Test Report

Dallas Integrated Corridor Management (ICM) Demonstration Project

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Notice

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Cover Photo Courtesy of Lisa Rising, Dallas Area Rapid Transit

16. Abstract

The Dallas Area Rapid Transit (DART) is leading the US 75 Integrated Corridor Management (ICM) Demonstration Project for the Dallas region.   Coordinated corridor operations and management is predicated on being able to share transportation information on highways, arterials, transit, weather, and incidents. The ICM system will utilize the existing TxDOT Center-to-Center standards based communication infrastructure, and will provide direct connections to agencies not on the Center-to-Center network, via a web-based interface known as SmartNET. The ICM system uses SmartNET as the main graphical user interfaces for the ICM Stakeholders to create, edit, and view events in the corridor and region, view current conditions of field devices and congestion on the roadway network, and coordinate responses to incidents within the corridor.

This Test Report covers the test process and results for the various phases of testing for the ICM system.

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1 Executive Summary

As a part of the Dallas US-75 Integrated Corridor Management (ICM) Demonstration Project, the Dallas ICM team developed an acceptance test plan for verifying the requirements of the ICM System (ICMS).[1]

This document includes the test results for the Integration Testing, Pre-System Acceptance Testing, and the System Acceptance based on the Final System Acceptance Test Plan. It also includes a discussion on the testing process, and an assessment of its effectiveness. The testing process included multiple phases: unit testing, integration testing, and system acceptance testing. Unit testing is completed by the developers when a piece of code is developed and is tested to ensure it works and meets the requirements. Once multiple pieces of code are completed and unit tested is met, integration testing is performed to ensure that the code works properly together as an integrated system. Once integration testing is completed, the System Acceptance Test (SAT) is conducted for the stakeholders to verify that the system meets all requirements, and works as expected.

For the integration testing 10 defects were found in the first round of testing, and an additional 4 defects in the second round. These defects were corrected and re-tested prior to the Pre-System Acceptance Testing (Pre-SAT). During Pre-SAT, several test scripts were not completed due to the unavailability of data from external systems. These test scripts were noted, and approved by the stakeholders prior to SAT. For SAT, four scripts were identified prior to testing and were not completed due to changes in requirements or for systems interfaces which would be completed in the future.

Overall, the testing was successful and the stakeholder team approved the ICM System for operation.

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[1] The acceptance test plan was used to test the ICMS, not to validate the data provided by external sources. Thus, if the data is erroneous and the ICMS reports the erroneous data in an accurate and timely manner, then the ICMS has performed successfully.

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2 Introduction

This document is intended as a listing of a set of test results to verify the Requirements for the US-75 ICMS Demonstration Project in Dallas. The SmartFusion subsystem is to provide the data processing, fusion, and data dissemination functions for the ICMS. The SmartFusion Subsystem receives data from and provides data to the SmartNET Subsystem information exchange tool. The SmartFusion Subsystem also receives data from external interfaces described in this document. The basic SmartFusion subsystem already exists and provides the majority of the functionality needed for the ICMS.

The Decision Support Subsystem uses the data from the SmartFusion Subsystem in selecting appropriate response plans, and sending those recommended response plans to the ICM Coordinator in order to coordinate responses to incidents within the corridor.

2.1 References

- US-75 ICM System Acceptance Test Plan, Dallas Integrated Corridor Management (ICM) Demonstration Project, version 3.0, February 16, 2013
- US-75 ICM System Requirements, Dallas Integrated Corridor Management (ICM) Demonstration Project, December 2012
- US-75 ICM System Design Document, Dallas Integrated Corridor Management (ICM) Demonstration Project, June 21, 2013
- Data Dictionary, Dallas Integrated Corridor Management (ICM) Demonstration Project, November 2012

2.2 Key Stakeholders

The stakeholders for the project include:
- Dallas Area Rapid Transit
- City of Dallas
- City of Richardson
- City of Plano
- Town of Highland Park
- City of University Park
- North Central Texas Council of Governments
- North Texas Tollway Authority
- Texas Department of Transportation – Dallas District

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3 Test Summary

Project Name: US-75 Integrated Corridor Management Demonstration
System Name: ICMS
Version Number: release 1.0
Additional Comments: Release 1.0 of the ICMS was used for the soft launch on April 26, 2013. Release 1.1 of the ICMS was used for the hard launch on October 26, 2013.

3.1 Unit Testing

Unit testing was performed by the developers to test their code in a standalone fashion.
Test Owner: Fariel Bouattoura
Test Date: December 2012
Test Results: All unit testing was successful prior to integration testing.

3.2 Integration Testing

Test Owner: Fariel Bouattoura
Test Date: January 24, 2013 and February 20, 2013
Test Results: Held two rounds of integration testing, one month apart, to verify functionality and correct some of the data exchange. Minor defects were found and no major defects.
Additional Comments: none

3.3 Pre-SAT Testing

Pre-System Acceptance Testing (SAT) testing was completed the week prior to SAT to ensure system readiness and prepare for the Test Readiness Review. The Test Readiness Review (TRR) demonstrated the system was ready for SAT.

Test Owner: Fariel Bouattoura
Test Date: 3/15/2013
Test Results: Completed most SAT test scripts to ensure system was ready for SAT.
Additional Comments: none

3.4 SAT Testing

Test Owner: Koorosh Olyai
Test Date: 03/18/2013 to 03/20/2013
Test Results: All test scripts passed with only some minor comments and suggestions

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Additional Comments: Several scripts were not run due to data being unavailable, as noted in the test plan. In addition, the test scripts for the Decision Support Subsystem (DSS) were modified from the approved plan to only utilize relevant scripts.

3.5 Post SAT Testing

As new data links were added to the system, including parking management data, streaming video, and Automatic Vehicle Location/ Automatic Passenger Counter (AVL/ APC) data the system was fully tested by the Operations and Management (O&M) team to ensure all functionality was still working properly.

Test Owner: Fariel Bouattoura
Test Date: varied
Test Results: All testing was completed, and all scripts successful prior to promotion to production of the software.
Additional Comments: Testing occurred during 2 separate events. First, once parking data was available from the Parking Management System software. Second, once AVL/ APC data was available from the Dallas Area Rapid Transit (DART) Data Interface (DI). Streaming video was also added, and the icons within SmartNET changed to indicate streaming video versus snapshot. Lastly, any change orders were fully tested by the O&M team prior to promotion to production.

4 Test Assessment

Overall, the testing has some minor limitations. For instance, the test scripts were mostly related to data exchange, and not to ensure that the response from the data provided was completely accurate. As an example, the Prediction model was tested to show that it could receive data and provide a resulting Measure of Performance – but there was a trust by the stakeholders that the model is performing properly, and the Measure of Performance it provided were valid.   Several systems were not demonstrated fully, and were "black box" with data exchange verified only.

In addition, due to outside systems not being complete, the entire SAT scripts were not performed during SAT. This meant that the system was accepted for operation without all data being available, and required a lot more testing later once the data became available. The testing at a later date was not witnessed by the stakeholders, but the

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system was demonstrated to them after any major change and prior to promotion to production.

5 Test Results

Overall, the testing of the system revealed very minor technical defects. The majority of the enhancement and change requests were due to operational use of the system. For instance, the SmartNET Graphical User Interface (GUI) was later modified to streamline the response plan actions; this was discovered during an operational test of the system prior to go-live. The operators participating in the operational test found the system to function as expected, but requested several changes that would make their jobs more efficient.

5.1   Integration Testing

Unit, module, and system integration testing activities were performed during the development of the system build or release. Results were not recorded, but were used by the developers to correct and bugs or issues prior to integration testing.

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5.2 Integration Testing

For integration testing, the software modules tested in unit testing are combined and tested as a group. Integration testing included end-to-end testing of the ICMS using multiple scripts, and tested the work flow of the event management and response process flow shown in the System Design Document, and using the scripts provided in the System Acceptance Test Plan.

All SAT scripts were not tested, but rather just the scripts related to the integration of the SmartNET, SmartFusion and Decision Support subsystems.

The table below summarizes the issues found during the integration testing:

Table 1: Integration Test Defects

No.	Issue Title	Type	Receipt Date	Originator	Status	Resolution	Close Date
1	Description not updated when "no. lanes" & "lane status" was changed	Defect	1/24/2013	Fariel Bouattoura	Closed	Fixed in 2.5.16 (next release)	2/20/2013
2	During prediction status as "unknownTTIStatus"	Defect	1/24/2013	Fariel Bouattoura	Closed	Table lookup	2/20/2013

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No.	Issue Title	Type	Receipt Date	Originator	Status	Resolution	Close Date
3	During recommended state – Agencies can select accept or reject even though ICM coordinator hasn't decided	Defect	1/24/2013	Fariel Bouattoura	Closed		2/20/2013
4	Reject After vote doesn't trigger a reject message	Defect	1/24/2013	Fariel Bouattoura	Closed	Screen is updated to show rejected	2/20/2013
5	Re-open event that was closed is still showing in XML as implemented	Defect	1/24/2013	Fariel Bouattoura	Closed		2/20/2013
6	Terminated status in Expert Rules not working for simultaneous events reporting the same incident	Defect	1/24/2013	Brian Miller	Closed		2/20/2013

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No.	Issue Title	Type	Receipt Date	Originator	Status	Resolution	Close Date
7	Expert Rules does not clear events with terminated status after 10 min.	Defect	1/24/2013	Brian Miller	Closed		2/20/2013
8	Terminated status in Expert Rules not working when multiple response plan recommendation for the same event on re-open,	Defect	1/24/2013	Brian Miller	Closed		2/20/2013
9	Expert Rules manager not updating user status screen	Defect	1/24/2013	Brian Miller	Closed		2/20/2013
10	Reopening an event does not trigger the Expert Rules to re-propose a recommended response plan again	Defect	1/24/2013	Brian Miller	Closed		2/20/2013

After some additional bug fixes were done, a second round of integration testing was completed. The following table includes the defects found during the second round of integration testing.

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Table 2: Integration Testing Defects (second round)

No.	Issue Title	Type	Receipt Date	Originator	Status	Resolution	Close Date
1	Not all response plan URLs are working	Defect	2/20/2013	Brian Miller	Closed		3/15/2013
2	Expert Rules is not processing Terminate message	Defect	2/20/2013	Brian Miller	Closed		3/15/2013
3	Prediction submitted response to Expert Rules, and Expert Rules was stuck	Defect	2/20/2013	Brian Miller	Closed		3/15/2013
4	Local event showing in XML web service to Expert Rules	Defect	2/20/2013	Fariel Bouattoura	Closed		3/15/2013

4.3 Pre SAT Testing

Pre SAT Testing is performed by the development team prior to the Test Readiness Review for the System Acceptance Test. This test is used to verify that all systems are ready for the SAT. All defects discovered during integration testing were corrected and

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verified prior to Pre SAT Testing. The table below summarizes the test cases employed for ad hoc testing and the test results obtained for each test case:

Table 3: Pre SAT Results

Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
SF1	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SF2	3/15/2013	Fariel Bouattoura	Passed with comments	N/A	N/A	Yes	
SF3	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SF4	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SF5		Fariel Bouattoura	Could not complete	N/A	N/A		These include data items not available at time of testing; will be completed at a later date.
SF6		Fariel Bouattoura	Could not complete	N/A	N/A		These include data items not available at time of testing; will be completed at a later date.

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Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
SF7		Fariel Bouattoura	Could not complete	N/A	N/A		These include data items not available at time of testing; will be completed at a later date.
SF8	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SF9	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SF10	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SF11		Fariel Bouattoura	Could not complete	N/A	N/A		These include data items not available at time of testing; will be completed at a later date.
SF12		Fariel Bouattoura	Could not complete	N/A	N/A		These include data items not available at time of testing; will be completed at a later date.
SF13	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SN1	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	

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Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
SN2	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SN3	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SN4	3/15/2013	Fariel Bouattoura	Partially completed / Couldn't complete	N/A	N/A	Yes	
SN5	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SN6	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SN7	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SN8	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SN9	3/15/2013	Fariel Bouattoura	Partially completed / Couldn't complete	N/A	N/A	Yes	Traffic Signal data not available, nor planned at this time.

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Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
SN10	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
SN11	3/15/2013	Fariel Bouattoura	Passed	N/A	N/A	Yes	
DS1	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	
DS2	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	
DS3	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	
DS4	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	
DS25	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	
DS30	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	
DS35	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	

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Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
DS55	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	
DS65	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	
DS90	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	
DS100	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	
DS120	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	
DS125	3/15/2013	Brian Miller	Passed	N/A	N/A	Yes	

4.4   System Acceptance Testing

As stated in ISO/IEC 15288:2008: The purpose of the validation process is to provide objective evidence that the services provided by a system when in use comply with stakeholders' requirements, achieving its intended use in its intended operational environment. This process performs a comparative assessment and confirms that the stakeholders' requirements are correctly defined. Where variances are identified, these are recorded and guide corrective actions. System validation is ratified by stakeholders.

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This process is invoked during the stakeholders requirements definition process to confirm that the requirements properly reflect the stakeholder needs and to establish validation criteria (i.e., that the right system has been built). This process is also invoked during the transition process to handle the acceptance activities; for the Dallas ICM Demonstration, this phase is also known as the SAT.

For the SAT, all scripts were performed by the development team and verified by the stakeholder team by witnessing the test being run. Comments were provided for any tests regarding business process, unexpected results, or defects.

The table below summarizes the test cases employed for user acceptance testing and the test results obtained for each test case.

Table 4: SAT Results

Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
SN1	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	Pass for CCTV, DMS, and Detectors. Will be tested for Parking, Vehicle Location at a later date.
SN2	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	Stakeholders recommended that Exchange Server be used instead of local e-mail client for sending e-mail alerts.
SN3	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	

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Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
SN4	3/19/2013	Fariel Bouattoura	Pass	Minor	Missing data feeds to be added at later date, once available	Yes	Step 5: Weather layer will not be added to SmartNET. Navteq data currently not on arterials – will be added and tested at a later time.
SN5	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	Stakeholders to provide needed reports at a later Operations Committee meeting.
SN6	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	Stakeholders to discuss Alarms and filtering at a later time.
SN7	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	
SN8	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	
SN9	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	Traffic signal data currently not planned.
SN10	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	

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Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
SN11	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	1.0.1.20 requirement needs to be modified since data in DSS originates in SmartFusion. Review other requirements associated with DSS to ensure consistency.
SF1	3/18/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	
SF2	3/18/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	Steps 9, 10, 11 SmartNET Map was used instead of Public Web map
SF3	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	
SF4	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	
SF5	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	
SF6							Not tested due to parking management project incomplete. Will test at a later time.

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Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
SF7							Traffic Signal data will not be added to the project, due to C2C plug-in project delay.
SF8	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	DART to provide new color code for blue line.
SF9	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	Remove ambiguity of requirements 1.20.530 from "Incident Response Plan" to "Incident Response Record"
SF10	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	
SF11							Alarms will be re-done with stakeholder recommendations.
SF12							Sending data to C2C removed from scope at decision of stakeholders.
SF13	3/19/2013	Fariel Bouattoura	Pass	N/A	N/A	Yes	
DS1	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	
DS2	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	
DS3	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	

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Test Case ID	Date Tested	Tester	Pass/Fail	Severity of Defect	Summary of Defect	Closed prior to Production Release?	Comments
DS4	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	
DS25	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	
DS30	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	
DS35	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	
DS55	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	
DS65	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	
DS90	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	
DS100	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	
DS120	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	Validation of Prediction model is needed. Test only showed data exchange and a result provided by Prediction system
DS125	3/20/2013	Roberto Macias	Pass	N/A	N/A	Yes	

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6 Variances

Several Data Sources described in the requirements, and shown on the Logical Architecture were not completed and available for the system. Since these are outside the boundaries of the ICMS, the SAT for the ICMS was completed. The data sources missing at SAT were:

- Parking Management Data
- Traffic Signal Data
- Transit AVL/ APC Data

In addition, it was decided during development that the Center-to-Center (C2C) link from the ICMS into the TxDOT C2C would not be done, since there was very limited data provided by the ICMS that was consumable by the TxDOT C2C. Transit Data is not robust in the TMDD, and thus the data available from DART would require TxDOT to modify their system, and funding is not available for that effort.

Due to unavailability of data sources, as mentioned above, the following test scripts from the *US-75 ICM System Acceptance Test Plan* were not completed during System Acceptance Testing: SN12, DS6 DS7 DS20, DS40, DS45, DS50, DS60, DS70, DS75, DS80, DS85, DS95, DS105, DS110, and DS115.

7 Recommendations

The ICMS was approved for operations at the end of SAT, since no major defects were found. As a change process, all future enhancements to the system will include the re-running of appropriate SAT scripts by the O&M team to verify that all functions still operate as expected.   Once changes are tested by the O&M team, the new software is demonstrated to the stakeholder team and approved for promotion to production.

During SAT, it was recommended by the stakeholders that some of the requirements be modified to more accurately indicate their intent at the time of operation. When a new system is being developed, the system needs to be able to be modified for small changes in the business process. It is also recommended that an Operational Test be done with the operators prior to final promotion of a new system, so that testing by the operators and hands-on training are accomplished.

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APPENDIX A: Test Report Approval

The undersigned acknowledge they have reviewed the **US-75 Integrated Corridor Management Demonstration Project Test Report** and agree with the approach it presents. Changes to this **Test Report** will be coordinated with and approved by the undersigned or their designated representatives.

Signature:	//s//	Date:	3/20/2013
Print Name:	Ahmad Sadegh		
Title:	Vice President		
Role:	Project Manager		

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