ITS MAINTENANCE PLAN

FINAL

August 2010

Presented to:

Louisiana Department of Transportation
And Development

ABMB ENGINEERS, INC.

ABMB 25
ENGINEERS, INC.

August 27, 2010

Mr. Erik Smith
ITS Maintenance and Communications Engineer
LA Dept of Transportation and Development
1212 E. Highway Dr.
Baton Rouge, LA 70802

RE: TO 701-65-1285, FAP ITS-9906(549) ITS MAINTENANCE PLAN

Dear Mr. Smith:

We are very pleased to submit the final ITS Maintenance Plan report.

All comments received to date have been addressed as part of this submittal.

The analysis of procurement methods in this document will readily support DOTD's efforts in selecting a contracting mechanism for maintenance on the ITS field device sites.

We can provide further assistance at your request.

Yours truly,

ABMB ENGINEERS, INCORPORATED

Jonathan Fox P.E., PTOE
Director of ITS Services

Attachments
ITS Maintenance Plan

Cc:
John Broemmelsiek, FHWA
Elizabeth Delaney, ITS Section

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1 Executive Summary

The technological nature of Intelligent Transportation Systems (ITS) often requires a different level of maintenance than the DOTD is typically accustomed to providing (i.e., roadway maintenance). ITS maintenance is the work regularly performed to keep the ITS in good condition and working order.

DOTD's existing ITS network consists of an extensive communications backbone that traverses the state that facilitates connections to ITS field equipment as well as office operations. The ITS field equipment deployed consists of an ever growing inventory of Closed Circuit Television (CCTV) Cameras, Dynamic Message Signs (DMS), and vehicle detectors (VD). The DOTD ITS Section is responsible for maintaining this ITS infrastructure throughout the state.

When FHWA and DOTD reviewed ITS maintenance in 2008, it was determined that the DOTD ITS Section had sufficient manpower, equipment and materials to maintain the ITS field devices that had been deployed with federal-aid funds[1]. However, as deployments expand across the State, the maintenance resources now available will be insufficient.

This document details pros and cons of various available methodologies for procuring ITS maintenance, assesses and evaluates each type utilizing a weighted average, and provides recommendations (**Section 5**). The result of the evaluation is the recommend use of a consultant contract, stated to have the greatest potential for success (**Section 6.1**). A hybrid option could give the best of both professional and construction services, but could result in "finger pointing" between the sides without well defined requirements within the final contract and an understanding that both parties teaming yields DOTD with a highly functional and reliable ITS.

ITS field equipment has a very short service life compared to other highway features. If additional funds for equipment replacement are not identified in the ITS budget partition within approximately 3-5 years, all of this budget partition will need to be used for maintenance and device replacement, with no funds available for system expansion. Criteria have been defined within this document for scheduling replacement of equipment based on considerations including: manufacturer no longer supporting the make or model, replacement parts no longer being available, and calculations on mean time between failure (MTBF) (**Section 8**).

These calculations on MTBF for defining equipment replacement criteria illustrate the importance of standardized maintenance reporting. By improving the quality of information available on configuration errors, communications equipment failures, or environmental factors, a more accurate MTBF calculation can be obtained for future reports (**Appendix A**).

[1] LDOTD /FHWA – LA Division, Process Review: Louisiana DOTD ITS Maintenance, April 1, 2008 (Appendix F)

2 Introduction

Over the past decade, the Louisiana Department of Transportation and Development (DOTD) has deployed Intelligent Transportation Systems (ITS) communications and field devices (i.e., infrastructure) throughout the state. Due to the growth of the ITS and increasing maintenance demands of the expanding system, DOTD's ITS Section is seeking solutions to efficiently maintain the ITS infrastructure.

The focus of this ITS Maintenance Plan is the field ITS infrastructure. Systems and components not in the field (e.g., in offices and other facilities) as well as those not being maintained by the ITS Section (e.g., toll facilities, traffic signals, etc.) are not included in this maintenance plan.

2.1 Purpose

This ITS Maintenance Plan provides the following:

- Documents the existing state of DOTD's ITS infrastructure
- Evaluates maintenance responsibilities
- Evaluates the annual maintenance staffing/budget
- Analyzes the various options available for procuring ITS field device maintenance
- Provides a plan to maintain, evaluate service life, and replace the ITS infrastructure
- Provides a maintenance reporting policy

3 Maintenance Responsibilities

The DOTD ITS Section (Section 56) is responsible for managing the ITS infrastructure throughout the state. Its responsibilities include planning, design, construction, management, operations, and maintenance.

The ITS infrastructure maintained by the ITS Section consists of the items identified below. Details on the ITS infrastructure are provided in **Section 3.1**.

- Closed circuit television (CCTV) cameras
- Dynamic message signs (DMS)
- Vehicle detectors (VD) – radar and video technologies
- Fiber optic communications
- Wireless communications

The DOTD ITS Section is also responsible for components of the ITS that are not in the field. These include the items identified below. Additional information on these components can be found in **Appendix B**.

- Traffic Management Centers (TMC)
- Communications equipment/Information Technology (IT) network
- Telephone systems
- Traveler information web site

DOTD also has certain systems and field components that are considered ITS under the National ITS Architecture. However, these systems are not primarily maintained by the ITS Section. See the list below for the field components and the level of ITS Section maintenance when applicable. Further information on the systems and components not maintained by the ITS Section may be found at: www.dotd.state.la.us.

- Ramp meters - District offices and Traffic Services (Section 45)
  - ITS Section provides maintenance on communications
- Portable changeable message signs – maintained by the District offices
  - ITS Section provides maintenance on communications
- Weigh in Motion (WIM) – maintained by Weights and Standards
- Toll facilities – maintained by the Crescent City Connection Division
- Traffic signal systems – maintained by the District offices and Traffic Services (Section 45)
  - ITS Section provides maintenance on communications for certain installations
- Transit – maintained by Public Transportation Section

3.1 Existing Infrastructure

DOTD currently owns, operates, and maintains an extensive communications backbone that facilitates connections for both ITS equipment as well as office operations. The fiber communication backbones traverse the state from east to west, in the north along I-20 and in the south along I-10, I-55, & I-12. Leased communication lines link the northern and the southern backbones**.**

To date, ITS equipment deployments have focused on the metropolitan areas. Completed device and communications deployments by metropolitan area are quantified in **Table 1**. **Figures 1 through 3** illustrate the intensity of the infrastructure throughout the state within the DOTD District boundaries. There have also been deployments focused on a statewide approach. These statewide deployments

consisted mostly of wide scale camera deployments and communications for connecting the metropolitan areas together. Typically, field devices outside of metropolitan areas are identified under "Statewide."

Table 1: Inventory of ITS Infrastructure

Area	CCTV Cameras (Sites/Units)		DMS Sites (1 Unit/Site)	RVD (Sites/Units)		VID (Sites/Units)		Wireless Links	*Fiber Optic Comm. Cable (mi)
Alexandria	0	0	0	0	0	0	0	0	0
Baton Rouge	49	72	8	43	48	3	5	38	22.1
Houma	15	15	2	4	5	3	3	2	12.5
Lafayette	5	12	2	0	0	3	7	5	0
Lake Charles	4	6	0	0	0	2	4	4	0
Monroe	5	5	0	0	0	0	0	5	0
New Orleans & North Shore	57	90	27	**62	**62	6	13	18	73.9
Shreveport	17	17	9	61	65	0	0	59	25.7
*Statewide	6	6	3	0	0	0	0	14	**412.4
Totals	158	223	51	108	118	17	32	145	134.2

*Note devices and communications not identified under an indicated region are quantified under Statewide.
**DOTD ITS Section not responsible for maintenance when indicated.

Figure 1: Existing ITS Infrastructure (CCTV Cameras)

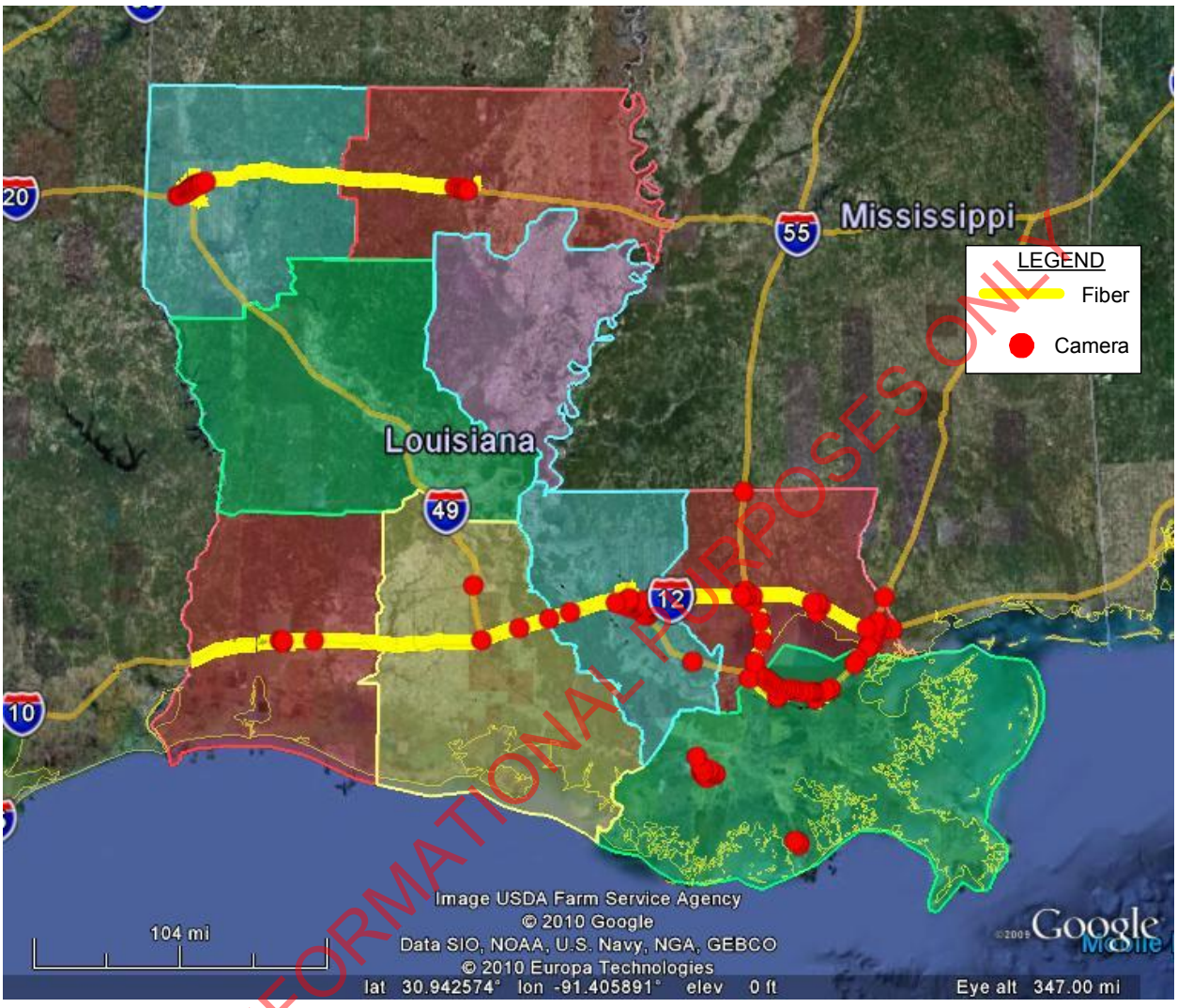


Figure 2: Existing ITS Infrastructure (DMS)

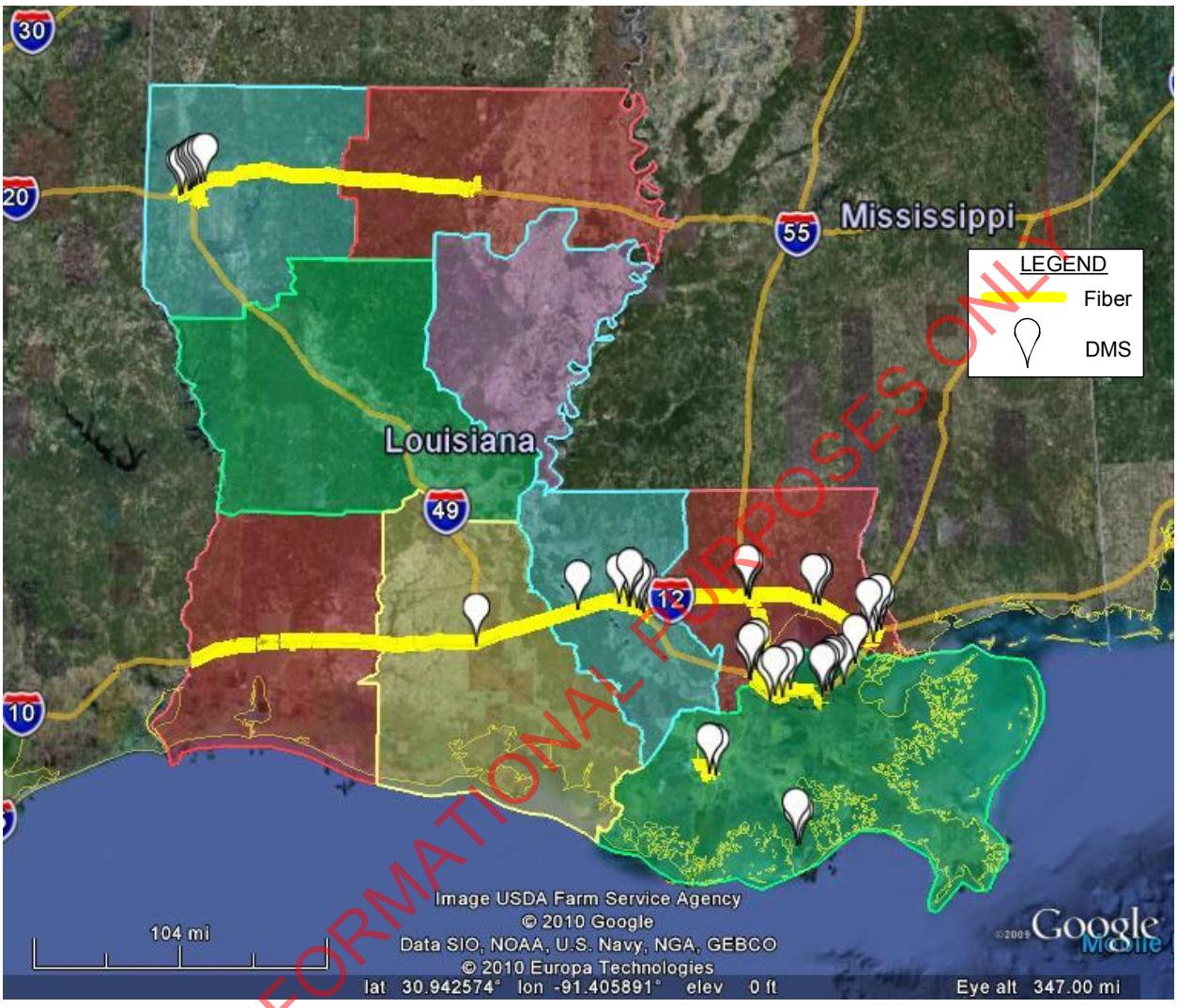
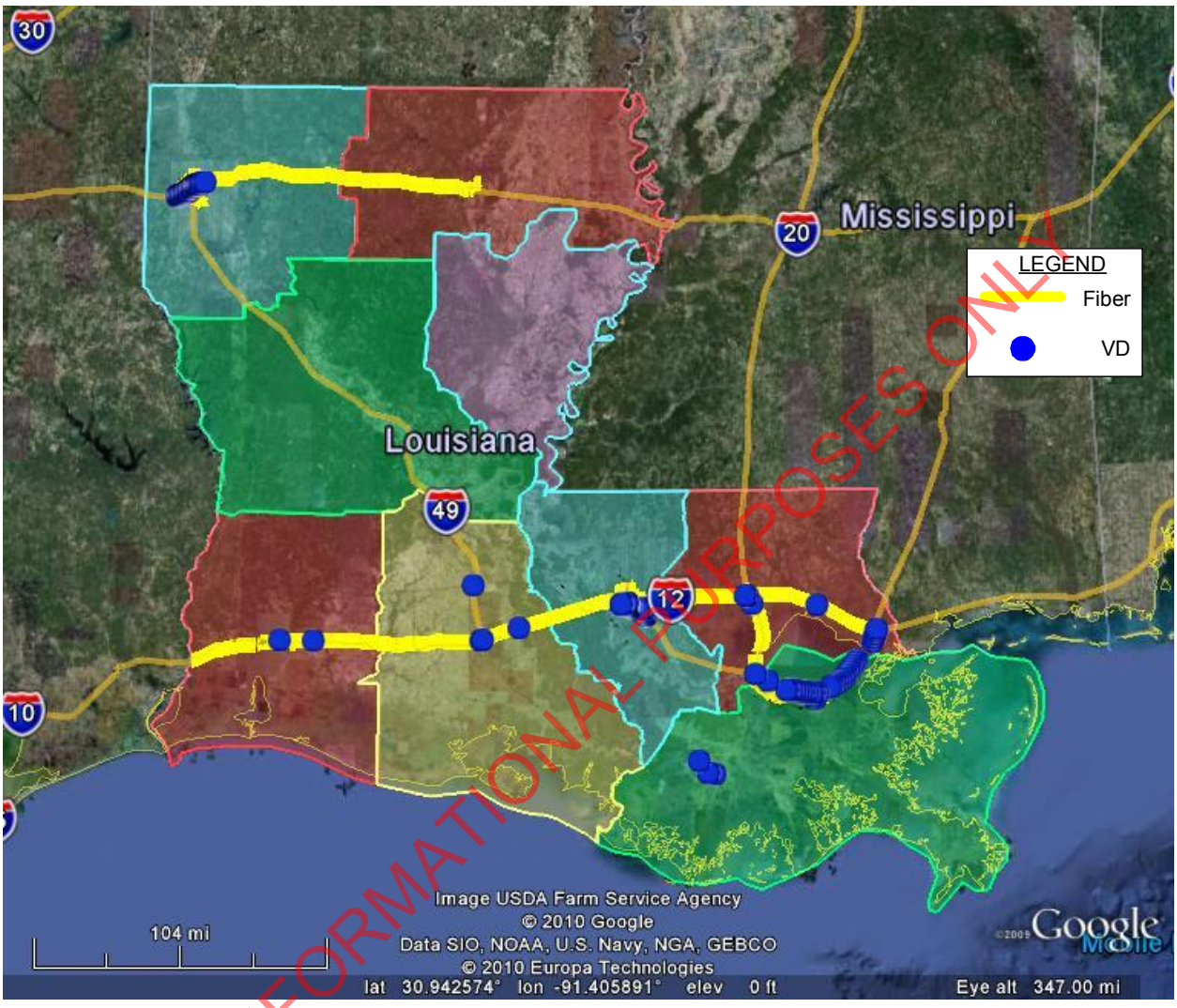


Figure 3: Existing ITS Infrastructure (Vehicle Detectors)



3.2 Esimated Future Infrastructure

The ITS infrastructure estimated for deployment within the next three years by area has been quantified in **Table 2**. The growth in the intensity of the infrastructure from the existing to the future infrastructure can be seen in **Figures 4 through 6**. Note the quantities have been indicated as a range since the projects are under design and actually quantities may vary.

Table 2: Future Inventory of ITS Infrastructure (3-Year Outlook)

Area	CCTV Cameras (Sites/Units)		DMS Sites (1 unit/site)	RVD (Sites/Units)		VID (Sites/Units)		Wireless Links	*Fiber Optic Comm. Cable (mi)
Alexandria	0-3	0-14	0-3	0-3	0-3	0-3	0-3	0-6	0
Baton Rouge	59-65	92-104	13-17	43-53	48-60	3-5	5-10	38-45	22.1-41.8
Houma	15-18	15-18	2-3	4-8	5-10	3-5	3-5	2-8	12.5-20
Lafayette	5-13	12-26	6-7	4-13	13-26	3-6	7-13	5-13	0-39
Lake Charles	4-6	6-10	0-3	0-2	0-2	2-4	4-8	4-6	0
Monroe	7-10	8-21	0-3	0-2	0-2	0-2	0-2	5-10	0
New Orleans & North Shore	62-69	110-115	32-37	**62-90	**62-90	6-12	13-25	18-40	73.9-87.4
Shreveport	29-40	29-40	15-17	66-72	73-79	0-3	0-3	59-68	25.7-53.3
*Statewide	6-8	6-8	3-4	0-2	0-2	0-2	0-2	14-20	**412.4-448.5
Totals	187-232	278-356	70-92	117-155	139-155	17-42	32-71	145-216	134.2-241.5

*Note devices and communications not identified under an indicated region are quantified under Statewide.
**DOTD ITS Section not responsible for maintenance when indicated.

Figure 4: Estimated Future ITS Infrastructure (CCTV Cameras) – 3 Year Outlook

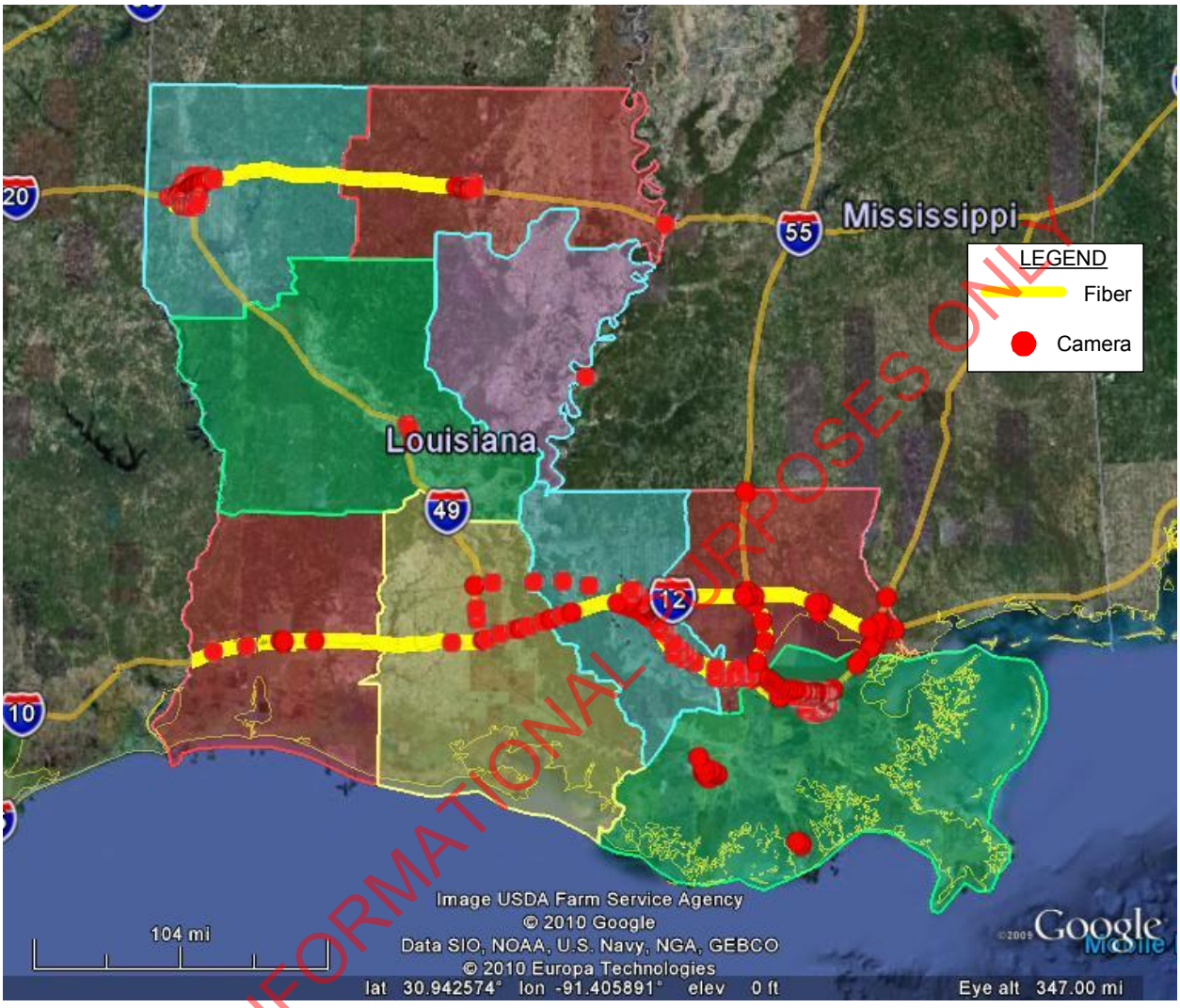


Figure 5: Estimated Future ITS Infrastructure (DMS) – 3 Year Outlook

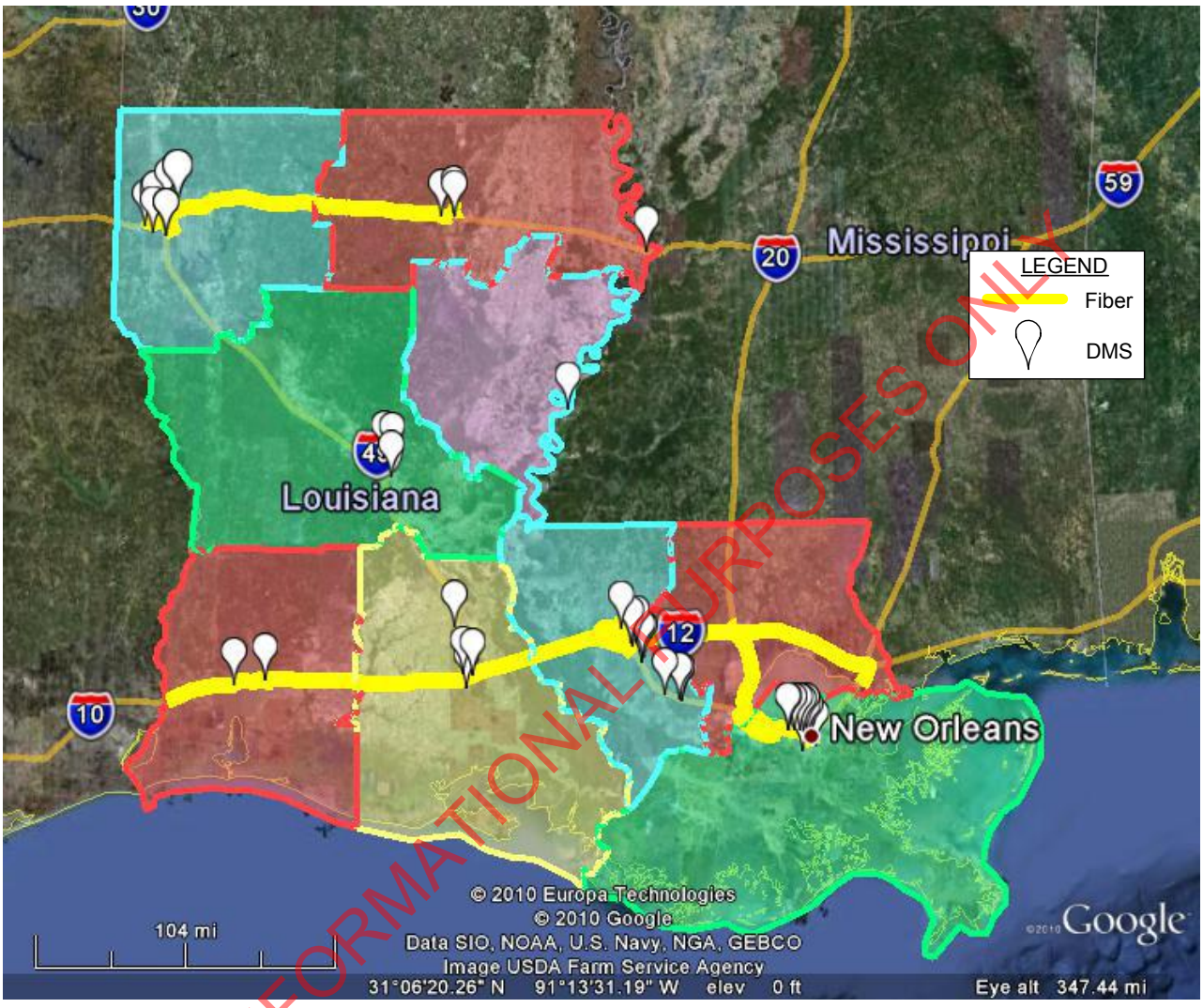
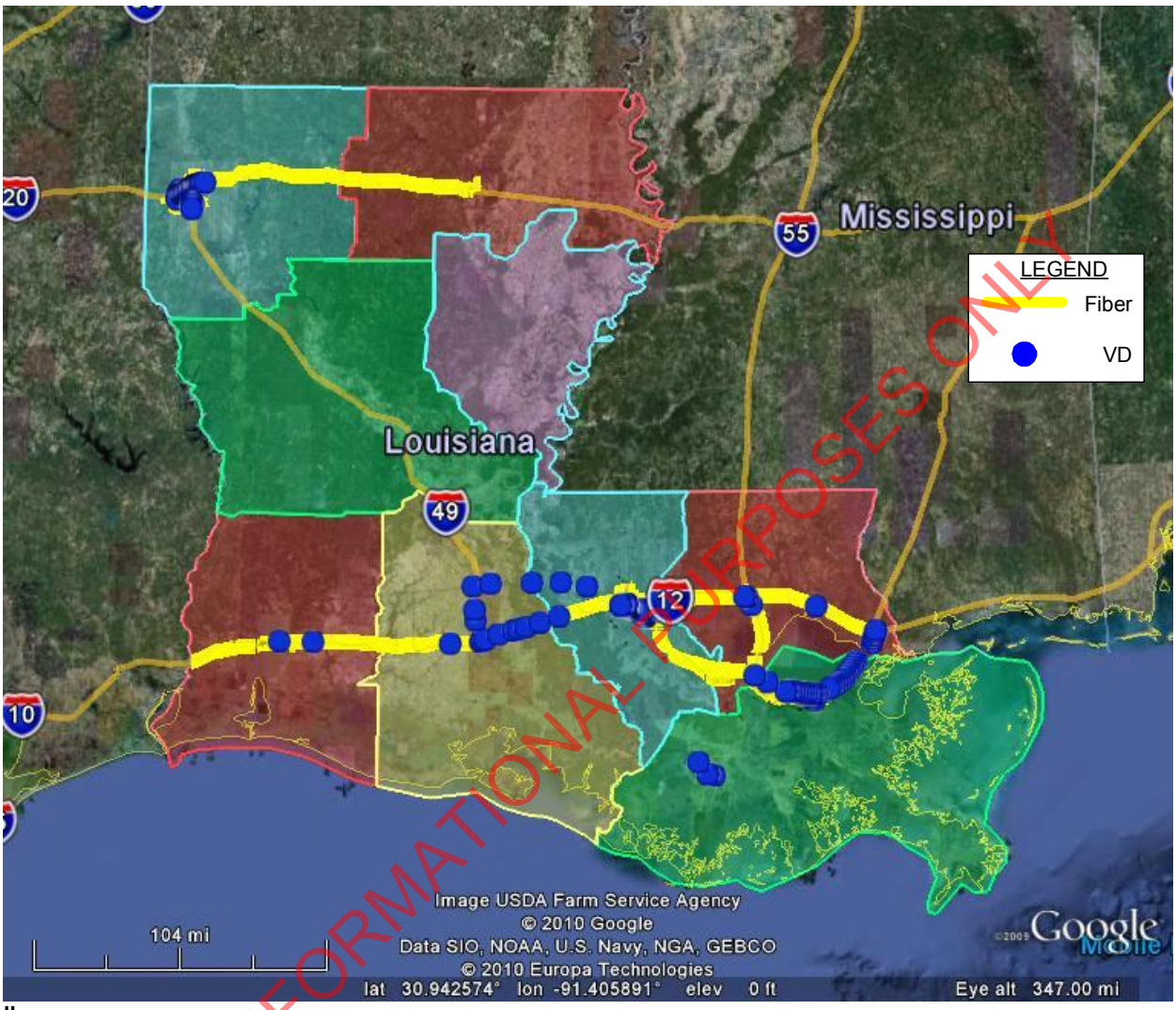


Figure 6: Estimated Future ITS Infrastructure (Vehicle Detectors) – 3 Year Outlook



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3.3 ITS Daily Status

Daily tests are run on the ITS by TMC Operators to determine if any components of the ITS are malfunctioning. The processes for running these tests are detailed in the TMC operations procedure documentation. When a component malfunctions, the TMC Operator includes this component in the TMC daily maintenance report that is provided to ITS Maintenance Engineer (See **Section 7.3.1** for maintenance reporting).

3.4 Routine Maintenance

Routine maintenance should be performed at regularly scheduled intervals for the upkeep of equipment. This may also be referred to as preventative maintenance. Typically, manufacturers provide routine maintenance procedures and schedules for their component of the ITS. It may be as simple as changing a filter, or vacuuming dust out of a cabinet, or cleaning cooling fans as well as record keeping. Routine maintenance generally is disregarded due to the demand of responsive maintenance, emergency maintenance, and a lack of available maintenance personnel to facilitate routine maintenance. Neglecting routine maintenance can increase failures causing a reduction in mean time between failures, which results in additional responsive and/or emergency maintenance.

Certain infrastructure components currently receive a basic level of routine maintenance. These items include:

- DMS Sites
  - Annual inspection on all components and filter change in enclosures
- CCTV Sites
  - Certain sites receive annual inspection and pest control in cabinet

3.5 Responsive Maintenance

Responsive maintenance is the repair or replacement of any reported failed or malfunctioned equipment in the ITS. Emergency maintenance is defined by the same criteria as responsive maintenance except that emergency maintenance requires immediate repair. Responsive and emergency maintenance generally follows the process outlined below.

1. Receive notification of malfunction
2. Secure the site (e.g., knock down, dangling device, etc.)
3. Diagnostics
4. Interim repairs
5. Log activity

Parameters that define an emergency, which would require immediate responsive maintenance may include:

- Critical Locations Requiring Traveler Information
  - DMS signs that provide information for key highway segments such as Mississippi River crossings or long elevated structures such as the I-10 Twin Span
- Highly Congested Roadway Segments
  - I-10/I-12 interchange in Baton Rouge
  - I-10 in New Orleans
- Declared Emergency Events
  - Key devices on evacuation routes during emergency evacuations

3.6 Equipment Analysis

Just as ITS has developed over the years so has the system of documenting system status. In 2007, operators at the Baton Rouge TMC began recording the daily status of ITS field equipment in the Baton Rouge metropolitan area to a database. This information has been used to provide weekly and monthly high level system status reports. When the mean time between failures (MTBF) for each device was calculated from the database, the findings were significantly higher than presently observed. This difference can be attributed to changes in standardizing database inputs since 2007. Also, field equipment has been recently updated with newer technology. The MTBF for the BR TMC can be found in Table 3. Note that despite improvements in documentation, sufficient data for 2007 through 2009 does not exist to determine whether failure was due to device hardware, power, or communication.

Table 3: System MTBF for Baton Rouge Devices

Service Summary Per Device Type (Days)								
Device	2007		2008		2009		Average	
	Down Time	MTBF	Down Time	MTBF	Down Time	MTBF	Down Time	MTBF
CCTV	34	23	26	38	23	29	29	36
DMS	24	18	45	12	26	15	31	19
RVD	47	25	16	31	5	26	24	33

Other TMCs have recorded the status of its field equipment similarly to the BR TMC but on a weekly basis in spreadsheet format. Analysis of data from the other TMCs would be cumbersome to process. Also, like Baton Rouge, field equipment in other areas is being updated and reporting methods standardized.

In order to better analyze and understand MTBF rates for field devices, MTBF data has been gathered from various manufacturers. The table below summarizes the findings in terms of hours/years.

Table 4: Device Level MTBF Based on Manufacturer's Data

Field Equipment Type and Manufacturers	MTBF (Days)*
CCTV Cameras	Average: 1329 (@ 8-hour/day PTZ operations)
Cohu (3960 iView")	833 (@ 8-hour/day PTZ operations)
Pelco (Spectra IV)	1825 (@ 8-hour/day PTZ operations)
Vehicle Detectors	Average: 3892
Econolite (Terra)	4375
EIS/RTMS (G4)	3650
Wavetronics (Smart Sensor HD)	3650
Dynamic Message Signs	Average: 4167
Daktronics (VF-2020)	4167
Video Encoder	Average: 6389
Teleste (MPC-E1)	8750
Cohu (9920)	6250
Axis (243SA)	4167
Ethernet Switch	Average: 6958
Ruggedcom (RS900G)	6958
* Note the MTBF indicated is only for the indicated component and is not representative of the entire site.	

The MTBF data calculated from the Baton Rouge TMC and the manufacturer's data appear almost contradictory. Some of the variance between these two tables can be attributed to newer manufacturer devices not appearing in the Baton Rouge MTBF table. Also, reporting standardization, configuration errors, communications equipment failures, and environmental factors (e.g., lightning strikes, flooding, etc.) are not indicated. Now that the TMC Operations Staff has standardized the maintenance reporting, the MTBF calculation in future reports should be more accurate. Further details on the ITS equipment database and on equipment reporting to DOTD management can be found in the TMC Operator System Engineering Analysis/Standard Operating Procedures documents as well as in **Section 7.3**.

4 Resource Analysis

4.1 Staffing Requirements

For most agencies maintaining an ITS, the demands on staff usually becomes greater than the number of staff available. Initially, as DOTD grew its ITS program, it also increased the number of ITS Maintenance Staff members. However, due to budget constraints and state hiring restrictions, ITS Maintenance Staff has now been limited to a fixed number of members.

The following tables have been developed to evaluate the number of required staff to maintain the ITS field devices. Probability of malfunctions was calculated using the MTBF from Baton Rouge area devices since it is was based on malfunctions for the entire site. The probability indicated for the DMS as shown is extremely high. However, the DMS are in the process of being swapped out with new units that have a greater MTBF and the probability of malfunctions is expected to be greatly reduced. Also, implementing routine maintenance will provide some relief to responsive maintenance. This reduction in the percentage of malfunctions is shown in **Table 6.** For this analysis, responsive maintenance hours encompass both emergency and non-emergency events.

Table 5: Field Elements Staff Requirements (Existing for 2010)

Routine Maintenance								
Field Device	Device Site Count	Responsive Maintenance Schedule (months)	Labor (hrs per person)	Number of People Per Crew	Travel Time (hr)	Labor Hours + Travel Time per device	Total Hours for all Devices/yr	
DMS	51	1	2	2	2.5	9	5508	
CCTV Camera	158	6	2	2	2	8	2528	
VD	125	6	2	2	2	8	2000	
Total Hours Required for Routine Maintenance							10036	
Total Full Time Staff Member Equivalent for Routine Maintenance							6	

Responsive Maintenance								
Field Device	Device Site Count	% of Malfunctions (based on MTBF)	Required Trips	Labor Hrs per person	Number of People Per Crew/visit	Travel Time (hr)	Labor Hours + Travel Time per device	Total Hours for all Devices
DMS	51	240.13%	123	8	2	2.5	21	2583
CCTV Camera	158	20.69%	33	5	2	2	14	462
VD	125	29.11%	37	4	2	2	12	444
Total Hours Required for Responsive Maintenance								3489
Total Full Time Staff Member Equivalent for Responsive Maintenance								2

Table 6: Field Elements Staff Requirements (3 Year Forecast)

Routine Maintenance								
Field Device	Device Site Count	Responsive Maintenance Schedule (months)	Labor Hours per person	Number of People Per Crew	Travel Time (hours)	Labor Hours + Travel Time per device	Total Hours for all Devices/yr	
DMS	92	1	2	2	2.5	9	9936	
CCTV Camera	232	6	2	2	2	8	3712	
VD	197	6	2	2	2	8	3152	
Total Hours Required for Routine Maintenance							16800	
Total Full Time Staff Member Equivalent for Routine Maintenance							10	
Responsive Maintenance								
Field Device	Device Count	% of Malfunctions (Est. MTBF)	Required Trips	Labor Hrs per person	Number of People Per Crew/visit	Travel Time (hours)	Labor Hours + Travel Time per device	Total Hours for all Devices
DMS	92	75.00%	69	8	2	2.5	21	1449
CCTV Camera	232	17.00%	40	5	2	2	14	560
VD	197	23.00%	46	4	2	2	12	552
Total Hours Required for Responsive Maintenance								2561
Total Full Time Staff Member Equivalent for Responsive Maintenance								2

Although the previous tables provide some measure to quantify maintenance staff needs, they cannot completely detail all needs. Other factors that are not easily quantifiable may increase the time required for providing maintenance and/or require additional maintenance staff. These factors include the following:

- Time required for coordination with administration/management
- Inventory check and equipment retrieval
- Maintenance on vehicles including fueling
- Compiling documentation and paperwork on the malfunction
- Bench testing

4.2 Gap Anlaysis

Based on the 2008 report[2] and the tables above, the difference in total hours required for maintenance can be calculated to determine if there are any “gaps” in maintenance staffing.

[2] LDOTD /FHWA – LA Division, Process Review: Louisiana DOTD ITS Maintenance, April 1, 2008

In using the 2008 report some assumptions must be made:

- Annual work hours per full time staff are 1680. Time for general administration (e.g., processing payroll, paid time off, management, etc) is not included in the 1680 hours.
- Assumed 85% of total hours dedicated to responsive maintenance and 15% to routine maintenance.

Table 7: Gap Analysis: ITS Maintenance Staffing for 2008 to 2013

Description	2008 Estimated	2010 Estimated (per Table 5)	2013 Estimated (per Table 6)
Routine Maintenance Hours	107	10036	16800
Responsive Maintenance Hours	961	3489	2561
Total Maintenance Hours	1068	13525	19361
Total Full Time Staff Member Equivalent [3]– Required	1	8	12
Total Full Time Staff Member Equivalent[3] – Employed	2	2	2
Gap ("-" indicates shortage)	+1	-6	-10

Based on the outcome of the Gap Analysis above, by 2013 DOTD will be short 10 full time staff members for performing maintenance if the current number of dedicated staff remains. It should be understood that by the use of full time staff member equivalents, the number of additional staffing may need to be greater if they are not 100% dedicated to ITS field device maintenance.

[3] Full time staff member equivalent is calculated based of 1068 hours per year.

5 Methodologies for Procuring ITS Maintenance

5.1 DOTD Provided Maintenance

The ITS Maintenance Staff currently provides maintenance for the ITS infrastructure. As the deployed equipment ages and maintenance response increases, it will be a significant challenge for ITS Maintenance Staff to maintain the system.

5.1.1 Pros of DOTD Provided Maintenance

- Only one agency involved in maintenance
- Staff members are already accustomed to entire ITS for the state

5.1.2 Cons of DOTD Provided Maintenance

- State budget restrictions on hiring additional staff
- Organization limitations. As the system grows, available staff will not able to sustain the entire ITS. ITS Maintenance staff currently cannot provide preventative maintenance due to the limited number of staff personnel.
- Limited time to gain expertise in all components of the system

5.2 Procured Maintenance: Municipality Provided

In general, DOTD has experience with local municipalities providing maintenance. The engineering offices at some of the larger city departments of public works have maintained traffic signal systems and the CCTV cameras at intersections. These cities include Baton Rouge, New Orleans, and Lafayette. Maintenance is provided under the guidance of a City-State Agreement. Although the level of success has varied depending on the availability of staff by the local municipalities, this method has reduced the demand on DOTD having to provide maintenance.

5.2.1 Requirements for Municipality Provided Maintenance

- The municipality must be willing
- The municipality must have available staff to provide maintenance
- A binding agreement must be created or an existing agreement modified to cover the maintenance
    - Requirements must be developed for level of maintenance required (i.e., quality of service and response time)
    - Fees or exchange in services for providing the maintenance must be determined

5.2.2 Pros of Municipality Provided Maintenance

- Can encompass the entire ITS within the limits of the municipality
- Reduces immediate demand on ITS Maintenance Staff
- One agency required for response and maintenance of traffic signal and ITS equipment

5.2.3 Cons of Municipality Provided Maintenance

- Requires an agreement to be solidified
- Coordination required during design to make sure elements can be maintained by the municipality
- Requires DOTD to provide oversight and enforce penalties if requirements of the agreement are not met

5.3 Procured Maintenance: Letter Bids

Letter bids are one of the available contracting methods used by DOTD for constructing a project or obtaining a contracted service. The critical limitation is the contract must be under $500,000. The ITS Section has attempted to use letter bids for maintenance purposes previously. Bids were solicited for ITS maintenance for Houma and Shreveport. The bids received were significantly higher than estimated due to unverified equipment conditions and DMS manufacturers not responding to proposers query. Thus the bids were rejected. Letter bids are governed by LA Revised Statute (RS) 39:2290 et al.

5.3.1 Pros of Letter Bids

- Short advertisement time
- Quicker contracting mechanism than developing a construction plan set
- Flexible in the type of construction and services that can be obtained as part of the letter bid
- Could be used for installing parts provided by DOTD

5.3.2 Cons of Letter Bid

- Limited to $500,000
- Federal funds are not available if using letter bids
- Not applicable to any project that's primary purpose is purchase or acquisition of materials, equipment, or supplies
- Addenda are prohibited except to withdraw the invitation for bids

5.4 Procured Maintenance: State Contracts

State contracts (i.e., Term Contract) are a procurement method in which a source of supply is established for a specific period of time and based on an indefinite quantity to be ordered as needed. State contracts are typically for furnishing supplies, but may also include labor and installation. State Contracts are governed by RS 39:1551 et al.

5.4.1 Pros of State Contracts

- Qualitative and cost based selection
- Quicker process than requesting sealed bids
- Ideal for maintenance by swapping out equipment

5.4.2 Cons of State Contracts

- Cannot be used for the sole purpose of maintenance (i.e., repairing a malfunction). Requires the contractor to replace with new equipment.
- Approval to bypass the use of a Term Contract when already established as the feasible means of procuring a particular item, requires written approval from the DOTD Procurement Director and would only be approved in cases of emergency
- The process is time consuming for a supplier to obtain a term contract
- Requires annual renewals
- Scope is limited by Department of the Division of Administration (DOA)
- DOTD is required to obtain bids from multiple suppliers when available when bids are over $25,000
- DOA limits total purchase to be under $250,000 with each item having to be under $25,000

5.5 Procured Maintenance: Louisiana Authorized Dealer

A LA authorized dealer is a company that satisfies the requirements of a resident business defined in RS 39:1591(6) and is authorized by the manufacturer to sell and/or provide service for their projects. The use of LA authorized dealers is covered under the Executive Order BJ 08-67, Small Purchase Procedures authorized by the governor. This method is considered a small purchase for repair parts and repairs for equipment obtained by DOTD with few limitations. DOTD has had success with this method as LA has readily available authorized dealers specializing in ITS equipment.

5.5.1 Pros of Authorized Dealer

- Manufacturer selected repair personnel
- Repair personnel are manufacturer trained
- Includes parts and repairs
- Non competitive process, with few exceptions

5.5.2 Cons of Authorized Dealer

- Competitive bid required for wire, related equipment, time and material charges to accomplish repairs, adds, moves, and/or changes to telecommunications systems exceeding $2,500.
- No time constraints
- Limited to repair; routine maintenance not covered

5.6 Procured Maintenance: Construction Contracts

Construction contract is the standard DOTD method for constructing any transportation based project. This process has been vetted by DOTD. Construction contracts are governed under RS 38:2290 et al.

5.6.1 Pros of Construction Contracts

- Advertisement on DOTD website for a minimum of 10 calendar days
- DOTD is familiar with enforcing penalties/stipulated damage for poor performance
- Contract can include performance requirements
- Payment, performance, and retainage bonds required as disincentives

5.6.2 Cons of Construction Contracts

- Low bid; not qualifications based
- Typically construction contracts are managed out of the district offices and are not experienced with maintaining ITS

5.7 Procured Maintenance: Extended Maintenance Agreements

The ITS Section has previously used extended maintenance agreements as a method of providing maintenance. The maintenance agreements were part of the construction projects. The awarded contractor was required to perform continued maintenance in yearly intervals based on the terms of the agreement. Success by this method was unsatisfactory.

5.7.1 Requirements for Extended Maintenance Agreements

The agreement is a contract document requiring the successful contractor to provide the defined maintenance on an entire ITS or specific components. Typically, extended maintenance agreements

accompany deployment projects, but they may be bid independent of construction.. The following topics are covered in an extended maintenance agreement:

- Scope of services
- Maintenance Plan
- System spares
- Close out testing
- Personnel qualifications
- Traffic Procedures
- Authorized Representatives
- Quality of parts and maintenance equipment
- Contractor warranties
- Manufacturer warranties
- Bonds and insurance
- Payment
- Penalties
- Terms and termination

5.7.2 Pros of Extended Maintenance Agreements

- Contractor fully responsible for maintenance for the defined scope
- System spares typically included in the agreement
- Renewable contract for multiple terms
- Response time can be incentive/disincentive based

5.7.3 Cons of Extended Maintenance Agreements

- Typically part of construction project. Contractors tend to underbid maintenance as well as front load their payment schedule and leave little money for maintenance.
- No defined method for monitoring extended maintenance agreement contractors
- Contractors are hesitant to acquire maintenance staff or dedicate staff solely for maintenance, not financially feasible

5.8 Procured Maintenance: Consulting Services Contract (Division of Administration)

Consulting services contracts are Department of Administration contracts for procuring work other than professional, personal, or social services to provide counsel, review, design, development, analysis or advice. They include the procurement of supplies and services when supplies and services are less than the consulting services. Consulting service contracts are governed by Title 34, RS 39:1490 et al.

5.8.1 Pros of Consulting Services Contracts

- Utilizes a Request for Proposal
- Qualitative and price based selection to determine “Most advantageous to the state”
- Multiple expertise can be utilized
- Management, reporting, and tracking at a level familiar to DOTD
- Single point of coordination services
- Response time can be incentive/disincentive based

5.8.2 Cons of Consulting Services Contracts

- Contract procurement, processing, and reporting must go through the Dept. of Administration
- Construction bonding (payment, performance and retainage) may be required by DOTD

5.9 Procured Maintenance: Consultant Contract Services Contracts (DOTD)

An engineering consultant led maintenance contract is a maintenance methodology where a consultant engineer firm is selected as the prime for providing maintenance services. The consultant provides initial

responses, troubleshoots, and uses subcontractors, subconsultants, manufacturers, and others as required to bring the system back to full operation. This is a labor based contract. The DOTD Consultant Contract Service (CCS) Section oversees the procurement of engineering consultants for DOTD. CCS contracts are limited to preconstruction, construction, planning, research and other activities. Consultant contracts are governed by RS 48:1490 et al.

5.9.1 Pros of CCS Contracts

- Multiple levels of expertise
- Provides design knowledge with maintenance
- QC and oversight of a professional engineer for performance
- Allows for the engineer to review the entire system during maintenance
- Qualitative based section; no low bid
- Multiple consultant teams can be utilized
- Audited billable rates can be utilized: office rates differ from field rates
- Consultant can directly provide routine maintenance without a sub
- The ITS can be divided up by task orders or retainer contracts
- Management, reporting, and tracking maintenance at a level familiar to DOTD
- Single point of coordination for ITS Maintenance staff
- Response time can be incentive/disincentive based

5.9.2 Cons of CCS Contracts

- Consultant cannot purchase parts; DOTD will have to provide spare parts
- Consultant may be required to obtain maintenance equipment
- Consultant may have to contract with other consultants/contractors/vendors/etc.
- Prime is required to perform a greater portion of the work than any sub (e.g., Prime-40%, Sub #1-20%, Sub #2-20%).
- Construction bonding (payment, performance and retainage) may be required by DOTD

5.10 Procured Maintenance: Hybrid Options

There are several feasible combinations of the previous methods for procuring contract maintenance. The pros/cons above can simply be merged for comparisons. Below are the possible combinations. Note with the hybrid options, DOTD has to manage these as two separate contracts. DOTD provided maintenance is still required for the communications of the ITS on these options.

5.10.1 CCS contract and LA authorized dealer

- Consultant provides management, reporting, system spare inventory, routine maintenance, and general maintenance oversight
- LA authorized dealer provides all repairs and replacements

5.10.2 CCS contract and letter bid

- Consultant provides management, reporting, system spare inventory, routine maintenance, and general maintenance oversight
- Contractor provides repairs and replacements. This would require bidding on cost per component for repair similar to how DOTD handles guardrail.

6 Assessment of Procurement Options

The previously discussed procurement options have been compiled and assessed based on the criteria indicated in **Table 8.** Each option was rated on the following scales and its associated weight. Rating was based on research conducted during the development of this plan and the ITS Section's past experiences with procuring maintenance.

- Very High = 4
- High =3
- Moderate =2
- Low =1
- N/A = has no weight (not part of average)

Table 8: Assessment of Procurement Options

Procurement Methods	DOTD's Risk	Maintainer's Risk	Budget	Problematic	Management Complexity	Average
DOTD Provided Maintenance	Very High	N/A	High	Moderate	Low	High
Municipality Provided Maintenance	Moderate	Very High	Moderate	High	Moderate	High
Letter Bids	Moderate	Very High	Low	Very High	High	High
State Contracts	High	High	High	Very High	Very High	High
LA Authorized Dealer	Moderate	Moderate	High	High	Moderate	Moderate
Construction Contracts	High	High	Moderate	High	Moderate	High
Extended Maintenance Agreements	Moderate	Very High	Low	Very High	Very High	High
Consulting Services Contract (DOA)	Low	High	Very High	Moderate	High	High
Consultant Contract Services Contract (DOTD)	Low	High	Very High	Low	Low	Moderate
Hybrid Option: Consultant Contract/ Authorized Dealer	Moderate	Moderate	Very High	Moderate	High	High
Hybrid Option: Consultant Contract/ Letter Bid	Moderate	Moderate	High	High	Very High	High
Weighted						
DOTD Provided Maintenance	4		3	2	1	2.5
Municipality Provided Maintenance	2	4	2	3	2	2.6
Letter Bids	2	4	1	4	3	2.8
State Contracts	3	3	3	4	4	3.4
LA Authorized Dealer	2	2	3	3	2	2.4
Construction Contracts	3	3	2	3	2	2.6
Extended Maintenance Agreements	2	4	1	4	4	3
Consulting Services Contract (DOA)	1	3	4	2	3	2.6
Consultant Contract Services Contract (DOTD)	1	3	4	1	1	2
Hybrid Option: Consultant Contract/ Authorized Dealer	2	2	4	2	3	2.6
Hybrid Option: Consultant Contract/ Letter Bid	2	2	3	3	4	2.8

6.1 Handling System Spares

System spares (i.e., spare parts) are a critical component of maintenance. The method of obtaining and maintaining an adequate spare parts inventory must be determined in order to insure their availability for maintenance. The procurement options previously evaluated does not fully address handling system spares. Not all of the procurement options allow for the contracted entity to provide parts. The table below identifies how each option could handle system spares.

Table 9: Procuring System Spares

Procurement Methods	Contracted Entity to Provide System Spares	DOTD to Provide System Spares
DOTD Provided Maintenance	N/A	Yes
Municipality Provided Maintenance	Minor items (typically limited to light bulbs and fuses)	Major items (i.e., structure items, cabinets, controllers, etc)
Letter Bids	Yes	No
State Contracts	Yes (full swap out)	No
LA Authorized Dealer	Yes	No
Construction Contracts	Yes	No
Extended Maintenance Agreements	Yes	No
Consulting Services Contract (DOA)	No	Yes
Consultant Contract Services Contract (DOTD)	No	Yes
Hybrid Option: Consultant Contract/ Authorized Dealer	Yes	No
Hybrid Option: Consultant Contract/ Letter Bid	No	Yes

6.2 Recommended Procurement Option

Based on the ITS Section's past experiences with the various contracting options, the consultant contract methodology shows to have the greatest potential for success. This does not mean that the other methodologies would not work. However the use of any of the other methodologies may require a very tight scope and more hands on management by ITS Section.

Consideration should also be given to a hybrid option which provides the best of both the professional and construction services. However this option does require both contracted parties providing maintenance to partner with DOTD and understand their teaming yields DOTD with a highly functional and reliable ITS. The downfall of this option is the management of the two contracts and any potential "finger pointing" between the sides. Well defined requirements within the final contract may reduce any potential problems.

6.3 Managing Maintenance Contract Scope

Based on the distribution of the ITS field equipment throughout the state, various options are possible for grouping maintenance activities. A matrix has been created to evaluate five potential options. Items taken into consideration for grouping have been identified below (see **Table 10**).

- Balance of sites per contract – provides for equal completion
- Drive time – lower drive time equals better response potential
- Number of contracts – simplifies management
- TMC Coverage – simplifies coordination with TMCs for reporting and testing during maintenance
- Problematic – gauge of potential to experience problems with the contract
- Use of Expertise – utilizing contractors/manufacturer's representatives for their field of expertise

6.3.1 Constraints

Although any contract type providing a sufficient quantity staff to provide management, inspection, and repair will improve the opportunity for a more reliable ITS, there are certain constraints that should be indicated in any contract for ITS maintenance. The following constraints are recommended for inclusion:

- Locations/sites
- Sites with specific constraints (e.g., hub sites co-located with a CCTV camera)
- Minimum personnel
- Minimum vehicles/equipment/tools required for maintenance
- Minimum number of visits per site type for routine maintenance
- Provisions for managing spare parts and inventory database
- Maximum response times for response and inspection
- Maximum response times for repair during
  - Emergency
  - Non-emergency
- Disincentives for failure to meet response time(s)
- Reporting response status
- Record keeping/logging maintenance
- Training

Table 10: Assessment of Procurement Options

OPTIONS	DATA				SCORING (1-5; High-Low)						
	CCTV Sites	DMS Sites	VD Sites	Total Sites/ Option	Balance of Sites/ Contract	Drive Time (hr)	Number of Contracts	TMC Coverage	Problematic	Use of Expertise	Average
Regional Option 1:											
Baton Rouge, New Orleans, Houma, NorthShore & Statewide	127	40	59	226		2	1	1	3	4	
Lake Charles, Lafayette, Shreveport, Monroe, Alexandria	31	11	66	108		5	1	2	3	4	
Scores-Regional Option 1:					2	3.5	2	1.5	3	4	2.67
Regional Option 2:											
Statewide, Baton Rouge, Lafayette, & Lake Charles	64	13	112	189		2	1	2	3	4	
New Orleans, Houma, Northshore	72	29	13	114		2	1	1	3	4	
Shreveport, Monroe, Alexandria	22	9	61	92		2	1	2	3	4	
Scores-Regional Option 2:					1	2	3	1.67	3	4	2.44
Device Types Option 1:											
Statewide for each type of device	158	51	125			5	3	4	3	1	
Scores-Device Type Option 1:					1	5	3	4	3	1	2.83
Device Types Option 2:											
Combined CCTV & VD Statewide	158		125	283		5	1	4	2	3	
DMS Statewide		51		51		5	1	4	3	1	
Scores-Device Types Option 2:					3	5	2	4	2.5	2	3.08
Device Types Option 3:											
Combined CCTV & VD w/ Regional Opt 2 Grouping											
Statewide, Baton Rouge, Lafayette, & Lake	64		112	189		2	1	2	2	3	
New Orleans, Houma, Northshore	72		13	114		2	1	1	2	3	
Shreveport, Monroe, Alexandria	22		61	92		2	1	2	2	3	
DMS Statewide		51		51		5	1	4	3	1	
Scores-Device Types Option 3:					1	2.75	4	2.25	2.25	2.5	2.46

7 Responsibilities, Resources and Processes

7.1 Responsibilities for Field Device Maintenance

The ITS infrastructure, as originally defined, includes both the communications and field devices. The statewide communications backbone is a combination of regional and local hardwired fiber connections, wireless connections, and leased communications. Because of the complex communications infrastructure throughout the state, the ITS Section will remain the provider of communications maintenance. This separation of the communications from the ITS field equipment sites is very logical. By DOTD retaining the communications maintenance, a clear demarcation between the ITS field device site and the communication link is established. For ITS field sites communicating via fiber optic communications, the typical demarcation is the patch panel. For wireless sites, the typical demarcation is the ITS field device side of the wireless link. The typical demarcation point as described is shown in **Figure 7**. Specific sites that do not follow suit with this demarcation will be defined within the final contract as a constraint.

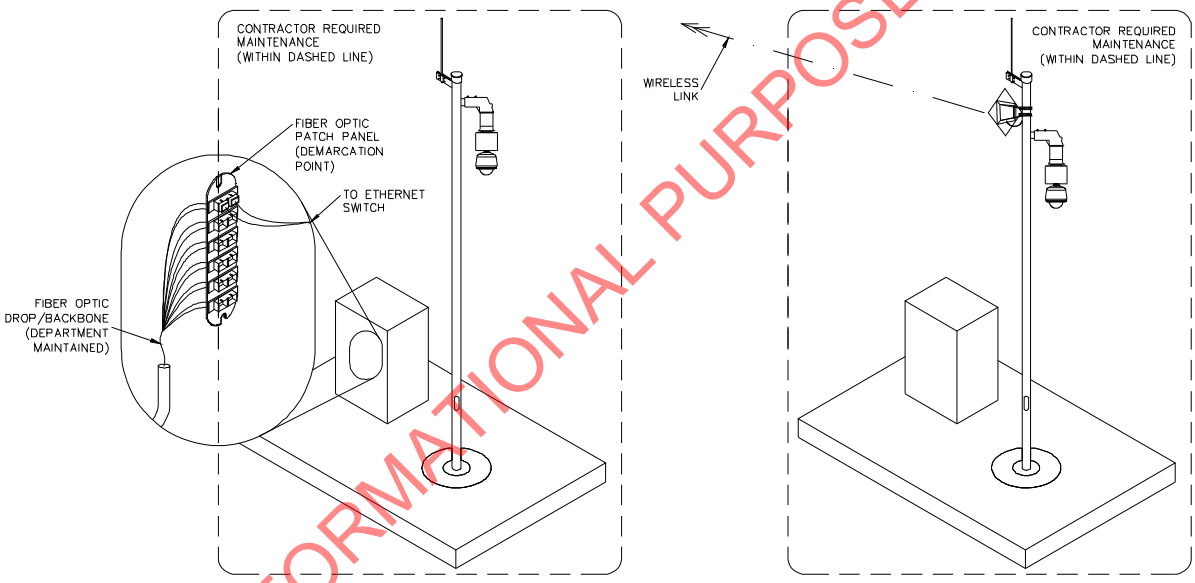

Figure 7: Demarcation Point

Although there is some communications on the contracted maintenance side of the site, it is limited. DOTD will maintain the configuration settings and the contracted maintainer will have to transfer existing settings to any replacement communication equipment units.

7.1.1 Contracted Maintenance Responsibliites

Although the final procurement option selected may dictate the contractual level of maintenance for the ITS field devices, there are certain high level minimum responsibilities that shall be maintained. These items are indicated below. Note in the list below, the term “contractor” is generic for whoever is performing the contracted maintenance and does not mean construction contractor. Specific component routine requirements shall be indicated within the final maintenance contract.

- Routine Maintenance
  - The contractor shall provide routine maintenance
  - Minimum routine maintenance items for each site:

        - Inspect site for abnormal occurrences (e.g., vandalism, structure fatigue, etc.)
        - Inspect and treat for insects
        - Clean/replace air filter
        - Vacuum cabinet and dust/blow out
        - Inspect all seals
        - Inspect temperature control equipment
        - Document all finding
    - Routine maintenance at CCTV camera sites shall be provided at least every 6 months
    - Routine maintenance at DMS Sites shall be provided at least every 4 months
    - Routine maintenance at VD Sites shall be provided at least every 4 months
- Response Maintenance
    - The contractor shall provide responsive maintenance to all notifications of ITS field device malfunctions
    - The contractor shall respond on-site to a request for response maintenance notifications (non-emergency) within 24 hours
        - Contractor to pay stipulated damages for failure to respond within the required time
    - The contractor shall respond on-site to a request for emergency maintenance notifications within 8 hours
        - Contractor to pay stipulated damages for failure to respond within the required time
    - The contractor shall complete on-site repairs and/or restoration of service within 48 hours after being notified of the request for maintenance unless stipulated otherwise by the DOTD ITS Maintenance and Communications Engineer
        - Contractor to pay stipulated damages for failure to complete on-site repairs and/or restoration of service within the required time

7.2 Required Resources for Field Device Maintenance

Based on the ITS Maintenance Staff's experience, the following items are needed for field device maintenance. Certain items have been noted as rental as they may not be feasible to be owned by the contracted staff. The minimum required equipment will be detailed in the contracts as the contract may be specific to region and/or device type.

- Vehicles (vans/pickup trucks)
- Laptop
- Vendor software (DOTD provided)
- Ladders (up to 24 feet)
- Hand tools
- Cordless power tools
- Electric power meter
- Wet/dry vacuum
- 60 foot bucket truck (rental)
- 115 foot bucket truck (rental)
- Fiber LED light source
- Fiber laser light source
- Pole lowering trailer (DOTD provided)
- Personal protection gear

- Safety harness

For reference, the current equipment used by the ITS Maintenance Staff has been included in **Appendix C**.

7.3 Current Processes

7.3.1 Notification

Approximately 90 percent of all ITS malfunctions are found by the TMC Operations Staff. As previously discussed, every morning at start up the TMC Operators are required to check the status of all field devices and provide notification to the Statewide TMC of any malfunctions. By checking the status of the field devices, the TMC Operators are in essence checking all the system components from the TMC to the field device. For example, the daily DMS check requires the TMC Operator to post a test message on all the DMS boards. A popup notification (success or failure) is provided to the operator. When a CCTV camera is available to view the DMS, the TMC Operator will verify the message has been appropriately posted. Successful message postings let the TMC Operator know that all the communication system, power, servers, etc. between the TMC and the DMS (and CCTV camera when available) are functioning.

The other 10 percent of malfunctions are found by ITS Maintenance Staff, other DOTD employees, communication monitoring service providers, motorists, and/or local television stations staff. Malfunctions may be reported to the ITS Section by telephone calls or via email. DOTD's webpage contains the ITS Section's contact information as well as a section to submit feedback to DOTD.

The ITS Section staff have been instructed to forward any received malfunction notifications to the ITS Maintenance and Communications Engineer who in turn will verify its inclusion in the compiled Daily Equipment Status Form and the ITS Maintenance Database. Any malfunctions witnessed, found, or received by TMC Operations staff are documented by the local TMC in the Daily Equipment Status Form. Each TMC is required to email Daily Equipment Status Form to the Statewide TMC Manager for compilation into a single Daily Equipment Status Form and entered into the ITS Maintenance Database. The compiled Daily Equipment Status Form along with work orders for the issues are emailed to the ITS Maintenance and Communications Engineer every morning for investigation and response to any malfunctions.

The ITS Maintenance Database is the repository of all equipment failures, restorations, equipment repaired/replaced, and MTBF. It is managed by the Statewide TMC Operations staff and is used for generating status reports and work orders on the field equipment.

7.3.2 Response

Response to a malfunction is generally investigated by ITS Maintenance Staff. Sometimes contracted personal under an authorized dealer contract may be requested by the ITS Maintenance and Communications Engineer to investigate a malfunction. Typically, the request to use an authorized dealer contract is due to a known, ongoing, or reoccurring problem for that type of component. Work orders are issued from the ITS Maintenance and Communications Engineer to the ITS Maintenance Staff. Form contracted maintenance, purchase orders (PO) are issued along with the work order.

ITS Maintenance Staff follow the response steps previously outlined in Section 3.5 (Receive notification of malfunction, Secure the site, Diagnostics, Interim repairs, & Log activity). Response

depends on the component of the infrastructure malfunctioning. The following sections detail the responsive maintenance for the various components of the infrastructure.

Once ITS Maintenance Staff members are on site, the conditions of the situation are observed then addressed. First priority is given to safety. Personal protection and the safety of others are critical. In cases of device knock downs, verifying that the power has been disconnected is grave.

For typical device malfunctions, power and communications connection checks are step one. If connections are secure, the device will be reset. If the reset fails to solve the malfunction, the malfunctioning device is swapped out with a spare. When it is not immediately determined which of multiple devices are malfunctioning, multiple swap outs may be required. However, no detailed troubleshooting on a device is permitted to be performed in the field. Detailed breakdown and troubleshooting occur in the office or repair shop.

Emergency maintenance (e.g., knockdowns, multiple switch/comm. failures, etc.) generally warrant greater efforts than simple device malfunctions. These efforts are treated differently as there usually is no immediate restoration to operational status. The level of destruction from a knockdown may warrant review and modification of the design as well as new construction to replace. Temporary repairs may include mechanical splices to bypass the site at the direction of the DOTD ITS Maintenance and Communications Engineer.

7.3.3 Verification

Upon repair or replacement of field equipment, the contracted maintenance personnel emails the ITS Maintenance and Communications Engineer indicating that the site has been restored. The items repaired or replaced along with the associated issue number(s) from the work order are included in the email. The ITS Maintenance and Communications Engineer forwards the email to the appropriate TMC for verification and copies the Statewide TMC Operations Manager on the email. The TMC operator verifies the equipment is working properly and replies to all on the email for reporting. The Statewide TMC finalizes its entries into the ITS Maintenance Database and the ITS Maintenance and Communications Engineer further processes the PO for the contracted maintenance.

TMC verification of ITS Maintenance Staff repairs utilizes verbal communication rather than email. Otherwise, the process is the same as described above for contracted maintenance. The TMC operator who verifies the restoration emails the Statewide TMC Operations Supervisor to update the entries in the ITS Maintenance Database.

8 Evaluation of Service Life and Replacement

Although routine and preventative maintenance measures may extend the life of the ITS infrastructure, replacement is inevitable. Due to the finite life span, an approach must be taken to determine at what point are the ongoing repair cost, down time, and user cost (i.e., the public's cost for downtime) outweighing the cost of replacement.

The ITS Section has begun replacing the original ITS devices deployed in 2001 and the equipment destroyed by Hurricane Katrina. DMS manufacturers no longer support hybrid fiber optic flip disk signs, so the existing flip disk DMSs are being replaced with LED DMS.

The following criteria had been determined to warrant immediate replacement of field devices:

- Components submerged by storm water
- Structural failure
- Direct lightning strike

The following criteria had been determined for scheduling replacement:

- Manufacturer no longer supporting make/model of equipment
- Replacement parts are no longer available
- MTBF of:
    - CCTV camera unit is 1/4 of the average of that same type of device (i.e, the frequency of responsive maintenance is 4 times greater)
    - DMS display and/or controller is 1/4 of the average of that same type of device (i.e, the frequency of responsive maintenance is 4 times greater)
    - VD unit is 1/2 of the average of that same type of device
    - Communication equipment is 1/3 of the average of that same type of device
- Attenuation (Db loss) in fiber optic cable segment has begun to affect video quality
- Attenuation (Db loss) due to fiber optic cable connector has begun to affect video quality
- Equipment no longer required for proper function (or future function) of a device should be removed (i.e., if it's not needed, remove it)

As performance measures are further tracked and daily device status is complied in the equipment database, this plan will be re-evaluated and updated.

9 Required Training

Proper training improves efficiency, reduces labor time, and increases safety for both the maintainer and the motoring public. All maintenance personnel are required by the ITS Section to be properly trained to perform the maintenance task(s) assigned. Upon request by the ITS Section, personnel shall submit proof of certification. The required minimum training shall include the following:

- At least one person on any roadside site undergoing maintenance shall have been trained and certified in work zone safety and traffic control. He/she shall be responsible for implementing and enforcing safety measures, educating others on site of safety, and deploying traffic control for the site
- Maintainer (agency/firm) shall have received training and certification from the manufacturer for providing maintenance and support on the equipment
- For fiber optic maintenance, certifications by Corning or approved equal for fiber installation

APPENDIX A
DRAFT MAINTENANCE REPORTING POLICY

TMC ITS MAINTENANCE REPORTING POLICY

I. Background

This policy has been adopted to promote consistency statewide for reporting ITS maintenance.

II. Goals and Objectives

a. Standardize reporting of ITS maintenance
b. Maintain ITS Maintenance Database

III. Roles and Responsibilities

a. TMC Operations Staff at each TMC shall run daily system checks to determine the functioning status of the ITS
b. TMC Operations Staff at each TMC shall document the findings of the daily system checks and malfunction notifications received from outsides sources using the Daily Equipment Status Form
c. TMC Supervisor at each TMC shall email the updated Daily Equipment Status Form to the TMC Operations Manager at the Statewide TMC
d. TMC Manager shall compile the reports from all TMC Supervisors into a single Daily Equipment Status Form and enter the data into the ITS Maintenance Database
e. TMC Manager shall email the ITS Maintenance and Communications Engineer the compiled Daily Equipment Status Form along with the work orders for those new issues for that day.

IV. Minimum Components of standardized Daily Equipment Status Form

a. Date of report
b. Types ITS field equipment other equipment issues
    i. Date of issue observed
    ii. Name of common name of field device site/system
    iii. Issue description (e.g., error message indicated or common terms used)
    iv. Indicate whether issue was observed is from ATMS software, vendor software, or both
c. Website images
    v. Date of issue observed
    vi. Common name of field device site and view direction
    vii. Issue description (e.g., error message indicated or common terms used)
d. Other equipment issues
    viii. Date of issue observed
    ix. Name of system, component or service having the issue
    x. Issue description (e.g., error message indicated or brief description)

V. Minimum Components on Work Orders

I. Issue number that corresponds to the ITS Maintenance Database
II. Date issue was received by the TMC
III. Device site information (automatically generated from ITS Inventory Database)

a. Device type
b. Location
c. Route
d. Common name of field device site

IV. Description of the issue as recorded by the TMC
V. Check boxes for Internal or External personnel to repair
VI. Blank lines for
    a. Assigned to
    b. Contact number
    c. Date work order assigned
    d. Date(s) of services provided
    e. Date and time of issue resolved
    f. Confirmed by (which TMC)
    g. Notes (specify work performed and what equipment was repaired/replaced)

Baton Rouge ITS Equipment Status Report

SAMPLE

Wednesday, April 28, 2010

Date	CCTV	Issue	Axis	Cameleon
3/26/10	11: I-10/I-110 Jct	Intermittent Video		x
3/26/10	21: I-10 at Picardy	Iris Issue		x
3/26/10	52: I-10 at Dalrymple	No video		x
3/26/10	22: I-10 at Siegen	No video		x
3/26/10	53: I-110 at Chippewa	Intermittent Video		x
4/5/10	47: Florida at Flannery	No video		x
4/13/10	41: I-10 at Highland (2)	No video	x	x
4/22/10	11: I-10/I-110 Jct	Image Issue		x
4/22/10	12: I-110 @ Government	Image Issue		x
4/22/10	13: I-110 @ Florida	Image Issue		x
4/22/10	18: I-110 @ N 22nd	Image Issue		x
4/22/10	14: I-10 @ Nicholson	Image Issue		x
4/27/10	42: I-10 at LA 73	No control: facing LA 73	x	x
4/28/10	33: I-12 @ Amite	No video: switch error	x	x
4/28/10	17: I-110 @ Governors Mansion	No video	x	x

Date	DMS	Issue
3/26/10	07: I-12 EB at Essen	ALRM: ATTACHED DEVICE ERROR, FAN ERROR, PIXEL ERROR
4/13/10	03: I-10 EB at Dalrymple	ALRM: LAMP ERROR, POWER ERROR
4/26/10	02: I-10 EB at Port Allen	ALRM: DEVICE ERROR
4/27/10	02: I-10 EB at Port Allen	ALRM: NO RESPONSE

Baton Rouge ITS Equipment Status Report

SAMPLE

Wednesday, April 28, 2010

Date	Website Image	Issue
3/26/10	US 61 at Highland (Old Troop A)	No video: Trafficland logo
3/26/10	Florida at Flannery	Image temporarily unavailable
3/26/10	I-110 at Chippewa	Image temporarily unavailable
3/26/10	I-12 at 4H-Club Rd - East	No video: black screen
3/26/10	I-12 at Millerville - North	Image temporarily unavailable
4/15/10	I-12 at Airline Hwy - North	Image temporarily unavailable
4/16/10	I-12 at Amite River	Intermitent availability
4/20/10	I-12 at GraysCreekBridge	No video: white screen
4/27/10	I-10 at Highland - East	No video: black screen
4/28/10	I-10 at LA 30 - West	displaying PTZ video feed
4/28/10	I-10 at LA 30 - East	displaying West fixed video feed

Date	Other Equipment Issues	

SAMPLE

ITS Equipment Work Order

Issue Number	Issue Received
BR-123456789	*01/01/10*

Device:

Type: *CCTV* Location: *Baton Rouge* Route *I-10 at College*

Common Name: BR CAM 07 I-10 at College

Issue Description:

Camera does not pan and focus is locked.

Resolution:

Assigned To: *John Smith* Internal *X* External

Date Assigned: *01/02/10* Contact Number: *225-555-1212*

Date(s) work performed: *01/03/10, 01/04/10*

Date Issue Resolved: *01/04/10 14:00* Confirmed by: *BR TMC Ops*

Notes:

Unit replaced after testing confirmed faulty motor drive

APPENDIX B
Components and Systems not in the field but maintained by the ITS Section

Area	Portable Changeable Message Signs*	Phones
Alexandria	3	200
Baton Rouge	14	1968
Houma	0	75
Lafayette	15	156
Lake Charles	8	190
Monroe	3	233
New Orleans	16	659
Shreveport	3	170
Statewide	3	134
*Only communications equipment maintained by ITS Section		

APPENDIX C

DOTD Assigned Maintenance Equipment

Title	Vehicle	Other Equipment *
ITS Tech #1	Heavy Duty Pickup Truck	
(Statewide)	35' Bucket Trailer	
	Pole Lowering Trailer	
	Small Cargo Trailer	
ITS Tech #2	Pickup Truck	
(Statewide)	29' Bucket Van	
ITS Network Tech #1 (Statewide)	Pickup Truck	
ITS Tech #3 (Statewide)	Mini Van	
DV&V Tech Dist 08	Pickup Truck	
DV&V Tech Dist 04	Van	Cable Locator
Maint & Comm Engr Mgr	Mini Van	
DV&V Tech Dist 03	Van	Fiber Kit
ITS Network Tech #2 (Statewide)	Mid Size Car	
Maintenance Mgr	Mid Size Car	
ITS Network Admin	Pickup Truck	
ITS Network Tech #3 (Statewide)	Van	
DV&V Tech Dist 62	Van	
ITS Field Maint Mgr	Mid Size Car	
DV&V Mgr	Mid Size Car	
ITS Network Tech	Mini Van	
DV&V Tech Dist 02	Mini van	
	Pole Lowering Trailer	
DV&V Tech Dist 05	Van	
ITS Tech	Mini Van	
DV&V Tech Dist 07	Mini Van	
DV&V Tech Dist 61	Mini Van	

ITS Tech #3 (Statewide)	Pickup Truck	Ditch Witch cable locator, Fiber termination kit
ITS Director	Mid Size Car	
ITS Network Tech #4 (Statewide)	Van	
ITS Tech #5 (Statewide)	Pickup Truck	
DV&V Tech Dist 58	DODGE RAM 1500	OTDR, LED Source, Laser Source, Optical PWR Meter, Optical Fiber ID, Fiber Microscope, Fiber Kit, Cable Locator
DV&V Tech Dist 02	FORD E350	
*Note all DOTD maintenance staff are equipped with general hand tools, power tools, electric power meter, laptop computers, vendor software, and interface cables. Ladders of various sizes are shared amongst maintenance staff.		

APPENDIX D

ITS Network Monitoring

Some of the ITS network communication components are under contracted monitoring service. Detel Wireless, LLC and Skyrider Communications, Inc. are responsible for monitoring some of the DOTD owned microwave links. Global Data, Inc. is responsible for monitoring the SONET equipment at the DOTD regeneration (regen) sites. Neither Detel Wireless, Skyrider, nor Global Data are contracted to provide maintenance response. However, they may be directed by the ITS Maintenance and Communications to provide response under one of the other contracting mechanisms.

Monitored Wireless Links

Permit Company	Radio Path Description
Detel Wireless, LLC	• Woodlawn Tower • Roanoke Tower • District 03 Tower • Grosse Tete Tower • Baptist Weigh Station Tower
Skyrider Communications, INC	• Bridge City Tower • Crescent City Connection Division (CCCD) Tower • Laplace Tower • DOTD Headquarters to Brittany • DOTD HQ–Jackson–Angola–Marksville–Alexandria–Cypress Bayou

APPENDIX E

Maintenance Responsibilities by Others

The outline below identifies the components of the ITS that are under the responsibilities of "others." Note the intent of this section is to identify the components of the ITS and communication links which are beyond DOTD's control and outside of DOTD's maintenance.

1. Baton Rouge Area
    - TMC Elements
        - ATM-EOC is a city owned facility maintained by the City-Parish, Department of Public Works.
            - Video wall
            - Consoles
            - Operator phones
        - Cable television feed – Cox Communications (City provided)
        - Motorist Assistant Patrol (MAP) Radios – Jack B. Harper or current contractor
        - Cellular phones service – AT&T (DOTD provided)
        - Video distribution – TrafficLand
    - Field Elements
        - CCTV cameras at traffic signals - under City-State agreement
        - Electricity – Entergy and/or Demco
        - Cellular service at CCTV camera sites – Verizon Wireless

2. New Orleans Area
    - TMC Elements
        - Video distribution – TrafficLand
        - Cable television feed – Cox Communications (City provided)
        - Satellite television feed – Direct TV
        - Internet Service Provider – Office of Telecommunications Management, OTM (DOTD provided)
        - General facility maintenance, day-to-day – Regional Planning Commission
        - Local telephone service connection - AT&T
    - Field Elements
        - RVD stations owned and maintained by Traffic.com. Data provided to TMC & ITS Section
        - Electricity - Entergy
        - Cellular service at CCTV camera sites – Verizon Wireless
3. Shreveport Area
    - TMC Elements
        - General facility maintenance – DOTD ITS Section
        - Video distribution – TrafficLand
        - Leased connection to DOTD Fiber Backbone – AT&T frame relay
        - Local telephone service connection - AT&T
    - Field Elements
        - Dial in modems phone service on DMS – AT&T
            - To be swapped out with cellular – AT&T

    - Electricity – AEP SWEPCO
4. Lafayette Area
    - TMC (District office) Elements
        - General facility maintenance – District maintenance staff
        - Leased connection to DOTD Fiber Backbone – AT&T frame relay
            - To be dropped after future connection to LONI network
        - Local telephone service connection - AT&T
    - Field Elements
        - CCTV cameras at traffic signals - under City-State agreement
        - Electricity – Lafayette Utility System (LUS), Entergy, CLECO
5. Houma Area
    - TMC (District office) Elements
        - General facility maintenance – ITS Section
        - Video distribution – TrafficLand
        - Leased connection to DOTD Fiber Backbone – AT&T frame relay
        - Local telephone service connection - AT&T
6. Other Areas Througout the State
    - Video distribution – TrafficLand
    - Cellular service for CCTV camera sites at state lines – Verizon Wireless
    - Cellular service for DMS sites - Verizon Wireless

APPENDIX F

Process Review: Louisiana Department of Transportation and Development Intelligent Transportation System Maintenance
LDOTD/FHWA - Louisiana Division
April 1, 2008

Executive Summary

The Louisiana DOTD ITS program formally started over eight years ago. The chief focus of effort over that time has been the planning and deployment of system elements. However, as projects have been completed, maintenance of those systems has become a much more important and critical issue. This process review studied the ITS maintenance program with an emphasis on identifying potential challenges that may appear within the next three to five years as current deployments begin to reach the end of their service life.

It was found that there are no national standards for the maintenance of ITS elements. Often, any requirements for maintenance tend to be ad hoc and not based on technical or economic principles. Despite this, DOTD appears to have sufficient resources to address their current maintenance requirements. However, as large deployments that are geographically dispersed across the State are deployed, DOTD will need to expand their maintenance forces either internally or through contract. Furthermore, the replacement of ITS field devices that have reached the end of their useful life, will put increasing pressure on the ITS construction budget such that no new expansions will be possible unless additional funding is secured.

In order to appropriately study and plan for these future challenges, it is recommended that an ITS maintenance strategic plan be developed and implemented. This plan will address future year maintenance needs, the expected impact on DOTD's ITS budget and other applicable issues. Lastly, it is recommended that several successful maintenance practices now in place be improved and expanded.

National Standards

The report that provides the most comprehensive information on ITS maintenance is Report # FHWA-OP-04-011 "Guidelines for Transportation Management Systems Maintenance Concept and Plans". This document summarizes ITS maintenance practices and offers a framework for development of maintenance programs. Furthermore, the IDAS (ITS Deployment Analysis System) software and the DOT/JPO ITS Cost and Benefit Database (www.itscosts.its.dot.gov) provide high-level estimates of life expectancies and maintenance costs associated with specific ITS elements.

Importantly, there are no national resources or standards that have been developed identifying for a particular type of ITS field device the following:

- Minimum downtime
- Minimum time between failure
- Minimum response time to repair
- Minimum time to detect a failure
- Types of failures not requiring response
- Number and duration of intermittent failures such that the device is classified as having "failed"

An ITS field element is usually installed as either a traffic *management* device or as a traffic *control* device. The function of the device and not the device itself is what determines how it is classified. A traffic management device is a device that is installed with the intention of improving the efficiency of traffic flow and the capacity of the roadway. A traffic control device is a device that is installed with the intention of controlling the flow of traffic up to and including the assignment of rights-of-way. For example, a camera can be used to monitor and assist in the quick clearance of roadway incidents (traffic *management*) or it can be used to detect vehicles in order to directly control the sequencing of a traffic signal (traffic *control*).

Therefore, the maintenance response behavior is generally less urgent when a field element functions as a traffic *management* device. Hence, not only are there no baseline performance measures or level-of-service for ITS field devices but there is no common philosophy or expectation as to system or device performance. The benefits of ITS deployments across the nation that have been quantified do not assume a system or device performance measure. At best, the benefit derived from a device installation could be "pro-rated" based on device down-time with a minimum performance break-even point somewhere greater than where the derived benefit equals the life cycle cost. Developing the described methodology to determine minimum system and device performance measures is outside the scope of this process review.

Inventory and Tracking of ITS Devices

Louisiana DOTD maintains a Geographic Information System (GIS) of ITS field devices. The database includes the fields listed below in Table A. The source(s) of data for that field is noted.

Table A

Field	Source(s)
MaintenanceID	ITS Planning
Device_No	ITS Planning
Tag	ITS Planning
Operational_Status	Contractor, ITS Planning, ITS Maintenance
ProjectName	Contractor, ITS Planning
SPNo	Contractor, ITS Planning
Device_Type	Contractor, ITS Planning
Metro_Area	Contractor, ITS Planning
DOTD_Dist	Contractor, ITS Planning
Location	Contractor, ITS Planning
Road_Type	Contractor, ITS Planning
Corridor	Contractor, ITS Planning
Route	Contractor, ITS Planning
Direction	Contractor, ITS Planning
Long_	Contractor, ITS Planning
Lat	Contractor, ITS Planning
Gps_accuracy	Contractor, ITS Planning
MistID	ITS Planning
PhysicalID	ITS Planning
Misc_location_info	Contractor, ITS Planning
Manufacturer	Contractor, ITS Planning
Model	Contractor, ITS Planning
CommMethod	Contractor, ITS Planning, ITS Maintenance
PowerMethod	Contractor, ITS Planning, ITS Maintenance
WarrentyBegin	Contractor, ITS Planning
WarrentyEnd	Contractor, ITS Planning

The database is normalized with records keyed on MaintenanceID. The database is scalable and can be easily exported to common formats. The data is accurate and includes all federal and state ITS deployments within the last seven years. A report showing all data is attached.

When ITS field devices are installed under a construction project, the Contractor is required to provide data that allows DOTD to append the GIS with data describing their installation. DOTD has the equipment and manpower to populate the data for deployments that may be performed through other work. The ITS Section has a GIS specialist on staff assigned to do this work.

The following are suggested improvements to the database/GIS based on the gaps that have been identified:

- Standardizing the naming format for fields

  Recurring maintenance reports are being generated by Traffic Management Centers as part of the regular duties. Consistency in formatting will allow for less costly and problematic integration of databases.

- Installation date

  The date of manufacturer and the date of installation need to be added to the GIS and the database populated with the information available. Even if an estimate is all that could be provided, some record that could determine whether the device has reached its approximate service life would be valuable. Old devices can be accurate to the year and new installations should include month and year.

- Integration with equipment and maintenance databases

  The purpose of this GIS is not to maintain maintenance records. However, given that maintenance databases are already being developed within the ITS Section, it is anticipated that users will expect to see this information integrated or at least accessed from a single application.

- Integration with device outputs

  Currently, a “closed-source” GIS is being used by LDOTD to access device-generated data or images. An example of this can be seen on LDOTD’s public website. It is anticipated that users will expect an “open-source” GIS with access to real-time device outputs. This would significantly improve the long-term scalability and integration costs of future ITS deployments.

  The cost to integrate with real-time, device outputs varies widely with the number and quality of features. Also, full development could not be achieved through a single, self-contained project but will require an evolutionary approach that would be achieved through a combination of integration tasks, construction and software specification changes, policy modification and changes in internal maintenance procedures.

Maintenance Responsibility

As a percentage of the capital cost, ITS devices require a large maintenance effort when compared to typical highway projects and Information Technology (IT) projects. This is due to the extreme environmental conditions in which ITS devices are exposed. Despite equipment that is specified to be hardened to NEMA (National Electrical Manufacturers Association) standards, excessive heat, wind, water, vibration, other factors and the large geographic scope of ITS deployments inevitably lead to a higher maintenance requirement compared to similar IT deployments in more stable and secure environments or installed within a much smaller geographic area.

Table B below identifies the Federal-aid ITS projects that have deployed field equipment and the current and future maintenance responsibility.

Table B

Project Name	Operational Status	Current Maintenance Responsibility	Planned Maintenance Responsibility
Atchafalaya ITS/TIM	In production	DOTD ITS Section	DOTD ITS Section
BR Phase 1	In production	DOTD ITS Section	DOTD ITS Section
BR Phase 2	In production	DOTD ITS Section	DOTD ITS Section
Contraflow	Deployed as needed	DOTD ITS Section	DOTD ITS Section
Houma Phase 1	In production	DOTD ITS Section	Contract Forces
Houma Phase 2	Under construction	Warranty maintenance	Contract Forces
Northshore Phase 1	In production (partially)	Warranty maintenance	Contract Forces
NO Phase 1B	Out of service	DOTD ITS Section	DOTD ITS Section
Shreveport Near Term Phase 1	In production	DOTD ITS Section	Contract Forces
Northshore Phase 2	In design	Warranty maintenance	Contract Forces
Southwest Contra-flow	In production	DOTD ITS Section	DOTD ITS Section
Traffic.com Deployment	In production (partially)	Contract Forces	Contract Forces

Maintenance Capability

Maintenance Reporting Procedures

The following observations on ITS reporting procedures were found:

- Traffic Management Center Operations reports
  DOTD's TMC Operators at the Baton Rouge ATM/EOC are generating weekly reports on the performance of ITS field devices in the Baton Rouge area. A sample of these reports is attached. As part of the new Statewide TMC Operations contract that will start July 1, 2008, TMC personnel will be required to generate similar reports for devices under their operational management. Contract operators have an incentive to report equipment failures in order to remove their culpability for devices not functioning as expected especially during emergencies and other events. This high-level reporting also provides incentives to maintenance personnel to perform preventative maintenance and regular testing.
- Warranty maintenance performed by Contractors
  Maintenance reports for devices under warranty are internal to the Contractor and can be reviewed by DOTD on an as-needed basis.
- Maintenance performed by DOTD forces
  The DOTD field technicians do not have a maintenance reporting system other than through their regular payroll system. Since DOTD takes a "system view" of maintenance, the ITS Section considers the TMC equipment reports to be an adequate method of monitoring the performance of maintenance personnel.

Maintenance Capability - Internal

The following observations were made regarding internal DOTD resources available for ITS field device maintenance:

- The ITS Section has ten (10) District communications technician under its direct supervision. These technicians function as the "first responder" to reported malfunctions and coordinate/secure District resources that may be required (heavy equipment and operators, welders, general electricians, etc.). District technicians have responsibilities beyond ITS including radio systems, networking, wiring and other related activities.
- The ITS Section has four (4) Statewide ITS technicians that have specialized skills and perform advanced diagnosis and repair. Statewide ITS technicians are devoted full time to ITS deployments.
- Technicians are adequately equipped and trained with tools and test gear for the ITS field devices and supporting communications infrastructure.
- The ITS Section must currently borrow a bucket truck from District forces or rent from local dealers, both of which require a certain amount of lead time. If a much quicker response for all types of failures is required, it will be necessary for the ITS Section to procure its own 2-man, bucket truck that can reach over 65 feet.
- The only field devices that are maintained in inventory are video encoders/decoders and cameras. Other items are procured on an as-needed basis usually under an existing State contract.

Maintenance Capability - Contracted

Except as mentioned below, maintenance by private contractors has only been performed as part of warranties associated with ITS construction projects. However, the ITS Section plans on contracting maintenance for Shreveport and Houma ITS deployments as they come out of warranty with the next year.

The Traffic.com deployment is currently the only ITS infrastructure under contract maintenance and is funded through a public-private partnership with FHWA HQ/Office of Operations. This deployment consists of about 80 traffic sensors along 80 miles of NHS roadways in the New Orleans area. As part of this partnership, Traffic.com will operate and maintain these devices for a period of at least 10 years.

Level of Maintenance Resources and Performance Measures

Descriptive Business Measures

The following is an estimate of the sufficiency of the number of technicians currently deployment by DOTD for ITS field device maintenance.

Field Device	Device Count (total)	Device Count (Fed-aid)	Man-Hours per Visit (incl. travel)	Avg. # of Visits per year	Annual Man-Hours Required
DMS	47	37	8	47	376
RVD	120	94	4	60	240
Camera	113	85	4	113	452
				Total Man-Hours Required:	1,068

Assumptions

- Devices are not at the end of their service life
- Capital outlay will replace those devices that have reached the end of their service life.

Assuming 5% of District Communication Technicians time is available for ITS field device maintenance response, the total capacity of the DOTD ITS Section for ITS field device maintenance response is the following:

Technician Type	Technician Count	% Time Available for ITS Field Device Maintenance	Total Available Yearly Man-Hours	Total Man-Hour Capacity for ITS Field Device Maintenance
District Communication	10	5%	16,800	840
Statewide ITS – General	4	20%	6720	1344
Statewide ITS – Device Specialist	1	100%	1680	1680
Total Man-Hour Capacity for ITS Field Device Maintenance:				3864

Even though conservative values are used for the key subjective factors of the average number of visits per year and the percent time available for ITS field device maintenance, there is still a large maintenance capacity available within the DOTD ITS Section. However, large planned deployments that are spread throughout the State will quickly eliminate this capacity. For this reason, the ITS Section is considering contract maintenance for deployments in Shreveport and Houma.

A weakness of the above approach is that larger system issues, such as telecommunication problems and software malfunctions, can contribute to what is perceived to be a field device failure. Therefore, while there may be sufficient capacity for field device maintenance, there may not be enough capacity to address other system problems. In this case, the field devices will not *function* even though the actual device does not *fail*. This is further complicated by the fact that not all portions of the ITS system are under the control and maintenance of the ITS Section and major portions of the system also serve user needs unrelated to ITS deployments.

A more comprehensive study is needed to determine the totality of the system that is to be maintained, the activities of technicians and those responsible for each piece of the system including different operating units within DOTD and private/contracted entities that impact system performance.

Observations, Conclusions and Recommendations

Observations and Conclusions

- DOTD has the following number of ITS field devices deployed: DMS – 47; RVD – 120; Camera – 113. The ITS Section has a maintenance force consisting of ten (10) District Communications specialists, four (4) Statewide ITS generalists, and one (1) Statewide ITS device specialist.
- At this time, the DOTD ITS Section has sufficient manpower, equipment and materials to maintain the ITS field devices that have been deployed with federal-aid funds. However, as deployments expand across the State, the maintenance resources now available will be insufficient.
- ITS equipment has a very short service life compared to other highway features. If additional replacement funds are not identified in the ITS budget partition within the next 3~5 years, all of this budget partition will be used for maintenance and device replacement, with no funds available for system expansion.
- ITS field devices (DMS, cameras) that appear to be malfunctioning to the public may not actually be defective. The cause may be malfunctions related to supporting infrastructure (communications lines, electrical service, software, etc.) or operations related (TMC did not get notified, TMC may only function during certain times of day, a camera may be turned off due to a crash, the default condition for a particular DMS may be a blank sign face, etc.).
- ITS field devices are supported by a larger telecommunications system and network that also supports other functions and organizations. The performance of these systems and networks impact the function of ITS field devices, sometimes substantially. However, maintenance for portions of these systems and networks are not under the control of the ITS Section.
- The detailed reporting of equipment status by TMC Operators is a highly effective measure of the relative performance of ITS field devices. The report currently issued by the Baton Rouge ATM/EOC is an excellent tool in organizing and prioritizing ITS maintenance efforts. The report accurately reflects the capability of the deployed systems to meet end-user requirements and includes the number of hours within a seven day (24 hour) period that field devices are fully, partially or not functional.
- The only region that has maintenance reporting for ITS equipment is Baton Rouge.
- There are no generally accepted, national baseline performance measures for ITS equipment performance.
- Diagnosing a malfunctioning field device is usually an iterative process, particularly for failures that are intermittent. Given this, a traditional work order system would be of little value and add an unnecessary burden to field maintenance personnel.
- The ITS Section plans to contract the maintenance of deployments in Shreveport and Houma.
- The ITS Section does not have a maintenance strategic plan.

Recommendations

- DOTD should develop standardized ITS equipment reports and require that all Traffic Management Centers issue periodic reports based on this standard. This standard should be modeled after the current Baton Rouge reports. Reporting requirements should be reviewed and improved on a continuous basis with changes reflecting input from stakeholders, improvements in technology and better data collection & manipulation.

- The TMC Operator (under a recently awarded DOTD contract) should modify the above mentioned reports to include additional fields and information that provides greater detail on maintenance activities such as when reported, when service begins/ends, etc. All reports need to be expanded to include communications infrastructure, network devices and software.
- Contractors should provide maintenance reports on a regularly defined basis for all work performed.
- DOTD ITS should develop a maintenance strategic plan that provides at a minimum the following:
    - Identifies future year maintenance resource needs based on planned system expansions, changes in design standards, improvements in technology and other applicable factors
    - Identifies the impact on the annual budget partition for system expansion as ITS field elements reach the end of their service life and must be replaced.
    - Identifies the scope of maintenance responsibility for the ITS Section including field devices, TMC equipment and facilities, software, telecommunications and other system elements.
    - Identifies those portions of the ITS system that do not fall under the maintenance responsibility of the ITS Section but can negatively impact system performance
    - Proposes an alternative method to a traditional work order system that properly assigns maintenance costs to a particular system element or design feature such that improvements in design standards can be made and are based on historical data.
    - Proposes a Department policy on maintenance reporting for all TMCs.