Report on Stakeholder Input on Transformational Goals, Performance Measures and User Needs for Integrated Dynamic Transit Operations

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Final Report — March 7, 2012
FHWA-JPO-12-084

U.S. Department of Transportation

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

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NOTICE

Technical Report Documentation Page

1. Report No. FHWA-JPO-12-084	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Report on Stakeholder Input on Transformational Goals, Performance Measures and User Needs for Integrated Dynamic Transit Operations		5. Report Date March 7, 2012	
		6. Performing Organization Code	
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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 Mr. Ron 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 on Stakeholder Input on Transformational Goals, Performance Measures and User Needs documents the stakeholder input on the goals, performance measures and user needs that will be used in the development of the Concept of Operations (ConOps) and high level functional requirements.

17. Key Words Integrated Dynamic Transit Operations, IDTO, Transformational Goals, Performance Measures, User Needs, 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 25	22. Price N/A

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Executive Summary

The purpose of the Report on Stakeholder Input on Transformational Goals, Performance Measures and User Needs for Integrated Dynamic Transit Operations (IDTO) is to document the stakeholder input on the goals, performance measures and user needs that will be used in the development of the Concept of Operations (ConOps) and high level functional requirements for the IDTO applications.

The IDTO applications are part of the United States Department of Transportation (USDOT)'s Intelligent Transportation Systems (ITS) Mobility Program. 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. Under this program, the USDOT has identified a portfolio of ten high-priority mobility applications, including a common bundle collectively identified as Integrated Dynamic Transit Operations, or IDTO. The three applications under the IDTO bundle will ultimately, enable transit systems to provide better information to travelers and increase the quality of service that they are able to provide. Being able to improve the transit experience will improve adoption allowing the program to meet its goals of improving the environment and increasing mobility.

These applications are:

- Connection Protection (T-CONNECT);
- Dynamic Transit Operations (T-DISP); and
- Dynamic Ridesharing (D-RIDE).

In selecting these applications, the USDOT sought applications that had the potential to be transformative (i.e., that they significantly alter existing transit services and result in substantial mobility improvements), that are achievable in the near-term, and that leverage the opportunities provided through connected entities. In the transit domain this led to the selection of applications that already exist in some fashion today.

Since portions of each application exists currently to some degree, stakeholder input was especially critical to develop transformative goals, performance measures and user needs for these applications. This report includes a brief description of the methods used to gather stakeholder feedback on these items. The feedback generated by stakeholders is presented in this report, along with the resulting draft final goals, objectives, performance measures and user needs. These will guide the development of the Concept of Operations for the three IDTO applications: T-CONNECT, T-DISP, and D-RIDE.

Chapter 1. Stakeholder Outreach for IDTO

As part of the effort to complete the ConOps for the IDTO bundle of applications, stakeholder input was solicited to identify transformative benefits or goals, corresponding performance measures, and user needs for the application. These will be used moving forward to inform the development of the IDTO ConOps and functional requirements.

The stakeholders identified for this project include a wide variety of participants from the public and private sector. This group represents developers, implementers and users of the potential applications, including transit ITS and intermodal traveler information experts in the research and developer community; transit system operators, managers, and users; transit vehicle original equipment manufacturers (OEMs); private system vendors and consultants; and travelers who regularly share rides with others.

The methodology for gathering feedback from the stakeholder group on the goals, performance measures and user needs included two meetings. The first meeting was an October 26, 2011 webinar that introduced the stakeholders to the IDTO project and to the three applications in the bundle. During this webinar, we solicited initial thoughts and feedback about the applications. A summary of that meeting was provided in the *Concept Development and Needs Identification for Integrated Dynamic Transit Operations (IDTO) Webinar Tech Memo* (submitted on November 7, 2011).

The next meeting was a face-to-face workshop that was held January 26 and 27, 2012 in Washington DC. This face-to-face meeting was designed to maximize the attendees' participation given that the meeting spanned two half day sessions. The project team designed the meeting to include a presentation of draft transformative goals, objectives, performance measures, scenarios, user needs, an overview of the DMA program and the required elements for the development of a ConOps and high level system requirements. This overview was given in order to provide context about the project and help focus the input and feedback that was sought during the workshop. In advance of the meeting, presentation slides as well as a workbook were developed so that meeting participants would be encouraged to provide input.

At the face-to-face workshop, participants received a workbook that included the presentation that was displayed during the meeting and copies of the scenarios, goals, objectives, performance measures, and user needs. Having a copy of the workbook allowed participants to make written notes on their own in addition to offering verbal comments to the group. In addition to the workbook, the project team at the meeting included note takers who recorded the conversations and comments.

The face-to-face meeting was designed to elicit feedback from the stakeholders in three ways. First, through group discussions about the overall project, and comments on the goals and objectives of each IDTO application, input was provided. Second, stakeholder input was provided in breakout groups – one group for each application. Finally, feedback was solicited in writing or follow-up emails after the meeting.

The first half of the meeting included an overview of the IDTO bundle, the draft visions of each application, and a review of the research and state of the practice. That was followed by a group discussion on the transformative concepts, goals, objectives and performance measures. This portion of the meeting ended with a brief review of the DMA Program and how the IDTO bundle fits into the larger USDOT DMA initiative.

The second half began by breaking out into groups to discuss the details each application. The breakout sessions were intended to discuss and comment on the draft scenarios and user needs of each application. The facilitator in each breakout group explained the scenarios and solicited input from the stakeholders. After the breakout sessions, the entire group of stakeholders reconvened and a representative from each breakout group presented the results of each discussion to the larger group.

A summary memo of the face-to-face meeting was submitted in the *Concept Development and Needs Identification for Integrated Dynamic Transit Operations (IDTO) Stakeholder Workshop Technical Memorandum* (submitted on February 9, 2012). The memo included the attendees and meeting notes from the meeting. The attendance at the meeting included representation from the identified stakeholder groups with the exception of the travelers who regularly share rides with others. As feedback is sought on the draft ConOps report, representation from this group can be targeted for specific feedback as needed.

Chapter 2. Stakeholder Feedback for IDTO

The following subsections present the stakeholder feedback gathered at the face-to-face workshop on the transformative goals, objectives, performance measures and user needs. Over the course of the workshop, these were presented and discussed. The discussions were conducted in an open-ended format with participants commenting or asking questions, and the facilitator addressing their input. Given time constraints, the user needs were discussed either very briefly or not at all. Stakeholder feedback will be solicited on those user needs is planned during the review of the ConOps. The subsections present the draft goals, objectives, performance measures, and user needs, are followed by the stakeholder comments, and then present revised versions.

2.1 Transformative Goals and Objectives

The final goals and objectives presented in this report are based on stakeholder feedback and comments. The goals and objectives then provide the basis of the ConOps for the IDTO bundle, including the T-CONNECT, T-DISP and D-RIDE applications. For the purposes of this report, the goals are qualitative, and represent broader and longer-term ideas about the purpose of the IDTO bundle and application. Objectives are quantitative, and represent more focused and shorter-term targets for the applications.

Workshop participants commented on the importance of having several goals at a higher level than the draft goals that were presented in the workshop. Given that the bundle is directly related to transit operations, the goals are closely aligned to goals that are frequently utilized for public transportation. A goal related to increasing ridership was felt to be a critical component of all three applications of the bundle. Another overall goal related to increasing ridership, was centered on conserving environment and energy use. A suggested goal was to reduce greenhouse gas emissions through increased transit ridership. Another theme that was repeated over the course of the meeting was that each application should be related to each other in order to maximize the mode choices for travelers. The disabilities, preferences and expectations of the traveler were other important considerations that were mentioned repeatedly through the discussion of each application. These considerations are especially important when designing services for the full range of disabilities (a person using a wheelchair, someone with a visual or auditory impairment, people travelling with children, someone using a mobility device, etc.) Another related consideration is the manner by which people access information, including in person, over the phone, using a mobile device, using a personal computer, etc. Also, a discussion about the costs and cost-effectiveness of the applications, which are often the most critical consideration for transit agencies given resource limitations, was held. Based on the discussion the following goals are presented for the IDTO bundle:

- Increase the mode share for public transportation and other shared-ride services through decreased single occupancy vehicle (SOV) use
- Decrease greenhouse gas emissions
- Reduce energy use

- Reduce or maintain operating costs for public transportation providers
- Address a broad range of user needs, disabilities and expectations
- Broaden the range of transit services available, especially in areas of low density or dispersed land use

The following subsections present the goals and objectives for each application, first, in draft form as they were presented to the meeting participants. Next, we describe the stakeholders' comments on the draft goals and objectives. Finally, we present the final goals and objectives based on the stakeholders' input.

2.1.1 Connection Protection (T-CONNECT)

Draft Goals:

The following draft goals for T-CONNECT were presented to the workshop participants:

- Implement a system that improves intermodal transfer connections involving multiple transit agencies
- Deploy an application that improves the probability of transit connections
- Improve rider satisfaction regarding transfers

Draft Objectives:

The following draft objectives were presented:

- Implement a system that improves coordination between transit agencies and vehicles through the use of various technologies
- Deploy a system that increases the number of successful connections
- Reduce overall round-trip travel times for transit riders requiring transfers
- Provide accurate and relevant real-time passenger information

Stakeholder Comments:

The comments from the stakeholders were as follows:

- The first priority is to operate a transit system as well as possible. If this is done, few connections would need to be maintained. Protecting as many connections as possible is a second priority. Maintaining connections should have a lower priority than scheduling and operating the system.
- While considering multiple transit agencies is a good component, it is important that the system could be used in a single agency environment as well.
- Since ridesharing may be part of T-CONNECT, the term "agency" may need to be changed to one that may be more inclusive of all transit options.
- All users should be considered, including those with disabilities.
- What is being sold must be clearly defined. If the intent is to sell an ability to get to a destination, considering long-haul regional transit is then significantly different than considering travel in an urban area with high-frequency services. How the application honors what was promised to its customers is what matters.
- Ties into congestion pricing for transit services could be made if travelers are willing to pay a premium for better connections.

- What constitutes a successful transfer must be clearly defined before trying to develop a system that seeks to increase the number of successful connections.
- There is a need to balance the cost between those who will benefit from the connection protection and those who will be affected by it.
- The objective may be simply to provide information onboard vehicles or on other mobile devices. This view was supported by the fact that recent focus groups indicated that while senior citizens want to be empowered and have the ability to make their own choice, they do not necessarily want to have choices made for them.
- It should be stated that the resulting system should be cost-effective and efficient.
- Minimization of operating costs.
- Use of T-CONNECT as a tool to increase the ridership base.
- Implementation of user-prioritization features, such as allowing vehicles to wait longer for frequent users of the service.
- Implementation of mode prioritization, such as allowing buses to wait longer than trains to protect connections.

Based on the stakeholder comments, the following revised goals and objectives are recommended:

Revised T-CONNECT Goals:

- Implement a system that enhances inter and intra-modal transfer opportunities for travelers using public, private and shared ride transportation modes
- Build upon efficiently and effectively scheduled transfers, and improve the probability of successful transfers/connections when needed
- Improve rider satisfaction regarding the length of their total trip time
- Include traveler preference and priority to account for frequency and time of travel (i.e. hold the last trip of the day longer, or for daily commuters)

Revised T-CONNECT Objectives:

- Allow for agency-defined thresholds and parameters that balance traveler expectations regarding making connections and waiting time while on-board
- Allow for transfer/connection times to be configurable by mode and route, depending on the specific operating environment (local, arterial, freeway)
- Allow for configurations based on modal priority (e.g. buses wait longer than trains)
- Increase the probability of transfers to be completed without a disruption in on-time performance (depending on the on-time performance standard)
- Reduce overall trip time for trips requiring a transfer
- Improve accuracy and relevance of real-time information for a traveler's complete journey, which may include providing information about transfers on-board using an automated announcement system

2.1.2 Dynamic Transit Operations (T-DISP)

Draft Goals:

The draft T-DISP goals and objectives that were presented to workshop participants were as follows:

- Provide travelers with information dynamically and in real-time
- Allow travelers to explore and assess different travel options from multiple transportation providers with predictable time and cost
- Dynamically schedule and dispatch multiple transportation modes by matching compatible traveler trip requests
- Reduce the costs of providing transit services, especially in areas of low density or dispersed land use

Draft Objectives:

The draft T-DISP objectives presented to the participants were:

- Expand use of demand-responsive transportation services through the use of personal mobile devices and transportation providers' on-board and central system technologies
- Provide a central or decentralized system to ease communication between transportation providers and leverage services from transit providers through dynamic routing, dispatching and scheduling based on real-time conditions
- Maximize the use of multiple transportation providers and types of service within a region to provide effective service to the community

Stakeholder Comments:

The comments from the stakeholders were as follows:

- There must be a tradeoff on how timely the system is and what options can be provided. The tradeoff is the ability to balance the number of riders, vehicles and their locations at any given time, and determine how to best route these vehicles to transport the maximum number of riders in the most cost-efficient manner
- The baseline against which cost reduction will be evaluated should be determined.
- Increasing ridership and revenue may be added as a goal
- There should be a focus on trip outcomes, not on outputs from trip requests
- The goals should reflect the fact that future routes may be dynamically generated through connected vehicle applications
- Environmental factors should be included in the goals
- Information equity should also be included in the goals since not all travelers will have access to a mobile device
- There should be consideration given to the business rules that transit agencies would follow under this application. Another consideration is why transit agencies would want to participate in this type of application
- There was a suggestion to be more inclusive of the potential for all modes, including private modes and shared rides
- The word effective or efficient may be more appropriate than maximize for the last objective
- Some questions were raised about where this type of application would be promoted, in areas where service already exists, or to be applied to areas where service does not exist currently. This has funding and resource implications for the service providers.

Based on the comments and feedback, the following revised goals and objectives are suggested:

Revised T-DISP Goals:

- Provide travelers with trip availability and cost information dynamically and in real-time about public, private and shared-ride transportation options
- Allow travelers to explore and assess different travel options from multiple transportation providers and modes with predictable times and cost
- Dynamically schedule and dispatch multiple transportation modes by matching compatible traveler trip requests

Revised T-DISP Objectives:

- Provide demand-responsive transportation services utilizing travelers' personal mobile devices in combination with transportation providers' on-board and central system technologies
- Provide a central or decentralized system to ease communication among transportation providers and leverage services from public and private providers through dynamic routing, dispatching and scheduling based on real-time conditions
- Promote the use of multiple transportation providers and types of services within a region to provide effective service to the community
- Develop a business model and rules that support a cooperative and/or competitive arrangement for trip assignment
- Define configurations and parameters within the system to schedule trips based on trip requests, available vehicles, trip time, trip location, in order to meet the stated business rules (e.g., maximize number of trips, reduce travel times, provide service to low density areas).
- Provide service at a cost-neutral or lower operating cost, while providing the same or more service to the community

2.1.3 Dynamic Ridesharing (D-RIDE)

Draft Goals and Objectives:

The draft D-RIDE goals and objectives were presented as follows:

- Improve feasibility and convenience of non-transit ride-sharing options to include mode-share and lessen congestion
- Provide secure location-based data and accurate reporting of status for high-occupancy vehicle (HOV) / high-occupancy toll (HOT) restricted lanes for occupancy enforcement and improving tolling strategies

Stakeholder Comments:

The following comments were made by the stakeholders on these draft goals and objectives:

- The modes considered should be clarified. Vanpools seem to fit into public transit in the currently defined objectives
- D-RIDE should be operated at the least possible cost. While some options may be available, no one may use them if they are too expensive
- An objective could be to monitor park-and-ride lots to obtain data on drop off and pick up sites

- There should be an objective ensuring ride security for both drivers and passengers

Based on the comments and feedback, the following revised goals and objectives are suggested:

Revised D-RIDE Goals:

- Increase use of non-transit ride-sharing options including carpooling and vanpooling.
- Improve accuracy of vehicle occupancy determination for occupancy enforcement and revenue collection on managed lanes.

Revised D-RIDE Objectives:

- Increase use of in-vehicle and/or hand held mobile devices to support non-transit ride sharing options for travelers.
- Increase use of in-vehicle and/or hand held mobile devices to support non-transit ride sharing options for tolling authorities and departments of transportation.
- Improve feasibility and convenience of non-transit ride-sharing options for travelers.
- Ensure security for drivers and passengers
- Increase non-transit ride sharing mode share and thereby reduce congestion.
- Provide methods for location-based data and reporting on vehicle occupancy status on capacity restricted and/or managed lanes, including HOV and HOT.

2.2 Performance Measures

In addition to the goals and objectives, performance measures will be used to guide the development of the ConOps, and are directly related to measuring whether or not each application achieves its goals and objectives. Also, the performance measures will be used as input into the development of the high level system requirements.

As the discussion at the workshop moved into the performance measures, participants offered comments regarding the reasonableness of the draft performance measures as well as identified gaps. However, different agencies, organizations and entities may have existing performance measures that may be complementary or in conflict. As the revisions to the performance measures were made, based on stakeholder input, the idea that exact measures would vary by the size and complexity of the operating environment was considered. As such, the performance measures may be more narrowly or broadly defined when applied to a specific agency or set of organizations.

2.2.1 T-CONNECT

Draft Performance Measures:

The following draft performance measures were presented at the meeting.

- Average transfer passenger waiting time (from incoming vehicle) is less than 3 min.;
- Average in-vehicle passenger waiting time (for the “outgoing” vehicle) is less than 1 min.;
- Average downstream passenger waiting time (for outgoing vehicle) less than 3 min.;
- Average successful low latency connections achieved: 20% (a connection that occurs within 1 minute);
- Average successful mid-latency connections achieved: 40% (a connection that occurs within 2 minutes);

- Percentage of successful connections involving more than one agency: 95%;
- Percentage of successful connections involving more than one mode: 95%;
- Percentage of successful connection involving fixed and flexible modes: 90%;
- Percentage of reduced complaints from customers regarding transfers: 90%; and
- Average response time to customers regarding a successful transfer request: 2 minutes.

Stakeholder Comments:

The comments from stakeholders including the following:

- Performance measures on travel time and trip time reliability are the most important aspects to the traveler
- Metrics should not only consider averages, but also peak and extreme values
- Allowable wait times should vary as a function of mode and route. This would allow taking into account different operating environments, such as a bus running on an arterial vs. a freeway.
- Metrics on reduced complaints should focus only on scheduled routes, as system operators often receive complaints regarding routes that were never scheduled.
- The term “on-time” is subjective. While some transit operators consider on-time as 1 minute early to five minutes late, others may use different criteria. The values shown in the presentation are very aggressive and some math needs to be done to determine appropriate values for each region/agency.
- The availability of supporting data availability must be considered. While the listed metrics look feasible, not all agencies may have available the data to calculate the measures.
- Customer satisfaction does not only result from connection protection, but also from the ability to do fewer connections.

The following additional performance measures were suggested by the stakeholders:

- Measures assessing connection improvements, such as reduction in missed connections
- Metrics quantifying the consequences for failing to meet a connection
- Measure of real-time travel time reliability
- Metrics quantifying the ability to attract new ridership
- Metrics relating program success to the amount funding received
- Number of agencies participating in T-CONNECT and number of riders subscribing to it as measures of success
- Number of requests successfully granted and failed, with reason(s) for failure

Revised T-CONNECT Performance Measures:

Based on the stakeholder comments, the following revised performance measures are recommended:

- Total trip time per passenger
- Trip time reliability as measured by length of trip (time) and factored by number of trips
- Transfer passenger waiting time from incoming vehicle (average, peak and extreme) is less than 3 min.

- In-vehicle passenger waiting time for the “outgoing” vehicle (average, peak and extreme) is less than 1 min
- Downstream passenger waiting time for outgoing vehicle (average, peak and extreme) is less than 3 min
- Successful Low Latency Connections Achieved (average, peak and extreme) is 20% (a connection that occurs within 1 minute)
- Successful Mid Latency Connections Achieved (average, peak and extreme) is 40% (a connection that occurs within 2 minutes)
- Percentage of connections requested and then made that involve more than one agency is equal to 95%
- Percentage of connections requested and then made that involve more than one mode is equal to 95%
- Percentage of connections requested and then made that involve fixed and flexible modes is equal to 90%
- Increased rider satisfaction based on trip time and perceived trip time
- Percentage of reduced complaints from customers regarding transfers is equal to 90%
- Average response time to customers regarding a successful transfer request is equal to 2 minutes
- Reduction in missed connections
- Number of transfer requests made
- Number of transfer requests not made
- Increased number of subscribers and agencies providing T-CONNECT

2.2.2 T-DISP

Draft Performance Measures:

The following draft performance measures were presented at the workshop:

- Average time from making a request to receiving a trip confirmation (45-second target)
- Number of trips scheduled by the Control Center compared to overall transit ridership, per time frame
- Average waiting time for a passenger pickup since time of trip request
- Average on-board time for passengers
- Average boarding time for group trips
- Number of trips performed by each transit mode: fixed, flex, demand response, private, or other shared ride
- Number of trips performed by each provider (public and private)
- Percentage of no shows and cancellations
- Reduction in trip cost per passenger

Stakeholder Comments:

Comments made by session participants on the draft performance measures include the following:

- A European project called Sunrise developed similar performance measures
- A missing metric is one quantifying route deviations for each passenger on-board
- The number of trips per mode is not a measure of effectiveness and should be removed
- The average time to complete a trip request in relation to the time a person reaches his goal should be added as a metric.
- An additional measure combining efficient and environmental goals could be passenger miles per unit of energy
- The number of modes participating in T-DISP could measure the program's success
- "On-board time" should be changed to "delay" to allow better comparison between short and long routes
- Trip time and trip reliability are two of the most important parameters for travelers. If this information is to be provided, travelers should receive values for the "worst-case scenario" so that trips will often be better than expected.
- An increase in overall mobility was suggested as a performance measure.
- A measure of the time taken to travel by single occupant vehicle (SOV) vs. this application was also suggested as a measure.

Revised T-DISP Performance Measures:

Based on stakeholders' comments, the following revised performance measures are recommended for T-DISP.

- Duration of time from making a request to receiving a trip confirmation (average, peak and extreme) Approximately 45 seconds
- Duration of time between passenger pickup and trip confirmation (average, peak and extreme)
- Number of trips scheduled by the Control Center compared to overall transit ridership per time frame By hour, day, week, month, year
- On-board time for passengers (average, peak and extreme)
- Delay for passengers (average, peak and extreme)
- Boarding time for group trips (average, peak and extreme)
- Number of trips performed by each mode to provide analysis and feedback on the system
- Number of trips performed by each provider (public and private)
- Number of modes participating in the system
- Percentage of no shows and cancellations
- Change in cost per passenger from one time period to the next Decrease or stable from quarter in previous year
- Time and length of route deviations for passengers on-board the vehicle (for flex and demand response modes)
- Increase in overall mobility as measured by the number of transit trips taken as compared to total single occupant vehicle trips
- Trip reliability as measured by the number of trips requested by travelers and the number of trips made by travelers

- Time comparison between SOV and transit mode for selected similar trips
- Provide accurate and reliable trip time and trip information to travelers to manage expectations

2.2.3 D-RIDE

Draft Performance Measures:

The following draft performance measures were presented to the workshop participants:

- Concentration of participating (number per n radius miles)
- Average passenger waiting time (10 min or less)
- Rate of occurrence of ride matches (ride matches per n trip requests)
- Rate of occurrence of late arrivals
- Average response time to customers about found rides
- Number of trips with modifications due to accident/incident with a vehicle
- Percentage of no-shows
- Average on-board time for passengers, by vehicle capacity
- Number of D-RIDEs per month with HOV lane utilization

Stakeholder Comments:

The stakeholders' comments on the draft performance measures include the following:

- There is little value in providing firm target values without extensive knowledge behind them. To provide appropriate context, the values need to be agency/region specific and tied into the number of requests.
- The metric for the rate of occurrence of ride matches is confusing as worded.
- Boundaries should be put on the measure assessing the concentration of participants. Alternatively, this measure could be considered in relation to the number of registered vehicles per locality.
- The HOV performance measure needs to be fixed. The percentage of HOV2+ should be greater than that of HOV3+, as a vehicle with four riders falls into both the HOV2+ and HOV3+ categories, while a vehicle with three riders only falls into the HOV2+ category.
- Suggestions for additional performance measures include:
- Environmental performance.
- Economic performance
- Time savings in both general purpose and HOV lanes.
- Reduction of VMT (or other congestion measure) on general purpose lanes.
- Number of repeat and new riders.
- Measures related to the safety of riders and drivers. This can be done through user-provided rankings, or measures about the number of times a rider uses the same driver.

Revised D-RIDE Performance Measures:

Based on the stakeholder comments, the following revised performance measures are suggested:

- Number of participants in the system measured as a percentage of the number of registered vehicles in the 'service area'
- Number of repeat riders and new riders.
- Participant satisfaction with safety/security of riders and drivers
- Overall participant satisfaction
- Participant perception of economic benefits in terms of trip costs.
- Concentration of participants in the system as defined by a number per n radius miles
- Passenger waiting time (average, peak, extreme) is equal to 10 minutes or less
- Percentage of ride matches to requests as defined by ride matches per n trip requests
- Rate of occurrence of instances when the ride does not arrive at the expected time
- Response time to customers about found rides
- Number of shared-ride trips with modifications due to accident/incident of the shared-ride vehicle
- Percentage of no-shows
- Average on-board time for passengers, by vehicle capacity
- Number of D-RIDE per month with HOV lane utilization
- Change in toll revenue from use of D-RIDE system
- Change in use of HOV lanes from D-RIDE participants
- Number of riders per vehicle
- Change in travel time on general purpose lane from year to year
- Change in travel time on managed lanesfrom year to year

2.3 User Needs

User needs, along with the goals, objectives and performance measures, will be used to develop the ConOps and the high-level system requirements. The user needs are a direct input into what is required for the resulting functionality of the IDTO applications. These user needs will form the basis for the requirements and the resulting "Needs to Requirements" matrix, which traces requirements back to the needs. As part of the workshop materials, a draft set of user needs was prepared and included in the workbook for the participants. Draft user needs were developed for each application and were based on the expected users of the system, which include the following:

- Travelers or riders using public and/or private transportation modes
- Drivers or passengers of private automobiles
- Software vendors, who would develop, provide and maintain software for the applications
- Transit agencies and transportation providers and their staff, including dispatchers, vehicle operators
- System manager and/or Control Center, which represents the entity that would physically or virtually manage and operate the applications, and their staff, such as an executive level manager

For each application the following draft user needs were presented during the breakout sessions. However, time constraints precluded a full discussion on the user needs. Additional stakeholder input will be solicited during the review of the ConOps.

2.3.1 T-CONNECT

User	User Need	Description
Dispatcher	Need to have the access to the T-CONNECT system to view the list of requested transfers, their status and operational resources (agencies, vehicles, drivers) involved	Dispatchers should always have access to the transfer requests and relevant analytical tools (view real-time status, calculate ETA, determine need for an additional bus etc.)
Dispatcher	Needs to have the access to the T-CONNECT system to manually intervene in the event there was a denial by the automated system for a valid transfer request due to operational anomalies	Dispatcher should have the ability to manually override the decision made by the T-CONNECT system in the event decision is going to have an impact on the operations due to real-time events not known to the automated system
Dispatcher	Needs to have access to real-time location, and real-time route and schedule adherence (RSA) information of vehicles involved in transfers.	Dispatcher should always have access to location, RSA and other event-based data (incident/accident) for all vehicles involved
Dispatcher	When multiple agencies/operational units are involved Dispatcher needs access to service agreements and service coordination tools	In the event where regional agencies are involved, access levels to operational tools owned by individual agencies should be determined. For example, Dispatcher of one particular agency may have access to only real-time location information for a partner agency vehicle
Executive Manager	Needs the T-CONNECT system to be connected to a traffic management center	Operational scenarios to be used by the automated T-CONNECT system should be established by the Executive Managers
Executive Manager	Need to establish regional fare collection and revenue sharing arrangements/technologies when multiple agencies are involved	Agencies involved in a particular transfer may have different transfer policies and fare collection technologies Thus managers should determine how these should be integrated such that the process is seamless to the rider.

User	User Need	Description
Rider	Needs access to T-CONNECT interface where transfer can be requested	Riders should be able to use a connected personal device to request transfer to a particular route
Rider	Needs access to T-CONNECT interface where real-time status of transfer request can be monitored	Riders should be able to use a connected personal device to monitor the status of their request
Rider	Needs access to T-CONNECT interface where approval/denial of transfer is notified	Riders should be able to receive a notification as per their preference (email, text message) when a transfer is approved or denied
System Manager	Needs to enable two-way communication between T-CONNECT system and the vehicle	Two-way communication gateway and infrastructure as needed should be established so that connected vehicles can communicate with control center(s) and the T-CONNECT applications
System Manager	Needs to enable two-way communication between agencies whose vehicles are involved in the transfer	Two-way communication gateway and infrastructure as needed should be established between regional agencies so that control centers and operational tools/applications hosted by those centers can communicate in real-time when needed
System Manager	Needs the T-CONNECT system to be connected to a traffic management center	Two-way communication with regional traffic management centers should be established so that estimated time of arrival of vehicles can be corrected based on real-time or historic traffic information when available
Vehicle operator	Needs the transit vehicle to be connected wirelessly to the T-CONNECT system	Vehicles should be wirelessly connected using Connected Vehicle or other conventional wireless technologies
Vehicle operator	Needs access to T-CONNECT interface where transfer can be requested using a terminal	Drivers should be able to access the interface using a mobile data terminal (MDT) or a similar interface
Vehicle operator	Needs access to T-CONNECT interface where approval/denial of transfer is notified	Audio/visual notification of transfer request approval/denial should be provided by the T-CONNECT system

2.3.2 T-DISP

User	User Need	Description
Control Center	Need to access real-time data (from multiple modes and jurisdictions)	Any T-DISP architecture will require access to real-time data from multiple modes of transportation
Control Center	Need to access network configuration data from one or more sources	Network configuration data includes field device locations, roadway network, bus routes, and other types of static data
Control Center	Need to process real-time and historical input data to predict future transportation network conditions	T-DISP will use real-time and historical data to predict future conditions using either algorithms and/or models
Control Center	Need to send trip description characteristics back to travelers	Travelers must be able to receive information about their possible trip
Control Center, Transportation Providers	Need business rules to guide decisions about how trips are distributed to transportation providers	Coordination efforts amongst transportation providers that include private and public entities will need to have an agreed business rule.
Software vendors, Control Center	Need to expand the current capabilities of scheduling and routing software programs	T-DISP architecture will need a more robust system to dynamically route multi-modal service
Software vendors, Control Center	Need to provide a real-time modeling capability to evaluate trip requests and routing strategies	Pre-stored and dynamic response plans are input into a real-time model (a model that runs fast enough to affect response decisions) for evaluation and/or selection
Software vendors; Control Center; Transportation Providers	Need to develop an interface for different dispatch and vehicle location systems into the reservations / scheduling system	In a multiple provider environment, different CAD/AVL systems may be used so vehicle location data will need to be standardized
Software vendors; Control Center; Transportation Providers	Need to develop an interface for different dispatch and vehicle location systems to receive messages from the reservations / scheduling system	In a multiple provider environment, different CAD/AVL systems may be used so sending trip request data to the vehicles will need to be standardized.
Transportation providers, Control Center	Need scheduling parameters and operational policies to determine how trips are assigned and routed.	Operational policies and detailed scheduling parameters will guide how individual trips are assigned and to which vehicle.

User	User Need	Description
Transportation Providers; Private and Public modes	Need to generate real-time data (from multiple modes and jurisdictions)	Any T-DISP architecture will need to generate real-time vehicle location data from multiple modes of transportation
Travelers	Need to send trip requests to the reservations and scheduling system	Travelers (customers) need to be able to send trip requests that have origin and destination (and for return trip)
Travelers	Need to receive information about trip times and options	Travelers (customers) need to be able to receive trip confirmations, denials, fare, and trip times

2.3.3 D-RIDE

User	User Need	Description
Driver	Need D-RIDE application that is hands-free/in-vehicle and can detect location with a high level of accuracy.	D-RIDE must be safe and accessible to drivers and provide accurate information on the whereabouts of the vehicle to inform the system and make the most accurate ridematches.
Passenger	Need D-RIDE application that is accessible by internet, any type of phone (fixed, mobile phone, smart phone, etc.), and other handheld devices	D-RIDE must be as accessible as possible to maintain concentration levels and enhanced convenience of ridesharing for travelers to make a mode shift.
Passenger	Need D-RIDE application to recognize location with a high level of accuracy.	D-RIDE must be able to locate a single traveler accurately for increased success rates for accurate matches.
Passenger/Driver	User interface needs to display information simplistically and ranked in order of efficiency.	To promote travelers understanding information about their trip and matches, information must be displayed in a user-friendly manner, especially for drivers who should not be distracted by poor informational displays or confusing messaging.
Passenger/Driver	Need to allow for two-way communications between passenger and driver.	Results of the ridematch must be communicated to the travelers who each accept the ridematch, with the acceptance messages being relayed back to the D-RIDE system.
Passenger/Driver	Need to be able to register for the D-RIDE program to create their user profile and define their preferences.	Automated ridematching can only occur if a user has set up their unique profile and established preferences for travel.

User	User Need	Description
System Manager	Need back-end services to be able to handle large quantities of data.	D-RIDE back-end services must be able to support a variety of data processing in real time (location, travel profile, requests, messaging) constantly, with increased activity during peak travel times.
System Manager	Need D-RIDE to communicate with other data centers (TMCs, tolling, enforcement).	D-RIDE must communicate with traffic data centers (TMCs), tolling centers, and enforcement to realize full potential of services.
System Manager	Need to access network configuration data from one or more sources.	Network configuration data includes field device locations, roadway network, priced routes, and other types of static data.
System Manager	Needs to have access to D-RIDE application.	Manual requests or system overrides may be necessary so the System Manager must be able to access the D-RIDE applications to either complete a user request or manually intervene when necessary.
System Manager	Needs to determine operational procedures on how ridematching should be performed.	Guidelines and logic regarding how ridematching is carried out must be established and maintained.
System Manager	Needs to define the how exception scenarios should be handled (e.g., incident/accident, delayed vehicle).	If an unforeseen circumstance compromises the completion of a trip, there must be an override function where the System Manager takes control to complete the trip.

Chapter 3. Next Steps

The next step in this project is to develop the draft ConOps and then finalize the ConOps based on any additional feedback from the stakeholder group and the USDOT team. The ConOps will include for each application the system overview, an overview of the current/existing systems, the justification for and nature of changes, the concepts for the proposed systems, operational scenarios, a summary of the proposed impacts, and an analysis of the proposed system.

Following the approval of the final ConOps, the functional and performance requirements will be developed. The requirements will identify what the IDTO bundle of applications shall accomplish in order to meet the goals and objectives identified in this report. The requirements will be organized into sub-systems in order to ensure that they can be traced back to the needs and issues identified in the ConOps. In addition to the requirements, the high level communications needs for implementation will be determined.

Both the ConOps and the functional requirements will be packaged into draft reports for review by the USDOT team and the stakeholder group. These documents will be reviewed in a face-to-face walkthrough meeting with the USDOT team.

The final phase of this project includes an assessment of test-readiness for the IDTO applications. This step includes identifying the technical and non-technical issues related to field testing the applications. This information will be packaged in a brief summary report and submitted to the USDOT team.

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FHWA-JPO-12-084

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