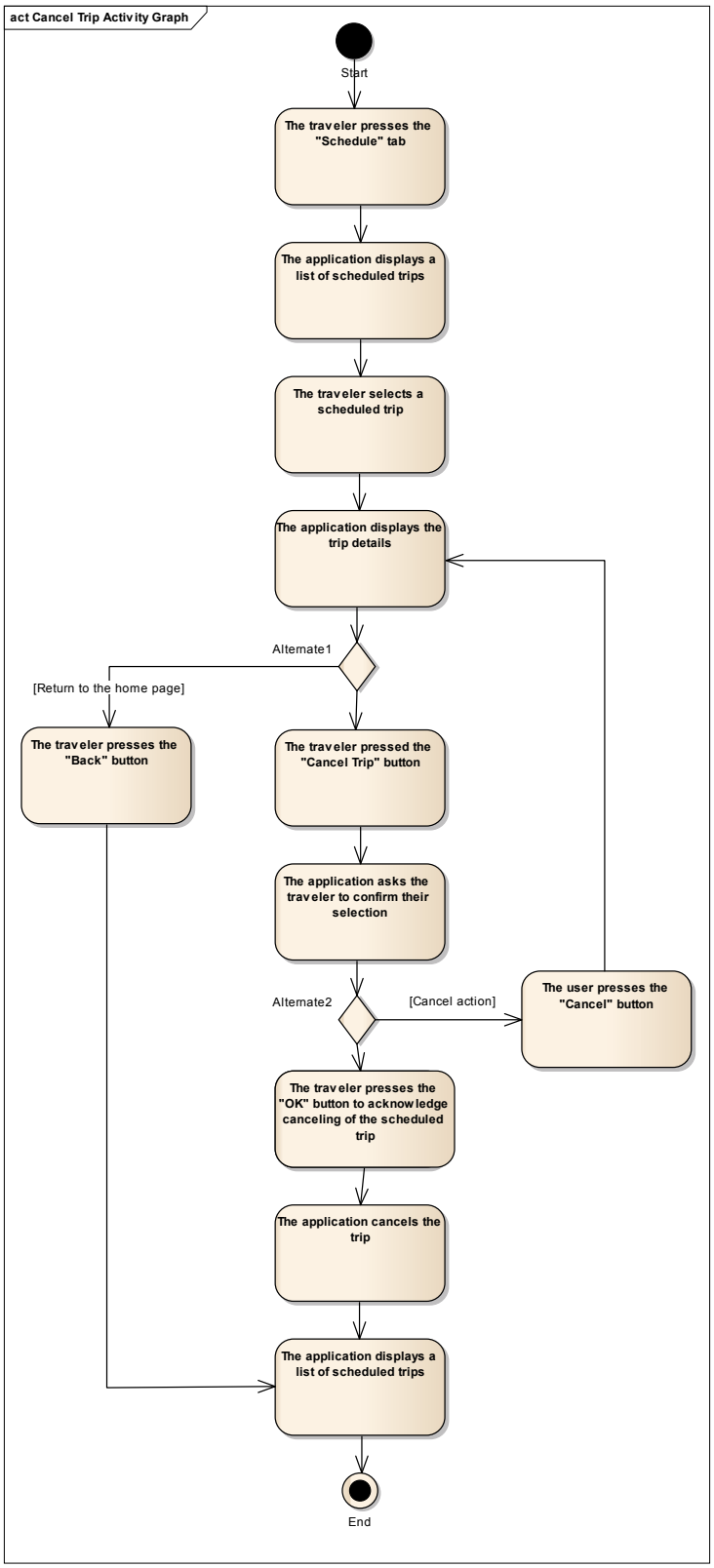
The traveler selects a mobility preference.

Select a bicycle preference:

The traveler selects a bicycle preference.

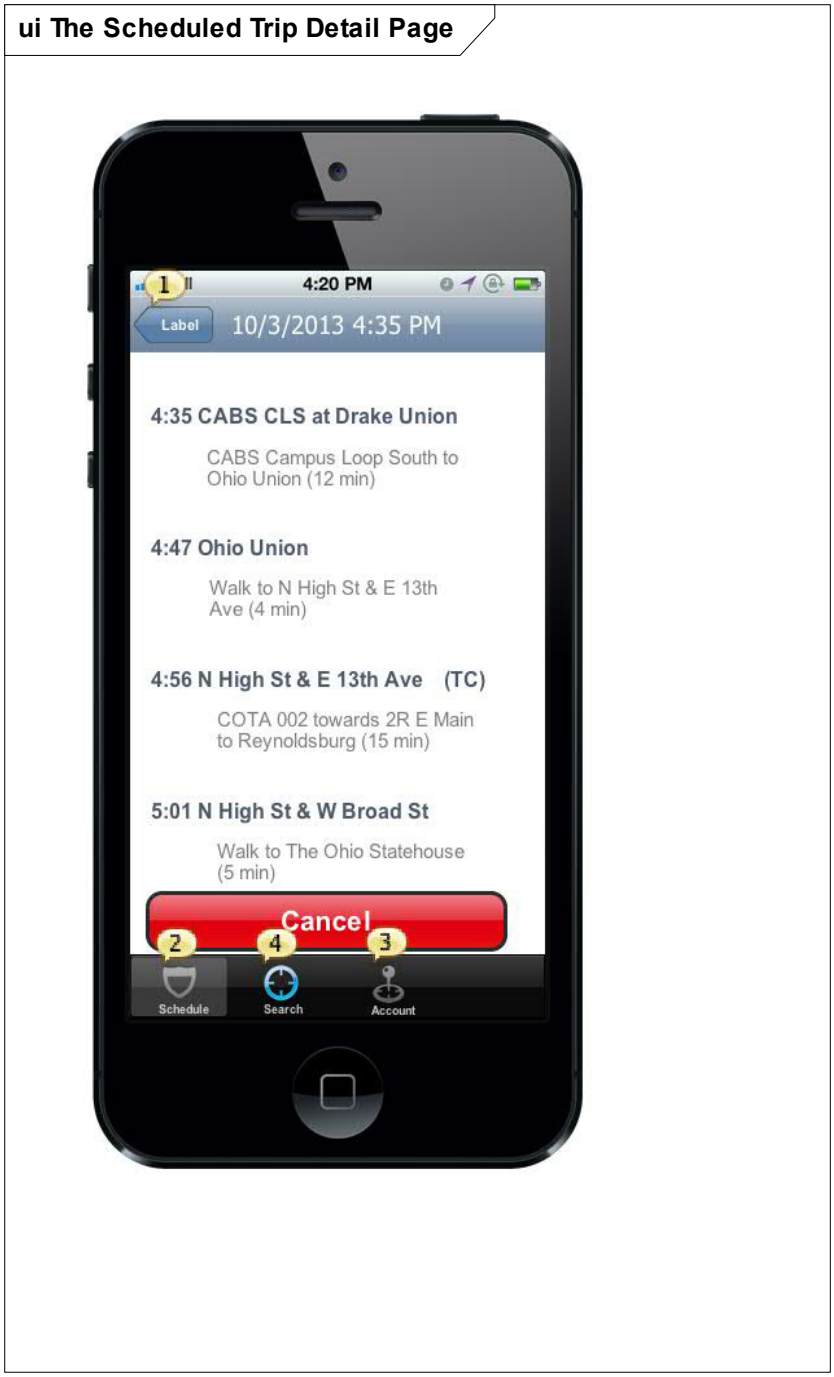
4.1.5 Cancel Trip

The traveler cancels a previously scheduled trip using the following steps.



Source: Battelle

Figure 4-13. Cancel Trip Activity Graph



Source: Battelle

Figure 4-14. The Scheduled Trip Detail Page

4.1.5.1 Cancel trip

Basic Path

Basic Path:

[1] The traveler presses the "Schedule" tab. [2] The application displays a list of scheduled trips. [3] The traveler selects a scheduled trip. [4] The application displays the trip details (Figure 4-14). [5] The traveler pressed the "Cancel Trip" button. [6] The application asks the traveler to confirm their selection. [7] The traveler presses the "OK" button to acknowledge canceling of the scheduled trip. [8] The application cancels the trip. [9] The application displays a list of scheduled trips.

Alternate Paths

Return to the home page:

(at [5])

The traveler presses the "Back" button.

Cancel action:

(at [7])

The user presses the "Cancel" button.

Pre-condition

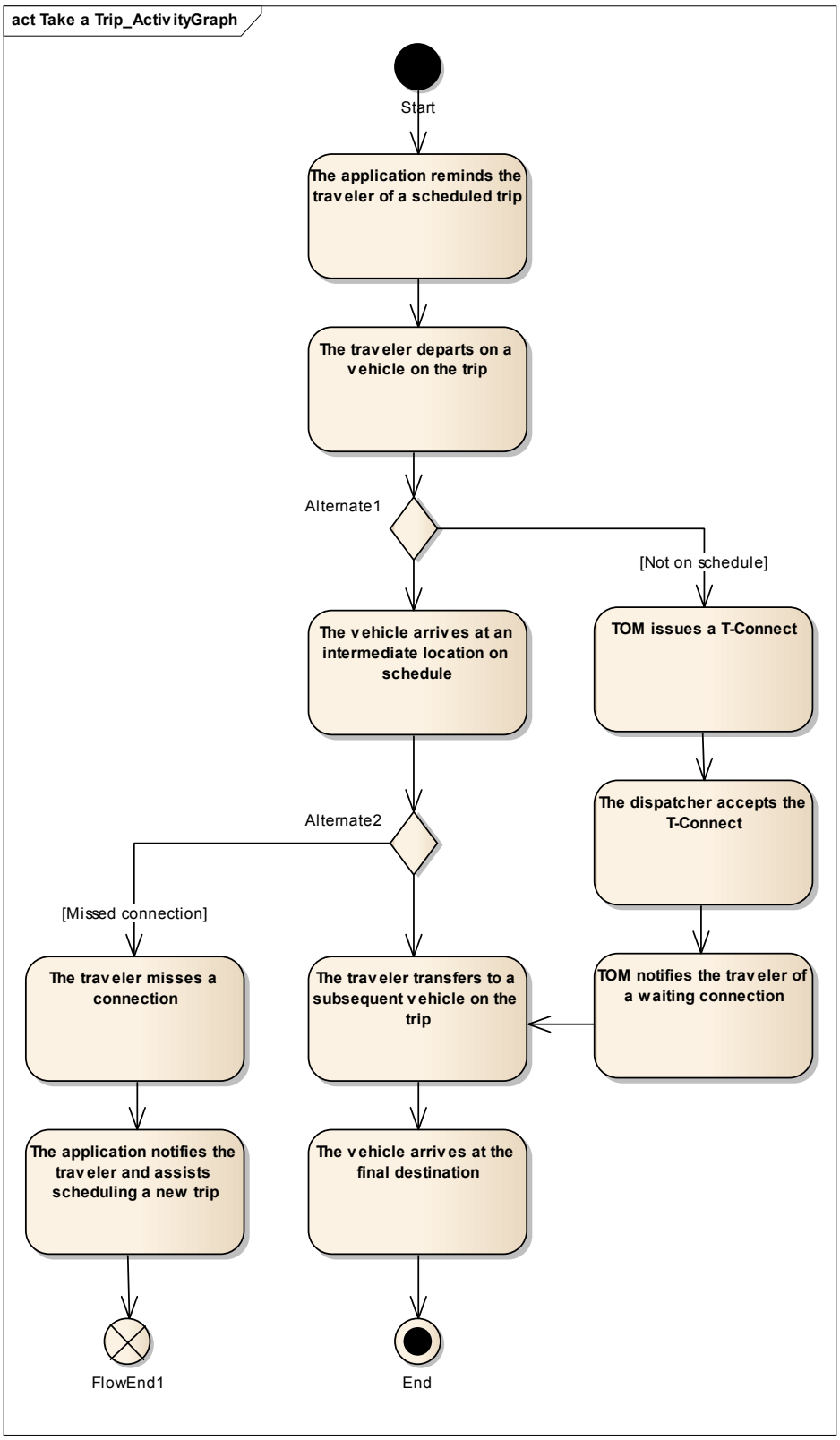
The traveler is on the home page of the application

Post-condition

The traveler is on the home page of the application

4.1.6 Take a Trip

The IDTO mobile application keeps the traveler informed of the status of his connections and transfers on the trip, and can aid the traveler in rescheduling a trip in the event a connection is missed.



Source: Battelle

Figure 4-15. Take a Trip_ActivityGraph

4.1.6.1 Take a Trip

Basic Path

Basic Path:

[1] The application reminds the traveler of a scheduled trip. [2] The traveler departs on a vehicle on the trip. [3] The vehicle arrives at an intermediate location on schedule. [4] The traveler transfers to a subsequent vehicle on the trip. [5] The vehicle arrives at the final destination.

Alternate Paths

Not on schedule:

(at [3])

TOM issues a T-Connect. The dispatcher accepts the T-Connect. TOM notifies the traveler of a waiting connection.

Missed connection:

(at [4])

The traveler misses a connection. The application notifies the traveler and assists scheduling a new trip.

4.1.7 Logout

At the end of a session the traveler logs out of the IDTO application.

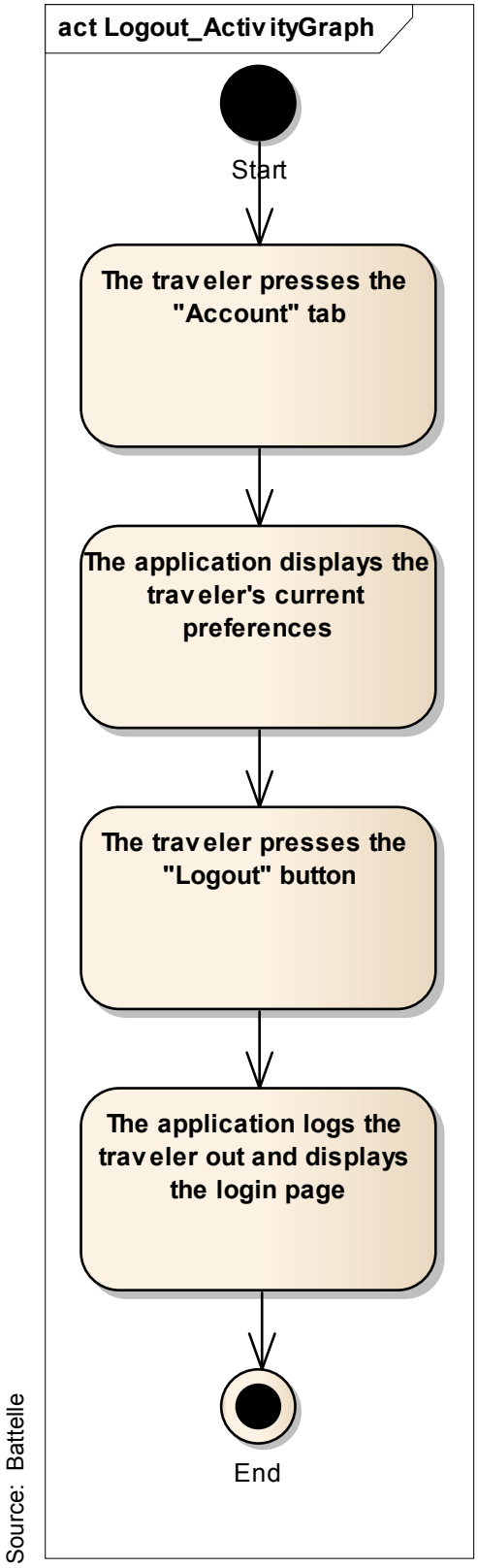


Figure 4-16. Logout_ActivityGraph

4.1.7.1 Logout

Basic Path

Basic Path:

[1] The traveler presses the "Account" tab. [2] The application displays the traveler's current preferences. [3] The traveler presses the "Logout" button. [4] The application logs the traveler out and displays the login page.

Pre-condition

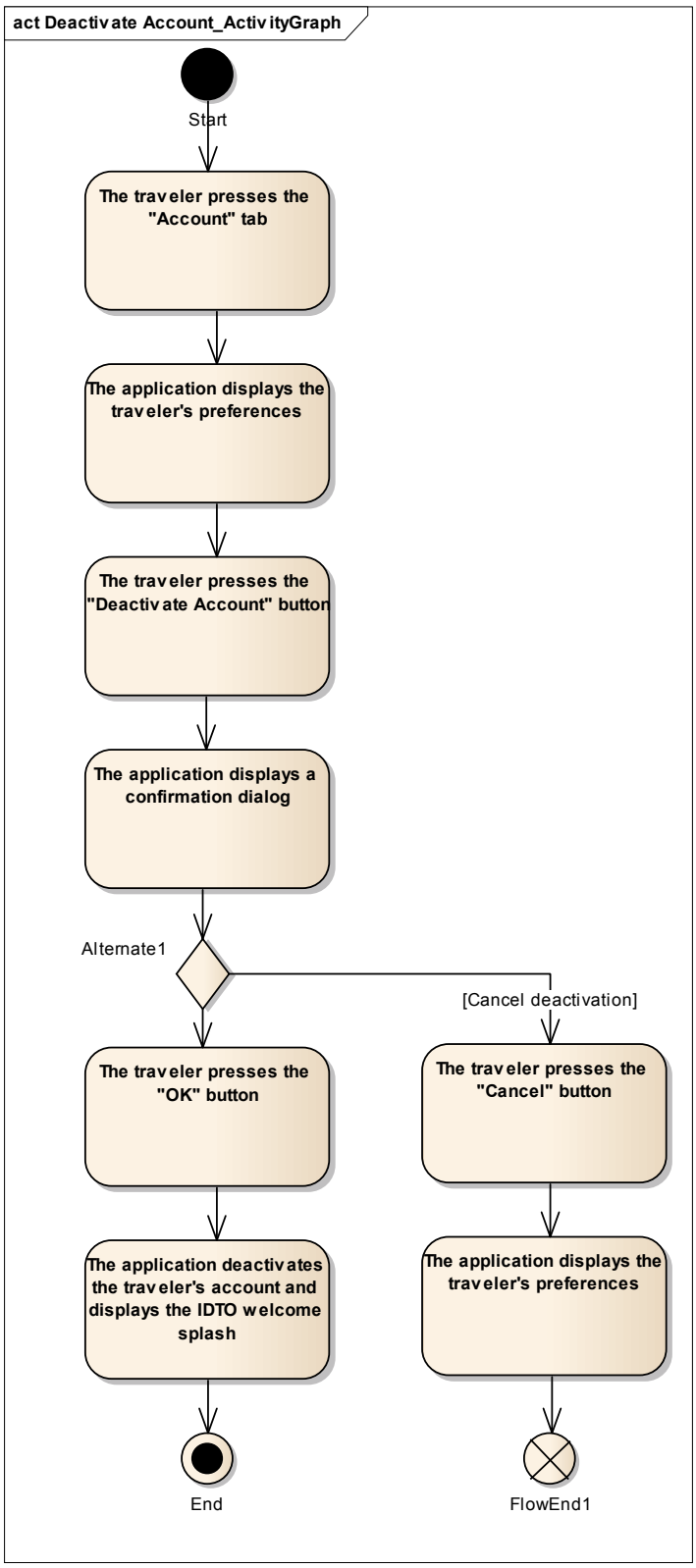
The traveler is logged in to the IDTO mobile application

Post-condition

The traveler is not logged in to the IDTO mobile application

4.1.8 Deactivate Account

The traveler may, at any time, cease their involvement with the IDTO Prototype and deactivate their account by following the following steps.



Source: Battelle

Figure 4-17. Deactivate Account_ActivityGraph

4.1.8.1 Deactivate Account

Basic Path

Basic Path:

[1] The traveler presses the "Account" tab. [2] The application displays the traveler's preferences. [3] The traveler presses the "Deactivate Account" button. [4] The application displays a confirmation dialog. [5] The traveler presses the "OK" button. [6] The application deactivates the traveler's account and displays the IDTO welcome splash.

Alternate Paths

Cancel deactivation:

(at [5])

The traveler presses the "Cancel" button. The application displays the traveler's preferences.

4.2 Fixed Route Dispatcher Experience

For the Phase I effort, the sum total of the dispatcher's interaction with the IDTO Prototype is to accept or reject T-Connect requests presented by the system. These activities are described here.

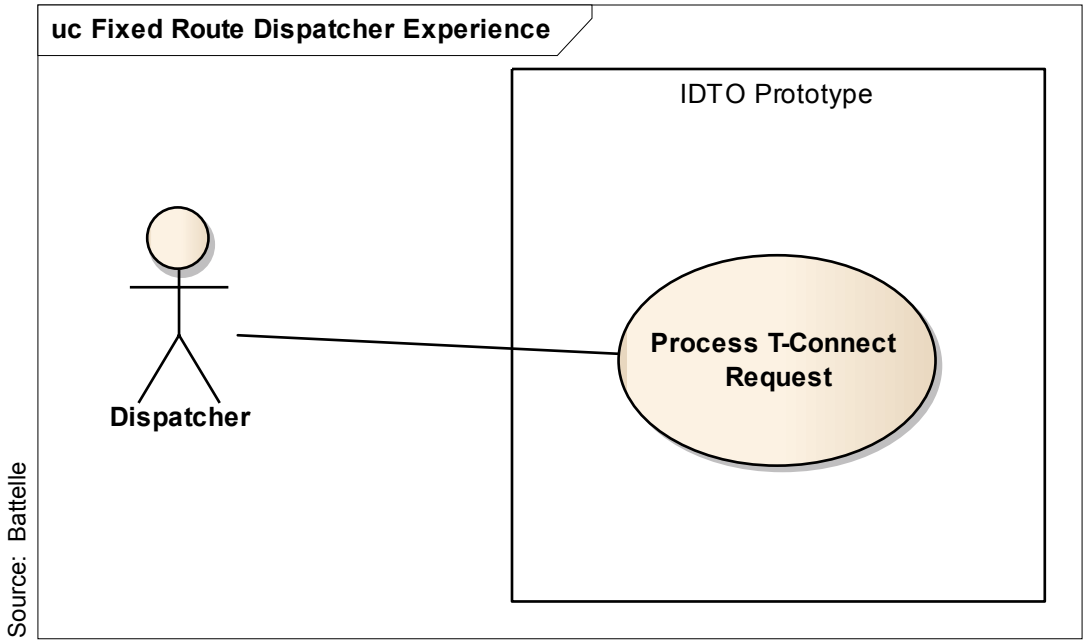
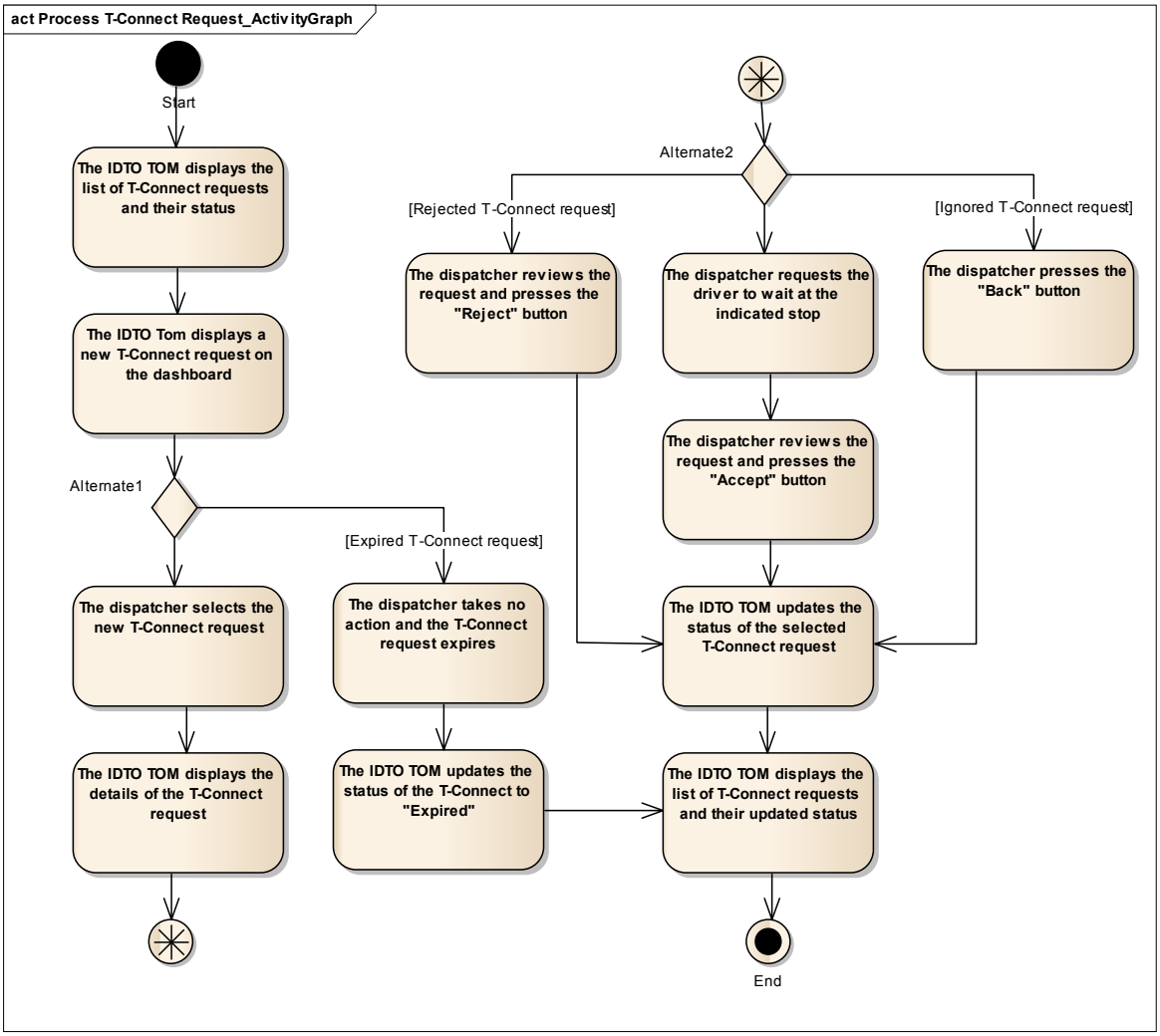


Figure 4-18. Fixed Route Dispatcher Experience

4.2.1 Process T-Connect Request

The core of the IDTO Prototype is the T-Connect. A T-Connect is a request to a Provider to hold a vehicle at a scheduled stop for a brief period of time, long enough for a traveler from a late arriving incoming connection to make the transfer. The T-Connect request gives the traveler a chance to make a connection during a scheduled trip that would otherwise not be possible.

For the Phase I implementation, the dispatcher of the Fixed Route Provider is responsible for either accepting or rejecting a T-Connect request, and subsequently relaying appropriate instructions to a vehicle driver.



Source: Battelle

Figure 4-19. Process T-Connect Request_ActivityGraph

4.2.1.1 Process T-Connect Request

Basic Path

Basic Path:

[1] The IDTO TOM displays the list of T-Connect requests and their status. [2] The IDTO Tom displays a new T-Connect request on the dashboard. [3] The dispatcher selects the new T-Connect request. [4] The IDTO TOM displays the details of the T-Connect request. [5] The dispatcher requests the driver to wait at the indicated stop. [6] The displatcher reviews the request and presses the "Accept" button. [7] The IDTO TOM updates the status of the selected T-Connect request. [8] The IDTO TOM displays the list of T-Connect requests and their updated status.

Alternate Paths

Rejected T-Connect request:

(at [5])

The dispatcher reviews the request and presses the "Reject" button.

Expired T-Connect request:

(at [3])

The dispatcher takes no action and the T-Connect request expires. The IDTO TOM updates the status of the T-Connect to "Expired".

No Action:

Ignored T-Connect request:

(at [5])

The dispatcher presses the "Back" button.

4.3 Private Incoming Driver Experience

Private incoming providers will have a mobile data terminal (MDT) in the vehicle to allow the driver of the vehicle to assist travelers in making protected connections to other providers, in particular, to another fixed route T-Connect provider. The MDT will enable the driver to effectively schedule a trip in the immediate future which connects to an outbound T-Connect provider as soon as the traveler boards the vehicle. The key to this operation is lean, efficient interface for the driver to perform this operation. The activities enabled by the IDTO Prototype are described here.

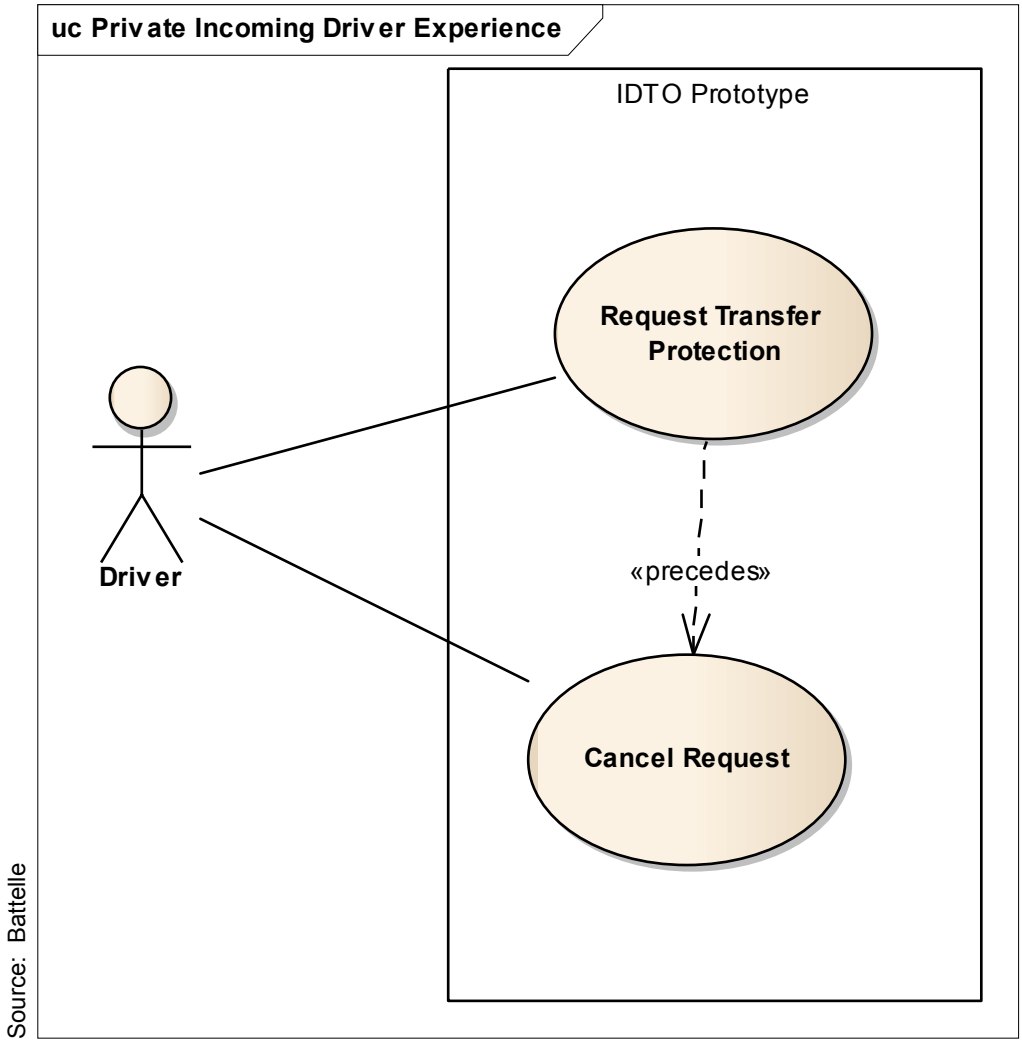
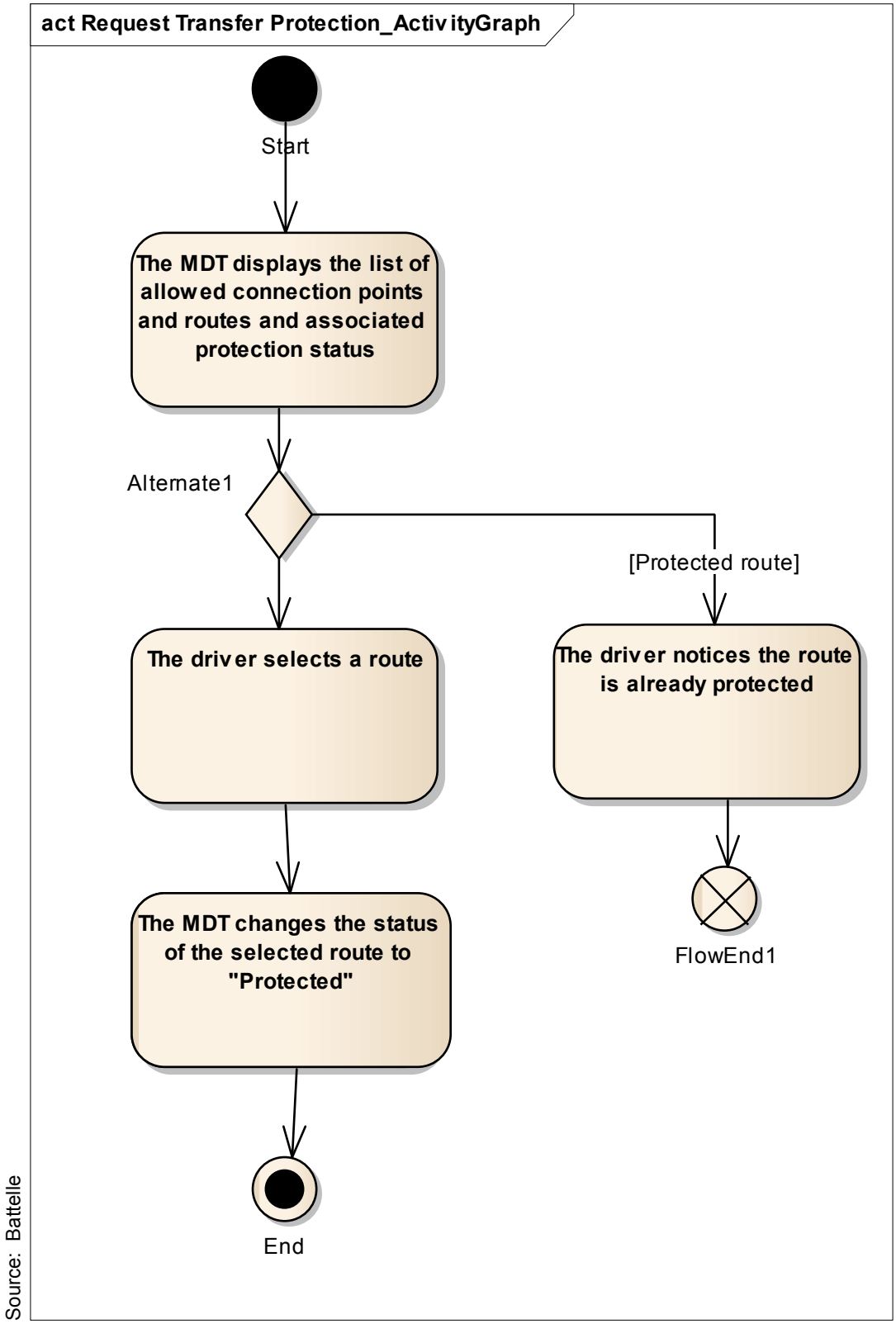


Figure 4-20. Private Incoming Driver Experience

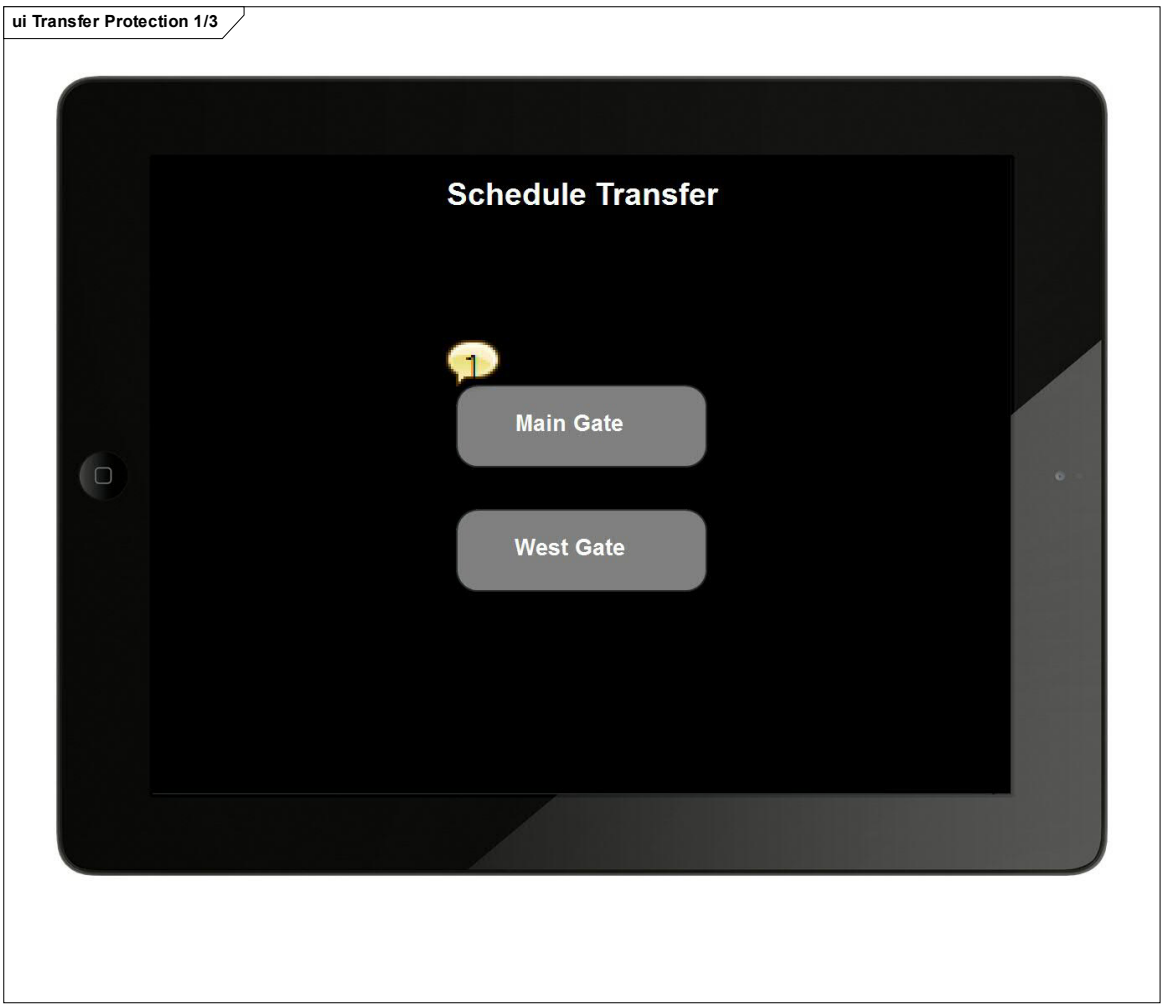
4.3.1 Request Transfer Protection

When a traveler boards the vehicle, he informs the driver of his desire to transfer to an outbound provider, identifying both the location of the transfer and the desired route from the transfer point. The driver captures this information in the MDT. If a protection request already exists for the new traveler already exists, the driver need take no further action.



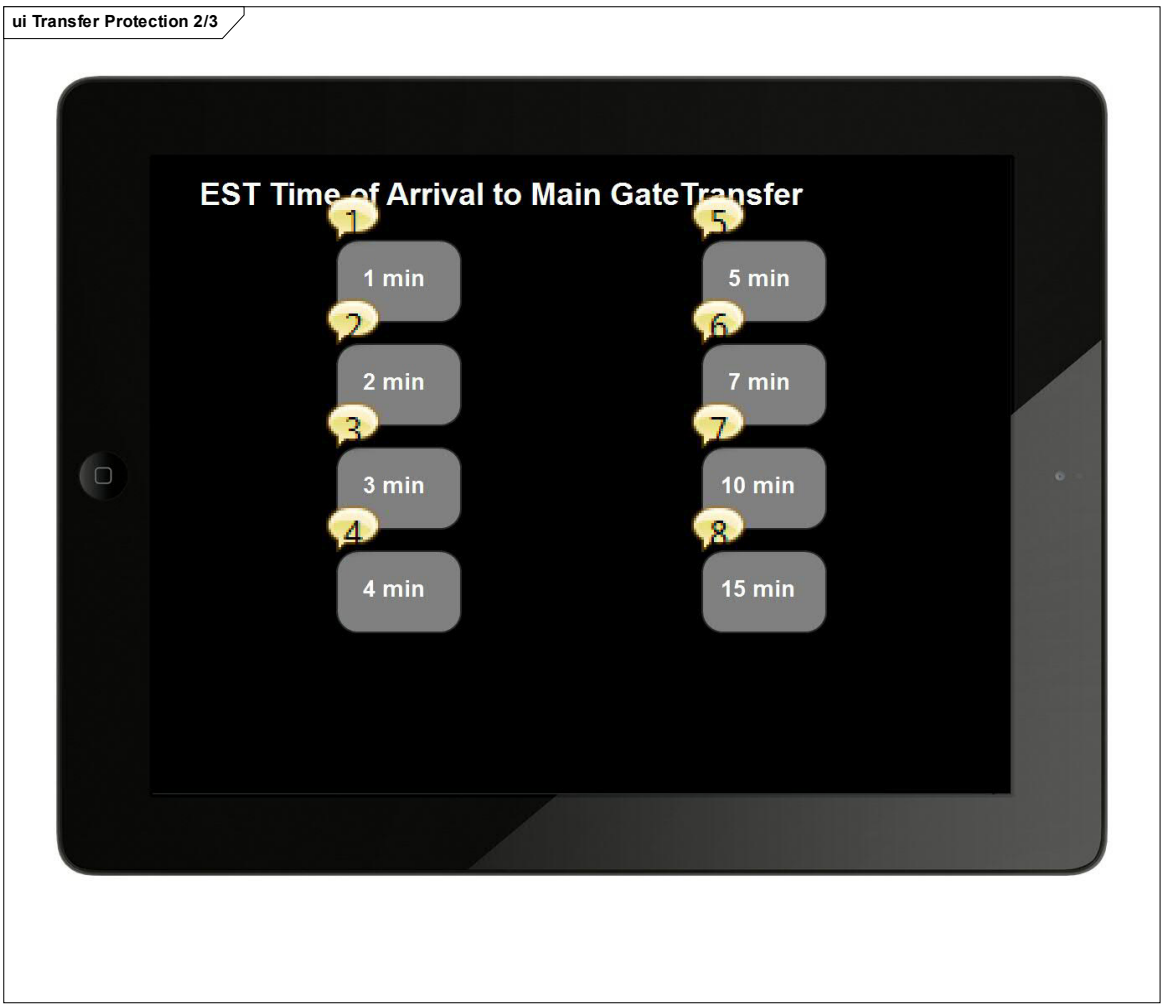
Source: Battelle

Figure 4-21. Request Transfer Protection_ActivityGraph



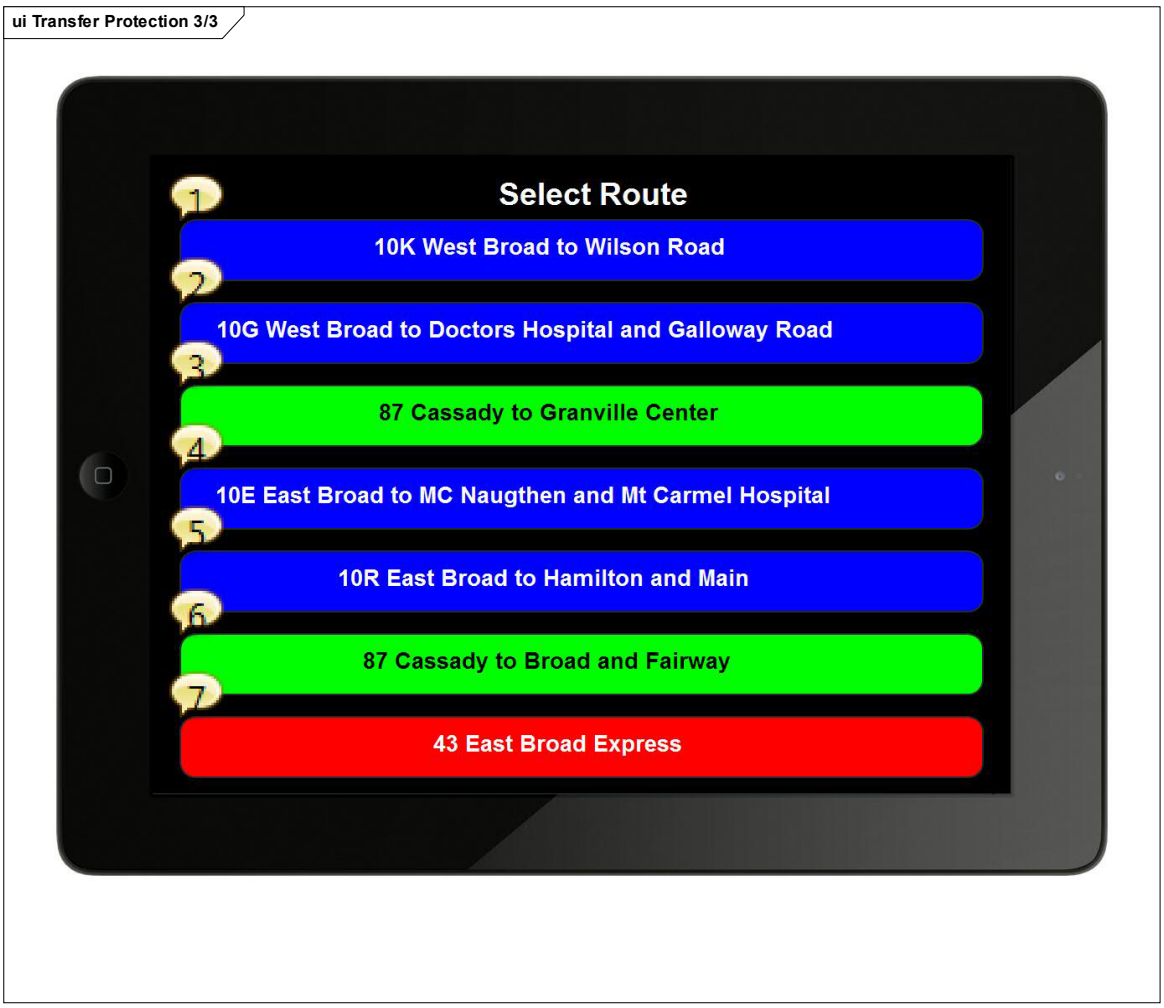
Source: Battelle

Figure 4-22. Transfer Protection 1/3



Source: Battelle

Figure 4-23. Transfer Protection 2/3



Source: Battelle

Figure 4-24. Transfer Protection 3/3

4.3.1.1 Request Transfer Protection

Basic Path

Basic Path:

[1] The MDT displays a list of allowed connection points and routes and associated protection status (Figure 4-24). [2] The driver selects a route. [3] The MDT changes the status of the selected route to "Protected".

Alternate Paths

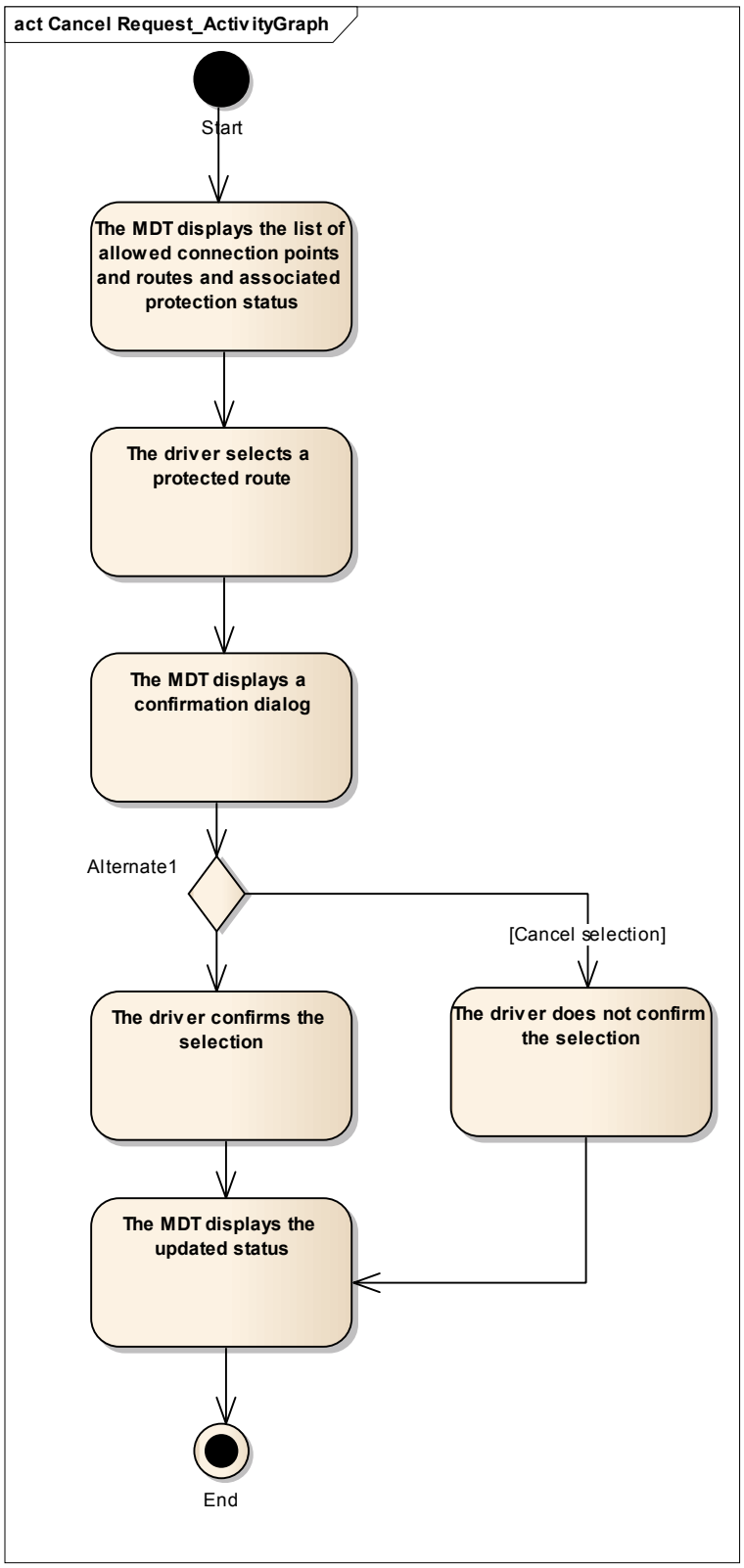
Protected route:

(at [2])

The driver notices the route is already protected.

4.3.2 Cancel Request

The driver can, as need arises, cancel a protection request from the vehicle's MDT.



Source: Battelle

Figure 4-25. Cancel Request_ActivityGraph

4.3.2.1 Cancel Request

Basic Path

Basic Path:

[1] The MDT displays the list of allowed connection points and routes and associated protection status. [2] The driver selects a protected route. [3] The MDT displays a confirmation dialog. [4] The driver confirms the selection. [5] The MDT displays the updated status.

Alternate Paths

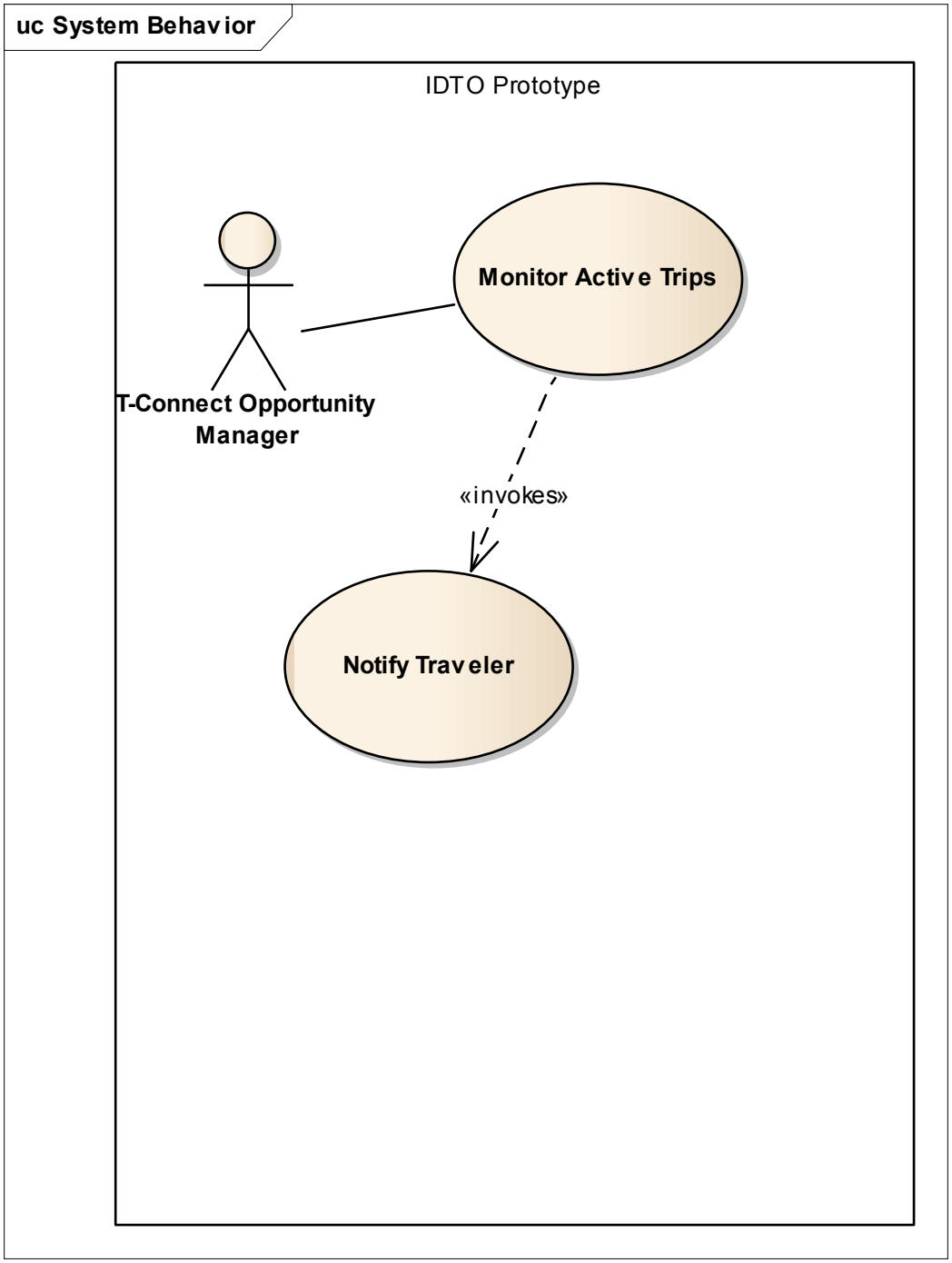
Cancel selection:

(at [4])

The driver does not confirm the selection.

4.4 System Behavior

Many of the details of operation in the IDTO Prototype are not mediated by human intervention. These activities between the various components, internal and external to the system, are described here.

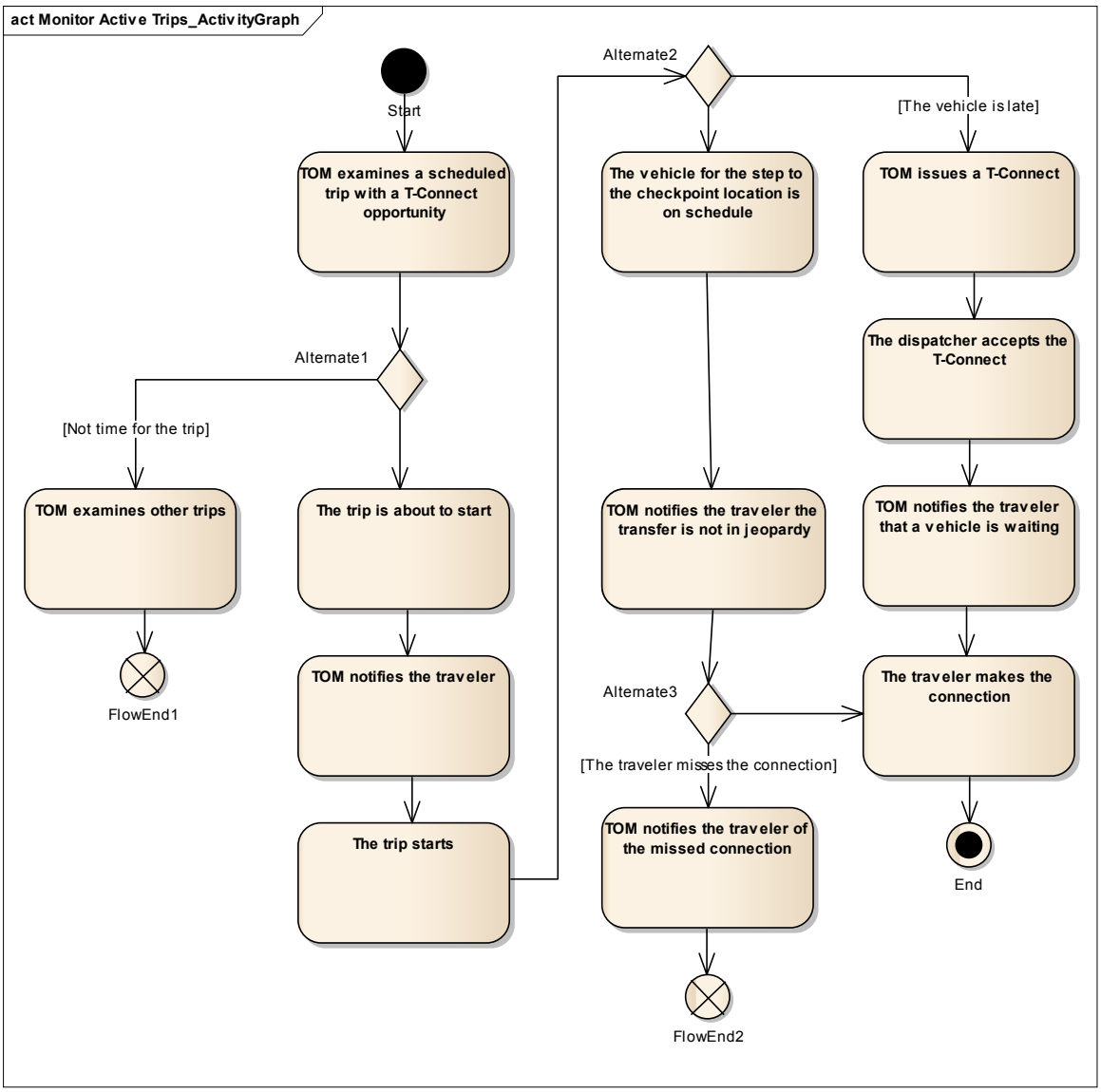


Source: Battelle

Figure 4-26. System Behavior

4.4.1 Monitor Active Trips

The TOM is the heart of the IDTO Prototype. The TOM actively monitors all scheduled trips in the IDTO Prototype, notifying the traveler of upcoming trips and issuing T-Connect requests when a traveler is observed in jeopardy of missing a connection.



Source: Battelle

Figure 4-27. Monitor Active Trips_ActivityGraph

4.4.1.1 Monitor Active Trips

Basic Path

Basic Path:

[1] The TOM examines a scheduled trip with a T-Connect opportunity. [2] The trip is about to start. [3] The TOM notifies the traveler. [4] The trip starts. [5] The vehicle for the step to the checkpoint location is on schedule. [6] The TOM notifies the traveler the transfer is not in jeopardy. [7] The traveler makes the connection.

Alternate Paths

Not time for the trip:

(at [2])

The TOM examines other trips.

The vehicle is late:

(at [5])

The TOM issues a T-Connect. The dispatcher accepts the T-Connect. The TOM notifies the traveler that a vehicle is waiting.

The traveler misses the connection:

(at [7])

The TOM notifies the traveler of the missed connection.

4.4.2 Notify Traveler

Various events noticed by the TOM are of interest to the traveler. The TOM relays messages to the traveler at opportune times to inform the traveler of these events.

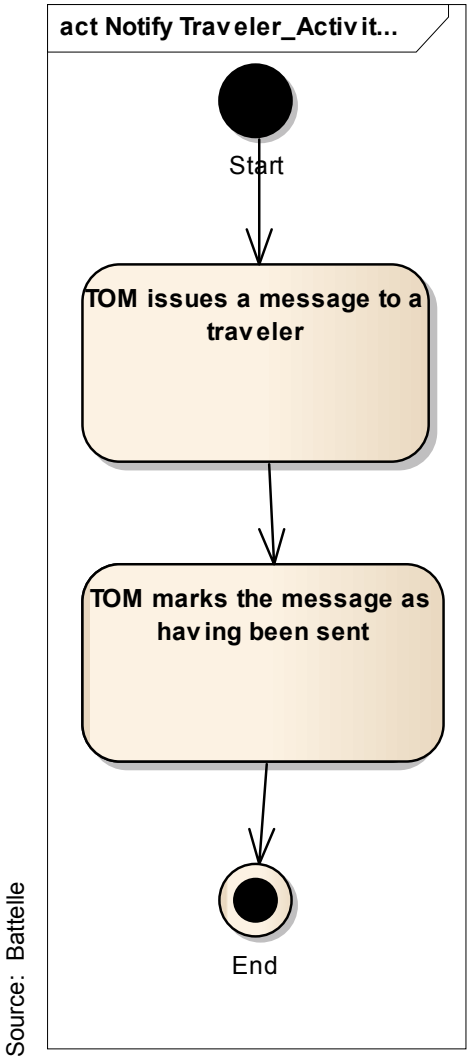


Figure 4-28. Notify Traveler_ActivityGraph

4.4.2.1 Notify Traveler

Basic Path

Basic Path:

[1] The TOM issues a message to a traveler. [2] The TOM marks the message as having been sent.

5 Interfaces

The IDTO Prototype interfaces with five categories of service providers, including three variations of fixed route providers, one demand/response provider, and one rideshare provider. The general outline of the interfaces for each of these providers is described in the following sections.

5.1 Traveler

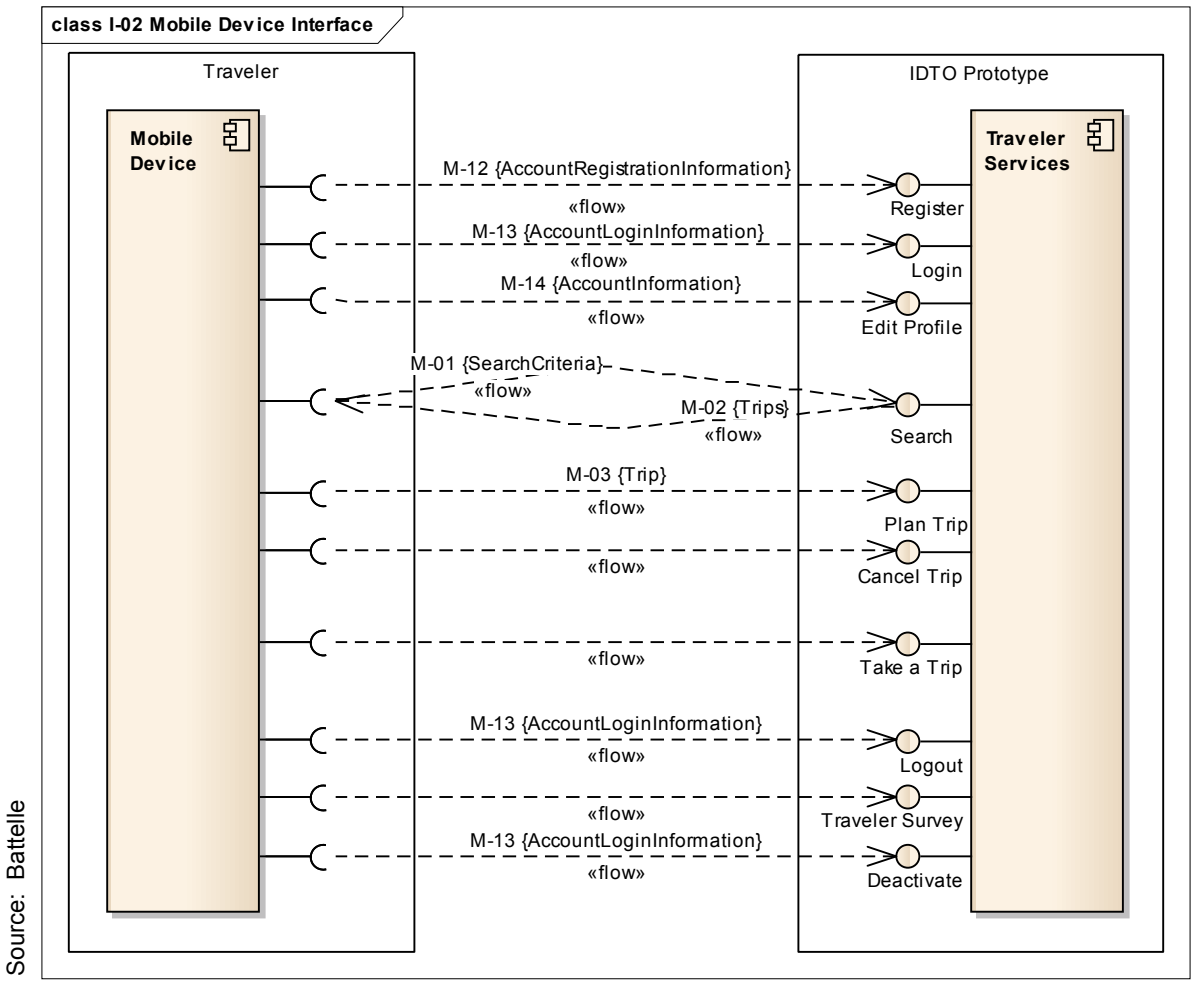
The interface between a traveler and the IDTO Prototype consists of six distinct information exchanges, listed in Figure 5-1, all through an application running on the traveler's mobile device.

The traveler must first create an IDTO user account and corresponding profile of trip preferences. The user account enables user authentication, while the preferences are used by the IDTO Prototype to facilitate trip scheduling for the traveler. This capability is referred to as Account Management and is supported via both the Traveler Smartphone APP and the Traveler Portal.

Once an account is established, the traveler is able to explore and schedule trips, enabled via both the Smartphone App and the Web Portal. Route searches from the traveler result in trip options presented back to the traveler. The traveler selects a trip which is saved and subsequently monitored within the IDTO Prototype. A critical design outcome is such that a traveler must be validated as being on the designated incoming bus in order for T-CONNECT transfers to be protected.

Once a trip is scheduled, the IDTO Prototype begins monitoring, notifying the traveler when the scheduled trip is about start, tracking the traveler through the trip via the traveler's mobile device, and providing feedback to the traveler, especially on the status of any T-Connect enabled legs of the trip.

Similar data exchanges occur between the Traveler Services component and a standard web browser, with the possible exception of location services provided back to the IDTO Prototype. Note that in either case, the traveler's mobile device or through a web browser, connectivity to the IDTO prototype must be maintained throughout an active trip for active T-Connect status to be provided.



Source: Battelle

Figure 5-1. I-02 Mobile Device Interface

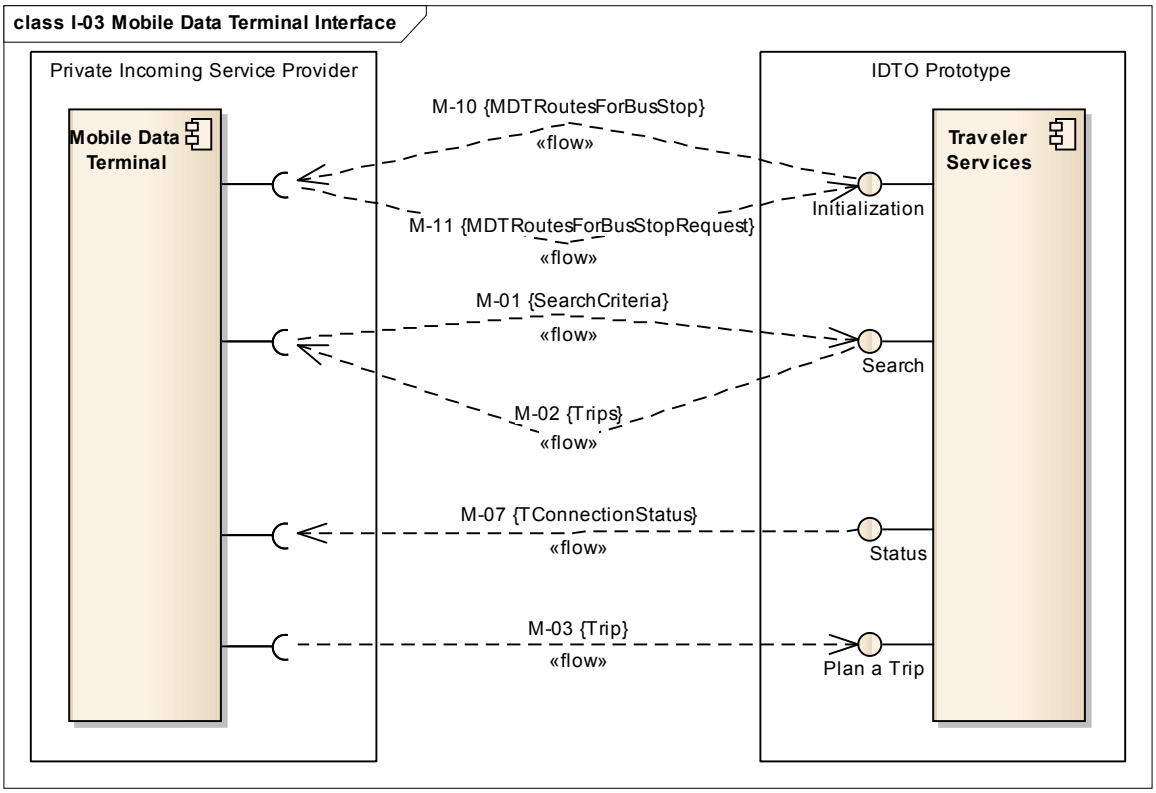
5.2 Private Incoming Service Provider

The Phase I implementation of the interface with a Private Incoming Fixed Service Provider is mediated entirely through a Mobile Data Terminal deployed in the Provider's vehicles, allowing significantly more functionality to be implemented that with the other incoming, fixed service providers. Many of the features provided to the driver are simplified trip scheduling features, allowing the driver to readily schedule trips on behalf of riders and effectively give the driver the ability to give connection protection to T-Connect Provider transfers for those riders. See Figure 5-2.

The Mobile Data Terminal interfaces with many of the same functions as the traveler's mobile device, however with a much simplified interface, limited to scheduling trips specific to the vehicle's known route, and only for immediately upcoming transfers to a T-Connect provider.

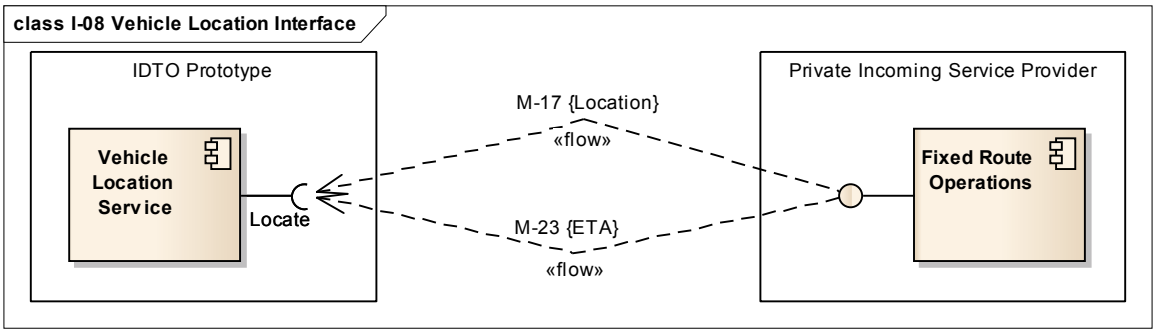
The Mobile Data Terminal does not directly allow the creation of a T-Connect request for a trip. Instead, by providing incoming vehicle data to the IDTO Prototype's Vehicle

Location Service (see Figure 5-3), the IDTO Prototype is able to make the determination if a T-Connect is warranted, and make the request on the vehicle's behalf.



Source: Battelle

Figure 5-2. I-03 Mobile Data Terminal Interface



Source: Battelle

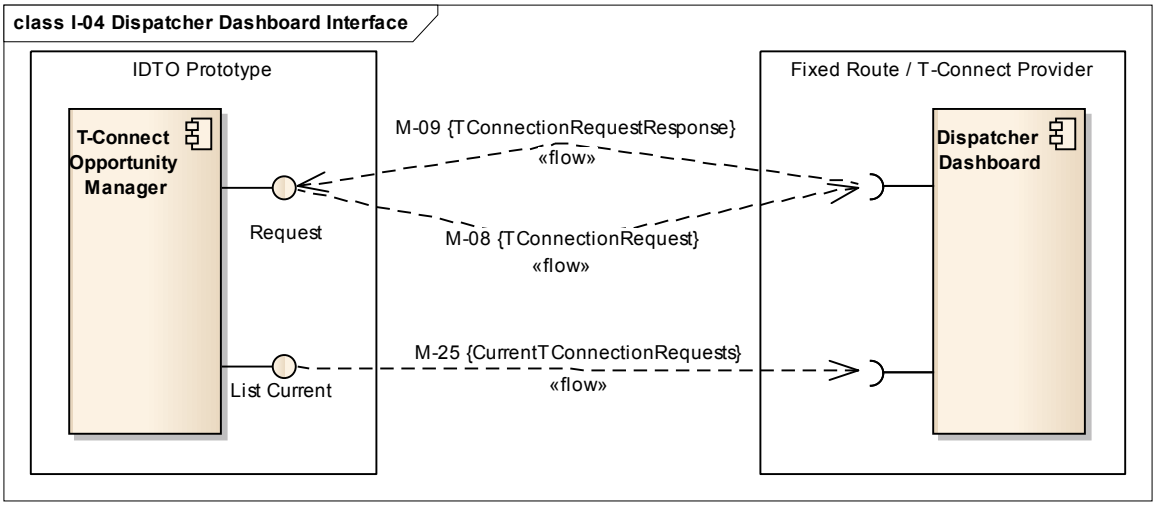
Figure 5-3. I-08 Vehicle Location Interface

5.3 Fixed Route / T-Connect Provider

The IDTO Prototype Application interfaces with a Fixed Route provider that provides T-Connect functionality via several interfaces. The following figure identifies the specific interfaces and functionality associated with these interfaces. As shown, Bus Stop ETA from Fixed Route Operations software (e.g. Trapeze Novus ITS product) is provided to the IDTO Prototype in the form of GTFS-Realtime. The Vehicle Location Service within

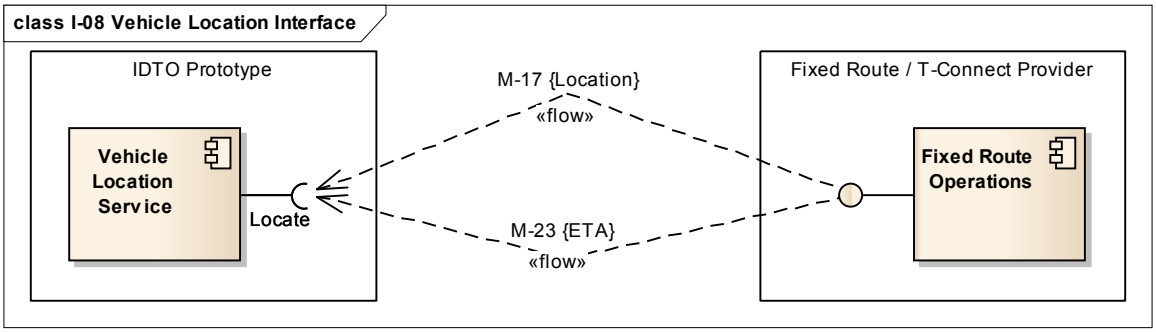
the Prototype persists this information in the ETA database. The T-CONNECT Opportunity Manager Service, which monitors traveler transfer requests along with incoming and outgoing buses, uses this ETA data to determine if and when a T-CONNECT is required. If a T-CONNECT is warranted, the IDTO Notification Service communicates the T-CONNECT request to the Dispatcher Dashboard, where the T-CONNECT is either accepted or rejected (see Figure 5-4). A return notification from the Dispatcher Terminal to the IDTO Notification Service completes this transaction.

In parallel with these exchanges, GTFS data is also being made available to the Route Provider (e.g. Open Trip Planner) to support traveler's trip planning needs.



Source: Battelle

Figure 5-4. I-04 Dispatcher Dashboard Interface



Source: Battelle

Figure 5-5. I-08 Vehicle Location Interface

5.4 Rideshare Provider

For the Phase I effort, the IDTO Prototype implements only a single Rideshare Provider interface. Trip data from the Rideshare Provider is pulled from the provider's interface by the Dynamic Schedule Service within IDTO Prototype in a format and mechanism TBD (see Figure 5-6). The IDTO Prototype subsequently makes this available for travelers to select as possible route alternatives.

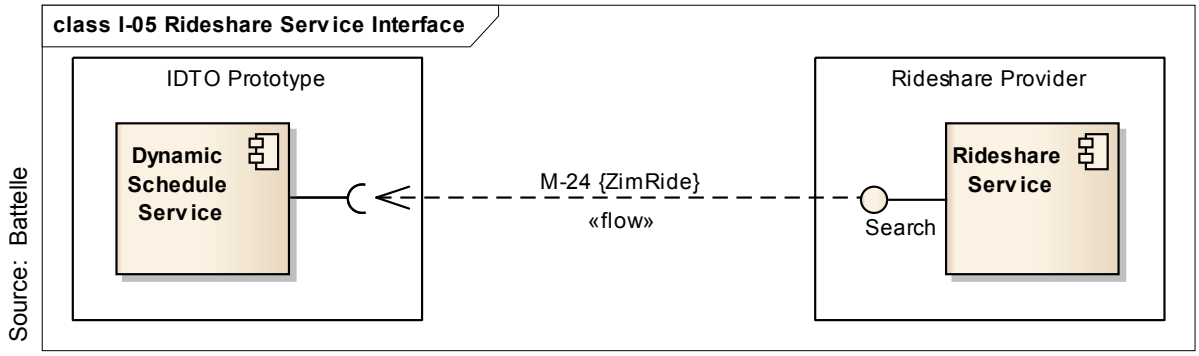


Figure 5-6. I-05 Rideshare Service Interface

5.5 Demand / Response Provider

The IDTO Prototype Application will implement a single interface with the OSU TaxiCABS provider. Figure 5-7 identifies the specific interface, and the functionality associated with this interface. As shown, Schedule data from OSU's TaxiCABS operations (as provided by Trapeze) is provided to the IDTO Prototype in an as yet unspecified format. The Trip Collection Service within the Prototype then transforms this information to provide the traveler with possible trip options.

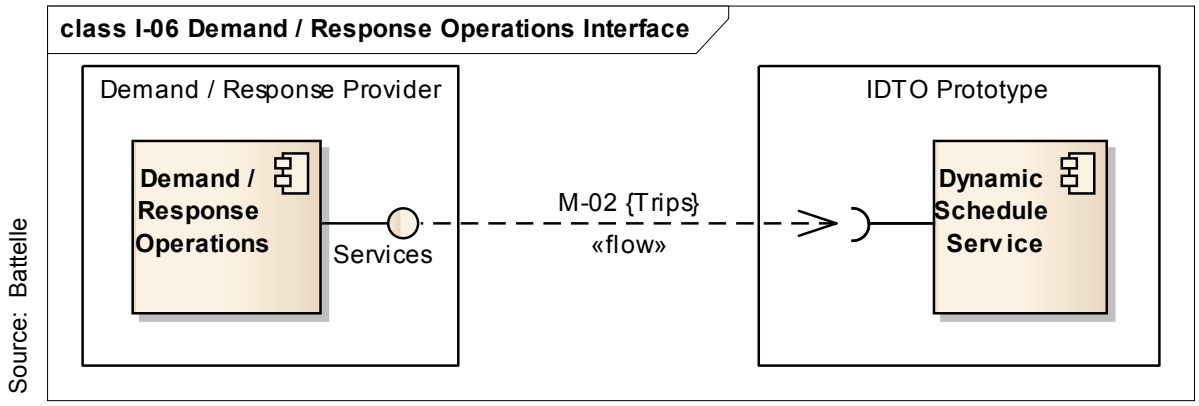


Figure 5-7. I-06 Demand / Response Operations Interface

5.6 Incoming Fixed Route Provider

The IDTO Prototype interfaces with an Incoming Fixed Route Provider slightly differently from the way it interfaces with a T-Connect Provider. The Incoming Provider need only provide the IDTO Prototype with current vehicle location data to allow the IDTO Prototype to judge the certainty a traveler has of making a subsequent connection to a T-Connect Provider, and requesting transfer protection in the form of a T-Connect request if that transfer is deemed to be threatened. As shown in Figure 5-8, Bus Location and Bus Stop ETA are provided to the IDTO Prototype from RESTful Web service calls to the Vehicle Location Service. The Vehicle Location Service persists this information in the IDTO Prototype where it is subsequently used by the T-CONNECT Opportunity

Manager Service to monitor traveler transfers between buses, issuing transfer protection requests as necessary. Bus Stop ETA data is provided dynamically to the IDTO Prototype rather than through GTFS data to better judge when a protection request is justified.

GTFS data is also being made available to the Route Provider (e.g. Open Trip Planner) to support traveler's trip planning needs.

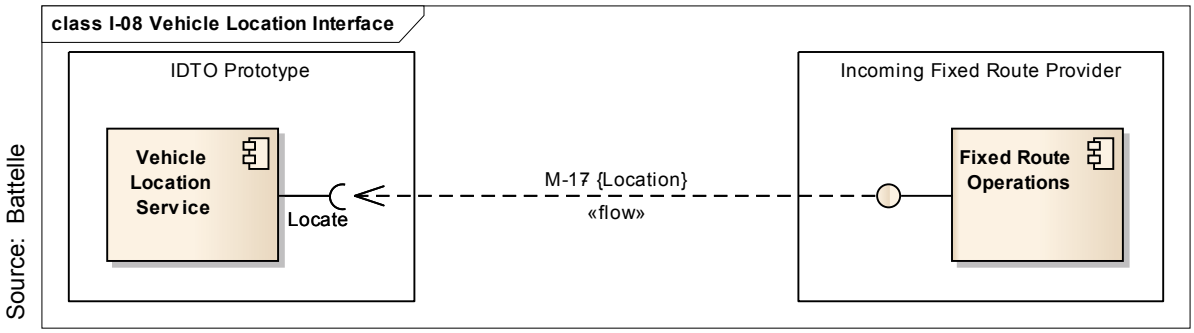


Figure 5-8. I-08 Vehicle Location Interface

5.7 Route Provider

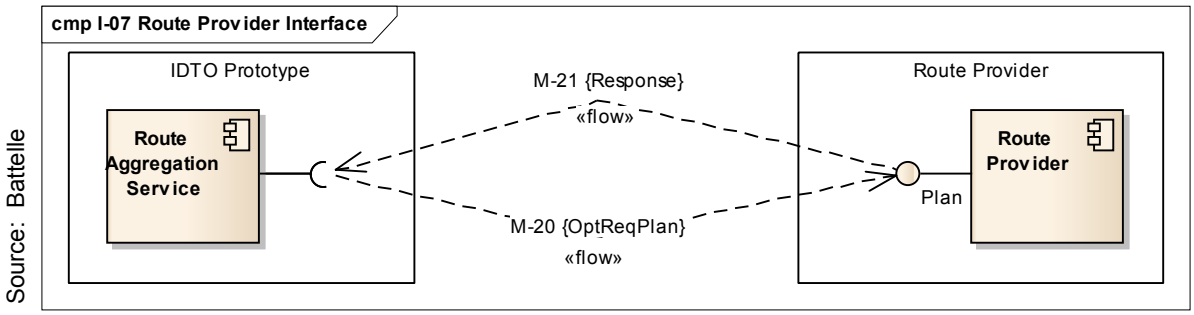


Figure 5-9. I-07 Route Provider Interface

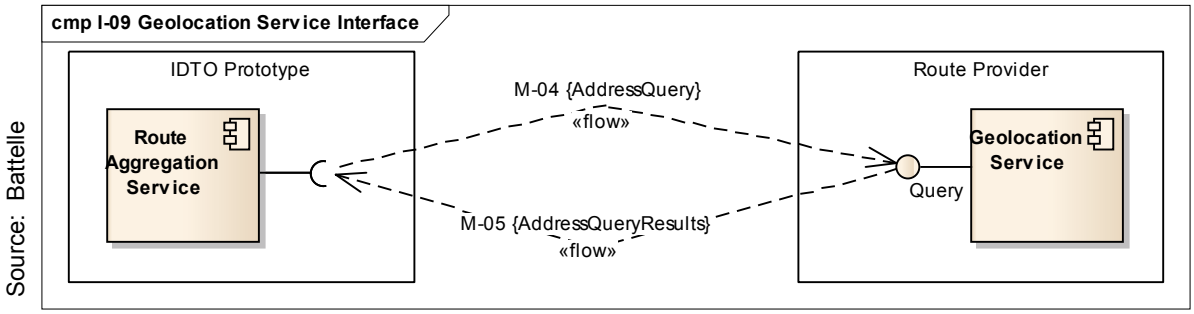
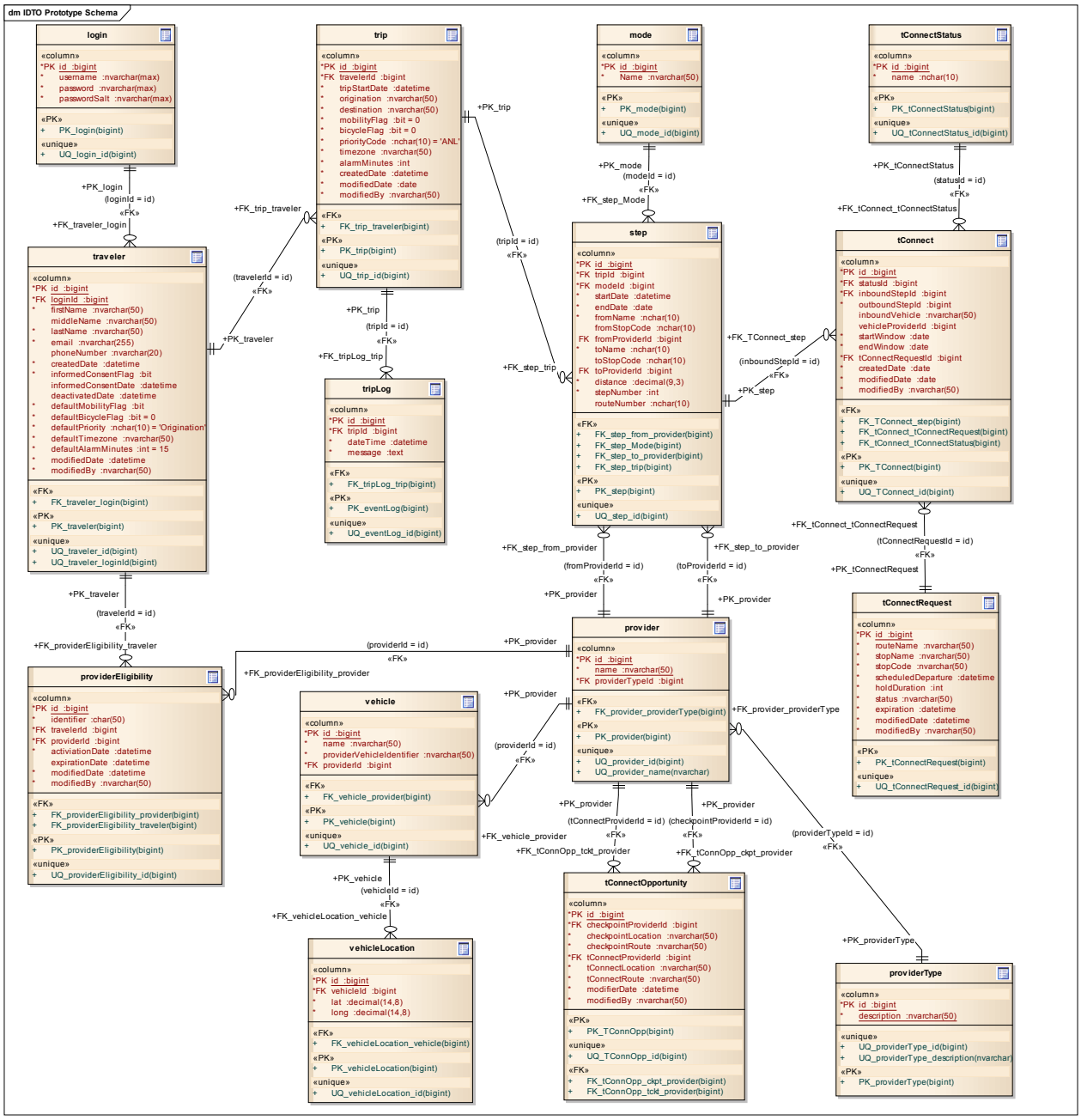


Figure 5-10. I-09 Geolocation Service Interface

6 IDTO Data Model and Schema



Source: Battelle

Figure 6-1. IDTO Prototype Schema

6.1 login

Traveler identity created from initial registration. This table contains the users encrypted login credentials.

Table 6-1. login Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key
False	username	nvarchar(max)	True	False	0	Traveler's username
False	password	nvarchar(max)	True	False	0	Encrypted password
False	passwordSalt	nvarchar(max)	True	False		Salt used for the hashing algorithm used to encrypt the password

Source: Battelle

Table 6-2. login Table Column Constraints

Name	Type	Columns
PK_login	Public	id
UQ_login_id	Public	id

Source: Battelle

Table 6-3. login Table Relationships

Columns	Association
(loginId = id)	**0..*** traveler.FK_traveler_login **1** login.PK_login

Source: Battelle

6.2 mode

Lookup table for available modes of travel, i.e. fixed-route, ride share, etc.

Table 6-4. mode Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key
False	Name	nvarchar	True	False	50	

Source: Battelle

Table 6-5. mode Table Column Constraints

Name	Type	Columns
PK_mode	Public	id
UQ_mode_id	Public	id

Source: Battelle

Table 6-6. mode Table Relationships

Columns	Association	
(modeId = id)	**0..***	step.FK_step_Mode
	1	mode.PK_mode

Source: Battelle

6.3 provider

A provider of transportation services, e.g. COTA, ZimRide, CABS, etc.

Table 6-7. provider Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key.
False	name	nvarchar	True	True	50	The name of a provider.
False	providerTypeId	bigint	True	False	0	Foreign key into the providerType table. Indicates the kind of services this provider supplies.

Source: Battelle

Table 6-8. provider Table Column Constraints

Name	Type	Columns
FK_provider_providerType	Public	providerTypeId
PK_provider	Public	id
UQ_provider_id	Public	id
UQ_provider_name	Public	name

Source: Battelle

Table 6-9. provider Table Relationships

Columns	Association	
(checkpointProviderId = id)	**0..***	tConnectOpportunity.FK_tConnOpp_ckpt_provider
	1	provider.PK_provider
(fromProviderId = id)	**0..***	step.FK_step_from_provider
	1	provider.PK_provider
(providerId = id)	**0..***	vehicle.FK_vehicle_provider
	1	provider.PK_provider
(providerId = id)	**0..***	providerEligibility.FK_providerEligibility_provider
	1	provider.PK_provider
(providerTypeId = id)	**0..***	provider.FK_provider_providerType
	1	providerType.PK_providerType
(tConnectProviderId = id)	**0..***	tConnectOpportunity.FK_tConnOpp_tckt_provider
	1	provider.PK_provider
(toProviderId = id)	**0..***	step.FK_step_to_provider
	1	provider.PK_provider

Source: Battelle

6.4 providerEligibility

This table identifies eligibility privileges a traveler has with the providers in the system.

Table 6-10. providerEligibility Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key
False	identifier	char	True	False	50	The provider's identifier for this traveler.
False	travelerId	bigint	True	False	0	Foreign key into traveler table. Identifies which traveler this privilege belongs to.
False	providerId	bigint	True	False	0	Foreign key into provider table. Identifies which provider this privilege represents.
False	activiationDate	datetime	True	False	0	The date this privilege becomes effective.
False	expirationDate	datetime	False	False	0	The date this privilege expires.
False	modifiedDate	datetime	True	False	0	The date this data was last modified
False	modifiedBy	nvarchar	True	False	50	The last modifier of this data

Source: Battelle

Table 6-11. providerEligibility Table Column Constraints

Name	Type	Columns
FK_providerEligibility_provider	Public	providerId
FK_providerEligibility_traveler	Public	travelerId
PK_providerEligibility	Public	Id
UQ_providerEligibility_id	Public	id

Source: Battelle

Table 6-12. providerEligibility Table Relationships

Columns	Association
(providerId = id)	**0..*** providerEligibility.FK_providerEligibility_provider **1** provider.PK_provider
(travelerId = id)	**0..*** providerEligibility.FK_providerEligibility_traveler **1** traveler.PK_traveler

Source: Battelle

6.5 providerType

This table defines the valid types of service providers in the IDTO prototype:

- Fixed Route / T-Connect Provider
- Incoming Fixed Route Provider
- Private Incoming Service Provider
- Demand / Response Provider
- Rideshare Provider
- Pedestrian
- Bicycle

Table 6-13. providerType Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key.
False	description	nvarchar	True	True	50	The description of a provider type.

Source: Battelle

Table 6-14. providerType Table Column Constraints

Name	Type	Columns
UQ_providerType_id	Public	id
PK_providerType	Public	id
UQ_providerType_description	Public	description

Source: Battelle

Table 6-15. providerType Table Relationships

Columns	Association	
(providerTypeId = id)	**0..***	provider.FK_provider_providerType
	1	providerType.PK_providerType

Source: Battelle

6.6 step

Part of a scheduled trip. A series of steps connect a scheduled trip's origination to the trip's destination.

Table 6-16. step Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key.
False	tripId	bigint	True	False	0	Foreign key into trip table. Identifies which scheduled trip this step belongs to.
False	modeId	bigint	True	False		Mode of transportation
False	startDate	datetime	True	False		Step start date and time
False	endDate	date	True	False		step end date and time
False	fromName	nchar	True	False	10	From Name given by the Route Provider
False	fromStopCode	nchar	False	False	10	From Stop Code given by the Route Provider
False	fromProviderId	bigint	False	False		Foreign key into the Provider table. Indicates the provider for this step.
False	toName	nchar	True	False	10	To Name given by the Route Provider
False	toStopCode	nchar	False	False	10	To Stop Code given by the Route Provider
False	toProviderId	bigint	False	False		Foreign key into the Provider table. This is the provider for the Stop Code
False	distance	decimal	True	False		Distance for this step
False	stepNumber	int	True	False		Step sequence number
False	routeNumber	nchar	False	False	10	Route number for this step

Source: Battelle

Table 6-17. step Table Column Constraints

Name	Type	Columns
FK_step_from_provider	Public	fromProviderId
FK_step_Mode	Public	modeId
FK_step_to_provider	Public	toProviderId
FK_step_trip	Public	tripId
PK_step	Public	id
UQ_step_id	Public	id

Source: Battelle

Table 6-18. step Table Relationships

Columns	Association	
(fromProviderId = id)	**0..***	step.FK_step_from_provider
	1	provider.PK_provider
(inboundStepId = id)	**0..***	tConnect.FK_TConnect_step
	1	step.PK_step
(modeId = id)	**0..***	step.FK_step_Mode
	1	mode.PK_mode
(toProviderId = id)	**0..***	step.FK_step_to_provider
	1	provider.PK_provider
(tripId = id)	**0..***	step.FK_step_trip
	1	trip.PK_trip

Source: Battelle

6.7 tConnect

This table logs the history of all T-Connect requests generated in the IDTO Prototype.

Table 6-19. tConnect Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key.
False	statusId	bigint	True	False	0	Foreign key into the tConnectStatus table. The status of the request, one of "Pending", "Accepted" or "Rejected".
False	inboundStepId	bigint	True	False	0	Foreign key into the step table.
False	outboundStepId	bigint	True	False		Foreign key into the step table.
False	inboundVehicle	nvarchar	False	False	50	Vehicle identifier for the Inbound Vehicle
False	vehicleProviderId	bigint	False	False		Foreign key into the provider table. The inbound vehicle for this tConnect.
False	startWindow	date	True	False		Start of ETA window where a t-Connect Request will be issued.
False	endWindow	date	True	False		End of ETA window where a t-Connect request will be issued.
False	tConnectRequestId	bigint	True	False		Foreign key into the tConnectRequest table.
False	createdDate	date	True	False		Date this data was created.
False	modifiedDate	date	True	False	0	Date this data was last modified.
False	modifiedBy	nvarchar	True	False	50	Last modifier of this data.

Source: Battelle

Table 6-20. tConnect Table Column Constraints

Name	Type	Columns
FK_TConnect_step	Public	inboundStepId
FK_tConnect_tConnectRequest	Public	tConnectRequestId
FK_tConnect_tConnectStatus	Public	statusId
PK_TConnect	Public	id
UQ_TConnect_id	Public	id

Source: Battelle

Table 6-21. tConnect Table Relationships

Columns	Association	
(inboundStepId = id)	**0..***	tConnect.FK_TConnect_step
	1	step.PK_step
(statusId = id)	**0..***	tConnect.FK_tConnect_tConnectStatus
	1	tConnectStatus.PK_tConnectStatus
(tConnectRequestId = id)	**0..***	tConnect.FK_tConnect_tConnectRequest
	1	tConnectRequest.PK_tConnectRequest

Source: Battelle

6.8 tConnectOpportunity

This table defines every potential sequence of locations that can potentially trigger a T-Connect request. Any active trip in which one of these sequences appears is monitored closely by the T-Connect Opportunity Manager.

This table is pre-populated with all inbound checkpoint location / T-Connect departure location pairs. The provider type of the departure location must be a T-Connect provider, while the provider type at the inbound location must be an Inbound provider.

Table 6-22. tConnectOpportunity Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key.
False	checkpointProviderId	bigint	True	False	0	Foreign key into provider table.
False	checkpointLocation	nvarchar	True	False	50	The location of the inbound destination.
False	checkpointRoute	nvarchar	True	False	50	Route identifier for the inbound vehicle.
False	tConnectProviderId	bigint	True	False		Foreign key into the provider table. Indicates the provider associated with this tConnect opportunity.
False	tConnectLocation	nvarchar	True	False	50	The location of the tConnect point of origin.
False	tConnectRoute	nvarchar	True	False	50	Route of the outbound vehicle
False	modifierDate	datetime	True	False		Date this data was last modified.
False	modifiedBy	nvarchar	True	False	50	Last modifier of this data.

Source: Battelle

Table 6-23. tConnectOpportunity Table Column Constraints

Name	Type	Columns
PK_TConnOpp	Public	id
UQ_TConnOpp_id	Public	id
FK_tConnOpp_ckpt_provider	Public	checkpointProviderId
FK_tConnOpp_tckt_provider	Public	tConnectProviderId

Source: Battelle

Table 6-24. tConnectOpportunity Table Relationships

Columns	Association		
(checkpointProviderId = id)	**0..***	tConnectOpportunity.FK_tConnOpp_ckpt_provider provider.PK_provider	**1**
(tConnectProviderId = id)	**0..*** **1**	tConnectOpportunity.FK_tConnOpp_tckt_provider provider.PK_provider	

Source: Battelle

6.9 tConnectRequest

This table defines the connection protection requests which have been issued by the system. Records in this table will be used to track the status of the requests.

Table 6-25. tConnectRequest Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key
False	routeName	nvarchar	True	False	50	Name of the route.
False	stopName	nvarchar	True	False	50	Name of the stop.
False	stopCode	nvarchar	True	False	50	Stop Code of the requested delay
False	scheduledDeparture	datetime	True	False		Scheduled time of departure
False	holdDuration	int	True	False		Requested delay
False	status	nvarchar	True	False	50	Status of the request.
False	expiration	datetime	True	False		Date and time that the request expires
False	modifiedDate	datetime	True	False		Date this data was last modified.
False	modifiedBy	nvarchar	True	False	50	Last modifier of this data.

Source: Battelle

Table 6-26. tConnectRequest Table Column Constraints

Name	Type	Columns
PK_tConnectRequest	Public	id
UQ_tConnectRequest_id	Public	id

Source: Battelle

Table 6-27. tConnectRequest Table Relationships

Columns	Association	
(tConnectRequestId = id)	**0..***	tConnect.FK_tConnect_tConnectRequest
	1	tConnectRequest.PK_tConnectRequest

Source: Battelle

6.10 tConnectStatus

A lookup table which contains the possible status values for a TConnect.

Table 6-28. tConnectStatus Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key
False	name	nchar	True	False	10	

Source: Battelle

Table 6-29. tConnectStatus Table Column Constraints

Name	Type	Columns
PK_tConnectStatus	Public	id
UQ_tConnectStatus_id	Public	id

Source: Battelle

Table 6-30. tConnectStatus Table Relationships

Columns	Association	
(statusId = id)	**0..***	tConnect.FK_tConnect_tConnectStatus
	1	tConnectStatus.PK_tConnectStatus

Source: Battelle

6.11 traveler

The profile and account record for a traveler.

Table 6-31. traveler Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key
False	loginId	bigint	True	True	0	Foreign key into the login table. Identifies the unique login associated with this traveler profile.
False	firstName	nvarchar	True	False	50	Traveler's first name.
False	middleName	nvarchar	False	False	50	Traveler's middle name or initial.
False	lastName	nvarchar	True	False	50	Tarveler's last name.
False	email	nvarchar	True	False	255	email address of the traveler, used as the unique account name for the IDTO Prototype.
False	phoneNumber	nvarchar	False	False	20	Traveler's phone number.
False	createdDate	datetime	True	False	0	GMT Date and time of account creation.
False	informedConsentFlag	bit	True	False	0	Indicates that the traveler has acknowledged the informed consent notice.
False	informedConsentDate	datetime	False	False	0	Date and time the traveler acknowledged the informed consent notice.
False	deactivatedDate	datetime	False	False	0	GMT Date and time account was deactivated, or null if active.
False	defaultMobilityFlag	bit	True	False	0	Boolean value indicating whether the traveler prefers enhanced mobility services.
False	defaultBicycleFlag	bit	True	False	0	Boolean value indicating whether the traveler prefers services that support transporting bicycles.
False	defaultPriority	nchar	True	False	10	Preferred mode of scheduling trips, one of: 1. "Destination": Use the trip time as the time of arrival at the trip's destination. 2. "Origination": Use the trip time as the time of departure from the trip's point of origin.
False	defaultTimezone	nvarchar	True	False	50	Traveler's default time zone, as in 'US/Eastern', 'US/Central', 'US/Mountain', 'US/Arizona', 'US/Pacific', etc.
False	defaultAlarmMinutes	int	True	False	0	Number of minutes in advance of a scheduled trip that an alarm is sent to the traveler. Zero indicates that no alarm is sent.
False	modifiedDate	datetime	True	False	0	Date of last change to this data
False	modifiedBy	nvarchar	True	False	50	The last modifier of this data

Source: Battelle

Table 6-32. traveler Table Column Constraints

Name	Type	Columns
FK_traveler_login	Public	loginId
PK_traveler	Public	id
UQ_traveler_id	Public	id
UQ_traveler_loginId	Public	loginId

Source: Battelle

Table 6-33. traveler Table Relationships

Columns	Association	
(loginId = id)	**0..***	traveler.FK_traveler_login
	1	login.PK_login
(travelerId = id)	**0..***	providerEligibility.FK_providerEligibility_traveler
	1	traveler.PK_traveler
(travelerId = id)	**0..***	trip.FK_trip_traveler
	1	traveler.PK_traveler

Source: Battelle

6.12 trip

A trip scheduled by a traveler, from a specified location to a specified destination, and a specific time, with parameters selected by the traveler.

Table 6-34. trip Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key.
False	travelerId	bigint	True	False	0	Foreign key into the traveler table. Identifies which traveler scheduled this trip.
False	tripStartDate	datetime	True	False	0	The traveler specified trip time, may be an arrival or departure time, depending on the priorityCode. UTC, local timezone.
False	origination	nvarchar	True	False	50	The traveler-specified starting location of the trip.
False	destination	nvarchar	True	False	50	The traveler-specified destination of the trip.
False	mobilityFlag	bit	True	False	0	Does this trip require mobility facilities?
False	bicycleFlag	bit	True	False	0	Does this trip require bicycle facilities?
False	priorityCode	nchar	True	False	10	The scheduling priority for this trip. One of: • "DNL": Depart from point of origin no later than a specified time. • "ANL": "Arrive at destination no later than a specified time. • "DNS": Depart from point of origin no sooner than a specified time. • "ANS": Arrive at destination no sooner than a specified time.
False	timezone	nvarchar	True	False	50	The timezone of the scheduled trip
False	alarmMinutes	int	True	False	0	
False	createdDate	datetime	True	False	0	Date trip was scheduled
False	modifiedDate	date	True	False	0	Date this data was last modified
False	modifiedBy	nvarchar	True	False	50	The last modifier of this data.

Source: Battelle

Table 6-35. trip Table Column Constraints

Name	Type	Columns
FK_trip_traveler	Public	travelerId
PK_trip	Public	Id
UQ_trip_id	Public	id

Source: Battelle

Table 6-36. trip Table Relationships

Columns	Association
(travelerId = id)	**0..*** trip.FK_trip_traveler **1** traveler.PK_traveler
(tripId = id)	**0..*** step.FK_step_trip **1** trip.PK_trip
(tripId = id)	**0..*** tripLog.FK_tripLog_trip **1** trip.PK_trip

Source: Battelle

6.13 tripLog

This table records notable events for diagnostic and historical purposes.

Table 6-37. tripLog Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key.
False	tripId	bigint	True	False	0	Foreign key into trip table. Identifies the trip associated with this log event.
False	dateTime	datetime	True	False	0	Date and time stamp of event in UTC / Zulu time.
False	message	text	True	False	0	The text of the log message.

Source: Battelle

Table 6-38. tripLog Table Column Constraints

Name	Type	Columns
FK_tripLog_trip	Public	tripId
PK_eventLog	Public	id
UQ_eventLog_id	Public	id

Source: Battelle

Table 6-39. tripLog Table Relationships

Columns	Association
(tripId = id)	**0..*** tripLog.FK_tripLog_trip **1** trip.PK_trip

Source: Battelle

6.14 vehicle

This table maintains the data for the different vehicles in which the IDTO system will be monitoring.

Table 6-40. vehicle Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key
False	name	nvarchar	True	False	50	Name of the vehicle.
False	providerVehicleIdentifier	nvarchar	True	False	50	Unique identifier of the vehicle given by the provider.
False	providerId	bigint	True	False		Foreign key into the provider table. This is the provider that operates this vehicle.

Source: Battelle

Table 6-41. vehicle Table Column Constraints

Name	Type	Columns
FK_vehicle_provider	Public	providerId
PK_vehicle	Public	id
UQ_vehicle_id	Public	id

Source: Battelle

Table 6-42. vehicle Table Relationships

Columns	Association
(providerId = id)	**0..*** vehicle.FK_vehicle_provider **1** provider.PK_provider
(vehicleId = id)	**0..*** vehicleLocation.FK_vehicleLocation_vehicle **1** vehicle.PK_vehicle

Source: Battelle

6.15 vehicleLocation

This table is used to store the location of the monitored vehicles. This data is used to calculate the estimated time of arrival for inbound vehicles and used in the algorithms for determining the need to issue a T-Connect Request.

Table 6-43. vehicleLocation Relational Database Table Columns

PK	Name	Type	Not Null	Unique	Len	Notes
True	id	bigint	True	True	0	Primary key
False	vehicleId	bigint	True	False	0	Foreign key into vehicle table. The vehicle at this location.
False	lat	decimal	True	False		The latitude of the vehicle at a given moment in time.
False	long	decimal	True	False		The longitude of the vehicle at a given moment in time.

Source: Battelle

Table 6-44. vehicleLocation Table Column Constraints

Name	Type	Columns
FK_vehicleLocation_vehicle	Public	vehicleId
PK_vehicleLocation	Public	id
UQ_vehicleLocation_id	Public	id

Source: Battelle

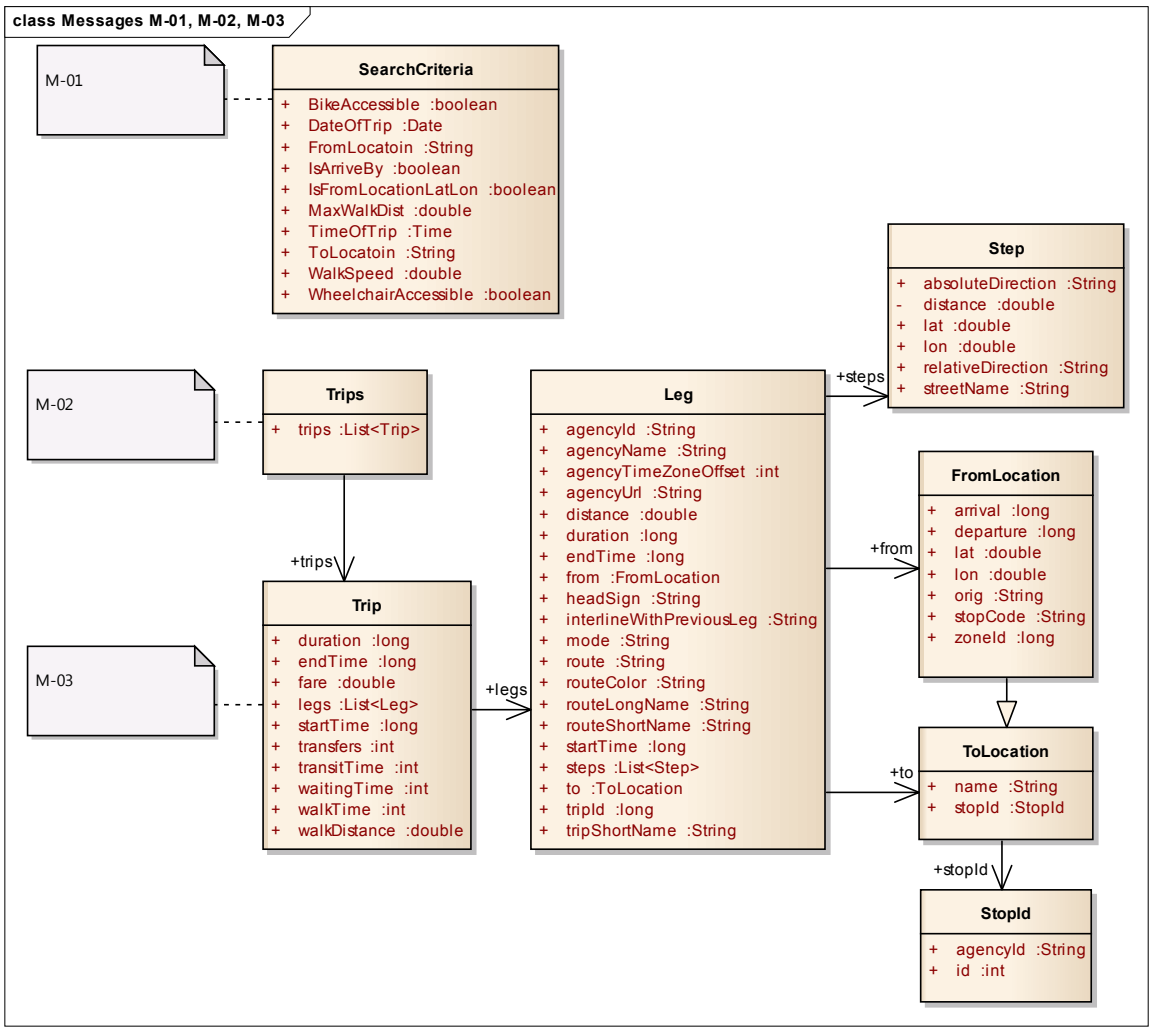
Table 6-45. vehicleLocation Table Relationships

Columns	Association	
(vehicleId = id)	**0..***	vehicleLocation.FK_vehicleLocation_vehicle
	1	vehicle.PK_vehicle

Source: Battelle

APPENDIX A. Interface Messages

Interface Messages



Source: Battelle

Figure A-1. Messages M-01, M-02, M-03

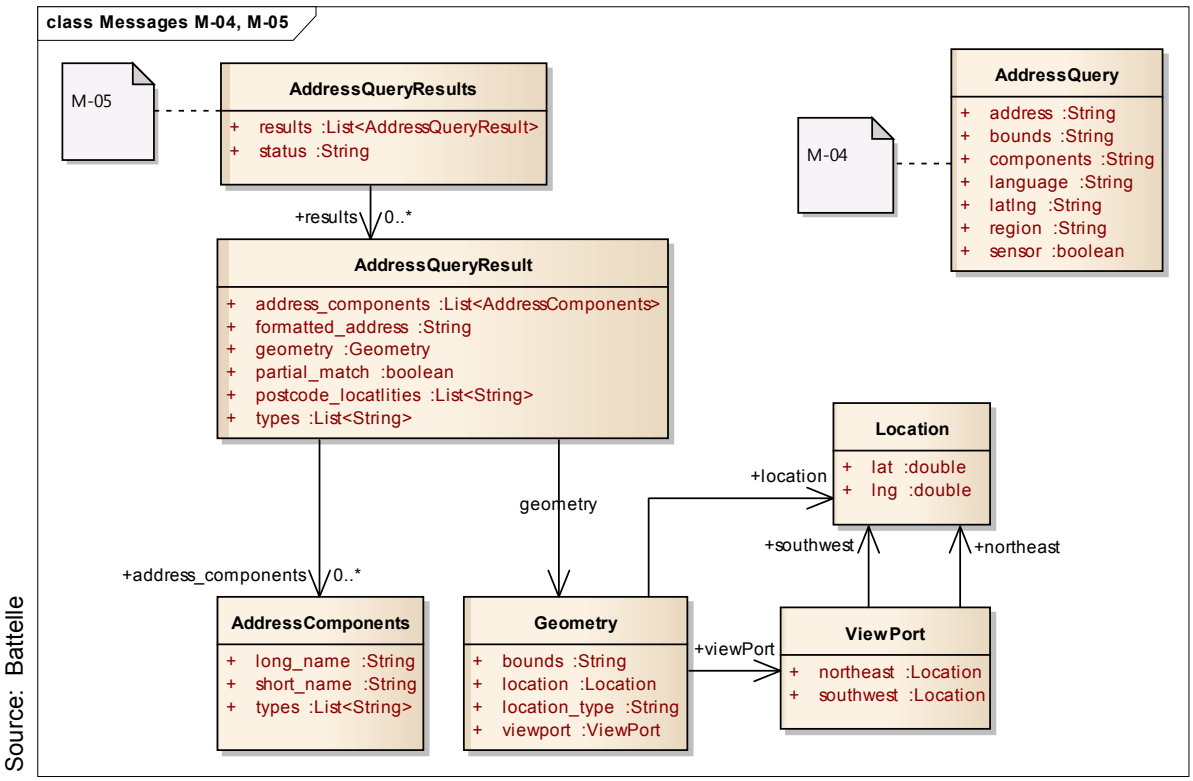


Figure A-2. Messages M-04, M-05

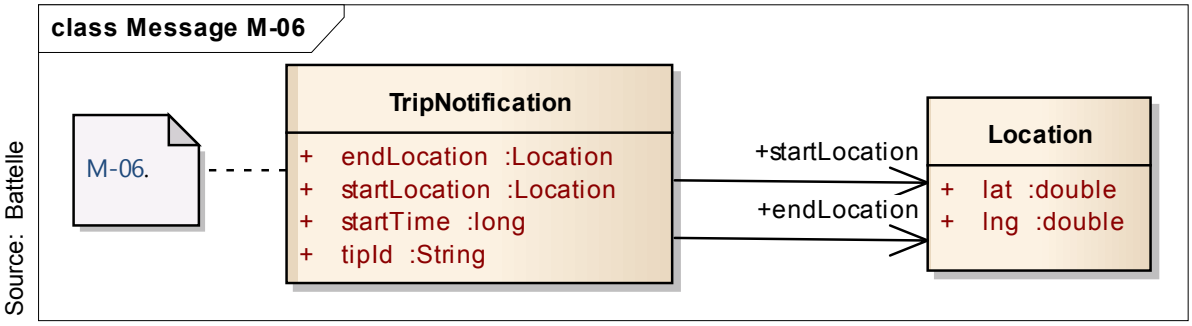


Figure A-3. Message M-06

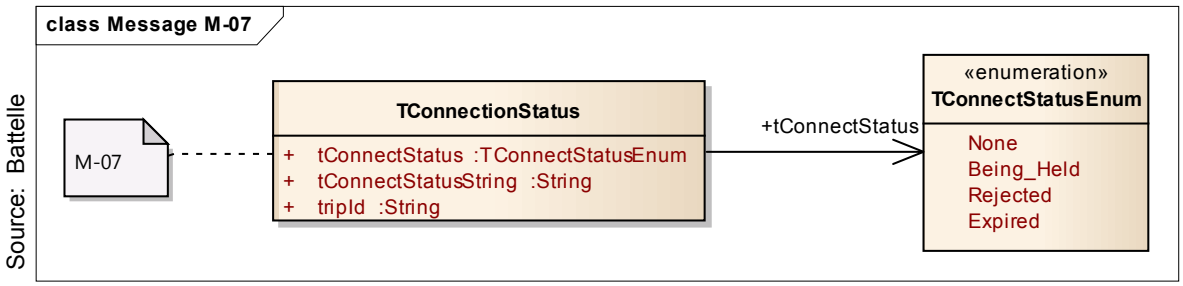


Figure A-4. Message M-07

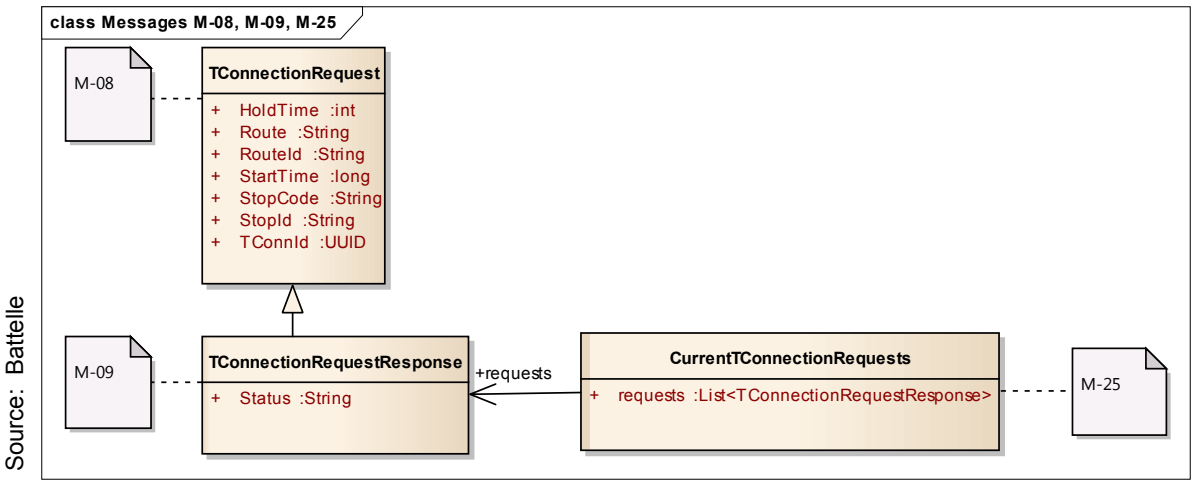


Figure A-5. Messages M-08, M-09, M-25

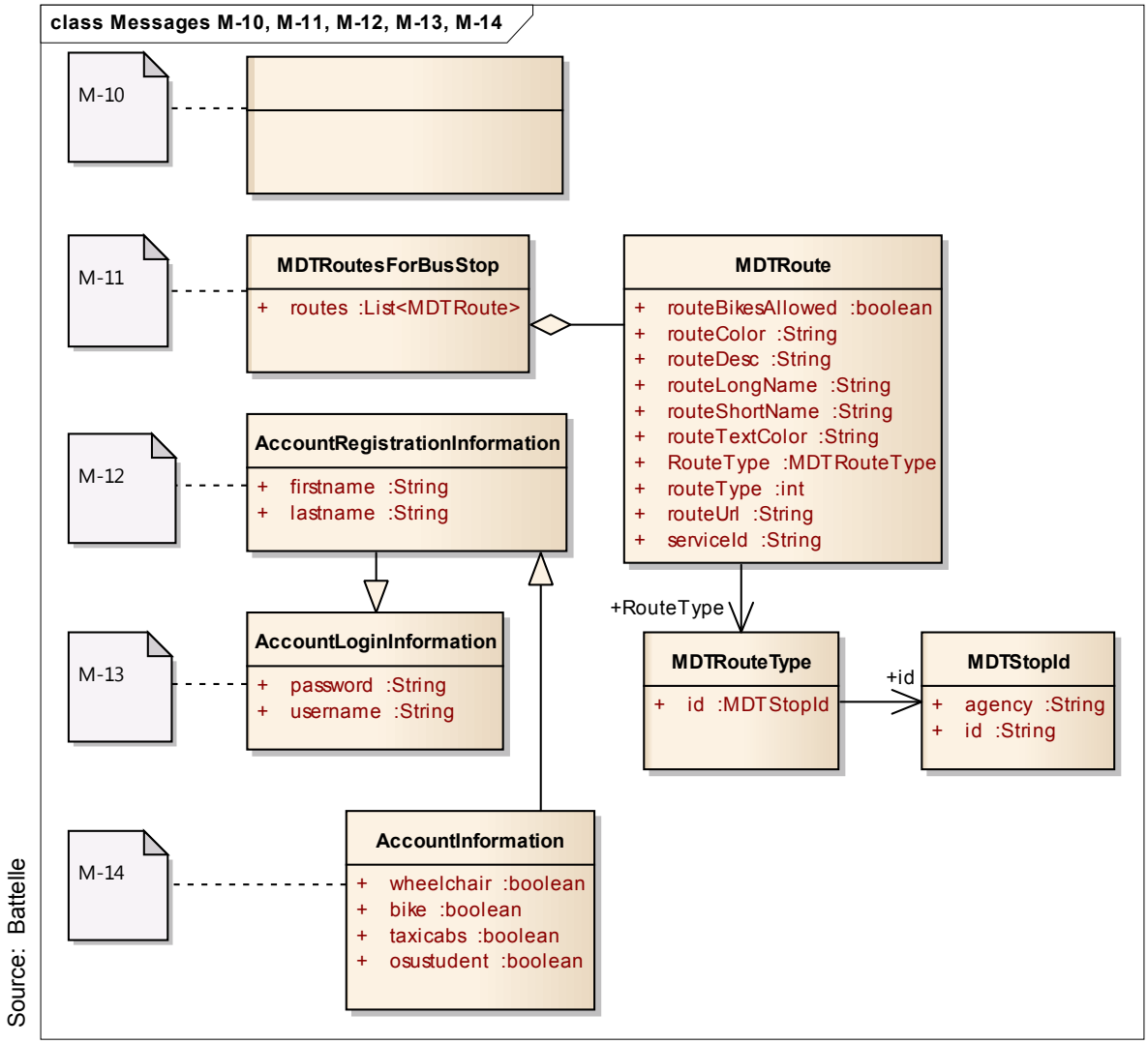


Figure A-6. Messages M-10, M-11, M-12, M-13, M-14

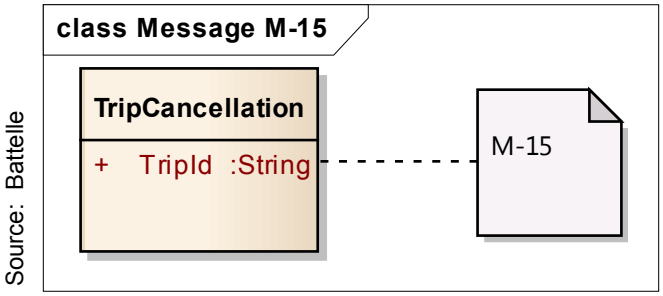


Figure A-7. Message M-15

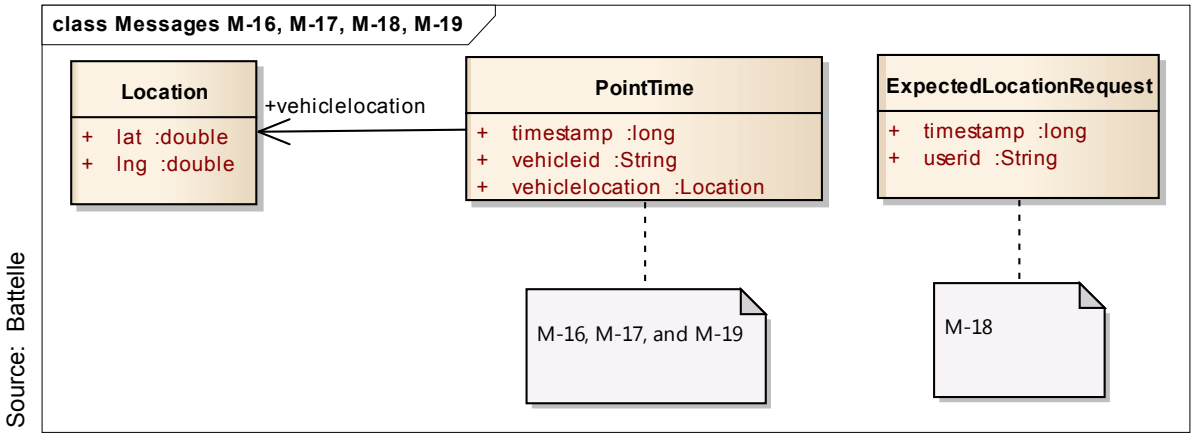
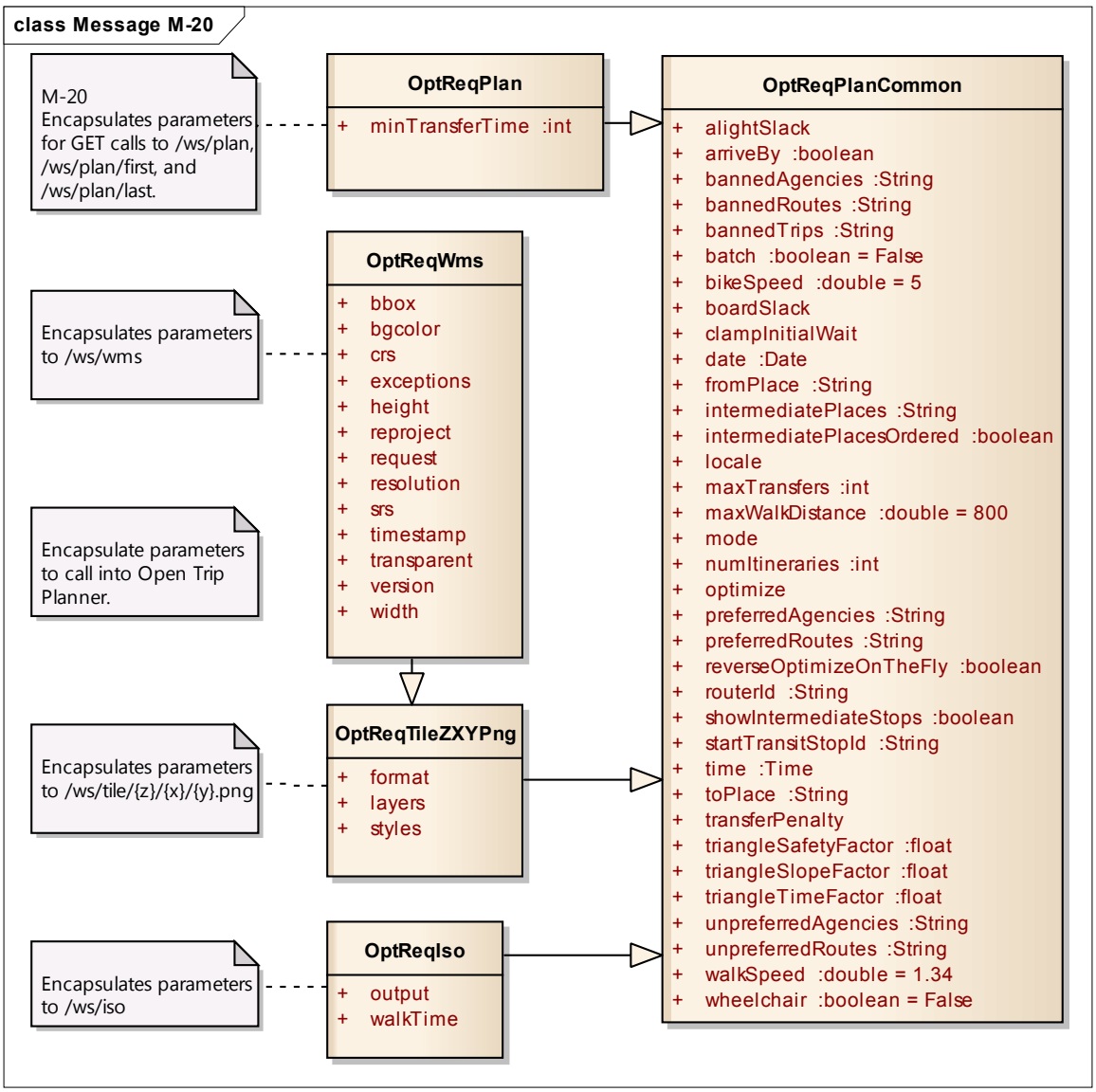
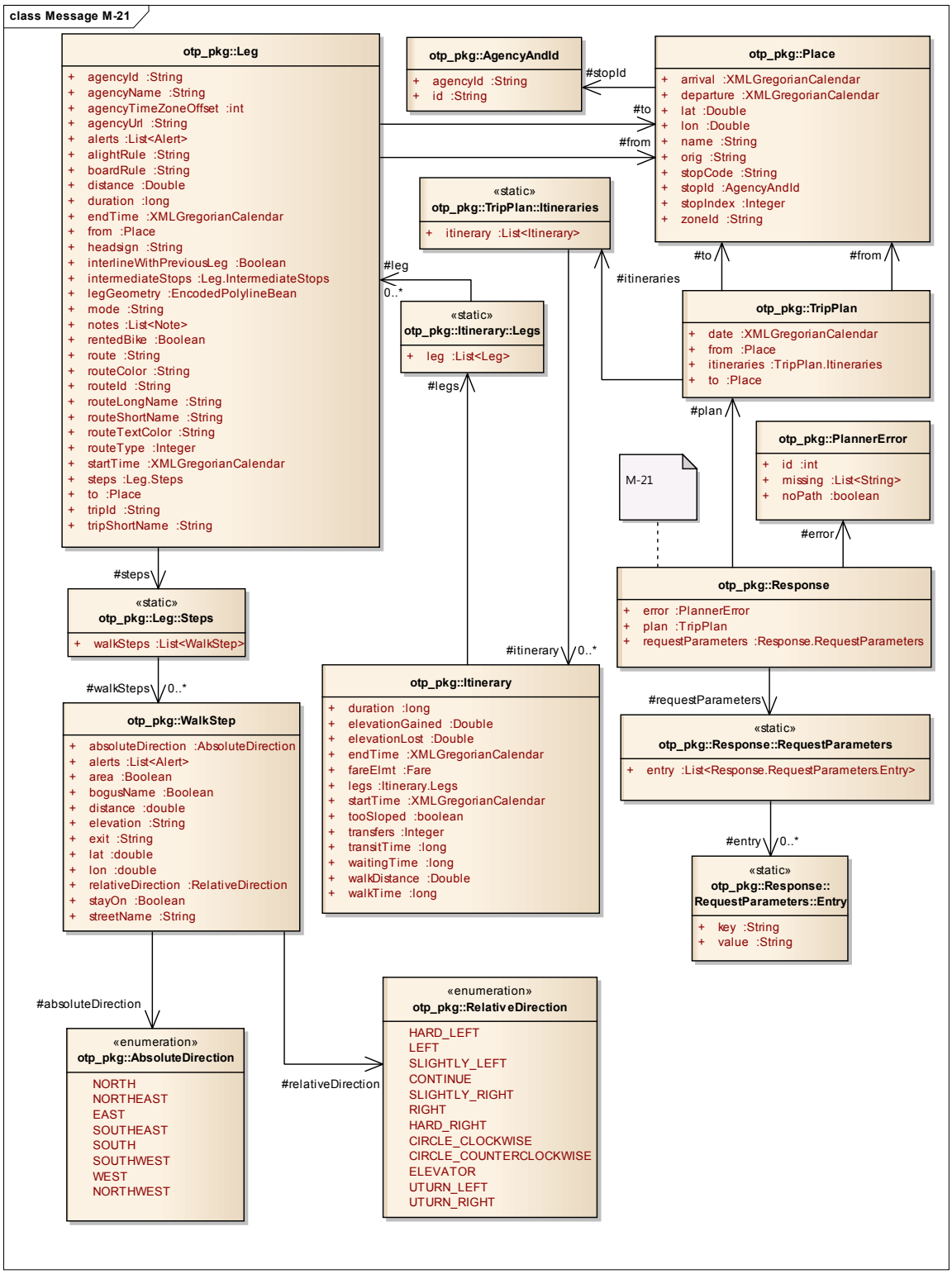


Figure A-8. Messages M-16, M-17, M-18, M-19



Source: Battelle

Figure A-9. Message M-20



Source: Battelle

Figure A-10. Message M-21

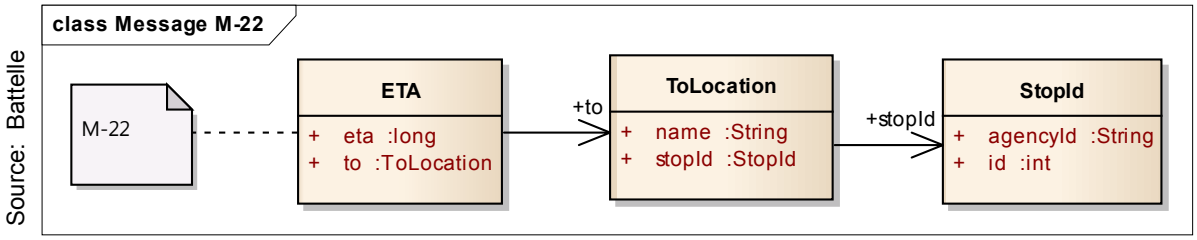


Figure A-11. Message M-22

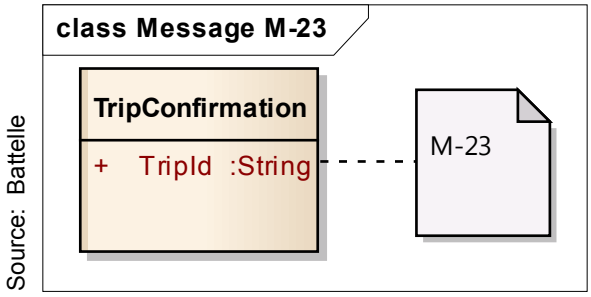


Figure A-12. Message M-23

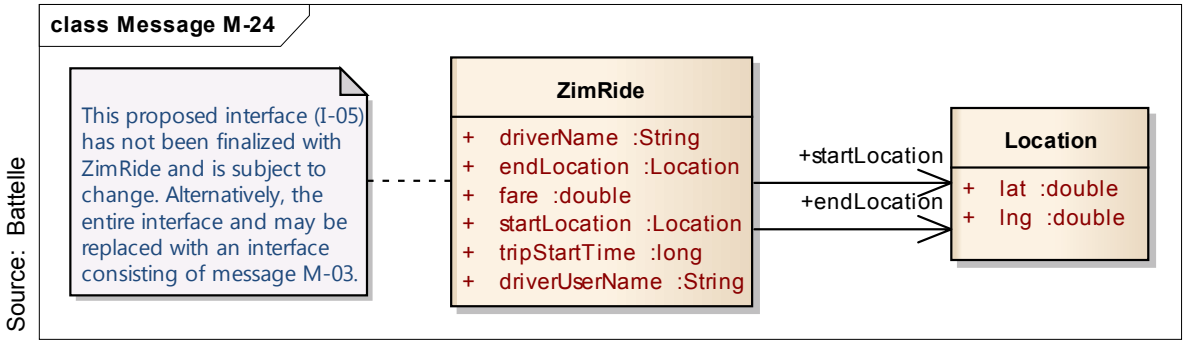


Figure A-13. Message M-24

AccountInformation

No description available.

AccountLoginInformation

No description available.

AccountRegistrationInformation

No description available.

AddressComponents

Note that address_components[] may contain more address components than noted within the formatted_address.

AddressQuery

Required parameters

address — The address that you want to geocode.

or

latlng — The textual latitude/longitude value for which you wish to obtain the closest, human-readable address. See Reverse Geocoding for more information.

or

components — A component filter for which you wish to obtain a geocode. See Component Filtering for more information. The components filter will also be accepted as an optional parameter if an address is provided.

sensor — Indicates whether or not the geocoding request comes from a device with a location sensor. This value must be either true or false.

Maps API for Business users must include valid client and signature parameters with their Geocoding requests.

AddressQueryResult

The only information used by the application is the location in geometry from the addressqueryresult.

AddressQueryResults

M-05, Geolocation Result

The result returned by the Google Geolocation Service that contains the address components plus the location coordinates in latitude and longitude for the searched address.

CurrentTConnectionRequests

No description available.

ETA

No description available.

ExpectedLocationRequest

M-18, Where Should I Be For Trip

Description

This message is a request for the location of the bus that a traveler should be on for a given trip.

FromLocation

No description available.

Geometry

No description available.

Leg

No description available.

Location

No description available.

MDTRoute

No description available.

MDTRouteType

No description available.

MDTRoutesForBusStop

No description available.

MDTRoutesForBusStopRequest

No description available.

MDTStopId

No description available.

OptReqIso

Parameters for the GET command against /ws/iso.

OptReqPlan

Holds the common parameters to make GET calls for /ws/iso, /ws/plan, /ws/plan/first, and /ws/plan/last.

OptReqPlanCommon

Holds the common parameters to make GET calls for /ws/iso, /ws/plan, /ws/wms, /ws/plan/first, and /ws/plan/last.

OptReqTileZXYPng

No description available.

OptReqWms

No description available.

PointTime

Associate a time with the location so that it is understood when the reading took place.

M-16, Bus Location Message

M-17, Vehicle Location

M-19, Where Should I Be For Trip Response Location

SearchCriteria

M01: Criteria supplied by the traveler used to search for transit opportunities. The From and To Location fields can be either an address or latitude and longitude coordinate pair. The format of the Date of Trip is MM/dd/yyyy and Time hh:mmzz. Distance is in meters and speed in meters per second.

Step

No description available.

StopId

No description available.

TConnectionRequest

M-08, T-Connection Request

Description

The T-Connection Request is generated by the TOM and sent to the Dispatcher Dashboard where the Dispatcher will either approve or reject the request.

JSON


```
{
   "TConnId": "21EC2020-3AEA-1069-A2DD-08002B30309D",
   "Route": "002",
   "RouteId": "5429",
   “StopId”: “1296”,
   "StopCode": "HIG13TS",
   "HoldTime": 2,
   "StartTime":1381935831000
}
```

TConnectionRequestResponse

M-09, T-Connection Request Response

Description

This message is generated when the Dispatcher approves or rejects a T-Connection Request (M-08) using the Dispatcher Dashboard.

JSON


```
{
   "TConnId": "21EC2020-3AEA-1069-A2DD-08002B30309D",
   "Route": "002",
   "RouteId": "5429",
   “StopId”: “1296”,
   "StopCode": "HIG13TS",
   "HoldTime": 2,
   "Status": "Rejected",
   "StartTime":1381935831000
}
```


TConnectionStatus

M-07, T-Connect Status

Description

This message is generated by the IDTO Traveler Services component and sent to the mobile device of the traveler when a T-Connection has been created and the status of that T-Connection. When the status of that T-Connection changes, an updated message is generated and sent to the traveler.

ToLocation

No description available.

Trip

M-03, Trip

The Trip message contains the attributes and information for a particular trip. It includes duration of the trip, start and end times, legs and steps that the traveler will take to complete the trip. Durations are in milliseconds, distance in meters, speed in meters per second, times are milliseconds since epoch.

TripCancellation

M-15, Trip Cancelation

TripConfirmation

No description available.

TripNotification

M-06, Trip Notification

Description

This is a message generated by the IDTO Traveler Services component to the mobile device of the traveler notifying them of an upcoming trip. The notification will include the details of the trip including the start time and duration.

This may end up being the same as M-03 (Trip)

Trips

M-02, Trips

The Trips message contains an array of trip (M-03) objects.

ViewPort

Viewport contains the recommended viewport for displaying the returned result, specified as two latitude,longitude values defining the southwest and northeast corner of the viewport bounding box. Generally the viewport is used to frame a result when displaying it to a user.

ZimRide

I-05, our ZimRide interface, is undefined because we really don't know what we are doing with ZimRide. Most likely we will be screen scraping to find ride opportunities (trips ?), and maybe could use M-03 for that.

TConnectStatusEnum

No description available.

APPENDIX B. List of Abbreviations and Acronyms

Acronym	Description
AVA	Automatic Vehicle Annunciation
AVL	Automatic Vehicle Location
CAD	Computer-Aided Dispatch
ConOps	Concept of Operations
COTM	Contracting Officer's Task Manager
DMA	Dynamic Mobility Applications
DMS	Dynamic Message Sign
DOT	Department of Transportation
D-RIDE	Dynamic Ridesharing IDTO application
FHWA	Federal Highway Administration
GPS	Global Positioning System
HOT	High Occupancy Toll
HOV	High Occupancy Vehicle
IEEE	Institute of Electrical and Electronics Engineers
IDTO	Integrated Dynamic Transit Operations
ITS	Intelligent Transportation Systems
MDT	Mobile Data Terminal
MPO	Metropolitan Planning Organization
PDT	Project Development Team
PMP	Project Management Plan
RSA	Route and Schedule Adherence
SEMP	Systems Engineering Management Plan
SEP	Systems Engineering Process
SIRI	Service Interface for Real-time Information
SOW	Statement of Work
SRS	System Requirements Specifications
T-CONNECT	Transfer Connection IDTO application
TCP	Transfer Connection Protection
T-DISP	Transit Dispatch IDTO application

TMO	Transportation Management Organization
TRB	Transportation Research Board
US DOT	United States Department of Transportation

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