Impact Assessment of Integrated Dynamic Transit Operations

Evaluation Plan and Addendum

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16. Abstract

This document details the process that the Volpe Center intended to follow in evaluating the impacts of the Integrated Dynamic Transit Operations (IDTO) prototype demonstration in Columbus, Ohio and Central Florida. The document also includes the addendum to the original plan, which reflects the changes that occurred based on the changes to the demonstrations. The set of IDTO impacts was evaluated based upon a series of hypothesis tests governing travel behavior and strategies enacted by participating organizations. These tests related to usage of the IDTO technological bundle, changes in travel demand, changes in travel time, changes in operational costs, and changes in inter-organizational cooperation. Each of the hypotheses were tested based upon information provided by the prototype developer and participating organizations, as well as analysis conducted by the Impact Assessment team. In the final step of the analysis, the estimated impacts of the demonstration and analysis formed the basis of a projection of monetized benefits.

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Foreword

This report contains the Evaluation Plan and the Evaluation Plan Addendum completed as part of the Integrated Dynamic Transit Operations (IDTO) Impact Assessment (IA). The original evaluation plan detailing the intended objectives, data needs, and analytical processes for the IA was completed on April 21, 2014, just as the IDTO prototype demonstrations were commencing. Based on the changes to the demonstrations over time, the IA team made several changes to its plans. The addendum details those changes within the construct of the original plan, and was formally completed on February 3, 2016. These documents are meant to be read in tandem, as a result, they are included together here.

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Evaluation Plan: Executive Summary

The United States Department of Transportation (U.S. DOT) Intelligent Transportation Systems Joint Program Office (ITS JPO) has sought to transform the future of surface transportation systems management through connected vehicles and other innovative technologies and systems. To this end, they have developed the Dynamic Mobility Applications (DMA) Program which features, among other projects, the Integrated Dynamic Transit Operations (IDTO) bundle. This evaluation plan will outline the steps for completing Track 5, Evaluation and Performance Measures, for the IDTO bundle. The U.S. DOT defines the IDTO bundle to be the following three mobility applications:

- Connection Protection (T-CONNECT) is designed to increase the likelihood that a traveler makes a successful transfer, particularly when transferring between transit modes or agencies.
- Dynamic Transit Operations (T-DISP) involves two components: real-time trip planning information and demand-responsive transportation. The real-time trip planning component gives a traveler the ability to obtain real-time information on available transit options for a desired trip, including cost and predicted time. The demand-responsive component enables travelers to gain access to transit vehicles whose schedules or routes are modified dynamically to satisfy travel needs.
- Dynamic Ridesharing (D-RIDE) provides an efficient ridesharing network to travelers by quickly communicating needs (passengers) or available space (drivers) to other travelers.

The two demonstration sites will be Columbus, Ohio and Central Florida. The table below summarizes the specifics of and differences between the two sites.

Table 0-1. Comparison of Demonstration Sites

Area of Comparison	Columbus	Central Florida
Number of Agencies Involved	5	5
Number of T-CONNECT Locations	4	TBD
T-CONNECT Provider(s)	Central Ohio Transit Authority	LYNX, Sunrail
T-CONNECT Feeders	Campus Area Bus Service, Capital Transportation	Veolia Transportation (possible, still in planning), Sunrail, FlexBus (possible, still in planning)
T-DISP Provider(s)	TaxiCABS	FlexBus
D-Ride Provider(s)	Zimride	Zimride
Coordination of Trip Requests	Both passenger and driver driven	Both passenger and driver driven

The data that comes out of the test will help relevant stakeholders and program leadership make more informed decisions regarding IDTO technical feasibility and potential IDTO value.

Impact Areas and Hypotheses

The Volpe Center will conduct the Impacts Assessment (IA) of the prototype of the IDTO bundle of applications and will extrapolate observed findings from the two-site prototype demonstration to estimate the effectiveness and impacts of a full IDTO operational deployment in the regions where the small-scale demonstration occurs. The Volpe Center has formulated hypotheses based on six key impact areas, listed below. Specific means of testing each hypothesis, including necessary data elements and their sources, are contained within the plan.

Table 0-2. Description of Impact Areas

Impact	Description
Travel Times	How the bundle affects user travel time and user travel reliability
User Demand	The extent to which transit users ultimately use the software package and specific IDTO applications to improve their travel alternatives
Behavioral Change	The extent to which users develop a reliance on the bundle to improve their travel alternatives, independent of demand
Functionality of the IDTO Bundle	The multidimensional functionality of the bundle covering the experiences of both travelers and transit agencies
T-DISP Provider(s)	The specific strategies employed by travelers and transit agencies to improve their decision making
Inter-Agency Cooperation	The changes resulting from inter-agency cooperation

Data Collection

The Volpe Center will collect quantitative and qualitative data. Quantitative will originate from multiple sources and recurrent data transfers will be posted to the Research Data Exchange (RDE). Qualitative data will be gathered through interviews of project staff and local agency stakeholders.

Mapping Impacts to Full-Scale Scenarios

The Volpe Center will also estimate the region-wide (monetized) impacts of a full-scale implementation of the IDTO bundle. Impacts measured directly from the demonstration will need to be adjusted to account for sampling bias that may arise from the choice of non-representative demonstration components. Additionally, estimates of full-scale impacts will be translated into valuations, where feasible, for use within the national DMA evaluation. In general, valuations will be limited to the subset of impacts that can be represented as a tangible benefit or cost.

Next Steps

This document is the final Volpe Center's evaluation plan. Any future revisions based on continuing discussion with data providers and stakeholders will be presented in the form of an addendum. Addenda will also include any specific analytical techniques developed upon review of the sample data.

The projected IDTO evaluation schedule is highlighted below. The Columbus prototype demonstration baseline period began in March 2014 and the demonstration will go live on May 8th, lasting approximately eight months. The Central Florida prototype demonstration will go live on July 1st, lasting six months.

Table 0-3. Project Schedule

Deliverable	Projected Date
Columbus Prototype Demonstration – Start of Baseline Period	3/7/14
Columbus Prototype Demonstration – Demonstration Goes Live	5/8/14
Data Acceptability Memo – Columbus	Approx. 5/14
Central Florida Prototype Demonstration – Demonstration Goes Live	Approx. 7/1/14
Data Acceptability Memo – Central Florida	Approx. 7/14
Final Project Report – Battelle	12/5/14
Prototype Demonstration Ends (Both Sides)	12/31/14
Impacts Assessment Final Report	3/23/15

Chapter 1 Introduction and Background

1.1 The U.S. DOT DMA Program

The United States Department of Transportation (U.S. DOT) Intelligent Transportation Systems Joint Program Office (ITS JPO) has been working to transform the future of surface transportation systems management through the use of connected vehicles and other innovative technologies and systems. To this end they have developed the Dynamic Mobility Applications (DMA) Program which features four environments with several activity clusters in each, including the Integrated Dynamic Transit Operations (IDTO) bundle of three applications within the Corridor (Control) data environment.

The objective of this program is to "improve the capability of the transportation system to provide safe, reliable, and secure movement of goods and people."[1] This Evaluation Plan will describe the plans to complete Track 5, evaluation and performance measures, for the IDTO bundle. The research tracks and program description can be found on the DMA Fact Sheets website.[2]

In 2011, the DMA Program concluded a first phase of activity focused on foundational research and is now engaged in a second phase focused on applications development and testing, initiating coordinated research activities on a portfolio of high-priority mobility applications. A description of all the high-priority applications and the process through which they were selected and grouped can be found on the Mobility Program website.[3]

As a first step, the DMA Program partnered with the research community to further develop these high-priority transformative concepts and to refine data and communications needs. These data and communication needs will inform related efforts in the Real-Time Data Capture and Management (DCM) Program in support of application development to collect, assemble, and provide relevant data resources integrating data from wirelessly connected vehicles, travelers, and roadside/wayside infrastructure. This IDTO Impacts Assessment (IA) and associated prototyping activity are examples of the effort to assess data and communications needs, collect relevant data, and inform the DMA program on potential impacts. In later phases of the DMA Program, selected mobility applications will be identified for further research and refinement, and for benefits assessment utilizing these open data environments (see the DMA Program Roadmap website[4]).

The U.S. DOT wishes to advance the IDTO bundle from concept formulation to demonstration and test if the IDTO bundle works as envisioned. The data that comes out of the test will help relevant stakeholders and program leadership make more informed decisions regarding IDTO technical feasibility and potential IDTO value.

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[1] DMA Research Description and Scope (http://www.its.dot.gov/dma/)
[2] http://www.its.dot.gov/factsheets/dma_factsheet.htm
[3] http://www.its.dot.gov/press/2011/mobility_app.htm
[4] http://www.its.dot.gov/roadmaps/dma_roadmap.htm

1.2 The U.S. DOT IDTO Program

The U.S. DOT defines the IDTO bundle to be the following three mobility applications:

- Connection Protection (T-CONNECT) is designed to increase the likelihood that a traveler makes a successful transfer, particularly when transferring between transit modes or agencies.
- Dynamic Transit Operations (T-DISP) involves two components: real-time trip planning information and demand-responsive transportation. The real-time trip planning component gives a traveler the ability to obtain real-time information on available transit options for a desired trip, including cost and predicted time. The demand-responsive component enables travelers to gain access to transit vehicles whose schedules or routes are modified dynamically to satisfy travel needs.
- Dynamic Ridesharing (D-RIDE) provides an efficient ridesharing network to travelers by quickly communicating needs (passengers) or available space (drivers) to others.

This evaluation plan itemizes and describes research activity that the Volpe Center will conduct to address the IA of the prototype of the IDTO bundle of applications and extrapolation of observed findings from a two-site prototype demonstration to estimate the effectiveness and impacts of a full IDTO operational deployment in the regions where the small-scale demonstration occurs. These regions are Columbus, Ohio and Central Florida. This work is performed in cooperation with an IDTO Prototype Development (PD) task to conduct a small-scale demonstration test.[5]

1.2.1 Columbus

The Columbus, Ohio test site will be for the areas surrounding the Ohio State University (OSU) campus and the Defense Supply Center Columbus (DSCC) for T-CONNECT and T-DISP, while the entire metropolitan area will be covered by D-RIDE. The baseline evaluation period will begin in March 2014, and the prototype will go live in May 2014. The evaluation will last nine months in total.

The Central Ohio Transit Authority (COTA) is the primary public transit provider in the region. Four additional transportation service providers will take part in the demonstration: OSU’s Campus Area Bus Service (CABS), TaxiCABS (operated by CABS), DSCC’s Capital Transportation, and Zimride.

The OSU main campus is located slightly north of downtown Columbus. CABS and COTA provide fixed-route transit to students, faculty, other staff, and visitors. TaxiCABS will provide flex-route service between campus locations for OSU faculty. The DSCC campus is located east of downtown Columbus and the OSU campus. Capital Transportation provides on-demand, flex-route service between DSCC campus locations and security gates at the base adjacent to COTA bus stops. Access to Zimride, the service used to support dynamic (i.e., real-time) ridesharing, will be restricted to OSU students and staff upon the launch of the demonstration; there may be scope to extend Zimride access to all participants within the demonstration.

[5] The PD task is being conducted by the Battelle Memorial Institute under contract to the ITS JPO.

The Columbus demonstration is multimodal in nature. Within the demonstration, T-CONNECT will be provided from CABS to COTA and from Capital Transportation to COTA. T-CONNECT can feasibly be provided between all combinations of agencies, except from CABS to Capital Transportation. T-DISP will be demonstrated through the use of TaxiCABS, and D-RIDE will take advantage of Zimride.

The level of automation and coordination of various IDTO transactions depends on the participating partners and the varying types of users. Users of the system in the campus-area will be able to use automated features available via a smartphone app to view and “book” various transportation options. Riders in the DSCC area will be supported by the operators of the on-base shuttle, Capital Transportation. When a passenger (or surrogate) enters his or her desired trip, the software package displays this information to riders, who may then respond to a request. After a driver responds, the software package will send confirmation to the passenger. The supporting partners also receive notifications from the system, allowing them to facilitate the various requests from riders.

1.2.2 Central Florida

The Central Florida prototype demonstration will be conducted in much the same way as in Columbus. The prototype will center on the LYNX bus system. LYNX serves the greater Orlando region, including the University of Central Florida (UCF).

T-CONNECT will be offered between four LYNX bus routes at a central hub. In addition, T-CONNECT will be provided between these LYNX routes and both the SunRail commuter rail service and the UCF campus shuttle system, which is operated by Veolia Transportation. T-DISP will be provided by FlexBus, which provides on-demand, flex-route service. FlexBus will provide service to twenty-six stations located between the cities of Altamonte Springs, Casselberry, Longwood, and Maitland. These municipalities will be responsible for providing the FlexBus service. SunRail stations in each of these cities will also be served by T-DISP, with the exception of Casselberry. When no connections are available, users will be offered D-RIDE options; as in Columbus, D-RIDE service will be provided by Zimride. The Columbus demonstration will have manual coordination of IDTO transactions via dispatchers.

The implementation of these Central Florida demonstration services will occur in stages. The demonstration is tentatively planned to begin on July 1, 2014 involving LYNX, Veolia Transportation, and Zimride. The addition of SunRail will occur in early August 2014 and the addition of FlexBus is expected to occur in September 2014. Similar to Columbus, access to Zimride will be restricted to UCF students and staff.

1.2.3 Summary and Comparison

The following is a brief description summarizing the specifics of and differences between the two demonstration sites:

Table 1-1. Comparison of Demonstration Sites

Types of Agencies	Columbus	Central Florida
Number of Agencies Involved	5	5
Number of T-CONNECT Locations	4	TBD
T-CONNECT Provider(s)	Central Ohio Transit Authority	LYNX, Sunrail
T-CONNECT Feeders	Campus Area Bus Service, Capital Transportation	Veolia Transportation (possible, still in planning), Sunrail, FlexBus (possible, still in planning)
T-DISP Provider(s)	TaxiCABS	FlexBus
D-Ride Provider(s)	Zimride	Zimride
Coordination of Trip Requests	Both passenger and driver driven	Both passenger and driver driven

1.3 IDTO Demonstration Stakeholders – Roles

The IDTO project consists of multiple organizations, each with their own area of responsibility. Table 1-2 below lists each organization and their role in the project.

Table 1-2. Major Stakeholders

Stakeholder	Role
Battelle	Prototype Developer and Demonstration Lead
Booz Allen Hamilton	Evaluator of National-Level Program Impacts
Intelligent Transit Systems Joint Program Office (ITS JPO)	Program Leader
Federal Transit Administration (FTA)	Provider of oversight and expertise on transit related portion of program
Noblis	Provider of technical and project management support to ITS JPO and FTA
Volpe Center	The changes resulting from inter-agency cooperation

1.4 Evaluation Objectives

This project will comprise a subset of the inputs used in a national-level DMA evaluation, conducted by Booz Allen Hamilton. The DMA evaluation will include a benefit-cost analysis of DMA technology bundles that are being demonstrated at multiple sites. The benefit-cost analysis will compare monetized improvements to transit system productivity and traveler mobility at the national level. Specifically, this IA will support the national-level DMA evaluation through:

- The generation of estimated impacts of the IDTO demonstration at the regional level
- Assistance in identifying means of converting impacts to monetized benefits (e.g., converting travel time savings in minutes per use of a technology within the demonstration to dollars' worth of travel time savings from using the technology across the regions where the demonstration takes place).

Coordination meetings between the Volpe Center and the DMA program evaluation team (Booz Allen Hamilton) will guide the development of regional-level benefit-cost inputs from the demonstration for use within the national-level evaluation.

1.5 High-Level Project Schedule

Table 1-3 highlights the projected schedule. The Columbus prototype demonstration is set to begin in March of 2014. After a baseline period, the demonstration will go live on May 8th, and will last approximately eight months. The Central Florida prototype demonstration is set to go live on July 1st, and will last six months. The Volpe Center's evaluation period will begin in conjunction with the demonstration and analysis will continue after its completion.

Table 1-3. Project Schedule

Deliverable	Projected Date
Columbus Prototype Demonstration – Start of Baseline Period	3/7/14
Columbus Prototype Demonstration – Demonstration Goes Live	5/8/14
Data Acceptability Memo – Columbus	Approx. 5/14
Central Florida Prototype Demonstration – Demonstration Goes Live	Approx. 7/1/14
Data Acceptability Memo – Central Florida	Approx. 7/14
Final Project Report – Battelle	12/5/14
Prototype Demonstration Ends (Both Sites)	12/31/14
Impacts Assessment Final Report	3/23/15

1.6 Report Organization

This evaluation plan will discuss the analysis approach that will be used to evaluate the IDTO bundle. Section 2 describes the full approach with hypotheses, measures of effectiveness (MOEs), and preferred data sources. Section 3 describes the data-collection process, and Section 4 discusses the methods and approach intended to scale the demonstration-level impact assessment up to a regional-level evaluation. Finally, Section 5 summarizes, and provides a roadmap of future steps.

Chapter 2 Approach to Impacts Analysis and Evaluation

The Volpe Center identified six key impact areas for the IDTO demonstration. These impact areas were determined through analysis of DMA and IDTO documentation, analysis of Battelle's Project Management and Work Plan, and analysis of the planned demonstrations themselves. These impact areas broadly encompass what the Volpe Center will measure and assess. The impact areas, and the specific impacts relevant to each area, are listed in Table 2-1.

Table 2-1. Description of Impact Areas

Impact Area	Description	Specific Impacts
Travel Times	How the bundle affects user travel time and user travel reliability	• User travel time savings • User reliability gains
User Demand	The extent to which transit users ultimately use the software package and specific IDTO applications to improve their travel alternatives	• Changes in travel and transit demand accompanying bundle usage • Differences in bundle usage across trip contexts
Behavioral Change	The extent to which users develop a reliance on the bundle to improve their travel alternatives, independent of demand	• Software package use is higher during disruptions • Software package is relied on habitually
Functionality of the IDTO Bundle	The multidimensional functionality of the bundle covering the experiences of both travelers and transit agencies	• Increased throughput • Increased fleet efficiency • Increased rate of multi-modal transfers • Increased rate of multi-agency transfers • Benefits of software package exceed costs
Strategies of IDTO Bundle Usage	The specific strategies employed by travelers and transit agencies to improve their decision making	• Increased scheduling flexibility for transit agencies and users • Increased routing flexibility for transit agencies • Reduced effect (travel time loss) of disruptions on users and reduced burden of disruptions on transit agencies
Inter-Agency Cooperation	The changes resulting from inter-agency cooperation	• Increased levels of inter-agency communication, stream-lined improvements, and mitigated confusion, disruption, and operational inefficiencies

Each of these specific impacts are discussed below, including an itemization of the hypotheses relevant to each impact, the specific means of testing the hypotheses, necessary data, and data sources. The discussion of each impact will continue with the Volpe Center's approach to the analysis and highlight any key considerations that will need to be addressed for the team to evaluate the hypotheses.

Vehicle and user position data will be utilized to determine impacts on travel times, functionality of the IDTO bundle, and strategies of IDTO bundle usage. In order to understand passenger and system movement, mapping and geographic information system (GIS) techniques will be necessary. First, this data can be analyzed to improve our representation of pre-demonstration travel patterns. Second, geospatial data can be utilized to determine which connections or trip routes are most likely to be impacted by the demonstration, based on travel times, and what that impact will be. Third, the user position data can be segmented into wait time and travel time to evaluate changes in user experiences and service quality under the demonstration. This measure can be compared to pre-demonstration levels, and can also be used to determine impacts on travel time, passenger decision-making and bundle functionality.

The assessment of these impacts will be applied to a generalized cost model often used in transit and transportation planning frameworks. This model can be utilized to dynamically determine the effect of congestion on transit travel and also to isolate different portions of the trip, such as time at stop or time on vehicle, in order to accurately quantify their effect. Using this model, the Volpe Center will quantify the monetary and non-monetary costs incurred by users and non-users of the IDTO software package to determine the overall generalized cost. These users and non-users are defined below and the application of the generalized cost model is detailed in Section 4.3 of this report.

2.1 Impacts on Travel Times

This impact area centers on travel time, which is arguably the most direct means of mapping outcomes onto quantifiable and expandable impacts. Travel times inherently represent a large contributing factor in determining the effectiveness of the IDTO bundle and ultimately how helpful the bundle is for users. This impact area is also related closely to others, specifically the functionally and strategies of usage for the bundle. By evaluating the impact of the IDTO bundle on travel times, and scaling accordingly, the Volpe Center will be able to determine how effective the bundle will be in a full-scale implementation. The specific impacts being assessed in this area are as follows:

- User travel time savings
- User reliability gains

2.1.1 Evaluation Hypotheses and Links to Impacts

The hypotheses used to evaluate this impact area intuitively focus on individual traveler efficiency. The specific hypotheses are as follows (hypotheses in bold indicate high-priority relationships to test):

- Hypothesis 1: The software package and IDTO applications enable users to reach target destinations in less travel time compared to the baseline or non-users.
- Hypothesis 2: The software package and IDTO applications enable users to reach target destinations with less variation in travel time compared to the baseline or non-users.
- Hypothesis 3: Passenger wait time is reduced.

The evaluation of Hypothesis 1 will help to determine whether the software package or applications lead to user travel time savings. The travel time savings, which will be converted to monetary equivalents in the projection of impacts within a full-scale implementation, will also be disaggregated by factors such as commute versus non-commute trips and periods of high congestion or service disruption versus normal periods, as discussed in Section 2.5. The evaluation of Hypothesis 2 will help to determine whether the software package or applications lead to improvements in travel time reliability. Reliability gains will be evaluated independently of travel time savings (i.e., the specific impacts of decreased variability in outcomes around their mean), to reflect the specific impacts of increased certainty in the quality of public transit alternatives. Finally, the length of passenger wait time (Hypothesis 3) will lead to a diagnostic evaluation of the D-RIDE application and the overall software package to determine if the prototype functions as intended.

2.1.2 Key MOEs and Data

Table 2-2. Evaluation of Travel Times: Hypotheses 1-3

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 1a: The IDTO software package enables users to reach destinations faster compared to the baseline or non-users	• Times from origin to destination (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Battelle user position data (GPS coordinates) • Transit agency vehicle position data (GPS coordinates) • Transit agency baseline data (distribution of arrival times by stop and route)	• Battelle via Research Data Exchange (RDE) • Transit agency via one-time transfer or RDE	• User-level travel time savings compared to the baseline or non-users • Vehicle travel time savings • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 1b: T-CONNECT enables users to reach destinations faster compared to the baseline or non-users	• Times from origin to destination on trips affected by T-CONNECT (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Battelle user position data (GPS coordinates) • Transit agency vehicle position data (GPS coordinates) • Transit agency baseline data (distribution of arrival times by stop and route)	• Battelle via RDE • Transit agency via one-time transfer or RDE	• User-level travel time savings under T-CONNECT compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 1c: T-DISP enables users to reach destinations faster compared to the baseline or non-users	• Times from origin to destination on trips affected by T-DISP (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Battelle user position data (GPS coordinates) • Transit agency vehicle position data (GPS coordinates) • Transit agency baseline data (arrival times by stop and route)	• Battelle via RDE • Transit agency via one-time transfer or RDE	• User-level travel time savings under T-DISP compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 1d: D-RIDE enables users to reach destinations faster compared to the baseline or non-users	• Times from origin to destination on trips affected by D-RIDE (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Battelle user position data (GPS coordinates) • Battelle post-trip surveys (of users)	• Battelle via RDE	• User-level travel time savings under D-RIDE compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 2a: The IDTO software package enables users to reach destinations more reliably compared to the baseline or non-users	• Standard deviations of times from origin to destination (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Battelle user position data (GPS coordinates) • Transit agency vehicle position data (GPS coordinates) • Transit agency baseline data (distribution of arrival times by stop and route)	• Battelle via RDE • Transit agency via one-time transfer or RDE	• Improvements in trip reliability for users compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 2b: T-CONNECT enables users to reach destinations more reliably compared to the baseline or non-users	• Standard deviations of times from origin to destination on trips affected by T-CONNECT (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Battelle user position data (GPS coordinates) • Transit agency vehicle position data (GPS coordinates) • Transit agency baseline data (distribution of arrival times by stop and route)	• Battelle via RDE • Transit agency via one-time transfer or RDE	• Improvements in trip reliability for users compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 2c: T-DISP enables users to reach destinations more reliably compared to the baseline or non-users	• Standard deviations of times from origin to destination on trips affected by T-DISP (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Battelle user position data (GPS coordinates) • Transit agency vehicle position data (GPS coordinates) • Transit agency baseline data (arrival times by stop and route)	• Battelle via RDE • Transit agency via one-time transfer or RDE	• Improvements in trip reliability for users compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 2d: D-RIDE enables users to reach destinations more reliably compared to the baseline or non-users	• Standard deviations of times from origin to destination on trips affected by D-RIDE (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Battelle user position data (GPS coordinates) • Battelle post-trip surveys (of users)	• Battelle via RDE	• Improvements in trip reliability for users compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 3a: The IDTO bundle reduces passenger wait times at the origin within flexible modes	• Passenger waiting times for flexible mode pickup	• Battelle post-trip surveys (of users) • Battelle user position data (GPS coordinates)	• Battelle via RDE	• Travel time savings • Waiting time savings (if using separate value of time)
Hypothesis 3b: The IDTO bundle reduces passenger wait times at the origin within fixed modes	• Passenger waiting times at stop for fixed modes	• Battelle post-trip surveys (of users) • Battelle user position data (GPS coordinates)	• Battelle via RDE	• Travel time savings • Waiting time savings (if using separate value of time)
Hypothesis 3c: The IDTO bundle reduces passenger wait times during transfers	• Passenger transfer times	• Battelle post-trip surveys (of users) • Battelle user position data (GPS coordinates)	• Battelle via RDE	• Travel time savings • Transfer time savings (if using separate value of time)
Hypothesis 3d: Boarding time for rides scheduled via D-RIDE are within a satisfactory interval of their scheduled boarding times	• Difference between observed and scheduled boarding times on trips booked via D-RIDE • User satisfaction	• Battelle user position data (GPS coordinates) • IDTO user device data/logs (bundle transactions) • Battelle post-trip surveys (of users)	• Battelle via RDE	• As is – diagnostic: relative reliability of D-RIDE trips. • Alternative: using post-trip survey data on perceived improvements in travel alternatives

2.1.3 Analysis Approach

Impacts of the IDTO bundle on travel times are a critical set of measures to identify, both directly and as inputs into related impact measures discussed elsewhere in this plan. The Volpe Center's broadest travel time outcome to measure involves changes in travel times for users of the IDTO software package, regardless of the specific application selected (if any). That is, the Volpe Center will compare the full set of travel times for those who consult the software package relative to travel times before the demonstration, after accounting for primary external factors that could influence system performance. These external factors include, but are not limited to, demand and schedule variations. Statistical models will be applied to identify the presence and scale of any significant travel time changes across the set of trips before which users consult the software package. These statistical models include, but are not limited to, regression analysis and discrete choice analysis. Travel times will be presented in multiple ways but the most reasonable unit is average travel time savings per user.

Volpe will also pursue simulation techniques to generate a comparison profile of travel outcomes (i.e., travel times, reliability, and waiting times) for non-users. Central inputs for this analysis would include vehicle position data, service frequency data and distributions (empirical or assumed) of behavioral parameters such as waiting time buffers.

The Volpe Center will repeat this analysis for all uses of the specific applications: T-CONNECT, T-DISP, and D-RIDE. The analyses for T-CONNECT and T-DISP will involve comparisons of fixed route and demand-response services as the implementation progresses, after accounting for primary external factors; this approach is consistent with the approach for the analysis of general software package use. If it is infeasible to obtain carpooling data prior to implementation, because carpooling frequencies within the sample are too low or carpooling trips are difficult to identify within the data, the Volpe Center may be limited in its ability to identify D-RIDE-specific travel time savings. In such a case, three useful empirical strategies may be to:

- Seek information on representative carpooling trips, through estimated distributions of wait times for carpoolers for trips similar to those captured in the demonstration;
- Compare travel times in D-RIDE trips to the closest comparable transit trips, and then scale the estimated travel time savings down to represent the share of carpooling trips composed of users switching their travel mode from transit to rideshare; and
- Include a question in the post-trip survey for D-RIDE users prompting users for their estimates of changes in waiting time under D-RIDE relative to before the demonstration.

Estimated travel time savings will map directly to impacts, the generalized cost model, and projected effects of full-scale implementation of the IDTO bundle. Disaggregation of distributions of travel time savings by primary contexts (e.g., discretionary/non-discretionary travel, service disruptions), within the analysis of other impact types, will help to confirm whether there are any particular travel decision-making settings in which the bundle leads to impacts distinctly to the sample average. Furthermore, a comparison of travel time savings by application will illuminate the degree to which particular components of the bundle have relatively high impacts on travel times.

Key input data for the analysis of travel time impacts center on user- and vehicle-position data. The Volpe Center will establish a method for using positional data to identify any otherwise unidentified pre-demonstration trips that take place on transit. The Volpe Center will also establish a method for segmenting user position data into components representing time accessing and waiting for a vehicle, time on-vehicle, transfer waiting time, and time following arrival at the destination. These two methods will enable specific comparisons of the subset of door-to-door travel time that could feasibly be affected by the demonstration, relative to the corresponding subset of door-to-door travel time in pre-demonstration trips. These methods apply to several impact areas and are described in detail within Section 2 of this plan.

2.1.4 Key Considerations

The primary consideration with the evaluation of this impact area is establishing a measure for *a priori* travel times. While measuring travel times throughout the demonstration will be helpful to see how they change from the beginning of the demonstration to the end, it will also be insightful to see how demonstration travel times compare to pre-demonstration travel times. Obtaining data from the three-month baseline period may be sufficient; it may also be helpful to obtain past or current travel time data from transit agencies where available. Additionally, fluctuations in student population during the baseline and demonstration periods may have a significant effect on results and will therefore need to be accounted and controlled for. While we understand that T-CONNECT specifically could increase travel times for some passengers as their vehicle is idling waiting for other passengers to make a connection, this occurrence will be controlled for and captured through measuring passenger throughput (Section 2.4.1 Hypothesis 9).

A broader consideration centers on the structural differences between Columbus and Central Florida. Volpe will need to account for differences in factors across the two demonstration sites when making broader inferences on the demonstration's impacts on travel times, including:

- Congestion;
- Distances traveled;
- The nature of trips (e.g., college campus to nearby attractor, college campus to city center, work location to residential area);
- The shares of travelers in particular cohorts (e.g., college students, workers); and
- Speed limits

2.2 Impacts Relating to User Demand

With this impact area, the Volpe Center is attempting to determine the extent to which the software package and IDTO applications are being used. Evaluating the use of the software package and individual IDTO applications will have significant implications not only to determine the level of demand for the bundle, but also to determine how useful and necessary the bundle is. By measuring the level of bundle demand, the Volpe Center will be able to determine which groups are more likely to use the software package, including the individual applications within it, and how the bundle changes travel demand. These results will be used to help project the impact the bundle would have on transportation network capacity under a full-scale implementation scenario. Furthermore, interviews with transit agency representatives will help to confirm the implications of the level of bundle usage in the demonstration, as it relates to a potential full-scale implementation. The specific impacts being assessed in this area are as follows:

- Changes in travel and transit demand accompanying bundle usage
- Differences in bundle usage across trip contexts

2.2.1 Evaluation Hypotheses and Links to Impacts

The hypotheses used to evaluate this impact area focus on the level of use of the software package itself, and the different IDTO applications individually, as they relate to transit demand overall. These hypotheses are as follows (hypotheses in bold indicate high-priority relationships to test):

- Hypothesis 4: The IDTO bundle was consulted and utilized at a meaningful level overall, and for trips originating from, or destined to, specific locations.
- **Hypothesis 5: Transit demand is a positive function of IDTO bundle usage.**

The primary impact we will evaluate within Hypotheses 4 and 5 is the degree to which the presence of the bundle influences transit demand. For example, the Volpe Center will determine whether people who use T-CONNECT increase their transit trip volumes. Within this broad impact, we will evaluate the extent to which the bundle's influence on transit demand varies across trip contexts. For example, the Volpe Center will determine whether trips to a major activity center involving the bundle are linked to increased transit demand overall.

2.2.2 Key MOEs and Data

Table 2-3. Evaluation of User Demand: Hypotheses 4-5

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 4a: The software package was consulted and used at a meaningful level	• Software package usage rates or levels overall and by trip characteristics • Qualitative evidence in support of hypothesis	• Battelle user device data/logs (bundle transactions) • Interviews of Battelle Transit Agency	• Battelle via RDE Volpe Center	• Distribution of software package use rates by geographic location • Changes in travel demand as a function of total software package use
Hypothesis 4b: T-CONNECT was utilized at a meaningful level	• T-CONNECT transactions overall and by trip characteristics • Qualitative evidence in support of hypothesis	• Battelle T-CONNECT user device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via RDE • Volpe Center	• Distribution of T-CONNECT use rates by geographic location • Changes in travel demand as a function of T-CONNECT use
Hypothesis 4c: T-DISP was consulted and used at a meaningful level	• T-DISP transactions overall and by trip characteristics • Qualitative evidence in support of hypothesis • Trips planned • Trips taken as a share of trips planned	• Battelle T-DISP user device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via RDE • Volpe Center	• Distribution of T-DISP use rates by geographic location • Changes in travel demand as a function of T-DISP use

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 4d: D-RIDE was consulted and used at a meaningful level	• D-RIDE transactions overall and by trip characteristics • Qualitative evidence in support of hypothesis • Rides requested • Rides matched • Rides completed as a share of rides requested	• Battelle D-RIDE user device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via RDE • Volpe Center	• Distribution of D-RIDE use rates by geographic location • Changes in travel demand as a function of D-RIDE use
Hypothesis 5a: Transit demand is a positive function of software application usage	• Comparison of transit trip volumes and software application use • Qualitative evidence in support of hypothesis	• User device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via RDE • Volpe Center	• Travel volumes • Time savings • Transit agency costs • Transit agency revenues
Hypothesis 5b: Transit demand is a positive function of T-CONNECT usage	• Comparison of transit trip volumes and T-CONNECT transaction rates • Qualitative evidence in support of hypothesis	• User device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via RDE • Volpe Center	• Travel volumes • Time savings • Transit agency costs • Transit agency revenues
Hypothesis 5c: Transit demand is a positive function of T-DISP usage	• Comparison of transit trip volumes and T-CONNECT transaction rates • Qualitative evidence in support of hypothesis	• User device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via RDE • Volpe Center	• Travel volumes • Time savings • Transit agency costs • Transit agency revenues
Hypothesis 5d: Transit demand is a positive function of D-RIDE usage	• Comparison of transit trip volumes and D-RIDE transaction rates • Qualitative evidence in support of hypothesis	• User device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via RDE • Volpe Center	• Travel volumes • Time savings • Transit agency costs • Transit agency revenues

2.2.3 Analysis Approach

The Volpe Center's preferred means of assessing demand for the IDTO bundle involves the quantification of usage levels and a comparison with overall trip levels and frequencies. This will be done by determining the shares of trips where the bundle plays a role. Interviews with transit agency representatives will confirm whether the usage patterns are meaningful. Rather than testing only general demand for the bundle, the analysis will be disaggregated to assess demand for: the user software package (separate to specific choices to use a particular IDTO application), T-CONNECT, T-DISP and D-RIDE. In the event that particular usage thresholds are identified in consultation with transit agencies, the analysis will include a comparison of demand levels against the appropriate threshold.

Thresholds will be tested using standard significance tests such as t-tests and Chi-squared tests. In the absence of defensible threshold values, the analysis will focus on comparisons of observed usage across trip contexts. This usage will include, but will not be limited to, trips involving travel to or from OSU or the DSCC and peak-period trips versus off-peak trips. This will be done both to assess heterogeneity in behavior across contexts, and to enable more meaningful mapping of outcomes to impacts that can be generalized to full-scale implementation.

The central input data for the hypothesis tests includes user logs for the software package (to gauge demand for consulting the software package itself), transaction-level data for each of the applications, and transit agency interviews. In the case of combining trip contexts and demonstration elements (e.g., use of T-DISP at OSU), the Volpe Center will only estimate impacts in cases where a significant outcome is confirmed within the hypothesis tests. That is, if the impact of the demonstration element on the particular trip context is not statistically or qualitatively significant, then combinations of them will not be as well. Impacts will be estimated in greater detail by evaluating not only whether elements of the demonstration experience meaningful demand, but also whether travel demand is a function of IDTO bundle demand. For example, the Volpe Center will determine whether users of D-RIDE increase their travel volumes. This will enable the quantification of impacts on travel demand resulting from use of the bundle. Statistical modeling tools such as regression or discrete choice analysis will be applied to identify links between bundle use and travel behavior. These tests will be supported by qualitative interviews with Battelle and transit agencies.

2.2.4 Key Considerations

The Volpe Center will use the locations of transactions and types of transactions as proxies for the cohorts to which users belong for a given trip. For example one cohort could be an OSU campus TaxiCABS trip and another could be a DSCC COTA trip. This information in particular will be very helpful in terms of mapping demonstration outcomes to full-scale implementation impacts. It is important to note that limitations with respect to the use and storage of personally identifiable information (PII) may restrict the ability to link proxy cohort information back to all records belonging to a given participant. For example, the Volpe Center may be able to project that a given TaxiCABS user is a member of OSU faculty for a given trip, but the Volpe Center may be unable to flag all trips made by the user as belonging to a member of OSU faculty.

A broader consideration centers on the structural differences between Columbus and Central Florida. Volpe will need to account for differences in factors across the two demonstration sites when making broader inferences on the demonstration's impacts on user demand. These include:

- The set of potential connections that participants can utilize;
- The level of transit service;
- Distances traveled;
- The nature of trips (e.g., college campus to nearby attractor, college campus to city center, work location to residential area); and
- The shares of travelers in particular cohorts (e.g., college students, workers)

2.3 Impacts Relating to Behavioral Change

With this impact area, the Volpe Center will investigate whether participants grow to depend on the software package and individual applications. The Volpe Center will do this by focusing on behavioral change based specifically on the IDTO bundle; that is, independent of the degree of demand. A statistical model will be used to control for demand, and other relevant factors such as traffic conditions, thereby isolating the impacts of behavioral change based on the bundle. In doing so, the Volpe Center will investigate the extent to which users develop a reliance on the bundle to improve their travel alternatives. The extent of reliance will create widespread implications for transit agencies and transportation network planning overall. If the bundle affects behavioral change within the demonstrations, there is likely to be a significant impact in a full-scale scenario (Section 4.2 addresses the issue of a non-representative sample). The specific impacts being assessed in this area are as follows:

- Software package use is higher during disruptions
- Software package is relied on habitually

2.3.1 Evaluation Hypotheses and Links to Impacts

The hypotheses used to evaluate this impact area focus first on isolating the portion of demand for the software package or IDTO applications which acts as a function of one-time or individual circumstances, and second on determining continual or habitual use of the software package or applications. These hypotheses are as follows:

- Hypothesis 6: Demand for the IDTO bundle is a function of personal needs and traffic conditions.
- Hypothesis 7: The IDTO bundle is utilized by individual users on a continuous or repeated basis.

The evaluation of Hypothesis 6 will support the analysis of impacts on users, by disaggregating overall impacts on travel time by travel time savings and reliability gains. This will be done with respect to systematic influences including travel conditions, such as relatively high congestion levels, and trip constraints, such as commutes to and from work. In turn, it will help to identify whether a disproportionate share of impacts accrue under primary contexts (e.g., that the bundle offers particularly high travel time savings under high congestion), which may improve the projection of impacts under full-scale implementation.

The analysis will include a focus on service disruptions, such as incidents and accidents, inclement weather, or other unusual delays. While the Volpe Center does not assume that most IDTO users will only use the bundle during an incident, it is feasible that a disproportionate amount of the value offered by the bundle could manifest itself during disruptions. The evaluation of Hypothesis 7 will confirm the extent to which user demand may become habitual, which will help to identify the potential for specific impacts, such as travel time savings, to grow as a full-scale implementation matures.

2.3.2 Key MOEs and Data

Table 2-4. Evaluation of Behavioral Change: Hypotheses 6-7

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 6a: Demand for the software package is a function of personal needs and level of service	• Software package use varies with respect to observable factors, including congestion, time of day and variability in total trip times • Qualitative evidence in support of hypothesis	• Battelle user device data/logs (bundle transactions) • Traffic congestion data (distribution of travel speeds by network segment) • Battelle post-trip surveys (of users)	• Battelle via RDE • Transportation Authority via RDE • Volpe Center	• Split apart general software package use rates – focus on distributions of use rates under classes of disruptions
Hypothesis 6b: Demand for T-CONNECT is a function of personal needs and level of service	• T-CONNECT transactions vary with respect to observable factors, including congestion, time of day and variability in total trip times • Qualitative evidence in support of hypothesis	• Battelle T-CONNECT user device data/logs (bundle transactions) • Traffic congestion data (distribution of travel speeds by network segment) • Battelle post-trip surveys (of users) • Transportation Authority stakeholder interview	• Battelle via RDE • Transportation Authority via RDE • Volpe Center	• Split apart general T-CONNECT use rates – focus on distributions of use rates under classes of disruptions
Hypothesis 6c: Demand for T-DISP is a function of personal needs and level of service	• T-DISP transactions vary with respect to observable factors, including congestion, time of day and variability in total trip times • Qualitative evidence in support of hypothesis	• Battelle T-DISP user device data/logs (bundle transactions) • Traffic congestion data (distribution of travel speeds by network segment) • Battelle post-trip surveys (of users) • Transportation Authority stakeholder interview	• Battelle via RDE • Transportation Authority via RDE • Volpe Center	• Split apart general T-DISP use rates – focus on distributions of use rates under classes of disruptions

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 6d: Demand for D-RIDE is a function of personal needs and traffic conditions	• D-RIDE transactions vary with respect to observable factors (such as congestion and time of day) • Qualitative evidence in support of hypothesis	• Battelle D-RIDE user device data/logs (bundle transactions) • Transportation Authority stakeholder interview	• Battelle via RDE • Volpe Center	• Split apart general D-RIDE use rates – focus on distributions of use rates under classes of disruptions
Hypothesis 7a: The software application is utilized by individual users on a continuous or repeated basis	• Individual software application usage rates or levels (on an interval basis/moving average) • Qualitative evidence in support of hypothesis	• Battelle user device data/logs (bundle transactions) • Interviews of Battelle	• Battelle via RDE • Volpe Center	• Interact with distributions of software use and travel demand to disaggregate by recurring and non-recurring congestion
Hypothesis 7b: T-CONNECT is utilized by individual users on a continuous or repeated basis	• Individual T-CONNECT usage rates or levels (on an interval basis/moving average) • Qualitative evidence in support of hypothesis	• Battelle user device data/logs (bundle transactions) • Interviews of Battelle	• Battelle via RDE • Volpe Center	• Interact with distributions of T-CONNECT use and travel demand to disaggregate by recurring and non-recurring congestion
Hypothesis 7c: T-DISP is utilized by individual users on a continuous or repeated basis	• Individual T-DISP usage rates or levels (on an interval basis/moving average) • Qualitative evidence in support of hypothesis	• Battelle user device data/logs (bundle transactions) • Interviews of Battelle	• Battelle via RDE • Volpe Center	• Interact with distributions of T-DISP use and travel demand to disaggregate by recurring and non-recurring congestion
Hypothesis 7d: D-RIDE bundle is utilized by individual users on a continuous or repeated basis	• Individual D-RIDE usage rates or levels (on an interval basis/moving average) • Qualitative evidence in support of hypothesis	• Battelle user device data/logs (bundle transactions) • Interviews of Battelle	• Battelle via RDE • Volpe Center	• Interact with distributions of D-RIDE use and travel demand to disaggregate by recurring and non-recurring congestion

2.3.3 Analysis Approach

The Volpe Center's preferred means of assessing the degree to which users incorporate the bundle into their travel decision making includes two sets of behavioral outcomes. The first set involves the sensitivity of demand for the bundle to personal needs, such as discretionary versus non-discretionary travel, and traffic conditions, such as peak versus non-peak. Statistical significance tests will be applied to gauge the degree to which travelers vary their use of the bundle as conditions vary. A reasonable and testable base expectation is that bundle use would be more likely under time constraints, such as commutes, and deteriorated traffic conditions or service disruptions. Primary bundle sensitivity test inputs include:

- Software package and application use data (consistent with hypothesis tests for impacts relating to demand);
- Traffic network data (e.g., indicators of major congestion in areas covered by the demonstration, indicators of transit service disruptions, indicators of travel speeds by AM peak, mid-day, and PM peak);
- Post-trip survey data on personal needs relating to travel (i.e., discretionary versus non-discretionary trip purpose).

The possible correlation between personal needs and traffic conditions will be controlled for within the analysis using these inputs.

For all cases where the hypothesis tests confirm significant variation in bundle demand, the Volpe Center will estimate impacts of the presence of the bundle on travel behavior for the case in question. This will include, but will not be limited to, all travel under service disruptions and non-discretionary travel by OSU students. The information revealed in the hypothesis tests will help to identify important variations in behavior – and hence relative effects of service uncertainties on bundle usage. These tests will be supported by qualitative transportation authority stakeholder interviews.

The second set of behavioral outcomes involves the development of usage patterns upon increasing experience with the bundle. Transaction-level and software package usage information will be used to test whether individual usage rates or levels (on an interval basis) increase as experience with the bundle grows, all else being equal. The analysis will likely require controlling for temporal effects to account for external factors. This will include, but will not be limited to, controlling for periods of lower expected transit demand.

For all cases where the hypothesis tests confirm significant recurring use of the bundle, the Volpe Center will estimate impacts of the presence of the bundle on travel behavior. Meaning, the team will analyze through statistical estimation and post-trip surveys how "recurrent" or "habitual" bundle use impacts travel demand, travel patterns, and the transit network overall. The information revealed in the hypothesis tests will help to identify important variations in behavior for travelers that demonstrate repeated use of the bundle, relative to the sample overall. These tests will be supported by qualitative interviews with Battelle.

2.3.4 Key Considerations

Adjusting for key contextual factors may require coordination with transit agencies to account for key influences. The use of data that track the travel patterns of participants must be restricted to prevent the direct use or generation of personally identifiable information.

A broader consideration centers on the structural differences between Columbus and Central Florida. As with the evaluation of impacts on user demand, Volpe will need to account for differences in factors across the two demonstration sites when making broader inferences on the demonstration's impacts on user behavior. These include:

- The set of potential connections that participants can utilize;
- The level of transit service;
- Distances traveled;
- The nature of trips (e.g., college campus to nearby attractor, college campus to city center, work location to residential area); and
- The shares of travelers in particular cohorts (e.g., college students, workers)

2.4 Impacts Relating to the Functionality of the IDTO Bundle

This impact area centers on the functionality of the IDTO bundle; that is, is the technology working? This impact area is inter-connected with several others because if the functionality of the bundle is inconsistent or inconclusive, then there is likely to be a ripple effect across several other impacts, such as demand, and the error bars around other impact estimates will need to be adjusted (up) accordingly.

This impact area is multidimensional, covering the experiences of both travelers and transit agencies. By determining the bundle's functionality, the Volpe Center will first be able to diagnose if the software package and applications perform in the manner intended, and then, how practical the applications are, through a form of abbreviated benefit-cost analysis.

This impact area differs from system acceptance tests in that it is less detailed or rigorous and measures only what is necessary to demonstrate that changes in traveler behavior can be traced to software that functions as expected. The specific impacts being assessed in this area are as follows:

- Increased passenger throughput
- Increased fleet efficiency
- Increased rate of multi-modal transfers
- Increased rate of multi-agency transfers
- Benefits of software package exceed costs

2.4.1 Evaluation Hypotheses and Links to Impacts

There are several hypotheses used to evaluate this impact area. These hypotheses focus on user experience, the likelihood of making transfers and completing trips successfully, the applications' cost-effectiveness, and whether the applications function as they are designed to function. The specific hypotheses are as follows (high-priority hypotheses in bold):

- Hypothesis 8: Predicted travel and wait time information from package-DISP improves users' ability to manage their trips.
- **Hypothesis 9: The IDTO bundle increases system efficiency.**
- **Hypothesis 10: T-CONNECT increases the likelihood of making successful transfers.**
- Hypothesis 11: T-CONNECT and T-DISP are cost-effective applications for improving services and intermodal transportation.

These hypotheses link to the IDTO bundle's functionality by helping the Volpe Center to determine whether the software package adds value to users. The Volpe Center will also be able to determine if increasing connections made by travelers reduces schedule delays. In other words, the Volpe Center will determine if meaningful travel time savings and reliability gains are achieved through using T-CONNECT. The hypotheses will also serve to determine if the IDTO applications represent tools to decrease overall and unit (i.e., passenger-level) costs, through both cost savings arising from improved vehicle utilization and passenger throughput. Finally, in many ways, these hypotheses will incorporate diagnostic tests of the applications and software package to observe if the software functions as expected and whether or not that functionality affects demand or usage.

An important component of the analysis for Hypothesis 10 will involve generating a simulated profile of trips made by non-users of the software package, based upon observed trips by users. This will be done by comparing expected outcomes for like trips in the absence of information or alternatives from the software package. Non-user trip outcomes will be estimated using vehicle position and schedule data. Analysis will include parameterized assumptions about general user behavior for transit trips, such as distributions of waiting times. Vehicle position data will enable the identification of like trips and alternative trips that allow for conditional effects such as missed vehicles or missed connections. This will include either the identical vehicle used by a participant, where appropriate, or another vehicle traveling to the same destination as the participant under the same travel conditions. Schedule data will be linked to assumptions about waiting times, for cases where frequency is sufficiently low to cause users to attempt to reach a particular vehicle, to establish distributions of times that users would arrive at a given vehicle stop.

The comparison of observed outcomes for software package users, with simulated outcomes for non-users, will offer (upper-bound) evidence of trip-level improvements experienced by software package users. Variability in general transit user behavior and experiences can be captured probabilistically by repeating the calculation of simulated trips and estimating distributions of outcomes, against which observed trips would be compared.

2.4.2 Key MOEs and Data

Table 2-5. Evaluation of the Functionality of the IDTO Bundle: Hypotheses 8-11

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 8: Predicted travel and wait time information from T-DISP improves users' ability to manage their trips	• Post-trip survey attitudinal scores above neutral	• Battelle post-trip surveys (of users)	• Battelle via RDE	• Minor/diagnostic: users agree that the software package offers value
Hypothesis 9a: The IDTO bundle increases passenger throughput	• Passengers per vehicle hour • Vehicle cycle times	• Transit agency demonstration ridership data (passengers per vehicle / per day) • Transit agency historic ridership data • Vehicle position data	• Transit agency via one-time transfer or RDE	• Changes in passenger throughput by corridor/service type • Fleet efficiency impacts (e.g., costs per passenger per vehicle-hour, costs per vehicle cycle)
Hypothesis 9b: The IDTO bundle increases average transit rider travel times	• User travel times	• Transit agency demonstration ridership data • Vehicle position data	• Transit agency via one-time transfer or RDE	• Changes in passenger throughput by corridor/service type • Fleet efficiency impacts (e.g., costs per passenger per vehicle-hour)
Hypothesis 10a: T-CONNECT increases the likelihood of making successful multi-modal transfers	• Passenger transfers under T-CONNECT • # of T-CONNECT requests • Post-trip survey attitudinal scores above neutral	• Battelle user position data (GPS coordinates) • IDTO user device data/logs (bundle transactions) • Battelle post-trip surveys (of users) • Transit agency current and historical ridership and transfer data • Transit agency current and historical vehicle position data	• Battelle via RDE • Transit agency via one-time transfer or RDE	• Indirect/diagnostic: Relative increase in successful multi-modal connections by corridor (With expanded design could assess schedule delay reduction in multi-modal travel)

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 10b: T-CONNECT increases the likelihood of making successful multi-agency transfers	• Passenger transfers under T-CONNECT • # of T-CONNECT requests • Post-trip survey attitudinal scores above neutral	• Battelle user position data (GPS coordinates) • IDTO user device data/logs (bundle transactions) • Battelle post-trip surveys (of users) • Transit agency current and historical ridership and transfer data • Transit agency current and historical vehicle position data	• Battelle via RDE • Transit agency via one-time transfer or RDE	• Indirect/diagnostic: Relative increase in successful multi-agency connections by corridor (With expanded design could assess schedule delay reduction in multi-agency travel)
Hypothesis 10c: T-CONNECT increases connections made involving fixed and flexible modes to above 90% of connections requested	• Percentage of T-CONNECT connections made for all trips versus total connections requested or attempted	• Battelle user position data (GPS coordinates) • Battelle T-CONNECT user device data/logs (bundle transactions) • Battelle post-trip surveys (of users)	• Battelle via RDE	• Diagnostic only: no impact
Hypothesis 11a: T-CONNECT is a cost-effective application for improving transit services (efficiency, throughput) for transit agencies	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis • Cost-effectiveness measure	• Transit agency interviews • Transit agency cost data (unit and shared costs of implementation and maintenance)	• Volpe Center • Transit agency via one-time transfer or RDE	• Relative agency support of T-CONNECT for improving transit services • Conduct basic benefit-cost analysis for T-CONNECT (compare mode-specific impacts to modal share of costs)
Hypothesis 11b: T-CONNECT is a cost-effective application for improving intermodal transportation (efficiency, throughput) for transit agencies	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis • Cost-effectiveness measure	• Transit agency interviews • Transit agency cost data (unit and shared costs of implementation and maintenance)	• Volpe Center • Transit agency via one-time transfer or RDE	• Relative agency support of T-CONNECT for improving intermodal transportation • Conduct basic benefit-cost analysis for T-CONNECT (allocate shared costs and benefits – e.g., intermodal patronage/impacts on connection waiting time - to get intermodal BCA)

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 11c: T-DISP is a cost-effective application for improving intermodal transportation (efficiency, throughput) for transit agencies	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis • Cost-effectiveness measure	• Transit agency interviews • Transit agency cost data (unit and shared costs of implementation and maintenance)	• Volpe Center • Transit agency via one-time transfer or RDE	• Relative agency support of T-DISP for improving intermodal transportation • Conduct basic benefit-cost analysis for T-DISP (allocate shared costs and benefits – e.g., intermodal patronage/impacts on connection waiting time - to get intermodal BCA)
Hypothesis 11d: T-DISP is a cost-effective application for improving transit services (efficiency, throughput) for transit agencies	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis • Cost-effectiveness measure exceeds threshold	• Transit agency interviews • Transit agency cost data (unit and shared costs of implementation and maintenance)	• Volpe Center • Transit agency via one-time transfer or RDE	• Relative agency support of T-DISP for improving transit services • Conduct basic benefit-cost analysis for T-DISP

2.4.3 Analysis Approach

The Volpe Center's preferred means of assessing the degree to which the functionality of the bundle impacts system performance includes one set each of behavioral outcomes, operational outcomes, and technical outcomes. The set of behavioral outcomes involves impacts on users' travel experiences, including the ability to manage trips, and the relative ease of making transfers. The Volpe Center will assess impacts on travel experiences through both stated information from post-trip surveys and analysis of users' trips relative to projected trips by non-users. In assessing impacts, the role of significance testing of post-trip survey responses is limited to confirming subjective views that the bundle improves users' ability to manage their trips and minimize travel time in trips involving transfers. A comparison of observed trips by users relative to representative trips by non-users, calibrated with respect to pre-demonstration trip data or reasonable assumptions about common travel experiences, will offer tangible evidence of value offered by the bundle in improving users' travel experiences. This will include, but will not be limited to, distributions of travel time savings for trips involving connections, by corridor, or service type. This evidence will be used as inputs into the generalized cost model.

The set of operational outcomes focuses on passenger throughput and transit agency cost-effectiveness measures. Passenger throughput (by corridor or service type, measured in passengers per vehicle-hour or hour) will be compared to pre-implementation levels, after adjusting for external factors that could influence throughput such as seasonality or fare changes. It is not technically necessary to increase passenger throughput for the bundle to offer value to agencies, but changes in efficiency are a critical component of operational impacts to represent in the analysis. This measure will also be useful in helping to determine the effect of idling vehicles due to T-CONNECT holding the vehicle for incoming passengers. Transit agency cost-effectiveness is the broadest operational-level outcome to evaluate; if the bundle does not yield cost-effective solutions to agencies, it could be difficult to justify investments in full-scale implementations of the bundle.[6] The Volpe Center will assess cost-effectiveness through both qualitative (i.e., stakeholder interviews) and quantitative (i.e., estimates of cost per unit system improvement) means. Information from stakeholder interviews will help to identify both overall attitudes of stakeholders toward the value offered by the bundle, and specific areas where the bundle performs strongly or weakly; the interviews would also serve to set benchmarks for the quantitative analysis by identifying meaningful thresholds for cost-effectiveness. For example, these measures will include dollars per minute of travel time savings per passenger.

The set of technical outcomes are chiefly diagnostic in nature. Significance tests of technical outcomes will reveal how well T-CONNECT and T-DISP perform in the demonstration. The performance of T-CONNECT will be evaluated to confirm whether T-CONNECT requests are honored at or above a target rate of 90 percent. Further analysis may be conducted to identify factors that may lead to outcomes that fall short of the 90 percent target, such as whether there are systematic and isolated factors that lead to connections not being honored.

[6] It is possible that this limited demonstration may have different cost-effectiveness than a full-scale roll-out due to economies of scale; this possibility will be considered in the extrapolation effort.

2.4.4 Key Considerations

This evaluation will contain some degree of qualitative evidence which may lend itself to be subjectively interpreted. This is an area which will be monitored closely to avoid any biases.

A broader consideration centers on the structural differences between Columbus and Central Florida. Volpe will need to account for differences in factors across the two demonstration sites when making broader inferences on the functionality of the IDTO bundle. These include:

- The set of potential connections that participants can utilize;
- The volume of transit services;
- Distances traveled,
- Congestion
- Speed limits

2.5 Impacts Relating to Strategies of IDTO Bundle Usage

This impact area centers on specific strategies employed by travelers and transit agencies to improve their decision making. In other words, the Volpe Center is attempting to determine how the technology is being used. While the transportation network likely operates effectively under normal circumstances, problems may arise in cases of disruption or incidents that require one or multiple agencies to adapt. Measuring how effectively the IDTO bundle manages these scenarios and improves decision making, for both users and transit agencies, will provide information on how significant the impact of the bundle is. By monitoring these scenarios, the Volpe Center will be able to determine the bundle's usefulness. The specific impacts being assessed in this area are as follows:

- Increased scheduling flexibility for transit agencies and users
- Increased routing flexibility for transit agencies
- Reduced effect (travel time loss) of disruptions on users and reduced burden of disruptions on transit agencies

2.5.1 Evaluation Hypotheses and Links to Impacts

The hypotheses used to evaluate this impact area focus on the T-DISP's ability to support dynamic routing and scheduling and the ability of the software package and individual applications to mitigate the effect of and improve the reliability of travel alternatives under disruptions. The specific hypotheses are as follows (high-priority hypotheses in bold):

- Hypothesis 12: T-DISP extends demand response services to support dynamic routing, scheduling, and changing number of vehicles in service.
- **Hypothesis 13: The IDTO bundle improves users' ability to mitigate effects of disruptions to the network.**

The evaluation of Hypothesis 12 will offer insight into the degree to which scheduling and routing flexibility improve users' transit experiences. This information will be considered in concert with users' changes in transit demand to gauge the impact of demand-response services on overall transit ridership and trip quality improvements. Hypothesis 12 will also enable an analysis of the extent to which T-DISP impacts operational decisions, such as the share of vehicle trips that are impacted by T-DISP transactions, and costs. Hypothesis 13 links to the strategies of bundle usage impact area by determining the level of flexibility that T-DISP adds to the transportation network and as an indicator for whether the software package or individual applications are used by travelers to mitigate the effect of disruptions.

2.5.2 Key MOEs and Data

Table 2-6. Evaluation of the Strategies of IDTO Bundle Usage: Hypotheses 12-13

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 12a: T-DISP extends demand response services to support dynamic routing	• # of Route variations caused by user requests	• Battelle command center data • Transit agency interviews	• Battelle via RDE	• Degree that T-DISP adds route flexibility • Service quality improvement for users
Hypothesis 12b: T-DISP extends demand response services to support dynamic scheduling	• # of Schedule variations caused by user requests	• Battelle command center data (time and result of transaction/activity) • Transit agency interviews	• Battelle via RDE	• Degree that T-DISP adds schedule flexibility • Service quality improvement for users
Hypothesis 12c: T-DISP extends demand response services to support changing number of vehicles in service	• # of Decisions to change number of vehicles	• Transit agency service logs (details of status, schedule, and route changes) • Transit agency interviews	• Transit agency via RDE • Volpe Center	• For removal of vehicles: • Estimate of reduced operating costs (need cost info from agencies) • For addition of vehicles: • Analyze travel times • Estimated demand and schedule/expected wait times to estimate wait time/travel time reductions
Hypothesis 13a: The IDTO software package improves users' ability to mitigate the effects of disruptions to the traffic network or transit system and enhances network and system reliability	• Post-trip survey attitudinal scores above neutral • Travel time for users in incident conditions vs. estimated travel time for non-users	• Battelle post-trip surveys (of users) • Battelle user position data (GPS coordinates) • Transit agency vehicle position data (GPS coordinates) • Incident logs	• Battelle via RDE • Transit agency via RDE • Transportation Authority via RDE	• Indicator: app is used to mitigate effects of traffic network or transit system disruptions

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 13b: T-CONNECT improves the reliability of travel alternatives under disruptions to the traffic network or transit system	• Post-trip survey attitudinal scores above neutral • Travel time for users in incident conditions vs. estimates for non-users	• Battelle post-trip surveys (of users) • Battelle user position data (GPS coordinates) • Transit agency vehicle position data (GPS coordinates) • Incident logs	• Battelle via RDE • Transit agency via RDE • Transportation Authority via RDE	• Indicator: T-CONNECT is used to mitigate effects of disruptions to the traffic network or transit system
Hypothesis 13c: T-DISP improves the reliability of travel alternatives under disruptions to the traffic network or transit system	• Post-trip survey attitudinal scores above neutral • Travel time for users in incident conditions vs. estimates for non-users	• Battelle post-trip survey (of users) • Battelle user position data (GPs coordinates) • Transit agency vehicle position data (GPS coordinates) • Incident logs	• Battelle via RDE • Transit agency via RDE • Transportation Authority via RDE	• Indicator: T-DISP is used to mitigate effects of disruptions to the traffic network or transit system
Hypothesis 13d: D-RIDE improves the reliability of travel alternatives under disruptions to the traffic network or transit system	• Post-trip survey attitudinal scores above neutral • Travel time for users in incident conditions vs. estimates for non-users	• Battelle post-trip surveys (of users) • Battelle user position data (GPS coordinates) • Incident logs	• Battelle via RDE • Transportation Authority via RDE	• Indicator: D-RIDE is used to mitigate effects of disruptions to the traffic network or transit system

2.5.3 Analysis Approach

The Volpe Center's preferred means of assessing the degree to which users and agencies use the bundle strategically includes behavioral outcomes for users and agencies. The user-specific set of outcomes focuses on the use of the bundle as a strategic tool for mitigating the effects disruptions to the travel network or transit system. That is, separate to analyses of overall bundle use, this set of outcomes relates to strategic use of the bundle to minimize effects of reduced levels of service due to unusual traffic congestion or transit service disruptions. Consistent with the approach to assessing user-centered impacts relating to the functionality of the bundle, the Volpe Center will assess strategic use of the bundle by travelers through analyses of information from post-trip surveys and comparisons of travel times for users and representative non-users in cases of congestion or service disruptions. These service disruptions will be identified through transit agency incident logs.

In assessing user-centered impacts, the role of significance testing of post-trip survey responses is limited to confirming subjective views that the bundle improves users' ability to mitigate the effects of disruptions to the traffic network or transit system. A comparison of observed trips by users relative to representative trips by non-users, calibrated with respect to pre-demonstration trip data or reasonable assumptions about common travel experiences, will offer tangible evidence of value offered by the bundle under disruptions. This will include analyzing distributions of travel time savings for trips under disruptions, by corridor or service type. The analysis will be targeted at identifying the relative scale of benefits offered to users under disruptions, compared to average trips. Essential input data for the analysis includes information from traffic authorities and transit agencies regarding major disruptions, such as incident logs.

The agency-specific set of outcomes focuses on the role of T-DISP in influencing operational decisions for demand-response services. In particular, the Volpe Center will test hypotheses that T-DISP leads to significant levels of route variations, schedule variations, and changes in active fleet size. Variations in schedule refer to cases where vehicles are held to pick-up a rider. Variations in route refer to cases where demand-response vehicles change course to pick up a rider. Variations in the fleet size were listed in previous bundle documentation, although it is unclear if transit agencies intend on making such adjustments. These tests will be supported by qualitative transit agency interviews.

In all cases, the hypotheses will be tested relative to pre-implementation baselines that are adjusted for external factors. Key input data for significance testing of the role of T-DISP in influencing operational decisions for demand-response services include measures of route variations, schedule variations, and decisions to change the number of vehicles in service both before-and-after implementation of T-DISP. The degrees to which T-DISP adds flexibility in routing and scheduling demand-response vehicles will be reflected as relatively intangible impacts in the analysis. Changes in active fleet size will involve two distinct, tangible impacts: changes to operating costs, such as product of net change in vehicle-hours and cost per vehicle-hour, and impacts on travel times and wait times arising from changes in active fleet size.

2.5.4 Key Considerations

The primary considerations associated with evaluating this impact area involve the subjective nature of evaluating the magnitude of disruptions to the transportation network. Another issue associated with this impact area is estimating the travel time for non-users. This could be achieved based on transit agency data, surveying non-users, or projecting travel decisions that non-users would make within users' trips.

A broader consideration centers on the structural differences between Columbus and Central Florida. Volpe will need to account for differences in factors across the two demonstration sites when making broader inferences on strategies relating to IDTO bundle usage. These include:

- The set of potential connections that participants can utilize;
- The level of transit service;
- Distances traveled;
- The nature of trips (e.g., college campus to nearby attractor, college campus to city center, work location to residential area); and
- The shares of travelers in particular cohorts (e.g., college students, workers)

2.6 Impacts Relating to Inter-Agency Cooperation

The final impact area centers on transformative operational changes in inter-agency cooperation. Many of the benefits of the IDTO bundle - and T-CONNECT, in particular – can be increased through higher levels of collaboration between agencies. Establishing strategies to support the success of transfers involving transportation provided by multiple agencies, such as transfers between Capital Transportation and COTA services, may improve the effectiveness of T-CONNECT transactions involving multiple agencies, relative to purely arms-length operations. Furthermore, the presence of the bundle itself could reduce barriers to cooperation between agencies by placing attention on the interdependence of transit services across agencies and on specific high demand transfers which involve narrow transfer windows. Viewing the impact of the bundle more broadly, the presence of the software package may also stimulate increased cooperation between agencies, by framing otherwise independent transit alternatives as part of a cohesive unit. The specific impact being assessed in this area is as follows:

- Increased levels of inter-agency communication, stream-lining improvements and mitigating confusion, disruption, and operational inefficiencies

2.6.1 Evaluation Hypotheses and Links to Impacts

Similar to the travel times hypotheses, these hypotheses focus on capturing the change in coordination between different agencies which already communicate to varying degrees. The specific hypothesis is as follows:

- Hypothesis 14: The IDTO bundle stimulated increased coordination to enhance effectiveness between transit agencies and others.

The evaluation of this hypothesis will help to gauge the extent of any observed improvement in inter-agency cooperation, both in general and for the purpose of improving service. Changes in inter-agency coordination are likely to be the least tangible outcome to link to impacts, but could serve to frame the scope for broader improvements to service quality arising from implementing the bundle.

2.6.2 Key MOEs and Data

Table 2-7. Evaluation of Inter-Agency Cooperation: Hypothesis 14

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 14a: The presence of the IDTO bundle motivated an increase in inter-agency coordination	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis	• FTA stakeholder interview • Transit agency stakeholder interviews • Transportation Authority stakeholder interview	• Volpe Center	• Representative: relative improvement in inter-agency cooperation
Hypothesis 14b: Agencies increased coordination to enhance the effectiveness of T-CONNECT	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis	• FTA stakeholder interview • Transit agency stakeholder interviews • Transportation Authority stakeholder interview	• Volpe Center	• Representative: relative improvement in inter-agency cooperation
Hypothesis 14c: Agencies increased coordination to enhance the effectiveness of T-DISP	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis	• FTA stakeholder interview • Transit agency stakeholder interviews • Transportation Authority stakeholder interview	• Volpe Center	• Representative: relative improvement in inter-agency cooperation
Hypothesis 14d: Transit agencies increased coordination under the IDTO bundle to improve overall service quality	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis	• FTA stakeholder interview • Transit agency stakeholder interviews • Transportation Authority stakeholder interview	• Volpe Center	• Representative: relative improvement in inter-agency cooperation for the purpose of improving level of service

2.6.3 Analysis Approach

The Volpe Center's preferred means of identifying impacts relating to inter-agency cooperation is qualitative, focusing on insights gained from stakeholder interviews. The Volpe Center will collect and analyze stated attitudes toward inter-agency cooperation through Likert-scale responses, in conjunction with responses to open-ended interview questions on the subject. The analysis would only be able to reveal quantifiable impacts if respondents are able to indicate tangible improvements resulting from cooperation with other agencies. However, in the absence of evidence of tangible improvements resulting from increased cooperation, the Volpe Center can present evidence of the relative degree of cooperation both to indicate the potential for the bundle to stimulate cooperation, and as a contextual factor underlying the tangible impacts quantified elsewhere in the analysis. The stakeholder interviews will be designed to elicit views on the role of the bundle in improving both coordination between agencies and overall service quality, along with views on the extent to which agencies have worked together to enhance the effectiveness of T-CONNECT. The implications of the analysis will reveal relative impacts in two different directions of causality: whether the bundle increases cooperation, and whether cooperation increases the effectiveness of the bundle and its components.

2.6.4 Key Considerations

The primary consideration with evaluating this impact area is that it will rely on qualitative evidence and the opinions of interviewees which could be biased or incomplete. As a result, this evaluation will include some level of subjectivity.

A broader consideration centers on the structural differences between Columbus and Central Florida. Volpe will need to account for differences in the relative demands on, and dependency among, organizations participating in the demonstration across the two demonstration sites when making broader inferences on the demonstration's impacts on inter-agency cooperation.

Chapter 3 Data Collection

The Volpe Center's data collection efforts will occur in two tracks. The primary data required will be quantitative and originate from multiple sources. Recurrent data transfers will be posted to the RDE. The purpose of this data is to conduct statistical analysis and isolate impacts. The secondary data required will be qualitative and originate through interviews conducted by the Volpe Center and surveys of users built into the software bundle by Battelle. This data will support quantitative findings and capture information and impacts best communicated through discussion.

Sections 3.1 and 3.2 detail the data required by the Volpe Center and the data that the Volpe Center is preparing to gather through quantitative interviews. It is anticipated, through discussions and sample data review, that the data providers have access to the data listed and are prepared to deliver the data in the manner and timeframe outlined. Specific considerations and alterations regarding data will be determined and conveyed through data acceptability memos and discussions as the demonstrations progress.

3.1 Quantitative Data Collection

It is expected that all data with a frequency greater than once will be posted to the RDE by the responsible organization. All one-time data transfer may be posted to the RDE or can be transferred through another format. While the request is largely similar across various stakeholder agencies, differences arise based on data availability and data provider processes. These differences may continue to emerge and any changes to the data needs will be reflected in the form of an addendum to this final evaluation plan. The priority hypotheses are listed in bold.

The Volpe Center will need the following quantitative data from the sources listed in the remainder of this section, grouped by demonstration location.

3.1.1 Columbus Demonstration Data Needs

Table 3-1. Data Needs from Battelle-Columbus

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Post-trip survey data – Survey responses and trip- and transaction-specific data (e.g., time, service, type of transaction)	Every trip for trip-specific questions; every two weeks for attitudinal questions	All trips using the software package, T-CONNECT, T-DISP and D-RIDE with unique user identifier	• H3, H6, H8, H10, H13	• CSV	• Every month
System centered data/logs – Details of transaction/activity (See Appendix A for description of data being captured by Battelle)	Every case where a user or vehicle communicates with the system	All user transactions, all interactions with vehicles	• H12	• CSV	• Every month
User centered device data/logs – Time stamped user trip activities (See Appendix A for description of data being captured by Battelle)	All individual uses of the software package	All individual uses of the software package with unique user identifier	• H4, H5, H6, H7, H10	• CSV	• Every month
User position data – GPS Coordinates (latitude, longitude)	At 30 second intervals relative to the schedule and/or actual transitions. For example, starting 2 minutes before the scheduled trip departure.	From time at origin stop to time at destination stop with unique user identifier	• H1, H2, H3, H10, H13	• CSV	• Every month

Table 3-2. Data Needs from CABS-Columbus

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ridership data – Passengers per vehicle or per day by route and service (split by season/periods of different demand or performance, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV	• Once
Baseline (historical) schedule data – Scheduled arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration	• H1, H9, H10	• CSV	• Once
Baseline (historical) vehicle position data – Mean and standard deviation (known or estimated) of arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Distributions of arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration	• H1, H9, H10	• CSV	• Once
Cost data – Unit costs by bundle element (e.g., T-CONNECT implementation costs per vehicle), shared costs by bundle element (e.g., costs of implementing T-DISP outside of vehicle-specific costs), unit operating costs by service type (e.g., hourly operating cost of CABS service)	Unit and shared costs of implementing the bundle, costs of maintaining the bundle, unit operating costs	All services covered by the demonstration	• H11	• XLSX file provided by Volpe Center and complet ed by Agency	• Once
Current (demonstration) ridership data – Passengers per vehicle or per day by route and service (split by periods of different demand or performance, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV	• Monthly
Incident logs – Times of service disruptions by service	Durations of service disruptions (including GPS coordinates of disruption)	All services covered by the demonstration	• H13	• CSV	• Every month
Logs of communications between drivers and dispatchers either over radio or mobile data terminal	Each communication including the initiator and reason for communicating	All services covered by the demonstration	• H13	• CSV	• Every month

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Service logs – Indicators of status changes, nature of schedule changes (e.g., held by x minutes), time and duration of route changes	All status changes (in service/out of service) and all changes in route and schedule, AVL data with up to 30-second resolution	All vehicles within services covered by the demonstration	• H12	• CSV	• Every month

Table 3-3. Data Needs from Capital Transportation-Columbus

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ride data – Passengers per vehicle or per day (split by season/periods of different demand or performance, if relevant)	Ride specific demand	All services covered by the demonstration	• H9	• CSV	• Once
Baseline (historical) ride data – Scheduled rides by pick-up/drop-off and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at pick-up/drop-off (including location or GPS coordinates of pick-up/drop-off)	All rides served within the demonstration	• H1, H9, H10	• CSV	• Once
Baseline (historical) vehicle position data – Mean and standard deviation (known or estimated) of arrival times by pick-up/drop-off and route	Distributions of arrival times at pick-up/drop-off (including location or GPS coordinates of pick-up/drop-off)	All rides served within the demonstration	• H1, H9, H10	• CSV	• Once
Cost data – Unit costs by bundle element (e.g., T-CONNECT implementation costs per vehicle), shared costs by bundle element (e.g., costs of implementing T-DISP outside of vehicle-specific costs), unit operating costs by service type (e.g., hourly operating cost of Capital Transportation services)	Unit and shared costs of implementing the bundle, costs of maintaining the bundle, unit operating costs	All services covered by the demonstration	• H11	• XLSX file provided by Volpe Center and completed by Agency	• Once
Current (demonstration) ride data – Passengers per vehicle or per day (split by periods of different demand or performance, if relevant)	Ride specific demand	All services covered by the demonstration	• H9	• CSV	• Monthly
Incident logs – Times of service disruptions by service	Durations of service disruptions (including GPS coordinates of disruption)	All services covered by the demonstration	• H13	• CSV	• Every month
Logs of communications between drivers and dispatchers either over radio or mobile data terminal	Each communication including the initiator and reason for communicating	All services covered by the demonstration	• H13	• CSV	• Every month

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Service logs – Number of pick-ups or rides, time and duration of routes	All pick-ups or rides, AVL data at a 10-second resolution	All vehicles within services covered by the demonstration	• H12	• CSV	• Every month

Table 3-4. Data Needs from COTA-Columbus

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ridership and transfer data – Passengers per vehicle or per day by route and service (split by season/periods of different demand or performance and by vehicle transfers, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV	• Once
Baseline (historical) schedule data – Scheduled arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration for fixed-route services	• H1, H9, H10	• GTFS	• Once
Baseline (historical) vehicle position data – Mean and standard deviation (known or estimated) of arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Distributions of arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration for fixed-route services	• H1, H9, H10	• CSV	• Once
Cost data – Unit costs by bundle element (e.g., T-CONNECT implementation costs per vehicle), shared costs by bundle element (e.g., costs of implementing T-DISP outside of vehicle-specific costs), unit operating costs by service type (e.g., hourly operating cost of COTA bus services)	Unit and shared costs of implementing the bundle, costs of maintaining the bundle, unit operating costs	All services covered by the demonstration	• H11	• XLSX file provided by Volpe Center and completed by Agency	• Once
Current (demonstration) ridership data – Passengers per vehicle or per day by route and service (split by periods of different demand or performance, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV	• Monthly
Incident logs – Times of service disruptions by service	Durations of service disruptions (including GPS coordinates of disruption)	All services covered by the demonstration	• H13	• CSV	• Every month

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Logs of communications between drivers and dispatchers either over radio or mobile data terminal	Each communication including the initiator and reason for communicating	All services covered by the demonstration	• H13	• CSV	• Every month
Service logs – Indicators of status changes, nature of schedule changes (e.g., held by x minutes), time and duration of route changes	All status changes (in service/out of service) and all changes in route and schedule	All vehicles within services covered by the demonstration	• H12	• CSV	• Every month
Vehicle position data – GPS coordinates (latitude, longitude)	Real-time GTFS data at highest resolution possible	All operations where feasible	• H1, H13	• CSV	• Every month

Table 3-5. Data Needs from TaxiCABS-Columbus

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ride data – Passengers per vehicle or per day (split by season/periods of different demand or performance, if relevant)	Ride specific demand	All services covered by the demonstration	• H9	• CSV	• Once
Baseline (historical) ride data – Scheduled rides by pick-up/drop-off and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at pick-up/drop-off (including location or GPS coordinates of pick-up/drop-off)	All rides served within the demonstration	• H1, H9, H10	• CSV	• Once
Baseline (historical) vehicle position data – Mean and standard deviation (known or estimated) of arrival times by pick-up/drop-off and route	Distributions of arrival times at pick-up/drop-off (including location or GPS coordinates of pick-up/drop-off)	All rides served within the demonstration	• H1, H9, H10	• CSV	• Once
Cost data – Unit costs by bundle element (e.g., T-CONNECT implementation costs per vehicle), shared costs by bundle element (e.g., costs of implementing T-DISP outside of vehicle-specific costs), unit operating costs by service type (e.g., hourly operating cost of TaxiCABS services)	Unit and shared costs of implementing the bundle, costs of maintaining the bundle, unit operating costs	All services covered by the demonstration	• H11	• XLSX file provided by Volpe Center and completed by Agency	• Once
Current (demonstration) ride data – Passengers per vehicle or per day (split by periods of different demand or performance, if relevant)	Ride specific demand	All services covered by the demonstration	• H9	• CSV	• Monthly
Incident logs – Times of service disruptions by service	Durations of service disruptions (including GPS coordinates of disruption)	All services covered by the demonstration	• H13	• CSV	• Every month
Service logs – Number of pick-ups or rides, time and duration of routes	All pick-ups or rides	All vehicles within services covered by the demonstration	• H12	• CSV	• Every month

Table 3-6. Data Needs from Transportation Authorities-Columbus

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Incident logs – Times and locations of accidents and lane/road closures causing traffic congestion	Durations and GPS coordinates of accidents and lane/road closures	All corridors covered by the demonstration	• H13	• CSV	• Every month
Traffic congestion data – Mean and standard deviation (known or estimated) of travel speeds by network segment (split by season/periods of different demand or performance for baseline purposes, if relevant)	Distributions of travel speeds (including GPS coordinates of areas where travel speed was collected)	All corridors covered by the demonstration	• H6	• CSV	• Once for baseline, every month during demonstration

Table 3-7. Data Needs from Zimride-Columbus

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ride data – Passengers per vehicle or per day (split by season/periods of different demand or performance, if relevant)	Ride specific demand	All services covered by the demonstration	• H9	• CSV	• Once
Baseline (historical) ride data – Scheduled rides by pick-up/drop-off and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at pick-up/drop-off (including location or GPS coordinates of pick-up/drop-off)	All rides served within the demonstration	• H1, H9, H10	• CSV	• Once
Current (demonstration) ride data – Passengers per vehicle or per day (split by periods of different demand or performance, if relevant)	Ride specific demand	All services covered by the demonstration	• H9	• CSV	• Monthly
Service logs – Number of pick-ups or rides, time and duration of routes	All pick-ups or rides	All vehicles within services covered by the demonstration	• H12	• CSV	• Every month

3.1.2 Central Florida Demonstration Data Needs

Table 3-8. Data Needs from Battelle-Central Florida

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Post-trip survey data – Survey responses and trip- and transaction-specific data (e.g., time, service, type of transaction)	Every trip for trip-specific questions; every two weeks for attitudinal questions	All trips using the software package, T-CONNECT, T-DISP and D-RIDE with unique user identifier	• H3, H6, H8, H10, H13	• CSV	• Every month
System centered data/logs – Details of transaction/activity (See Appendix A for description of data being captured by Battelle)	Every case where a user or vehicle communicates with the system	All user transactions, all interactions with vehicles	• H12	• CSV	• Every month
User centered device data/logs – Time stamped user trip activities (See Appendix A for description of data being captured by Battelle)	All individual uses of the software package	All individual uses of the software package with unique user identifier	• H4, H5, H6, H7, H10	• CSV	• Every month
User position data – GPS Coordinates (latitude, longitude)	At 30 second intervals relative to the schedule and/or actual transitions. For example, starting 2 minutes before the scheduled trip departure.	From time at origin stop to time at destination stop with unique user identifier	• H1, H2, H3, H10, H13	• CSV	• Every month

Table 3-9. Data Needs from FlexBus-Central Florida

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ride data – Passengers per vehicle or per day (split by season/periods of different demand or performance, if relevant)	Ride specific demand	All services covered by the demonstration	• H9	• CSV	• Once
Baseline (historical) ride data – Scheduled rides by pick-up/drop-off and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at pick-up/drop-off (including location or GPS coordinates of pick-up/drop-off)	All rides served within the demonstration	• H1, H9, H10	• CSV	• Once
Baseline (historical) vehicle position data – Mean and standard deviation (known or estimated) of arrival times by pick-up/drop-off and route	Distributions of arrival times at pick-up/drop-off (including location or GPS coordinates of pick-up/drop-off)	All rides served within the demonstration	• H1, H9, H10	• CSV	• Once
Cost data (if available) – Unit costs by bundle element (e.g., T-CONNECT implementation costs per vehicle), shared costs by bundle element (e.g., costs of implementing T-DISP outside of vehicle-specific costs), unit operating costs by service type (e.g., hourly operating cost of FlexBus services)	Unit and shared costs of implementing the bundle, costs of maintaining the bundle, unit operating costs	All services covered by the demonstration	• H11	• XLSX file provided by Volpe Center and completed by Agency	• Once
Current (demonstration) ride data – Passengers per vehicle or per day (split by periods of different demand or performance, if relevant)	Ride specific demand	All services covered by the demonstration	• H9	• CSV	• Monthly
Incident logs – Times of service disruptions by service	Durations of service disruptions (including GPS coordinates of disruption)	All services covered by the demonstration	• H13	• CSV	• Every month
Service logs – Number of pick-ups or rides, time and duration of routes	All pick-ups or rides	All vehicles within services covered by the demonstration	• H12	• CSV	• Every month

Table 3-10. Data Needs from LYNX-Central Florida

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ridership and transfer data – Passengers per vehicle or per day by route and service (split by season/periods of different demand or performance and by vehicle transfers, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV	• Once
Baseline (historical) schedule data – Scheduled arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration	• H1, H9, H10	• CSV or GTFS	• Once
Baseline (historical) vehicle position data – Mean and standard deviation (known or estimated) of arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Distributions of arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration	• H1, H9, H10	• CSV	• Once
Cost data – Unit costs by bundle element (e.g., T-CONNECT implementation costs per vehicle), shared costs by bundle element (e.g., costs of implementing T-DISP outside of vehicle-specific costs), unit operating costs by service type (e.g., hourly operating cost of LYNX bus services)	Unit and shared costs of implementing the bundle, costs of maintaining the bundle, unit operating costs	All services covered by the demonstration	• H11	• XLSX file provided by Volpe Center and completed by Agency	• Once
Current (demonstration) ridership data – Passengers per vehicle or per day by route and service (split by periods of different demand or performance, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV	• Monthly
Incident logs – Times of service disruptions by service	Durations of service disruptions (including GPS coordinates of disruption)	All services covered by the demonstration	• H13	• CSV	• Every month
Logs of communications between drivers and dispatchers either over radio or mobile data terminal (if available in usable format)	Each communication including the initiator and reason for communicating	All services covered by the demonstration	• H13	• CSV	• Every month

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Service logs – Indicators of status changes, nature of schedule changes (e.g., held by x minutes), time and duration of route changes	All status changes (in service/out of service) and all changes in route and schedule	All vehicles within services covered by the demonstration	• H12	• CSV	• Every month
Vehicle position data – GPS coordinates (latitude, longitude)	Every 30-60 seconds	All operations covered by the demonstration	• H1, H13	• CSV	• Every month

Table 3-11. Data Needs from SunRail-Central Florida

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ridership data – Passengers per vehicle or per day by route and service (split by season/periods of different demand or performance, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV	• Once
Baseline (historical) schedule data – Scheduled arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration	• H1, H9, H10	• CSV	• Once
Baseline (historical) vehicle position data – Mean and standard deviation (known or estimated) of arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Distributions of arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration	• H1, H9, H10	• CSV	• Once
Cost data (if available) – Unit costs by bundle element (e.g., T-CONNECT implementation costs per vehicle), shared costs by bundle element (e.g., costs of implementing T-DISP outside of vehicle-specific costs), unit operating costs by service type (e.g., hourly operating cost of SunRail services)	Unit and shared costs of implementing the bundle, costs of maintaining the bundle, unit operating costs	All services covered by the demonstration	• H11	• XLSX file provided by Volpe Center and completed by Agency	• Once
Current (demonstration) ridership data – Passengers per vehicle or per day by route and service (split by periods of different demand or performance, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV	• Monthly
Incident logs – Times of service disruptions by service	Durations of service disruptions (including GPS coordinates of disruption)	All services covered by the demonstration	• H13	• CSV	• Every month
Logs of communication between drivers and dispatchers either over radio or mobile data terminal (if available in usable format)	Each communication including the initiator and reason for communicating	All services covered by the demonstration	• H13	• CSV	• Every month

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Service logs – Indicators of status changes, nature of schedule changes (e.g., held by x minutes), time and duration of route changes	All status changes (in service/out of service) and all changes in route and schedule	All vehicles within services covered by the demonstration	• H12	• CSV	• Every month
Vehicle position data – GPS coordinates (latitude, longitude)	Every ten seconds	All operations covered by the demonstration	• H1, H13	• CSV	• Every month

Table 3-12. Data Needs from Transportation Authorities-Central Florida

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Incident logs – Times and locations of accidents and lane/road closures causing traffic congestion	Durations and GPS coordinates of accidents and lane/road closures	All corridors covered by the demonstration	• H13	• CSV	• Every month
Traffic congestion data – Mean and standard deviation (known or estimated) of travel speeds by network segment (split by season/periods of different demand or performance for baseline purposes, if relevant)	Distributions of travel speeds (including GPS coordinates of areas where travel speed was collected)	All corridors covered by the demonstration	• H6	• CSV	• Once for baseline, every month during demonstration

Table 3-13. Data Needs from Veolia Transportation-Central Florida

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ridership data – Passengers per vehicle or per day by route and service (split by season/periods of different demand or performance, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV	• Once
Baseline (historical) schedule data – Scheduled arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration	• H1, H9, H10	• CSV	• Once
Baseline (historical) vehicle position data – Mean and standard deviation (known or estimated) of arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Distributions of arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration	• H1, H9, H10	• CSV	• Once
Cost data (if available) – Unit costs by bundle element (e.g., T-CONNECT implementation costs per vehicle), shared costs by bundle element (e.g., costs of implementing T-DISP outside of vehicle-specific costs), unit operating costs by service type (e.g., hourly operating cost of service)	Unit and shared costs of implementing the bundle, costs of maintaining the bundle, unit operating costs	All services covered by the demonstration	• H11	• XLSX file provided by Volpe Center and completed by Agency	• Once
Current (demonstration) ridership data – Passengers per vehicle or per day by route and service (split by periods of different demand or performance, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV	• Monthly
Logs of communications between drivers and dispatchers either over radio or mobile data terminal (if available in usable format)	Each communication including the initiator and reason for communicating	All services covered by the demonstration	• H13	• CSV	• Every month

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Service logs – Indicators of status changes, nature of schedule changes (e.g., held by x minutes), time and duration of route changes	All status changes (in service/out of service) and all changes in route and schedule, AVL data with up to 30-second resolution	All vehicles within services covered by the demonstration	• H12	• CSV	• Every month

Table 3-14. Data Needs from Zimride-Central Florida

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ride data – Passengers per vehicle or per day (split by season/periods of different demand or performance, if relevant)	Ride specific demand	All services covered by the demonstration	• H9	• CSV	• Once
Baseline (historical) ride data – Scheduled rides by pick-up/drop-off and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at pick-up/drop-off (including location or GPS coordinates of pick-up/drop-off)	All rides served within the demonstration	• H1, H9, H10	• CSV	• Once
Current (demonstration) ride data – Passengers per vehicle or per day (split by periods of different demand or performance, if relevant)	Ride specific demand	All services covered by the demonstration	• H9	• CSV	• Monthly
Service logs – Number of pick-ups or rides, time and duration of routes	All pick-ups or rides	All vehicles within services covered by the demonstration	• H12	• CSV	• Every month

3.2 Qualitative Data Collection

Table 3-15. summarizes the groups that will participate in interviews, and the corresponding hypotheses that will be evaluated using information collected in the interviews.

Table 3-15. Interviews and Related Hypotheses

Data Source	Related Hypotheses
Battelle Interviews – Interview transcripts/recordings and completed questionnaires	H4, **H5**, H7
FTA Interviews – Interview transcripts/recordings and completed questionnaires	H14
Transit Agency Interviews – Interview transcripts/recordings and completed questionnaires	H11, H12, H14
Transportation Authority Interviews – Interview transcripts/recordings and completed questionnaires	H6, H14

These data needs will require multiple interviews with multiple interviewees from the various agencies and authorities described above. These interviews can be separated into five separate types:

- Lessons Learned
- Transportation and Traffic Management
- Inter-Agency Coordination
- Intra-Agency Operation and Structure
- User Experience
- Application Usage

The specific purpose, timeline with approximate dates, and interviewees for each interview type are outlined in the sections below. A brief compilation of this information can be found in Table 3-16 below. Following Table 3-16is the planned interview for each interview type, organized by period of time (before, during, or after deployment) and interviewee.

Table 3-16. Description of Interviews by Interview Category

Stakeholder	Title of Interviewee	Lessons Learned	Traffic Management	Inter-Agency Coordination	Intra-Agency Operation	User Experience	Application Usage
Battelle (Columbus)	Development Team Manager (*Columbus*)	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15				• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15
Battelle (Central Florida)	Development Team Manager (*Central Florida*)	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15				• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15
Bundle Users (Columbus)	Consumer (*Columbus*)					• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14	
Bundle Users (*Central Florida*)	Consumer (Central Florida)					• 7/15/14 • 9/15/14 • 11/15/14	
CABS	Manager/ Supervisor	• 11/15/14	• 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			
CABS	Project Manager	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 1/15/15

Stakeholder	Title of Interviewee	Lessons Learned	Traffic Management	Inter-Agency Coordination	Intra-Agency Operation	User Experience	Application Usage
Capital Transportation	Manager/ Supervisor	• 1/15/15	• 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			
Capital Transportation	Project Manager	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15
COTA	Manager/ Supervisor	• 1/15/14	• 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			
COTA	Project Manager	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15
FlexBus	Manager/ Supervisor	• 1/15/15	• 1/15/15	• 9/15/14 • 11/15/14 • 1/15/15			
FlexBus	Project Manager	• 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15	• 9/15/14 • 11/15/14 • 1/15/15	• 9/15/14 • 11/15/14 • 1/15/15	• 9/15/14 • 11/15/14	• 9/15/14 • 11/15/14 • 1/15/15

Stakeholder	Title of Interviewee	Lessons Learned	Traffic Management	Inter-Agency Coordination	Intra-Agency Operation	User Experience	Application Usage
FTA Region 4 (*Central Florida*)	Region Officer	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			
FTA Region 5 (*Columbus*)	Region Officer	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			
LYNX	Manager/ Supervisor	• 1/15/15	• 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			
LYNX	Project Manager	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15
MetroPlan Orlando	Manager/ Supervisor	• 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			
Mid-Ohio Regional Planning Commission	Manager/ Supervisor	• 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			

Stakeholder	Title of Interviewee	Lessons Learned	Traffic Management	Inter-Agency Coordination	Intra-Agency Operation	User Experience	Application Usage
SunRail	Manager/ Supervisor	• 1/15/15	• 1/15/15	• 9/15/14 • 11/15/14 • 1/15/15			
SunRail	Project Manager	• 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15	• 9/15/14 • 11/15/14 • 1/15/15	• 9/15/14 • 11/15/14 • 1/15/15	• 9/15/14 • 11/15/14	• 9/15/14 • 11/15/14 • 1/15/15
TaxiCABS	Manager/ Supervisor	• 1/15/15	• 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			
TaxiCABS	Project Manager	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15
Veolia Transportation	Manager/ Supervisor	• 1/15/15	• 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			
Veolia Transportation	Project Manager	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15

Stakeholder	Title of Interviewee	Lessons Learned	Traffic Management	Inter-Agency Coordination	Intra-Agency Operation	User Experience	Application Usage
Zimride (Columbus)	Manager/ Supervisor (*Columbus*)	• 1/15/15	• 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			
Zimride (Columbus)	Project Manager (*Columbus*)	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14	• 5/15/14 • 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15
Zimride (Central Florida)	Manager/ Supervisor (*Central Florida*)	• 1/15/15	• 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15			
Zimride (Central Florida)	Project Manager (*Central Florida*)	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15	• 7/15/14 • 9/15/14 • 11/15/14	• 7/15/14 • 9/15/14 • 11/15/14 • 1/15/15

Table 3-17. Descriptions of Lessons Learned Interviews

Stakeholder	Title of Interviewee	Name of Interviewee	5/15/14 (Columbus Only)	7/15/14	9/15/14	11/15/14	1/15/15
Battelle	Development Team Manager	Tom Timcho	X	X	X	X	X
CABS	Director, Transportation & Traffic Management	Beth Snoke					X
CABS	Field Logistics and Information Coordinator	Tim Smith	X	X	X	X	X
Capital Transportation	Supervisor	Darla Lawson					X
Capital Transportation	Business Services Manager	Dave Evans	X	X	X	X	X
COTA	Director, Transportation	Chris Cole					X
COTA	Superintendent, Transportation	Matt Allison	X	X	X	X	X
FlexBus	Manager/ Supervisor						X
FlexBus	Project Manager				X	X	X
FTA Region 4	Region Officer			X	X	X	X
FTA Region 5	Region Officer		X	X	X	X	X
LYNX	Manager/ Supervisor						X
LYNX	Project Manager			X	X	X	X
MetroPlan Orlando	Manager/ Supervisor						X
Mid-Ohio Regional Planning Commission	Manager/ Supervisor						X
SunRail	Manager/ Supervisor						X
SunRail	Project Manager				X	X	X
TaxiCABS	Director, Transportation & Traffic Management	Beth Snoke					X
TaxiCABS	Field Logistics and Information Coordinator	Tim Smith	X	X	X	X	X
Veolia Transportation	Manager/ Supervisor						X
Veolia Transportation	Project Manager			X	X	X	X
Zimride	Manager/ Supervisor						X
Zimride	Project Manager		X	X	X	X	X

3.2.1 Interviews on Lessons Learned

In this series of interviews, the Volpe Center will gather feedback from stakeholders on lessons learned in the development and deployment of the IDTO bundle. Interviews will be conducted before, during, and after the demonstration. The interviews are targeted at both implementers at the agency as well as managers and decision-makers. Interviews will also be conducted with the development team and the Federal stakeholders involved in oversight. The purpose of these interviews is to determine the adjustments necessary to implement the IDTO bundle in practice, how the IDTO bundle can be improved in practice, and to determine factors that lead to variations in software package use. Table 3-17below describes the frequency of each interview.

3.2.1.1 Periodically During Deployment

For All

- Question 1.1, First Interview for Both Sites: First, can you describe your role (or your responsibilities) in the IDTO demonstration project?

For Battelle

- Question 1.2, First Interview for Both Sites: What adjustments have been required to this point to implement the IDTO bundle in the field for site X, relative to the final implementation plan?
    - PROBE: Have there been features that you have not been able to implement as planned?
- Question 1.3, First Interview for Both Sites: Based upon your experience with the IDTO bundle in site X to this point, how do you feel the bundle could be improved?
    - PROBE: [Ask for each application]
- Question 1.4 Have any new adjustments been required over the past [time since last interview] to implement the IDTO bundle in the field for site X?
    - PROBE: [Ask for each application]
- Question 1.5: When considering the progress of the site X demonstration over the past [time since last interview], have you observed any ways in which the IDTO bundle could be improved in practice?
    - PROBE: [Ask for each application]

For FTA

- Question 1.6, First Interview for Both Sites: Have there been any issues or problems related to the IDTO bundle? Have there been any issues or problems related to the demonstration more generally?

For Battelle/FTA

- Question 1.7: Over the [time since last interview], have there been any issues or problems related to the IDTO bundle? Have there been any issues or problems related to the demonstration more generally?

- Question 1.8: Do you have any other comments or feedback you would like to share about the IDTO demonstration?

For Transit Agency Project Managers

- Question 1.9, First Interview: What aspects of the demonstration have been most successful?

- Question 1.10: {Prompt with answers/summary of answers from previous interviews} Over the past [time since last interview], what aspects of the demonstration have been most successful?

- Question 1.11, First Interview: Which aspects of the demonstration, if any, have been less effective than expected?

- Question 1.12: {Prompt with answers/summary of answer from previous interviews} Over the past [time since last interview], what aspects of the demonstration have been less effective than expected?

3.2.1.2 After Deployment

For All

- Question 1.13: Based on the IDTO demonstration, are there any lessons learned – regarding either the IDTO bundle or the demonstration – that you would share with other agencies that are deploying these applications?

- Question 1.14: Do you have any other comments or feedback you would like to share about the IDTO demonstration?

3.2.2 Transportation/Traffic Management

In this series of interviews, the Volpe Center will gather feedback from stakeholders on transportation and traffic management as it relates to the development and deployment of the IDTO bundle. Interviews will be conducted during and after the demonstration. The interviews are targeted at both implementers at the agency as well as managers and decision-makers. Interviews will also be conducted with the Federal stakeholders involved in oversight. The purpose of these interviews is to determine if the IDTO bundle has eased the burden on the transit network, if the bundle has improved the function of the transit network, and how the bundle has impacted travel patterns and congestion. Table 3-18 below describes the frequency of each interview.

Table 3-18. Description of Transportation and Traffic Management Interview

Stakeholder	Title of Interviewee	Name of Interviewee	5/15/14 (Columbus Only)	7/15/14	9/15/14	11/15/14	1/15/15
Battelle	Development Team Manager	Tom Timcho					X
CABS	Director, Transportation & Traffic Management	Beth Snoke					X
CABS	Field Logistics and Information Coordinator	Tim Smith					X
Capital Transportation	Supervisor	Darla Lawson					X
Capital Transportation	Business Services Manager	Dave Evans					X
COTA	Director, Transportation	Chris Cole					X
COTA	Superintendent, Transportation	Matt Allison					X
FlexBus	Manager/ Supervisor						X
FlexBus	Project Manager						X
FTA Region 4	Region Officer			X	X	X	X
FTA Region 5	Region Officer		X	X	X	X	X
LYNX	Manager/ Supervisor						X
LYNX	Project Manager						X
MetroPlan Orlando	Manager/ Supervisor			X	X	X	X
Mid-Ohio Regional Planning Commission	Manager/ Supervisor		X	X	X	X	X
SunRail	Manager/ Supervisor						X
SunRail	Project Manager						X
TaxiCABS	Director, Transportation & Traffic Management	Beth Snoke					X
TaxiCABS	Field Logistics and Information Coordinator	Tim Smith					X

Stakeholder	Title of Interviewee	Name of Interviewee	5/15/14 (Columbus Only)	7/15/14	9/15/14	11/15/14	1/15/15
Veolia Transportation	Manager/ Supervisor						X
Veolia Transportation	Project Manager						X
Zimride	Manager/ Supervisor						X
Zimride	Project Manager						X

3.2.2.1 Periodically During Deployment

For FTA

- Question 2.1: Do you think that the IDTO demonstration has improved the function of the transit network?
- Question 2.2N [If the respondent answers “no” to Question 2.1]: What factors or constraints explain why the IDTO demonstration has not improved the function of the transit network?
- Question 2.3N [If the respondent answers “no” to Question 2.1]: What do you think the outcomes would be if these constraints were eased (if more than one is named, address each constraint independently)? What impacts would the IDTO demonstration have on the functioning of the transit network if these factors could be addressed?
- Question 2.2Y [If the respondent answers “yes” to Question 2.1]: In what ways has the function of the transit network improved under the demonstration?
- Question 2.3Y [If the respondent answers “yes” to Question 2.1]: Which of the following factors have been most important in improving the function of the transit network? Inter-organizational cooperation, technological improvements, or operational improvements?
  - PROBE: Are there other factors related to the IDTO demonstration that have improved the function of the transit network?
- Question 2.4Y [If the respondent answers “yes” to Question 2.1]: What, if anything, do you think is constraining the demonstration from being more effective? Do you feel there are there any factors or constraints that are limiting the effectiveness of the demonstration?
  - IF YES – PROBE.
- Question 2.5Y [If the respondent answers “yes” to Question 2.4Y]: What do you think the outcomes would be if these constraints were eased (if more than one is named, address each constraint independently)? What impact would it have [on the transit network?] if these factors or constraints could be addressed?

For Transportation Authority Managers/Supervisors

- Question 2.6: To what extent has the IDTO demonstration affected traffic congestion?
- Question 2.7 [If the respondent indicates at least some effect on traffic congestion in response to Question 2.6]: At what times of day has this effect (if any) been most noticeable?
- Question 2.8 [If the respondent indicates at least some effect on traffic congestion in response to Question 2.6]: In which locations (if any) has this effect been most noticeable? What specific changes have been observed in these locations?

- Question 2.9: To what extent has the IDTO demonstration influenced changes in travel patterns?

- Question 2.11 [If the respondent indicates at least some effect on travel patterns in response to Question 2.9]: At what times of day has this effect (if any) been most noticeable?

- Question 2.12 [If the respondent indicates at least some effect on travel patterns in response to Question 2.9]: In which locations has this effect been most noticeable? What specific changes have been observed in these locations?

- Question 2.13: Have you observed evidence that the share of travelers using T-CONNECT tends to change with the time of day or traffic conditions? If so, in what way? [Could probe on data source, if it is not clear in their response]

- Question 2.14: Have you observed evidence that the share of travelers using T-DISP tends to change with the time of day or traffic conditions? If so, in what way?

- Question 2.15: Have you observed evidence that the share of travelers using D-RIDE tends to change with the time of day or traffic conditions? If so, in what way?

For FTA and Transportation Authority Managers/Supervisors

- Question 2.16: Do you have any other comments or feedback you would like to share about the IDTO demonstration and its impact on transportation or traffic management in your region?

3.2.2.2 After Deployment

For FTA and Transportation Authority Managers/Supervisors

- Question 2.17: Do you have any other comments or feedback you would like to share about the IDTO demonstration and its impact on transportation or traffic management in your region?

3.2.3 Inter-Agency Coordination

In this series of interviews, the Volpe Center will gather feedback from stakeholders on inter-agency coordination as it relates to the development and deployment of the IDTO bundle. Interviews will be conducted during and after the demonstration. The interviews are targeted at both implementers at the agency as well as managers and decision-makers. Interviews will also be conducted with the Federal stakeholders involved in oversight. The purpose of these interviews is to determine how the IDTO bundle impacted inter-agency coordination and if inter-agency coordination impacted customer service quality. Table 3-19 below describes the frequency of each interview.

Table 3-19. Description of Inter-Agency Coordination Interviews

Stakeholder	Title of Interviewee	Name of Interviewee	5/15/14 (Columbus Only)	7/15/14	9/15/14	11/15/14	1/15/15
CABS	Director, Transportation & Traffic Management	Beth Snoke	X	X	X	X	X
CABS	Field Logistics and Information Coordinator	Tim Smith	X	X	X	X	X
Capital Transportation	Supervisor	Darla Lawson	X	X	X	X	X
Capital Transportation	Business Services Manager	Dave Evans	X	X	X	X	X
COTA	Director, Transportation	Chris Cole	X	X	X	X	X
COTA	Superintendent, Transportation	Matt Allison	X	X	X	X	X
FlexBus	Manager/ Supervisor				X	X	X
FlexBus	Project Manager				X	X	X
FTA Region 4	Region Officer			X	X	X	X
FTA Region 5	Region Officer		X	X	X	X	X
LYNX	Manager/ Supervisor			X	X	X	X
LYNX	Project Manager			X	X	X	X
MetroPlan Orlando	Manager/ Supervisor			X	X	X	X
Mid-Ohio Regional Planning Commission	Manager/ Supervisor		X	X	X	X	X
SunRail	Manager/ Supervisor				X	X	X
SunRail	Project Manager				X	X	X
TaxiCABS	Director, Transportation & Traffic Management	Beth Snoke	X	X	X	X	X

Stakeholder	Title of Interviewee	Name of Interviewee	5/15/14 (Columbus Only)	7/15/14	9/15/14	11/15/14	1/15/15
TaxiCABS	Field Logistics and Information Coordinator	Tim Smith	X	X	X	X	X
Veolia Transportation	Manager/ Supervisor			X	X	X	X
Veolia Transportation	Project Manager			X	X	X	X
Zimride	Manager/ Supervisor		X	X	X	X	X
Zimride	Project Manager		X	X	X	X	X

3.2.3.1 Periodically During Deployment

For FTA, Transit Agency Project Managers, and Transportation Authority Managers/Supervisors

Now I'd like to ask you the extent to which you agree or disagree with a series of four statements about the IDTO bundle, using a seven-point scale. The scale consists of the following levels {the respondent will be given a reference sheet with the scale listed on it}: 1 = "strongly disagree," 2 = "disagree," 3 = "disagree somewhat," 4 = "neither agree nor disagree," 5 = "agree somewhat," 6 = "agree," and 7 = "strongly agree." {After the respondent indicates a numerical value or a verbal response that matches one of the numerical values, the interviewer will ask follow-up questions}

- Question 3.1: The first statement is the following: "Organizations increased coordination to enhance the effectiveness of T-CONNECT". [If not first interview, remind the respondent of their previous response]
    - {If the respondent agrees (i.e., score greater than 4)}: In what ways did organizations increase coordination to enhance the effectiveness of T-CONNECT? What were the effects of this increased coordination? What barriers, if any, do you feel existed to increasing coordination further for T-CONNECT, in particular? [IF THE RESPONSE HAS CHANGED SINCE LAST TIME, PROBE: Why has caused your response to change?]
    - {If the respondent disagrees or is neutral (i.e., score less than 5}: do you feel the lack of increased coordination between organizations had an impact on the effectiveness of T-CONNECT? [IF YES, PROBE: What type of impact?] What barriers do you feel existed to increasing coordination for T-CONNECT, in particular? [IF THE RESPONSE HAS CHANGED SINCE LAST TIME, PROBE: Why has caused your response to change?]
- Question 3.2: The next statement is the following: "Organizations increased coordination to enhance the effectiveness of T-DISP". [If not first interview, remind the respondent of their previous response]
    - {If the respondent agrees (i.e., score greater than 4)}: In what ways did organizations increase coordination to enhance the effectiveness of T-DISP? What were the net effects of this increased coordination? What barriers, if any, do you feel existed to increasing coordination further for T-DISP, in particular? [IF THE RESPONSE HAS CHANGED SINCE LAST TIME, PROBE: Why has caused your response to change?]
    - {If the respondent disagrees or is neutral (i.e., score less than 5}: Do you feel the lack of increased coordination between organizations had an impact on the effectiveness of T-DISP? [IF YES, PROBE: What type of impact?] What barriers do you feel existed to increasing coordination for T-DISP, in particular? [IF THE RESPONSE HAS CHANGED SINCE LAST TIME, PROBE: Why has caused your response to change?]
- Question 3.3: The final statement is the following: "The presence of the IDTO bundle motivated an increase in coordination across organizations" (if appropriate, the interviewer could name other agencies). [If not first interview, remind the respondent of their previous response]
    - {If the respondent agrees (i.e., score greater than 4)}: In what ways did organizations increase coordination in response to the IDTO bundle? What were the net effects of this increased coordination? Do you feel there were there any barriers that limited further coordination? [IF THE RESPONSE HAS CHANGED SINCE LAST TIME, PROBE: Why has caused your response to change?]

- o {If the respondent disagrees or is neutral (i.e., score less than 5}: Did the lack of increased coordination have any impact on the effectiveness of the IDTO bundle? IF YES: Please explain. [IF THE RESPONSE HAS CHANGED SINCE LAST TIME, PROBE: Why has caused your response to change?]

- Question 3.3Y: [If the respondent agrees with Question 3.3] in what ways did organizations increase coordination to improve overall service quality? What were the net effects of this increased coordination?

- Question 3.3N: [If the respondent does not agree with Question 3.3] what do you feel were the net effects on overall service quality due to a lack of increased coordination between agencies?

3.2.3.2 After Deployment

For FTA, Transit Agency Project Managers, and Transportation Authority Managers/Supervisors

- Question 3.4: To what extent has the demonstration influenced the nature of cooperation among participating organizations?

- Question 3.5: Do you have any other comments or feedback you would like to share about the IDTO demonstration and its impact on inter-agency coordination?

3.2.4 Intra-Agency Operation/Structure/Organization

In this series of interviews, the Volpe Center will gather feedback from stakeholders on intra-agency operations and structure as they relates to the development and deployment of the IDTO bundle. Interviews will be conducted during and after the demonstration. The interviews are targeted at both implementers at the agency as well as managers and decision-makers. The purpose of these interviews is to determine if the IDTO bundle has increased agency costs, if the IDTO bundle impacted operations including scheduling, routing, and number of vehicles in service, and if the IDTO applications are cost-effective tools. Table 3-20 below describes the frequency of each interview.

Table 3-20. Description of Intra-Agency Operation and Structure Interviews

Stakeholder	Title of Interviewee	Name of Interviewee	5/15/14 (Columbus Only)	7/15/14	9/15/14	11/15/14	1/15/15
CABS	Field Logistics and Information Coordinator	Tim Smith	X	X	X	X	X
Capital Transportation	Business Services Manager	Dave Evans	X	X	X	X	X
COTA	Superintendent, Transportation	Matt Allison	X	X	X	X	X
FlexBus	Project Manager				X	X	X
LYNX	Project Manager			X	X	X	X
SunRail	Project Manager				X	X	X
TaxiCABS	Field Logistics and Information Coordinator	Tim Smith	X	X	X	X	X
Veolia Transportation	Project Manager			X	X	X	X
Zimride	Project Manager		X	X	X	X	X

3.2.4.1 Periodically During Deployment

For Transit Agency Project Managers:

- Question 4.1, First Interview: First, can you describe your role (or your responsibilities) in the IDTO demonstration project?

- Question 4.2, First Interview: At this point in time, has the IDTO demonstration had a net increase, net decrease, or no net effect on your agency's costs?

- Question 4.3, First Interview: [IF NET INCREASE OR DECREASE IN QUESTION 4.2] What have been the primary drivers of changes in costs under the demonstration?

- Question 4.4, First Interview: What cost components would be likely to change on a per-unit basis (i.e., per unit of input) if the demonstration were expanded to some measure of full-scale implementation?

- Question 4.5, First Interview: In what ways (if any) would these costs change?

- Question 4.6: {Prompt with answers from previous months} Over the past [time since last interview], has the net effect of the IDTO demonstration on costs to your agency changed?

- Question 4.7: If so, have the primary drivers of costs changed, or have cost impacts changed overall?

- Question 4.8: Over the past [time since last interview], has your view changed regarding cost components that would be likely to change on a per-unit basis (i.e., per unit of input) if the demonstration were expanded to some measure of full-scale implementation? [Remind respondent of previous response]

- Question 4.9: If so, in what ways?

- Question 4.10, Interview Involving an Organization with Demand-Response Service: Has the presence of T-DISP lead to changes in the number of demand-response (i.e., TaxiCABS, FlexBus, Capital Transportation) vehicles in service?
    - IF YES: PROBE: Increases? Decreases?
    - {IF INCREASES}: Under what circumstances is fleet size increased (PROBE: What drives increases in the number of vehicles in service?) Typically, how many vehicles have been added to service? How quickly are new vehicles put into service?
    - {IF DECREASES}: Under what circumstances is fleet size decreased? (PROBE: what drives decreases in the number of vehicles in service? What happens when vehicles are taken out of service?

- Question 4.11, Interview Involving an Organization with Demand-Response Service: To what extent is the active fleet size constrained by existing labor agreements with operators? For example, if a driver and vehicle are activated, is there a minimum shift duration?

- Question 4.12: Has T-CONNECT resulted in schedule changes?
    - IF YES: Please describe some of the schedule changes that have occurred.
    - How often have schedule changes occurred? How does this compare to other factors leading to schedule changes?

- Question 4.13, Interview Involving an Organization with Demand-Response Service: In addition to fleet size changes, has T-DISP resulted in schedule changes?
    - IF YES: Please describe some of the schedule changes that have occurred.
    - How often have schedule changes occurred? How does this compare to other factors leading to schedule changes?

- Question 4.14: Has T-DISP resulted in routing changes?
    - IF YES: Please describe some of the routing changes that have occurred.
    - How often have routing changes occurred? How does this compare to other factors leading to routing changes?

- Question 4.15, Interview Involving an Organization with Demand-Response Service: What has the net effect of these changes been on operating costs?

- Question 4.16: In what ways has the demonstration impacted transit operations?

- Question 4.17: Do you have any other comments or feedback you would like to share about the IDTO demonstration and its impact on intra-agency operation?

3.2.4.2 After Deployment

For Transit Agency Project Managers

Now I'd like to ask you the extent to which you agree or disagree with a series of four statements about the IDTO bundle, using a seven-point scale. The scale consists of the following levels {the respondent will be given a reference sheet with the scale listed on it}: 1 = "strongly disagree," 2 = "disagree," 3 = "disagree somewhat," 4 = "neither agree nor disagree," 5 = "agree somewhat," 6 = "agree," and 7 = "strongly agree." {After the respondent indicates a numerical value or a verbal response that matches one of the numerical values, the interviewer will ask follow-up questions}

- Question 4.18: The first statement is the following: T-CONNECT is a cost-effective application for improving transit services.
    - {If agreed (value greater than 4)}: Why do you feel that T-CONNECT is a cost-effective application for improving transit services? When taking cost into account, how does T-CONNECT compare to other alternatives your agency has used or would consider using to improve transit services (and what are these alternatives)?
      {If disagreed or neutral (value less than 5)}: Why do you feel that T-CONNECT is not a cost-effective application for improving transit services? When taking cost into account, how does T-CONNECT compare to other alternatives your agency has used or would consider using to improve transit services (and what are these alternatives)?

- Question 4.19: The next statement is the following: D-RIDE is a cost-effective application for improving transit services.
    - {If agreed (value greater than 4)}: Why do you feel that D-RIDE is a cost-effective application for improving transit services? When taking cost into account, how does D-RIDE compare to other alternatives your agency has used or would consider using to improve transit services (and what are these alternatives)?
    - {If disagreed or neutral (value less than 5)}: Why do you feel that D-RIDE is not a cost-effective application for improving transit services? When taking cost into account, how does D-RIDE compare to other alternatives your agency has used or would consider using to improve transit services (and what are these alternatives)?

- Question 4.20: The next statement is the following: T-CONNECT is a cost-effective application for improving intermodal transportation.
    - {If agreed (value greater than 4)}: Why do you feel that T-CONNECT is a cost-effective application for improving intermodal transportation? When taking cost into account, how does T-CONNECT compare to other alternatives your agency has used or would consider using to improve intermodal transportation (and what are these alternatives)?

  - o {If disagreed or neutral (value less than 5)}: Why do you feel that T-CONNECT is not a cost-effective application for improving intermodal transportation? When taking cost into account, how does T-CONNECT compare to other alternatives your agency has used or would consider using to improve intermodal transportation (and what are these alternatives)?
- Question 4.21: Do you have any other comments or feedback you would like to share about the IDTO demonstration and its impact on intra-agency operation?

3.2.5 User Experience

In this series of interviews, the Volpe Center will gather feedback from stakeholders on user experience as it relates to the development and deployment of the IDTO bundle. Interviews will be conducted during the demonstration. The interviews are targeted at bundle users, as well as implementers at the agency, managers, and decision-makers. The purpose of these interviews is to determine if the IDTO bundle has impacted user wait and travel times and if the bundle has impacted transit user experiences. Table 3-21 below describes the frequency of each interview.

Table 3-21. Description of User Experience Interviews

Stakeholder	Title of Interviewee	Name of Interviewee	5/15/14 (Columbus Only)	7/15/14	9/15/14	11/15/14
Bundle Users	Consumers		X	X	X	X
CABS	Field Logistics and Information Coordinator	Tim Smith	X	X	X	X
Capital Transportation	Superintendent, Transportation	Matt Allison	X	X	X	X
COTA	Business Services Manager	Dave Evans	X	X	X	X
FlexBus	Project Manager				X	X
LYNX	Project Manager			X	X	X
SunRail	Project Manager				X	X
TaxiCABS	Field Logistics and Information Coordinator	Tim Smith	X	X	X	X
Veolia Transportation	Project Manager			X	X	X
Zimride	Project Manager		X	X	X	X

Please indicate how much you agree with the following statements, on a scale of 1 (strongly disagree) to 7 (strongly agree). Table 3-22 shows the answer choices for Questions 5.1 through 5.9.

Table 3-22. Bundle User Answer Choices

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	N/A
1	2	3	4	5	6	7	X

- Question 5.1: The predicted travel and wait times from C-Ride[7] improve my ability to manage my trips.
- Question 5.2: The T-CONNECT feature[8] of C-Ride improves my ability to make transfers between different types of transportation.
- Question 5.3, The T-CONNECT feature of C-Ride improves my ability to make transfers between different transit service providers.
- Question 5.4: C-Ride reduces the impact that heavy traffic or other disruptions have on my trips.
- Question 5.5: The T-CONNECT feature of C-Ride allows me to find travel alternatives in instances of heavy traffic or other disruptions.
- Question 5.6: The T-CONNECT feature of C-Ride allows me to use travel alternatives in instances of heavy traffic or other disruptions.
- Question 5.7: The T-DISP feature[9] of C-Ride allows me to find travel alternatives in instances of heavy traffic or other disruptions.
- Question 5.8: The T-DISP feature of C-Ride allows me to use travel alternatives in instances of heavy traffic or other disruptions.
- Question 5.9: The D-RIDE feature[10] of C-Ride allows me to find and use travel alternatives in instances of heavy traffic or other disruptions.

[7] A prototype developer meeting on March 13, 2014 confirmed that the software package will be branded as "C-Ride"
[8] This term will be updated to reflect what the user sees as the name for this application.
[9] This term will be updated to reflect what the user sees as the name for this application.
[10] This term will be updated to reflect what the user sees as the name for this application.

3.2.5.1 Periodically During Deploymet

For Transit Agency Project Managers

- Question 5.10, Interviews Involving an Organization with Demand-Response Service: What has been the net effect on user wait times caused by changes in the number of demand-response (i.e., TaxiCABS, Lynx, Capital Transportation) vehicles in service? What evidence have you observed regarding changes in user wait times?

- Question 5.11, Interviews Involving an Organization with Demand-Response Service: What has been the net effect on travel times caused by routing changes due to T-DISP?

- Question 5.12, First Interview: In what ways has the IDTO demonstration impacted (or will impact, if before the demonstration has been active sufficiently long) users' [travel or transit] experiences?

- Question 5.13, First Interview: To what extent do (do you expect, if before the demonstration has been active sufficiently long) these impacts offer value to transit users?

- Question 5.14, First Interview: Are there any ways in which you feel the demonstration could offer (additional) value to transit users if it were structured differently?
- PROBE: Different technological focus? Different geographical/inter-agency coverage?
- Question 5.15: {If not first interview, prompt with answers/summary of answers from previous interviews} Over the past [time since last interview], has your view changed on of the effect of the IDTO demonstration on users' experiences? If so, in what ways?

- Question 5.16: {If Not first interview, prompt with answers/summary of answers from previous interviews} Over the past [time since last interview], has your view changed on the value of the demonstration to transit users? If so, in what ways?

- Question 5.17: {If not first interview, prompt with answers/summary of answers from previous interviews} Over the past [time since last interview], has there been any change in the ways you feel the demonstration could offer (additional) value to transit users if it were structured differently (e.g., different technological focus, different geographical/inter-agency coverage)?

For All

- Question 5.18: Do you have any other comments or feedback you would like to share about the IDTO demonstration and its impact on user experience?

3.2.5.2 After Deployment

For All

Question 5.19: Do you have any other comments or feedback you would like to share about the IDTO demonstration and its impact on user experience?

3.2.6 Application Usage

In this series of interviews, the Volpe Center will gather feedback from stakeholders on application usage as it relates to the development and deployment of the IDTO bundle. Interviews will be conducted during and after the demonstration. The interviews are targeted at implementers at the agency, managers, and decision-makers. The purpose of these interviews is to determine the behavioral usage of the IDTO bundle.
Table 3-23 describes the frequency of each interview.

Table 3-23. Description of Application Usage Interviews

Stakeholder	Title of Interviewee	Name of Interviewee	5/15/14 (Columbus Only)	7/15/14	9/15/14	11/15/14	1/15/15
Battelle	Development Team Manager	Tom Timcho	X	X	X	X	X
CABS	Field Logistics and Information Coordinator	Tim Smith	X	X	X	X	X
Capital Transportation	Business Services Manager	Dave Evans	X	X	X	X	X
COTA	Superintendent, Transportation	Matt Allison	X	X	X	X	X
FlexBus	Project Manager				X	X	X
LYNX	Project Manager			X	X	X	X
SunRail	Project Manager				X	X	X
TaxiCABS	Field Logistics and Information Coordinator	Tim Smith	X	X	X	X	X
Veolia Transportation	Project Manager			X	X	X	X
Zimride	Project Manager		X	X	X	X	X

3.2.6.1 Periodically During Deployment

For Battelle Development Team Manager

- Question 6.1, First Interview: Based upon what you have observed, to what extent does it appear that participants are using T-CONNECT on a repeated basis? Are there particular types of participants that are more likely to be involved in repeated use of T-CONNECT? Are there particular types of trips that are likely to be involved in repeated use of T-CONNECT?

- Question 6.2, First Interview: Based upon what you have observed, to what extent does it appear that participants are using T-DISP on a repeated basis? Are there particular types of participants or trips that are more likely to be involved in repeated use of T-DISP? Are there particular types of trips that are likely to be involved in repeated use of T-DISP?

- Question 6.3, First Interview: Based upon what you have observed, to what extent does it appear that participants are using D-RIDE on a repeated basis? Are there particular types of participants or trips that are more likely to be involved in repeated use of D-RIDE? Are there particular types of trips that are likely to be involved in repeated use of D-RIDE?

- Question 6.4, First Interview: Based upon what you have observed, to what extent does it appear that participants are using the IDTO bundle on a repeated basis? Are there particular types of participants that are more likely to be involved in repeated use of the bundle? Are there particular types of trips that are likely to be involved in repeated use of the bundle?

- Question 6.5, First Interview: Based upon what you have observed, to what extent do you think a broader rollout of the IDTO bundle would cause an increase in transit service demand?

- Question 6.6: Based upon what you have observed over the past [time since last interview], to what extent does it appear that participants are using T-CONNECT on a repeated basis? Are there particular types of participants that are more likely to be involved in repeated use of T-CONNECT? Are there particular types of trips that are likely to be involved in repeated use of T-CONNECT?

- Question 6.7: Based upon what you have observed over the past [time since last interview], to what extent does it appear that participants are using T-DISP on a repeated basis? Are there particular types of participants or trips that are more likely to be involved in repeated use of T-DISP? Are there particular types of trips that are likely to be involved in repeated use of T-DISP?

- Question 6.8: Based upon what you have observed over the past [time since last interview], to what extent does it appear that participants are using D-RIDE on a repeated basis? Are there particular types of participants or trips that are more likely to be involved in repeated use of D-RIDE? Are there particular types of trips that are likely to be involved in repeated use of D-RIDE?

- Question 6.9: Based upon what you have observed over the past [time since last interview], to what extent does it appear that participants are using the IDTO bundle on a repeated basis? Are there particular types of participants that are more likely to be involved in repeated use of the bundle? Are there particular types of trips that are likely to be involved in repeated use of the bundle?

For Battelle Development Team Manager and Transit Agency Project Managers

- Question 6.10, First Interview: Based upon what you have observed, to what extent do you think a broader rollout of the IDTO bundle would cause an increase in transit service demand?

- Question 6.11: Based upon what you have observed over the past [time since last interview], to what extent do you think a broader rollout of the IDTO bundle would cause an increase in transit service demand?

For All

- Question 6.12: Do you have any other comments or feedback you would like to share about the IDTO demonstration?

3.2.6.2 After Deployment

For Battelle Development Team Manager and Transit Agency Project Managers

- Question 6.13: Based upon what you have observed over the past [time since last interview], to what extent do you think a broader rollout of the IDTO bundle would cause an increase in transit service demand?

For All

- Question 6.14: Do you have any other comments or feedback you would like to share about the IDTO demonstration?

Chapter 4 Mapping Impacts to Full-Scale Scenarios

Following the quantification of specific impacts within each impact area, the Volpe Center's final task is to estimate the region-wide (monetized) impacts of a full-scale implementation of the IDTO bundle. There are three steps required to satisfy this task:

- Defining meaningful parameters for a full-scale implementation;
- Projecting estimated demonstration-level impacts to the domain of the full-scale implementation; and
- Converting full-scale impacts into monetary measures, where feasible.

That is, the Volpe Center must first assume a set of elements defining the portion of the region affected by a full-scale implementation, such as the number of transit vehicles, locations, and the potential ridership. The team must then map impacts from corresponding elements within the demonstration to the full-scale case, and then convert full-scale impacts to valuations.

4.1 Defining the Scope of a Full-Scale Implementation

In the absence of direct information from transit agencies, there is unlikely to be one clear candidate composition of a full-scale implementation for a given region. Rather, there is likely some spectrum of reasonable strategies that regions could employ. The Volpe Center acknowledges this by proposing to generate a set of projected full-scale impacts, using multiple scenarios along a hypothesized spectrum defined by:

- A lower bound, in which T-CONNECT is present at major hubs or along high-frequency routes/corridors; and
- An upper bound, in which T-CONNECT is present at all points where any two services overlap (or are adjacent).

The role of T-DISP and D-RIDE is less clear along the spectrum. The Volpe Center expects that T-DISP coverage would be highly constrained in some cases and less constrained in others. This could possibly be because the potential scope of demand-response services may be limited or broad depending on the demonstration. D-RIDE should be available everywhere the software package is available. For example, in Columbus, demand-response services may only cover trips on or near the OSU campus (TaxiCABS) or at the DSCC (Capital Transportation), but one could download the software package and seek a ridesharing partner anywhere in the region. Hence, the Volpe Center expects to focus variation along the spectrum on the intensity of T-CONNECT services, with corresponding follow-on effects in the definition of coverage of T-DISP, D-RIDE, and the software package, unless consultation with stakeholders reveals that increased variation across scenarios would be warranted.

The Volpe Center's initial expectation of required information to define scenarios includes:

- Specific geographic boundaries;
- Key hotspots, such as hubs and high-frequency corridors;
- Ridership within the boundaries and at hotspots;
- Volume of services within the boundaries; and
- Required infrastructure.

Geographic boundaries will be required to condition the identification of services and ridership affected by the bundle. Clear representation of the geographic boundaries of a given full-scale scenario would also enable clearer comparisons with the demonstration, by comparing the geographic coverage of the scenario and demonstration.

Key hotspots are important to identify for at least two reasons. Firstly, T-CONNECT demand would likely be considerably higher at locations through which a high number of services travel. Secondly, and more generally, a large concentration of travel demand takes place at hubs and along high-frequency corridors. In both of these cases, the Volpe Center would need to account for this relatively high demand when measuring impacts.

Ridership volumes will be essential to define in scenarios to yield meaningful projections of demonstration-level impacts that are strong functions of travel demand. This holds both for general purposes (i.e., as represented within the geographic boundaries as a whole, scaling smaller gross impacts within the demonstration to the full-scale case), and for location-sensitive purposes (e.g., as represented at hotspots with relatively high demand for T-CONNECT).

It will be essential to identify the volume, or number of vehicles by application type, of services that are linked to the bundle in all scenarios. The Volpe Center's projections of demonstration-level impacts will vary with respect to the number of vehicles affected. In other words, such as passengers per route-mile per hour, certain projections will be correlated meaningfully with the number of vehicles in service. This will be especially important if the level of service offered within the demonstration is divergent to the level of service offered within the boundaries of a full-scale scenario. In other words, the share of vehicles accessible by demonstration participants that are equipped with T-CONNECT is much higher than the share of vehicles equipped with T-CONNECT within the scenario.

Lastly, the volume of required infrastructure within a full-scale scenario will be used primarily within calculations of cost-effectiveness measures and net benefits. Information on the volume of services will likewise be used within calculations of cost-effectiveness measures and net benefits.

There may be more relevant contextual information to capture, but this information would be sufficient to give a clear definition of the location and scale of the deployment (and corresponding resource requirements), along with the scale of demand that could be influenced by the deployment. Ongoing work will be conducted to seek additional relevant contextual information required to define full-scale deployment scenarios. The data requested in Section 3 are expected to be sufficient for defining a full-scale implementation but it may be necessary to identify further data to map demonstration-level impacts to a full-scale case.

4.2 Mapping Demonstration-Level Impacts to the Full-Scale Case

Following directly from the specification of scenario attributes, the impacts measured directly from the demonstration will need to be adjusted to account for sampling bias that may arise from the choice of non-representative demonstration components, such as locations, services, participants. That is, it is plausible that one or both of the following is true within a given demonstration: (1) the locations or services selected for the demonstration are not fully representative of the portion of the region where full-scale implementation may take place; or (2) participants in the demonstration are not fully representative of transit users where full-scale implementation may take place. The Volpe Center will need to consult with local agencies to identify sufficient information to adjust for this type of sampling bias; for example, if the Volpe Center finds that OSU students tend to make 75% more transit trips per month than the average Columbus resident, the Volpe Center would want to scale down trip-related impacts linked to participants from OSU by a factor of 4/7 when projecting those impacts to the region. An important note to keep in mind is that the appropriate choice of scaling factors may be a function of the specification of the full-scale implementation, as the set of services, locations and users affected would also be a direct function of the specification of the full-scale implementation.

Once the Volpe Center identifies the set of scaled impacts, the team will map the impacts to all selected scenarios along the spectrum, by seeding each scenario with the required contextual information as discussed above.

Consider the upper-bound full-scale scenario, in which T-CONNECT is extended to all cases where two agencies' services overlap. In this scenario, one (simplified) example strategy for specifying the set of elements to seed the scenario, and the corresponding methods of expanding estimated demonstration-level impacts follows:

Table 4-1. Example Procedure for Expansion from Demonstration to Full-Scale Scenario

Element	In Demonstration	In Full-Scale Scenario	Expansion Method
Geographic boundaries	T-CONNECT: Routes covered by sample of CABS services and Capital Transportation services overlapping with sample of COTA services, routes covered by sample of COTA services. T-DISP: Service area covered by TaxiCABS services. D-RIDE: Locations of all trips covered by ridesharing.	T-CONNECT: Routes covered by all CABS services and Capital Transportation services overlapping with COTA services. T-DISP: Service area covered by TaxiCABS and Capital Transportation services. D-RIDE: Locations of all trips covered by ridesharing.	T-CONNECT: Scale by ratio of full-scale-to-demonstration miles covered. T-DISP: 1:1 mapping. D-RIDE: 1:1 mapping, unless changes in geographic coverage are observed.
Hotspots	T-CONNECT: OSU transfer points, DSCC perimeter. T-DISP: Major centers on the OSU and DSCC campuses. D-RIDE: Unidentified (as yet) transportation centers.	T-CONNECT: OSU transfer points, DSCC perimeter. T-DISP: Major centers on the OSU and DSCC campuses. D-RIDE: Unidentified (as yet) transportation centers.	All: In the lower bound case, no expansion factor is required to account for hotspots, as there is no change from the demonstration.

Element	In Demonstration	In Full-Scale Scenario	Expansion Method
Ridership	T-CONNECT: OSU students participating in the demonstration, OSU staff participating in the demonstration, DSCC employees participating in the demonstration, unidentified (as yet) others. T-DISP: OSU students, OSU staff, DSCC employees participating in the demonstration. D-RIDE: OSU students, OSU staff, DSCC employees participating in the demonstration, unidentified (as yet) others.	T-CONNECT: OSU students, OSU staff, DSCC employees, all other travelers along routes served by T-CONNECT, all travelers who choose to download the software package. T-DISP: OSU and DSCC staff. D-RIDE: OSU students, OSU staff, DSCC employees, all other travelers along routes served by T-CONNECT, all travelers who choose to download the software package.	T-CONNECT: Scale by the ratio of full-scale-to-demonstration ridership. T-DISP: Scale by ratio of eligible staff to employees participating in the demonstration. D-RIDE: Scale by the ratio of full-scale-to-demonstration ridership.
Volume of services	T-CONNECT: Services within sample of CABS services and Capital Transportation services overlapping with sample of COTA services, services within sample of COTA services. T-DISP: TaxiCABS and Capital Transportation services. D-RIDE: All sampled D-RIDE trips.	T-CONNECT: Services within all CABS services and Capital Transportation services overlapping with COTA services, services within all COTA services overlapping with CABS services and Capital Transportation services. T-DISP: TaxiCABS and Capital Transportation services. D-RIDE: All potential D-RIDE trips.	T-CONNECT: Scale by ratio of full set of overlapping services to sampled services. T-DISP: 1:1 mapping. D-RIDE: Scale by indicator of potential ratio of D-RIDE users to number of users in the demonstration.
Required infrastructure	T-CONNECT: Hardware, software and data storage for services within sample of CABS services and Capital Transportation services overlapping with sample of COTA services, services within sample of COTA services. T-DISP: Hardware, software and data storage for TaxiCABS and Capital Transportation services. D-RIDE: Hardware, software and data storage for the volume of trips in the demonstration.	T-CONNECT: Hardware, software and data storage for services within all CABS services and Capital Transportation services overlapping with COTA services, services within all COTA services overlapping with CABS services and Capital Transportation services. T-DISP: Hardware, software and data storage for TaxiCABS and Capital Transportation services. D-RIDE: Hardware, software and data storage for all potential D-RIDE trips.	T-CONNECT: Scale by ratio of full set of overlapping services to sampled services, with some reduction for common infrastructure between the demonstration and the full-scale scenario. T-DISP: 1:1 mapping. D-RIDE: 1:1 mapping may be a sufficient approximation.

Once an appropriate mapping between demonstration-level and full-scale-scenario-level attributes is found, the Volpe Center will also need to specify assumptions relating to the scale of the full-scale scenario. These assumptions will include, but are not limited to, whether to allow for returns to scale by introducing non-linear relationships. Some effects relating to scale may be relatively simple to confirm, such as the presence of reduced unit costs as scale increases. Other effects may be relatively difficult, such as the presence of reduced time savings as the set of potential T-CONNECT transactions increases.

In general terms, the Volpe Center can represent the method of projecting full-scale impacts as follows. For a given impact I_{dj} the Volpe Center can estimate for factor *j* in demonstration *d*, the Volpe Center will scale it up to a full-scale impact I_{fj} consistent with: $I_{fj} = I_{dj} * s_j * s_{dj}$. Within this formula, s_j represents a scaling factor that accounts for the relative non-representativeness of factor *j* within the demonstration (e.g., T-CONNECT was placed on buses with high shares of transfer demand) and s_{dj} represents a scaling factor that accounts for the relative scale of factor *j* in the full-scale deployment compared to the demonstration. For example, if factor *j* yields a benefit of x passenger minutes saved, the demonstration uses buses with two times the demand of average buses, and the full-scale deployment of *j* is projected to be ten times the size of the demonstration, the Volpe Center could estimate the full-scale impact as equal to x*0.5*10, or five times the estimated demonstration-level impact.

4.3 Monetizing Benefits and Costs within the Full-Scale Case

The final step centers on translating the estimates of full-scale impacts into valuations, where feasible, for use within the national DMA evaluation. In general, the scope of the valuations will be limited to the subset of impacts that can be represented as a tangible benefit or cost. For example, while travel time savings can be converted to monetized values, through the use of accepted measures, such as guidance from the DOT or empirical evidence, intangible impacts from increased inter-agency cooperation cannot be converted to monetized values easily.

The current set of hypotheses and available data will enable the estimation of the following monetized values:

- User travel time savings
- User reliability gains
- Value of incremental trips taken
- Vehicle travel time impacts on operating costs
- Vehicle fuel consumption impacts on operating costs
- Vehicle maintenance cost impacts
- Bundle-related expenditures
- Changes in transit revenues

Estimates of (monetized) impacts can be partitioned into those relating to users and those relating to providers. For impacts relating to users, the most important is likely to be the value of total travel time savings; this can be estimated as the product of hours of travel time saved and a preferred estimate of the (per-hour) value of travel time savings for trips via public transit. Monetized values for reliability gains can be estimated in a similar manner to travel time savings (e.g., per-trip value of a unit increase in reliability); two related issues to resolve in this area are selecting an effective unit for representing reliability, and selecting an appropriate per-unit value from empirical studies. Incremental trips (i.e., additional trips taken following from bundle usage) can be valued at their marginal cost, or could also include estimates of consumer surplus (i.e., value above marginal cost); the Volpe Center will consult empirical studies to identify the most effective means of valuing incremental trips.

To monetize impacts relating to providers, the Volpe Center will apply information on unit costs and total bundle demonstration deployment costs toward the set of vehicles and required support infrastructure under full-scale deployment. Information from interviews will serve as a consistency check with cost information obtained by other means. Lastly, estimates of changes in transit revenues will be specified as the product of changes in fare-generating trips (i.e., trips with a non-zero monetary cost to users) and the corresponding fares, by trip and fare type. While changes in transit revenues also represent equal changes in user expenditures, in evaluating impacts, the Volpe Center will represent changes in transit revenues distinctly to changes in user expenditures. That is, changes in transit revenues would not only impact the financial health of transit agencies, but would also offset at least some of the costs of implementing the IDTO bundle. Users would not be affected in the same way when taking additional (fare-generating) trips; the Volpe Center will assume that incremental trips generate at least as much value as their corresponding fares.

The monetization of these values will apply directly to the development of a generalized cost model. By determining the “out-of-pocket” cost of trips, the value of travel time lost or gained, and the cost of congestion or disruptions, the Volpe Center will be able to extrapolate an overall generalized cost from the demonstration. This generalized cost model can then be altered accordingly and applied within the full-scale case. The model will be of the form $g = p + u(w) + v(q,w)$ where g equals generalized cost, p equals monetary costs, $u(w)$ equals a function of non-monetary costs such as time, and $v(q,w)$ equals a function of congestion costs based on demand and capacity.

Chapter 5 Major Themes and Next Steps

In this section the Volpe Center briefly summarizes the information in this evaluation plan, by describing the major themes and trends within the plan, and the major issues and challenges that will need to be overcome to complete the IA. The discussion concludes with an update outlining the Volpe Center's next steps.

5.1 Major Themes of Evaluation

There are two clear objectives outlined in this evaluation plan. First, the Volpe Center will analyze and assess the impacts generated from the IDTO prototype demonstrations, and second, the Volpe Center will determine and estimate how these impacts can be scaled up in order to estimate a full-scale, region-wide implementation. These objectives are supported by necessary corresponding material, such as anticipated data needs.

The six major impact areas which the Volpe Center hopes to assess through this evaluation are user demand, behavioral change, the functionality of the IDTO bundle, strategies of IDTO bundle usage, travel time, and inter-agency cooperation. The Volpe Center feels that these broadly represent the major impacts that will determine the utilization, implementation, and success of the IDTO bundle. These impacts will be measured through hypotheses tests using quantitative and qualitative data from multiple sources. The Volpe Center's hypotheses tests focus primarily on evaluating the usage of the technology and how that usage impacts travel time and behavior. While there are some instances where comparative analysis such as before-and-after or user/non-user is required, overall this form of analysis is the exception rather than the rule.

The Volpe Center plans to generate the impacts of a full-scale implementation using multiple scenarios. These scenarios include a lower bound and upper bound which describe the hypothesized degrees of bundle implementation. These scenarios are built of elements including specific geographic boundaries, major hotspots such as hubs, ridership, volume of services, and required infrastructure. Based on these elements, the Volpe Center will expand and scale observed impacts accordingly. Finally, the Volpe Center will monetize these impacts accordingly to present an estimation of the benefits and cost associated with a full-scale implementation. These impact scenarios will be modified within the context of the Central Florida demonstration, once sufficient information is available.

5.2 Overview of Key Considerations

There are certain cases where before-and-after or user and non-user comparisons will need to be drawn. These evaluations bring up the larger issue of data limitations. While some of these questions can be resolved simply by asking the appropriate party to make the data available, others may be more challenging and will require the evaluation plan to be revised and altered if certain data are not available.

5.3 Next Steps

This document is the fourth and final draft of the Volpe Center's evaluation plan which the team submits for stakeholder review. Any future revisions to this plan will be made in the form of an addendum. The primary next steps include assessing sample data, establishing specific analytical techniques based upon the review of sample data, scheduling interviews, and beginning to conduct the IA.

Appendix A: Acronyms

Acronym	Definition
C-Ride	Software package
CABS	The Ohio State University's Campus Area Bus Service
COTA	Central Ohio Transit Authority
DCM	Data Capture and Management
DMA	Dynamic Mobility Applications
D-RIDE	Dynamic Ridesharing (IDTO Application)
DSCC	Defense Supply Center Columbus
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GIS	Geographic Information System
IA	Impacts Assessment
IDTO	Integrated Dynamic Transit Operations
ITS JPO	Intelligent Transportation Systems Joint Program Office
MOE	Measure of Effectiveness
OSU	The Ohio State University
PD	Prototype Development
RDE	Research Data Exchange
T-CONNECT	Connection Protection (Application)
T-DISP	Dynamic Transit Operations (Application)
UCF	University of Central Florida
U.S. DOT	U.S. Department of Transportation

Appendix B: Data Provided by Battelle

Table B-1. Data Type: Steps Connecting a Scheduled Trip's Origin and Destination

Variable Name	Description
modeId	Mode of transportation.
startDate	Step start date and time.
endDate	step end date and time.
fromName	From Name given by the Route Provider.
fromStopCode	From Stop Code given by the Route Provider.
fromProviderId	Foreign key into the Provider table. Indicates the provider for this step.
toName	To Name given by the Route Provider.
toStopCode	To Stop Code given by the Route Provider.
toProviderId	Foreign key into the Provider table. This is the provider for the Stop Code.
distance	Distance for this step.
stepNumber	Step sequence number.
routeNumber	Route number for this step.

Table B-2. Data Type: Log of the History of All T-CONNECT Requests Generated

Variable Name	Description
inboundVehicle	Vehicle identifier for the Inbound Vehicle.
vehicleProviderId	Foreign key into the provider table. The inbound vehicle for this tConnect.
startWindow	Start of ETA window where a t-Connect Request will be issued.
endWindow	End of ETA window where a t-Connect request will be issued.
tConnectRequestId	Foreign key into the tConnect Request table.
createdDate	Date this data was created.
modifiedDate	Date this data was last modified.

Table B-3. Data Type: Every Potential Sequence of Locations That Can Trigger a T-CONNECT Request

Variable Name	Description
checkpointLocation	The location of the inbound destination.
checkpointRoute	Route identifier for the inbound vehicle.
tConnectProviderId	Foreign key into the provider table. Indicates the provider associated with this tConnect opportunity.
tConnectLocation	The location of the tConnect point of origin.
tConnectRoute	Route of the outbound vehicle.
modifierDate	**Date this data was last modified.**

Table B-4. Data Type: T-CONNECT Requests That Have Been Issued by the System

Variable Name	Description
routeName	Name of the route.
stopName	Name of the stop.
stopCode	Stop Code of the requested delay.
scheduledDeparture	Scheduled time of departure.
holdDuration	Requested delay.
status	Status of the request.
expiration	Date and time that the request expires.
modifiedDate	Date this data was last modified.

Table B-5. Data Type: Trip Request Details

Variable Name	Description
travelerId	Foreign key into the traveler table. Identifies which traveler scheduled this trip.
tripStartDate	The traveler specified trip time, may be an arrival or departure time, depending on the priority Code. UTC, local timezone.
origination	The traveler-specified starting location of the trip.
destination	The traveler-specified destination of the trip.

Variable Name	Description
priorityCode	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..
createdDate	Date trip was scheduled.

Table B-6. Data Type: Location of Monitored Vehicles

Variable Name	Description
vehicleId	Foreign key into vehicle table. The vehicle at this location.
lat	The latitude of the vehicle at a given moment in time.
long	The longitude of the vehicle at a given moment in time.

Impact Assessment of Integrated Dynamic Transit Operations: Addendum to Evaluation Plan

Introduction to Addendum

This document is an addendum to the final evaluation plan for the Integrated Dynamic Transit Operations Impacts Assessment (IDTO IA) and accordingly describes changes to the original evaluation plan based on the final results of the prototype development (PD) work and IA.

The final evaluation plan was completed on April 21st, 2014, just after the baseline period of data collection for the Columbus demonstration began. However, as the work of the PD team continued and evolved, the IA team made several adjustments to the plan to account for changes in the demonstration. This document is intended to capture and account for those changes and to provide the final methodology for the IDTO Impact Assessment. Thus, this document can be viewed as a companion to the final evaluation plan (updating relevant sections as needed) and to the IDTO IA final report (which has incorporated this document by reference).

As the PD team began work testing the IDTO prototype, the original demonstration plans changed significantly. For the Columbus demonstration, only three of the five planned agencies took part, notably including those providing the planned D-RIDE and demand-response service component of T-DISP. Additionally, the number of general public application users within the demonstration was significantly smaller than expected. For the Central Florida demonstration, while a live demonstration had been planned with five partner agencies and active public users, instead, a proof-of-concept demonstration with three partner agencies and no public users occurred.

Consequently, the IA team did not rely solely on demonstration data in completing the planned analyses. Instead, the team engaged in two separate activities to gather additional non-demonstration information to evaluate the bundle. First, the team conducted interviews with entities conducting unique demand-response services to determine how T-DISP could function within their systems. Second, the team developed an analytical spreadsheet tool, the Integrated Dynamic Transit Operations – Bundle Evaluation Tool (IDTO-BET), to test how IDTO would perform given assumptions regarding a transportation network.

The sections below correspond to the original sections outlined in the final IDTO IA evaluation plan and describe the according changes to the plan based on what occurred within the demonstrations and IA.

Addendum-Executive Summary

A live demonstration occurred in Columbus, Ohio and a proof-of-concept demonstration occurred in Central Florida. An updated version reflecting what occurred in the demonstrations, is below:

Table Addendum 0-1. Comparison of Demonstration Sites

	Columbus	Central Florida
Number of Agencies Involved	3	3
Number of T-CONNECT Locations	4	3 (shown in proof-of-concept)
T-CONNECT Provider(s)	Central Ohio Transit Authority	LYNX
T-CONNECT Feeders	Campus Area Bus Service, Capital Transportation	Veolia Transportation, SunRail
T-DISP Provider(s)	Not Tested	Not Tested
D-Ride Provider(s)	Not Tested	Not Tested
Coordination of Trip Requests	Both passenger and driver driven	Done by developers during proof-of-concept testing

Impact Areas and Hypotheses

While components within the six impact areas changed, the IA team assessed the prototype of the IDTO bundle on the six planned impact areas. The degree of testability varied, as described within this document.

Data Collection

Data transfers of quantitative data for the demonstration were made through Battelle's File Transfer Protocol (FTP) site. Collected data included Battelle's developer database and bundle implementation cost information, bundle user survey responses, and agency vehicle position and communication logs. The IA team collected qualitative data by interviewing project staff and demonstration partners as well as separate entities that have developed unique demand-response services. The demand-response agency interviews were done to address gaps in the demonstrations based on partner agencies withdrawing.

Mapping Impacts to Full-Scale Scenarios

By developing and using the Integrated Dynamic Transit Operations – Bundle Evaluation Tool (IDTO-BET), the IA team was able to determine region-wide monetized impacts of a full-scale implementation of the IDTO bundle. The IA team set parameters and ran several scenarios using IDTO-BET. The tool is fully functional and able to be used by stakeholders and other agencies upon request.

Next Steps

An updated version reflecting the actual project schedule, is below:

Table Addendum 0-3. Project Schedule

Deliverable	Projected Date
Columbus Prototype Demonstration – Start of Baseline Period	3/7/14
Columbus Prototype Demonstration – Demonstration Goes Live	5/16/14
Data Acceptability Memo – Columbus	Delivered 8/14/14
Central Florida Proof-of-Concept Demonstration	11/5/14
Data Acceptability Memo – Central Florida	N/A (Scope of demonstration changed)
Final Project Report – Battelle	1/20/16
Prototype Demonstration Ends (Columbus)	12/19/14
Impacts Assessment Final Report	Approximately 2/16

Chapter 1 Introduction and Background

1.1 The U.S. DOT DMA Program

No changes were made to this background section describing the DMA program.

1.2 The U.S. DOT IDTO Program

No changes were made to this background section describing the IDTO concept.

1.2.1 Columbus

The Columbus, Ohio demonstration consisted of testing T-CONNECT and the trip planning component of T-DISP. The flexible service component of T-DISP and D-RIDE were not tested following the withdrawal of partner agencies from the demonstration. Battelle developed the system architecture for T-DISP and D-RIDE, but those applications were not tested as part of the demonstration. The demonstration baseline period began in March 2014, went live in May, and concluded in December. The Columbus, Ohio test site included the areas surrounding the Ohio State University (OSU) campus and the Defense Supply Center Columbus (DSCC). The Central Ohio Transit Authority (COTA) is the primary public transit provider in the region. Two additional transportation service providers took part in the demonstration: OSU's Campus Area Bus Service (CABS) and DSCC's Capital Transportation. Possible T-CONNECT opportunities existed from CABS to COTA and from Capital Transportation to COTA.

Planned partner TaxiCABS (operated by CABS) was not involved in the demonstration as the service was never implemented by CABS due to budget constraints. Planned partner Zimride withdrew from the demonstration after a change in ownership.

1.2.2 Central Florida

The Central Florida demonstration evolved from a live demonstration to a proof-of-concept demonstration that did not include live users. Instead, the IDTO bundle was tested during a one-day proof-of-concept activity on November 5th, 2015. The proof-of-concept demonstration tested T-CONNECT and the trip planning component of T-DISP. The flexible service components of T-DISP and D-RIDE were not tested due to the withdrawal of partner agencies from the demonstration. Battelle developed the system architecture for T-DISP and D-RIDE, but those applications were not tested as part of the demonstration.

The demonstration centered on the LYNX bus system. LYNX serves the greater Orlando region, including the University of Central Florida (UCF). Two additional transportation service providers took part in the demonstration: Veolia Transportation, which operates the UCF campus shuttle system, and SunRail, a commuter rail service. Possible T-CONNECT opportunities existed from Veolia to LYNX and from SunRail to Lynx.

Planned partner FlexBus (operated by LYNX) was not involved in the demonstration as the service was not yet implemented by LYNX due to schedule delays. Planned partner Zimride withdrew from the demonstration after a change in ownership.

1.2.3 Summary and Comparison

An updated version of what occurred in the demonstrations is below:

Table Addendum 1-1. Comparison of Demonstration Sites

	Columbus	Central Florida
Number of Agencies Involved	3	3
Number of T-CONNECT Locations	4	3 (shown in proof-of-concept)
T-CONNECT Provider(s)	Central Ohio Transit Authority	LYNX
T-CONNECT Feeders	Campus Area Bus Service, Capital Transportation	Veolia Transportation, SunRail
T-DISP Provider(s)	Not Tested	Not Tested
D-Ride Provider(s)	Not Tested	Not Tested
Coordination of Trip Requests	Both passenger and driver driven	Done by developers during proof-of-concept testing

1.3 IDTO Demonstration Stakeholders – Roles

No changes were made to the roles of the major stakeholders described in Table 1-2.

1.4 Evaluation Objectives

While the projection of region-level benefits was less robust than previously anticipated, no significant changes were made to the evaluation objectives. As intended, the IA team findings represent inputs for the national-level DMA evaluation. These findings were based on minimal survey responses and IDTO application usage, interviews conducted with demonstration agency partners and demand-response service providers, and analysis using IDTO-BET.

1.5 High-Level Project Schedule

An updated version of the actual project schedule is below:

Table Addendum 1-3. Project Schedule

Deliverable	Projected Date
Columbus Prototype Demonstration – Start of Baseline Period	3/7/14
Columbus Prototype Demonstration – Demonstration Goes Live	5/16/14
Data Acceptability Memo – Columbus	Delivered 8/14/14
Central Florida Proof-of-Concept Demonstration	11/5/14
Data Acceptability Memo – Central Florida	N/A (Scope of demonstration changed)
Final Project Report – Battelle	1/20/16
Prototype Demonstration Ends (Columbus)	12/19/14
Impacts Assessment Final Report	Approximately 2/16

1.6 Report Organization

No changes were made to the organization of the report.

Chapter 2 Approach to Impacts Analysis and Evaluation

While the robustness of the analysis decreased due to limitations that occurred throughout the demonstration, the six impact areas evaluated and described in Table 2-1 were unchanged. Demonstration partner agencies and demand-response service providers were interviewed and minimal bundle user surveys were collected. Vehicle position data was utilized within the context of IDTO-BET; however, user position data was unavailable. Additionally, a generalized cost model was not developed; rather, the IA team instead made estimates and assumptions utilizing IDTO-BET.

IDTO-BET includes functionality to incorporate all three specific applications of the bundle: T-CONNECT, T-DISP, and D-RIDE. The tool was informed by actual data from Columbus transit agencies in order to project travel time, reliability and demand impacts of IDTO usage across the network. The data applied within IDTO-BET included ridership and communication logs as well as vehicle position information. IDTO-BET was designed not only to enable the evaluation of IA hypotheses, but also to project impacts of full-scale deployment of IDTO and to support evaluations of additional hypothetical scenarios both within and outside the scope of the IDTO demonstration (i.e., scenario testing that can be customized to any specific application).

The central mechanisms in IDTO-BET involve the estimation of impacts on average travel times, average changes in buffer time (i.e., 95^{th}-percentile travel time) for IDTO users and other travelers, and transit demand. Each target impact is projected in IDTO-BET through statistical representations of transit service performance calibrated with respect to: observed data from the demonstration, supplementary data provided by demonstration participants, and analyst-controlled assumptions.

2.1 Impacts on Travel Times

No changes were made to the objectives of this impact area.

2.1.1 Evaluation Hypotheses and Links to Impacts

Hypotheses 1 and 2 were evaluated by using IDTO-BET. Conclusions regarding Hypothesis 3, while untestable based on data limitations, were drawn based on using IDTO-BET and the findings found for Hypotheses 1 and 2. By using the tool, the IA team was able to determine the effect of the bundle on user travel times and travel reliability. The specific hypotheses are as follows:

- Hypothesis 1: The software package and IDTO applications enable users to reach target destinations in less travel time compared to the baseline or non-users.
- Hypothesis 2: The software package and IDTO applications enable users to reach target destinations with less variation in travel time compared to the baseline or non-users.
- Hypothesis 3: Passenger wait time is reduced.

2.1.2 Key MOEs and Data

A modified and updated version of the evaluation of travel times reflecting the actual data inputs is below.

Table Addendum 2-2. Evaluation of Travel Times: Hypotheses 1-3

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 1a: The IDTO software package enables users to reach destinations faster compared to the baseline or non-users	• Times from origin to destination (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Transit agency baseline data (distribution of arrival times and ridership by stop and route)	• Battelle via FTP • Transit agency via FTP	• User-level travel time savings compared to the baseline or non-users • Vehicle travel time savings • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 1b: T-CONNECT enables users to reach destinations faster compared to the baseline or non-users	• Times from origin to destination on trips affected by T-CONNECT (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Transit agency baseline data (distribution of arrival times and ridership by stop and route)	• Battelle via FTP • Transit agency via FTP	• User-level travel time savings under T-CONNECT compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 1c: T-DISP enables users to reach destinations faster compared to the baseline or non-users	• Times from origin to destination on trips affected by T-DISP (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Transit agency baseline data (distribution of arrival times and ridership by stop and route)	• Battelle via FTP • Transit agency via FTP	• User-level travel time savings under T-DISP compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 1d: D-RIDE enables users to reach destinations faster compared to the baseline or non-users	• Times from origin to destination on trips affected by D-RIDE (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Analytical tool informed by demand-response agency interviews • Trip cost data for demand-response services	• Battelle via FTP • Demand-response agency interviews	• User-level travel time savings under D-RIDE compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 2a: The IDTO software package enables users to reach destinations more reliably compared to the baseline or non-users	• Standard deviations of times from origin to destination (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Transit agency baseline data (distribution of arrival times and ridership by stop and route)	• Battelle via FTP • Transit agency via FTP	• Improvements in trip reliability for users compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 2b: T-CONNECT enables users to reach destinations more reliably compared to the baseline or non-users	• Standard deviations of times from origin to destination on trips affected by T-CONNECT (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Transit agency baseline data (distribution of arrival times and ridership by stop and route)	• Battelle via FTP • Transit agency via FTP	• Improvements in trip reliability for users compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 2c: T-DISP enables users to reach destinations more reliably compared to the baseline or non-users	• Standard deviations of times from origin to destination on trips affected by T-DISP (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Transit agency baseline data (distribution of arrival times and ridership by stop and route)	• Battelle via FTP • Transit agency via FTP	• Improvements in trip reliability for users compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 2d: D-RIDE enables users to reach destinations more reliably compared to the baseline or non-users	• Standard deviations of times from origin to destination on trips affected by D-RIDE (user time beginning and ending from closest reasonable locations to the actual starting and ending points of the trip)	• Analytical tool informed by demand-response agency interviews • Trip cost data for demand-response services	• Battelle via FTP • Demand-response agency interviews	• Improvements in trip reliability for users compared to the baseline or non-users • Can also disaggregate by trip condition in parallel with H11a-d
Hypothesis 3a: The IDTO bundle reduces passenger wait times at the origin within flexible modes	• Passenger waiting times for flexible mode pickup	• Battelle post-trip surveys (of users)	• Battelle via FTP	• Travel time savings • Waiting time savings (if using separate value of time)
Hypothesis 3b: The IDTO bundle reduces passenger wait times at the origin within fixed modes	• Passenger waiting times at stop for fixed modes	• Battelle post-trip surveys (of users)	• Battelle via FTP	• Travel time savings • Waiting time savings (if using separate value of time)
Hypothesis 3c: The IDTO bundle reduces passenger wait times during transfers	• Passenger transfer times	• Battelle post-trip surveys (of users)	• Battelle via FTP	• Travel time savings • Transfer time savings (if using separate value of time)

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 3d: Boarding time for rides scheduled via D-RIDE are within a satisfactory interval of their scheduled boarding times	• Difference between observed and scheduled boarding times on trips booked via D-RIDE • User satisfaction			• As is – diagnostic: relative reliability of D-RIDE trips. • Alternative: using post-trip survey data on perceived improvements in travel alternatives

2.1.3 Analysis Approach

Hypotheses 1, 2, and 3 were evaluated using IDTO-BET as described in the IDTO IA Report. The inputs for IDTO-BET were determined through transit agency data from the Columbus demonstration partners and information posted to Battelle's FTP site. This included ridership, service, and communication logs. The data were cleaned and converted into summary statistics or averages which could serve as inputs into IDTO-BET. This information was augmented by data collected by the IA team from unique demand-response service providers. The composition and parameters of IDTO-BET are described in detail within Section 1.3.4 of the IDTO IA Report.

Based on data limitations and the reduced scope of the demonstration, use of travel simulation techniques and the development of a generalized cost model was unfeasible. Unfortunately, because the live demonstration in Columbus did not include D-RIDE, hypothesis H3d was untestable beyond what was possible to hypothesis within IDTO-BET.

2.1.4 Key Considerations

As noted above, travel time estimates were determined utilizing IDTO-BET. Data challenges were addressed by using IDTO-BET and conducting qualitative interviews with demand response agencies. Determining specific structural differences between Columbus and Central Florida was not necessary based on the final nature of the two demonstrations.

2.2 Impacts Relating to User Demand

No changes were made to the objectives of this impact area.

2.2.1 Evaluation Hypotheses and Links to Impacts

Hypotheses 4 and 5 were evaluated by assessing usage rates from Battelle's developer database as well as through interviews with agency partners. Further analysis of Hypothesis 5 was conducted by testing scenarios within IDTO-BET. The specific hypotheses are as follows:

- Hypothesis 4: The IDTO bundle was consulted and utilized at a meaningful level overall, and for trips originating from, or destined to, specific locations.
- Hypothesis 5: Transit demand is a positive function of IDTO bundle usage.

2.2.2 Key MOEs and Data

A modified and updated evaluation of user demand reflecting the actual data inputs is below.

Table Addendum 2-3. Evaluation of User Demand: Hypotheses 4-5

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 4a: The software package was consulted and used at a meaningful level	• Software package usage rates or levels overall and by trip characteristics • Qualitative evidence in support of hypothesis	• Battelle user device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via FTP • Partner agency interviews	• Distribution of software package use rates by geographic location • Changes in travel demand as a function of total software package use
Hypothesis 4b: T-CONNECT was utilized at a meaningful level	• T-CONNECT transactions overall and by trip characteristics • Qualitative evidence in support of hypothesis	• Battelle T-CONNECT user device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via FTP • Partner agency interviews	• Distribution of T-CONNECT use rates by geographic location • Changes in travel demand as a function of T-CONNECT use
Hypothesis 4c: T-DISP was consulted and used at a meaningful level	• T-DISP transactions overall and by trip characteristics • Qualitative evidence in support of hypothesis • Trips planned • Trips taken as a share of trips planned	• Battelle T-DISP user device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via FTP • Partner agency interviews	• Distribution of T-DISP use rates by geographic location • Changes in travel demand as a function of T-DISP use
Hypothesis 4d: D-RIDE was consulted and used at a meaningful level	• D-RIDE transactions overall and by trip characteristics • Qualitative evidence in support of hypothesis • Rides requested • Rides matched • Rides completed as a share of rides requested	• Trip cost data from demand response services	• Demand-response agency interviews	• Distribution of D-RIDE use rates by geographic location • Changes in travel demand as a function of D-RIDE use

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 5a: Transit demand is a positive function of software application usage	• Comparison of transit trip volumes and software application use • Qualitative evidence in support of hypothesis	• User device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via FTP • Partner agency interviews	• Travel volumes • Time savings • Transit agency costs • Transit agency revenues
Hypothesis 5b: Transit demand is a positive function of T-CONNECT usage	• Comparison of transit trip volumes and T-CONNECT transaction rates • Qualitative evidence in support of hypothesis	• User device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via FTP • Partner agency interviews	• Travel volumes • Time savings • Transit agency costs • Transit agency revenues
Hypothesis 5c: Transit demand is a positive function of T-DISP usage	• Comparison of transit trip volumes and T-DISP transaction rates • Qualitative evidence in support of hypothesis	• User device data/logs (bundle transactions) • Interviews of Battelle • Transit agency interviews	• Battelle via FTP • Partner agency interviews	• Travel volumes • Time savings • Transit agency costs • Transit agency revenues
Hypothesis 5d: Transit demand is a positive function of D-RIDE usage	• Comparison of transit trip volumes and D-RIDE transaction rates • Qualitative evidence in support of hypothesis	• Analytical tool informed by demand-response agency interviews	• Demand-response agency interviews	• Travel volumes • Time savings • Transit agency costs • Transit agency revenues

2.2.3 Analysis Approach

Hypotheses 4 and 5 were evaluated using application usage data from Battelle's developer database, interviews with partner agencies and demand-response agencies, and analysis conducted using IDTO-BET. The specific analysis conducted is described in the IDTO IA report and includes assessing application usage and interview responses related to usage and application demand. Due to limited data, it was not possible to test specific usage thresholds with statistical analysis and, in the case of the Columbus demonstration, it was not necessary to specifically determine OSU versus DSCC travelers. Instead, basic usage rates and counts, such as logged trips and T-CONNECT opportunities, were reported.

T-CONNECT and T-DISP were further evaluated using IDTO-BET to determine projected changes in transit demand due to changes in the generalized price of transit travel when utilizing the two applications.

2.2.4 Key Considerations

The IA team had planned a cohort analysis to evaluate sub-groups of the population such as OSU students, OSU faculty, and DSCC employees. However, this analysis was not necessary as the reduced scope of the demonstration led to a more basic analysis of usage information. Determining specific structural differences between Columbus and Central Florida was not necessary due to the final nature of the two demonstrations.

2.3 Impacts Relating to Behavioral Change

No changes were made to the objectives of this impact area.

2.3.1 Evaluation Hypotheses and Links to Impacts

Hypotheses 6 and 7 were evaluated by assessing usage patterns from Battelle's developer database, and assessing user satisfaction surveys. Further analysis was conducted by interviewing unique demand-response service providers. These hypotheses are as follows:

- Hypothesis 6: Demand for the IDTO bundle is a function of personal needs and traffic conditions.
- Hypothesis 7: The IDTO bundle is utilized by individual users on a continuous or repeated basis.

2.3.2 Key MOEs and Data

A modified and updated evaluation of behavioral change reflecting the actual data inputs is below.

Table Addendum 2-4. Evaluation of Behavioral Change: Hypotheses 6-7

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 6a: Demand for the software package is a function of personal needs and level of service	• Software package use varies with respect to observable factors, including congestion, time of day and variability in total trip times • Qualitative evidence in support of hypothesis	• Battelle user device data/logs (bundle transactions) • Battelle user satisfaction surveys (of users)	• Battelle via FTP • Partner agency interviews	• Split apart general software package use rates – focus on distributions of use rates under classes of disruptions
Hypothesis 6b: Demand for T-CONNECT is a function of personal needs and level of service	• T-CONNECT transactions vary with respect to observable factors, including congestion, time of day and variability in total trip times • Qualitative evidence in support of hypothesis	• Battelle T-CONNECT user device data/logs (bundle transactions) • Battelle user-satisfaction surveys (of users) • Transportation Authority stakeholder interview	• Battelle via FTP • Partner agency interviews	• Split apart general T-CONNECT use rates – focus on distributions of use rates under classes of disruptions
Hypothesis 6c: Demand for T-DISP is a function of personal needs and level of service	• T-DISP transactions vary with respect to observable factors, including congestion, time of day and variability in total trip times • Qualitative evidence in support of hypothesis	• Battelle T-DISP user device data/logs (bundle transactions) • Battelle user satisfaction surveys (of users) • Transportation Authority stakeholder interview • Analytical tool informed by demand-response agency interviews	• Battelle via FTP • Partner agency interviews	• Split apart general T-DISP use rates – focus on distributions of use rates under classes of disruptions
Hypothesis 6d: Demand for D-RIDE is a function of personal needs and traffic conditions	• D-RIDE transactions vary with respect to observable factors (such as congestion and time of day) • Qualitative evidence in support of hypothesis	• Analytical tool informed by demand-response agency interviews	• Partner agency interviews •	• Split apart general D-RIDE use rates – focus on distributions of use rates under classes of disruptions

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 7a: The software application is utilized by individual users on a continuous or repeated basis	• Individual software application usage rates or levels (on an interval basis/moving average) • Qualitative evidence in support of hypothesis	• Battelle user device data/logs (bundle transactions) • Interviews of Battelle	• Battelle via FTP • Partner agency interviews	• Interact with distributions of software use and travel demand to disaggregate by recurring and non-recurring congestion
Hypothesis 7b: T-CONNECT is utilized by individual users on a continuous or repeated basis	• Individual T-CONNECT usage rates or levels (on an interval basis/moving average) • Qualitative evidence in support of hypothesis	• Battelle user device data/logs (bundle transactions) • Interviews of Battelle	• Battelle via FTP • Partner agency interviews	• Interact with distributions of T-CONNECT use and travel demand to disaggregate by recurring and non-recurring congestion
Hypothesis 7c: T-DISP is utilized by individual users on a continuous or repeated basis	• Individual T-DISP usage rates or levels (on an interval basis/moving average) • Qualitative evidence in support of hypothesis	• Battelle user device data/logs (bundle transactions) • Interviews of Battelle	• Battelle via FTP • Partner agency interviews	• Interact with distributions of T-DISP use and travel demand to disaggregate by recurring and non-recurring congestion
Hypothesis 7d: D-RIDE bundle is utilized by individual users on a continuous or repeated basis	• Individual D-RIDE usage rates or levels (on an interval basis/moving average) • Qualitative evidence in support of hypothesis			• Interact with distributions of D-RIDE use and travel demand to disaggregate by recurring and non-recurring congestion

2.3.3 Analysis Approach

Hypotheses 6 and 7 were evaluated using application usage rates, user satisfaction surveys administered by Battelle, and interviews conducted with demonstration partner agencies and demand-response agencies. Based on data limitations and the scope of the demonstrations, the IA team was unable to independently evaluate the correlation between personal needs and traffic conditions. Instead, conclusions were based on limited survey data received and attitudinal interview responses. Additionally, while usage rates were evaluated, this analysis was not as robust as originally planned. The analysis includes interpretations related to habitual demand analyzing basic trends, rather than using thorough statistical tests.

Counts from the 17 user satisfaction surveys were reported along with anecdotal information from interviews. Basic usage counts relating to trips logged and repeat users were reported to identify how much usage was continuous or habitual. Unfortunately, because the live demonstration in Columbus did not include D-RIDE, hypothesis H7d was untestable.

2.3.4 Key Considerations

Data relating to specific user position and travel patterns was not available unless offered by users based on e-mail addresses (such as @osu.edu) or through open-ended survey responses.

As noted in the key consideration sections above, determining specific structural differences between Columbus and Central Florida was not necessary due to the final nature of the two demonstrations.

2.4 Impacts Relating to the Functionality of the IDTO Bundle

No changes were made to the objectives of this impact area.

2.4.1 Evaluation Hypotheses and Links to Impacts

Hypotheses 8, 9, and 10 were evaluated using post-trip surveys and conducting analysis within IDTO-BET. Hypothesis 11 was evaluated using cost data and information provided by Battelle and the demonstration partner agencies, through interviews, as well as through using IDTO-BET.

- Hypothesis 8: Predicted travel and wait time information from package-DISP improves users' ability to manage their trips.
- Hypothesis 9: The IDTO bundle increases system efficiency.
- Hypothesis 10: T-CONNECT increases the likelihood of making successful transfers.
- Hypothesis 11: T-CONNECT and T-DISP are cost-effective applications for improving services and intermodal transportation.

2.4.2 Key MOEs and Data

A modified and updated evaluation of the functionality of the IDTO bundle reflecting the actual data inputs is below.

Table Addendum 2-5. Evaluation of the Functionality of the IDTO Bundle: Hypotheses 8-11

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 8: Predicted travel and wait time information from T-DISP improves users' ability to manage their trips	• Post-trip survey attitudinal scores above neutral	• Battelle post-trip surveys (of users)	• Battelle via FTP	• Minor/diagnostic: users agree that the software package offers value
Hypothesis 9a: The IDTO bundle increases passenger throughput	• Passengers per vehicle hour • Vehicle cycle times	• Vehicle position data • Transit agency demonstration ridership data (passengers per vehicle / per day)	• Transit agency via FTP	• Changes in passenger throughput by corridor/service type • Fleet efficiency impacts (e.g., costs per passenger per vehicle-hour, costs per vehicle cycle)
Hypothesis 9b: The IDTO bundle increases average transit rider travel times	• User travel times	• Vehicle position data • Transit agency demonstration ridership data	• Transit agency via FTP	• Changes in passenger throughput by corridor/service type • Fleet efficiency impacts (e.g., costs per passenger per vehicle-hour)
Hypothesis 10a: T-CONNECT increases the likelihood of making successful multi-modal transfers	• Passenger transfers under T-CONNECT • # of T-CONNECT requests • Post-trip survey attitudinal scores above neutral	• IDTO user device data/logs (bundle transactions) • Battelle post-trip surveys (of users) • Transit agency current and historical ridership and transfer data (informing IDTO-BET) • Transit agency current and historical vehicle position data (informing IDTO-BET)	• Battelle via FTP • Transit agency via FTP	• Indirect/diagnostic: Relative increase in successful multi-modal connections by corridor (With expanded design could assess schedule delay reduction in multi-modal travel)

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 10b: T-CONNECT increases the likelihood of making successful multi-agency transfers	• Passenger transfers under T-CONNECT • # of T-CONNECT requests • Post-trip survey attitudinal scores above neutral	• IDTO user device data/logs (bundle transactions) • Battelle post-trip surveys (of users) • Transit agency current and historical ridership and transfer data (informing IDTO-BET) • Transit agency current and historical vehicle position data (informing IDTO-BET)	• Battelle via FTP • Transit agency via FTP	• Indirect/diagnostic: Relative increase in successful multi-agency connections by corridor (With expanded design could assess schedule delay reduction in multi-agency travel)
Hypothesis 10c: T-CONNECT increases connections made involving fixed and flexible modes to above 90% of connections requested	• Percentage of T-CONNECT connections made for all trips versus total connections requested or attempted	• Battelle T-CONNECT user device data/logs (bundle transactions) • Battelle post-trip surveys (of users)	• Battelle via FTP	• Diagnostic only: no impact
Hypothesis 11b: T-CONNECT is a cost-effective application for improving intermodal transportation (efficiency, throughput) for transit agencies	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis • Cost-effectiveness measure	• Transit agency interviews • Transit agency cost data (unit and shared costs of implementation and maintenance)	• Partner agency interviews • Battelle via FTP	• Relative agency support of T-CONNECT for improving intermodal transportation • Conduct basic benefit-cost analysis for T-CONNECT (allocate shared costs and benefits – e.g., intermodal patronage/impacts on connection waiting time - to get intermodal BCA)

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 11c: T-DISP is a cost-effective application for improving intermodal transportation (efficiency, throughput) for transit agencies	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis • Cost-effectiveness measure	• Transit agency interviews • Transit agency cost data (unit and shared costs of implementation and maintenance)	• Partner agency interviews • Battelle via FTP	• Relative agency support of T-DISP for improving intermodal transportation • Conduct basic benefit-cost analysis for T-DISP (allocate shared costs and benefits – e.g., intermodal patronage/impacts on connection waiting time - to get intermodal BCA)
Hypothesis 11d: T-DISP is a cost-effective application for improving transit services (efficiency, throughput) for transit agencies	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis • Cost-effectiveness measure exceeds threshold	• Transit agency interviews • Transit agency cost data (unit and shared costs of implementation and maintenance)	• Partner agency interviews • Battelle via FTP	• Relative agency support of T-DISP for improving transit services • Conduct basic benefit-cost analysis for T-DISP

2.4.3 Analysis Approach

Hypotheses 8, 9, and 10 were evaluated using post-trip survey responses and analysis within IDTO-BET. Post trip-survey responses were gathered and trends within the responses were identified. Hypothesis 11 was evaluated using cost data provided by Battelle and based on attitudinal responses from partner agencies collected through interviews.

Originally, the IA team had planned a more robust analysis regarding distributions of travel times and the development of a generalized cost model. The IA team had also planned to analyze passenger throughput during the demonstration relative to a baseline. However, these analyses were not possible as user position data was not available. Specific diagnostic analyses relating to technical outcomes were also limited based on the reduced scope of the demonstrations.

Instead, various vehicle headways were hypothesized and several sensitivity tests were conducted using IDTO-BET to determine the impact of T-CONNECT and T-DISP on system efficiency. IDTO-BET was also used to determine whether T-CONNECT would increase the likelihood of making successful transfers by testing various transfer scenarios. The tool was also used to monetize the benefit of T-CONNECT and determine the cost-effectiveness of the bundle and the projected increase in transit revenue based on bundle usage.

These tests were supported and augmented by interviews conducted with demonstration partner agencies related to costs and cost perceptions, cost data provided by Battelle, as well as post-trip survey questions developed by the IA team and administered by Battelle.

2.4.4 Key Considerations

The analysis resulted in qualitative evidence that could be viewed subjectively. As a result, the IA team presented all information collected directly along with the analysis and trends identified. As noted in the key consideration sections above, determining specific structural differences between Columbus and Central Florida was not necessary due to the final nature of the two demonstrations.

2.5 Impacts Relating to Strategies of IDTO Bundle Usage

No changes were made to the objectives of this impact area.

2.5.1 Evaluation Hypotheses and Links to Impacts

Hypotheses 12 and 13 were evaluated through interviews with demonstration partner agencies and post-trip surveys. Further analysis was conducted by interviewing unique demand-response service providers. The specific hypotheses are as follows:

- Hypothesis 12: T-DISP extends demand response services to support dynamic routing, scheduling, and changing number of vehicles in service.
- Hypothesis 13: The IDTO bundle improves users' ability to mitigate effects of disruptions to the network.

2.5.2 Key MOEs and Data

A modified and updated evaluation of the strategies of IDTO Bundle usage reflecting the actual data inputs is below.

Table Addendum 2-6. Evaluation of the Strategies of IDTO Bundle Usage: Hypotheses 12-13

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 12a: T-DISP extends demand response services to support dynamic routing	• # of Route variations caused by user requests	• Battelle command center data • Transit agency interviews	• Battelle via RDE	• Degree that T-DISP adds route flexibility • Service quality improvement for users
Hypothesis 12b: T-DISP extends demand response services to support dynamic scheduling	• # of Schedule variations caused by user requests	• Battelle command center data (time and result of transaction/activity) • Transit agency interviews	• Battelle via RDE	• Degree that T-DISP adds schedule flexibility • Service quality improvement for users
Hypothesis 12c: T-DISP extends demand response services to support changing number of vehicles in service	• # of Decisions to change number of vehicles	• Transit agency service logs (details of status, schedule, and route changes) • Transit agency interviews	• Transit agency via RDE • Volpe Center	• For removal of vehicles: • Estimate of reduced operating costs (need cost info from agencies) • For addition of vehicles: • Analyze travel times • Estimated demand and schedule/ expected wait times to estimate wait time/travel time reductions
Hypothesis 13a: The IDTO software package improves users' ability to mitigate the effects of disruptions to the traffic network or transit system and enhances network and system reliability	• Post-trip survey attitudinal scores above neutral • Travel time for users in incident conditions vs. estimated travel time for non-users	• Battelle post-trip surveys (of users) • Battelle user position data (GPS coordinates) • Transit agency vehicle position data (GPS coordinates) • Incident logs	• Battelle via RDE • Transit agency via RDE • Transportation Authority via RDE	• Indicator: app is used to mitigate effects of traffic network or transit system disruptions

Evaluation Hypothesis	MOEs	Data Inputs	Data Source	Link to Impacts
Hypothesis 13b: T-CONNECT improves the reliability of travel alternatives under disruptions to the traffic network or transit system	• Post-trip survey attitudinal scores above neutral • Travel time for users in incident conditions vs. estimates for non-users	• Battelle post-trip surveys (of users) • Battelle user position data (GPS coordinates) • Transit agency vehicle position data (GPS coordinates) • Incident logs	• Battelle via RDE • Transit agency via RDE • Transportatio n Authority via RDE	• Indicator: T-CONNECT is used to mitigate effects of disruptions to the traffic network or transit system
Hypothesis 13c: T-DISP improves the reliability of travel alternatives under disruptions to the traffic network or transit system	• Post-trip survey attitudinal scores above neutral • Travel time for users in incident conditions vs. estimates for non-users	• Battelle post-trip survey (of users) • Battelle user position data (GPS coordinates) • Incident logs	• Battelle via RDE • Transit agency via RDE • Transportatio n Authority via RDE	• Indicator: T-DISP is used to mitigate effects of disruptions to the traffic network or transit system
Hypothesis 13d: D-RIDE improves the reliability of travel alternatives under disruptions to the traffic network or transit system	• Post-trip survey attitudinal scores above neutral • Travel time for users in incident conditions vs. estimates for non-users	• Battelle post-trip surveys (of users) • Battelle user position data (GPS coordinates) • Incident logs	• Battelle via RDE • Transportatio n Authority via RDE	• Indicator: D-RIDE is used to mitigate effects of disruptions to the traffic network or transit system

2.5.3 Analysis Approach

Hypotheses 12 and 13 were evaluated using data collected in interviews and post-trip survey information. With the exception of an analysis of travel time distributions relating to traffic a congestion or service disruption, which was not possible given available data, these hypotheses were evaluated as originally planned. Information regarding agency operations, scheduling, and fleet size management was augmented by interviews conducted with demand-response agencies, which were not originally planned.

The demand-response agency interviews conducted by the IA team consisted of background information on the service, demand and operations, and the evolution of the service. A full synopsis of each interview can be in Appendix A of the IDTO IA report. Operations and cost information relating to these services were used to determine the impacts and operability of T-DISP within various flexible transit configurations.

Finally, several questions within the post-trip survey developed by the IA team and administered by Battelle related to travelers responding to traffic or network disruption. The survey results were presented within Section 3.5.2 of the IDTO IA report along with a basic interpretation of trends. Unfortunately, because the live demonstration in Columbus did not include D-RIDE, hypothesis H13d was untestable.

2.5.4 Key Considerations

Due to data limitations, the evaluation of these hypotheses relied on qualitative data that, in some cases, could be viewed subjectively. In the IDTO IA report, the IA team presented all information collected directly along with the analysis and trends identified.

Additionally, as noted in the key consideration sections above, determining specific structural differences between Columbus and Central Florida was not necessary due to the final nature of the two demonstrations.

2.6 Impacts Relating to Inter-Agency Cooperation

No changes were made to the objectives of this impact area.

2.6.1 Evaluation Hypotheses and Links to Impacts

Hypothesis 14 was evaluated using interviews conducted with demonstration partner agencies. The specific hypothesis is as follows:

- Hypothesis 14: The IDTO bundle stimulated increased coordination to enhance effectiveness between transit agencies and others.

2.6.2 Key MOEs and Data

A modified and updated evaluation of Inter-Agency cooperation reflecting the actual data inputs is below.

Table Addendum 2-7. Evaluation of Inter-Agency Cooperation: Hypothesis 14

Evaluation Hypothesis	MOEs	Data Inputs	Preferred Data Source	Link to Impacts
Hypothesis 14a: The presence of the IDTO bundle motivated an increase in inter-agency coordination	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis	• Transportation Authority stakeholder interview	• IA team conducted partner agency interviews	• Representative: relative improvement in inter-agency cooperation
Hypothesis 14b: Agencies increased coordination to enhance the effectiveness of T-CONNECT	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis	• Transportation Authority stakeholder interview	• IA team conducted partner agency interviews	• Representative: relative improvement in inter-agency cooperation
Hypothesis 14c: Agencies increased coordination to enhance the effectiveness of T-DISP	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis	• Transportation Authority stakeholder interview	• IA team conducted partner agency interviews	• Representative: relative improvement in inter-agency cooperation
Hypothesis 14d: Transit agencies increased coordination under the IDTO bundle to improve overall service quality	• Likert-scale opinion scores above neutral • Qualitative evidence in support of hypothesis	• Transportation Authority stakeholder interview	• IA team conducted partner agency interviews	• Representative: relative improvement in inter-agency cooperation for the purpose of improving level of service

2.6.3 Analysis Approach

The analysis of this hypothesis was conducted as planned, primarily utilizing partner agency interviews within the Columbus demonstration. Interviewees were asked to describe their levels of coordination and collaboration and whether or not they agreed that the bundle and applications increased coordination amongst agencies. Anecdotal evidence resulting from these interviews was also presented in Section 3.6.1 of the IDTO IA report.

2.6.4 Key Considerations

The key consideration regarding the potential bias or subjective nature of qualitative interview evidence remains in place and was addressed in the IDTO IA report. The IA team presented all Likert scale observations directly along with the analysis and trends identified through discussion with the partner agencies.

Chapter 3 Data Collection

As originally planned, the IA team's data collection effort occurred in two tracks. Recurrent data from partner agencies and Battelle was posted to the FTP site during and after the demonstrations. Additionally, the IA team conducted primary data collection with partner agencies, demand-response agencies, and transportation authorities. Based on the revised scope of the demonstrations, not all data was utilized to the full, originally planned extent.

3.1 Quantitative Data Collection

The revised tables of actual quantitative data are below. These revisions are based on what actually occurred and was collected during the demonstrations and, as a result, some tables and data items are no longer included. Certain agencies did not participate as planned and certain data needs did not materialize. Specifically, Tables 3-5–3-7 were deleted.

3.1.1 Columbus Demonstration Data Needs

Table Addendum 3-1. Data Needs from Battelle-Columbus

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Cost data – Unit costs by bundle element (e.g., T-CONNECT implementation costs per vehicle), shared costs by bundle element (e.g., costs of implementing T-DISP outside of vehicle-specific costs), unit operating costs by service type (e.g., hourly operating cost of CABS service) for each partner	Unit and shared costs of implementing the bundle, costs of maintaining the bundle, unit operating costs for each partner	All services covered by the demonstration	• H11	• XLSX	• Once
Post-trip survey data – Survey responses and trip- and transaction-specific data (e.g., time, service, type of transaction)	Every trip for trip-specific questions; every two weeks for attitudinal questions	All trips using the software package, T-CONNECT, T-DISP and D-RIDE with unique user identifier	• H3, H6, H8, H10, H13	• CSV/XLSX	• Ad hoc
System centered data/logs – Details of transaction/activity (See Appendix A for description of data being captured by Battelle)	Every case where a user or vehicle communicates with the system	All user transactions, all interactions with vehicles	• H12	• CSV/BAK	• Ad hoc
User centered device data/logs – Time stamped user trip activities (including user satisfaction survey responses)	All individual uses of the software package	All individual uses of the software package with unique user identifier	• H4, H5, H6, H7, H10	• CSV/BAK	• Ad hoc

Table Addendum 3-2. Data Needs from CABS-Columbus

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ridership data – Passengers per vehicle or per day by route and service (split by season/periods of different demand or performance)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV/TXT	• Once
Baseline (historical) schedule data – Scheduled arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration	• H1, H9, H10	• CSV/TXT	• Once
Baseline (historical) vehicle position data – Mean and standard deviation (known or estimated) of arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Distributions of arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration	• H1, H9, H10	• CSV/TXT	• Once
Current (demonstration) ridership data – Passengers per vehicle or per day by route and service (split by periods of different demand or performance, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• CSV/TXT	• Ad hoc
Logs of communications between drivers and dispatchers either over radio or mobile data terminal	Each communication including the initiator and reason for communicating	All services covered by the demonstration	• H13	• CSV/TXT	• Ad hoc
Service logs – Indicators of status changes, nature of schedule changes (e.g., held by x minutes), time and duration of route changes	All status changes (in service/out of service) and all changes in route and schedule, AVL data with up to 30-second resolution	All vehicles within services covered by the demonstration	• H12	• CSV/TXT	• Ad hoc

Table Addendum 3-3. Data Needs from Capital Transportation-Columbus

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Current (demonstration) ride data – Passengers per vehicle or per day (split by periods of different demand or performance, if relevant)	Ride specific demand	All services covered by the demonstration	• H9	• PDF	• Ad hoc
Vehicle position data – GPS coordinates (latitude, longitude)	Every 10 seconds	All operations where feasible	• H1, H13	• CSV	• Ad hoc

Table Addendum 3-4. Data Needs from COTA-Columbus

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Baseline (historical) ridership and transfer data – Passengers per vehicle or per day by route and service (split by season/periods of different demand or performance and by vehicle transfers, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• XLSX	• Once
Baseline (historical) schedule data – Scheduled arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Scheduled arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration for fixed-route services	• H1, H9, H10	• GTFS/XLSX	• Once
Baseline (historical) vehicle position data – Mean and standard deviation (known or estimated) of arrival times by stop and route (split by season/periods of different demand or performance, if relevant)	Distributions of arrival times at stops (including location or GPS coordinates of stop)	All stops served within the demonstration for fixed-route services	• H1, H9, H10	• XLSX/BAK	• Once

Data Element	Resolution	Coverage	Related Hypotheses	Transfer Format	Transfer Frequency
Current (demonstration) ridership data – Passengers per vehicle or per day by route and service (split by periods of different demand or performance, if relevant)	Route- or service specific demand	All services covered by the demonstration	• H9	• XLSX	• Monthly
Logs of communications between drivers and dispatchers either over radio or mobile data terminal	Each communication including the initiator and reason for communicating	All services covered by the demonstration	• H13	• XLSX	• Monthly
Service logs – Indicators of status changes, nature of schedule changes (e.g., held by x minutes), time and duration of route changes	All status changes (in service/out of service) and all changes in route and schedule	All vehicles within services covered by the demonstration	• H12	• XLSX	• Monthly
Vehicle position data – GPS coordinates (latitude, longitude)	Real-time GTFS data at highest resolution possible	All operations where feasible	• H1, H13	• XLSX/BAK	• Monthly

3.1.2 Central Florida Demonstration Data Needs

Due to the revised nature of the Central Florida demonstration, which moved from a full demonstration to a proof-of-concept test, it was not necessary to collect quantitative data in Central Florida within the demonstration. Instead, the IA team was on hand for the proof-of-concept test and collected qualitative data via interviews with partner agencies. Specifically, Tables 3-8–3-14 were deleted.

3.1.3 Central Florida Demonstration Data Needs

Quantitative data were not needed from the restructured Central Florida demonstration. Tables 3-8–3-14 were deleted.

3.2 Qualitative Data Collection

The primary difference in the process of qualitative data collection and interviewing transit agencies between the final evaluation plan and what actually occurred centers on the agencies interviewed. Below, the revised Table Addendum 3-15 includes an updated set of interviewees. This update removes transportation authority and FTA interviews, which did not occur, and adds demand-response agency interviews.

Table Addendum 3-15. Interviews and Related Hypotheses

Data Source	Related Hypotheses
Battelle Interviews – Interview transcripts	H4, H5, H7
Demand-Response Agency Interviews – Interview transcripts	H1, H2, H3, H5, H6, H12
Transit Agency Interviews – Interview transcripts	H11, H12, H14

The six categories of interviews and the associated interview questions did not change. While some material was removed from the interview questions based on relevance due to what actually occurred, these changes are largely self-explanatory. Additional categories of demand-response related interview questions were added and used for the demand-response agency interviews. The revised tables of interviewees and interview dates, both overall and by interview category, can be found below.

Table Addendum 3-16. Interview Completion by Dates

Stakeholder	Title of Interviewee	Lessons Learned	Traffic Management	Inter-Agency Coordination	Intra-Agency Operation	User Experience	Application Usage
Battelle (*Columbus*)	Development Team Manager (*Columbus*)	• 9/26/14 • 2/20/15	• 2/20/15				• 9/26/14 • 2/20/15
Battelle (*Central Florida*)	Development Team Manager (*Central Florida*)	• 2/20/15	• 2/20/15				• 2/20/15
Bundle Users (*Columbus*)	Consumer (*Columbus*)					• Continuous	
CABS	Director, Transportation & Traffic Management	• 6/10/14 • 8/28/14	• 2/27/15	• 6/10/14 • 8/28/14 • 2/27/15	• 6/10/14 • 8/28/14 • 2/27/15	• 6/10/14 • 8/28/14	• 6/10/14 • 8/28/14 • 2/27/15
Capital Transportation	Business Services Manager	• 7/10/14 • 12/5/14	• 12/5/14	• 7/10/14 • 12/5/14			
Capital Transportation	Supervisor	• 7/10/14 • 9/26/14 • 12/5/14	• 12/5/14	• 7/10/14 • 9/26/14 • 12/5/14	• 7/10/14 • 9/26/14 • 12/5/14	• 7/10/14 • 9/26/14	• 7/10/14 • 9/26/14 • 12/5/14
COTA	Director, Transportation	• 2/10/15	• 2/10/15	• 9/3/14 • 2/10/15			
COTA	Transportation Services Superintendent	• 9/3/14 • 11/21/14 • 2/10/15	• 2/10/15	• 9/3/14 • 11/21/14 • 2/10/15	• 9/3/14 • 11/21/14 • 2/10/15	• 9/3/14 • 11/21/14	• 9/3/14 • 11/21/14 • 2/10/15

Stakeholder	Title of Interviewee	Lessons Learned	Traffic Management	Inter-Agency Coordination	Intra-Agency Operation	User Experience	Application Usage
LYNX	Senior ITS Developer	• 3/2/15	• 3/2/15	• 3/2/15	• 3/2/15	• 3/2/15	• 3/2/15
SunRail	SunRail Program Management	• 3/6/15	• 3/6/15	• 3/6/15	• 3/6/15	• 3/6/15	• 3/6/15
UCF	Assistant Director of Operations	• 3/3/15	• 3/3/15	• 3/3/15	• 3/3/15	• 3/3/15	• 3/3/15
UCF	Supervisor	• 3/3/15	• 3/3/15	• 3/3/15	• 3/3/15	• 3/3/15	• 3/3/15

3.2.1 Interviews on Lessons Learned

The information presented in Table 3-17 of the evaluation plan included planned interviewees and estimated dates. Please refer to Table 3-16 and Section 3.2 for actual interviewees and dates of interviews. Additionally, interview questions were modified slightly based on what actually occurred within the demonstration. However, these modifications were largely self-explanatory and not substantial in nature; as a result, they are not described here.

3.2.2 Transportation/Traffic Management

The information presented in Table 3-18 of the evaluation plan included planned interviewees and estimated dates. Please refer to Table 3-16 and Section 3.2 for actual interviewees and dates of interviews. Additionally, interview questions were modified slightly based on what actually occurred within the demonstration. However, these modifications were largely self-explanatory and not substantial in nature; as a result, they are not described here.

3.2.3 Inter-Agency Coordination

Interview questions were modified slightly based on what actually occurred within the demonstration. However, these modifications were largely self-explanatory and not substantial in nature; as a result, they are not described here.

3.2.4 Intra-Agency Operation/Structure/Organization

The information presented in Table 3-20 of the evaluation plan included planned interviewees and estimated dates. Please refer to Table 3-16 and Section 3.2 for actual interviewees and dates of interviews. Additionally, interview questions were modified slightly based on what actually occurred within the demonstration. However, these modifications were largely self-explanatory and not substantial in nature; as a result, they are not described here.

3.2.5 User Experience

The information presented in Table 3-21 of the evaluation plan included planned interviewees and estimated dates. Please refer to Table 3-16 and Section 3.2 for actual interviewees and dates of interviews. For bundle users, application users were surveyed continuously throughout the demonstration by Battelle. Thirteen survey responses were received in total. Additionally, interview questions were modified slightly based on what actually occurred within the demonstration. However, these modifications were largely self-explanatory and not substantial in nature; as a result, they are not described here.

3.2.6 Application Usage

The information presented in Table 3-22 of the evaluation plan included planned interviewees and estimated dates. Please refer to Table 3-16 and Section 3.2 for actual interviewees and dates of interviews. Additionally, interview questions were modified slightly based on what actually occurred within the demonstration. However, these modifications were largely self-explanatory and not substantial in nature; as a result, they are not described here.

Chapter 4 Mapping Impacts to Full-Scale Scenarios

No changes were made to this introductory section, as projected impacts were linked to full-scale monetized benefits as planned.

4.1 Defining the Scope of a Full-Scale Implementation

The projection of the impacts of full-scale implementation of IDTO centered on the combination of scenario analysis within IDTO-BET and information on the plausibility of alternative specifications of full-scale implementation. The IA team identified preferred specifications of full-scale implementation through thorough review of demonstration data and interview findings. Key factors defining plausible specifications of full-scale implementation included scale limitations (i.e., limits on feasible volumes of T-CONNECT requests per day) and multi-dimensional distributions of trip quality, travel patterns and associated demand (e.g., service frequency of outbound vehicles, on-time reliability of connecting vehicles, number of passengers on board outbound vehicles). The analytical scenarios, and the resulting scope of the full-scale demonstration, are described within the IDTO IA Report.

4.2 Mapping Demonstration-Level Impacts to the Full-Scale Case

The IA team projected the impacts of full-scale implementation of IDTO, by applying the findings from the scenario analysis in IDTO-BET to plausible specifications of full-scale implementation informed by demonstration data and interview findings. The scenarios analyzed in IDTO-BET were designed to estimate average impacts for IDTO users and net impacts across all transit users for each T-CONNECT request, each protected connection generated via T-CONNECT, and each (projected) use of dynamic demand-response service via T-DISP. The scenarios were informed by data collected during the demonstration, and supplemented by interview findings and academic literature. The method to accomplish this and the resulting full-scale impacts are described within the IDTO IA Report.

4.3 Monetizing Benefits and Costs within the Full-Scale Case

Rather than utilizing a generalized cost model, monetized benefits and costs were determined through analysis within IDTO-BET. This analysis was informed by data collected from the demonstrations as well as independently by the IA team.

Chapter 5 Major Themes and Next Steps

No changes were made to this introductory section.

5.1 Major Themes of Evaluation

The major themes of the evaluation did not change; however, additional themes were added. Key themes included additional analysis conducted by the IA team which consisted of interviews of demand-response agencies providing unique transit services, and the development of IDTO-BET, an evaluation tool which can be used not only to evaluate IDTO, but also by agencies who are considering implementing the bundle.

5.2 Overview of Key Considerations

The key considerations shifted during the course of the demonstrations as the work of the PD team progressed. Rather than emphasizing before-and-after and user-versus-non-user comparisons, the primary key consideration of the IA team focused on data availability. As it became clear that certain planned for data items would not be available, the IA team shifted its focus to develop analytical alternatives.

5.3 Next Steps

No changes were made to this explanatory section.

Appendix B: Data Provided by Battelle

No changes were made to this appendix.

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