Test Readiness Assessment Summary for Integrated Dynamic Transit Operations (IDTO)

www.its.dot.gov
Final Report — October 19, 2012
FHWA-JPO-12-086

U.S. Department of Transportation

Produced under the “Technical Support and Assistance for the Federal Highway Administration’s Office of Operations” contract
Federal Highway Administration
Research and Innovative Technology Administration

Cover photo credits, Carol Schweiger.

NOTICE

Technical Report Documentation Page

1. Report No. FHWA-JPO-12-086	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Test Readiness Assessment Summary for Integrated Dynamic Transit Operations		**5. Report Date** October 19, 2012
		6. Performing Organization Code
7. Authors Carol Schweiger, Santosh Mishra, Ayeshah Abuelhiga, Robert Sanchez		**8. Performing Organization Report No.**
9. Performing Organization Name and Address Science Applications International Corporation (SAIC) 8301 Greensboro Drive, Mailstop E-12-3 McLean, VA 22102		**10. Work Unit No. (TRAIS)**
		11. Contract or Grant No. DTFH61-06-D-00005, Task No. T-11-018
12. Sponsoring Agency Name and Address United States Department of Transportation ITS Joint Program Office Research And Innovative Technology Administration (RITA) 1200 New Jersey Avenue, SE Washington, DC 20590		**13. Type of Report and Period Covered** Final Report
		14. Sponsoring Agency Code HOIT-1

15. Supplementary Notes
Ronald Boenau, COTM

16. Abstract

In support of USDOT's Intelligent Transportation Systems' (ITS) Mobility Program, the Dynamic Mobility Applications (DMA) program seeks to create applications that fully leverage frequently collected and rapidly disseminated multi-source data gathered from connected travelers, vehicles and infrastructure to increase efficiency and improve individual mobility while reducing negative environmental impacts and safety risks. There are three Integrated Dynamic Transit Operations (IDTO) applications: Connection Protection (T-CONNECT); Dynamic Transit Operations (T-DISP); and Dynamic Ridesharing (D-RIDE). The T-CONNECT application will provide transit users and riders the means to ensure successful transit transfers. T-DISP will allow travelers to make real-time trip requests through personal mobile devices. D-RIDE will identify and accept potential ridesharing opportunities along a given travel route.

This report summarizes the assessment of key technical and non-technical issues related to field-testing the IDTO bundle of applications. In addition, the assessment describes the implication of the issues, an assessment of the test readiness for the 2012-2013 timeframe, and a brief description of the utility of testing. The document contains the following sections: Section 1 provides an overview of IDTO and an introduction to this document. Section 2 summarizes the functional and performance requirements assessments for the three IDTO applications. Section 3 summarizes the key findings related to field-testing the IDTO bundle.

17. Key Words Integrated Dynamic Transit Operations, IDTO, Test Readiness, T-CONNECT, T-DISP, D-RIDE, Dynamic Mobility Applications, DMA, Intelligent Transportation Systems, ITS.	**18. Distribution Statement** No restrictions.		
19. Security Classif. (of this report) Unclassified	**20. Security Classif. (of this page)** Unclassified	**21. No of Pages** 19	**22. Price** N/A

Preface

In support of USDOT's Intelligent Transportation Systems' (ITS) Mobility Program, several of the Department's agencies are fully engaged in exploiting active interaction between fixed and mobile transportation system entities both in the way new forms of data are being exchanged and in the opportunities that are afforded to extend the geographic scope, precision and control of our Nation's surface transportation system. An important initiative within the framework of this strategic effort is the Dynamic Mobility Applications (DMA) program which, in part, seeks to create applications that fully leverage frequently collected and rapidly disseminated multi-source data gathered from connected travelers, vehicles and infrastructure, and that increase efficiency and improve individual mobility while reducing negative environmental impacts and safety risks.

To that end, the Integrated Dynamic Transit Operations (IDTO) applications, which are the subject of this document, will provide transit users and riders the means to ensure successful transit transfers (T-CONNECT), to make real-time trip requests through personal mobile devices (T-DISP), and to identify and accept potential ridesharing opportunities along a given travel route (D-RIDE). The purpose of this report is to summarize the assessment of key technical and non-technical issues related to field-testing the IDTO bundle of applications. In addition, the assessment describes the implication of the issues, an assessment of the test readiness for the 2012-2013 timeframe, and a brief description of the utility of testing.

Table of Contents

List of Tables

Chapter 1. Introduction

1.1 Background

In support of USDOT's Intelligent Transportation Systems' (ITS) Mobility Program, several of the Department's agencies are fully engaged in exploiting active interaction between fixed and mobile transportation system entities both in the way new forms of data are being exchanged and in the opportunities that are afforded to extend the geographic scope, precision and control of our Nation's surface transportation system. An important initiative within the framework of this strategic effort is the Dynamic Mobility Applications (DMA) program which, in part, seeks to create applications that fully leverage frequently collected and rapidly disseminated multi-source data gathered from connected travelers, vehicles and infrastructure, and that increase efficiency and improve individual mobility while reducing negative environmental impacts and safety risks.

To that end, the Integrated Dynamic Transit Operations (IDTO) applications will provide transit users and riders the means to ensure successful transit transfers (T-CONNECT), to make real-time trip requests through personal mobile devices (T-DISP), and to identify and accept potential ridesharing opportunities along a given travel route (D-RIDE).

1.2 Document Overview

The USDOT initiated this Systems Engineering (SE) project to define the Concept of Operations (ConOps), requirements and readiness of the IDTO bundle. The ConOps is a prerequisite to this document and is recommended reading prior to reading this document. The ConOps describes the characteristics of the three applications within the IDTO bundle from the system user's viewpoints. The requirements build upon those concepts, particularly the User Needs, to document the required functionality, performance, interfaces, and other required characteristics for the IDTO applications. Both the IDTO Requirements and the Concept of Operations were used to identify and assess key technical and non-technical issues related to field-testing the IDTO bundle or its individual component applications.

The purpose of this report is to summarize the assessment of key technical and non-technical issues related to field-testing the IDTO bundle of applications. In addition, the assessment describes the implication of the issues, an assessment of the test readiness for the 2012-2013 timeframe, and a brief description of the utility of testing. This document consists of the following sections:

- Section 1 provides an overview of IDTO and an introduction to this document.
- Section 2 summarizes the functional and performance requirements assessments for the three IDTO applications.
- Section 3 summarizes the key findings related to field-testing the IDTO bundle.

Chapter 2. Assessment of Functional and Performance Requirements

This section provides an assessment of the functional and performance requirements for the three IDTO applications. The assessment includes key technical and non-technical issues, implication of the issues, an assessment of the test readiness for the 2012-2013 timeframe, and a brief description of the utility of testing.

2.1 T-CONNECT

Table 1 describes the assessment of issues and test readiness of the functional and performance requirements for the T-CONNECT application. Three categories of requirements were considered during the assessment: in-vehicle, central system and customer-end system requirements.

Table 1. T-CONNECT Requirements

Category	Technical and Non-Technical Issues	Rqmt No.	Implication	Test Ready?	Utility
In-Vehicle	Technical issue: Dwell times at transfer points	RC-1 through RC-6, RC-68 and RC-69	While the T-CONNECT concept focuses on customers making transfer requests themselves using mobile devices, there will still be situations where transfer requests made by customers are "entered" by drivers using mobile data terminals (MDT). Since requests made this way have to be entered for each rider separately, data entries by drivers could result in high dwell times at transfer points.	Additional research required	Further research on new technologies will provide alternatives for faster input of transfer requests.
In-Vehicle	Technical and Non-Technical Issue (institutional): Integration with fare payment systems in a multi-agency environment	RC-12 and RC-13	In the absence of such integration, agencies will have to establish after-the-fact fare/ revenue reconciliation procedures which could be time consuming and expensive.	Additional research required	Even though not prevalent, several regional fare systems have been implemented. However, additional research may be required regarding the level of integration required for participating agencies (e.g., in-vehicle or central integration). Further, standards regarding fare payment systems should be identified or developed if they do not exist in order to facilitate the integration.

Category	Technical and Non-Technical Issues	Rqmt No.	Implication	Test Ready?	Utility
In-Vehicle	Technical Issue: Access to real-time status of requested transfers	RC-7 and RC-9	In-vehicle information on transfer requests (e.g., trip cancellations or no-shows) that is incorrect or not timely will result in unnecessary trips or wait times for drivers and passengers.	Test ready	Testing of real-time access to status of transfer requests on both outgoing and incoming vehicles will identify areas for improvement in the accuracy and reliability of wireless data communication with the central system and in-vehicle hardware/ software configurations.
In-Vehicle	Technical Issue: Determination of "hold-until" times	RC-7 and RC-9	Determination of an appropriate threshold for "hold-until" times is critical to avoid excessive wait times for drivers and passengers, and impacts on the schedule adherence for downstream stops (with respect to a transfer point).	Additional research required	Further research is required to determine the best practices related to "hold-until" times at transfer stops.
Central System	Technical and Non-technical Issue (institutional): Multi-agency coordination in real-time	RC-14 through RC-18	The lack of data sharing arrangements among regional agencies for operational information could result T-CONNECT not functioning as defined in the requirements.	Test ready	Testing will verify the accuracy and timeliness of data available from participating agencies and relevant areas for improvement. The identification/agreement of necessary data sharing and integration standards would be expected to occur during high-level and detailed design (prior to testing) and testing would be used to confirm that necessary standardization has occurred between systems.
Central System	Technical Issue: Implementation of multi-agency trip planners based on real-time information	RC-45 and RC-46	In a multi-agency environment, customers should have access to a real-time trip planner to assess details related to transfer alternatives (e.g., wait times, transfer fare).	Test ready	Implementation and testing of a real-time trip planner (e.g., Google) will identify areas of improvement in algorithm optimization. The identification/agreement of necessary data sharing and integration standards would be expected to occur during high-level and detailed design (prior to testing) and testing would be used to confirm that necessary standardization has occurred between systems.

Category	Technical and Non-Technical Issues	Rqmt No.	Implication	Test Ready?	Utility
Central System	Technical Issue: Determination of performance criteria	RC-75 through RC-82	Performance criteria still need to be determined as part of the system design.	Additional research required	Further research will identify basic performance criteria. These criteria will need to be refined further according to agency characteristics when the application becomes test ready.
Central System	Technical and Non-technical Issue organizational): Finalization of system optimization parameters	RC-14 through RC-18	System optimization parameters have a direct effect on productivity. These parameters are required for the T-CONNECT Request Broker subsystem.	Test ready	Testing will identify the appropriate system parameters according to agency characteristics and customer preferences/ requirements.
Customer-end System	Technical Issue: Accuracy and reliability of real-time information	RC-60 through RC-67	Incorrect information will result in excessive wait times at transfer points for customers.	Test ready	Testing will help verify accuracy, reliability and timeliness of information and reduce customer wait times at transfer points.
Customer-end System	Technical Issue: Security of personally-identifiable information (PII)	RC-54 through RC-56	T-CONNECT should provide reasonable safeguards to protect the information contained in a customer's profile, transactions, and real-time information to protect against fraudulent and malicious uses of the information.	Test ready	Testing will ensure the security of PII

2.2 T-DISP

Table 2 describes the assessment of issues and test readiness of the functional and performance requirements for the T-DISP application. Three categories of requirements were considered during the assessment: in-vehicle, central system and customer-end system requirements.

Table 2. T-DISP Requirements

Category	Technical and Non-Technical Issues	Rqmt No.	Implication	Test Ready?	Utility
In-Vehicle	Technical Issue: Integration with existing in-vehicle systems	RD-1 through RD-7	T-DISP functions (e.g., real-time schedule adjustments and vehicle assignments/ reassignments) are heavily dependent on integration with in-vehicle systems (e.g., MDT and voice/data communication subsystem). Any abnormal (according to the requirements) functioning of in-vehicle equipment will adversely affect T-DISP functions.	Test ready	Testing will identify the issues associated with in-vehicle system integration. Also, in-vehicle system parameters (to be determined as part of system design) related to agency characteristics can be refined during testing.

Category	Technical and Non-Technical Issues	Rqmt No.	Implication	Test Ready?	Utility
Central System	Technical and Non-technical Issue (institutional): Multi-agency coordination in real-time	RD-9 through RD-35	Service coordination arrangements will directly affect the T-DISP application's ability to access and process trip planning/ scheduling and operational data from multiple agencies. Institutional issues related to service coordination must be addressed so that participating agencies can access and process data as described in the requirements.	Test ready	Testing will verify T-DISP's ability to access and process data from multiple agencies when regional service coordination is in place. In the event that institutional barriers are limiting the application's ability to access and process data, additional provisions for coordination may be required for enhancing T-DISP capabilities (e.g., resolving billing /funding or revenue sharing issues, and exploring private service alternatives such as taxi service). The identification/agreement of necessary data sharing and integration standards would be expected to occur during high-level and detailed design (prior to testing) and testing would be used to confirm that necessary standardization has occurred between systems.
Central System	Technical Issue: Implementation of multi-agency trip planners based on real-time information	RD-29 and RD-30	In a multi-agency environment, customers should have access to a real-time trip planner to assess details related to trip alternatives (e.g., modes, transfers, wait time, and walk time).	Test ready	Implementation and testing of a real-time trip planner (e.g., Google) will identify areas of improvement in algorithm optimization. The identification/agreement of necessary data sharing and integration standards would be expected to occur during high-level and detailed design (prior to testing) and testing would be used to confirm that necessary standardization has occurred between systems.
Central System	Technical Issue: Determination of performance criteria	RD-61 through RD-67	Performance criteria still need to be determined as part of the system design.	Additional research required	Further research will identify basic performance criteria. These criteria will need to be refined further according to agency characteristics when the application becomes test ready.

Category	Technical and Non-Technical Issues	Rqmt No.	Implication	Test Ready?	Utility
Central System	Technical and Non-technical Issue (organizational): Finalization of system optimization parameters	RD-8 through RD-30	System optimization parameters will directly affect productivity. These parameters are required for the multi-modal scheduling subsystem.	Test ready	Testing will identify the appropriate system parameters according to agency characteristics and customer preferences/ requirements.
Customer-end System	Technical Issue: Access to reservations/ scheduling systems	RD-42, RD-44, and RD-48 through RD-57	Customers should be able to reserve trips and make modifications/cancellations through a variety of electronic media.	Test ready	Access to reservation systems should be tested for their effectiveness according to the agencies' service area characteristics. Further, additional research may be conducted to explore the possibility of integration with existing public information systems such as 211, 311 and 511.
Customer-end System	Technical Issue: Access to accurate and reliable real-time traveler information	RD-59, RD-60, RD-68 and RD-69	In a multi-modal environment, particularly involving different agencies, access to real-time traveler information is critical for customer satisfaction.	Test ready	Testing will help verify accuracy, reliability and timeliness of information and areas for improvements.
Customer-end System	Technical Issue: Security of personally-identifiable information (PII)	RD-44 through RD-47	T-DISP should provide reasonable safeguards to protect the information contained in a customer's profile, transactions, and real-time information to protect against fraudulent and malicious uses of the information.	Test ready	Testing will ensure the security of PII.

2.3 D-RIDE

Table 3 describes the assessment of issues and test readiness of the functional and performance requirements for the D-RIDE application. The two categories of requirements were considered during the assessment: user interface and data (control) center requirements.

Table 3. D-RIDE Requirements

Category	Technical and Non-Technical Issues	Rqmt No.	Implication	Test Ready?	Utility
User Interface	Non-technical Issue: Social acceptance of real-time ridesharing	N/A	Much of the D-RIDE technology discussed through the ConOps and System Requirements is here today; however, technology developers struggle with getting enough users to use the application.	Test Ready	Pilots on acceptability of the technology can help provide a market case for developers as well as inform the traveling public about technology-driven ridesharing options.
User Interface	Technical Issue: Ensuring reliable location information	RR-2, RR-8, RR-11, RR-15, and RR-17	Identifying current user location may be difficult if users choose not to enable location services or in areas where transmission services may be unreliable.	Test Ready	Testing reliability of service ensures optimal ridematches and routing information is provided to the driver.
User Interface	Non-technical Issue: Pricing policy must be defined and accepted	RR-7 and RR12	A pricing scheme must be established that is both economical enough to the rider to choose ridesharing over transit and lucrative enough to support driver-related costs (i.e., gas, maintenance, tolls)	Test Ready	Testing different rate structures and methods for charging will provide market research for which developers can base competitive pricing and services.
User Interface	Technical Issue: In-vehicle systems will require on-board D-RIDE applications to minimize driver distraction	RR-1, RR-6, RR-10, and RR-21	Design development will need to include working with the automotive industry or relying on more customizable on-board systems to allow for D-RIDE application integration.	Additional Research	Further research will allow for completely hands-free interface and push messaging to the driver to minimize distraction.

Category	Technical and Non-Technical Issues	Rqmt No.	Implication	Test Ready?	Utility
User Interface	Technical Issue: Application communication performance measures need to be defined and acceptable to the user	RR-19, RR-20, and	Application message transmission and ridematch processing times need to be determined as both feasible by the developer and acceptable to the user.	Test Ready	Testing will identify optimal performance metrics for application transmission times, further increasing the utility of D-RIDE.
User Interface	Technical Issue: Security of personally-identifiable information (PII)	RR-4, RR-8, RR-11, RR-13, RR-14, RR-15, and RR-16	D-RIDE should provide reasonable safeguards to protect the information contained in a customer's profile, transactions, and real-time information to protect against fraudulent and malicious uses of the information.	Test ready	Testing will ensure the security of PII.
Data (control) Center	Technical Issue: Integration with real-time transit trip planners	RR-17	The application will need to interface with transit trip planners to offer transit as a possible ridesharing option – this requires interfacing with transit agency trip planners, schedules, and route information in the correct format needed for inputting into the D-RIDE application.	Additional Research	Further research will determine the best formats for data, data rights and access, and solve other transit integration issues. Further, standards regarding transit trip planners should be identified or developed if they do not exist in order to facilitate the integration.
Data (control) Center	Technical Issue: Data Center must be capable of storing a large quantity of information from a variety of sources	RR-11, RR-14, and RR-16	D-RIDE will need enough capacity to run a large number of queries and profiles, as well as geographic information so data storage and aggregation services will need to be robust to handle the load.	Test Ready	Testing of various data repositories will help determine optimal configurations for storage for developers.

Category	Technical and Non-Technical Issues	Rqmt No.	Implication	Test Ready?	Utility
Data (control) Center	Technical Issue: Data Center communication performance measures need to be defined and acceptable to the user	RR-21 and RR-22	Data transmission and ridematch processing times need to be determined as both feasible by the developer and acceptable to the user.	Test Ready	Testing will identify optimal performance metrics for data transmission times, further increasing the utility of D-RIDE.
Data (control) Center	Technical Issue: Security of personally-identifiable information (PII)	RR-4, RR-8, RR-11, RR-13, RR-14, RR-15, and RR-16	D-RIDE should provide reasonable safeguards to protect the information contained in a customer's profile, transactions, and real-time information to protect against fraudulent and malicious uses of the information.	Test ready	Testing will ensure the security of PII.

Chapter 3. Summary

This section summarizes the key issues related to field-testing the IDTO bundle and the individual applications. In addition, elements needing additional research, elements ready to be tested in 2012-2013 and the utility of testing are also highlighted.

First, it is critical that the systems engineering process continues in the development of the IDTO bundle of applications. Given that the requirements were developed in the prior task in this project, the next logical step is the high-level design, followed by the detailed design. In the absence of these subsequent steps, testing will be limited, addressing only the baseline requirements. Testing in the context of the systems engineering approach takes place after implementation, which follows detailed design. Thus, testing immediately after the requirements development will impact the quality of the IDTO applications and the ability of the applications to address the issues described in Section 2 of this report.

Second, as described in the ***Report on Assessment of Relevant Prior and Ongoing Research for the Concept Development and Needs Identification for Integrated Dynamic Transit Operations*** and stated in Section 2 of this report, perhaps the most significant issues associated with the deployment of IDTO applications are institutional and organizational. T-DISP, in particular, will be successful if regional agencies share operational data and agree to provide services in a different way than they do today. Agencies will be providing customers with a wider selection of services, meaning that trips that might have been taken on one authority's system could be taken on another's system, on a private carrier or using ridesharing. As this could affect each provider's revenue, addressing these institutional issues will be challenging.

However, as demonstrated in the Integrated Corridor Management (ICM) Program, these issues can be addressed. We expect that the interest in utilizing IDTO applications will provide the encouragement for regional agencies to address the institutional issues.

Third, common standards currently do not exist for data sharing and integration, which are critical functions that must exist within the IDTO bundle of applications. The development of such standards must be followed closely to determine their applicability to the IDTO applications.

Finally, since each IDTO application is in some stage of deployment already in the field, testing will be facilitated in those regions that already have some experience with the applications. For T-CONNECT, most of the requirements are test-ready (as described in Section 2.1). Those requiring additional research cover the following topics:

- Dwell times due to drivers having to enter transfer requests on behalf of customers (e.g., where the customer does not have a mobile device) will likely increase. Additional research is necessary to ensure that any data entry and transfer confirmations are made as quickly as possible so as not to increase dwell times.
- Integration with multiple fare systems will be necessary to facilitate transfers between and among a variety of transportation providers. While several regional fare systems already exist throughout the U.S., not all regions that may deploy T-CONNECT have integrated fare systems. Further, if both public and private services are available in a region, fare integration between these services likely does not exist already.

- Appropriate hold times must be determined depending on several factors. Additional research is needed to identify these factors and develop best practices in calculating hold times.
- In terms of the Central System requirements, performance criteria must be defined to ensure reasonable operational speed.

In T-DISP, the majority of functional requirements are test ready. Addressing the institutional, operational and technical impacts as stated in the ***Report on Assessment of Relevant Prior and Ongoing Research for the Concept Development and Needs Identification for Integrated Dynamic Transit Operations*** will be critical to the success of deploying this application. However, currently, the FlexBus demonstration being conducted by LYNX in Orlando, FL will be testing many of the T-DISP requirements.

Because of the advancements in ridesharing over the past several years, most of the D-RIDE functions are test ready. The two requiring additional research include identifying in-vehicle systems that minimize driver distraction and making real-time trip planners including ridesharing options available. There are several efforts at the Federal level to address driver distraction and real-time trip planners are becoming more sophisticated. For example, TriMet's new map trip planner (see http://www.trimet.org/howtoride/maptripplanner.htm) includes non-transit options, such as biking, and includes car-sharing locations. While this is not exactly what is described in the D-RIDE requirements, this trip planner incorporates more non-transit options than prior trip planners.

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487
www.its.dot.gov

FHWA-JPO-12-086

U.S. Department of Transportation