JACKSON METRO INCIDENT MANAGEMENT PROJECT SYSTEMS ENGINEERING ANALYSIS

MDOT-ITS 100-01-001

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Jackson Metro Incident Management Project
Systems Engineering Analysis

1.0 Purpose

This Systems Engineering Analysis (SEA) is intended to document the development process that was followed to meet the FHWA minimum systems engineering requirements outlined in Title 23 – Code of Federal Regulations, Section 940. This SEA will document the following:

1. Identification of the portions of the regional ITS architecture being implemented.
2. Identification of participating agencies roles and responsibilities.
3. Requirements definitions.
4. Analysis of alternative system configurations and technology options to meet requirements.
5. Procurement options.
6. Identification of applicable ITS standards and testing procedures.
7. Procedures and resources necessary for operations and management of the system.

2.0 Description of Project

The Jackson Metro Incident Management Project includes the installation of nine Dynamic Message Signs (DMS) and related communications equipment along sections of I-55, I-20 and Highway 49. The purpose of the project is to provide for improved incident management, improved safety and to provide real-time travel information to motorists.

The Dynamic Message Signs will be controlled from the MDOT Statewide Transportation Management Center (TMC) in Jackson. At this TMC, operators will monitor traffic flow along the interstates using existing CCTV cameras along with additional new cameras that will be installed by MDOT personnel (separate from this DMS project). When incidents occur, the operators will be able to notify the appropriate response personnel and will also post messages on the dynamic message signs to notify motorists of the incident. This real-time information will reduce accidents by providing advance notices of potential back-ups or lane closures and will reduce delays by providing motorists an opportunity to take alternative routes. The DMS will also be used

to post advance information regarding upcoming construction and maintenance activities that may impact traffic flow.

The communications system from the DMS to the TMC will consist of a combination of different communication modes. Some of the signs are located in sections where MDOT already has a fiber optic network in place and those signs will connect to the existing fiber at a nearby pullbox or communications hut. One DMS is located near existing City of Jackson fiber and will connect to the City's fiber system which is then routed back to the MDOT Statewide TMC. The remaining signs will be located in areas where fiber is not available and will utilize leased communications from BellSouth.

The locations of the DMS were determined based on the concept of providing information to motorists in advance of entering the vicinity of the downtown Jackson area. The DMS are located in advance of potential detour routes which will allow motorists to make informed decisions based on real-time traffic information. Based on the available budget for this initial project, this strategy provides the most benefits and can be operated as a complete system. As funds become available, future projects will include additional DMS to cover other areas of Jackson as well as the outgoing routes. These future projects will also likely include speed detection devices that will allow for the addition of travel time messages on the DMS.

This system will be operated utilizing the existing 360 Surveillance software installed at the MDOT Statewide TMC. This software will be used to control both the existing CCTV cameras as well as the Dynamic Message Signs. This software is a server-client software that supports center to center communications. If another public agency or TMC needs to monitor or control portions of this system, MDOT will be able to provide that agency with a copy of the 360 Surveillance software and that location can function just as another workstation on the MDOT system.

It is likely that multiple agencies may be given access to view and control the CCTV cameras; however, the ability to display messages on the DMS will initially be limited to MDOT personnel since the signs are located on MDOT controlled roadways. However, the software easily supports control by others if particular situations or locations may warrant that multi-agency control.

3.0 Identification of the Portions of the Regional ITS Architecture Being Implemented.

This project was initially started in 2001 and is implementing specific portions of the current Mississippi Statewide Architecture that was completed in 2002. These elements are also consistent with the National ITS Architecture and include the following market packages for this project:

MARKET PACKAGE	KEY FUNCTIONS
Network Surveillance	• Monitor traffic and road conditions • Process, update, and retrieve traffic surveillance data for traffic strategy development • Identify and verify incidents
Traffic Information Dissemination	• Provide traffic information to drivers and vehicles via dynamic message signs • Notify drivers of incidents and diversion routes • Dissemination of real time information on road/bridge closures due to maintenance and construction activities
Incident Management System	• Provide incident detection capabilities via roadside surveillance devices and through coordination with emergency and weather service entities. • Direct incident response personnel to incident locations • Monitor incident status while the response arrives • Provide incident information to travelers in advance of the incident location • Provide alternate route information to travelers
Regional Traffic Control	• Provide sharing of traffic information among traffic management centers • Provide communication links between various jurisdictions • Implement traffic management strategies that are coordinated between allied traffic management centers

The information and data flows related to the market packages above are being implemented between the following entities:

- MDOT Statewide TMC to and from the MDOT Field Elements
- MDOT Statewide TMC to and from the Jackson TMC
- MDOT Statewide TMC to and from the Jackson Police Headquarters/911 Center

4.0 Identification of Participating Agencies Roles and Responsibilities

4.1 Mississippi Department of Transportation

MDOT is the lead agency in the design, construction and operation of the Jackson Metro Incident Management Project. MDOT is funding the project and will have overall responsibility for all elements including the operation and maintenance of the system. MDOT will coordinate with and share information with the City of Jackson and the Jackson Police/911 regarding response to incidents verified through the system.

4.2 City of Jackson

The City of Jackson is providing MDOT with permission to utilize existing City of Jackson fiber for communications from one of the DMS to the MDOT TMC. The City of Jackson's responsibility will be to ensure continued access to that fiber link and to coordinate with MDOT on traffic incidents that may detour traffic onto routes managed and operated by the City of Jackson. As defined previously in the Project Description section of this SEA, the City of Jackson TMC and the MDOT TMC can be integrated and interoperable by installing a client version of the 360 Surveillance Software at the Jackson TMC. This would allow that location to have the same functions and capabilities as a workstation within the MDOT TMC.

4.3 Jackson Police Headquarters/911 Center

The Jackson Police Headquarters/911 Center will be responsible for responding to incidents and dispatching the appropriate responders when notified by the MDOT TMC of an incident.

5.0 Requirements Definitions

In the National ITS Architecture, User Services describe what the system will do from the user's perspective. To date, thirty-three User Services have been jointly developed by US DOT and ITS America with substantial stakeholder input. A set of requirements covering each of these User Services are the basis for the National ITS Architecture definition.

The project team conducted a review of the functional requirements contained in the thirty-three User Services contained in the National Architecture to determine which of those requirements were applicable to the Jackson Metro Incident Management Project. Specifically, the Travel and Traffic Management User Service Bundle contains the high-level functional requirements, or User Service Requirements, applicable to this Project.

Within the Travel and Traffic Management User Service Bundle, there are three User Services that contain requirements applicable to this project. These are as follows:

1. En-route Driver Information;
2. Traffic Control; and
3. Incident Management.

The first User Service Requirement, En-route Driver Information, is described as follows:

> "En-route driver information provides vehicle drivers with information that will allow alternative routes to be chosen for their destination. Driver information consists of two major functions, which are (1) Driver Advisory and (2) In-vehicle Signing. The potential decrease in traffic demand on congested routes may also

provide benefits in highway safety, reduced air pollution and decreased congestion."

En-route driver information will be disseminated from the Jackson Metro Incident Management project through the following:

A. Dynamic Message Signs – Provides freeway travelers information regarding specific incidents, roadwork, and other real-time information.

The second User Service Requirement, Traffic Control, is described as follows:

"ITS shall include a Traffic Control (TC) function. Traffic Control provides the capability to efficiently manage the movement of traffic on streets and highways. Four functions are provided, which are, (1) Traffic Flow Optimization, (2) Traffic Surveillance, (3) Control, and (4) Provide Information. This will also include control of network signal systems with eventual integration of freeway control."

For the Jackson Metro Incident Management Project, the specific high-level Traffic Control requirements as stated in the National ITS Architecture, are as follows:

- Traffic Control shall include a Traffic Surveillance Function.
  - > Traffic Surveillance shall include a wide-area surveillance capability to include several jurisdictions.
  - > The wide area surveillance shall acquire sufficient data to provide the system with the knowledge of the existing conditions.
- Traffic Control shall include a Device Control function.
  - > Device control shall communicate control data to the DMS and surveillance cameras.
  - > Device control shall provide the operator with the capability to manually override the system's automatic controls.

The third User Service Requirement, Incident Management, is described as follows:

"ITS shall include an Incident Management (IM) function. Incident Management will identify incidents, formulate response actions, and support initiation and ongoing coordination of those response actions. Four major functions are provided, which are, (1) Incidents Identification, (2) Response Formulation, (3) Response Implementation, and (4) Predict Hazardous Conditions."

For the Jackson Metro Incident Management Project, the high-level Incident Management requirements are as follows:

- Incident Management shall provide an incident identification function to identify incidents.

  - The incident identification function shall use information from the following types of sources, where available to identify probable incidents: traffic flow sensors, public safety sources, public cell phone inquiries, media sources, etc.
- Incident Management shall provide a response formulation function to formulate appropriate response actions to each identified incident and revise those actions when necessary.
- Incident Management shall include a response implementation function to provide the services to implement a response coordinated with all appropriate agencies.
  - The response implementation function shall provide decision support capabilities needed to implement coordinated incident response actions by all participating institutions.
  - The response implementation function shall provide the capability to disseminate information related to response status to other agencies and user services.

These high-level requirements represent the general functions as defined in the National ITS Architecture to be performed by the Intelligent Transportation System that is to be deployed by the Jackson Metro Incident Management Project. It should also be noted that this specific project is for the installation of the DMS field components and communication system that connects to the Transportation Management Center. The TMC and the software that will be utilized are both existing as they were included in previous projects.

6.0 Analysis of Alternative System Configurations and Technology Options to Meet Requirements

MDOT considered a wide range of various DMS technologies and configurations during the planning and early design stages of this project. The various alternatives that were considered included the following:

6.1 DMS Technology and Configuration Alternatives

- LED vs. Shuttered Fiber Optic
- Full Matrix vs. Line Matrix vs. Character Matrix
- Walk-in vs. Front Serviceable
- Various options on number of characters per line
- Communication Interface Options – RS232 vs. Ethernet vs. Both

Based on lessons learned from other states and the specific needs for this project, the following decisions were made:

The specifications and plans for the Dynamic Message Signs require full matrix LED signs which will provide letter size flexibility and improved image clarity over other DMS technology options. The full matrix will also allow for graphics capabilities should they be desired in the future. For locations that have more than 2 travel lanes, the DMS will be mounted over the roadway and will require walk-in structures to accommodate maintenance activities without closing a lane. For locations that have only 2 lanes, the

DMS will be front serviceable signs mounted on a pedestal on the side of the roadway. All signs shall support 3 lines of 18" characters with 21 characters per line to allow for maximum messaging flexibility. The signs are also required to provide both an Ethernet interface and a RS232 interface to allow for maximum communications flexibility.

The DMS specifications require full compliance with the *NEMA Standards Publication TS 4-2004 Hardware Standards for Dynamic Message Signs (DMS) with NTCIP Requirements*

6.2 Communication System Alternatives

- Fiber vs. Wireless vs. Leased

In locations where existing fiber optic communications were available the decision to use the existing fiber was the obvious decision. In other locations, the sites were evaluated to determine if wireless or leased communications were the most appropriate. Due to the remote locations of those signs, it was determined that leased communications was the most cost effective and reliable communications alternative.

6.3 Software Alternatives

- Existing Software vs. New Software

MDOT has recently procured 360 Surveillance software for controlling the existing CCTV cameras. This software also has the necessary drivers to control NTCIP compliant Dynamic Message Signs and will be used for this project. This software is a client-server software and provides capabilities for center to center communications through multiple software site licenses. MDOT will be able to provide licenses of this software package to other public agencies or TMCs which would then be able to function as another workspace on the MDOT system (provided they have sufficient communication links in place). This software configuration assures complete integration and interoperability between the MDOT Statewide TMC and other TMC's within the Region or State that may need to control or coordinate with this system.

7.0 Procurement Options

This project is a construction project and will therefore be procured through MDOT's normal low-bid construction process. Various options were considered for ensuring that the contractor is qualified to install and configure the dynamic message signs. The final specifications will require that installation of the dynamic message signs shall be performed by the manufacturer or a Contractor trained and certified by the manufacturer. If a certified Contractor performs the installation and configuration, a factory representative shall supervise and assist the Contractor during installation and configuration

8.0 Identification of Applicable ITS Standards and Testing Procedures

8.1 Standards

The dynamic message signs are required to meet the latest approved National Transportation Communications for ITS Protocols (NTCIP) standards. In addition, the specifications require compliance with the *NEMA Standards Publication TS 4-2004 Hardware Standards for Dynamic Message Signs (DMS) with NTCIP Requirements.*

8.2 Testing

The NEMA TS-4 specification referenced above requires extensive testing which will be enforced on this project. In addition, the payment terms for the signs are tied directly to the successful completion of a series of tests to ensure complete compliance with the specifications and project requirements. These tests include a Factory Acceptance Test before the signs can leave the manufacturers facility, a pre-installation test after the signs are shipped, a stand-alone test after the signs are installed and then a final system test from the TMC. Refer to the final DMS specifications for more details on these extensive testing requirements.

9.0 Procedures and Resources Necessary for Operations and Management of the System

9.1 Operations

The system will be operated from the MDOT Statewide TMC in Jackson. Prior to completion of the field construction MDOT will be hiring and training operators to run the system. The exact hours of operation, staffing requirements and operational procedures will be defined in detail in the TMC Policy Manual and TMC Operations Manual that will be prepared by the Statewide ITS Integrator prior to the completion of field construction. It is anticipated that at least one full time operator will be at the TMC at all times during the normal hours of operation. Part time personnel may be used to supplement during peak hours and during major events. The ITS manager will be responsible for overseeing the TMC staff.

9.2 Maintenance

MDOT does not have any staff available with DMS maintenance experience. Therefore, the construction contractor will be required to provide a warranty as well as a two year extended maintenance period once the warranty expires. During this maintenance period the contractor will also be required to train MDOT personnel on the various maintenance activities. At the end of the maintenance period, MDOT may choose to assume the maintenance responsibilities or may issue a new maintenance contract depending upon the current staffing and expertise available.