Regional ITS Deployment Plan

Southwest Region

December 2014 | Version 1

Prepared by:

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1 INTRODUCTION

The Michigan Department of Transportation (MDOT) has continued to strive to be a leader in the application of technology to improve transportation. Projects that are selected to implement these technological solutions are required to conform to regional intelligent transportation systems (ITS) architecture if they utilize federal funds. Prior to 2005, the focus of technology deployments was in the urban areas, but needs began to arise that warranted solutions for other areas of the state. In 2008, the Department completed an effort that supplemented existing documentation and completed regional ITS architectures and deployment plans that comprehensively covered all seven regions and provided a statewide vision for MDOT's ITS program. In 2014, MDOT initiated an administrative update for all but two of the regional ITS architectures. The two omitted were completed more recently and cover the metropolitan planning organizations (MPOs) around Grand Rapids and Lansing.

The National ITS Architecture is the standard template that regions and statewide ITS architectures customize to bridge stakeholders, their needs, and the solutions for ITS projects. The architecture represents a shared view between agencies on how to integrate information and resources to provide solutions that help move travelers through the region safely and efficiently. The architecture is a foundation of the long range vision for what could be implemented without being technology specific. It also allows stakeholders to derive strategies that can be implemented through more specific ITS projects that benefit the current regional transportation system.

1.1 Project Overview

The administrative update led by MDOT included an effort to align all but two regional ITS architectures within the state with the newest version of the National ITS Architecture (Version 7). In addition, the administrative update included an update to the regional deployment plan for the MDOT Southwest Region and some of the neighboring counties in the University Region. This update aligns the analysis method used in deployment plans for the other regions and assists in prioritizing the projects based on a benefit/cost analysis.

The regional ITS architecture is used to define the user needs and map the service packages that can be identified to address those needs. It is technology agnostic and prescribes high-level connections between elements in the region versus more specific, project-level information. The deployment plan, however, is much more specific and does present technology solutions with geographic limits. It defines the technology and location and provides stakeholders with a phased program for implementing potential projects: 0-3 years (including some currently programmed projects), 4-8 years, and greater than 8 years.

The previous Southwest Region Deployment Plan was completed in 2008 and included Jackson and Shiawassee Counties. The updated version adds Hillsdale and Lenawee Counties, but omits Shiawassee. Due its proximity to the Bay Region, Shiawassee was included in the Amendment to the Bay Region ITS Architecture. During the next full update, the deployment plan for the Bay Region will include Shiawassee for project prioritization.

1.2 Document Structure

The deployment plan for the Southwest Region comprises three sections:

1 – Introduction

This section provides a project overview and economic information for the Southwest Region and parts of the University Region.

2 – Deployment Plan Development

This section highlights the process of developing the deployment plan for the Southwest Region. It includes the existing inventory, a consolidated identification of possible projects, and the methodology used to perform the analysis.

3 – Deployment Plan Analysis

This section expands upon the development to evaluate the results from the analysis and provide a benefit/cost ratio identifying prioritized projects.

The deployment plan for the Southwest Region includes one appendix: Appendix A – Meeting Notes from the Stakeholder Workshops (March 2014)

1.3 Economic Information

This project includes an update of the ITS deployment plan that includes the Southwest Region and a portion of the University Region. An extensive deployment plan was completed for the Southwest Region in 2008. The 2008 plan identified projects with full ITS coverage of the region's freeways and a large percentage of the arterial roadways. Since 2008, two of the high priority projects that have been implemented include I-94 in Berrien County, from the Indiana line north to Benton Harbor, and I-94 in Kalamazoo and Calhoun Counties, from the City of Kalamazoo east to Battle Creek. The proposed equipment and density for the remaining proposed projects have been scaled back to align with deployment strategies in other regions. The counties included in this update primarily are grouped along the I-94 corridor and include several key north-south highways: US-131, I-69, US-127, and US-31. A few shorter, connector interstate highways include I-196 and I-194.

Urban fixed-route transit systems are operated within Kalamazoo and Battle Creek, with a more limited system in Berrien County. In the more rural counties of Barry, Cass, Van Buren, Branch, and St. Joseph, demand-responsive service is provided through either county or municipal governments.

Table 1. Southwest Region County Information

County	Population	Major Roadways	Transit Provided
Berrien	156,813	I-94, I-196, US-12, US-31	Berrien Bus Niles Dial-a-Ride Benton Harbor/Twin Cities Area Transportation Authority Buchanan Dial-a-Ride
Van Buren	76,258	I-94	Van Buren Public Transit
Allegan	111,408	I-196, US-31	Allegan County Transportation (ACT) Interurban Transit Authority (ITA)
Barry	59,175	M-43, M-37	Barry County Transit
Kalamazoo	250,331	I-94, US-131, I-194	Kalamazoo Metro Transit System

Table 1. Southwest Region County Information

County	Population	Major Roadways	Transit Provided
Calhoun	136,146	I-94, I-69	Battle Creek Transit The Link (City of Marshall Dial-a-Ride)
Branch	45,248	I-69, US-12	Branch Area Transit Authority (BATA)
St. Joseph	61,295	US-12, US-131	St. Joseph County Transportation Authority
Cass	52,286	M-51, M-60	Cass County Transportation Authority Dowagiac Dial-a-Ride (DART)

Source: Population numbers from 2010 U.S. Census.

There has not been a comprehensive ITS plan developed for the University Region, but some counties have been included in other deployment plans and architecture updates. These include an ITS plan originally developed for the Lansing area, or Tri-County Regional Planning Commission (TCROC), in 2001 and updated in 2010. The University region counties of Livingston, Monroe, and Washtenaw were incorporated in a regional plan for the Southeastern Michigan Council of Governments (SEMCOG) most recently updated in 2008. Since neither of these efforts focused on Jackson County or the rural counties of Hillsdale and Lenawee to the south, they were incorporated into this effort. Major highways that serve the region in addition to I-94 include US-127, US-12, and US-223. In Jackson County, the Jackson Area Transportation Authority provides both fixed-route and demand responsive service, while demand responsive services are available in Hillsdale and Lenawee Counties.

Table 2. University Region County Information

County	Population	Major Roadways	Transit Providers
Jackson	160,248	I-94, US-127	Jackson Area Transportation Authority
Hillsdale	46,688	US-12, US-127	Hillsdale Dial-a-Ride
Lenawee	99,892	US-12, US-223	Lenawee County

Source: Population numbers from 2010 U.S. Census.

2 DEPLOYMENT PLAN DEVELOPMENT

The deployment plan includes a summary of current ITS deployments in the study areas. For the freeways, these implementations are concentrated along I-94. Proposed technology deployments derived from the regional needs and stakeholder feedback are presented along with summaries of benefits and costs for each. The analysis was conducted using TOPS-BC, an operations-oriented benefit/cost tool developed by the Federal Highway Administration (FHWA). In general, the analysis indicated that a large majority of the proposed investments in the region will result in positive benefit/cost ratios, with benefits primarily realized in travel time savings and reduced secondary crashes. A narrative description of additional ITS services—including transit investments, Road Weather Information Systems (RWIS), and signal improvements—appears at the end of the document.

2.1 Inventory

As noted in the introduction, the current ITS inventory in the region is focused on the deployment of freeway management systems and includes detection, closed-circuit television (CCTV) cameras, and dynamic message signs (DMS) along the I-94 corridor. The two segments currently covered include a 34-mile section that is still under construction between the Indiana border and Benton Harbor in Berrien County and a 37-mile segment between Battle Creek and Kalamazoo in Kalamazoo and Calhoun Counties. In addition, the region is designing Phase 1 of a regional RWIS implementation and installing Automatic Vehicle Location (AVL) equipment on MDOT maintenance vehicles. Deployed equipment is summarized in **Table 3**. **Figure 1** through **Figure 4** display where each specific device is located.

Table 3. Existing Devices

System	County	Device Type
Freeway Management Systems		
	Kalamazoo	CCTV Cameras, DMS
	Calhoun	CCTV Cameras, DMS
	Berrien	DMS
	Van Buren	DMS
	Jackson	CCTV Cameras, DMS
Winter Weather Maintenance		
	Regional	Regional Phase 1 RWIS Deployment (in design)
Construction/Maintenance Management		
	Regional	Regional MDOT Direct Forces Vehicles
	Regional	AVL systems implemented on all county maintenance vehicles

Southwest Region

Existing ITS Device Map

EB CCTV
SB CCTV
WB CCTV
EB TPIMS Sign
WB TPIMS Sign
TPIMS Detection
DSRC
EB DMS
NB DMS
SB DMS
WB DMS
MVDS
Regional Office
Trans. Service Center

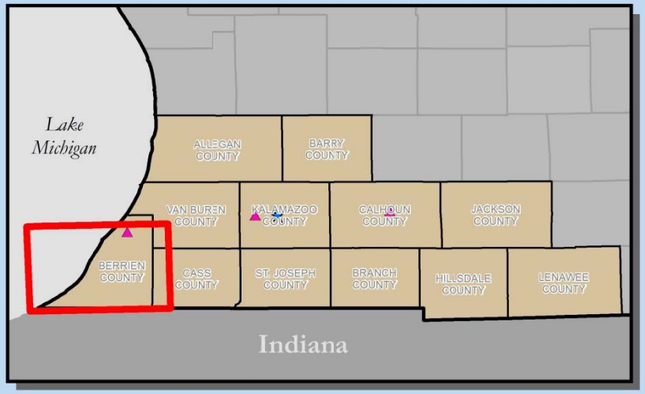

Figure 1. Existing Devices (Berrien County)

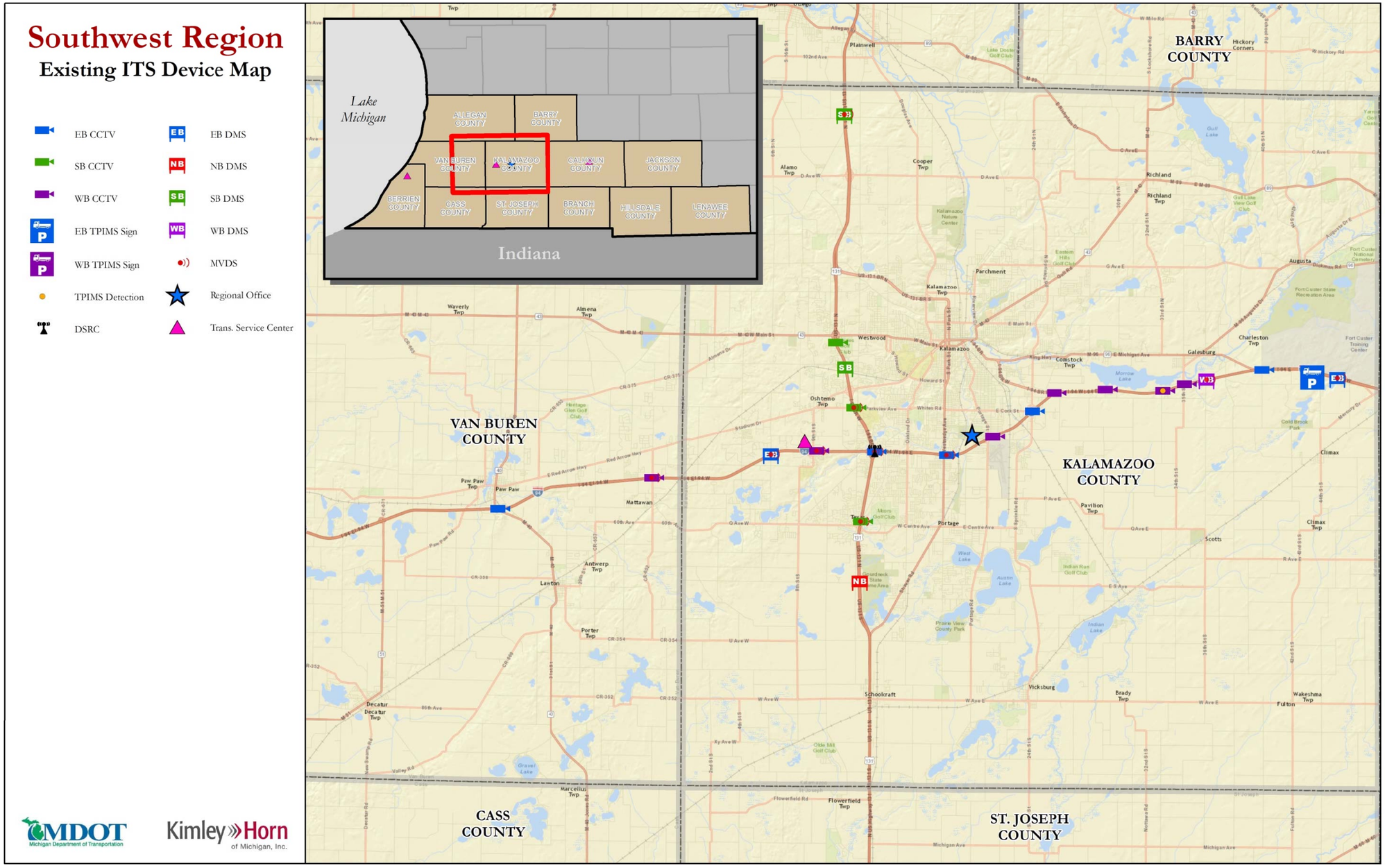

Figure 2. Existing Devices (Van Buren and Kalamazoo Counties)

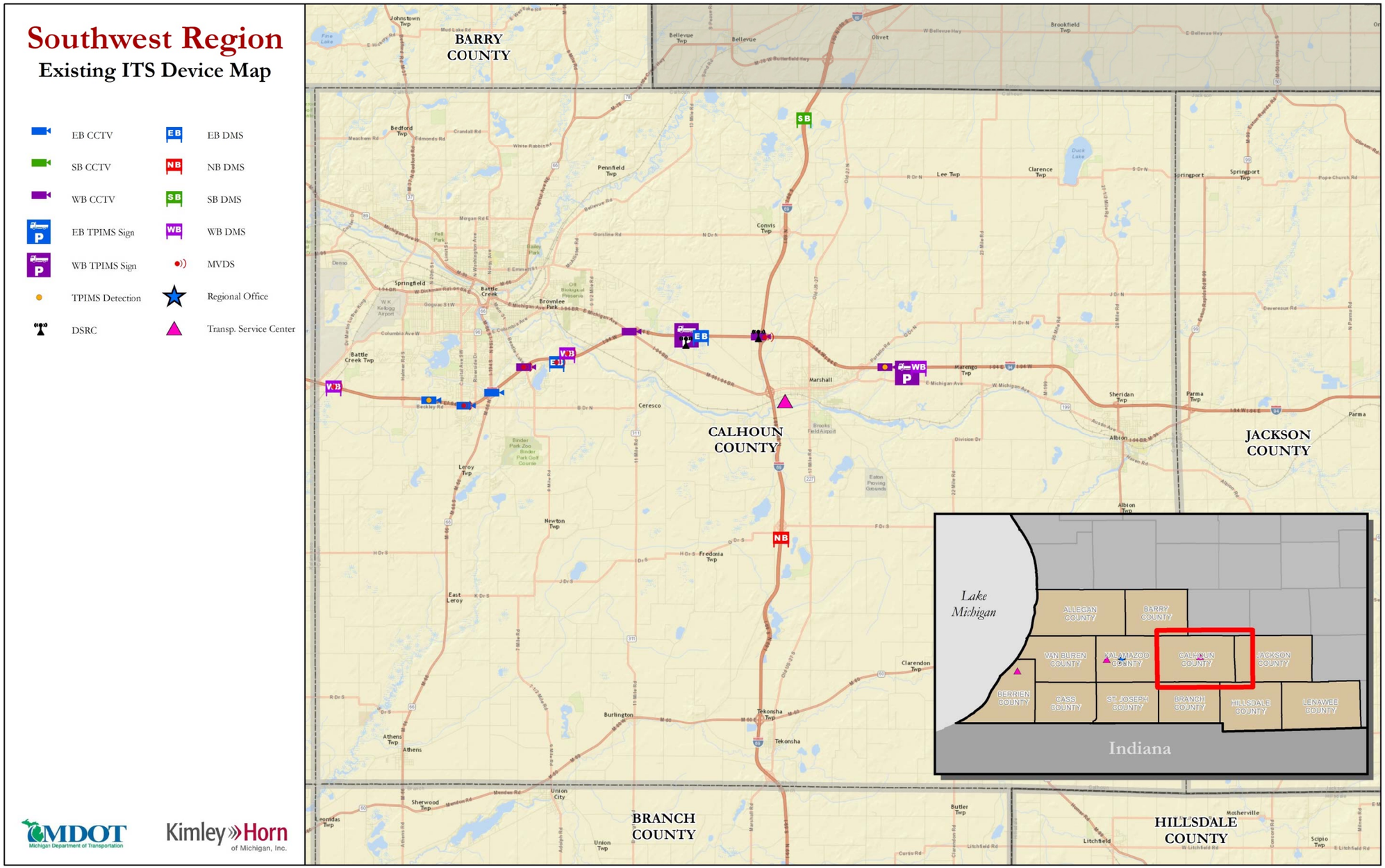

Figure 3. Existing Devices (Calhoun County)

Southwest Region

Existing ITS Device Map

EB CCTV
SB CCTV
WB CCTV
EB TPIMS Sign
WB TPIMS Sign
TPIMS Detection
DSRC
EB DMS
NB DMS
SB DMS
WB DMS
MVDS
Regional Office
Transp. Service Center

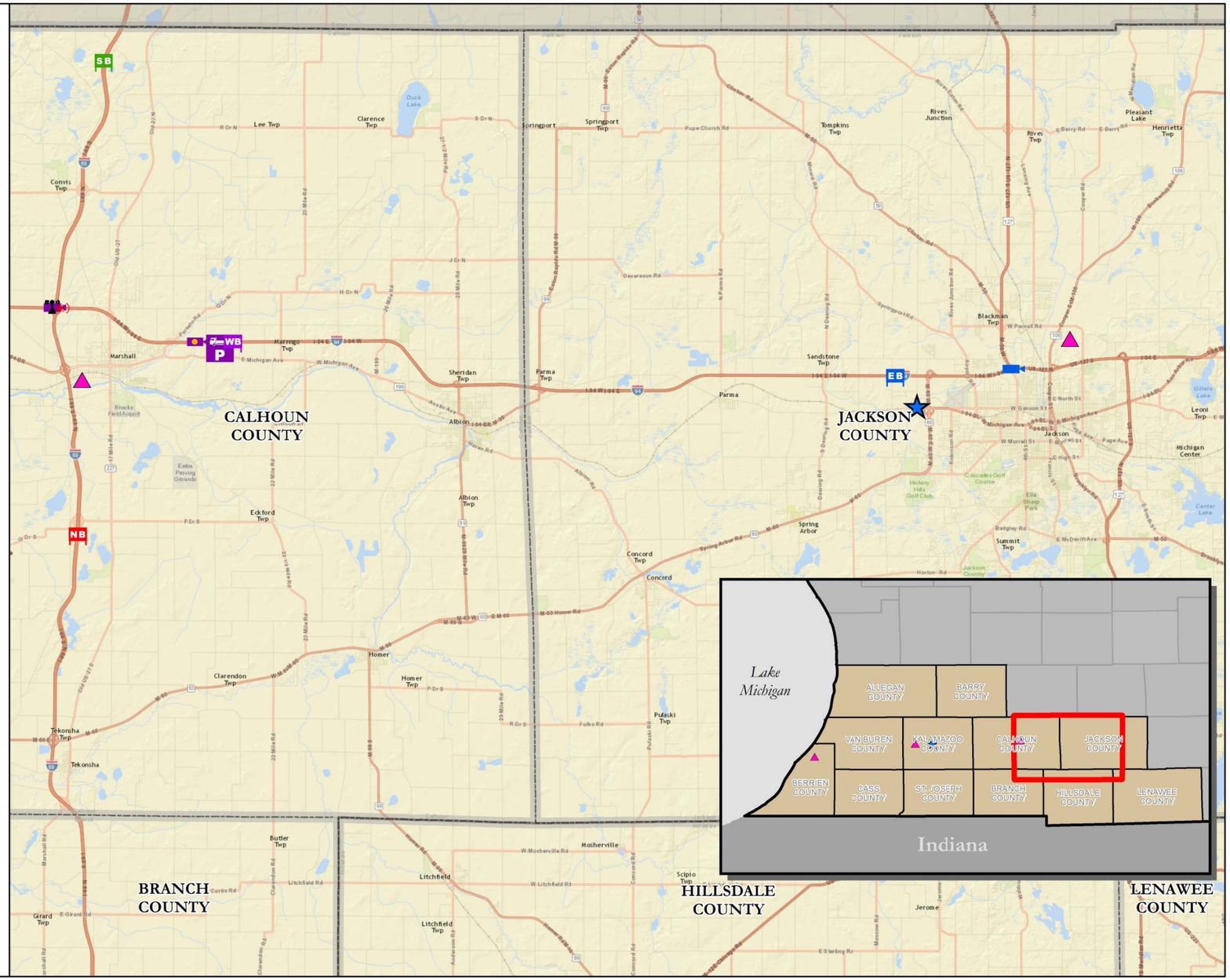

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Figure 4. Existing Devices (Calhoun and Jackson Counties)

The system is primarily monitored and controlled from the Statewide Traffic Operations Center (STOC) in Lansing, but video can be accessed via the statewide Advanced Transportation Management System (ATMS) software at the Southwest Region headquarters in Kalamazoo and the Transportation Service Centers (TSC) in Coloma (Berrien County), Marshall (Calhoun County), and Kalamazoo.

In addition to freeway management system deployments, MDOT has been expanding RWIS implementations primarily in the North and Superior Regions. Additional plans for other MDOT regions have been completed and are driving phased and prioritized implementations. Currently, Southwest Region road conditions are monitored from field forces while atmospheric data is available from several of the region's airport weather stations. It is envisioned that a regional RWIS implementation will supplement and enhance the data available for road weather management.

The Southwest Region is focusing on mobile sources of weather data with implementation of an Integrated Mobile Observation (IMO) deployment project in conjunction with the University of Michigan Transportation Research Institute (UMTRI). This project is outfitting 10 MDOT fleet trucks and 10 vehicles with surface patrol sensors to obtain road temperature and condition. In addition, 40 vehicles will be outfitted with on-board diagnostic units to obtain various characteristics such as Automated Braking System, traction control, and RPM data. In addition, 20 MDOT fleet trucks will be outfitted with Android phones to provide accelerometer data, GPS data, and imagery. (Source: *MDOT RWIS Existing System Evaluation*, prepared by Parsons Brinckerhoff and Iteris, August 2013)

MDOT currently is implementing a demonstration project to address issues related to truck parking. This project is focused on the I-94 corridor in the Southwest Region and involves several elements, including:

- Detectors installed at both public and private truck parking areas to monitor occupancy and calculate an estimate of remaining capacity
- A communications system that allows parking area availability to be updated in real-time
- A series of Dynamic Parking Signs along I-94 that provide information on available truck parking areas
- Dissemination of parking availability information directly to truck drivers through in-vehicle telematics systems

The ultimate status of the system, including any expansion, will await the completion of the demonstration period and an assessment of the benefits for both truck drivers and parking lot managers. It also should be noted that mitigation of unsafe truck parking, one of the key objectives of the project, also will have benefits for the general public.

MDOT also is remaining on the forefront of Connected Vehicle implementations by participating in multiple test bed and pilot projects. At this time, specific projects were not identified by the stakeholders participating in this effort. For future iterations, it will be important to revisit the topic to confirm potential implementations that should be integrated within the regional ITS plans.

2.2 Stakeholder Feedback

Stakeholder meetings were conducted as part of the regional ITS architecture project development. Two meetings were held in March 2014 to obtain input specific to this deployment plan. The University Region meeting was held in Jackson on March 18, 2014. The Southwest Region workshop was held in Kalamazoo on March 19, 2014. Each meeting gave stakeholders the opportunity to provide feedback specific to regional needs and project-related needs. A summary highlighting the feedback received is located in **Appendix A – Meeting Notes**.

2.3 Methodology

Projects were developed and derived from stakeholder needs and input, with consideration for traffic volumes in the region. A focus was placed on major investments for portions of the I-94 corridor that currently are not equipped with any ITS technologies. I-94 is a critical corridor for Michigan's economy with large volumes of commercial vehicles moving between Canada, Detroit, Chicago, and other major centers of the Midwest. Traveler information is critical, particularly during the winter months, when lake effect snow can cause major disruptions. This information is regularly part of the Lake Michigan Interstate Gateway Alliance (LMIGA) as well as the Great Lakes Regional Transportation Operations Coalition (GLRTOC). Stakeholders cited a need for full coverage of traveler information solutions to inform motorists about conditions on alternate north-south routes, including US-31, US-131, I-69, and US-127. Current deployments provide extensive coverage around the I-94/I-69 interchange, but other roads require additional coverage.

Stakeholders also noted a need for more localized information in the Kalamazoo and Battle Creek areas, particularly on the spur roads and business loops that intersect I-94. The Jackson area currently does not have ITS coverage on the region's limited access roads, I-94, US-127, and M-60. Projects identified for the region include additional DMS, CCTV cameras, detection, and signal upgrades for arterial corridors. Cost estimates included individual field equipment and communications infrastructure to support implementation. It is assumed that all of the freeway infrastructure would be operated from the STOC in Lansing, but some of the signal operations would be managed locally. Additionally, CCTV camera access would be available to regional TSCs and other partner agencies will gain access through MDOT's video sharing solution currently in development.

3 DEPLOYMENT PLAN RESULTS

Thirty-five projects were identified, as shown in **Table 4** and mapped in **Figure 5**. The 15 projects that include freeway management system deployments are presented in greater detail in **Table 5**. Precise locations for CCTV cameras are not defined for each project, but generally, rural deployments would have CCTV cameras installed at each interchange with additional equipment installed between interchanges where distances exceeded 5 miles; urban deployments of CCTV cameras would include installation density to provide full coverage of the freeway. DMS locations are based on the need to sign prior to the significant decision points of the network. MDOT currently is purchasing statewide probe data on all freeways to use for travel times, so detection installations were assumed at a density of between 5 to 10 miles, depending on the corridor, to obtain more granular count and classification data.

The benefits of these deployments were identified and estimated in the following four categories:

- **Traffic Incident Management** – The presence of CCTV cameras and detection promotes faster detection, verification, and response to incidents that occur on the roadways. TOC operators can use the CCTV cameras to verify unplanned events that impact the performance of the network. This information then is passed to incident responders, who can better determine the level and type of equipment and personnel required to respond. Faster response and incident clearance reduces the travel time delay of motorists approaching the incident and also reduces the potential of secondary crashes occurring in the queue.

- **En-Route Traveler Information** – Information on conditions ahead is provided primarily through DMS, but also is distributed through media outlets, Mi Drive, and smartphone apps. Interactive information sources, such as the latter two, only are desirable for vehicles with one or more passengers to reduce driver distraction. Increasingly, however, information can be provided through on-board navigation and, in the case of commercial vehicles, dispatching systems. DMS currently provide travel time information as default messages when other events are not taking priority. When major incidents occur, DMS messages enable motorists to select an alternate route, or in case of a lane blockage, prepare to move to an open lane. Both of these effects result in an overall travel time savings to the public.

- **Pre-Trip Traveler Information** – Similar information to the En-Route information can be provided to travelers through the Mi Drive website or numerous private sources. This information not only provides similar benefits to those of En-Route Traveler Information, but also enables the user to defer a trip departure time, or travel more based on current conditions.

- **Signal Coordination** – Several of the projects identified include improved coordination of signals with central control. This coordination can result in travel time savings and improved safety due to fewer stops. On projects 12 and 14, which include arterial improvements to I-94 relief routes in Battle Creek and Kalamazoo, CCTV cameras and DMS are proposed as well, to guide diverted motorists back to the freeway at the first viable interchange.

Since most of the projects listed below are only conceptual at this point, precise information was not available; general assumptions were made regarding the deployments. These include:

- **Freeway Management Systems** – Full CCTV coverage was assumed for urban segments with spacing of roughly one mile. In rural sections, CCTV was assumed at interchange locations.

Detectors were assumed to be in place between all interchanges in both urban and rural segments. Specific locations were selected for DMS.

- **Freeway Service Patrol** – Freeway Service Patrol operation was assumed on weekdays during peak periods.
- **Arterial Improvements** – Arterial improvements generally assumed a density of three signal improvements per mile in rural and outlying suburban areas, and six signals per mile in urban areas. Google Earth was used to estimate the proper density.

For some deployments, including Central Software and Emergency Management, benefits could not be estimated with any confidence; therefore, these alternatives were not included in the analysis.

Table 4. Project Descriptions

Project Number	Project Description	Agency
SWITS-1	This project covers 37 miles of I-94 between the Kalamazoo area and the limit of the current I-94 project just north of Benton Harbor. CCTV cameras are proposed at major interchanges with several between interchanges. Two DMS and four detector stations also are proposed. *This project is already programmed for implementation.*	MDOT
SWITS-2	This project covers 9 miles of I-94 in the western part of Jackson County. It is a rural deployment with five cameras and two detector stations proposed.	MDOT
SWITS-3	This project covers the urban section of I-94 running through the Jackson Metropolitan area. Due to higher volumes of traffic, eight CCTV cameras, roughly one per mile, are proposed along with DMS on either side of US-127 South and US-127 North.	MDOT
SWITS-4	This project covers I-94 east of Jackson and includes three CCTV cameras and one detector station.	MDOT
SWITS-5	This project covers I-94 in the eastern portion of Calhoun County, primarily east of I-69. Seven CCTV cameras are proposed in this rural section with one additional DMS.	MDOT
SWITS-6	This project includes 10 miles of primarily rural freeway on US-127 in Jackson County between I-94 and the Ingham County line. Four CCTV cameras, one DMS, and one detector station are proposed.	MDOT
SWITS-7	This project includes a largely urban section of US-127 in Jackson County from I-94 South to the interchange at Shaver Road. Six CCTV cameras, one DMS on the approach to I-94, and one detector station are proposed.	MDOT
SWITS-8	This project includes M-60, a short freeway section in Jackson County, between I-94 and Spring Arbor Road. Four CCTV cameras are proposed to monitor this section.	MDOT
SWITS-9	This project provides three CCTV cameras and one additional DMS on I-69 in Calhoun County between I-94 and the Eaton County line.	MDOT
SWITS-10	This project provides three CCTV cameras and one DMS along I-69 in Branch County near Coldwater. Future expansion of this system to the Indiana state line may be considered in the future.	MDOT
SWITS-11	This project covers the I-194 spur from I-94 into Battle Creek. Four CCTV cameras are proposed for this urban section along with 1 DMS and 1 detector station.	MDOT
SWITS-12	This project includes signal upgrades for eight intersections, including four CCTV cameras and two detector stations along 14 miles of arterial in the Battle Creek area. It should be noted that some of the CCTV cameras may already be in place. This deployment is designed to provide improved mobility in Battle Creek and an alternate route during times of major incidents on I-94.	Battle Creek

Project Number	Project Description	Agency
SWITS-13	This project covers 27 miles of US-131 north and south of I-94 in Kalamazoo County. A portion of this project is already programmed. A total of six CCTV cameras, two DMS, and two detector stations are proposed.	MDOT
SWITS-14	This project includes signal upgrades, four CCTV cameras, two DMS, and one detector station along 8.5 miles of arterial in Kalamazoo County. This will support mobility in the Kalamazoo region and support Business Route 94 as an alternate route for I-94 during major incidents.	Kalamazoo
SWITS-15	This project includes signal upgrades along M-66 in Sturgis, St. Joseph County.	St. Joseph County
SWITS-16	This project implements dynamic shoulder use on US-12 and possible M-50 before-and-after events at the Michigan International Speedway.	MDOT
SWITS-17	This project includes adding AVL units on all JATA fixed-route buses.	JATA
SWITS-18	This project includes installing CCTV security cameras on all JATA fixed-route buses.	JATA
SWITS-19	This project includes improving JATA's Traveler Information program for fixed-route buses.	JATA
SWITS-20	This project includes upgrading JATA's automatic passenger counters for fixed-route buses.	JATA
SWITS-21	This project includes upgrading the computerized dispatch system for JATA's demand response system.	JATA
SWITS-22	This project includes adding 800MHz radio communication to JATA's demand response system between JATA's buses and dispatch.	JATA
SWITS-23	This project includes adding mapping/navigation to JATA's demand response system.	JATA
SWITS-24	This project includes improving the MDOT Truck Parking Management System on I-94 by adding small dynamic signs and DMS at major truck stops to provide information on available spaces.	MDOT
SWITS-25	This project includes improving the MDOT Truck Parking Management System on I-94 by adding a system software that would communicate directly with truck fleets.	MDOT
SWITS-26	This project includes adding emergency signal preemption on Cooper Street to serve the hospital in the City of Jackson.	Jackson
SWITS-27	This project includes a phased deployment of Environmental Sensor Stations (ESS) in the University and Southwest Regions. The locations for ESS will be refined after the completion of Phase 1.	MDOT
SWITS-28	This project includes adding a common radio system between MDOT and local agencies to expedite communication on construction and maintenance projects.	MDOT
SWITS-29	This project includes providing MDOT with access to local agency CCTV cameras (Battle Creek, Portage, City of Kalamazoo, and Kalamazoo County).	MDOT
SWITS-30	This project for Kalamazoo Metro Transit System includes adding an AVL system.	KMTS

Project Number	Project Description	Agency
SWITS-31	This project for Kalamazoo Metro Transit System includes adding a bus stop-based traveler information system.	KMTS
SWITS-32	This project for Kalamazoo Metro Transit System includes development of a traveler information mobile app.	KMTS
SWITS-33	This project includes a parking management system that coordinates needs and parking availability between services from MDOT, Battle Creek, Kalamazoo, and Amtrak.	MDOT
SWITS-34	This project includes adding security cameras at MDOT maintenance facilities and rest areas.	MDOT
SWITS-35	This project includes a study for implementing variable speed limits along I-94.	MDOT
SWITS-36	FCP in Jackson County	MDOT
SWITS-37	FCP in Southwest Region	MDOT
SWITS-38	Expansion of Freeway Management System (CCTV cameras, DMS) on US 131 and I-196 in Allegan County	MDOT
SWITS-39	Expansion of Freeway Management System (DMS) on US 31 in Berrien County	MDOT

Table 5. Deployment Plan Projects - Freeway Management System

Project No	Project	From	To	County	CCTV	DMS	Detector	Signal Upgrades	Miles	AADT
SWITS-1	I-94	Exit 34	Exit 71	Berrien						
				Van Buren	12	2	4		37	36,400
				Kalamazoo						
SWITS-2	I-94	Exit 124	Exit 133	Jackson	5		2		9	29,500
SWITS-3	I-94	Exit 136	Exit 146	Jackson	8	4	2		9	58,400
SWITS-4	I-94	Exit 147	Exit 153	Jackson	3		1		6	43,000
SWITS-5	I-94	Exit 108	Exit 124	Calhoun	7	1	2		16	29,900
SWITS-6	US-127	I-94	Ingham Co.	Jackson	4	1	1		10	25,800
SWITS-7	US-127	I-94	Exit 34	Jackson	6	1	1		8	24,200
SWITS-8	M-60	I-94	Spring Arbor Rd.	Jackson	4				6	13,100
SWITS-9	I-69	I-94	Eaton Co.	Calhoun	3	1			10	24,000
SWITS-10	I-69	Exit 16	Exit 10	Branch	3	1			6	18,900
SWITS-11	I-194	I-94	Michigan Ave.	Calhoun	4	1	1		4	27,100
SWITS-12	BR-94	Exit 104	Exit 98	Calhoun	4	2		8	14	11,400
SWITS-13	US-131	Exit 55	Shaver Rd.	Kalamazoo	6	2	2		27	46,900
SWITS-14	BR-94	Exit 81 (I-94)	Exit 36 (US-131)	Kalamazoo	4	2		6	8.5	20,300
SWITS-15	M-66	M-149	M-139	St. Joseph				4		13,100

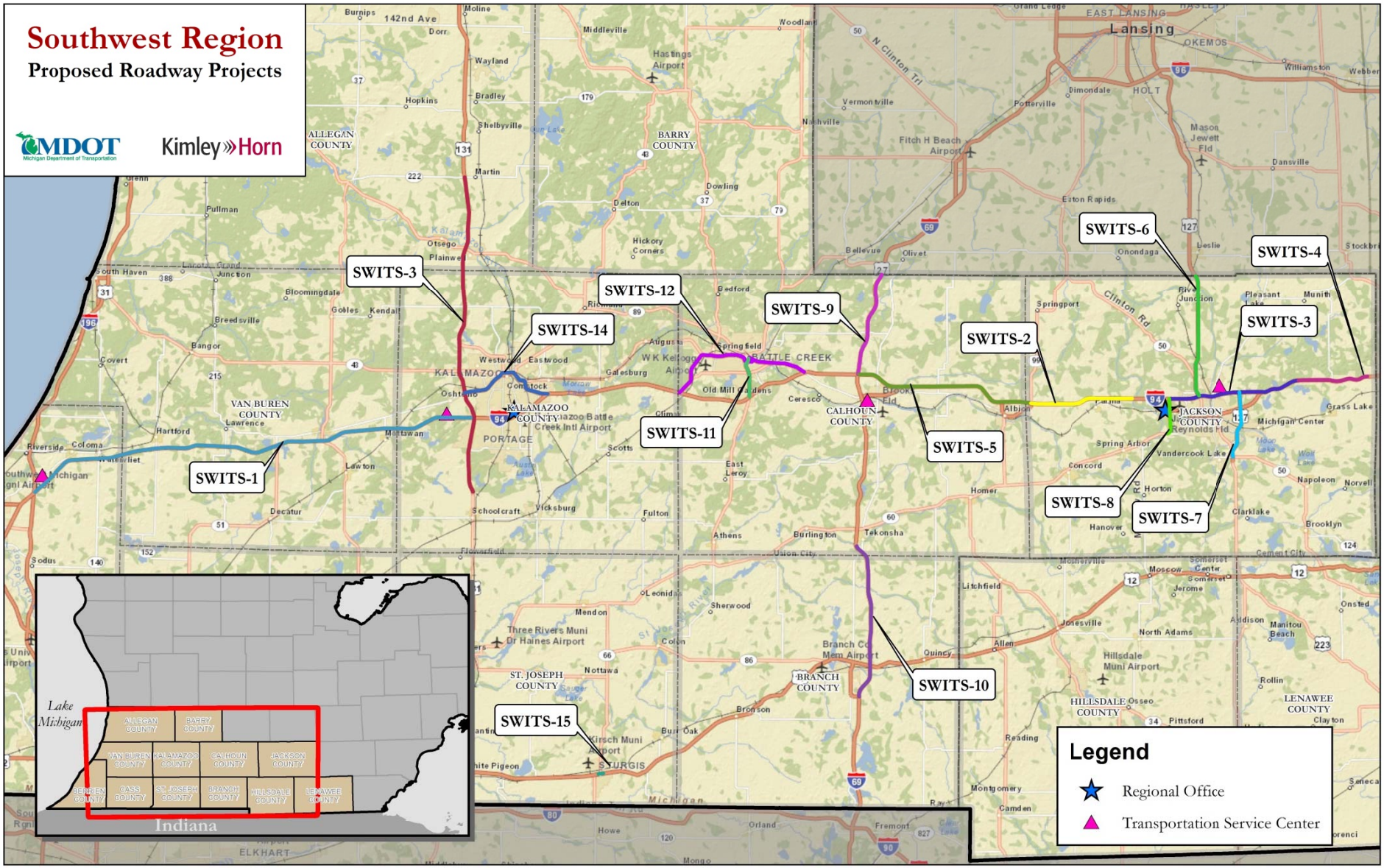

Figure 5. Proposed Freeway ITS Projects

The program used for the analysis is the Tool for Operations Benefit/Cost (TOPS-BC) developed by FHWA to provide benefit and cost estimates for a variety of ITS and operational alternatives. The program contains a range of default values for both benefits and costs and provides documentation of various studies used to derive those values. TOPS-BC is a spreadsheet-based tool that does not require a transportation network to operate. The analysis is based on roadway segments. Like similar benefit/cost tools, TOPS-BC annualizes capital costs based on assumed equipment life and adds this to operations and maintenance costs to obtain a total annualized cost. Benefits calculated include travel time savings, improved travel time reliability, crash reduction savings, and reduced fuel consumption. Each of these are assigned economic values, and in TOPS-BC, they are rolled together to provide a single dollar value of benefits. The benefit parameter assumptions used in this analysis are documented below in **Table 6,** the economic assumptions included in **Table 7,** and the cost assumptions included in **Table 8**. Both benefit parameters and economic assumptions are derived from TOPS-BC, but are similar to those used in previous deployment studies developed for MDOT that used the ITS Deployment Analysis System (IDAS) software. The cost assumptions were based on the 2010 deployment plan developed for the GVMC and TCRPC Regions.

Table 6. Key Benefit Parameter Assumptions

Deployment	Benefit Parameter	Assumption
Traffic Incident Management	Travel Time Savings	10% crash reduction
		40% reduction in crash duration
		1% improvement in speed
En-Route Travel Information (DMS)	Travel Time Savings	25% of time with actionable information
		10% of travelers act on information
		4 minutes average travel time savings
Pre-Trip Travel Information (Mi Drive, private sources)	Travel Time Savings	10% of users accessing information
		10% of users accessing information acting on information
		7 minutes average travel time savings
Signal Coordination	Travel Time Savings	12% corridor capacity increase
		2% crash reduction rate
		5% fuel consumption reduction

The KEY BENEFIT parameters were taken originally from IDAS software, which uses the FHWA benefit/cost database, and from survey data of drivers on how they respond to ITS-related information. For this project they were reviewed again based on TOPS-BC software which also uses FHWA benefit/cost database (http://ops.fhwa.dot.gov/publications/fhwahop12028/index.htm).

Also “actionable information” is understood when the DMS displays information on an incident or event that may cause some drivers to change their route or trip.

Table 7. Key Economic Assumptions

Benefit Parameter	Economic Value
Work-Related Travel	$28.00/hour
Other Travel	$14.00/hour
Commercial Truck Travel	$60.00/hour

Table 7. Key Economic Assumptions

Benefit Parameter	Economic Value
Property Damage Only Crash	$2,300
Injury Crash	$67,000
Fatality Crash	$6,500,000
Fuel Consumption	$3.67/gallon
"On the Clock" Travel Share	20%
Truck Percentage	10%/25% on I-94

Table 8. Cost Assumptions

Device	Deployment Density	Unit	Unit Cost	Lifespan (Years)	Annual O&M Costs
Urban Freeway					
Communication Fiber for Devices		$140,800	mile	30	$14,080
CCTV Cameras	1 per mile	$35,000	each	10	$3,500
DMS Units		$225,000	each	10	$22,500
Freeway Service Patrol*		$125,000	each	5	$72,500
DMS – Side Mount		$175,000	each	10	$17,500
ESS Station		$78,000	each	10	$9,200
Rural Freeway					
Wireless Infrastructure for Devices	1 per every 2 miles	$46,200	each	30	$4,620
CCTV Cameras	1 per every 2 miles	$35,000	each	10	$3,500
DMS Units		$225,000	each	10	$22,500
DMS – Side Mount		$175,000	each	10	$17,500
ESS Station		$78,000	each	10	$9,200
Arterial – Downtown/Heavy Commercial					
Communication Fiber for Devices		$140,800	mile	30	$14,080
Signal timing Improvements	3 per mile	$5,000	each	10	$500
CCTV Cameras	1 per mile	$35,000	each	10	$3,500
Arterial – Less Dense					
Communication Fiber for Devices		$140,800	mile	30	$14,080
Signal Timing Improvements	6 per mile	$5,000	each	10	$500
CCTV Cameras	1 per mile	$34,100	each	10	$3,410

**Annual O&M for FCP includes 1.5 FTE at $36K / year*

3.1 Evaluation of Alternatives

Results of the benefit/cost analysis are presented in **Table 9**. Based on the results of the analysis, the projects were assigned a deployment category, as noted in the last column. This category is intended to aid stakeholders in packaging and prioritizing the projects. "FUNDED" refers to projects that are early in their development, either design or construction. "SHORT" refers to projects with the highest B/C Ratio and are identified for implementation within the 0-to-3-year timeframe. "MEDIUM" designates the middle of the bell curve for the calculated B/C Ratio, and these projects are proposed for the 4-to-8-year timeframe for implementation. "LONG" represents those projects with the lowest B/C Ratio and that are expected to be considered more than 8 years in the future. Lastly, "NOT ASSESSED" is noted for projects, such as studies or regional deployments that cannot be evaluated using the TOPS-BC tools. They are still included in the summary so stakeholders can continue to consider these solutions in future conversations.

The projects are packaged, similar to the user services bundles from the National ITS Architecture, based on the type of deployment and technology identified. Freeway and arterial projects are easily evaluated as they are based on ADTs for the roadway segments connected to the geographic locations. Transit projects are connected to ridership data and also can be easily assessed. Other projects such as common radio systems, phase 2 of the regional ESS implementation, and studies needed to evaluate more specific impacts could not be easily evaluated as part of this effort, but are still listed in the table.

As noted above, projects were evaluated using TOPS-BC with primary criteria including:

- Travel Time Savings
- Improved Travel Time Reliability
- Crash Reduction
- Fuel Consumption Savings

Costs were estimated based on the information shown in **Table 8**. Capital costs are annualized based on the estimated life of the equipment. While some costs are provided for integration into existing software systems, it was assumed that all freeway management systems would be operated by the STOC in Lansing and that signal upgrades would be integrated into existing systems. As a result, no costs were included for entirely new software systems or operations facilities.

While air quality is another potential benefit of the proposed ITS systems, the TOPS-BC program currently does not have the capability of calculating that benefit. Previous evaluations of MDOT rural deployments did not indicate a large impact on air quality. Except in highly congested urban areas, the economic impact generally is very small, so this omission would not have a major impact on the analysis.

The lower benefit/cost ratios are a result of both lower volumes and a higher cost of providing communications in an urban setting. If communications infrastructure is available in these areas, the costs would be reduced and therefore increase the benefit/cost ratios for these deployments.

It is expected that stakeholders can reference this data during the development of regional and statewide planning efforts for future ITS implementations in the Southwest Region and related portions of the University Region. The B/C Ratio is one mechanism for evaluating the impact of projects and, within this context, provides MDOT stakeholders a consistent measure to compare projects across multiple regions.

Table 9. Summary of Project Benefit/Cost Analysis

Project Number	Project	From	To	County	Annual Benefit	Annual Cost	Annual Net Benefit	Total Capital Cost	Annual O&M	B/C Ratio	Deployment Status
SWITS-1	I-94	Exit 34	Exit 71	Berrien Van Buren Kalamazoo	$1,335,000	$195,000	$1,140,000	$2,000,000	$60,000	6.8	FUNDED (March 2015)
SWITS-2	I-94	Exit 124	Exit 133	Jackson	$352,000	$65,000	$287,000	$605,000	$25,000	5.4	**MEDIUM**
SWITS-3	I-94	Exit 136	Exit 145	Jackson	$1,590,000	$184,000	$1,406,000	$1,590,000	$42,000	8.6	**SHORT**
SWITS-4	I-94	Exit 147	Exit 153	Jackson	$460,000	$38,000	$422,000	$370,000	$16,000	12.1	**SHORT**
SWITS-5	I-94	Exit 108	Exit 124	Calhoun	$650,000	$85,000	$565,000	$1,040,000	$14,000	7.6	**MEDIUM**
SWITS-6	US-127	I-94	Ingham Co.	Jackson	$530,000	$60,000	$470,000	$704,000	$9,000	8.8	**SHORT**
SWITS-7	US-127	I-94	Exit 34	Jackson	$450,000	$72,000	$378,000	$792,000	$12,000	6.3	**MEDIUM**
SWITS-8	M-60	I-94	Spring Arbor Rd.	Jackson	$93,000	$32,000	$61,000	$349,000	$9,000	2.9	**LONG**
SWITS-9	I-69	I-94	Eaton Co.	Calhoun	$460,000	$50,000	$410,000	$610,000	$5,000	9.2	**SHORT**
SWITS-10	I-69	Exit 16	Exit 10	Branch	$270,000	$47,000	$223,000	$518,000	$10,000	5.7	**MEDIUM**
SWITS-11	I-194	I-94	Michigan Ave.	Calhoun	$335,000	$55,000	$280,000	$566,000	$9,000	6.1	**MEDIUM**
SWITS-12	BR-94	Exit 104	Exit 92	Calhoun	$210,000	$325,000	($115,000)	$1,020,000	$213,000	0.6	**LONG**
SWITS-13	US-131	Exit 55	Shaver Rd.	Kalamazoo Allegan	$800,000	$133,000	$667,000	$2,050,000	$15,000	6	FUNDED
SWITS-14	BR-94	Exit 81 (I-94)	Exit 36 (US-131)	Kalamazoo	$495,000	$285,000	$210,000	$950,000	$181,000	1.7	**LONG**
SWITS-15	M-66	M-149	M-139	St. Joseph	$90,000	$218,000	($128,000)	$585,000	$140,000	0.4	**LONG**
SWITS-16	Michigan International Speedway	US-12 and M-50		Brooklyn	-	-	-	-	-		*NOT ASSESSED*
SWITS-17	Jackson Area Transit Authority	AVL (Fixed-Route and Demand Response)		Jackson	$212,000	$57,000	-	-	-	3.7	**MEDIUM**
SWITS-18	Jackson Area Transit Authority	JATA's Fixed-Route Bus System		Jackson	-	-	-	-	-		*NOT ASSESSED*

Table 9. Summary of Project Benefit/Cost Analysis

Project Number	Project	From	To	County	Annual Benefit	Annual Cost	Annual Net Benefit	Total Capital Cost	Annual O&M	B/C Ratio	Deployment Status
SWITS-19	Jackson Area Transit Authority	JATA's Fixed-Route Bus System		Jackson	-	-	-	-	-		*NOT ASSESSED*
SWITS-20	Jackson Area Transit Authority	JATA's Fixed-Route Bus System		Jackson	-	-	-	-	-		*NOT ASSESSED*
SWITS-21	Jackson Area Transit Authority	JATA's Dynamic System (AVL)		Jackson	-	-	-	-	-		*NOT ASSESSED*
SWITS-22	Jackson Area Transit Authority	JATA's Dynamic System		Jackson	-	-	-	-	-		*NOT ASSESSED*
SWITS-23	Jackson Area Transit Authority	JATA's Dynamic System		Jackson	-	-	-	-	-		*NOT ASSESSED*
SWITS-24	I-94 Truck Parking	Detection and DMS		Regional	-	-	-	-	-		*NOT ASSESSED*
SWITS-25	I-94 Truck Parking	Communication System Software		Regional	-	-	-	-	-		*NOT ASSESSED*
SWITS-26	Jackson	Cooper Street Hospital Emergency Signal Preemption		Jackson	-	-	-	-	-		*NOT ASSESSED*
SWITS-27	RWIS	Phase 2		Regional	-	-	-	-	-		*NOT ASSESSED*
SWITS-28	Regional	Common Radios		Regional	-	-	-	-	-		*NOT ASSESSED*
SWITS-29	Regional	Local Agency CCTV Sharing		Regional	-	-	-	-	-		*NOT ASSESSED*
SWITS-30	KMTS	AVL		Kalamazoo	$1,260,000	$96,000	-	-	-	13	**SHORT**
SWITS-31	KMTS	Traveler Information		Kalamazoo	-	-	-	-	-		*NOT ASSESSED*
SWITS-32	KMTS	Mobile Application		Kalamazoo	-	-	-	-	-		*NOT ASSESSED*
SWITS-33	Regional	Parking Management		Regional	-	-	-	-	-		*NOT ASSESSED*

Table 9. Summary of Project Benefit/Cost Analysis

Project Number	Project	From	To	County	Annual Benefit	Annual Cost	Annual Net Benefit	Total Capital Cost	Annual O&M	B/C Ratio	Deployment Status
SWITS-34	Regional	Security CCTV		Regional	-	-	-	-	-		*NOT ASSESSED*
SWITS-35	I-94	Variable Speed Limit		Regional	-	-	-	-	-		*NOT ASSESSED*
SWITS-36	Regional	FCP		Jackson							*NOT ASSESSED*
SWITS-37	Regional	FCP		SW Regional							*NOT ASSESSED*
SWITS-38	US 131 / I-196	FMS (CCTV cameras, DMS)		Allegan							*NOT ASSESSED*
SWITS-39	US 31	FMS (DMS)		Berrien							*NOT ASSESSED*

Since most of these projects are still in the development stage, there is not enough information on specific locations or the type of equipment required. Benefit/cost was conducted for installation of AVL systems on the Jackson and Kalamazoo Transit systems. It was assumed that AVL would be installed on all fixed route and demand responsive buses on both systems, with supporting hardware and software at their respective dispatch centers. Assumptions are documented in the tables above. Thus both systems appear to be sound investments.

APPENDIX A – MEETING NOTES

Jackson – University Region (March 18)

Stakeholders in attendance at the workshop on March 18, 2014 provided feedback specific to regional needs and project-related needs. The following highlights a summary of stakeholder feedback that then was used to derive more specific projects for the University Region.

- An urban freeway management system is programmed for I-94 between US-127 North and US-127 South interchanges. DMS would be in both directions and full CCTV coverage would be provided. This deployment will be part of I-94 construction proposed for 2016-18.
- A less dense freeway management system is proposed for the rural sections of I-94 in Jackson County, with CCTV coverage at interchanges and DMS at strategic locations.
- A freeway management system on US-127 South was removed from the construction project, but should be considered as a potential future project.
- Freeway management technology should be considered for US-127 North. A rural deployment would focus on implementation of cameras at key interchanges.
- Needs regarding traffic management at Michigan International Speedway were discussed. In general, current traffic management works well, but dynamic shoulder use could be considered in the future to help expedite traffic movement.
- The Jackson Area Transportation Authority (JATA) is considering a number of technology improvements. For the fixed-route system, potential projects include GPS technology on buses, a public map, CCTV cameras for security on buses, and automated passenger counting. Demand responsive system projects include computerized dispatch, 800 MHz radio communication, and mapping/navigation systems in vehicles.
- The truck parking management system being implemented along I-94 will help with truck parking issues in the region. Expansion of the system should be considered as appropriate.
- There is a park-and-ride lot in the Jackson area that primarily serves traffic to the Ann Arbor area. There is limited traffic between the lot and downtown Jackson.
- All field equipment will be operated from the STOC. Stakeholders would like video sharing at the TSC and other local agency facilities. MDOT currently is developing needed policies for sharing of live camera streams.
- Emergency preemption is needed on Cooper Street, which serves as the main route between I-94 and the hospital. Other locations include Elm Street and the Washington/Glick two-way pair.
- Freeway Courtesy Patrols (FCP) are a priority for Jackson County at this time. After the freeway management system is installed, FCP may be considered in the future.
- An RWIS concept of operations is being scoped that will identify sites in the University Region. It is anticipated that up to 10 ESS will be deployed in a first phase.
- A common radio system that will allow direct communication between MDOT and local agencies would be helpful for maintenance and construction activity.
- There is a weigh-in-motion station on US-127 South at McDevitt.

Kalamazoo – Southwest Region (March 19)

Stakeholders in attendance at the workshop on March 19, 2014 provided feedback specific to regional needs and project-related needs. The following highlights a summary of stakeholder feedback that then was used to derive more specific projects for the Southwest Region.

- Eighteen new cameras are being installed on I-94 west of US-131. Some had to be cut from the 5-year program. There are 10 CCTV on I-94 between US-131 and I-69. Five are being added at rest areas in the corridor for truck parking.
- There currently is an issue with consistency of CCTV sharing at TSC facilities. Local agencies, including Emergency Response and transportation agencies, also would like access to the camera streams. In addition to improving response and coordination, a video sharing solution can help to reduce duplicate investments in infrastructure.
- Battle Creek has some CCTV installations on its signals. MDOT wants access to those. Other potential CCTV installations in the region include the City of Portage, the City of Kalamazoo, and Kalamazoo County.
- Kalamazoo County is installing GPS/AVL on all plow trucks.
- New CCTV cameras are proposed along US-131 north of I-94 at key interchanges. Other potential locations for CCTV camera installations include I-69 in the Coldwater area, I-69 north of I-94 to the Eaton County line, and I-194 in Calhoun County. Some arterial DMS and CCTV would be helpful along Business Route 94 in Battle Creek. Parking management is a potential application in Battle Creek and around Western Michigan University in Kalamazoo.
- Battle Creek is considering implementation of emergency signal preemption and is exploring trailblazer signs for detour routes using I-194 and other major arterials.
- The Kalamazoo Metro Transit System has implemented fare payment cards and CCTV on most buses. They are pursuing automatic vehicle location (AVL), bus stop-based traveler information, and mobile applications. They looked at the feasibility of implementing transit priority along some routes but chose not to implement.
- Battle Creek Transit is pursuing AVL implementation and CCTV on buses.
- Coordination of transit services in Battle Creek and Kalamazoo with Amtrak service should be considered to relieve parking shortages.
- MDOT direct forces winter maintenance trucks, as well those of the Calhoun and Kalamazoo County Road Commissions, are being outfitted with AVL. Calhoun County is implementing consolidated dispatch; both County maintenance and law enforcement will have AVL.
- Phase 1 ESS deployment in the Southwest Region will include 10 stations.
- CCTV for security at MDOT maintenance facilities should be considered. Some members of the public have requested security cameras at rest areas. The MDOT Rest Area Group is considering installation of a rest area emergency kiosk as a demonstration project.
- There was discussion of implementing variable speed limits on I-94 west of US-131 to lower speeds during incidents or poor weather conditions.
- A road closure system is currently being scoped for US-31 in the Holland area to address flooding situations. Traffic would be re-routed at key decision points, and detection and surveillance would be installed on alternate routes.