US-75 ICM System As-Built Design

Dallas Integrated Corridor Management (ICM) Demonstration Project

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16. Abstract

This As-Built document for the US-75 Integrated Corridor Management (ICM) Program has been developed as part of the US Department of Transportation Integrated Corridor Management Initiative. The basic premise behind the ICM initiative is that independent, individual network-based transportation management systems, and their cross-network linkages, can be operated in a more coordinated and integrated manner, thereby increasing overall corridor throughput and enhancing the mobility of the corridor users.

This report documents the As-Built design for the US-75 ICM System. It is an addendum to the US-75 ICM System Design Document (FHWA-JPO-13-072). The ICM System consists of three subsystems: Decision Support Subsystem, the SmartNET Subsystem, and the SmartFusion Subsystem their physically deployed systems to include the hardware and software and physical architecture.

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1 Executive Summary

The US-75 Integrated Corridor Management System Demonstration Project is a multi-agency, de-centralized operation which will utilize a set of regional systems to integrate the operations of the US-75 corridor. The purpose of the Dallas ICM System is to implement a multi-modal operations decision support tool enabled by real-time data pertaining to the operation of freeways, arterials, and public transit. The system will be shared between information systems and people involved in transportation operations and emergency response in the US-75 Corridor. The Dallas ICM System is intended to provide improved integration of operation procedures, including procedures that take advantage of the data sharing capabilities of the Dallas ICM System and facilitate improved emergency response, and traveler information.

A team headed by the Dallas Area Rapid Transit agency is providing technical and management services in support of the Dallas Integrated Corridor Management Demonstration Project.

2 Introduction

This document contains the As-Built System for the US-75 Integrated Corridor Management Demonstration Project, further down called the ICMS. It is an addendum to the US-75 ICM System Design Document (FHWA-JPO-13-072).

The Integrated Corridor Management System (ICMS) is a component based system which supports corridor management by sharing internal and external incident, construction, special event, transit, and traffic flow data, and utilizes this data to provide operational planning and evaluation through decision support.

Keeping in mind the vision of the ICM project, “Operate the US-75 Corridor in a true multimodal, integrated, efficient, and safe fashion where the focus is on the transportation customer”, the management and operations of the corridor and the ICM will be a joint effort involving all the stakeholders. The management and operations of the corridor and the ICM will be a joint effort involving all the stakeholders. To effectively manage and operate the ICM concept as described in the Con Ops document, the US-75 Steering Committee recommended the creation of a central corridor decision-making body. This body – designated as the US 75 ICM Subcommittee – will consist of leadership level representatives from each of the stakeholders in the US-75 Corridor. Due to the number of agencies involved in ITS and traffic operations in the Dallas – Fort Worth Region, the subcommittee is envisioned to be a subcommittee of the Regional ITS Steering Committee. The membership will consist of members from each of the corridor agencies; however, membership will be on a rotational basis so that the size doesn’t become too large.

The daily operation of the corridor will be coordinated through the existing arrangements and information will be exchanged through the center-to-center project, along with a Decision Support

system which will distribute response plan requests and utilize the center-to-center interface to communicate to the various agency systems. The central point of coordination for the corridor will be the DalTrans facility, with TxDOT, Dallas County, and DART co-located at the facility.

All operations among corridor networks and agencies (e.g., activation of specific ICM strategies) will be coordinated via the Decision Support system. The US 75 ICM Subcommittee will also investigate and prepare corridor response plans for various scenarios that can be expected to occur within the US-75 Corridor. The chairman of the committee will be responsible, with the other agency/service operations officers, for configuring the subcommittee with respect to its functions and staffing for all hours of operations. Staff will be assigned by the corridor stakeholders to support daily operations, develop response plans, analyze system deficiencies and needs, and general administration. Performance measurement and monitoring will be the responsibility of the US 75 ICM Subcommittee. The agency/service members, led by the chief chairman, will be accountable to the centralized decision-making body and make reports as the decision-making body designates.

Communications, systems, and system networks will be integrated to support the virtual corridor command center. Voice, data, video, information, and control will be provided to all agencies based on the adopted protocols and standards for the sharing of information and the distribution of responsibilities. The ICM will support the virtual nature of the corridor by connecting the member agency staff on a real-time basis via communications and other ITS technologies. While all the ICM operational strategies will be available for use, it is envisioned that only a subset of these strategies will be activated at any one time, depending on the operational conditions and events within the corridor.

2.1 System Overview

The ICMS consists of the following Subsystems:
- SmartNET – Information Exchange Network User Interface
- SmartFusion – Information Exchange Network Data Layer
- Decision Support System (DSS) - Decision Support Engine

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

2.2 Purpose

This document provides a description of the as-built ICM System that was deployed for the US-75 Integrated Corridor Management Demonstration Project.

The as-built design incorporates those elements that were deployed to provide a solution that fulfills the system and subsystem requirements, and the Stage 3 application to USDOT.

2.3 System Deployed

The US-75 corridor is an integrated transportation system – managed and operated collectively – in order to maximize its efficiency to corridor travelers. All corridor assets have been attuned to obtain the goals and objectives of the corridor, as well as the goals of each individual traveler as their preferences prescribe. The corridor users will recognize the US-75 Corridor as a multimodal, integrated, efficient, and safe transportation system that provides them with multiple viable alternatives that they can select based on their specific travel circumstances and needs.

2.4 Physical Architecture

The physical architecture represents actual software, hardware and networking components, where they will reside, the relationship between each component and how they will be integrated. For this Detailed Design, a physical architecture is provided, which includes both the physical architecture and a "virtual" physical architecture.

2.4.1 Network and Hardware

The network and hardware diagram below, shown in Figure 1, represents the physical components for the ICMS. This figure replaces Figure 14 of the Design Document (FHWA-JPO-13-072).

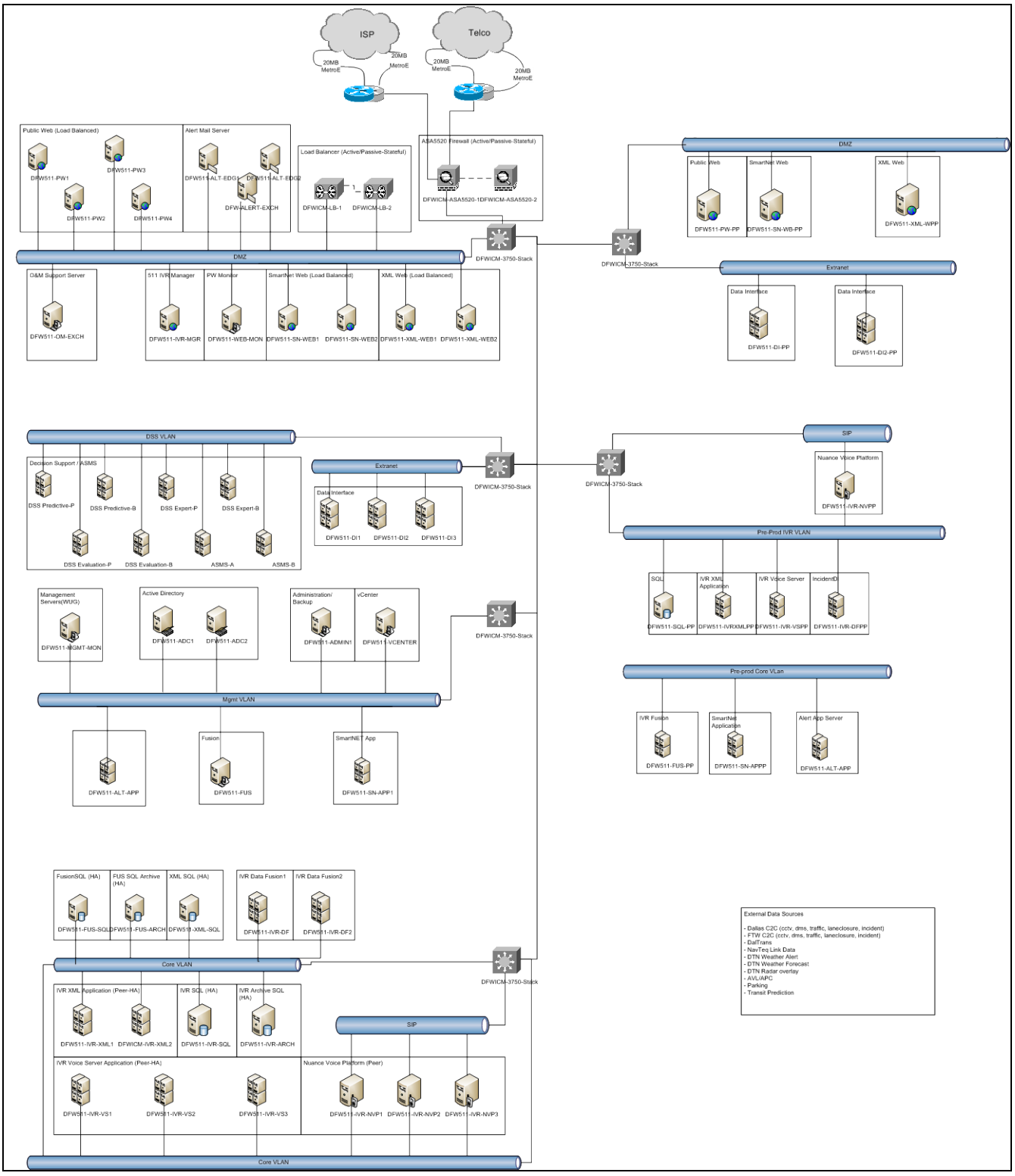

Figure 1: Physical Architecture (Virtual and Physical servers) (Source: Dallas Area Rapid Transit, May 2015)

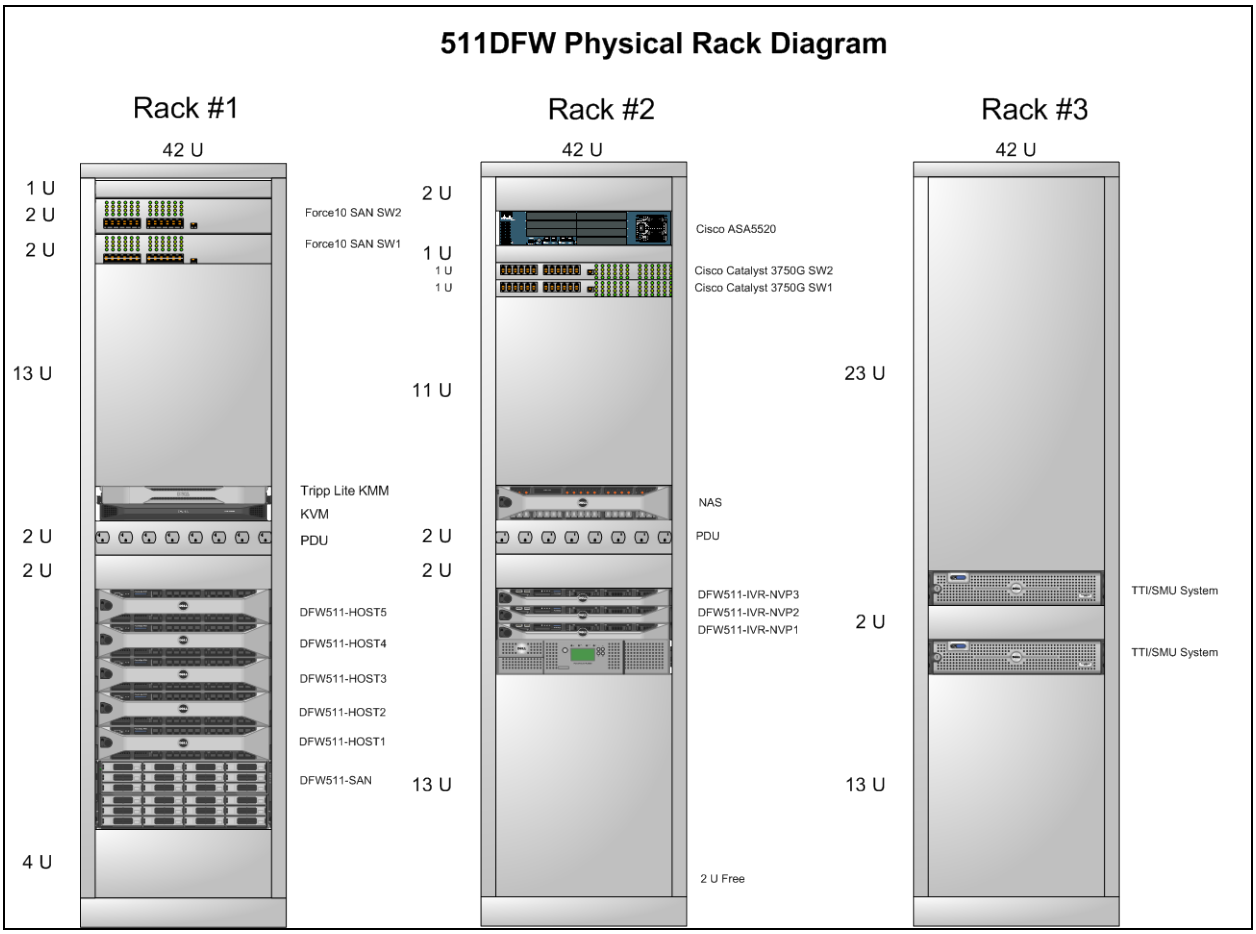

Figure 2: Rack Layout (Source: Dallas Area Rapid Transit, May 2015)

2.4.2 COTS Software and Hardware

The ICMS uses many COTS software and hardware products as part of the underlying physical architecture. This section is from section 3.12.2 of the Design Document.

2.4.2.1 Decision Support Subsystem

The Decision Support Subsystem utilizes the following COTS products:

- Windows Server Operating Systems – Server Operating System;
- Windows Workflow Foundation – Rules Engine;
- SQLite – Provide Database for the DSS.

2.4.2.2 SmartNET/ SmartFusion Subsystem

The SmartNET/ SmartFusion subsystems utilize the following COTS products:

- SmartNET™ – Web-based information exchange and management tool;
- Windows Server Operating Systems – Server operating system;
- Windows SQL Server – Database software;
- Microsoft IIS – Web server software;
- Oracle Weblogic – JMS application software;
- Geoserver – GIS mapping engine;
- Apache – SmartNET GUI webserver software.

2.4.2.3 Network Management

The ICMS Network Management and Administration Servers utilize the following COTS products:

- BackupExec – Provides back-up and restore capabilities for all servers;
- Symantec Endpoint AV – Provides anti-virus capabilities for all servers;
- WhatsUpGold – Provides network and application monitoring software;
- VMWare – Provides virtualization of hardware servers.

2.4.2.4 Maintenance Management

Remote access to the system is provided through use of Cisco IPSec VPN client sessions and typically uses RealVNC Enterprise Edition that provides encryption and Windows integrated authentication as the remote access application. The ICMS Maintenance Management will utilize the following COTS products:

- RealVNC Enterprise Edition – Provides remote control and access of servers.

2.4.2.5 Security Management

Security implementation is achieved with Windows Active Directory being utilized for server authentication, and SQL authentication for SQL client access. In addition, encryption is provided via HTTPS protocols and a single login and password can only be logged into the system once. The ICMS security management utilizes the following COTS products:

- Windows Active Directory – Provides domain control authentication and authorization for system.

2.4.3 Hardware Components

The hardware components provided for the ICMS hosting facility are listed in the following table.

Table 1: ICMS Hardware Physical Components

Device Number	System Name	System Function	COTS	Description
30001	DFW511-3750-Stack	Core LAN Switch	N/A	Cisco 3750G
30003	DFW511 -ASA5520-1	Firewall	N/A	Cisco ASA5520
30004	DFW511 -ASA5520-2	Firewall	N/A	Cisco ASA5520
30005	DFW511 -LB-1	Load Balancer	N/A	Barracuda
30006	DFW511 -LB-2	Load Balancer	N/A	Barracuda
30008	DFW511 -M8024-1	iSCIS Storage Switch	N/A	PowerConnect 8024F, 24 10 GbE SFP+ Ports, Four Combo Ports
30009	DFW511 -M8024-2	iSCIS Storage Switch	N/A	PowerConnect 8024F, 24 10 GbE SFP+ Ports, Four Combo Ports
100028	DFW511 -IVR-NVP1	Nuance NVP Server	Windows 2008 server R2 Symantec Antivirus RealVNC Nuance NVP	R710 Intel Xeon X5660, 2.8Ghz, 24 GB RAM 12M Cache, Turbo, HT, 1333MHz Max Mem
100029	DFW511 -IVR-NVP2	Nuance NVP Server	Windows 2008 server R2 Symantec Antivirus RealVNC Nuance NVP	R710 Intel Xeon X5660, 2.8Ghz, 24 GB RAM 12M Cache, Turbo, HT, 1333MHz Max Mem
100030	DFW511 -IVR-NVP3	Nuance NVP Server	Windows 2008 server R2 Symantec Antivirus RealVNC Nuance NVP	R710 Intel Xeon X5660, 2.8Ghz, 24 GB RAM 12M Cache, Turbo, HT, 1333MHz Max Mem
100061	DFW511 -VM-HOST1	VMWare Host Server	VMware ESX5.1	R710 Intel Xeon X5660, 2.8Ghz, 96 GB RAM 12M Cache, Turbo, HT, 1333MHz Max Mem

Device Number	System Name	System Function	COTS	Description
100062	DFW511 -VM-HOST2	VMWare Host Server	VMware ESX5	R710 Intel Xeon X5660, 2.8Ghz, 96 GB RAM 12M Cache, Turbo, HT, 1333MHz Max Mem
100063	DFW511 -VM-HOST3	VMWare Host Server	VMware ESX5	R710 Intel Xeon X5660, 2.8Ghz, 96 GB RAM 12M Cache, Turbo, HT, 1333MHz Max Mem
100064	DFW511 -VM-HOST4	VMWare Host Server	VMware ESX5	R710 Intel Xeon X5660, 2.8Ghz, 96 GB RAM 12M Cache, Turbo, HT, 1333MHz Max Mem
100065	DFW511 -VM-HOST5	VMWare Host Server	VMware ESX5	R710 Intel Xeon X5660, 2.8Ghz, 96 GB RAM 12M Cache, Turbo, HT, 1333MHz Max Mem
30007	DFW511 -SAN1	Storage Area Network		Dell EqualLogic PS6010XV, 10Gbe, High Performance, 15K SAS Drives (224-7558) 16x600GB
10052	DFWICM – PRED1	Prediction Server	Windows 2008 server R2 Microsoft SQL Server DIRECT	
10053	DFWICM – PRED2	Prediction Server	Windows 2008 server R2 Microsoft SQL Server DIRECT	
10054	DFWICM – PRED3	Prediction Server	Windows 2008 server R2 Microsoft SQL Server DIRECT	
10055	DFWICM – PRED4	Prediction Server	Windows 2008 server R2 Microsoft SQL Server DIRECT	

Device Number	System Name	System Function	COTS	Description
10056	DFWICM - EXPERT	Expert Rules	Windows 2008 server R2 Microsoft SQL Server Windows Workflow Foundation	
10057	DFWICM - EVAL	Evaluation Server	Windows 2008 server R2 Microsoft SQL Server	
10058	DFWICM - ASMS	Arterial Street Monitoring	Windows 2008 server R2 Microsoft SQL Server	

Table 2: ICMS Hardware Virtual Components – VMWare Servers

Device Number	System Name	System Function	COTS
100001	DFW511-ADC1	Windows Domain Controller	Windows 2008 server R2 Symantec Antivirus RealVNC
100002	DFW511-ADC2	Windows Domain Controller	Windows 2008 server R2 Symantec Antivirus RealVNC
100003	DFW511 -ADMIN1	Backup Server	Windows 2008 server R2 Symantec Antivirus RealVNC Symantec BackupExec
100004	DFW511-VCENTER1	VMware vCenter Manager	Windows 2008 server R2 Symantec Antivirus RealVNC
100005	DFW511-MGMT-MON	SNMP Management Server	Windows 2008 server R2 Symantec Antivirus RealVNC WhatsUp Gold
100007	DFW511-DI1	Data Interface Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100008	DFW511-DI2	Data Interface Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100009	DFW511-DI3	Data Interface Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100010	DFW511-PW1	Public Web, Mobile Web	Windows 2008 server R2 Symantec Antivirus RealVNC
100011	DFW511-PW2	Public Web, Mobile Web	Windows 2008 server R2 Symantec Antivirus RealVNC
100012	DFW511-PW3	Public Web, Mobile Web	Windows 2008 server R2 Symantec Antivirus RealVNC
100013	DFW511-PW4	Public Web, Mobile Web	Windows 2008 server R2 Symantec Antivirus RealVNC

Device Number	System Name	System Function	COTS
100014	DFW511-XML-WEB1	XML Web	Windows 2008 server R2 Symantec Antivirus RealVNC
100015	DFW511-XML-WEB2	XML Web	Windows 2008 server R2 Symantec Antivirus RealVNC
100016	DFW511-SN-WEB1	SmartNET Web	Windows 2008 server R2 Symantec Antivirus RealVNC Apache
100017	DFW511-SN-WEB2	SmartNET Web	Windows 2008 server R2 Symantec Antivirus RealVNC Apache
100018	DFW511-WEB-MON	Web Metrics	Windows 2008 server R2 Symantec Antivirus RealVNC
100019	DFW511 -SN-APP1	SmartNET Application Server	Windows 2008 server R2 Symantec Antivirus RealVNC WebLogic
100020	DFW511 -SN-APP2	SmartNET Application Server	Windows 2008 server R2 Symantec Antivirus RealVNC WebLogic
100021	DFW511-FUS	Data Fusion Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100022	DFW511-FUSION-DATA	Data Fusion Archive Repository	Windows 2008 server R2 Symantec Antivirus RealVNC
100023	DFW511-XML-SQL	XML SQL Server	Windows 2008 server R2 Symantec Antivirus RealVNC MS SQL
100024	DFW511-WEB-SQL	Web SQL Server	Windows 2008 server R2 Symantec Antivirus RealVNC MS SQL

Device Number	System Name	System Function	COTS
100066	DFW511-ALRT-APP	Driving Times alert My511 Alerts Processor	Windows 2008 server R2 Symantec Antivirus RealVNC
100025	DFW-ALERT-EXCH	My511 Alert Messaging Master Server	Windows 2008 server R2 Symantec Antivirus RealVNC MS Exchange
100026	DFW511-ALERT-EDGE1	My511 Alert Messaging Edge Server	Windows 2008 server R2 Symantec Antivirus RealVNC MS Exchange
100027	DFW511-ALERT-EDGE2	My511 Alert Messaging Edge Server	Windows 2008 server R2 Symantec Antivirus RealVNC MS Exchange
100067	DFW511-IVR-DF	IVR IncidentDI	Windows 2008 server R2 Symantec Antivirus RealVNC
100068	DFW511-IVR-DF2	Transit DI Prediction DI	Windows 2008 server R2 Symantec Antivirus RealVNC
100031	DFW511-IVR-VS1	IVR Voice Server	Windows 2008 server R2 Symantec Antivirus RealVNC Apache TomCat
100032	DFW511-IVR-VS2	IVR Voice Server	Windows 2008 server R2 Symantec Antivirus RealVNC Apache TomCat
100033	DFW511-IVR-VS3	IVR Voice Server	Windows 2008 server R2 Symantec Antivirus RealVNC Apache TomCat
100034	DFW511-IVR-XML1	IVR XML Server	Windows 2008 server R2 Symantec Antivirus RealVNC Apache TomCat

Device Number	System Name	System Function	COTS
100035	DFW511-IVR-XML2	IVR XML Server	Windows 2008 server R2 Symantec Antivirus RealVNC Apache TomCat
100036	DFW511-IVR-SQL	IVR SQL Server	Windows 2008 server R2 Symantec Antivirus RealVNC MS SQL
100037	DFW511-IVR-ARCH	IVR Archive SQL Server	Windows 2008 server R2 Symantec Antivirus RealVNC MS SQL
100039	DFW511-DI-PP	Pre-Production Data Interface Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100069	DFW511-DI2-PP	Pre-Production Data Interface Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100040	DFW511-PW-PP	Pre-Production Public Web Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100041	DFW511-XML-WPP	Pre-Production XML Web Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100042	DFW511-SN-WEB-PP	Pre-Production SmartNET Web Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100043	DFW511-SN-APPP	Pre-Production SmartNET Application Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100044	DFW511-FUS-PP	Pre-Production Fusion Application Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100045	DFW511-SQL-PP	Pre-Production SQL Server	Windows 2008 server R2 Symantec Antivirus RealVNC MS SQL

Device Number	System Name	System Function	COTS
100070	DFW511-IVR-DFPP	Pre-Production Incident DI Prediction DI Transit DI	Windows 2008 server R2 Symantec Antivirus RealVNC
100071	DFW511-AD1-PP	Pre-Production Windows Domain Controller	Windows 2008 server R2 Symantec Antivirus RealVNC
100072	DFW511-ALRT-APPP	Pre-Production Driving Times alert My511 Alerts Processor	Windows 2008 server R2 Symantec Antivirus RealVNC
100048	DFW511-IVR-NVPP	Pre-Production NVP Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100049	DFW511-IVR-VSPP	Pre-Production Voice Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100050	DFW511-IVR-XMLPP	Pre-Production XML Server	Windows 2008 server R2 Symantec Antivirus RealVNC
100051	DFW511-IVR-MGR	IVR Floodgate / Reporting Manager	Windows 2008 server R2 Symantec Antivirus RealVNC
100052	DFW511--OM-EXCH	O&M Exchange Server	Windows 2008 server R2 Symantec Antivirus RealVNC

2.4.4 Software Components

The software components provided for the ICMS hosting facility are listed in the following table, as previously provided in section 3.12.4 of the Design Document.

Table 3: ICMS Software Components

Name	Functions	Capabilities	Source (manufacturer)
HTTP Server Software	Open-source HTTP server	Provide web interface function for ICMS	Apache Tomcat
Java Application Server Software	Open-source Java application server	Provide Java based application support	Red Hat JBoss

Name	Functions	Capabilities	Source (manufacturer)
Monitoring Software	Monitoring and Alarms	Provide monitoring of system health and operation of the ICMS	Ipswitch WhatsUp Gold
E-mail server software	E-mail server	Provide E-mail function for sending alerts e-mails to users	Microsoft Exchange Server
Database software	Database	Provide database function for ICMS	Microsoft SQL Server
C2C Adapter Software	C2C Adapter	Provide JMS Capabilities for SmartNET	Apache ActiveMQ
Webserver Software	WebServer	Provide web interface function for ICMS	Oracle Weblogic
Fail-over software	Automated Fail-over	Provide Fail-over for servers between primary and back-up servers	VMWare
Disaster Recovery Software	High Availability and Disaster Recovery	Provide high availability software and disaster recovery software for any Windows-based application	VMWare
Back-up and Recovery software	File Backup and Recovery	Provide Backup and Recovery for all files on the ICMS servers	Symantec BackupExec Agent
Anti-Virus software	Anti-Virus	Provide Anti-Virus protection of all servers	Symantec Norton AV
Information Exchange Software – SmartNET	Information Exchange Interface/ GUI	Provide Information Exchange, monitoring and management of incidents, construction and special events	Telvent SmartNET
Expert System Software	Decision Support Rules Engine	Provide Decision Support Rules Engine for selection or response plans based on conditions system and criteria of stakeholders	Microsoft Workflow Foundation

Name	Functions	Capabilities	Source (manufacturer)
Server Operating System	Server Operating System	Provide Operating System for all ICMS related servers	Microsoft Windows Server
GIS based layer software	Display of layers on GIS map	Provide geo-coded display of layers onto the Google map	GeoServer
Prediction Software	Prediction Software	Provide prediction of ICMS traffic network condition for 30 minutes into the future	DIRECT

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4 Appendix A - List of Acronyms and Glossary

ACRONYMS

- ATIS – Advanced Traveler Information System
- ATMS – Advanced Transportation Management System
- ARDT – Arterial Detection Subsystem
- AVL – Automatic Vehicle Location
- C2C – Center-to-Center
- CAD – Computer Aided Dispatch
- CCTV – Closed Circuit Television
- Con Ops – Concept of Operations
- DalTrans – Dallas Transportation Management Center
- DART – Dallas Area Rapid Transit
- DMS – Dynamic Message Sign
- DNT – Dallas North Tollway
- DSS – Decision Support Subsystem
- ERD – Entity Relationship Diagram
- ETC – Electronic Toll Collection
- FHWA – Federal Highway Administration
- FTA – Federal Transit Administration
- FTP – File Transfer Protocol
- GIS – Geographic Information System
- HOV – High Occupancy Vehicle
- HTTP – Hypertext Transfer Protocol
- HTTPS – Hypertext Transfer Protocol Secure
- ICD – Interface Control Document
- ICM – Integrated Corridor Management
- ICMS – Integrated Corridor Management System
- IEEE – Institute of Electrical and Electronics Engineers
- INCOSE – INternational Council On System Engineering
- INFR – Infrastructure
- ISP – Information Service Provider
- ITS – Intelligent Transportation System
- IVR – Interactive Voice Response
- JMS – Java Messaging System
- LBJ – Lyndon Bayne Johnson
- LRT – Light Rail Transit
- LRV – Light Rail Vehicle
- MS/ETMC – Message Set for External TMC to TMC Communication
- MOD – ICM Model Subsystem
- NCTCOG – North Central Texas Council of Government
- NTTA – North Texas Tollway Authority
- P&R – Park & Ride

- PARK – Parking Management
- PDA – Personal Data Assistant
- PGBT – President George Bush Turnpike
- RITA – Research and Innovative Technology Administration
- RTC – Regional Transportation Council
- SAN – Storage Area Network
- SOAP – Simple Object Access Protocol
- SNMP – Simple Network Management Protocol
- SMS – Short Message Service
- SMTP – Simple Messaging Transport Protocol
- SRS – System Requirement Specification
- SSL – Secure Sockets Layer
- TCIP – Transit Communication Interface Protocol
- TCP – Transmission Control Protocol
- TLS – Transport Layer Security
- TMDD – Traffic Management Data Dictionary
- TRE – Trinity Railway Express
- TxDOT – Texas Department of Transportation
- USDOT – United States Department of Transportation
- VXML – Voice eXtensible Mark-up Language
- W3C – World Wide Web Consortium
- WDMS – Web-based Database Management System
- WSDL - Web Services Description Language
- XML – eXtensible Mark-up Language

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