CENTER-TO-CENTER

Local Self-Evaluation Report

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16. Abstract
Texas Department of Transportation implemented a software system to facilitate sharing of traffic management related information and control of Intelligent Transportation System field devices between Traffic Management Centers with heterogeneous Advanced Traffic Management Systems. The software utilizes the National ITS Standards for External Traffic Management Center Communications and Traffic Management Data Dictionary. The software has been deployed in the Dallas and Fort Worth Traffic Management Centers, implements a Web server for display of traffic conditions with the DFW metroplex, and will allow authorized operators in the Dallas (Fort Worth) center to control devices "owned" by the Fort Worth (Dallas) center. The software is currently under a statewide requirements review to add additional traffic sub-domains (ramp meters, HOV lane control, traffic signals, reversible lanes, transit, parking lot availability, etc.). Texas Department of Transportation has plans for statewide deployment.

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One Page Report
Center-To-Center
FY99 ITS Deployment Program

The State of Texas has a number of Traffic Management Centers (TMCs) either deployed or in the final stages of development. These include three of the top ten largest metropolitan areas in the United States: Dallas/Fort Worth (DalTrans and TransVision), Houston (TransStar), and San Antonio (TransGuide). Other metropolitan areas in Texas are in the process of deploying TMCs: Austin, El Paso, Laredo and Pharr. The last three cities mentioned also handle a significant amount of truck traffic, which has increased due to NAFTA.

In 1997, the Traffic Operations Division (TRF) of the Texas Department of Transportation (TxDOT) identified a growing need for systems and software engineering recourses to support the development, integration, deployment, maintenance, and improvement of Intelligent Transportation Systems (ITS).

In January 1998, Southwest Research Institute (SwRI) was selected as the Statewide Integrator (SI) to provide software development and integration services to TxDOT for the next four years.

The C2C project is consistent with the goals and objectives of Metropolitan Planning Organizations (MPO) in the major ITS regions including Dallas/Fort Worth, Houston, Austin and El Paso. Phase I and II will contribute directly to the efforts of the North Texas Council of Governments to develop a long range plan for coordination, communication, control, and sharing of information between the many ITS agencies and jurisdictions within the Dallas/Fort Worth region. Phase II will prove the concept and viability of using the national standards for effective center-to-center communications in a large, complex network of ITS systems.

C2C Phase I. The first phase of the C2C, the Dallas/Fort Worth Data Server (DFWDS) pilot project, requires that freeway conditions data be provided on a WWW server. The Web map will be implemented using ESRI's MapObjects Internet Map Server software.

C2C Phase ll. The second phase of the C2C project will extend the data server capabilities beyond freeway conditions to support coordinated incident management, information sharing and remote device monitoring and control.

The DFWDS is based on extensive use of ITS national standards including Traffic Management Data Dictionary (TMDD) data elements, Message Sets for External Traffic Management Center Communications (MS/ETMC2) and the National Communications for ITS Protocol (NTCIP) center-to-center communications (DATEX-ASN).

Executive Summary

Boundaries between different jurisdictions (state DOT districts, cities, counties, etc.) are commonly transparent to the freeway user, whether local user, commuter, long distance traveler or commercial vehicle operator. Adverse traffic conditions in one jurisdiction often impact traffic in adjoining jurisdictions long before the freeway user reaches the jurisdiction boundary. Cooperation between adjoining jurisdictions in matters of traffic management can positively affect overall traffic conditions. Maintaining a single point to distribute traffic information to the traveling public makes access more convenient to the user and contributes to goodwill.

The Texas Department of Transportation implemented a software system directed at those end results. The TxDOT center-to-center software system was implemented to facilitate sharing of traffic management related information and control of Intelligent Transportation System field devices between Traffic Management Centers with heterogeneous Advanced Traffic Management Systems. The implementation effort had three goals and met all of them; those goals were:

- Provide freeway conditions data on a graphical map between control centers and for an ITS internet site.
- Extend the data server capabilities beyond freeway conditions
- Will include additional development and integration activities

The software has been deployed in the Dallas and Fort Worth (DFW) Traffic Management Centers; a Web server has been implemented utilizing the C2C implementation and displays traffic conditions with the DFW metroplex. With plans to deploy the software statewide, TxDOT is currently under a statewide requirements review to add additional traffic sub-domains (ramp meters, HOV lane control, traffic signals, reversible lanes, transit, parking lot availability, etc.).

TABLE OF CONTENTS

1.0 INTRODUCTION

This self-evaluation report describes the efforts undertaken by the Texas Department of Transportation (TxDOT) under the direction of the Federal Highway Administration (FHWA). The purpose of the project was to provide a system which supports communications between Traffic Management Centers (TMC), and more specifically between dissimilar Advanced Traffic Management Systems (ATMS) software. It is common that the geographic areas for two TMC's abut each other. While the boundary is important to political bodies, it is not important to the traveling public as they may not even be aware of such boundaries. Thus sharing of information across the boundary between adjacent TMC geographic regions will be beneficial. Furthermore, sharing of the information in an automated, operator transparent manner can facilitate cooperation between the operators of the adjacent TMC's.

With this goal in mind, this report provides a review of the project with respect to 4 areas of interest.

- goals and objectives
- the work completed
- discussion of the technical issues
- institutional issues encountered

While self-evaluation reports typically include a discussion of the seven standard ITS (Intelligent Transportation Systems) measures, those are not discussed within this report. They are omitted for two reasons: most of the measures are not applicable to this effort, and secondly no measurement capability was available to perform an evaluation of the results. However, a qualitative discussion is presented that describes the perceived impact the ITS measures and current motivation for continuing the effort.

The seven standard ITS measures:

- Safety: Reductions in Non Fatal Crashes
- Safety: Reductions in Fatal Crashes
- Efficiency: Increased Throughput (Cars, or people, or goods moved per unit time)
- Mobility: Improved Customer Satisfaction
- Mobility: Increased Travel Time Reliability
- Productivity: Cost Savings
- Energy and Environment: Reduced Vehicle Fuel Consumption and Emissions

2.0 PROJECT REVIEW

2.1 Goals and Objectives:

The Center-to-Center (C2C) project had the following goals:

Goal: Provide freeway conditions data on a graphical map between control centers and for an ITS internet site.

- Provide a World Wide Web (WWW) based graphical map to display traffic conditions.

  Evaluation: Currently a WWW based graphical map is deployed in the Dallas-Fort Worth region containing traffic conditions within the Dallas and Fort Worth TxDOT districts. A prototype statewide web-server is depicted in the figure 1.

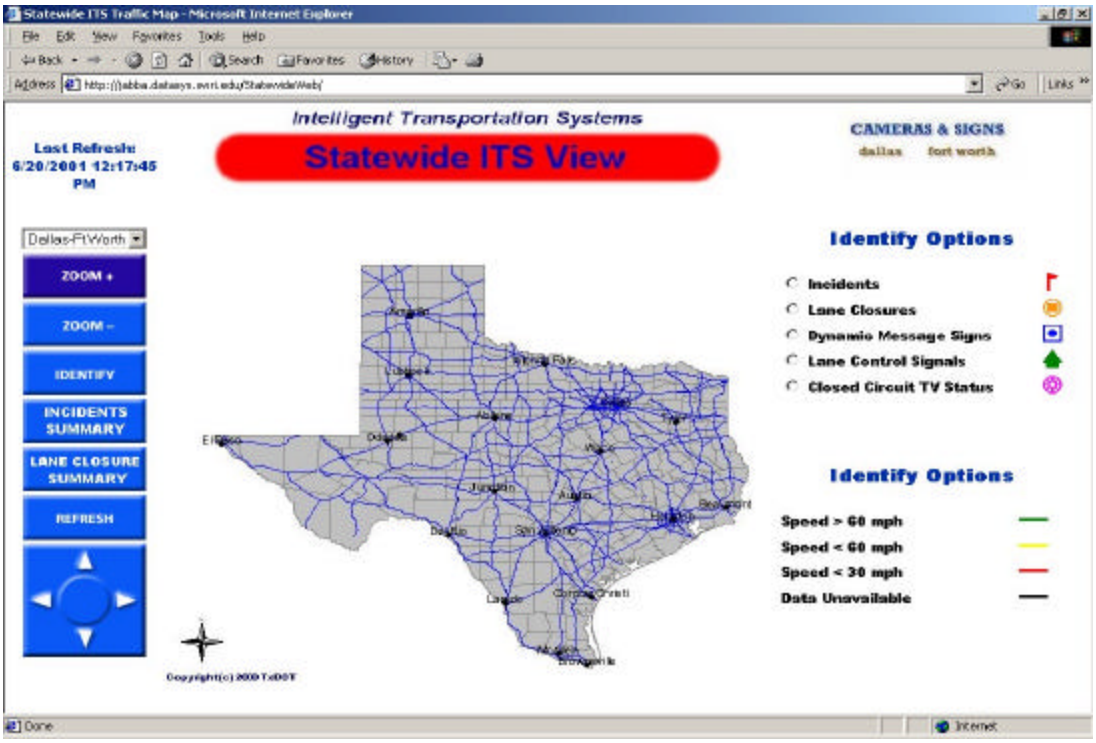

Figure 1 – WWW Map

Goal: Extend the data server capabilities beyond freeway conditions.

- Support ITS center-to-center communications for command/control/status of Dynamic Message Signs (DMS's), Lane Control Signals (LCS's) and Closed Circuit Television Cameras (CCTV's)

  Evaluation: The current C2C implementation supports status and command and control of DMS, LCS's, and CCTV's. The current CCTV display is through snap-shot only to reduce network load.

Goal: Will include additional development and integration activities

- Provide a software system that is extensible to other local or regional partners, or districts within TxDOT (i.e., other districts can re-use the software).

  Evaluation: The TxDOT C2C software has been deployed in the Dallas and Fort Worth TxDOT districts. Current deployment includes only a partial implementation of the software capabilities; status has been deployed, command and control has not. TxDOT plans to deploy the C2C statewide, with current plans including:

  - North Texas Council of Governments (TxDOT Dallas, TxDOT Ft. Worth, City of Dallas, City of Arlington, City of Richardson, City of Irving, City of Farmers Branch, City of Grand Prairie, CTO Council of Governments, Dallas Area Regional Transit, Dallas Fort Worth Airport, North Texas Transit Authority)
  - TxDOT Austin, Austin Police, Austin Fire, Austin EMS, City of Austin, Travis County Sheriff, etc.
  - San Antonio TxDOT district

  The TxDOT C2C software easily supports hierarchical deployments. The hierarchical deployments allow "local" repositories to be linked to create regional repositories to be linked to a statewide repository, etc. Figure 2 shows this "stacked" repositories (DFW feeds the statewide repository) concept.

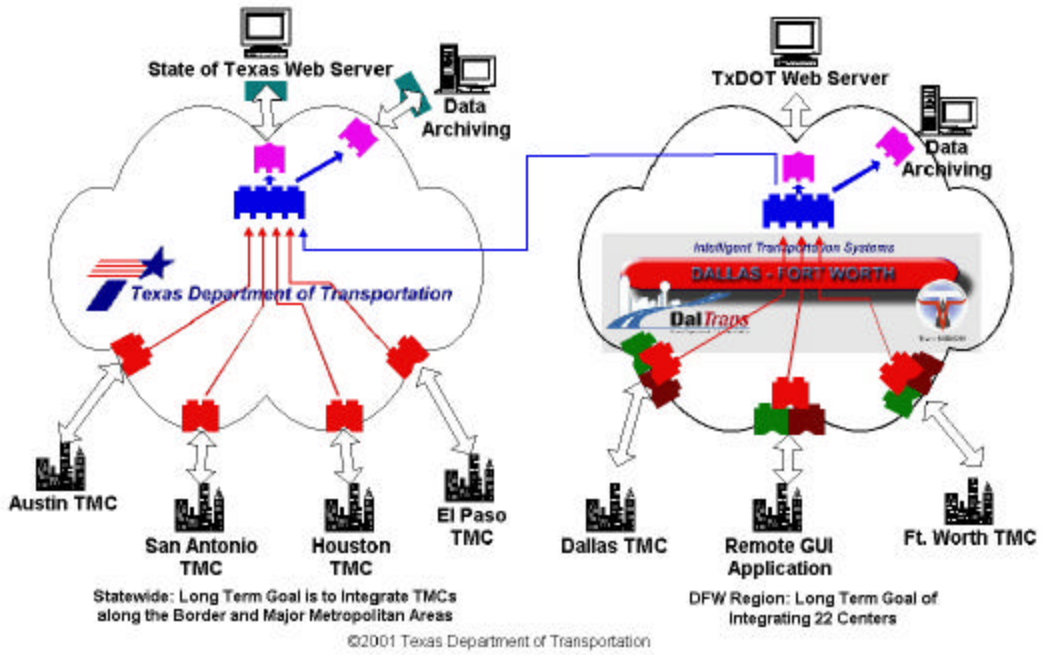

Figure 2 – Stacked Repositories

- Provide a common repository for traffic information.

  Evaluation: The TxDOT C2C software supports a common repository for traffic information. The current configuration contains a collector node which is a repository for all current traffic information fed to the collector. The data is kept in a common format.

- Utilize National ITS standards to implement the project.

  Evaluation: The National ITS standards, External Traffic Management Center Communications (ETMCC) and Transportation Management Data Dictionary (TMDD) were utilized for the implementation. Two modifications were made in the use of ETMCC and the TMDD, there were areas where the full range of values allowed by the TMDD was not implemented, and there were areas where the TTMCC and TMDD were extended.

  The TxDOT C2C implementation utilizes a plug-in concept which requires an ATMS specific plug-in to be built that matches the C2C application program interface (API). This API is described in a C2C Interface Control Document which essentially describes the C2C implementation of the National Standards. Each ATMS builds only plug-ins (status and control) to communicate between their ATMS and the C2C infrastructure. This approach resolved the problems of pair-wise communication requiring n-1 interfaces for n pairs of centers. This plug-in concept is pictured in the figure 3.

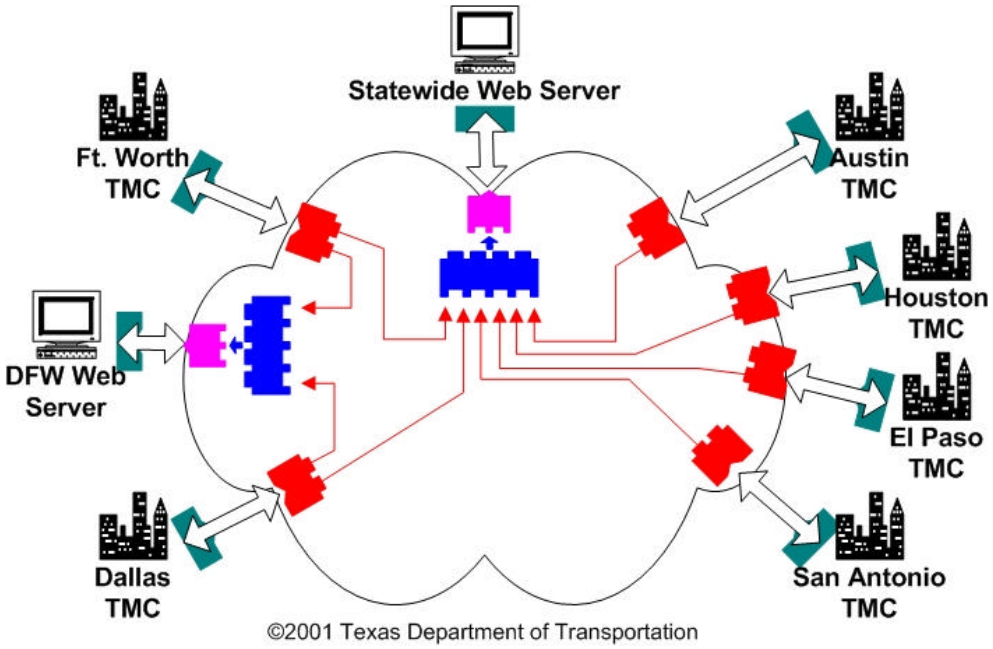

Figure 3 – Plug-in Concept

2.2 Work Completed

The final work product supports status and command and control.

- Roadway Network Information: Request and transmittal of the current roadway network. This frees the C2C implementation from being tied to a geographical map and allows adjustment of the roadway network on a dynamic basis.
- Incidents: Records maintained on all active incidents within the C2C area of interest.
- Traffic Conditions: Traffic conditions within the C2C area of interest.
- Field Device Status: Record of the status of the following ITS device types including on-/off- line as well as device settings (messages, current snap-shots, etc.):
    - Dynamic Message Sign (DMS)
    - Lane Control Signal (LCS)
    - Closed Circuit Television (CCTV)
- Field Device Control: control of the field devices including setting of messages, aiming (pan, tilt, zoom), etc.
    - DMS
    - LCS
    - CCTV

TxDOT has an effort underway to expand this list to include additional ITS devices as well as other transit sub-domains such as ramp meters, traffic signals, HOV (High Occupancy Vehicle) lanes, reversible lanes, dynamic lanes, parking lots, bus, light rail, etc.

2.3 Technical Issues

Authorization/encryption: The current protocols do not allow easy utilization or exchange of user authorization information in a secure manner prior to allowing inter-TMC control of ITS devices (CCTV, DMS, LCS, etc.)

Protocol Issues: The implementation, using the ASN.1 messaging and DATEX protocol became problematic. There are few (one) commercially available implementation of the DATEX protocol and no public domain implementations. Meanwhile there is great interest within the ITS community at large to replace ASN.1 and DATEX with open source or public domain implementation utilizing any number of other protocols including:

- SOAP over HTTP, SMTP, or FTP
- CORBA over IIOP
- XML over TCP/IP

- ASN.1 over DATEX

Segment Definition: The integration of dissimilar systems can be achieved. However, there may be some basic problems in terminology and definition. E.g. the ATMS in TxDOT Austin views each lane of a freeway as an independent segment on which traffic conditions are gathered (speed, volume, density, traffic mix, etc.). However, the current C2C implementation does not easily support the same. Some conversion is required.

Agencies without ATMS's: The NCTCOG has many small agencies without ATMS's which can contribute traffic conditions and closure information to the traveling public through utilization of ITS field devices, furthermore, access through the C2C infrastructure to ITS field devices to authorized personnel not in the TMC (at home) can also be advantageous. TxDOT addressed this by implementing a C2C Graphical User Interface (GUI) that runs in a browser window and provides both status and command and control access. The remote control GUI is depicted in the figure 4.

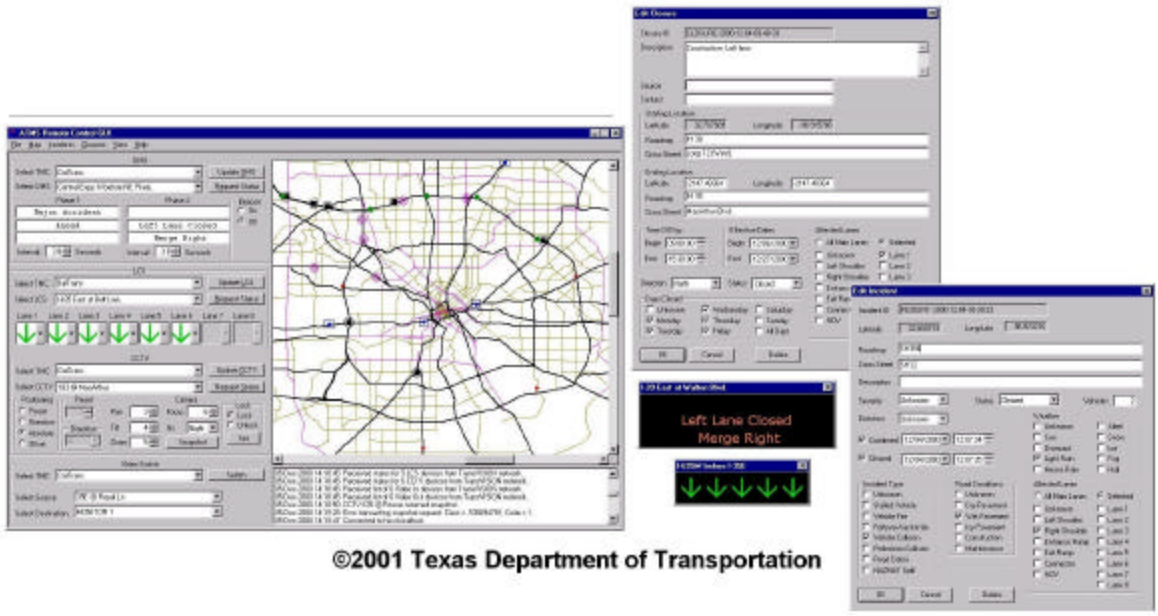

Figure 4 – Remote Control GUI

2.4 Institutional Issues

There were institutional challenges deploying the TxDOT C2C software. The deployment in the Dallas and Fort Worth districts currently addresses status information only. The software currently supports both status and command and control. However, the owner districts are reluctant to allow non-owner-district personnel to access district field devices. Stating this explicitly in terms of the area:

- The districts of Dallas and Fort Worth share status information with each other and the public. The other district and the public have access to traffic conditions and status of all the deployed field devices.
- Currently no-one outside of TxDOT Dallas has command and control access to the Dallas ITS field devices. No one outside of TxDOT Fort Worth has command and control access to the Fort Worth ITS field devices.

Both districts view sharing of command and control of the devices on their district boundaries as advantageous to themselves and each other. Control of Dallas district owned DMS on west bound freeways (in-bound to Fort Worth) would allow Fort Worth operators to post Fort Worth traffic condition displays (travel times), Fort Worth incident warnings, etc. that affect that traffic. However, the two TxDOT districts cannot overcome the institutional issue of ownership and fear of liability due to misuse by other than district personnel.

The problem of ownership and access will only worsen as the scope of the C2C software expands to traffic signals, ramp meters, HOV indicators, school zones and other sensitive traffic management devices.

2.5 Legal Issues

The legal aspects have been reviewed by legal counsel. There have not been any significant legal issues. The specifications in the procurement process have been designed and the contracts have been negotiated so as to avoid any contract, liability and intellectual property issues. Privacy is not at issue as the data collected does not indicate any particular vehicle or its owner. There are no regulatory issues with this type of project.

Appendix A
Acronyms

ACRONYMS

ASN.1	Abstract Syntax Notation One
API	Application Program Interface
ATMS	Advanced Traffic Management System
C2C	Center-to-Center
CCTV	Closed Circuit Television
CORBA	Common Object Request Broker Architecture
DATEX	Data Exchange
DFW	Dallas/Ft. Worth
DMS	Dynamic Message Sign
DOT	Department of Transportation
ETMCC	External Traffic Management Center Communications
FHWA	Federal Highway Administration
FTP	File Transfer Protocol
GUI	Graphical User Interface
HOV	High Occupancy Vehicle
HTTP	Hyper Text Transfer Protocol
IIOP	Internet Inter-ORB Protocol
ITS	Intelligent Transportation Systems
LCS	Lane Control Signal
NCTCOG	North Central Texas Council of Governments
ORB	Object Request Broker
SMTP	Simple Mail Transport Protocol
SOAP	Simple Object Access Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TMC	Traffic Management Center
TMDD	Traffic Management Data Dictionary
TxDOT	Texas Department of Transportation
XML	Extensible Markup Language
WWW	World Wide Web