Oklahoma City Area Regional Transportation Study (OCARTS) Intelligent Transportation Systems (ITS) Implementation Plan

Oklahoma Department of Transportation

In Coordination With:

U.S. Department of Transportation

October 2003

OCARTS Intelligent Transportation Systems (ITS) Implementation Plan

October 2003

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TABLE OF CONTENTS

1. INTRODUCTION 1
1.1 Purpose 1
1.2 Intended Audience and Region 2
1.3 Approach 4
1.3.1 Final Federal Highway Administration (FHWA) Rule and Federal Transit Administration (FTA) Policy on ITS Architecture Conformance 4
1.4 Organization 5

2. BACKGROUND 7
2.1 What is ITS? 7
2.2 Previous Regional ITS Architecture Work 8

3. INSTITUTIONAL FRAMEWORK 9
3.1 Traffic Management Agencies 10
3.1.1 ODOT 10
3.1.2 Oklahoma City Public Works Department – Traffic Management 10
3.1.3 Oklahoma Transportation Authority 10
3.2 Emergency Management and Response Agencies 11
3.2.1 Oklahoma City Fire Department 11
3.2.2 Oklahoma City Police Department 11
3.2.3 Emergency Medical Services Authority (EMSA) 11
3.2.4 Department of Public Safety / Oklahoma Highway Patrol 11
3.2.5 Oklahoma County Sheriff's Department 12
3.2.6 Edmond Police Department 12
3.2.7 Midwest City Police Department 12
3.3 Transit Management Agencies 12
3.3.1 Central Oklahoma Transportation and Parking Authority (COTPA) 12
3.4 Other ITS Implementing Agencies 12
3.4.1 The Association of Central Oklahoma Governments (ACOG) 12
3.4.2 Tinker Air Force Base 13
4.1 Existing ITS Elements 14
4.1.1 Closed Circuit Television Cameras (CCTV) 14
4.1.2 Dynamic Message Signs 14
4.1.3 Automated De-icing System 15
4.1.4 Emergency Vehicle Signal Pre-emption 15
4.1.5 *55 Emergency Call System 16
4.1.6 Centralized Traffic Signal Control System 16
4.1.7 On-Board Navigation Systems 16

4.1.8 Transit Automatic Vehicle Location Systems 16
4.1.9 Computer Aided Dispatch Systems 16
4.1.10 Pike Pass Electronic Toll Collection System 17
4.2 ITS Communications 17
4.2.1 Trunk Communications 17
4.2.2 Device-to-Trunk Communications 18
4.2.3 Wireline 18
4.2.4 Wireless 19

5. CONSIDERATIONS FOR ITS IMPLEMENTATION 21
5.1 Funding 21
5.1.1 Funding Needs 21
5.1.2 Funding Opportunities 22
5.2 Staffing 27
5.2.1 Regional Traffic Management Center (RTMC) Staffing 27
5.2.2 Maintenance 30
5.2.3 RTMC Hours of Operation 32
5.3 Procurement 32
5.4 Technical Resource Standardization 33

6. ITS IMPLEMENTATION PLAN 34
6.1 ITS Initiative Sequencing 34

APPENDIX: PROCUREMENT ISSUE PAPER 45

1. INTRODUCTION 46

2. TYPES OF CONTRACTS 47
2.1 Engineer / Contractor 47
2.2 Design/Build 48
2.3 System Manager 48
2.4 System Integrator 49
2.5 Commercial Off The Shelf (COTS) Software Acquisition 49
2.6 Build to Budget 50
2.7 Build-Own-Operate-Transfer and Franchise/Lease 50
2.8 Design to Cost and Schedule 51
2.9 Shared Resources 52
2.10 State Contract 54

3. METHODS OF AWARD 56
3.1 Sealed Bids 56
3.2 2-Step Bid Process 56
3.3 Competitive Proposals 57

3.4 Competitive Negotiations 57
3.5 Sole Source 57
3.6 Unsolicited Proposals 57

4. LAWS/REGULATIONS GOVERNING FEDERAL PROCUREMENT 58
4.1 Federal Law Considerations 58

5. PROCUREMENT ALTERNATIVES & RECOMMENDATIONS 60
5.1 Steps to Successful ITS Procurement 60
5.2 Statewide Considerations 70

LIST OF TABLES

Table 1: Agencies Participating in Regional ITS Architecture Development 9
Table 2: Summary of Regional Communications 20
Table 3: Typical TMC Full-time Positions and Functions/Responsibilities 27
Table 4: ITS Field Device Maintenance Activity Summary 31
Table 5: Summary of Initiative Costs (Costs in $1000s)* 35
Table 6: Statewide Fiber Optic Cable Expansion 36
Table 7: Implement/ Expand RTMC Field Devices 37
Table 8: RTMC Implementation/ Enhancements 38
Table 9: Individual Agency Data Archives 39
Table 10: Emergency Vehicle Signal Pre-emption Expansion 40
Table 11: Emergency/ Transit Vehicle AVL Implementation 41
Table 12: Coordinated Radio Communication System 42
Table 13: Alternate Route Implementation for Incident Management 43
Table 14: Traffic and Transit Information Kiosk Implementation 44

LIST OF FIGURES

Figure 1: OCARTS Region 3
Figure 2: Existing DMS in the OCARTS Region 15
Figure 3. Regional Management Centers Connections 34

LIST OF ACRONYMS

24/7	24 hours a day/7 days a week
AC	Advanced Construction
ACOG	Association of Central Oklahoma Governments
AVL	Automatic Vehicle Locator
CAD	Computer Aided Dispatch
CART	Cleveland Area Rapid Transit
CCTV	Closed Circuit Television
CDPD	Cellular Digital Packet Data
CMAQ	Congestion Mitigation and Air Quality
COTPA	Central Oklahoma Transportation and Parking Authority
CVO	Commercial Vehicle Operation
DDR	District Dedicated Revenue
DMS	Dynamic Message Sign
DPS	Department of Public Safety
DS	Dedicated State
DWDM	Dense Wave Division Multiplexing
EMSA	Emergency Medical Services Authority
ETC	Electronic Toll Collection
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GPS	Global Positioning System
HAR	Highway Advisory Radio
ISTEA	Intermodal Surface Transportation Efficiency Act
ITS	Intelligent Transportation Systems
MPO	Metropolitan Planning Organization
NOAA	National Oceanic and Atmospheric Administration
NCHRP	National Cooperative Highway Research program
NHS	National Highway System
OCARTS	Oklahoma City Area Regional Transportation Study
OCFD	Oklahoma City Fire Department
OCPD	Oklahoma City Police Department
ODOT	Oklahoma Department of Transportation
OTA	Oklahoma Transportation Authority
OU	Oklahoma University
PTZ	Pan/Tilt/Zoom
RTMC	Regional Traffic Management Center
RWIS	Roadway Weather Information System

SIB	State Infrastructure Bank
STP	Surface Transportation Program
TAFB	Tinker Air Force Base
TEA-21	Transportation Equity Act for the 21st Century
TIFIA	Transportation Infrastructure Finance and Innovation Act of 1998
TIP	Transportation Improvement Plan
TMA	Transportation Management Area
TMC	Transportation Management Center
UHF	Ultra High Frequency
USDOT	United States Department of Transportation
VMS	Variable Message Sign

1. INTRODUCTION

The Oklahoma Department of Transportation (ODOT) and the Association of Central Oklahoma Governments (ACOG), have identified a growing need for improved traffic management and traveler safety in and around the Oklahoma City metropolitan area. These agencies along with other local traffic management, emergency management, law enforcement, and transit agencies have implemented ITS technologies in an effort to improve operations and reduce operational costs. The Oklahoma City transportation management area is defined in the Oklahoma City Area Regional Transportation Study (OCARTS). The Intelligent Transportation Systems (ITS) Implementation Plan, therefore, provides guidance to transportation officials and system implementers within the OCARTS region on how to deploy ITS technologies in an efficient and cost effective manner.

Many agencies within the OCARTS region have recognized the benefits of ITS and have begun implementing these technologies. As these agencies deploy additional ITS technologies, and as other agencies begin to deploy their own systems, it will be critical that these relatively expensive "investments" are implemented in a manner that maximizes their potential benefits. This will lead to increased traveler safety, improved operational efficiency, and less congestion, as well as, better use of existing roadway capacity. Indirectly, ITS technologies that are implemented in an effective manner will lead to improved public perception of the region's transportation system and the people who manage, maintain, and plan it. With this in mind, the OCARTS ITS Implementation Plan uses the National ITS Architecture as a framework to ensure that system implementation follows a proven and nationally accepted approach.

1.1 PURPOSE

The purpose of the OCARTS ITS Implementation Plan is to guide local transportation officials and system implementers in the effective deployment and integration of ITS technologies within the OCARTS region. ITS elements are often implemented in an isolated or "stove-pipe" fashion resulting in expensive resources that are not utilized to their maximum extent. If implemented efficiently, regional agencies and users of the transportation system will reap additional benefits through improved use of integrated systems.

The OCARTS ITS Implementation Plan identifies high level ITS project initiatives that, when integrated with existing ITS elements, will lead to improved transportation network efficiency. Regional ITS initiatives are phased for implementation based on current and planned ITS deployments, costs and benefits, technical feasibility, institutional issues, and readiness of proposed projects. In addition to these objectives, the OCARTS ITS Implementation Plan accomplishes the following:

- Defines the boundaries of the region;
- Summarizes previously completed work applicable to ITS;
- Briefly describes regional agencies in terms of ITS;
- Identifies potential funding sources for initiatives/projects; and
- Identifies initiative/project costs and rationale.

The OCARTS ITS Implementation Plan addresses regional transportation needs and is intended to help foster the deployment of ITS in the near-term. The plan can be updated to include transportation needs as they arise.

1.2 INTENDED AUDIENCE AND REGION

The OCARTS ITS Implementation Plan has been developed for the OCARTS region, which includes 42 different government jurisdictions. The geographical area covered by this plan is the same as the OCARTS metropolitan planning boundary, shown in Figure 1. This area includes Oklahoma and Cleveland Counties and portions of Canadian, Grady, Logan, and McClain Counties. The OCARTS ITS Implementation Plan will be of particular interest to individuals that are involved with ITS implementation within the OCARTS region or those that are wishing to learn more about it. This group of individuals may include system integrators, state and local implementers wishing to integrate ITS systems, and other decision makers and transportation officials that are developing, or supporting the development of regional ITS systems.

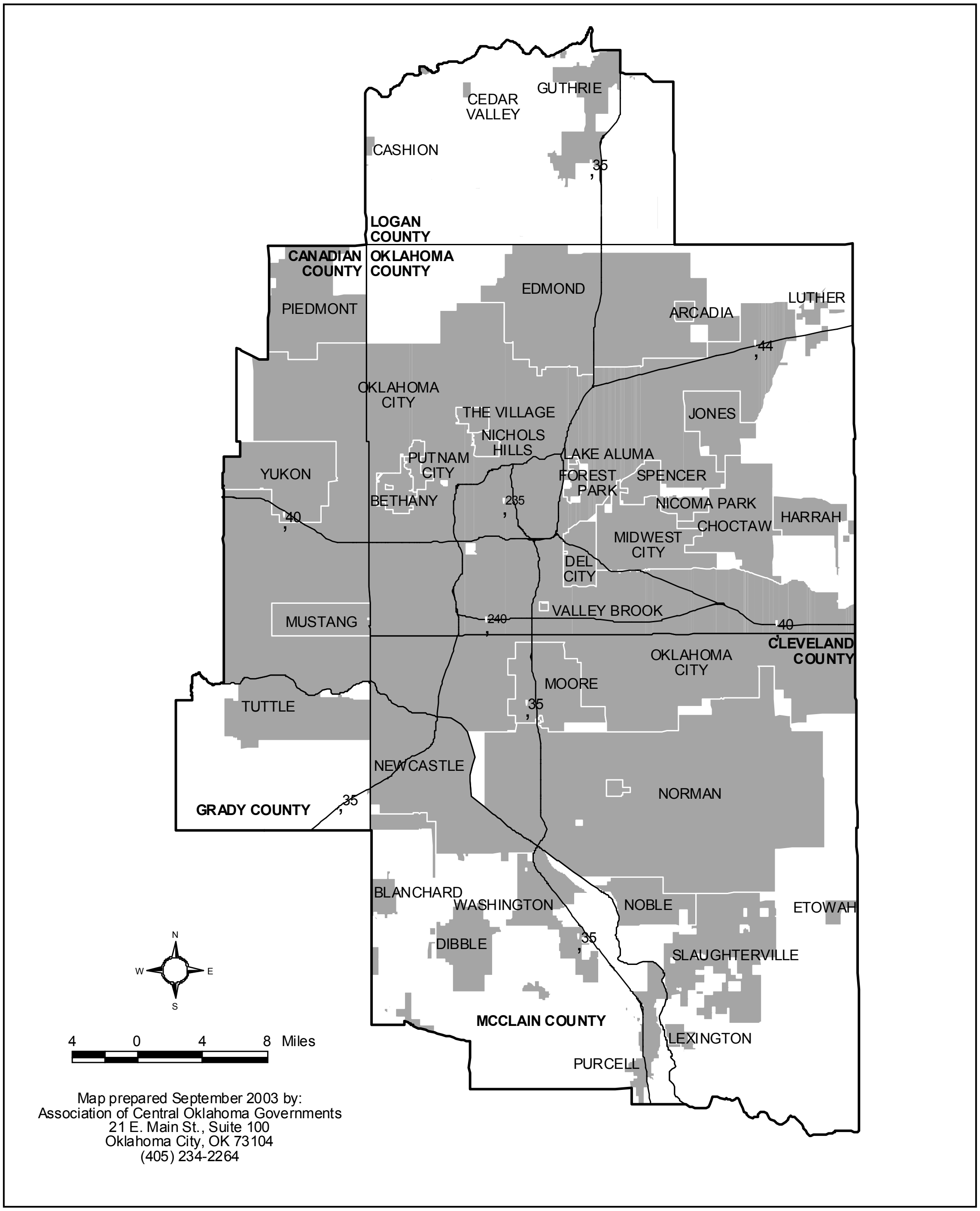


Figure 1: OCARTS Region

1.3 APPROACH

The following section describes the general approach taken to develop the OCARTS ITS Implementation Plan.

Development of the OCARTS ITS Implementation Plan is based on a nationally accepted approach and generally employs the following tasks:

- Build upon previously completed work. This work includes:
    - Electronic Inventory of existing and planned ITS
    - OCARTS 2002-2005 Transportation Improvement Plan
    - Oklahoma Statewide ITS Implementation Plan
- Identify stakeholder needs and employ stakeholder input. This included workshops and interviews with local stakeholder agencies.

1.3.1 Final Federal Highway Administration (FHWA) Rule and Federal Transit Administration (FTA) Policy on ITS Architecture Conformance

The United States Department of Transportation requires regions funding ITS projects through the National Highway Trust Fund to develop a Regional ITS Architecture that conforms with the National ITS Architecture. Jurisdictions that had deployed an ITS project prior to April 8th, 2001, are required to develop a Regional ITS Architecture within four years, or by April 8th, 2005. Areas yet to deploy an ITS project are required to have a Regional ITS Architecture developed within four years of the first ITS deployment. ITS projects that are not funded through the National Highway Trust Fund are exempt from the Rule/Policy.

If a region has not developed a Regional ITS Architecture before the April 8th, 2005 deadline of four years after the first deployment, no new ITS projects can advance if they are funded through the National Highway Trust Fund. Projects can only advance when the Regional ITS Architecture is finished, and if the project can show conformance with it.

As ITS projects are implemented, there will be a need to update the Regional ITS Architecture. The stakeholders in the OCARTS region should clearly identify the agency responsible for maintaining the Regional ITS Architecture. The ITS architecture produced by ACOG (and used for this report) should serve as the baseline architecture as the OCARTS region moves forward. The stakeholders also need to determine how often the ITS architecture should be updated. Based on activity in the OCARTS region, annual updates should be adequate to keep an up-to-date architecture. The Regional ITS Architecture should reflect changes in the regional needs, changes in ITS project priorities, changes in ITS funding, and changes in ITS project scopes. The National ITS Architecture is also expanding and being updated. The changes in the National ITS Architecture that impact the OCARTS region should be reflected in future versions of the regional ITS architecture.

In the OCARTS region, stakeholders have taken several steps to ensure that ITS technologies are deployed in a manner that is not only effective but one that conforms to the FHWA rule and FTA policy. These efforts include:

- Development of the OCARTS area ITS Early Deployment Plan – This plan was the initial step stakeholders employed to lay out the framework for using ITS technologies in the OCARTS region. Finalized in October 1999, the plan provides a high-level process for deploying ITS technologies over a 20-year timeframe. The plan also includes an Incident Management Plan to describe the approach to managing regional incidents and a Alternate Route Plan to identify potential alternate route plans for each major transportation corridor in the OCARTS region.
- Establishment of committees to over see ITS Deployment – Several ITS committees were formed in 2001 to foster statewide planning and implementation of ITS initiatives:
  - ITS Steering Committee
  - Incident Management Subcommittee
  - Technology and Operations Subcommittee
  - Traveler Information Subcommittee
- Attending FHWA Tier 1 and Tier 2 Workshops – On June 21st, 2001 ODOT hosted the Tier 1 workshop to educate regional and state stakeholders on the need for ITS integration in the OCARTS region, need for a Regional ITS Architecture process by which a Regional ITS Architecture is developed, and how the National ITS Architecture can assist in the development of a local ITS architecture. This workshop gave stakeholders the information needed to plan for ITS technologies in an efficient, effective, and coordinated manner. On October 23-25th, ACOG hosted the Tier 2 workshop to help participants develop a draft version of the Regional ITS Architecture. The draft version of the Regional ITS Architecture was developed using the Turbo software tool, and was verified by local stakeholder agencies. ACOG Staff finalized the OCARTS Regional ITS Architecture based on additional stakeholders input.
- A survey of Regional ITS Infrastructure – ACOG staff surveyed regional ITS stakeholders to determine the existing and planned ITS-related systems and transportation services/needs for the OCARTS region. The survey was conducted in July 2002, and was used in the development of the Regional ITS Architecture.

1.4 ORGANIZATION

The OCARTS ITS Implementation Plan consists of an Introduction (Chapter 1) and five additional chapters. An overview of Chapters 2 through 6 is provided below.

Chapter 2: Background – provides supplementary information that may help readers understand concepts expressed in this document. ITS is described, as is the relevant work leading to the completion of this document.

Chapter 3: Institutional Framework – identifies the regional transportation stakeholders that disseminate/receive information from ITS sources. Agencies responsible for implementing ITS systems within the OCARTS region are described and their respective ITS technologies highlighted.

Chapter 4: Regional ITS Elements – describes the region's existing ITS environment from a system's perspective.

Chapter 5: Considerations for ITS Implementation – describes issues that may affect the success of ITS implementation. Recommendations with regard to these issues are provided in an effort to ensure success.

Chapter 6: ITS Implementation Plan – provides a series of regional ITS initiatives to foster effective deployment of ITS systems in the OCARTS region. Each initative is described and characteristics such as cost, desired outcomes, benefits, and specific projects are provided. The ITS initiatives provided in this section are based on existing and planned ITS deployments and are phased for implementation based on several factors, including need, costs, and expected benefits.

2. BACKGROUND

A successful approach to any project requires a clear understanding of project objectives and desired outcomes. Additionally, the approach undertaken must ensure that the end product is understood by those who will use it and offers some measure of benefit. This chapter provides background information that lays the foundation from which readers can begin to understand concepts expressed in this plan, including; what ITS is and why an ITS Implementation Plan is needed.

As previously stated, the primary objective of the OCARTS ITS Implementation Plan is to provide guidance to local officials so that future ITS systems in the OCARTS region can be implemented in an efficient and cost-effective manner. The OCARTS ITS Implementation Plan specifically identifies regional transportation needs, and the role ITS can play in satisfying these needs. Finally, project initiatives are recommended and guidance provided so effective implementation can occur.

2.1 WHAT IS ITS?

An ITS is a collection of technologies or systems (e.g., advanced sensors, computers, communication systems) that enable multiple agencies to work together to collectively manage the entire regional transportation network. Among other things, ITS increases roadway capacity without adding lanes and alerts drivers en-route and pre-trip to conditions (e.g., weather, construction, accidents) affecting travel. The ITS in the OCARTS region can:

- Enhance incident management operations,
- Improve traveler safety and mobility,
- Enhance security of critical transportation investments (e.g., bridges and tunnels),
- Improve work-zone safety, and
- Improve commercial vehicle operations.

ITS elements improve the transportation system's efficiency and effectiveness for both providers and consumers of transportation services. By monitoring what is occurring on the system, making adjustments when needed, responding to unexpected traffic patterns or incidents, and providing real-time information, travelers may adjust their use of the system or adjust their routing based on prevailing conditions. Such actions lead to: improved traveler satisfaction through reduced traveler delay; reduced operational costs through reduced fuel consumption; environmental improvements through a reduction in vehicle emissions; efficient use of fixed assets (e.g., roadways), and faster treatment of injured persons through improved emergency response time.

A good source of information on ITS benefits is the report Intelligent Transportation Systems Benefits and Costs Report (2003). This report was prepared by Mitretek Systems under contract to the Federal Highway Administration (www.benefitcost.its.dot.gov).

2.2 PREVIOUS REGIONAL ITS ARCHITECTURE WORK

The OCARTS ITS Implementation Plan is based on, and compliments regional and statewide work. The OCARTS ITS Implementation Plan is a logical extension of the Oklahoma Statewide ITS Architecture. As the state's largest city, much of the focus of the Statewide ITS Plan pertains to Oklahoma City and the surrounding region. As such, several regional ITS projects have already been identified and included in the Statewide ITS Plan. These projects from the Oklahoma Statewide ITS Implementation Plan form the foundation from which the OCARTS ITS Implementation Plan was developed.

In addition, ACOG recently inventoried (and stored electronically) the existing and planned ITS elements within the region. As part of this inventory, the stakeholder agency that owns each ITS element is provided, as is the type of information shared between elements. The regional ITS inventory helped to fill the gaps left by the Statewide Plan, and helped to define future ITS initiatives based on the input expressed by regional stakeholders.

3. INSTITUTIONAL FRAMEWORK

Agencies that own or operate regional ITS elements are identified in Table 1. Although these agencies influence how data and information are shared on a regional level, only a few are currently using ITS elements. For the purpose of this plan, only the agencies responsible for implementing ITS in the OCARTS region are described in greater detail.

Table 1: Agencies Participating in Regional ITS Architecture Development

• Association of Central Oklahoma Governments (ACOG)*	• National Weather Service
• Central Oklahoma Transportation and Parking Authority (COPTA)*	• Norman Communications Center
• Cleveland Area Rapid Transit (CART)	• Norman Fire Department
• Del City 9-1-1	• Norman Traffic Management
• Department of Public Safety (DPS)/Oklahoma Highway Patrol (OHP)*	• Oklahoma City Emergency Management
• Edmond Fire Department	• Oklahoma City Fire Department (OCFD)*
• Edmond Emergency Management Department	• Oklahoma City Police Department *
• Edmond Engineering Department – Transportation Management	• Oklahoma City Public Works Department – Traffic Management Division*
• Edmond Police Department*	• Oklahoma County Sheriff's Department*
• The Emergency Medical Services Authority (EMSA)*	• Oklahoma Department of Transportation (ODOT) – Planning*
• Mercy Mobile Health	• Oklahoma Department of Transportation (ODOT) – Division 4*
• Midwest City Fire Department	• Oklahoma Department of Transportation (ODOT) – Maintenance*
• Midwest Emergency Operations Center	• Oklahoma Department of Transportation (ODOT) – Public Affairs*
• Midwest City Police Department*	• Oklahoma Transportation Authority (OTA)*
• Midwest City Public Works – Traffic Management	• Oklahoma University (OU)
• Moore 911 Emergency Management and Communications Department	• Oklahoma University DPS
• Moore Fire Department	• Tinker Air Force Base Fire Department*
• Moore Public Works – Traffic Management	• Will Rogers Airport

*Agency described in greater detail

3.1 TRAFFIC MANAGEMENT AGENCIES

The following section identifies and describes the regional traffic management agencies that own or operate ITS technologies in the OCARTS region. Generally speaking these agencies are responsible for monitoring and managing traffic on regional roadways. At times these agencies may communicate with each other to manage the transportation system more effectively, or with other regional emergency and transit management agencies to improve emergency response and transit operations.

3.1.1 ODOT

ODOT's mission is to "provide a safe, economical, and effective transportation network for the people, commerce and communities of Oklahoma". ODOT Division 4 is responsible for much of the OCARTS region. ODOT Division 4 operates regional DMS through a dial-up connection with a PC at the Division 4 – Oklahoma City Division Office.

ODOT, through a cooperative agreement with the University of Oklahoma (OU), has an ITS research lab on the north campus of OU at Max Westheimer airport in Norman. Software interfaces are being developed and tested in the lab to control Dynamic Message Signs (DMS) and Closed Circuit Television (CCTV) cameras.

ODOT owns an extensive fiber optic cable network that parallels I-35 from the Oklahoma/Texas border to the Oklahoma/Kansas border, and on I-44 from the Oklahoma/Texas border to the Oklahoma/Missouri Border, and on -40 from the Missouri Turnpike to the Oklahoma/Arkansas border. This network interfaces with OTA's fiber network which is installed along the Turner, Cimarron, and Muskogee Turnpikes. At the writing of this report, neither the ODOT owned nor the OTA owned fiber was lit. There are contracts in place to light initial portions of the fiber network in Tulsa and Oklahoma in late 2003 and early 2004.

ODOT also has a 155.25 MHz statewide radio system. This system is a voice only system.

3.1.2 Oklahoma City Public Works Department – Traffic Management

The Oklahoma City Public Work's Department – Traffic Management Division is responsible for coordinating with other divisions, departments, and agencies to find solutions to all traffic related problems within the city. The department plans, designs, and implements new traffic control devices including traffic signals. The Department manages several traffic signal systems throughout the metropolitan area.

3.1.3 Oklahoma Transportation Authority

The Oklahoma Transportation Authority (OTA) is responsible for operating Oklahoma's Turnpike System and electronic toll collection (ETC) system (named Pike Pass). As part of the Pike Pass system, 65 cameras are used to enforce toll gate violations. Additionally, newer toll facilities are equipped with built-in automatic de-icing equipment, that are tied-in with pavement and roadway sensors.

As mentioned previously, OTA also owns an extensive fiber optic cable network that parallels the turnpike system.

3.2 EMERGENCY MANAGEMENT AND RESPONSE AGENCIES

Emergency management agencies include those agencies responsible for responding to regional incidents and emergencies. As such it is critical that these agencies obtain timely information and respond as quickly as possible to mitigate the impacts of the situation. These agencies communicate with traffic management agencies primarily to obtain traffic-related information.

3.2.1 Oklahoma City Fire Department

The Oklahoma City Fire Department (OCFD) provides fire suppression, fire prevention, rescue and other emergency services. The department currently owns 91 vehicles, 17 with on-board navigation capabilities and 25 with traffic signal pre-empt capabilities. By the year 2005, the department plans to add signal pre-empt capabilities to an additional 25 vehicles for a total of 50 vehicles. Additionally, the department plans to add another 4 vehicles to their current fleet. Fire vehicles are dispatched through the department's computer aided dispatch (CAD) system. Fire vehicles are also equipped with mobile data terminals, which will eventually be replaced by Mobile Computer Terminals. The terminals will allow firefighters to search databases, and access and store information locally.

3.2.2 Oklahoma City Police Department

The Oklahoma City Police Department (OCPD), located within the City's Emergency Operations Center, is responsible for ensuring the overall safety of residents within the region. As part of this task, the OCPD is responsible for operating the City's Emergency Management and 9-1-1 programs. The department currently operates a fleet of 620 vehicles, 571 of which have the necessary equipment to be dispatched through the department's CAD system. Similar to the city's fire vehicles, mobile data terminals installed in police vehicles will be replaced with mobile computer terminals.

3.2.3 Emergency Medical Services Authority (EMSA)

EMSA is the exclusive emergency medical service provider of several cities within Oklahoma, including several in the OCARTS region. EMSA has a state-of-the-art operating center which features a satellite monitored CAD system. Each EMSA ambulance is equipped with an AVL system, so dispatchers can quickly locate and dispatch the vehicle closest to an incident.

3.2.4 Department of Public Safety / Oklahoma Highway Patrol

The Department of Public Safety (DPS) is Oklahoma's statewide roadway enforcement authority. The DPS has 13 troops (or divisions) statewide. One troop is dedicated solely to the statewide turnpike system. The DPS currently operates an 800MHz radio system. Additionally, DPS provides the *55 call system statewide so motorists can report incidents and obtain necessary assistance. The DPS also maintains a website (http://www.dps.state.ok.us/cgibin/weathermap.cgi) for reporting near-real time weather conditions to statewide motorists. Troop S has installed satellite uplink capability used primarily for DPS applications in connection to commercial vehicle operations.

3.2.5 Oklahoma County Sheriff's Department

The Oklahoma County Sheriff's Department operates a CAD system. Approximately one third (60 of 180 vehicles) of the departments' vehicles are equipped with the necessary CAD equipment. Plans call for the entire fleet to be equipped with CAD equipment by 2005. At this time it is expected that the total number of vehicles will increase to 300.

3.2.6 Edmond Police Department

The Edmond Police Department has a small portion of its vehicles equipped with traffic signal preemption systems (7 of 75 vehicles). The department plans on expanding its fleet of vehicles to 85 by 2005, and its number of vehicles with signal pre-emption capabilities to 12 (5 additional vehicles). The department also plans on implementing a CAD system and installing corresponding equipment in all 85 vehicles.

3.2.7 Midwest City Police Department

The Midwest City Police Department has a CAD system. The necessary CAD equipment resides in every vehicle within their fleet.

3.3 TRANSIT MANAGEMENT AGENCIES

3.3.1 Central Oklahoma Transportation and Parking Authority (COTPA)

The Central Oklahoma Transit and Parking Authority (COTPA) is a public trust responsible for providing downtown parking alternatives as well as safe, efficient, and convenient transportation to the citizens of the Greater Oklahoma City Metropolitan area. COTPA operates METRO Transit, Oklahoma City's main transit provider. METRO Transit buses and vans serve more than 20 fixed bus routes covering the main traffic areas of Oklahoma City. METRO Transit also provides transportation for mobility-impaired persons with Metro-Lift. METRO uses NextBus service to provide customers with real-time public transit information.

3.4 OTHER ITS IMPLEMENTING AGENCIES

3.4.1 The Association of Central Oklahoma Governments (ACOG)

ACOG provides coordination, planning, technical and educational services and leadership for local governments in Central Oklahoma. ACOG's proposal is to cooperatively plan for regional needs, including those associated with ITS.

The ACOG is the primary agency within Central Oklahoma responsible for providing local jurisdictions with transportation planning services.

3.4.2 Tinker Air Force Base

Traffic to/from Tinker Air Force Base (TAFB) occurs at any time of the day. TAFB operates a 24/7 operations center, that will eventually be integrated with CCTV and DMS to monitor and control traffic. Tinker Air Force base also receives weather information from National Oceanic and Atmospheric Administration (NOAA) and other agencies and posts this information on its website (http://www-ext.tinker.af.mil/status/) to provide current information, and operational status to individuals traveling to the Air Force base.

4. REGIONAL ITS ELEMENTS

Because OCARTS is just beginning their ITS program, there are relatively few ITS elements deployed within the region. Regional ITS stakeholders, however, understand the benefits ITS can play in improving traffic operations and safety, and have taken the initial steps to expand the current system. This is exemplified by the fact that stakeholders have developed an inventory of regional ITS elements to identify areas where ITS-related systems can improve the existing transportation system.

4.1 EXISTING ITS ELEMENTS

The various ITS-related technologies that exist within the OCARTS region are described in the following paragraphs.

4.1.1 Closed Circuit Television Cameras (CCTV)

Closed Circuit Television Cameras (CCTV) cameras are used by traffic operations personnel to detect, verify and determine the nature of incidents, monitor traffic and roadway conditions, and acquire the necessary information needed to clear an incident in a timely manner. Through the use of CCTV cameras and the video/images acquired, operators can dispatch appropriate staff and equipment to a scene of an incident. This reduces the time to treat injured persons as well as impacts of the incident on traffic. CCTV cameras can also be used to monitor tunnels, bridges, and other significant infrastructure to enhance security and improve safety of motorists.

At the time of writing this report, there has only been one CCTV camera installation within the OCARTS region. This installation, located along I-35 in the City of Norman near the Robinson Street Interchange, is owned and operated by ODOT. ODOT has let a contract to install four (4) additional CCTV cameras along I-40 near Tinker Air Force Base.

4.1.2 Dynamic Message Signs

Dynamic message signs (DMS), posted alongside or over the roadway, provide motorists with important traveler information while en-route. This improves regional incident management activities by diverting motorists to alternate routes when incidents occur. These signs can also be used when regional emergencies occur, to guide motorists safely to evacuation routes.

Eleven dynamic message signs have been deployed in the OCARTS region. The locations of these devices are shown in Figure 2.

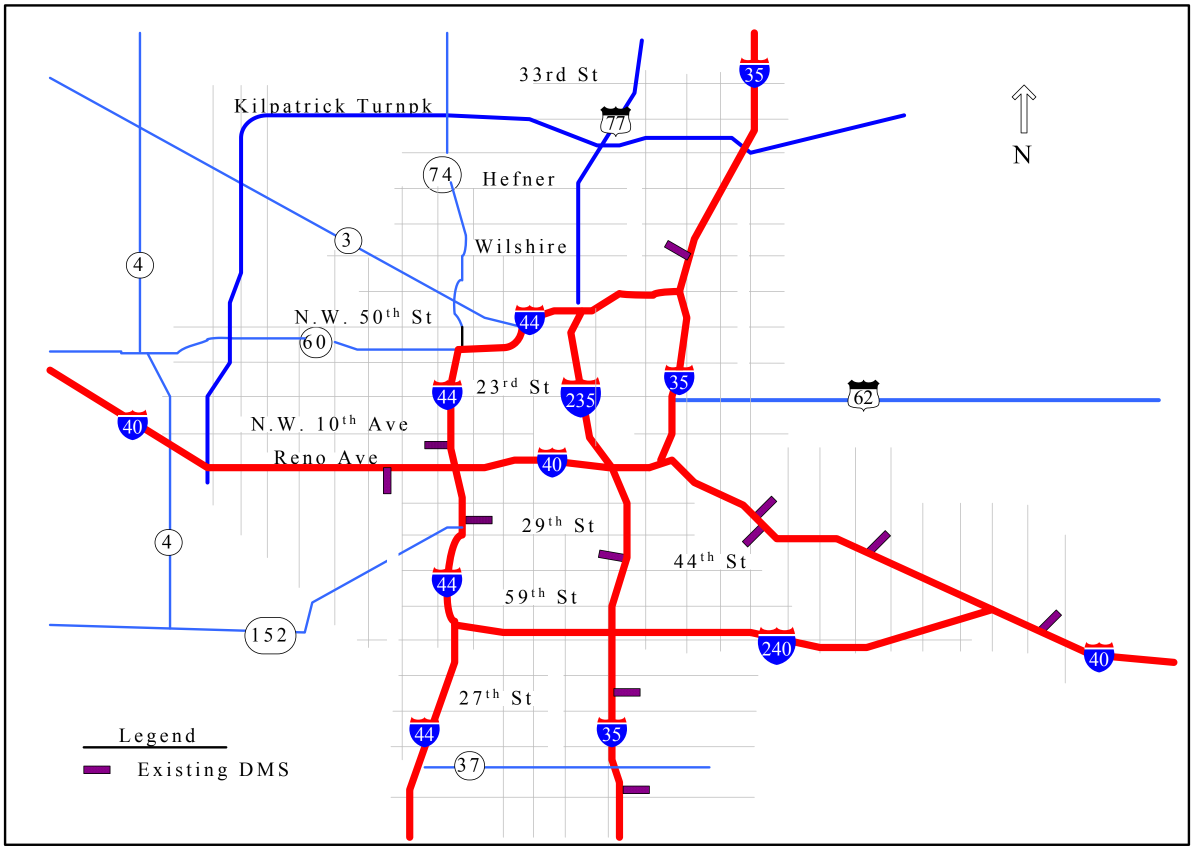


Figure 2: Existing DMS in the OCARTS Region

4.1.3 Automated De-icing System

Automated de-icing systems prevent ice from developing on facilities that are often subject to freezing and thus produce a safety problem. Automated de-icing systems are tied-in with road weather sensors and are activated when these sensors indicate that conditions are right for freezing to occur.

Within the OCARTS area, automated de-icing systems have been deployed at newer toll-booth facilities and at one location near the I-40/I-35 interchange.

4.1.4 Emergency Vehicle Signal Pre-emption

Emergency vehicle signal pre-emption systems greatly benefit emergency vehicle response time and thus motorist safety. Specifically, emergency vehicle signal pre-emption systems give a green light to emergency vehicles when approaching a traffic signal. This reduces the possibility of a collision with cross-traffic, and reduces the time needed to slow for and then travel around cars stopped at a red light.

Emergency vehicle signal pre-emption systems are used in Oklahoma City, Norman, and Edmond.

4.1.5 *55 Emergency Call System

The *55 emergency call system provides motorists with a direct voice link with the Department of Public Safety. As previously stated the system is statewide and provided by the DPS.

4.1.6 Centralized Traffic Signal Control System

Oklahoma City maintains two central control systems. Both are MultisonicsVMS systems. One controls 143 signals in the downtown and medical center area. It is controlled by a computer at the Traffic Management Division. The second system controls 36 signals along the Northwest Expressway and 39th Street. The computer is housed at a dedicated control center building located at the intersection of N.W. 63rd and the Northwest Expressway. Oklahoma City also operates ten closed loop systems.

4.1.7 On-Board Navigation Systems

On-board navigation systems provide unfamiliar motorists with real-time navigational guidance en-route from origin to destination. Such systems consist of a graphical display and associated equipment to track vehicle location in real-time and provides a recommendation for which route to take. The following agency currently operates an on-board navigation system.

- Oklahoma City Fire Department (17 Vehicles)

Similarly, the following agencies have indicated that on-board navigation systems will be operational by 2005.

- Midwest City Fire Department (8 vehicles)
- Midwest City EMS (8 vehicles)
- Norman Fire Department (8 vehicles)

4.1.8 Transit Automatic Vehicle Location Systems

On-board vehicle navigation systems also known as automatic vehicle locations systems enable operators to identify the geographical location of a vehicle in real-time. These applications are most beneficial on emergency and transit vehicles, but are practical for other applications when installed on maintenance vehicles such as snow plows and street sweepers.

4.1.9 Computer Aided Dispatch Systems

Computer aided dispatch (CAD) systems are often used by emergency agency operators to enter information. Agencies that currently operate CAD systems include:

- Oklahoma City Fire Department
- Midwest City Fire Department
- Norman EMS

The following agencies will have CAD systems in place by 2005:

- Midwest City EMS
- Edmond Fire Department
- Norman Fire Department

4.1.10 Pike Pass Electronic Toll Collection System

Electronic toll collection systems such as the Pike Pass program increases roadway capacity, improves toll collection operations, and decreases fuel consumption and emissions. Pike Pass is owned and operated by the Oklahoma Transportation Authority and has been developed and implemented for the Oklahoma Turnpike System. In the OCARTS region, the Pike Pass system is implemented on the John Kilpatrick Turnpike and the Turner Turnpike (I-44). There are currently over 500,000 Pike Pass users.

4.2 ITS COMMUNICATIONS

Communications systems are discussed in this chapter as trunk and distribution. Distribution communications connect field devices to the trunk. The trunk brings communications to a specific facility such as the regional traffic management center (RTMC) proposed for the OCARTS region.

Both trunk and distribution communications needs can be divided into two types: low bandwidth and high bandwidth requirements. For ITS, low bandwidth devices include voice and data transmissions. Highway Advisory Radio (HAR), DMS, Road Weather Information Systems (RWIS) and vehicle detectors require only small amounts of data (low bandwidth needs). High bandwidth requirements in ITS are needed by full-motion video. Full motion video images from CCTV cameras require very large amounts of continuous data. Because the ITS devices to be installed on the highways include full motion CCTV cameras, high bandwidth requirements control the trunk communications. For communications linkages to the trunk, only those locations with full motion CCTV cameras need to consider high bandwidth requirements.

4.2.1 Trunk Communications

High bandwidth communications can be served using fiber optic cable and/or microwave communications. Both systems are reliable and stable. Fiber optic cable is capable of transmitting data, voice and video by converting this information into a series of coded light pulses and sending them through optical fiber. The series of light pulses is then internally reflected, and guided by the optical fiber between source and destination.

Microwave communication networks convey point-to-point signals at ultra high frequencies (UHF) and beyond. These signals are emitted in a straight line through the atmosphere to and from antennas, but are limited by local topography and the curvature of Earth's surface.

In the area of communications, most emerging technologies relate to the means of compressing and transmitting data and video, which are software elements. These new technologies can reduce bandwidth requirements. There are many other emerging technologies on the horizon in the communications infrastructure in high bandwidth applications. Some of these, such as Dense Wave Division Multiplexing (DWDM) are being considered in Statewide networks and long haul applications utilizing fiber optic cable but would not be necessary in a project of this size.

4.2.2 Device-to-Trunk Communications

Several options exist for connecting field devices to communications trunks. They include both land line and wireless applications. Land line options include:

- Twisted pair cable
- Coaxial cable
- Fiber optic cable

Wireless communications include:

- Microwave radio
- Area radio networks
- Spread spectrum radio
- Cellular radio

The land line communications options are discussed first, followed by the wireless options.

4.2.3 Wireline

Commonly used in telephone communications, twisted-pair wire is also the most commonly used communications medium used for transportation systems, particularly traffic signal systems. Twisted-pair wire consists of strands of copper wire twisted around each other in pairs. Twisted-pair wire is an ideal medium for carrying audio signal frequencies in the range associated with the human voice. This cable type exhibits high reliability over long distances (>10miles) at low data transmission rates (300 bps to 56k bps). Twisted-pair wire is also capable of transferring data at higher rates up to 1.5 – 2 Mbps at high reliability but at much shorter distances (3 – 4 miles). Transferable information includes; data, voice, and slow scan CCTV images. New video compression technologies are enabling transmission of full motion (i.e., 30 frames per second) video over twisted-pair wire. These methods, however, are currently proprietary. Overall, twisted-pair wire is a relatively inexpensive communications medium.

Another land line system that can be installed above or below ground is coaxial cable. This medium can transfer data, voice, and video signals. It has the capability of transferring up to 75 video signals, primarily due to its high bandwidth capabilities. In addition, it can transmit digital data at very high speeds (7.5Mbps) with minimal signal losses and low signal leakage.

Fiber optic cable is the last main type of wireline communication. Fiber optic cable has the highest bandwidth capability, by far, of any of the communications media discussed. Its capabilities can be considered virtually limitless.

4.2.4 Wireless

The key advantage of wireless communications is that it does not require trenching or pushing conduit for underground installations. In addition, operations costs are lower for wireless applications than for land line applications. Wireless communications are not subject to breaks in the system, that sometimes occur in land lines (i.e., due to construction, shifting in subsurface, etc.). However, wireless applications require poles, power and antennas be installed. The hardware is reasonably small for field device to trunk communications. In addition, most wireless means of communications (except spread spectrum radio, which is described below) or other digitally encrypted radio, are less secure than land line systems.

Microwave radio is a stable means to transmit signals from field devices to communications trunks. The technology involved was described above in the trunk communications section.

Area radio networks transmit signals to an area, in the 30MHz to 890MHz bands. These bands are emitted uniformly in all directions. In some cases, the signal may penetrate buildings or bend around changes in topography. Whenever a signal is interrupted, the strength of the signal may decrease. Installation of an area radio network is beneficial when right of way is not permitted to install other communication systems. Similarly, the area radio network does not require installation of a medium by which the signal will be transmitted, therefore providing savings on installation.

Spread spectrum radio is a wireless technology that can transmit data and a limited number of full motion video channels. Originally developed for the military, spread spectrum radio is a secure wireless transmission technique. It is considered secure because data is transmitted over a wide range of the signal frequency spectrum. When the receiver detects the transmission, the signal is then reconstituted to its original form.

Cellular radio has a number of transportation applications. First, cellular radio can be an effective means of communicating with individuals or devices on an infrequent basis. Such communication can be made to staff or emergency crews, motorist call boxes and/or to control remote equipment. Use of cellular radio on a more frequent basis can be quite expensive when compared to the majority of other communications media. Cellular digital packet data (CDPD), a form of cellular radio that uses otherwise unoccupied cellular channels, can transmit data at rates up to 19.2 kbps, and is useful in certain non-critical applications. The primary drawback to using cellular technology is that in critical times, when traffic accidents occur, drivers may be using the cell tower capacity and calls from the RTMC may not get through to the field devices.

Regional Communications are summarized in Table 2.

Table 2: Summary of Regional Communications

Agency	Communications
ODOT	• 155.25MHz voice only radio system • DMS controlled through dial-up connection • Portion of the Fiber Optic Backbone that parallels non-toll interstate facilities
OTA	• Portion of the Fiber Optic Backbone that parallels toll road facilities
DPS	• 800MHz radio system (existing), trunked digital system (planned)

5. CONSIDERATIONS FOR ITS IMPLEMENTATION

There are several issues that may indirectly affect the success of ITS implementations – including funding, staffing, standards, maintenance activities, and others. These issues, if not considered and addressed, may decrease the effectiveness of the implementing agency, their respective systems, and the regional ITS as a whole. The following chapter discusses these issues in detail.

5.1 FUNDING

The costs associated with designing, deploying and operating an ITS requires jurisdictions to be flexible in their use of federal, state and local revenues. Since the advent of the Intermodal Surface Transportation Efficiency Act in 1991, and its successor the Transportation Equity Act for the 21st Century (TEA-21) of 1998, the federal government has provided states with unprecedented flexibility and discretion in how Federal Highway Trust Fund money can be used to enhance the surface transportation system. However, this distributed responsibility results in more demands from all sectors of the transportation community. Furthermore, budgets are becoming more and more limited as local revenues are restrained due to economic shortfalls or other factors. ITS projects will encounter greater competition with other types of both traditional and non-traditional transportation projects. For instance, ITS projects often have to compete for funding with more traditional transportation, construction, and improvement projects. This often delays the funding of planned ITS projects, and subsequently shifts ITS systems implementation. During such delay, it is likely with ITS projects that newer technologies will emerge limiting the effectiveness of the planned project when it is implemented. The following paragraphs describe considerations like these as well as potential funding sources.

5.1.1 Funding Needs

Specific items must be funded in order to successfully develop, implement, operate, and maintain ITS.

Planning and Design

As with most capital projects, ITS projects require planning and design work to determine what will be built, how it will be built, and what level of mitigation (if any) is required. ITS projects, however, are not the same as typical roadway design projects. Because of the computers, software, and networks, a “systems engineering” approach is required by the Federal Highway Administration (FHWA) in planning and design ITS projects. Special attention needs to be paid to ensure that enough funds are allocated for the planning and design phase to accomplish the systems engineering process. The systems engineering process focuses on the end product. Issues such as “how will the system be used?”, “how will the system be tested?”, and “what other systems (existing or planned) are effected?” must be answered at the beginning of the project. This is crucial for adequately defining the project, so that true costs are reasonably accurate to budget for the construction, operations, and maintenance phases.

Project Capital

Capital expenditures for ITS will include, but are not limited to:

- Infrastructure, including roadside devices, communications media (e.g., fiber optic cable), and the infrastructure required for the RTMC
- Software
- Other materials directly tied to the project implementation (e.g., marketing, training materials, etc.). These are generally one-time charges.

Operations and Maintenance

Adequate operations and maintenance funding is needed for effective system development and operation. The level of sophisticated technical and software systems inherent in most ITS projects is substantial. Funding is necessary not only at project implementation but is also needed to maintain these systems, communication networks, and devices. ITS often requires additional funding for operations and maintenance of ITS devices as compared to traditional transportation projects such as road maintenance. The agencies within the OCARTS region need to account for routine maintenance and the additional costs that may apply to ensure a full design lifecycle for each system. These investments need to be protected to avoid premature system(s) replacement.

One positive attribute of ITS standards adoption will be the development of more interoperable equipment and common system platforms, which will encourage more choices among vendors, thus helping to reduce replacement costs.

Training

As the ITS elements are deployed in the OCARTS region, it will be increasingly important to ensure that the staff responsible for operating and maintaining these devices receive adequate training. Training will be required for all existing and new employees who will be responsible for operating and maintaining ITS. Providing proper and adequate training will help ensure that maximum benefits are derived and that system life is maximized.

5.1.2 Funding Opportunities

Funding is a vital element of any transportation program. The purpose of this section is to provide the information necessary for ODOT to consider the funding alternatives (and their requirements) that are available for the ITS projects. Innovative funding sources are included.

Federal Sources

The enabling legislation allocating federal funds is Title 23 of U.S. Code as modified by the Transportation Equity Act for the 21st Century (TEA-21). TEA-21 is a six year funding package signed into law in 1998 and is due to expire at the end of this year. TEA-21 authorizes $217 million in funds for deploying multimodal transportation projects, including ITS, over a six-year period. For ITS, TEA-21 allocates funding primarily for ITS Integration, ITS Standards, Operational Tests, Research, and ITS Deployment Incentives. ODOT has been successful in obtaining earmarked funds for deployment of ITS projects in the OCARTS region. TEA-21 legislation is expected to be replaced by the congressionally approved Safe, Accountable, Flexible and Efficient Transportation Equity Act of 2003 (SAFETEA).

If approved in its current form, the SAFETEA package will establish a categorical program (the ITS performance Incentive Program) for ITS. For the State of Oklahoma the six year aggregate summary of SAFETA apportionments for the ITS Performance Incentive Program is expected to be $15,230,015. This differed from TEA-21 where funding for ITS was set-aside form other programs like the NTS. In addition to this categorical program, there is also a CVISN portion, that directs $25 million per year to states so they can complete the CVISN program, which would bring funding to Oklahoma for commercial vehicle operation (CVO) applications.

Applications for ITS funds must submit 1) an analysis of the life cycle costs for operations and maintenance (if capital costs exceed $3 million), and 2) a multi-year financing and operations plan.

Under TEA-21, several changes were made to mainstream the ITS program into the well-funded traditional federal-aid highway categories. As a result, ITS projects are explicitly eligible for NHS, STP, CMAQ funding. Further, ITS "capital and operating costs for traffic monitoring, management, and control facilities and programs" are eligible. Use of CMAQ funds for operations is limited to a three-year period. The other traditional funds do not have a time limit.

This national package includes the following funding programs that may be tapped to support ITS deployment:

- National Highway System (NHS)
- Surface Transportation Program (STP)
- Congestion Mitigation Air Quality (CMAQ)

National Highway System (NHS)

This program provides funds to improve rural and urban roadways that are part of the NHS. Under the NHS Designation ACT of 1995, over 160,995 miles of roads, which are most critical to interstate travel and national defense, those that connect with other transportation modes, and those essential for international trade are eligible for funding. Until 1991, the NHS funding program limited the period in which funding could be used for traffic management and control to two years. However, TEA-21 and its predecessor (ISTEA) eliminated this limitation. This is inclusive of start-up and operating costs. TEA-21 also includes "infrastructure-based intelligent transportation system capital improvements" as eligible projects for NHS funding. Additionally, as defined in 23 USC 103(b)(6), the term "operating costs for traffic monitoring, management, and control" now includes a much broader range of eligible expenditures, including the following:

- Labor costs
- Administrative costs
- Utilities and rent
- Other costs associated with the continuous operation of traffic control, such as integrated traffic control centers

Operating expenses are now defined to include hardware and software upgrades, as well as major systems maintenance activities (i.e., those undertaken to ensure peak performance). The replacement of defective or damaged computer components and other traffic management system hardware, including street-side hardware, is also eligible. However, restrictions still preclude the use of these funds for the routine maintenance of computer components and system hardware.

Surface Transportation Program

The Surface Transportation Program (STP) is a block-grant type program that can be used by state and local governments on any road (including NHS) that is functionally classified as a local or rural minor collector or higher. Infrastructure-based intelligent transportation system capital improvements are eligible for STP funding. STP funds can be used for capital and operating costs for traffic monitoring, management, and control facilities. However, as with NHS funding, they cannot be used for maintenance.

Congestion Mitigation and Air Quality Program

As part of the federal Clean Air Act, the Congestion Mitigation and Air Quality Program (CMAQ) channels air quality improvement resources to non-attainment areas for ozone, carbon monoxide, and particulate matter. Traffic and congestion management strategies are eligible for CMAQ funding, provided that the sponsor can demonstrate that these strategies will improve air quality.

Operating expenses for traffic monitoring, management, and controls are eligible for CMAQ funding under the following conditions:

- The project produces demonstrable air quality benefits
- Project expenses are incurred as the result of new or additional service levels
- Previous funding mechanisms, such as fees for services, are not replaced

Use of CMAQ funds for operations is limited to a three-year period. The other traditional funds do not have a time limit. In addition to the funds authorized specifically for ITS, ITS activities are eligible for funding from other programs. Both NHS and STP funds may be used for infrastructure-based ITS capital improvements and CMAQ funding may be used for implementing ITS strategies to improve traffic flow, which contributes to air quality improvement. Transit-related ITS projects are defined to be capital projects and are therefore eligible for funding under specific transit capital programs, such as the Urbanized Area Formula Grant Program and the formula grant program for non-urbanized areas. This is in addition to the STP, NHS and CMAQ programs.

State Sources

Another consideration in funding eligibility is the role of the Metropolitan Planning Organization (MPO). In Transportation Management Areas (TMAs), NHS and Interstate Maintenance projects are selected by the State, in consultation with the MPOs, and consistent with the Transportation Improvement Program (TIP). With all other federally funded projects, the MPOs select the projects in consultation with the State, consistent with the TIP. In reality, ODOT and the MPOs strive for consensus on all of the projects in the TIP, whether or not federally funded.

Dedicated State (DS)

Dedicated State (DS) funds are the primary source of state transportation funding for state highways. DS funds may be used for ITS purposes on any state highway, any bus system or rail system without any program restrictions on eligibility.

District Dedicated Revenues (DDR)

Derived from the State Comprehensive Enhanced Transportation System Tax, these funds must only be used for state transportation projects in the specific counties where the revenues were collected to the maximum extent feasible.

ITS Earmarks

ITS earmarks will continue to be another source for ITS project funding. Although the predictability of this funding is somewhat limited, this source can provide supplemental resources for various ITS projects in the pipeline for implementation, or help start ITS projects that haven't faired well through other more established TEA-21 funding programs. After the State receives ITS earmark monies, the OCARTS region may apply to the State to receive funding. The ODOT ITS Policy Committee decides how the Earmark money is allocated.

Innovative Funding Mechanisms and Special Programs

"Innovative financing" refers to changing the traditional FHWA financing process from a single strategy of funding on a "grants reimbursement" basis, to a diversified approach that provides new options. Innovative funding has been advocated for ITS for some time perhaps due to the unique, relatively new nature of ITS projects. Many of these ideas come from the most innovative financing concepts developed in the public and private sectors. A prime objective of innovative financing is to maximize the states' ability to leverage federal capital for needed investment in transportation systems and to foster the efficient use of funds.

Transportation Infrastructure Finance and Innovation Act of 1998 (TIFIA)

TEA-21 established a new innovative financing program called the "Transportation Infrastructure Finance and Innovation Act of 1998" (TIFIA). Eligibility for TIFIA extends to projects that are of critical national importance such as intermodal facilities, border crossing infrastructure, multi-state highway trade corridor expansion, and other investments that have regional and national benefits. The TIFIA credit program is designed to fill market gaps and leverage substantial private co-investment, through supplemental and subordinate capital.

TIFIA permits the USDOT to provide financial assistance to projects in the form of direct loans, loan guarantees, and lines of credit. Almost any project that costs over $100 million is eligible for this program. ITS projects are specifically included for costs of $30 million or more. Federal credit assistance may not exceed 33% of the total project cost.

ITS Deployment Program

Under this program, eligible projects must demonstrate integration of multi-modal ITS components in metropolitan areas, rural areas, statewide, and/or multi-state city settings to improve mobility, promote safety, increase traffic flow, etc. including building on existing ITS projects. The federal share is 50%.[1] This fact requires sponsors of projects to gain local congressional support for candidate projects.

Partnerships

A public/private partnership is a business relationship between the public and private sectors. Both entities, to a specific degree, share responsibilities and the costs, risks, and rewards associated with delivering goods and/or services. From a transportation standpoint, a public/private partnership is a form of service delivery with a collaborative approach based on reallocating traditional responsibilities, costs, risks, and rewards between the public agency and private entities.

State Infrastructure Bank (SIB)

The SIB is an investment fund that offers loans, credit enhancements and other forms of financial assistance to surface transportation projects that meet federal standards and are eligible for assistance under Title 23 and capital projects defined by Title 49. The loans are capitalized with federal funds.

Advanced Construction (AC)

This approach involves using state funds for a project eligible for eventual reimbursement with federal funds. Advanced Construction funds can be used in Interstate Maintenance, National Highway System, and Congestion Mitigation / Air Quality programs. This approach is characterized as an excellent tool to ensure that no available Federal funds are lost in a Federal fiscal year.

State Match

State Match involves credit for the non-federal share of funding on a project. Toll revenue expenditures are used as a credit toward the non-federal matching share of all programs authorized, with certain exceptions. A different form of state match involves use of the value of in-kind services for the soft match, under certain rules.

[1] The FHWA lead contact person is Toni Wilbur, HOTM-1, Telephone, (202) 366-2199. Proposals are submitted to FHWA Washington Headquarters. Traditionally, however, these funds have been earmarked by Congress.

5.2 STAFFING

5.2.1 Regional Traffic Management Center (RTMC) Staffing

In Chapter 6, it is recommended that a RTMC be established to monitor and manage traffic on regional roadways, and to disseminate relevant information to travelers (pre-trip and en-route) and other agencies. A variety of RTMC personnel, from the manager to the individual technical assistants, play significant roles and perform essential duties in the operation of the RTMC. Regardless of the type of RTMC, effective day-to-day operations require the RTMC team to perform a number of basic tasks and administrative procedures, including:

- Maintain the continuity, integrity, and efficiency of traffic management operations
- Obtain, retain, process, analyze, manipulate, and archive data
- Provide for security, operations, and administration of the RTMC's software, hardware, databases, LANs, communications systems, servers, etc.
- Perform RTMC functions with authorized, dedicated, and properly trained personnel
- Communicate and coordinate with affected agencies and organizations
- Document or maintain logs of all RTMC tasks and activities

The number of staffing positions needed depends on the hours of operation and the functions that are carried out in the RTMC. It will also vary depending on whether the RTMC is operated by the responsible agency or by outside sources. The RTMC Board must determine which agencies will provide staff for the needed positions or, in case of contractor operations, what each agency's funding contributions will be. Another variable is the number of full-time and part-time positions that will be available in the RTMC. Typical full-time positions are described in Table 3.[2]

Table 3: Typical TMC Full-time Positions and Functions/Responsibilities

Position	Functions and Responsibilities
Supervisory Operators/ Technicians	• Be able to clearly communicate and supervise operators • Be able to perform duties of the operator for short periods of time when conditions warrant • Host visitors to the Control center (Usually more intense during first 18 months of operation) • Must formulate policies regarding system operations and DMS operations • Be able to interact with the press and be able to provide information to maintain good public relations. • Responsible for scheduling work, and incase of technicians must be ale to record work performed and is required to prepare quantity and cost estimates for the annual budget.

[2] Building Professional Capacity in ITS: Guidelines for Staffing, Hiring, and Design Ideal Project Teams. U.S. Department of Transportation – Joint Programs Office. April 1999

Position	Functions and Responsibilities
Operator	• Monitor system capacity and flow • Help to make real-time decisions and communicate those to the public • Help to diagnose incidents and provide coordinated quick response to traffic and incidents by dispatching appropriate assistance • Broadcast status information, possibly interact with media • Be well-versed in agency polices and procedures for disseminating information • Be able to utilize ITS technologies such as variable message signs for broadcast to and management of the traveling public • Identify and report/repair minor communications/ computing system problems; understand the system well enough technically to trouble shoot minor problems with hardware/equipment functionality. • Be able to clearly communicate with the information system support professionals (I/S or MIS or System Maintenance and Support Technicians) about minor and major problems. • For transit and traveler information operators, provide automated trip planning services, determine caller needs; offer suggestions for travel options.
Dispatcher	• Manage location devices to track fleet • Dispatch and schedule procedures • Determine caller needs • Provide coordinated quick-response to traffic and incident problems by dispatching appropriate assistance • Identify and report/ repair system problems
Systems Administrator/ Support Technician	• Work with systems designers to ensure technical and technological feasibility of design and physical placement • Maintain network and server, including data archiving and backups • Assist systems integrators with installation and testing • Maintain and troubleshoot systems hardware and software problems • Assist with the evaluation of ITS deployments • Maintain and update hardware and software • Manage network; manage user accounts • In cooperation with electronic maintenance technicians, repair and replace ITS technologies • Follow maintenance procedures for prevention
Field Electronics Inspectors and Maintenance Technicians	• Test and inspect construction and integration work, especially fiber optic splices and connections • Work with systems designers on technology selection and physical replacement • Evaluate project operations • Troubleshoot problems in the filed, including repairing and replacing ITS technologies (electronic devices) and hardware • Troubleshoot hardware and software problems • Install new equipment and integrate with existing systems • Supervise and inspect contractor installations • Maintain and repair traffic signal control systems

Position	Functions and Responsibilities
	• Work with systems designers to establish a proper cabinet and equipment placement within the infrastructure, as the human factors and safety considerations are particularly important for future repair and expansion.
Data Manager/ Analyst	• Help define data standards to enable cross agency data sharing; help define and support data sharing across agencies • Design, maintain and manage relational databases for decision making • Turn rata data into usable information • Design report formats and run queries (SQL) and reports; perform analysis as requested, generate useful and timely reports, coordinate data sharing with other agencies and monitor data security and storage • Analyze data for patterns and trends; interpret data and use it for problem solving and decision making • Report and disseminate data throughout organization; disseminate data results to other agencies • Responsible for overall quality and integrity of data generated and used by the system • Keep project management well-informed of potential uses of data for planning, project evaluation and other purposes • Assist with studies: for example in highway agencies, speed and volume studies; in transit agencies, performance reports that support the scheduling, fleet management, and service planning staff functions • Ensure databases comply with standard communications protocols.
Communications Specialist	• Must be knowledgeable in the operations of a variety of wireline, wireless technologies, and radio communications (AM and FM) systems supporting video, data and voice transmissions. • Must support field device implementation • Must support implementation of devices with TMC control facility

The following positions have been described by agencies surveyed as part of a recent national cooperative highway research program (NCHRP) survey as part-time, full-time, or as-needed staff based on the needs of individual RTMCs:

- Additional workstation operators and analysts
- Desk operators (operators that monitor the system without control capabilities)
- Radio dispatchers
- HAR broadcasters
- Emergency planners
- Maintenance technicians
- Task-oriented trainees (operators and technicians in training that perform tasks for the RTMC manager or shift supervisor)
- Public information and media relations personnel
- Intern employees

Staffing levels and hours of operation depend on many factors, such as the amount of coverage of the system, functions performed, number of field devices, and desired service level. Staffing coverage should be determined by the responsible agency while developing the strategic management plan. Such a needs assessment should take into account the overall function of the RTMC, the tasks that will be conducted, and a variety of local conditions that may affect staffing coverage. Even though some agencies operate their TMCs continuously, they may not have dedicated staff in the RTMC for the entire time. During "off hours", the functions of the RTMC may be transferred to the statewide TMC, an outside agency or to the police in a jointly operated center. In other cases, the functions of the system may be performed automatically with notice being given to an on-call operator or supervisor when unexpected events arise.

5.2.2 Maintenance

Another important consideration in staffing a RTMC is responsive and preventive maintenance of field devices, RTMC hardware and software, and communications infrastructure.

Device Repair Prioritization

There are several critical factors agencies must consider before ITS devices are maintained. One of these factors is the order or priority in which devices are maintained. Key factors that should influence repair prioritization for ITS devices include:

- Fulfill legal mandates – The first priority for ITS maintenance should be to satisfy legislative mandates or legal requirements.
- Safety critical – ITS devices that have a high impact on motorist safety should have a high repair priority.
- Operation critical – ITS devices that enhance and improve the operational efficiency of the transportation system.
- All other devices – ITS devices that may have no direct safety benefits and very limited operational benefit but are perceived as very valuable by the traveling public for the information they provide.

Responsive Maintenance

Responsive maintenance is the response taken by an agency to any reported equipment or system malfunction. Responsive maintenance includes both field procedures used to restore operation and shop procedures followed to repair and test the malfunctioning equipment. Responsive maintenance follows the five general steps below.

- Receive notification
- Secure the site
- Diagnose the problem
- Perform interim repairs
- Log the activity

Preventive Maintenance

Preventive maintenance consists of a set of checks and procedures performed at regular scheduled intervals to maintain the service life of the equipment. Preventive maintenance is intended to ensure reliable mechanical and electrical operation of the system, thereby, reducing the equipment failures, responsive maintenance, road users costs, and liability exposure. Preventive maintenance includes the following:

- Inspection
- Record keeping
- Cleaning
- Replacement based on the function and rated service life of the component

Table 4 provides a general list of preventive maintenance activities for a handful of ITS devices. Field device manufactures will provide details regarding maintenance activities specific to their devices.

Table 4: ITS Field Device Maintenance Activity Summary[3]

Device	Component	Maintenance Procedure	Frequency
DMS	Controller/ Internal Wiring	Visual inspection and testing	Every 6 months
	Sign Matrix, Panels, Modules	Testing and cleaning, replace bulbs, and pixels as necessary	Every 6 months
	Display	Cleaning and visual inspection	Every 6 months
	Sign Housing	Visual inspection; check connections; and clean or replace filters	Every 6 months
HAR	Antenna Assembly	Visual inspection	Every 12 months
	Transmitter	Check power and range and frequency	Every 12 months
	Beacon Equipment	Visual inspection and testing	Every 12 months
	Recorder/ Play unit	Test: check connections	Every 12 months
Weather/ Pavement Sensors	Sensors	Visual inspection; cleaning and calibration	Every 12 months
	Flashing Beacon and Sign	Visual inspection and testing	Every 12 months
	Field Controllers	Visual inspection and testing	Every 12 months
Cameras (CCTV)	PTZ Units	Visual Testing	Every 6 months
	Camera/ Lens/ Filter	Clean lens; visual inspection; check enclosure pressure	Every 6 months
	Camera Control Receiver	Check PTZ capability using laptop; check connections	Every 6 months
	Camera Housing and Cables	Cleaning and visual inspection; check connections	Every 6 months
	Support Structure	Visual inspection	Every 6 months

[3] Traffic Control System Operations: Installation, Management and Maintenance, James M. Giblin and Walter H. Kraft. ITE, 2000

5.2.3 RTMC Hours of Operation

Ideally, RTMC staffing coverage should be 24 hours per day, 7 days per week since incidents can occur at anytime within a day. If, due to workload, staffing or funding issues, this coverage can not be maintained, then the minimum acceptable coverage of AM and PM peak hours on weekdays should be accomplished. This typically means the hours from 6 a.m. to 6 p.m. need to be covered. More desirable for part-time operation is to cover the peak periods sixteen hours per day, 5 days per week. When the RTMC is not staffed, the RTMC functions should be transferred to another agency. The Oklahoma Highway Patrol could perform the duties in the OCARTS region. An on-call supervisor could also handle many of the RTMC functions remotely as required. As workload increases, and more staffing and funding become available, the center operation should be expanded towards the ideal 24/7 operations.

The initial OCARTS RTMC will be handled as a part-time facility. Table 3 contains a typical staffing chart for TMC operation. Employees can be full-time or part-time during the first two shifts. Operator 1 positions provide full coverage 8 hours per day, Monday through Friday, and Operator 2 positions provide full coverage and supervision 8 hours per day, Monday through Friday, to accommodate increased activity during peak hours. Similar staffing tables can be developed for operations of fewer hours. Some agencies provide for overlapping shifts to maintain continuity among operations personnel.

A training program will need to be developed to provide operator training on the functions of the RTMC, operation of a RTMC workstation, the use of any software packages that may be needed in conjunction with the workstation, and incident management training. Operator burnout should be mitigated by adjustment of assignments and use of part-time shifts where multiple task activities occur.

5.3 PROCUREMENT

One critically important aspect of deploying ITS is the use of the proper procurement method. It is well document and accepted by the FHWA that the use of low bid methods for the delivery of ITS is not appropriate.

Among all of the candidate procurement methods for ITS as described in the Procurement Issue Paper (See Appendix at the end of this document), those considered viable have one common characteristic - the contracted party to ODOT is a single entity. Further, this entity is selected for their capabilities, not on the basis of a low bid. The system manager contract type has been found to perform well for implementing agencies and should be considered for use by ODOT. This firm referred to as the system manager is responsible for the system planning and design, and ultimately responsible for providing the system platform, integrating this with the field hardware and communications, and delivering the working system to ODOT. This single point of responsibility reduces the risks associated with implementing ITS. The approach specifically provides the following additional benefits:

- Unlike with low bid, where the software is designed to do the absolute minimum required to meet the specifications, the system manager can take advantage of the latest thinking and processes in a rapidly evolving technological market.

- The system manager provides the owner access to the system development and integration process. If the field hardware installation is let with the software the bid will be won by an electrical contractor who does not provide software platforms. The electrical company will subcontract the software to another company.
- The system manager approach provides a product that not only incorporates consistent leading edge technologies; it can also enable integration with any traffic control systems of the adjacent network or elsewhere in the state.
- In the current environment of TEA 21 funding using a system manager allows the State to readily modify the implementation to take advantage of new funding sources, such as demonstration projects and other sources of funds.
- The design of the telecommunications network can be prepared to include future requirements that can be designated later by the owner. Often systems that are low bid have limited expansion capabilities. These limitations are often not discovered until control elements are expanded or modified later.
- As upgrades to the system hardware and software are needed in later years, they can be designed and deployed uniformly and with minimum expense.

Design build is an increasingly popular approach to project delivery in the areas of buildings, roadway and bridge. Its weakness, when used for ITS, is ODOT's loss of control or choice over the final product. This final product is only defined in terms of functional requirements with this method, leaving the outcome uncertain, except for the cost. However, ITS at the lowest price is often unsatisfactory. Weighing price with technical submissions mitigates this disadvantage, but technical submittals prepared over a short period of time within a fixed number of pages leaves much to be determined later by the contractor, adding risk to the owner. Perhaps the most important distinction of design build over the system manager methods above is that an electrical installation contractor is typically the prime contractor, removing ODOT from a direct relationship with the system provider/integrator.

5.4 TECHNICAL RESOURCE STANDARDIZATION

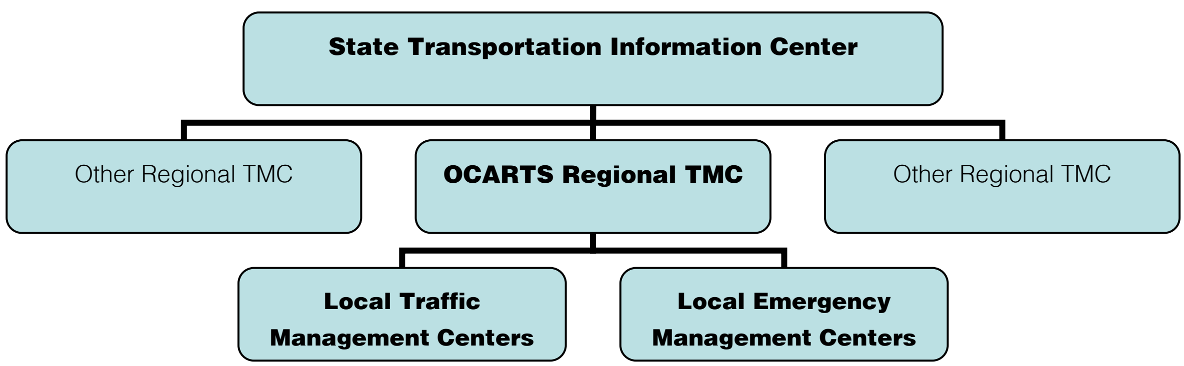
Agencies within the OCARTS region should standardize their technical resources as much as possible in an effort to reduce costs and increase ITS efficiency. Agencies operating different software platforms may wish to adopt a common or open platform to reduce the cost and time needed to train staff. Common or open software platforms will also ensure that files can be easily exchanged between agencies, thus reducing the need to reproduce similar data in different formats. For example, the exchange of geographic information system (GIS) data between agencies will be more easily accomplished through a common software program. Similarly, standardizing field equipment is likely to produce significant benefits. Similar to software platforms, standardization of field equipment will reduce the burden of having to train staff on varying pieces of equipment. In addition, standardization of field equipment will reduce maintenance costs, by reducing the number of parts that need to be ordered and kept in stock. Last but not least, inter-agency communications can be improved if similar systems are used. This will allow an individual agency to listen to communications of other agencies so as to implement the most appropriate response when regional emergencies occur.

6. ITS IMPLEMENTATION PLAN

The OCARTS ITS Implementation Plan provides a framework for efficient, cost-effective integration of ITS systems within the OCARTS area. A number of regional ITS initiatives recommended for implementation in the next ten years are provided and described in individual, stand-alone tables. Within each table, the recommended ITS initiatives are described in terms of their key functions, desired outcomes, potential benefits, planned or programmed projects, implementation phase (short- or long-term) and costs.

Regional ITS initiatives represent key infrastructure objectives (e.g., expand fiber optic cable network) that promote system interoperability and efficiency, and lead to improved transportation system safety and mobility. The regional ITS initiatives presented in this chapter were derived through a review of the region's electronic inventory of ITS elements and/or have been identified as a desired project in the Oklahoma Statewide ITS Strategic Plan. ITS initiatives are provided, as opposed to specific projects, to give system implementers flexibility when defining projects in the future given funding constraints or other impedances to ITS implementation. However, specific projects currently planned or programmed are identified under their corresponding ITS initiative.

Figure 3. Regional Management Centers Connections



6.1 ITS INITIATIVE SEQUENCING

ITS initiatives proposed for the OCARTS region are phased for deployment within the next ten years. Due to the dynamic nature of ITS and likely shift in regional needs, a specific deployment sequence is not prescribed. Instead, projects are recommended for deployment in either the short- or long-term (0-5 and 5-10 years respectively), with project deployment occurring at anytime within the proposed term. In a few cases, project deployment may occur in the short-term with additional project development occurring in the long-term. Project deployment phases are described in greater detail below.

Short-term – present to five years into the future. Short-term initiatives focus heavily on the provision of 1) infrastructure, including communications needed to physically connect ITS elements and to manage the transportation network, 2) regional traveler information, and 3) network surveillance. Short-term initiatives build on existing ITS deployments, while providing the necessary infrastructure needed to support long-term initiatives.

Long-term – five to ten years into the future. Initiatives that fall into this term build upon projects phased in the short-term and are intended to expand, maintain or complete portions of the regional ITS system.

A summary of the ITS costs for short-term and long-term is shown in Table 5. Short and long-term ITS initiatives for the OCARTS region are described in greater detail in the Tables 6 - 14.

Table 5: Summary of Initiative Costs (Costs in $1000s)*

Initiative:	**Short-term**	**Long-term**	**Total**
Regional Transportation Management Center Implementation/ Enhancements	$3,500	$500	$4,000
Implement / Expand RTMC Field Devices	$10,200	$15,000	$25,200
Statewide Fiber Optic Cable Expansion	$800	$500	$1,300
Individual Agency Data Archives	N/A	$500	$500
Emergency Vehicle Signal Pre-emption Expansion	$60	$60	$120
Emergency / Transit AVL Implementation	$1,180	$250	$1,430
Coordinated Radio Communication System	N/A	$500	$500
Alternate Route Implementation for Incident Management	$100	TBD	TBD
Traffic and Transit Information Kiosk Implementation	N/A	$150	$150
Total	$14,560	$17,210	$31,770

* All costs provided in 2003 dollars.

Table 6: Statewide Fiber Optic Cable Expansion

Initiative:	**Statewide Fiber Optic Cable Expansion**	
Description:	The statewide fiber optic cable network will be expanded to provide connections with the RTMC, and other transportation management and emergency management agencies in the OCARTS region. As part of the project, fiber will be deployed along I-235 (approximately 5 miles). The project will lead to improved data exchange among centers, and between the RTMC and STIC. Currently over 900 miles of fiber exist within the state, with fiber running the entire length of I-35 and I-44. To date the fiber has not been lit, therefore this project will include the installation of fiber optic multiplexers and switches to light the fiber and enable the exchange of data.	
Specific Projects:	• *Muskogee, Perry, Tulsa and Oklahoma City Fiber Connection* – ITS Construction project for the integration of the Muskogee, Perry, Tulsa and Oklahoma City headquarter buildings along with Reno Annex to allow for CCTV monitoring cameras connected to the statewide fiber optic backbone. • *I-235 Fiber Expansion* – ITS construction project for the expansion of the statewide fiber optic backbone allowing additional access to ODOT's fibers. Project includes placement of a communications hut for switching activities and deployment of CCTV cameras along I-235.	
Key Functions:	• Data Exchange • Communications	
Desired Outcomes:	• Improved electronic data exchange (i.e., upload/download times) • Exchange of CCTV video and images among multiple agencies	
Benefits:	• Improved Communications • Improved Agency Operations	
Plan:	Install fiber along I-235 (6 miles) and terminate connections with Emergency and Traffic Management Centers in the short-term. Expand coverage to include other regional freeways including 12 miles on I-40 (from I-35/I-40 junction to exit mile marker 165 on I-40), and 16 miles on I-240 (from I-44/I-240 junction to exit mile marker 16 on I-240).	
Considerations:	Expand fiber optic network to existing centers and field devices first. Expand fiber optic cable network outward to provide connections to planned field devices and other centers.	
Cost Basis:	Fiber Optic Cable = $20,000 per mile	
Estimated Cost*:	Short-term	Long-term
	$800,000 (assumed 40 miles)	$500,000 (assumed 25miles)

* All costs provided in 2003 dollars.

Table 7: Implement/ Expand RTMC Field Devices

Initiative:	**Implement/ Expand RTMC Field Devices**	
Description:	This project will expand existing DMS and implement CCTV cameras at locations where devices have not been deployed and the need for such devices exist. It is expected that additional CCTV cameras with full Pan/Tilt/Zoom (PTZ) capabilities and web cameras will be deployed. DMS will be permanently installed at the roadside.	
Specific Projects:	• *I-40/Tinker AFB CCTV/DMS Project* – Construction for the deployment of two DMS and four CCTV cameras along I-40 parallel to Tinker Air Force Base. Includes operator console equipment/connections at the AFB. • *I-235 CCTV Project* – Installation of CCTV cameras along I-235. This project to take place after expansion of fiber optic cable along I-235. • *I-44/I-40 CCTV/ DMS Project* – Construction for the deployment of CCTV cameras and vehicle detectors along I-44 and I-40 in the OCARTS region. Also, the integration of existing ITS components such as dynamic message signs and signal interconnects. • *Expand DMS/CCTV/Sensor for regional coverage.* Near-term 30 miles and long-term an additional 50 miles.	
Key Functions:	• Traffic Monitoring • Incident Detection, Verification, and Response • En-route Traveler Information Dissemination • Security	
Desired Outcomes:	• Improved Emergency Response • Improved Incident Response	
Benefits:	• Reduced Delays, Improved Safety and Traffic Flow	
Plan:	Implement programmed projects in the short-term. Implement additional devices in the long term	
Considerations:	• Policies are needed to establish how CCTV cameras are operated and resulting video and images are to be distributed.	
Cost Basis:	CCTV Camera Unit = $17,000 (includes unit and installation) Camera Pole = $7,000 (includes foundation, conduit, and installation) DMS = $120,000 IP-Based Web Cameras = $1,000 Expansion of System $300,000 per mile (includes CCTV cameras, vehicle detectors, DMS, and Fiber Installation)	
Estimated Cost*:	Short-term	Long-term
	Individual projects: $1,200,000 plus integration costs. (Assumed 25 Cameras = $600,000, 5 DMS = $600,000, 200 IP-based cameras = 200,000) System Expansion: $9,000	System Expansion $15,000 (50 mi)

* All costs provided in 2003 dollars.

Table 8: RTMC Implementation/ Enhancements

Initiative:	**Regional TMC Implementation/ Enhancements**	
Description:	The Regional Traffic Management Center will serve as the focal point for collection and dissemination of traffic and traveler information for the OCARTS region. The RTMC will gather information about the transportation network, process and fuse this information with other operational and control data, and provide near real-time information to partner agencies and travelers. Specifically, RTMC operators will use ITS infrastructure installed along freeways to monitor and verify freeway operations and conditions. RTMC operators will detect and verify the status of incidents on regional freeways and will coordinate with other regional transportation and emergency response agencies to clear incidents in a timely manner. Additionally, any information collected on the regional level will be shared with the Statewide Transportation Information Center, in an effort to better manage statewide transportation.	
Specific Projects:	• Regional Traffic Management Center	
Key Functions:	• Freeway incident detection and verification • Provide transportation network operating data including video imagery to participating agencies, the public, and the media for wide dissemination • Coordinate incident management activities with other agencies	
Desired Outcomes:	• Coordinated traffic operations • Coordinated incident management	
Potential Benefits:	• Improved incident response • Enhanced traffic monitoring and incident verification • Improved data collection and dissemination	
Plan:	• Build facility in short-term.	
Considerations:	Seven acres of land at the ODOT Division 4 annex has been reserved for the RTMC. This site is located close to the I-35/I-235/I-40 interchange within Oklahoma City.	
Cost Basis:	$3,500,000 for purchase of basic facility, $500,000 for hardware, software and integration for regional control	
Estimated Cost*:	Short-term	Long-term
	$3,500,000	$500,000 (upgrades)

* All costs provided in 2003 dollars.

Table 9: Individual Agency Data Archives

Initiative:	**Individual Agency Data Archives**	
Description:	Project provides participating agencies with hardware and software to establish individual data archives. The intent of the project is to establish a regionally distributed data archive, as a means to efficiently manage and exchange various types of data. The project lays the framework for a regional data archive if desired in the future.	
Specific Projects:	None Proposed	
Key Functions:	• Data Collection • Data Analysis • Data Exchange	
Desired Outcomes:	• Effective storage and exchange of data • Limit Data Redundancy	
Benefits:	• Improved Operations • Enhanced Data Analysis	
Plan:	Establish individual data archives within each agency. Develop common standards and protocols. Long-term integrate this into a regional database where all ITS agencies can access data.	
Considerations:	• Need to identify common data standards and protocols that will enable the merging of data from individual agency archives • Need to identify a common approach for accessing data • Need to identify means to avoid sharing sensitive data and information	
Cost Basis:		
Estimated Cost*:	Short-term	Long-term
	TBD	$500,000

* All costs provided in 2003 dollars.

Table 10: Emergency Vehicle Signal Pre-emption Expansion

Initiative:	**Emergency Vehicle Signal Pre-emption Expansion**	
Description:	This project expands the number of emergency vehicles equipped with signal pre-emption systems to improve regional emergency response operations. Project only applies to the agencies that currently have pre-emption equipment installed on their fleet. Project can be expanded in the future to include new implementation as desired.	
Specific Projects:	• Install signal preemption systems on twenty-five (25) Oklahoma City Fire Department vehicles • Install signal preemption systems on three (3) Norman Fire Department vehicles • Install signal preemption systems on two (2) Midwest City Fire Department vehicles	
Key Functions:	• Emergency Response	
Desired Outcomes:	• Improved Emergency Vehicle Response	
Benefits:	• Improved Safety	
Plan:	In the short-term, implement specific projects identified above.	
Considerations:		
Cost Basis:	$2,000 for each vehicle signal preemption emitter	
Estimated Cost*:	Short-term	Long-term
	$60,000 (30 units)	$60,000 (30 units assumed)

* All costs provided in 2003 dollars.

Table 11: Emergency/ Transit Vehicle AVL Implementation

Initiative:	**Emergency/ Transit Vehicle AVL Implementation**	
Description:	AVL sensors installed on emergency and transit vehicles will communicate with Global Positioning Systems (GPS) to provide dispatchers with real-time vehicle locations and movements. This information enables dispatchers to assign vehicles to a location (e.g., incident location, transit stop) based on the current location of an available vehicle. This technology can also be used to quickly locate a stalled or disabled vehicle and to provide real-time bus arrival information to transit users via the internet, kiosks, or message boards installed at traffic stops.	
Specific Projects:	• Install AVL sensors on eight (8) Norman Fire Department vehicles • Install AVL sensors on eight (8) Midwest City Fire Department vehicles • Install AVL sensors on eight (8) Midwest City EMS vehicles • Install AVL sensors on twelve (12) transit vehicles	
Key Functions:	• Real-time vehicle identification and location	
Desired Outcomes:	• Enhanced emergency/ transit vehicle dispatch • Improved public perception and use of transit • Increase transit ridership • On-time performance monitoring	
Benefits:	• Reduced emergency response • Reduced waits at transit stops • Reduced vehicle emissions and fuel consumption • Reduced traffic delays	
Plan:	Implement potential projects in short-term.	
Considerations:		
Cost Basis:	$5,000 per individual in-vehicle unit and $1 Million for base system	
Estimated Cost*:	Short-term	Long-term
	$1,180,000 (36 sensors assumed)	$250,000 (50 sensors assumed)

* All costs provided in 2003 dollars.

Table 12: Coordinated Radio Communication System

Initiative:	**Coordinated Radio Communication System**	
Description:	The coordinated radio communication system will improve agency operations and help foster the exchange of information between different agencies in the field. As it exists today, individual agency radio communications are "closed" to other agencies. Therefore, in order to communicate (or share information), communication must be transmitted between operators at the respective center and then passed to the personnel in the field. A coordinated radio communication system establishes a common frequency through which all communication is passed, allowing seamless interagency communication. Ideally, this project would upgrade communication systems between agencies in the OCARTS region to enable interagency communications in the field. However, at this time it is not feasible to do a system wide implementation. Therefore, this project will provide a few radios, agencies can use to exchange information more effectively and efficiently.	
Specific Projects:	None Proposed	
Key Functions:	• Inter- and intra-agency communications	
Desired Outcomes:	• Improved inter-agency communication in the field • Ability to make quick decisions in the field	
Benefits:	• Improved agency operations	
Plan:	Provide 2 radios to each agency in the OCARTS region that has a need for improved interagency communications.	
Considerations:	• Need to determine the agencies that have a need for in-the-field communications.	
Cost Basis:	$500,000 for 2 radios per agency (3 agencies assumed).	
Estimated Cost*:	Short-term	Long-term
	Not Planned	$1,500,000

* All costs provided in 2003 dollars.

Table 13: Alternate Route Implementation for Incident Management

Initiative:	**Alternate Route Plans**	
Description:	When major freeway incidents occur, traffic up stream of the incident location can be diverted off the freeway, and guided around the incident to freeway entrances downstream of the incident. This reduces mainline traffic delays while improving incident management operations on the freeway. Before traffic is diverted however, is necessary to establish alternate route plans to ensure traffic is diverted in an efficient and effective manner. The project will establish several alternate route plans based on different accident scenarios.	
Specific Projects:	None Proposed	
Key Functions:	• Freeway Incident Management • Emergency Response	
Desired Outcomes:	• Reduced traveler delay due to major freeway accidents • Reduced secondary crashes on freeways	
Benefits:	• Improved Safety • Reduced fuel consumption • Reduced emissions • Improved commercial vehicle operational efficiency	
Plan:	In the short-term, evaluate potential alternate routes in terms of available capacity, signage in place, and other factors that may impact traffic operations when traffic is diverted off regional freeways. Following route evaluation, develop specific alternate route plans based on different accident criteria (e.g., accident location, accident severity, etc.). Formally adopt alternate route plans once alternate route plans are evaluated and the necessary infrastructure is in place to guide diverted motorists effectively along arterials to freeway entrances.	
Considerations:	• Impact of diverted traffic on local arterial streets • Guide signage for diverted traffic • State/local agency partnership agreements	
Cost Basis:	Cost of alternate route planning study Cost of infrastructure improvements need to be evaluated.	
Estimated Cost*:	Short-term	Long-term
	$100,000	TBD

* All costs provided in 2003 dollars.

Table 14: Traffic and Transit Information Kiosk Implementation

Initiative:	**Traffic and Transit Information Kiosk Implementation**	
Description:	Kiosks, installed at strategic sites, will provide near real-time pre-trip traveler information to travelers. A traveler can use a kiosk and the information provided to make decisions regarding their trip before they embark. Easy to follow menus on the kiosks allow the user to select the type of information desired, so as to obtain a personalized report detailing their trip. This project will deploy both traffic and transit oriented kiosks. Transit kiosks, located at transit facilities, will provide transit users with personalized transit information including but not limited to transit routes and schedules, fares, and other transit services. Traffic kiosks will be connected to the RTMC to provide traffic and traveler information to motorists at the airport, stadiums, and other large trip generating sites.	
Specific Projects:	No locations have been identified.	
Key Functions:	• Provide personalized pre-trip transit information • Provide personalized pre-trip traffic and traveler information	
Desired Outcomes:	• Improved public perception and use of transit • Enhanced trip planning capabilities • Increased transit ridership (mode shift)	
Benefits:	• Reduced traffic delays • Reduced vehicle emissions and fuel consumption • Improved safety	
Plan:	Prioritize and implement in the long-term as funding dictates.	
Considerations:	Should consider the extent of data to be displayed via kiosks.	
Cost Basis:	$15,000 per kiosk	
Estimated Cost*:	Short-term	Long-term
	Not Planned	$150,000 (Assumed 10 kiosks)

* All costs provided in 2003 dollars.

APPENDIX: PROCUREMENT ISSUE PAPER

1. INTRODUCTION

Successful ITS implementation, operation and maintenance requires effective procurement processes to acquire the services, hardware and software necessary for these systems. But many conventional procurement processes are not well suited to buying these systems, and new approaches present their own unique challenges. This issue paper presents brief descriptions of various contracting methods. It is important to recognize that this paper is merely intended to serve as an initial survey. It is not a detailed analysis and considerably more effort would be needed to further investigate and implement the alternatives and recommendations described here. The purpose of this issue paper is to summarize the state of the practice for procuring ITS and other advanced technology implementations.

2. TYPES OF CONTRACTS

This section summarizes a wide range of contracting vehicles available for the procurement of ITS.

2.1 ENGINEER / CONTRACTOR

Traditional highway construction projects have been procured using a process in which the project design is developed by a public agency or a consultant (the "Engineer"). A bid solicitation is issued which includes forms and design specifications and an award is made (to the "Contractor") on the basis of the lowest bid received. While this process is highly competitive, it is not well suited to the development of complex, high-tech information and communications systems which are the core of ITS.

If a consultant is to be used to design the project, the consulting engineer is selected based on qualifications and experience to perform the work. The engineer typically prepares the contract documents (plans and specifications). Construction contractors are invited to submit bids in accordance with the contract documents. Award is based on the lowest responsive bid. Once awarded, the contractor builds the project according to the bid documents. The engineer (or another CE&I consultant) inspects the construction, certifies completion and may interpret the bid documents. Most highway construction and smaller closed-loop type traffic control system projects nationally have been procured successfully utilizing this approach.

Advantages:

- The public agency is the responsible entity
- This approach has a long history of use, with roles clearly defined
- Its history provides well-established legal precedent to handle disputes arising from this approach
- The end product is well defined at an early stage in the project
- The contractor manages the subcontractors
- This approach is well-suited to highway construction

Disadvantages:

- Artificial dividing line between design and construction
- Not well-suited to software development in that software projects are difficult to specify and the buyer may not know his needs
- Software/systems integration is not usually performed by the prime contractor
- The contractor has financial incentive to find deficiencies in the bid documents and "changed" site conditions to seek change orders

2.2 DESIGN/BUILD

This type of contract combines both the design function and the construction/installation function into a single contracting vehicle. Also known as a turnkey or public turnkey, the procurement is for the design prepared by the procuring agency. Design/build contracts are usually most successful when they are structured around a preliminary design completed to the 20 to 60 percent level. The agency's role is to monitor the design/build work. Partnering is generally involved. This contracting alternative can allow for rapid completion of the project and can provide for streamlined procurement. Engineering and construction work can be done cooperatively with a single entity to resolve problems that are common in traditional contracting, where the engineering and construction functions are handled by separate firms. These contracts may also include warranty or operations management tasks. Under this arrangement, the agency assumes greater responsibility for inspections and approvals, and requires a significant quality control effort on the part of the public agency. Selection is often based on low bid, and bids may be somewhat higher than with a traditional approach because of the increased risks to the contractor.

Advantages:

- The time to deliver the project can be reduced significantly
- Used extensively in private sector (legal precedent)
- Reduced involvement of agency staff in production and construction inspection stages
- Single point of responsibility for project design and implementation
- This approach is well-suited to complex systems procurement and integration

Disadvantages:

- Many agencies lack experience in this approach
- Reduced level of control over system components and construction methods
- Final product may not be clearly understood until proposal time
- Requires contract clauses / incentives to assure quality materials and construction

2.3 SYSTEM MANAGER

Under this contracting approach, the system manager is selected using conventional consultant procurement processes. The system manager is responsible for the design (plans and specifications), software development, hardware procurement, integration, training, and overall quality control. Equipment and electrical contracting services are usually procured on a low bid basis. System managers are often used for technology-based projects. Large traffic control and freeway traffic management systems have been procured nationally using this approach.

Advantages:

- Overall system design, software development, and testing are controlled by a single entity
- The software developer is usually the prime contractor
- This approach minimizes the shifting of fault
- Its flexibility allows for more changes than traditional contracting approaches
- It is well suited to ITS projects
- There is relatively strong competition available

Disadvantages:

- Requires careful examination of firm qualifications to assure requisite blend of skills
- This approach is somewhat unfamiliar to local engineers and procurement officials
- This approach relies heavily on the successful performance of the system manager
- The end product tends to be less well defined than under the engineer/contractor approach and it is difficult to manage "expectancies"
- Low bid services (such as equipment and electrical contracting) are the responsibility of the public agency. This may include inspection and acceptance.

2.4 SYSTEM INTEGRATOR

This approach is virtually the same as the system manager, except that the system integrator can bid on equipment and electrical contracting services. This approach was used in Georgia for the Atlanta area ATMS project.

Advantages:

- Single point of responsibility
- Contracting is simplified

Disadvantages:

- This approach is not well known to public agencies
- Allowing contractors to directly bid to the system integrator may violate the public agency's procurement processes

2.5 COMMERCIAL OFF THE SHELF (COTS) SOFTWARE ACQUISITION

This approach is new to ITS, but it used for the majority of software acquisitions in both the public and private sectors. The local agency develops a functional specification or needs statement, along with an evaluation procedure. It then evaluates all commercially available systems and selects the system that most closely suits its needs, using a predefined evaluation procedure.

Advantages:

- Essentials of competitive procurement are maintained
- Proven effective throughout the computer industry
- Increases that probability of receiving mature relatively bug-free software
- Costs are reduced
- Implementation problems and schedule slippage are minimized
- Encourages the use of standard communications protocols

Disadvantages:

- Agencies cannot readily tailor software to their specific requirements
- Only a limited number of COTS currently exist
- This approach will not work for new applications
- It is difficult for an agency to assume ownership of compute source code

2.6 BUILD TO BUDGET

This approach is different from Design/Build in that functional requirements are used in place of a detailed design. Proposers, then, develop designs based on their best solutions to meeting the functional requirements identified, using existing elements where practical. This approach has been used frequently in toll projects.

Advantages:

- Similar to design/build
- Allows maximum flexibility to proposers to use their most cost-efficient designs
- Reduces the risk based on previous developments and applications
- May allow added functionality for a given budget

Disadvantages:

- Similar to design/build
- Very unusual practice for public agencies
- Increased risk because of a lack of detailed designs
- Detailed design documents may prove contentious and delay the project
- This is a very expensive approach for proposers

2.7 BUILD-OWN-OPERATE-TRANSFER AND FRANCHISE/LEASE

This approach involves long-term contracts with a consortium to finance, design, build, operate and collect revenue. From the system implementation phase, it is equivalent to either the design/build or build to budget alternatives. The differences occur during the system operations and maintenance phases. These alternatives are typically considered because they do not involve an up-front capital cost for the owner.

The most recent example of this approach is Kentucky DOT's use of a "Tax Exempt Master Lease" to finance the construction and operation of an ITS project in Louisville. The contractor receives construction funds (and later operational funds) through a private leasing arrangement. Once the system is operational, the DOT makes periodic payments to the leaseholder. Because private investors are assuming much of the risk, the return is considered tax-free.

Advantages:

- Contractor financing reduces the up-front capital requirements of agency
- O&M the responsibility of the contractor
- Allows maximum flexibility to proposers to use their most cost-efficient designs
- Reduces the risk by tying payment to delivery of service (i.e., system operations)

Disadvantages:

- Similar to design/build
- Very unusual practice for public agencies
- Requires long-term (10-15 year) commitment to assure contractor's return on investment
- This is a very expensive approach for proposers

2.8 DESIGN TO COST AND SCHEDULE

Under this approach, the public agency develops a prioritized list of requirements. The contractor then supplies all of the mandatory items and as many of the optional items as is feasible under the given cost and schedule constraints.

Advantages:

- This approach reduces scope creep
- It reduces cost and schedule risks

Disadvantages:

- Bidders, in an effort to win the job, may be unwilling to propose not meeting all the optional features
- Overly optimistic proposals, therefore, will win

2.9 SHARED RESOURCES

A shared resource project is any agreement between one or more public sector agencies and one or more private sector organizations with the objective of providing services using the combined resources of both -- often trading a grant of a right to a public resource for the addition of a private entity to achieve a service or facility of mutual benefit to both partners. Its most common form in the ITS context is a partnership for sharing highway rights-of-way in exchange for private telecommunications expertise and capacity to further both public sector and private sector objectives.

A shared resource project in this context has four specific features:

- Public-private partnering
- Private longitudinal access to public roadway right-of-way
- Installation of telecommunications hardware
- Compensation granted to the right-of-way owner over and above administrative costs

Advantages:

- Contractor financing reduces the up-front capital requirements of agency
- O&M the responsibility of the contractor
- Agency receives state of the art equipment, built to industry standards
- Potential revenue generator for agency for valuable right-of-way access

Disadvantages:

- Dependant on private market forces to create financial incentives
- Very unusual practice for public agencies
- Requires long-term (15-20 year) commitment to assure contractor's return on investment
- Agency requirements may not match those of private sector, resulting in few to no bidders or increased costs to agency

There are a number of examples of shared resource arrangements, discussed below:

Florida Fiber Net: FDOT and DMS are preparing to issue an RFP for a shared resource project to provide the state with a fiber optic network using approximately 2000 miles of limited access right of way throughout the state. In exchange for providing the fiber, the successful proposer will get use of the right-of-way for up to 99 years for the construction of a commercial fiber network. In addition to supporting ITS applications, the network also will be used as the principal backbone communications link for various traffic operations centers, data centers and administration buildings. DMS will also offer the opportunity for the successful proposer to provide it with a SONET-based, point to point backbone bandwidth for the state's SUNCOM network. The successful contractor also will be given the opportunity to compete for other communications contracts to provide other state services.

City of Leesburg, Florida: The City's Communications Utility and two private partners (Knight Enterprises and Alternative Communications Networks (ACN)) developed a fiber optics system to deliver telecommunications services in the city. In exchange for the city's grant of right-of-way access to the above ground utility poles and it's construction funding, ACN has designed and contracted the network and is leasing the capacity to public or private customers under a five-year contract with the city.

The city, in return, owns the dark fiber on its right-of-way. Customers own the fiber from the ROW line to their own facilities, pay ACN a fee for access to the city-owned backbone, and can either use their own equipment or pay ACN for the use of its equipment to light the fiber. A total of about 40 miles of fiber will be installed. Leesburg is receiving cash compensation based on lease payments in addition to the fiber capacity. After capital costs are repaid, the revenues will be split evenly between the city and its telecommunications partner.

Maryland: The state has allowed MCI access to 75 miles of ROW for 40 years, in which MCI may lay as many conduits as feasible and desired, and pull fiber as needed afterward. MCI is providing the state with 24 dark fibers for its use. MCI also will serve as the lead contractor for building and maintaining the system. Another partner, Teleport Communications Group (TCG), entered the agreement as a subcontractor to MCI. TCG is paying MCI to install and maintain fiber in privately held conduits. TCG is giving the state equipment needed to light the fibers, and additional fiber capacity for public sector use. Each party retains ownership of the fiber dedicated to its use. Maryland set up the project strictly as a procurement to purchase telecommunications capacity through ROW access.

Minnesota: Mn/DOT has issued a Communications Infrastructure Request for Proposal offering one time communications access to its freeway ROW in exchange for communications infrastructure, consisting of both fiber optics and wireless towers. In August, 1996, the state selected International Communications Systems (ICS) and Stone and Webster to install 96 fibers on the state's 1000 miles of freeway and on enough trunk highway mileage statewide to connect all of Mn/DOT's district offices and the Department of Administration's 13 Mnet HUB sites. Under the agreement, Mn/DOT will grant ICS and Stone and Webster the right to install the cable in the ROW. In return, the state will receive access to a 1500 mile high speed communications network at no cost. In addition, the private partners agreed to develop the network not only in the metropolitan areas, but also in the less populated areas of the state. The project has received opposition from two groups: long distance and other providers who object to the fact that only one provider will be using freeway ROW, and independent phone companies throughout the state who feel threatened by the competition likely to result from the partnership.

In addition, the state has filed a petition with the Federal Communications Commission for a ruling that the grant of exclusive longitudinal use of freeway rights-of-way do not violate Section 253(a) of the Telecommunications Act. Section 253(a) prohibits state and local governments from enforcing statutes, regulations or other requirements that prohibit or have the effect of prohibiting the ability to provide telecommunications service. Section 253(c) of the Act preserves the authority of state and local governments to manage public ROW and to require fair and reasonable compensation from telecommunications providers on a competitively neutral and nondiscriminatory basis for use of public ROW. Mn/DOT is arguing that the partnership is consistent with section 253(c) of the Telecommunications Act.

Missouri: Missouri selected Digital Teleport Inc. (DTI) to install 1300 miles of fiber optic cable to create a statewide communications backbone system. In return for allowing access to the ROW, Missouri received six lighted fibers for state highway use and DTI's maintenance services for the system. The arrangement provides the state with two strong advantages. First, there is limited competition from ROW alternatives, such as railroads, in the areas of greatest interest to bidders (particularly the St. Louis metropolitan area). Second, it grants exclusivity to one telecommunications firm, although that firm can lease access to other telecommunications firms on its lines and is, in fact, doing so.

Missouri also structured the deal strictly as a procurement, purchasing telecommunications capacity through highway ROW, and DTI's access to the ROW is considered a procurement contract awarded to a single contractor, in a competitive process, rather than a special privilege.

2.10 STATE CONTRACT

Purchases of goods and services that are ongoing and are common to several state agencies generally are consolidated under standard specifications and are developed into state contracts or joint institutional purchases. Under the state contract approach, the state issues a Request for Bids for various (and usually indefinite quantities of) commodities and services. Vendors then provide prices for those products and services based on the terms and conditions of the RFB. The vendor providing the lowest bid is selected. The prices are good for some specified period of time. State agencies can then order the products and services they need from a list of providers. While this approach allows agencies to plan for and procure goods and services more easily (prices are known and fixed, ordering process is relatively quick and easy, etc.), it is not well-suited to complex procurement, such as ITS systems and equipment. This approach has both advantages and disadvantages.

Advantages:

- Latest technology can be procured through State contract
- Eliminates submittal review process when equipment in known to the Department
- State is in complete control over the schedule of equipment and software delivery
- State contracts directly with equipment and software suppliers, giving State greater leverage to insure products supplied are as promoted
- State can quickly procure alternate products when equipment or technology becomes obsolete or unavailable
- State contract equipment has already been product tested and approved
- Allows State to contract and deal directly with suppliers on all testing, giving State more power over suppliers meeting product schedules and adhering to test requirements
- Time required to negotiate and process supplemental agreements due to vendor equipment reduced or eliminated
- State is able to take greater responsibility and control over the success and outcome of the project

- Cost to operate equipment is reduced when the State procures equipment with known, quantifiable operating requirements

Disadvantages:

- Potential for delays getting new products approved and bid to new State contract list
- Contractors' ability to provide innovative approaches restricted or eliminated
- Introduces fourth party (vendors) as a major player in deciding on what and how system functions will be delivered
- Greatly increases Department involvement and liability in system procurement and acceptance
- Transfers some of the responsibility for ultimate system operation from Systems Manager and contractor to the State

3. METHODS OF AWARD

In addition to considering the type of contract vehicle most appropriate to a particular ITS project, the public agency must also consider which method of awarding the contract is most appropriate to ensure adequate competition for the award. A variety of options are described below.

3.1 SEALED BIDS

This approach is perhaps the most common method of award for both Federal and state contracting. This approach requires that contracts be awarded only on a lowest cost, responsible and responsive bidder basis. This approach tends to maximize the number of private firms competing against each other solely on the basis of price, and gives the procuring agency the "best buy."

The sealed bid process is easy to defend in protests because of its objectivity. However, sealed bidding works best when the agency can develop a complete, adequate, and realistic set of specifications, there are two or more responsible bidders willing to compete, the procurement lends itself to a firm, fixed price contract, and the selection itself can be made on price.

In the ITS context, however, sealed bidding presents some significant disadvantages. Detailed specifications may not be available for emerging technology, sealed bidding inhibits innovation, it precludes the public sector from considering anything but price in its selection, and it limits opportunities for the public and private sector to engage in meaningful dialogue to find the most appropriate solution to the agency's needs.

To mitigate some of these disadvantages, many public agencies have adopted pre-qualification procedures to ensure that low bidders have the requisite skills and competencies to successfully execute the work. This is particularly important in the ITS environment.

Lifecycle contracting is another approach agencies have employed to ensure that they receive both low cost and good value in their procurements. Lifecycle contracting is a competitive procurement process that results in the selection of the bid with the lowest lifecycle costs or that increases the weight given to lifecycle cost considerations.

3.2 2-STEP BID PROCESS

This approach allows the procuring agency to gain the advantages of a sealed bid approach when it lacks adequate specifications for a project. The process starts with a solicitation from the public agency that sets forth its technical needs and requirements. Proposers make technical proposals based on the solicitation, without discussing price. Those firms submitting technically acceptable proposals in step one would be invited to submit sealed fixed price bids based on their proposals.

3.3 COMPETITIVE PROPOSALS

This approach uses Requests for Proposals (RFPs) and Requests for Qualifications (RFQs) to select contractors when price and other considerations must be weighed. In general, the more design and professional services that are bundled into a solicitation, the more appropriate the use of competitive proposals. This approach is usually employed when there is more than one source capable of providing the services. While there is some subjectivity involved in selecting a contractor under this method, the process is sufficiently objective to allow for courts to review decisions, if a proposer issues a protest. Competitive proposals encourage innovation, but if the solicitation is too loosely defined, proposers may submit bids that the public agency does not consider to be responsive. The process also does not allow for bidders to clarify their bids in such circumstances. This approach may also invite political problems if the low bid contractor is not selected.

3.4 COMPETITIVE NEGOTIATIONS

Competitive Negotiation uses an RFP/RFQ process to identify one or more firm with which to conduct negotiations. This allows the agency to negotiate different contract terms than those used as the basis for the bid. Among the criteria to be considered in determining whether competitive negotiations are appropriate are whether there are significant variations in how the services to be procured can be provided, whether attributes other than price are to be considered, and whether there is a need for bidders to revise their work plans after the initial evaluation of the proposals.

3.5 SOLE SOURCE

Sole source contracting is allowed in only very limited circumstances. This approach involves the selection of a contractor for negotiations based on the firm's reputation or its prior relationship with the owner. It should be used only when the supplies or services to be procured are available from only one source.

3.6 UNSOLICITED PROPOSALS

Unsolicited proposals allow public agencies to obtain innovative or unique methods for meeting agency needs. Contracts can generally only be awarded when the unsolicited proposal does not resemble a pending competitive acquisition

4. LAWS/REGULATIONS GOVERNING FEDERAL PROCUREMENT

ITS deployment occurs largely in the realm of state and local agencies. But Federal law considerations play a role in determining what types of contracting vehicles and award methods can be used. This section describes some of the most significant Federal legal requirements to be considered in procurement.

4.1 FEDERAL LAW CONSIDERATIONS

Common Rule

Under the Common Rule, if a public agency is receiving Federal-aid funds, it is required to use the established state or local procurement procedures, but must also ensure that the contracts issued include relevant clauses required by Federal statute, executive order or regulation.

Title 23 Requirements

Title 23 states that highway construction contracts must use bidding methods that are effective in securing competition. In other words, competitive bidding methods are required, unless the state demonstrates that another method is more cost effective or an emergency requires the use of an alternative method.

The definition of construction includes traffic control systems. Currently, there is little guidance as to whether Title 23 requirements apply to specific ITS projects. But in general, if a contract involves installation, then it is considered construction and competitive bidding applies.

Other sections of Title 23 require that contracts for engineering, architectural, and design services must be awarded in the same manner as architecture and engineering services procured under the qualifications-based selection process prescribed in the Brooks Act (or some equivalent qualifications based requirement). Thus, since construction (or installation) projects require the use of competitive low bid methods for procurement, and architectural/ engineer/ design services require a qualifications-based selection process, a number of ITS projects could result in the need for two separate contracts (one for the engineering services and one for the installation services) and two separate contractors.

SEP-14 Innovative Contracting Methods

Within the context of the Common Rule and Title 23, FHWA has been promoting the evaluation of innovative contracting methods known as Special Experimental Project number 14 (SEP-14) for ITS projects. For eligible projects, SEP-14 allows the use of innovative contracting methods, such as design-build, for procurement of construction related items. ITS projects that receive federal aid funds and that have any elements that may be classified as construction items are required to follow the SEP-14 process if using the design-build contracting method. The SEP-14 process requires prior approval of the concept before proceeding with design-build contract.

There are no required selection criteria for design-build projects under the SEP-14 process, however it is the policy of FHWA that cost must be one of the factors. Other factors usually included in award criteria include quality and construction time considerations. The SEP-14 process has been used in North Carolina to award a design-build contract for construction of the Congestion Avoidance and Reduction for Automobiles and Trucks (CARAT) project near Charlotte. Utah DOT used “best value” award criteria for a design-build procurement for reconstruction of I-15 through Salt Lake City, including an area-wide ATMS, in time for the 2002 Winter Olympics.

The exemption allows the state or political subdivision to effectively and efficiently administer a government program and the administration of the program is significantly impaired without the exemption.

5. PROCUREMENT ALTERNATIVES & RECOMMENDATIONS

While there is still much confusion and consternation relative to ITS procurement, one thing is certain -- there are steps agencies can take to improve the acquisition of the hardware, software and services required. It also is true that there are no silver bullets, no magic solutions. A procurement process which worked successfully for one type of ITS procurement may not be appropriate for another one. This section discusses some general guidelines ODOT should employ in preparing for ITS procurements and provides some recommendations for which contracting vehicles should be considered for specific procurements. It concludes with a few additional recommendations for ODOT to consider in easing current procurement processes.

5.1 STEPS TO SUCCESSFUL ITS PROCUREMENT

There are six basic steps to be considered in preparing to purchase ITS. While these generally apply to system and software acquisitions, many of these steps can and should be applied to acquiring consultant services, as well. Each step is discussed briefly below:

Step 1 -- Build a Team

As many transportation professionals, long accustomed to traditional highway contracting procedures, have discovered, procuring ITS is different. It requires the involvement of a myriad of disciplines and specialties, some of which may be outside the Department of Transportation. The team may serve a number of functions: developing the plan and requirements for the procurement, evaluating the proposals, and ensuring that the goods or services procured are meeting the needs identified in the plan. The team can also serve to cement existing interagency relationships or build new relationships which will be critical not only to procuring the ITS system, but also to deploying and maintaining it.

Who should be on the team? Several people, including:

- Software technical expertise
- End users
- Maintainer and administrators of the system
- Domain experts
- Contracting and purchasing officials
- Software, information systems, and intellectual property legal expertise
- "Translators" who can explain technical jargon, concepts, etc across disciplines.

Step 2 -- Plan the Project

Good procurements are ones that are well-planned. Project plans need not be long and detailed, but should concisely present the goals and objectives of the project and highlight high-level strategic decisions about the procurement. The project plan will help to define the boundaries of the project, identify who needs to be on the project team, and provide a communications tool for all those involved in the project procurement. Importantly, the plan helps to explain "why" the project is being pursued - justifying the purchase and ensuring the procurement is focused on meeting these needs. Some things to include in the plan:

- Description of the project
- Rationale for the project
- Project Schedule
- Roles and responsibilities of team members
- Funding estimates and sources
- Facilities
- How the system will be acquired (the build or buy decision) (note: early in the project, this section may be in the form of alternatives)
- How the project fits in with other "legacy" or planned ITS systems
- Standards
- Risk Management
- Contracting Strategy (the extent to which consultants and outside support will be used for the project)
- Contracting Vehicles
- Contract Management
- System Operation and Use (who will use the system, who will administer and manage the system, etc.)
- Acceptance Strategy (how will the system, once acquired, be accepted?)
- Training Plans (how will users be trained in using the system?)
- Maintenance Plans (who will be responsible for maintaining the system?)
- Reality Check (what constraints and conditions must be considered in relation to the procurement?)

A key thing to remember is that the plan should be a living document and be a tool to guide the procurement. It should not become an overwhelming task that inhibits, rather than facilitates the procurement. Items within the document are likely to (and should) change as the project evolves and team members contribute their various perspectives to the project. In addition, externalities affecting the project (budget, schedule, etc.) may force a reevaluation of certain parts of the plan.

Step 3 -- Develop Requirements (Software and Systems Projects)

A good set of requirements is perhaps one of the most important things you can do in a software or systems acquisition. This is where your project team can play an invaluable role. Requirements should be well documented in a configuration control document. The requirements should focus on the functional and performance requirements the system must meet. It should not get into design and technical requirements. Doing so confuses the issue and unnecessarily limits the options available to the agency.

It is important to thoroughly review and revise the requirements. Do not ask for too much. Unnecessary or superfluous requirements can greatly increase cost and complexity, without adding much in the way of functionality. Also consider quality factors in the requirements analysis. Ensure that the system will be able to accommodate anticipated changes.

Step 4 -- Make the "Build or Buy" Decision

Over the last several years, a variety of software and system applications and field devices have been developed and enhanced. Many of these existing systems and devices provide extensive functionality and can be integrated with other existing systems. Too often, however, public agencies have failed to consider "off-the-shelf" products for their systems. It is when systems are customized that bugs and costs explode. Off-the-shelf products can provide agencies with cost-effective systems that are well integrated and meet most, if not all, of their requirements. One approach to determining whether to build or buy a system is to develop a matrix for evaluating off the shelf products. An example is shown below in Table 1.

Table 1. Example Table for Evaluating and Comparing Product Features

	Product 1	Product 2	Product 3
Mandatory Requirements			
Requirement A			
Requirement B			
Requirement C			
Other Criteria			
Security			
Data Rights			
Life Cycle Costs			

Using the matrix, weed out products that do not meet your mandatory criteria. It is important to ensure that your mandatory requirements are, in fact, that. Carefully evaluate the remaining products, either through hands on use, or through a rigorous demonstration under conditions as close to yours as possible. Contact the vendor's other customers to determine the product's quality and reliability, the extent and quality of the vendor's support for the product, maintenance issues, etc. If you chose to use off-the-shelf products, be sure the contract includes provisions to accommodate changes in requirements, functionality, costs, etc. Also be sure that you get a flexible licensing agreement for the system. If you choose to customize off-the-shelf products, recognize that there are intellectual property rights issues to be considered, as the "commercialized" portions of your system will be subject to certain restrictions.

Step 5 -- Select a Contracting Vehicle

The next step in the procurement process is to select an appropriate contracting vehicle. This paper has presented a number of contracting types and issues to consider for each type. In addition, the Table 2 provides more guidance on how to select the right contracting vehicle for specific procurements.

In addition to the details presented in Table 2, the following are other general observations about procurement methods:

- There is no "one-size-fits-all" for ITS procurements. Contracting vehicles appropriate for some simple field devices will not likely be appropriate for other more complex acquisitions.
- The engineer/contractor approach is not appropriate for software.
- Consider the full range of options before selecting one. Selecting a contracting vehicle because it is familiar may seem easy and convenient initially, but it is likely that the approach's deficiencies for the procurement will become readily apparent, causing significant problems, creating delay and increasing the costs associated with the procurement.
- The requirements definition stage for system and software applications is critical and will play a key role in determining which contracting vehicle is most appropriate.

Table 3 presents a summary of the types of procurement that are appropriate for each type of ITS project or product. These recommendations are based on past experience, in other states.

Step 6 -- Understand Intellectual Property and Other Contractual Terms and Conditions

Traditional infrastructure design and construction does not present issues relating to rights in intellectual property. Software and system design can and do. It is important that these issues and other contractual terms and conditions (warranties, royalties, etc.) be fully understood by the project team when embarking on an ITS procurement. The active involvement of legal experts in these areas is critical to ensure the maximum response from the private sector and to fully protect the interests of the public agency.

Table 2. Contracting Approaches[4]

Contract Approach	Description of Alternative	Advantages	Disadvantages	Example Applications
Engineer/ Contractor	Engineer is selected using a conventional consultant procurement process that is based on qualifications and experience to perform the work. The engineer typically prepares the contract documents are invited to submit bids in requirements of the contract documents. Once the bid has been awarded, the contractor builds the project per bid documents The engineer may inspect construction and interpret bid documents. The agency is the responsible entity.	Long history of use Well-defined roles Legal precedent for handling disputes End product well-defined at early stage Contractor manages subcontractors Well-suited to highway construction	Artificial dividing line between design and construction Not well-suited to software development work (difficult to specify, buyer may not know needs) Software/systems integration not usually performed by prime contractor Contractor has financial incentive to find deficiencies in bid documents and “changed” site conditions to seek change orders Limits communications between customer and software developer when software is developed by a subcontractor	Several agencies surveyed have used this approach, including: Colorado, the Gary-Chicago-Milwaukee Corridor, Houston, I-95 Corridor, Maryland, Missouri, Virginia, Washington and Wisconsin. Most have used for furnishing and installing field devices One ITS software contractor found itself third tier down on a construction contract, effectively shut off from all contact with the customer. Result was very bad software experience for all involved, because of the lack of communication and interaction with the client.

[4] Sources: Salwin, *The Road to Successful ITS Software Acquisition* and Tarnoff, *Procurement of Professional Services in a High Tech Era*

Contract Approach	Description of Alternative	Advantages	Disadvantages	Example Applications
Systems Manager	The systems manager is selected using conventional consultant procurement process (i.e., qualifications-based followed by competitive negotiation). The systems manager is responsible for design (plans and specifications), software development, hardware procurement, integration, training, and overall quality control. Equipment and electrical contracting services procured on low bid basis. System managers are often used for technology-based projects.	• Overall system design, software development, system integration, and testing controlled by a single entity. • Software developer is usually prime contractor • Minimizes shifting of fault • More flexibility to allow changes than in traditional approach • Well-suited to ITS projects • Avoids use of low-bid selection • Gives customer access to systems manager	• Fewer firms in marketplace with requisite blend of skills • Somewhat unfamiliar to local engineers/procurement officials • Heavy reliance on successful performance of system manager • End product less well-defined than engineer/contractor approach; difficult to manage "expectancies." • Low bid services (equipment and electrical contracting) responsibility of public agency; may include inspection and acceptance	• Used by both the Houston and I-95 Corridors in furnishing and installing field devices and software, ITS operations and ITS maintenance. • Dade County, Florida is using this approach for a signal system upgrade. Proposers were requested to propose based on capabilities of existing system and improvements identified at functional level. Allowed proposers to use base package.
System Integrator	Same as system manager, except the system integrator can bid on equipment and electrical contracting services.	• Single point of responsibility • Simplified contracting	• Not well-known by agencies • Direct bidding to system integrator may violate agency procurement process	• Used by Colorado, GCM corridor, Maryland, Missouri and Washington for furnishing and installing software. • Used by GCM, Missouri, Virginia and Wisconsin for ITS Operations.

Contract Approach	Description of Alternative	Advantages	Disadvantages	Example Applications
Design/ Build	The agency must commission the concept plans. The concept plan is normally 15 to 30 percent complete at the design level before the contractor is selected. this approach relies on a single entity to be responsible for the design and construction of a project. The agency's role is to monitor the design/build work. The design/build approach is frequently used for federal procurements involving structures. Partnering is generally involved.	• Full transfer of responsibility to design/build team • Eliminates imperfect transfer of design knowledge from designer to contractor • Rapid completion possible; significant time-savings • Streamlined procurement possible • Engineer and construction work done cooperatively with a single entity to resolve problems. • Financial incentive to rapidly complete work • May include warranty of operations management	• Agency assumes greater responsibility for inspection and approval process • May be indistinguishable from engineer/contractor approach when plans developed by engineer and design/build • May increase costs because of contractor risk and high proposal costs (design not complete) • May violate statutes (17 states) • Significant agency commitment to quality control	• Detroit used this approach for a freeway management system upgrade. Primary objective of the procurement was to provide field infrastructure, but did include TMC remodeling, new central control hardware, and operating software enhancements.
Design to Cost and Schedule	A prioritized requirements list is generated. The contractor supplies all the mandatory items and as many of the optional items within cost and schedule constraints.	• Reduces requirements creep • Reduces costs and schedule risks	• Bidders may be unwilling to propose not meeting all the optional features • Overly optimistic proposals will win	• Utah used this approach for their initial I-15 freeway management system procurement. Limited response led to selection of design/build approach for ultimate system

Contract Approach	Description of Alternative	Advantages	Disadvantages	Example Applications
Build to Budget	Different from design/build in that functional requirements used in place of detailed design. Proposers develop designs based on their best solution to meeting functional requirements using existing elements where practical..	• Similar to design build • Allows maximum flexibility to propospers to use their most cost-efficient designs • Reduced risk based on previous developments and applications • May allow added functionality for given budget	• Similar to design/build • Very unusual practice for agencies • Risk based on lack of detailed designs • Detailed design document may prove contentious point and delay project • Very expensive for proposers	• Sometimes used by commercial builders. • For transportation projects, this approach has been used mostly in toll projects and major bridges.
Shared Resource	Any agreement between one or more public sector agencies and one or more private sector organizations with the objective of providing services using the combined resources of both -- often trading a grant of a right to a public resource for the addition of a private entity to achieve a service or facility of mutual benefit to both partners. sector objectives.	• Allows public agency to obtain goods/services with little or no up-front costs	• Complex and numerous legal issues (some of which are in limbo, including interpretation of key provisions of Telecommunications Act) • Somewhat limited application	• Several state and local agencies have used this approach to provide a telecommunications backbone, including Maryland, Ohio Turnpike, Missouri, Bay Area Rapid Transit, City of Leesburg.

Contract Approach	Description of Alternative	Advantages	Disadvantages	Example Applications
State Contract	Purchases of goods and services that are ongoing and are common to several state agencies consolidated under standard specifications and developed into state contracts or joint institutional purchases.	• Quick and easy method of procuring standard equipment and supplies • All state agencies buy the same type of equipment • Standard equipment may ease maintenance and operation • Easier planning and budgeting	• Constrains system to only those products on the state contract, thereby limiting flexibility in system design • Long term contracts limit ability to buy latest versions	• Caltrans pioneered this method for traffic signal controllers and VMS • Utah currently using state contract prices for major components on the I-15 Salt Lake City ATMS. This is good approach for purchase of COTS software.
Build, Own, Operate, Transfer (BOOT) **Franchise or Lease**	Long-term contracts with a firm or consortium to finance, design, build, operate and collect revenue. Equivalent to design/build or the build-to-budget for implementation, but requires seller financing and adds the own-operate phase. These alternatives are typically considered because they do not involve an up-front capital cost for the owner.	• Similar to design build • Bidders provide financing, reducing up-front capital costs for the agency. • Allows maximum flexibility to prospers to use their most cost-efficient designs • Reduced risk of operations and maintenance costs, since this is bidder's responsibility.	• New approach - often requires statutory authority • Reduces agency control over project • Finance requirement may limit competition • Interest costs ultimately add to total for the project	• Dulles Greenway Toll Road Extension, No. Virginia (BOOT) • Calif. SR 91 HOV / Toll Lanes (Franchise/Lease)

Table 3. Recommended Procurement Method by Type of System and/or Product

Work Type	Contract Type						
	Engineer/ Contractor "Low-Bid"	**System Manager**	**System Integrator**	**Design-Build**	**BOOT**	**Shared Resources**	**State Contract**
Traffic Signal Installation	X						X
Time-Based Signal System	X						X
Closed Loop Signal System	X			X			X
Traffic Adaptive / Hybrid Signal System		X	X	X	X		
Ramp Metering System	X	X		X			
Communications System			X	X	X	X	
Dynamic Message Signs		X	X	X	X		
Highway Advisory Radio	X			X			X
Motorist Aid System (Call Boxes, etc.)	X						X
CCTV Monitoring System			X	X		X	
Electronic Toll Collection System		X	X	X	X		
Multi-modal Systems (transit, ridesharing, etc.)		X	X	X			
ISP (website, travel planning center, etc.)	X	X		X	X	X	

Note: For complex ITS projects, such as an integrated system combining communications, field equipment and software development, the project may be broken up into multiple procurements, with each using the method most appropriate to the items being specified.

5.2 STATEWIDE CONSIDERATIONS

This paper is intended to provide an overview of ITS procurement alternatives and issues as they relate to Oklahoma. Time and budget constraints do not allow for a significant and in-depth analysis of this very complex issue. In addition to the comments and recommendations above, Oklahoma DOT should consider the following:

Present hypothetical scenarios to the Attorney General to obtain clearer guidance on issues related to Public Records Laws and ITS procurements. While there are some AGOs available on the application of the public records law and agency rights in agency-produced software, copyrighted software, and trade secrets, there is little in these opinions which illuminates the issues presented by ITS procurements. There are presumably instances in which procurements have not gone forward, or private firms have been reluctant to bid on projects because of the Public Records Law. These scenarios should be presented to the Attorney General to clarify the law's application to these instances.

Develop clear guidelines on the Public Records Law and its application to ITS procurement. Once these AGOs are obtained, the ODOT should develop clear and concise guidelines on how Public Records Laws are applied and how proposers can effectively comply with its mandates.

Consider developing new contracting vehicles for ITS procurements. There has been interest and some effort in some states to develop new contracting vehicles for ITS procurement (or to adopt existing procurement methods from other state agencies to buy ITS). In Virginia, after frustrations with the low-bid contracting approach, DOT officials used a procurement category called "non-professional services" to obtain ATMS software. Originally the state had included software development as a part of a freeway construction project. The construction portion of the project was completed late, leaving very little money left for software development. VDOT terminated the contract and is now procuring the software through an "administrative services" RFP, giving the state greater flexibility in selecting an appropriate vendor. It has developed its requirements and scope of work and has adopted a design and process approach. Under the first phase of the project, a detailed design of the software will be developed and "frozen." The software will be built and additional features and functionality will be added later, as necessary. Other states have toyed with the idea of creating new contracting approaches, building on past procurement successes, and incorporating lessons learned from past failures. Oklahoma should consider (perhaps in conjunction with other states and/or with the Federal government) developing these new vehicle.