Dayton/Springfield Freeway Management System

ITS Architecture, Strategic Plan and Integration Strategy
Final Report - Draft

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Prepared For:
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# TABLE OF CONTENTS

1.0 **INTRODUCTION** .................................................................................................................. 1

2.0 **BACKGROUND** ................................................................................................................... 2

3.0 **APPROACH** .......................................................................................................................... 5  
   3.1 Project Architecture ............................................................................................................. 5  
   3.2 Data Collection ....................................................................................................................... 5  
   3.3 Concept of Operations ............................................................................................................. 6  
   3.4 Conceptual Layout ................................................................................................................... 6  
   3.5 Transportation Operations Center ............................................................................................ 6  
   3.6 Implementation Plan .............................................................................................................. 6  

4.0 **DATA COLLECTION** .............................................................................................................. 8  
   4.1 Traffic Data ............................................................................................................................. 8  
   4.2 Diversionary Routes ................................................................................................................. 11  
   4.3 Public Service Answering Points ............................................................................................ 14  
      4.3.1 Ohio State Highway Patrol ............................................................................................ 14  
      4.3.2 Multi Agency Radio Communications System ............................................................... 15  
      4.3.3 Montgomery County ....................................................................................................... 15  
      4.3.4 Other PSAPs within Montgomery County ...................................................................... 16  
      4.3.5 Clark County ................................................................................................................... 17  
      4.3.6 Miami County .................................................................................................................. 17  
      4.3.7 Greene County ................................................................................................................ 17  

5.0 **CONCEPT OF OPERATIONS** ............................................................................................. 20  
   5.1 Freeway Operations Management ......................................................................................... 20  
   5.2 Emergency Management ....................................................................................................... 21  
   5.3 Maintenance and Construction Management ......................................................................... 21  
   5.4 Traveler Information .............................................................................................................. 21  
   5.5 Operating Scenario ................................................................................................................. 22  

6.0 **CONCEPTUAL DESIGN** ....................................................................................................... 24  
   6.1 Design Criteria ....................................................................................................................... 24  
   6.2 Detectors ............................................................................................................................... 24  
   6.3 Dynamic Message Signs ......................................................................................................... 24  
   6.4 Closed-Circuit Television ...................................................................................................... 25  
   6.5 Highway Advisory Radio ....................................................................................................... 28  
   6.6 Communications .................................................................................................................... 29  
   6.8 Traffic Operations Center ....................................................................................................... 30  
   6.9 Cost Estimates ....................................................................................................................... 33  

7.0 **RECOMMENDATIONS AND NEXT STEP** .......................................................................... 35  

**APPENDICES**  
**APPENDIX A** DRAFT PROJECT ITS ARCHITECTURE  
**APPENDIX B** IMPLEMENTATION PLAN  
**APPENDIX C** TRAFFIC OPERATIONS CENTER LOCATION ANALYSIS
FIGURES

Figure 1.1  Dayton/Springfield FMS Regional Study Area ..................................... 1
Figure 2.1  ODOT ITS Deployments Around the State........................................... 3
TABLES

Table 6.1  Cost Estimates ..................................................................................... 34
1.0 INTRODUCTION

The Miami Valley Regional Planning Commission (MVRPC), in conjunction with the Clark County Springfield Transportation Coordinating Committee (CCSTCC), the City of Dayton and the Ohio Department of Transportation (ODOT), initiated the Dayton/Springfield Freeway Management System, Intelligent Transportation System (ITS) Architecture, Strategic Plan and Integration Strategy in September 2002. The study’s goals has been to develop a plan for implementing a Freeway Management System (FMS) in the Miami Valley area that would appropriately meet the needs of the region and is in harmony with ODOT’s ITS vision throughout the state.

The study developed a framework for planning a Dayton/Springfield Freeway Management System (D/SFMS) that would combine technological and operational solutions to address the incident and traffic management issues on freeways and provide timely and accurate traveler information to the motorists. The key to developing any successful FMS is identifying the unique requirements of a region and then applying the appropriate technology and operations to meet that region’s needs. The study area used in this effort is illustrated below.

This report documents the D/SFMS planning efforts and provides a conceptual design for the system along with the estimated costs.
2.0 BACKGROUND

This project began with an already rich history of other ITS projects having been completed throughout the region and the state. The D/SFMS effort brings the Miami Valley region closer to the envisioned transportation system outlined in some of these previous ITS studies. The Miami Valley Early Deployment Plan (EDP) completed in 1997 established a prioritized list of ITS goals for the Miami Valley region. In addition, the EDP effort provided the opportunity to build awareness of the benefits that ITS projects could bring to the region. The EDP was also the first major effort the Miami Valley region made towards developing a regional ITS program system. The EDP documents several regional goals for improving the efficiency of the Miami Valley transportation system. The D/SFMS ranked as a regional priority. This current study provides the initial step towards implementing ITS strategies along the region's freeways while meeting the regional transportation system improvement goals.

Since the completion of the EDP in 1997, regional ITS accomplishments include the implementation of advanced traffic signal controllers by various municipalities throughout the region and the deployment of an Automated Vehicle Location (AVL) system on the Greater Dayton Regional Transit Authority’s fixed bus fleet. Also, as part of the I-70/I-75 interchange reconstruction project, ODOT plans to install CCTVs to aid in traveler information and traffic monitoring in the area. Conduit and pullbox installation for future communications networks have also been discussed as being included as part of any future freeway reconstruction project in ODOT Districts 7 and 8.

The EDP effort began with MVRPC and CCSTCC forming an ITS Management Committee. The membership of this group included a wide range of transportation stakeholders, including members from the traffic, transit, and emergency service communities, in hopes of hearing as many viewpoints as possible. The group assisted with the inventory of current conditions and identification of deficiencies with the Miami Valley transportation system. This input led to the development of a prioritized list of transportation system improvements for the Miami Valley. Congestion of the region’s freeways was a top priority.

The ITS Management Committee was reconvened for the D/SFMS study. As mentioned earlier, this current study is the first regional ITS effort undertaken as a result of the EDP. The support and contribution of the Committee members on the D/SFMS provides continuity to the previous ITS planning efforts and reenergizes the ITS program in the region. Committee members
provided feedback throughout the development of the D/SFMS. The information gathered provided the foundation for the ITS user services and recommendations presented in this report.

Two workshops have also recently been conducted for the D/SFMS stakeholders in conjunction with this effort. These workshops were sponsored by the FHWA to assist the region in developing a regional ITS architecture, which is required in order to receive federal funding for the construction of ITS projects. Local FHWA staff led a workshop held on October 30, 2002 and the National Architecture Team staff led a second held on November 13-14, 2002. Both of these workshops have enhanced the D/SFMS development as well as ITS project implementation planning for the region.

No regional FMS plan can be developed in Ohio without building on ODOT’s previous ITS experience in the state (ARTIMIS in Cincinnati and the Columbus Metropolitan Freeway Management System) and adhering to the guidelines of ODOT’s ITS Program Office. It is important to note that in addition to the Miami Valley effort, other regions around the state are planning ITS deployments. The established and emerging ODOT ITS programs in the state are presented in Figure 2.1.

![Figure 2.1 ODOT ITS Deployments Around the State](image)

In 2000, with ODOT’s focus moving toward improving incident management and congestion mitigation, ITS strategies became an option toward achieving the Department’s goals. As a result, the ITS Program Office was created, which in turn prepared a Best
ITS Management Best Practices and Technologies Report completed in July 2001. It is important for the D/SFMS to be consistent with ODOT’s goals so that regional goals align with statewide and other regional efforts. The focus of the Best Practices study was to address the following points:

- Incident Management;
- Multi-agency Coordination;
- Traffic Monitoring and Surveillance;
- Traffic Control and Traveler Information;
- Low cost/operationally effective;
- Operations based;
- Hybrid approach to communications;
- Minimize detection by the roadside and leverage PSAP call centers.

Both the Columbus and Cincinnati systems adhere to the above statewide goals. Regional integration and cooperation will facilitate the development of the D/SFMS effort and enhance opportunities to integrate with surrounding regions to one day establish a seamless statewide FMS.

Based on this strong foundation, the Miami Valley region is moving forward toward developing a regional FMS that will improve incident and traffic management on freeways and provide timely and accurate traveler information to the motorists in the region.
3.0  APPROACH

This study utilized a requirements based systems approach in developing this plan. The involvement of the ITS Management Committee provided the local knowledge necessary to develop a comprehensive FMS for the region. A series of stakeholder workshops, conducted as part of this study, provided the forum for generating and quickly assessing a wide range of candidate ITS strategies. This allowed for accomplishing the project goals within the allotted timeframe.

3.1  PROJECT ARCHITECTURE

To ensure that this project conforms to the National ITS Architecture, one of the first steps in this study was the development of a project ITS architecture. The project ITS architecture development began with the study’s first workshop and explored all the potential integration and data sharing opportunities for the FMS. The D/SFMS’ draft project ITS architecture is presented in Appendix A. The project ITS architecture has been reviewed and modified by the ITS Management Committee during a series of two meetings. The architecture remains draft at this stage simply because as the D/SFMS project moves into preliminary design, it must be updated to ensure it accurately captures the entire capability of the system.

As the D/SFMS is the initial major freeway ITS effort for the region, it serves as the foundation for the project regional ITS architecture MVRPC and CCSTCC will be developing as a subsequent ITS effort. By developing a well thought out D/SFMS architecture, the region will be closer to achieving conformity with the National ITS Architecture. Thus, the region will be able to meet the goals outlined in FHWA’s ITS Architecture and Standards Final Ruling and promote ITS strategies to enhance the ITS goals as set forth in the EDP.

3.2  DATA COLLECTION

Several factors were taken into consideration in the data collection for developing the recommendations and conceptual design of the D/SFMS. First, a look at the previous studies and workshops, mentioned previously, provided the direction and motivation for the development of the D/SFMS. Second data collected for this effort included current and future traffic volumes, congestion, and high crash rates along the regional freeways. In addition, diversion routes were developed to assist in planning the system. Finally, public service answering points (PSAP) were inventoried across the region. These locations are the central point for emergency
calls and dispatching for emergency services to incidents on the region’s freeways. The results of the data collection effort are included in Section 4.

3.3 CONCEPT OF OPERATIONS

Based on the data collected effort, recommendations on the structure and operations of the D/SFMS were devised. Functional requirements are the goals and objectives of the D/SFMS and establish a framework for operations. The functional requirements are then explained in a concept of operations for the D/SFMS. The concept of operations provides, in a narrative format, how the system will function with respect to data collection, processing and delivery and is detailed in Section 5 of this report.

3.4 CONCEPTUAL LAYOUT

Based on the project ITS architecture and the concept of operations, a conceptual layout of a full-build scenario for the D/SFMS was developed. It provides an overview of the design criteria used in developing the recommended field components, their approximate locations, and the communications for the D/SFMS. In addition, this section provides an overview of the field components, communications and Transportation Operations Center (TOC) components as well as associated costs for the system. The conceptual design is detailed in Section 6 of this report.

3.4 TRANSPORTATION OPERATIONS CENTERS

Site selection for a TOC can be challenging; issues such as proximity to the freeways and available property play an important role. To assist MVRPC and CCSTSS in finalizing a location for a TOC, a site-selection trade-off methodology was developed. The premise of the methodology is to provide discriminating criteria to be applied to each potential site. Ultimately, the highest scoring site is the most conducive location to operate the D/SFMS. The site selection methodology is described in Appendix C.

3.6 IMPLEMENTATION PLAN

The final step in this study’s approach was the development of an implementation plan. The implementation plan is a federal requirement which documents how the system was planned, developed, procured, how it will be operated and maintained and how it will be funded. The draft D/SFMS implementation plan, which will also need to be expanded and refined as the project matures, is presented in Appendix B.
4.0 Data Collection Results

The first step in developing a conceptual layout for the D/SFMS is collecting relevant data to ensure the FMS will appropriately address high priority issues. Collecting pertinent data allowed the Study Team to draw conclusions as to which ITS applications best meet the Miami Valley region’s needs. Prior to collecting data, information on the issues and concerns of the ITS Management Committee was collected at the workshop held on September 27, 2002. Numerous issues and ideas on the various ITS elements were discussed. Input received from the ITS Management Committee was integrated into the data collection process. Key data collection items suggested for developing the conceptual design and diversionary routes were the following.

- Determine recurring congestion areas
- Determine congestion/incident hot spots
- Use recent data
- Suggest secondary diversionary routes

4.1 TRAFFIC DATA

Traffic volumes were not field collected as part of this study, but determined from data available in previous studies and/or collected by local agencies. Sources contacted and literature reviewed for information on traffic volumes, congestion, planned roadway improvements, deficient shoulder widths, and crash information included the following:

- Miami Valley ITS Early Deployment Plan – Strategic Deployment Plan; September/1997;
- Miami Valley ITS Early Deployment Plan – User Service Plan; July/1997;
- MVRPC Long Range Plan (Miami, Montgomery and Greene Counties);
- Clark County Transportation Plan (2025); January 1999;
- Clark County Interstate 70 Corridor Study; March 2002;
- ODOT – Offices of Tech Services and Traffic Engineering.

Once the data was collected maps were developed showing:

- Congestion (LOS ‘D, E & F’) for existing and 2025 conditions versus Crash Rates (per Million Vehicle Miles Traveled) by two-mile segments for years 1999-2000; data displayed also included total crashes, ADT, and number of lanes;
- Deficient Shoulder Widths versus Crash Rates.

These maps are presented figures included in the folders at the end of this report.
4.2 Diversionary Routes

Diversionary route schemes, a necessary element in a FMS, are also needed to assist in the determination of field device locations. Diversionary routes must be realistic to the user and should utilize major highways/roadways (state routes, US routes and major/minor arterials) as much as possible. Diversionary route suitability criteria were developed. In accordance with ODOT guidelines, the primary diversionary routes should be freeway to freeway. Secondary routes would be utilized in situations where freeway to freeway routing is not available. The secondary routes indicated at this stage were based primarily on the recommendations of the stakeholders, suitability criteria and field review. However, secondary routes should not be used until the various agencies meet, review the criteria, concur on the use of the route under what conditions and enter into agreement.

This information was presented to the stakeholders at the second workshop on December 4, 2002 using color maps and a power point presentation. Comments/suggestions from those present were incorporated into the final maps, criteria and conclusions.

Development of the diversionary routes followed the suitability criteria (in no order of priority) presented below.

- Road Congestion, Level of Service (LOS)
- Travel Time on Diversionary Route
- Construction Activities
- Crash Rates
- Pavement Condition
- Multiple Jurisdictions (Communications-Coordination)
- Traffic Monitoring on Alternate Routes
- Truck Restrictions
- Bridge Vertical Clearance
- Turning Radii Restrictions
- Community Issues -Presence of Schools, Hospitals, Nursing Homes, Residential
- Ease of Access to and from Freeway
- Signal Coordination
- Safety of Motorists on Diversionary Routes

General conclusions from the data and mapping:

- Statewide crash rate average is 0.88 crashes per million vehicle miles traveled
- Sections of freeway with daily congestion are scattered, but occur mostly in Montgomery County
• Numerous sections of freeway have future daily congestion projected, with 24 of these sections showing existing crash rates more than 1.0, but the higher crash rates are not always where congestion occurs (no direct correlation indicated)
• The highest crash rates are on the rural highways
• Many sections of Major Roadways (non-freeway) available for possible secondary diversionary routes have future daily congestion projected
• A considerable amount of freeway miles in this area have deficient shoulder widths, but the crash rates in these locations vary from some of the lowest rates to some of the highest rates in the study area (no direct correlation indicated)
• Major Congestion Locations (Existing)
  o I-75, south of I-70
  o I-75 AT US-35
  o I-75 AT SR-725
  o Stanley Avenue, north of SR-4
  o I-70 AT SR-4
  o I-70 AT I-675
  o I-70 AT SR-202
• Major Congestion Locations (Future)
  o I-75, Dixie Highway to north of the CBD
  o I-75, south of I-675
  o US-35, east of I-75
  o I-70, SR-4 east to Madison County Line

Recommended primary (freeway to freeway) and secondary routes are illustrated in the following figure.
Map for Routes here
4.3 **Public Service Answering Points**

The proliferation of cell phones have revolutionized the method in which incidents on freeways are detected. The 9-1-1 PSAPs, who receive and dispatch emergency response personnel, now have nearly real-time notification of incidents. However, verifying the severity and type of the incident being reported by citizens calling into the PSAP is difficult. Many times people reporting an incident cannot accurately assess the situation and many times are confused as to even the location of the incident. Therefore, visual verification by emergency personnel is important. Partnering and sharing incident data will provide the public with a transportation system that is operating more safely and efficiently without relinquishing any jurisdictional control or authority. This approach is currently being developed for the Columbus FMS. The goal of this task was to identify the PSAPs in the region that receive cell phone 911 calls and could assist the D/SFMS in identifying and verifying incidents.

The D/SFMS study area includes several PSAPs throughout the four county region. The Study Team contacted PSAPs within the region, to determine whether their jurisdiction included parts of the freeway system and other relevant information such as Computer Aided Dispatch (CAD) software and communication infrastructure. The next step is to explore the potential for the regional CAD systems to accept information from an ODOT ITS deployment such as video and share incident information (that has been sanitized of any personal information). Many times this interface will simply require an additional software module to be written. Both technical and operational issues surrounding the interface will be considered as the project moves forward.

The following discussion lays the groundwork for deploying a key element of the emergency operations component for the D/SFMS. The PSAPs and safety organizations that are involved with response to incidents on the Miami Valley freeway system are discussed.

### 4.3.1 Ohio State Highway Patrol

In Ohio, the Ohio State Highway Patrol (OSHP) generally enforces law and investigates accidents on interstate highways, outside of municipal corporations. The posts for each of the four counties in the study area are:

- Montgomery County – Dayton
- Miami County – Piqua
- Clark County – Springfield
- Greene County – Xenia
The patrolmen from these posts are dispatched via radio. The OSHP does not operate a PSAP in the region at this time. Therefore, cell phone calls reporting freeway incidents are initially directed to a county sheriff or city PSAP and then re-directed to the appropriate patrol post for OSHP dispatch. The OSHP is in the process of upgrading their communications system, which is discussed in the following section.

4.3.2 MULTI AGENCY RADIO COMMUNICATIONS SYSTEM

The Multi Agency Radio Communications System (MARCS) is a project coordinated by the Ohio Department of Administrative Services and includes the Highway Patrol as a major user of the planned system. The new system will include an upgraded 800 MHz trunked radio system, a Computer Aided Dispatch (CAD) system, installation of Mobile Computer Terminals (MCT’s) in patrol vehicles, and an AVL system.

Not only will the new system allow for an upgrade to the existing system, it will also establish a communications link between the Highway Patrol and other agencies such as the State and County Emergency Management Agencies, the Ohio Department of Natural Resources, and County Sheriff’s departments. The OSHP districts in the study area are likely to have the system by 2004 or 2005. The OSHP districts that serve the D/SFMS study are the following:

- Piqua District - Miami, Montgomery and Clark Counties
- Wilmington District - Greene County

4.3.3 MONTGOMERY COUNTY

Several PSAPs within Montgomery County receive cell phone calls for assistance with freeway incidents. However, either the Montgomery County Sheriff’s Office or the Dayton Police PSAPs receives the majority of calls concerning freeway incidents. In turn, the calls reporting freeway incidents outside the Dayton city limits are forwarded via telephone to the OSHP. Dayton Police dispatch personnel to incidents that occur on freeway sections within Dayton. However, it should be noted that the County Sheriff and Township police departments could also handle problems on the Interstate Highways in their jurisdictions if they so desire.

The Montgomery County Sheriff’s Office uses Tiburon CAD software and an 800 MHz radio system. The Dayton Police use a CAD system originally developed by NCR in the mid 1980s. This software has been modified and maintained by Dayton Police staff.
since that time. The Dayton Police have an 800 MHz radio system. The OSHP, as mentioned previously, does not at this time have CAD. All personnel are radio dispatched.

4.3.4 Other PSAPs within Montgomery County

Some Montgomery County PSAPs dispatch emergency personnel for only their jurisdiction, some for more than one. Some services are dispatched by different agencies, for example, the Montgomery County Sheriff's Office dispatch for Riverside Police, while Dayton dispatches for Riverside Fire. The following outline lists the PSAPs near each of the freeways within Montgomery County and the jurisdictions for which they dispatch. Again, it is the decision of each jurisdiction to respond to a freeway incident.

Interstate 70
- Brookville (Brookville Police & Fire and Phillipsburg Fire)
- Montgomery County Sheriff's Office (Sheriff's Office, Clay Township Police and Butler Township Police)
- Englewood (Englewood Police; Clayton Fire; Butler Township Fire)
- Vandalia (Vandalia Police and Fire)
- Huber Heights (Huber Heights Police and Fire)
- Ohio State Highway Patrol

Interstate 75
- Vandalia (Vandalia Police and Fire)
- Englewood (Butler and Harrison Township Fire Departments)
- Montgomery County Sheriff's Office (Sheriff's Deputies provide police protection for Harrison Township)
- Dayton (Dayton Police and Fire)
- Moraine (Moraine Police and Fire)
- West Carrollton (West Carrollton Police and Fire)
- Miamisburg (Miamisburg Police and Fire)
- Miami Township (Miami Township Police and Fire)
- Ohio State Highway Patrol

Interstate 675
- Miami Township (Miami Township Police and Fire)
- Montgomery County Sheriff's Office
- Washington Township Fire
- Centerville

US35
- Montgomery County Sheriff's Office (Riverside Police)
- Dayton (Dayton Police and Fire and Riverside Fire)

State Route 4
- Montgomery County Sheriff's Office (Riverside Police)
• Dayton (Dayton Police and Fire and Riverside Fire)
• Huber Heights

4.3.5 CLARK COUNTY

Clark County has two PSAPs; one is the Clark County Sheriff’s Office and the other is the Springfield Police. The Clark County Sheriff’s Office uses Emergitech software and a highband radio system. The Office is looking to upgrade both the software and radio system in the near future. Both the Clark County Sheriff’s Office or the Springfield Police could receive cell phone calls along I-70. These calls would be transferred to the OSHP personnel for dispatch and response.

4.3.6 MIAMI COUNTY

Miami County has one PSAP that coordinates response to freeway incidents. However, the OSHP responds to incidents along I-75. As the D/SFMS develops, the system would tie into the OSHP dispatching system.

4.3.7 GREENE COUNTY

Within Greene County, the portions of I-675 and US 35 are included as part of the D/SFMS. Cell phone calls received reporting an incident along these roadways may be directed to any of the following PSAPs depending upon the cell tower that receives the call.

• Greene County Sheriff
• Beaver creek Township Police
• Fairborn Police
• Sugarcreek Township Police
• Bellbrook Police

Response to incidents along these corridors would be conducted by the jurisdiction in which the incident occurred. However, the responding jurisdiction may call upon the OSHP or other County emergency response agencies to assist in the response. The Greene County Sheriff Office operates an 800 MHz trunked radio system and Geac CAD software.

Figure 4.4 illustrates the jurisdictional issues surrounding incident management on the freeways in the Miami Valley region. As one can see, being able to accurately locate incidents can save significant time in responding with the correct jurisdiction.
As the D/SFMS moves into final design, the technical aspects of integrating the PSAPs, which dispatch emergency services to incidents along the freeways, will be further researched. The ITS Management Committee recommended that all relevant PSAPs be included as the D/SFMS develops to ensure a regional scope. By connecting to the necessary PSAPs, the D/SFMS will be able to receive incident information that may affect traffic in the coverage area. The contact information for all of the PSAPs has been forwarded to MVRPC, CCSTCC and ODOT under separate cover so that further discussion can occur as the project moves forward.
5.0 CONCEPT OF OPERATIONS

Based on the data collected and input from the ITS Management Committee, a concept of operations was developed that would address the region’s requirements for a FMS.

The D/SFMS will operate during the peak rush hours and be served by an operations center for collecting, disseminating and coordinating transportation information among regional transportation and emergency agencies along the Miami Valley regional freeway system. The system will be owned, operated and maintained by ODOT. It is anticipated that they system could be operated with one operator. Key regional stakeholders, such as the City of Dayton, the City of Springfield and the GDRTA will share transportation information with the D/SFMS. This concept of operations is based on the Project ITS Architecture presented in Appendix A, and has been developed with the assistance of the ITS Management Committee. The D/SFMS will provide the following user services or functional capabilities:

- Traffic Management
- Maintenance of Traffic
- Incident Management
- Traveler Information
- Multimodal Integration

Operational elements anticipated to be key components of the D/SFMS include: Freeway Management, Emergency Management, Maintenance and Construction Management, Traveler Information Operations, and Regional Transportation Coordination Operations. These elements, as summarized below, define the concept of operations for the facility. These descriptions will be further refined during the D/SFMS design phase.

5.1 FREEWAY OPERATIONS MANAGEMENT

The D/SFMS system will enhance incident detection, traffic monitoring, maintenance of traffic and traffic information dissemination for the major freeways in the region including I-70, I-75, I-675 and SR-4. Traffic and incident information will be collected from CCTV and cell phone calls from the traveling public via PSAPs in the region. The D/SFMS will operate weekdays during the peak hours to monitor and detect traffic incidents along the freeways. During off-peak hours, the system will have the capability to be controlled by other ODOT facilities such as ARTIMIS or the Columbus FMS. Furthermore, the D/SFMS will dispatch and communicate with Freeway Service Patrols operated
by ODOT in the region. Dispatching responsibilities will be coordinated with the local district radio operations.

5.2 EMERGENCY MANAGEMENT

The D/SFMS will provide the Miami Valley emergency agencies with improved traffic and incident information. The D/SFMS will receive incident notification through a software connection with local PSAPs in the area. D/SFMS operators will be able to verify and validate the nature and severity of the incident and transmit traveler information alerts through DMS and HAR. Furthermore, video information will be shared with interested local emergency dispatching operators so they can utilize the CCTV images in dispatching the appropriate resources to the scene. The D/SFMS will also share video feed with the local county Emergency Management Agencies so they could utilize the surveillance capabilities during any large-scale incidents. Finally, video information shared with the media will be designed such that D/SFMS operators could blankout images that the media should not receive i.e. during a serious personal injury or fatality. These ITS applications will allow police and fire to respond more rapidly and motorists the opportunity to select diversionary routes to avoid the incident.

5.3 MAINTENANCE AND CONSTRUCTION MANAGEMENT

Maintenance and construction along freeways can be a major source of congestion for a region. The implementation of the D/SFMS will realize several benefits to the ODOT highway maintenance and construction crews as well as regional travelers. First, during weather emergencies, CCTV images in conjunction with ODOT’s freeway weather stations may assist in the distribution of service crews. Secondly, during reconstruction efforts, DMS and HAR if updated in a timely manner, can be utilized to inform travelers of the length and travel restrictions of the given project. In addition, with the traveler information devices in use, worker safety is improved. Lastly during an incident which might require removal of debris, the D/SFMS’ CCTV will be used to verify the location and type of debris thereby ensuring the proper maintenance assets are dispatched.

5.4 TRAVELER INFORMATION OPERATIONS

Information that is collected from the field devices will be directed to the D/SFMS control center where the data will be processed and packaged into traveler information. This information will be distributed to the motorists in their vehicles through DMS and HAR messages. Motorists will also be able to receive more accurate and timely traveler information from local radio stations that will be
developing their traffic reports based on information shared from the D/SFMS. The media will also share their traffic images with the D/SFMS. This link with the media is critical to the success of the system in providing useful traveler information.

The D/SFMS will have its own regionally based traveler information web site providing pre-trip traveler information. This webpage will be a critical component to Buckeye Traffic, ODOT’s new statewide traveler information webpage.

5.5 REGIONAL TRANSPORTATION COORDINATION OPERATIONS

An important aspect in developing a regional FMS is the opportunity to share traveler information with surrounding systems, in particular construction and incident information. A contiguous information stream, it will provide through travelers with seamless information. The D/SFMS will share incident information and video images with other regional and ODOT control centers.

5.6 OPERATING SCENARIO

This section concludes with a conceptual scenario designed to provide the reader with a glimpse of what could occur on a given day given the draft concept of operations for the D/SFMS presented above.

On Tuesday morning, during the A.M. rush hour, an accident occurs, blocking all lanes on I-75 southbound just south of the I-70/I-75 Interchange. The City of Dayton’s PSAP receives numerous cell phone calls reporting the incident; but the reports are conflicting as to the location and severity of the incident. Due to ODOT’s deployment of CCTV cameras in key corridors and interchanges, the PSAP supervisors utilize the video feed from the D/SFMS to verify the incident from their workstations. The D/SFMS operator receives notification of the incident via the PSAP’s incident alert feed and begins to monitor the incident via the CCTV monitors. The operator updates any appropriate DMSs that could allow travelers to divert, should they so choose, before entering the congestion. The operator also updates the D/SFMS HAR system and activates the beacons on the HAR signs to alert motorists of an incident. Soon, the operator monitors what has become a major backup on this vital freeway. I-70 ramps become congested as the traffic attempts to merge onto I-75. Additionally, the operator notifies GDRTA back at their control centers of the incident so they can implement decisions about buses, schedules, detours and passenger delays.
The D/SFMS webpage is also updated with information about the incident. The media, receiving updates from the D/SFMS also updates their system with the incident and they relay that information to their broadcasters and web pages. Additionally, the incident information is forwarded to Buckeye Traffic to post on their system.

The ODOT garage operators will be sent an alert and will dispatch the appropriate vehicles if debris needs to be removed. Once traffic returns to normal, the D/SFMS operator resets or clears the various traveler information devices and services, and notifies the GDRTA and others that the incident is over.

The D/SFMS provides an opportunity for the ITS Management Committee to explore other regional coordination efforts such as the coordination of signal systems across jurisdictional boundaries that will lead to more efficient major arterials for the region. Additionally, it can further strengthen the operational relationship with the state and county partners in the region.

This concept of operations is an evolving entity and is anticipated to continue to mature as the project moves into preliminary design.
6.0 **CONCEPTUAL DESIGN**

This section presents the conceptual layout of a full-build scenario for the D/SFMS. It provides an overview of the design criteria used in developing the recommended field components, their approximate locations, and the communications for the D/SFMS. In addition, this section provides an overview of the field components, communications and TOC components.

A preliminary cost estimate is provided based on the quantity and type of field devices, communication circuits, and TOC equipment.

6.1 **DESIGN CRITERIA**

The design criteria set forth was developed based on a needs assessment, field reviews, traffic count and pattern reviews, and partnering agency workshops. During this process, the ITS field device locations were also prioritized. This prioritization is illustrated on the map (Figure 6.1) with green being first priority and blue being second. The final budget for the ultimate build-out of the system will be the primary determinant for specifically how many of the field components are deployed. The following design criteria were utilized in locating field components.

6.2 **DETECTORS**

ODOT experiences in the operation and management of ITS systems in other parts of the state, coupled with views discussed during the partnering workshops, indicated that vehicle detectors were not required at this time.

6.3 **DYNAMIC MESSAGE SIGNS**

The primary function of the DMS is to inform motorists of approaching traffic conditions in time to alter their route resulting in the saving of time and money in a safe efficient manner. Therefore, location of the DMS must be in advance of viable alternate routes.

The recommended DMS locations are graphically depicted in the D/SFMS Conceptual Design presented in Figure 6.1. Again, as mentioned earlier, the green elements on the map were considered first priority and blue second priority.

There are a wide vary of DMS technologies related to message display or illumination. Some different DMS display technologies are:
- Light Emitting Diode (LED)
- Fiber Optic
- Flip Disk
- Hybrid Flip Disk (Fiber and LED)

ODOT has established a state standard for DMS display technology based on LED. The sign dimensions will provide for three lines of 12 characters per line, with a character height of 18”.

DMSs are generally installed on cantilever, sign bridge, or post type structures. The sign bridge DMS type structure that spans several lanes are the most expensive and the road side DMS post type structure is the least expensive. Generally, the DMS structure accounts for ½ to 2/3 of the “furnish and install” cost of the sign. The Study Team assumed a cantilever structure for project budgetary estimate purposes.

6.4 CLOSED-CIRCUIT TELEVISION

The primary function of the CCTV system is to monitor traffic conditions and verify incident reports. The CCTV camera spacing will provide adequate coverage of I-75 and SR35 roadways through the Dayton downtown area, such that operators can verify queue lengths / delays, determine the severity of the incident, develop traffic management strategies, and monitor the effectiveness of the strategies. The severity of the incident must be detectable to a level sufficient to deploy the necessary resources to quickly remove the incident.

For the remaining road network within the project limits, critical intersections were identified during the workshops for CCTV installation. All CCTV locations are graphically depicted in the D/SFMS Conceptual Design, Figure 6.1. Again, as mentioned earlier, the green elements on the map were considered first priority and blue second priority.

Generally, the design height of the CCTV units is driven by maintenance concerns. The higher the CCTV camera, the more difficult it can be to maintain. The designer or the engineer of the subsequent design should conduct a bucket truck review for each CCTV location. During this review, an engineer uses a video recorder to simulate the view that the CCTV camera will have once installed. This review will also determine the final number of cameras required to achieve the required view and coverage.

Based on a height of 40 feet, a CCTV camera should be able to provide an adequate viewing area of ½ mile in each direction. Horizontal and vertical geometric curves in the roadway will
require additional CCTV cameras to maintain adequate coverage. A governmental radio tower adjacent to I-75 was identified during one of the workshops as a possible CCTV site.

CCTV units should be located to view DMS signs to ensure proper message display and enable the system operators to view the impact the message has on the motoring public.

6.5 **HIGHWAY ADVISORY RADIO**

An HAR system is a low power AM radio station designed to broadcast messages to motorists through standard car radios. Messages can be broadcast live or from a pre-recorded audio source that periodically cycles through one or a series of messages. Each system has four primary components: an audio source, transmitter, an antenna and grounding system.

By Federal Communication Commission (FCC) regulation, HAR systems are limited to a maximum power output of 10 watts. A Class 1 commercial AM station will have a maximum power output of 50,000 watts. HAR systems are only licensed to government entities and are regulated by the FCC per Section 90.242 of the FCC rules and Regulations.

HAR broadcasts are subject to static interference and range limitations, and are not always clearly received by motorists. The problems can intensify at night when commercial stations from hundreds and even thousands of miles away can reduce the HAR signal through skipping of the AM frequency off of the atmosphere. These problems can be mitigated during the design and installation phases.

The recommended HAR systems for the D/SFMS include the use of static signs with flashing beacons for use in alerting motorists when emergency messages are being broadcast on the system. Using flashing beacons to notify motorists when real-time information is being broadcast will encourage commuters to listen to HAR messages. If motorists find the messages useful, they will likely listen to HAR messages again when the beacons are flashing. These active signs are much more useful to motorists than static signs which inform commuters that traffic information is available on the HAR station. If a motorist listens to a message only to find that the broadcast is not providing real-time information, it is unlikely they will tune in again. Signs should be clearly marked with the appropriate frequency. Guidelines for the sign types are specified in the Manual of Uniform Traffic Control Devices (MUTCD).
The static signs with flashing beacons should be located at the outer limits of the HAR coverage area, approaching the transmitter and in advance of potential alternate routes to allow motorists to tune in their radios, listen and comprehend the message and act in a safe manner.

6.7 COMMUNICATIONS

The objective of the communications network is to facilitate a reliable system dedicated initially to the D/SFMS and eventually integrated it into a regional ITS communication system.

The ITS technologies identified for deployment include CCTV cameras, DMSs, and a HAR with flashing beacons. The design of the communications architecture should accommodate these technologies and yet have additional capacity to accommodate growth beyond these initial technologies. As a result, a hybrid communication system consisting of the following is recommended:

- Fiber Optic Cable;
- Unlicensed Spread Spectrum Radio;
- Leased Communication Circuits.

Initially, the highest density of field devices will be located along the I-75 corridor in the downtown Dayton area. The communication needs for these field devices are best served by installing a fiber optic cable. The fiber trunk will also be utilized to carry the signal of ITS field devices located within wireless radio range to make maximum usage of the cable. It is possible that the fiber optic trunk could be expanded in the future as funding becomes available and road-widening projects include installation of conduit infrastructure.

The fiber optic communication system is divided between the physical cable plant and the network electronics. These two separate subsystems combine to form the complete fiber optic communication system. The conceptual design of the physical cable plant will contain approximately 10 miles of 72-strand fiber optic trunk cable. It is recommended that the fiber optic cable will utilize 1” High Density Polyethylene (HDPE) conduit that will be installed as part of the project. It is also recommended that at least one spare conduit be installed at the same time to facilitate maintenance procedures or accommodate future growth.

The next communication medium that is recommended for deployment is unlicensed spread spectrum radio. This technology is referred to as unlicensed because the Federal Communication
Commission does not require a license to operate within the designated frequency bands. The technology is frequently used for last mile connectivity or short-range links between sites. The technology has three utilization bands or frequencies:

- 902 to 918 MHz
- 2.4 GHz
- 5.8 GHz

Initially the technology utilized the 902 to 918 MHz band in the early 1990s. As this band became more saturated with users, the technology shifted to the 2.4 GHz in the late 1990s. Currently, the 5.8 GHz band is less utilized and therefore would be a better choice for future CCTV and DMS usage.

The final communication medium recommended consists of leased communication circuits from Time Warner or another local carrier. Currently, Time Warner is the recommended carrier because their Road Runner cable modem service provides superior bandwidth and cost benefits over DSL service. Time Warner has indicated they provide service throughout the project area. However, the telecommunications industry is undergoing rapid changes in technology, service pricing, and company mergers and a cost benefit review is recommended at the start of final design. This conceptual communication design is presented in Figure 6.2.

### 6.8 Transportation Operations Center

It is recommended to locate the TOC in relation to the initial deployment of the fiber optic trunk cable. In this manner, the fiber can be utilized to bring communication signals directly into the TOC.

Figure 6.3 below depicts the system configuration for the D/SFMS TOC system components. They include:

- Video Monitors to view CCTV images;
- Operator Workstations;
- Video Switch to route CCTV images to monitors;
- Server(s) to provide for data exchange, fax, weather, DMS and CCTV Control software;
- Router with firewall software to provide connectivity to the Wide Area Network;
- Fiber Distribution Panel to terminate the fiber trunk cable inside the TOC.
The final TOC configuration should address design considerations, such as human/machine interface, display legibility and operator consoles. Other design considerations are listed below:

- All computers, monitors and printers should be specified and protected with uninterruptible power supplies (UPS);
- Surge protectors should be provided for all processors
- Lighting controls should be designed to minimize glare and eye strain;
- The consoles should be evaluated to determine if they could accommodate the proposed equipment and ergonomic and operational demands;
- The center should provide the infrastructure for network backbones for LAN/WAN installations, incoming/outgoing communication lines and power outlets.

The figures illustrate two “potential” locations for a TOC. The requirements of this facility would only require space in an existing facility—not construction of a new facility. Consequently, the Study Team worked with the stakeholders in developing these two initial sites for costing purposes. In the cost estimate that follows, the City Hall location was used as the TOC location and assumes that the D/SFMS could share the City of Dayton fiber from the interstate to that facility.

### 6.9 Cost Estimates

The cost estimate for the D/SFMS is presented on the following page along with the assumptions used in developing this estimate. This estimate will be refined as the project advances in development, changes in communication philosophy, as well as number and location of field devices; all play a major role in the final cost of the system.
### Dayton Springfield Freeway Management System Conceptual Design Cost Estimate

<table>
<thead>
<tr>
<th>Equipment Category</th>
<th>Description</th>
<th>Unit of Measure</th>
<th>Quantity</th>
<th>Estimated Cost</th>
<th>Subtotal</th>
<th>Assumptions</th>
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<tbody>
<tr>
<td><strong>TMC Equipment</strong></td>
<td>Workstations</td>
<td>EA</td>
<td>2</td>
<td>$3,500.00</td>
<td>$7,000.00</td>
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<td></td>
<td>Servers</td>
<td>EA</td>
<td>2</td>
<td>$4,500.00</td>
<td>$9,000.00</td>
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<tr>
<td></td>
<td>Video Monitors</td>
<td>EA</td>
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<td>Video Switch</td>
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<td>$25,000.00</td>
<td>$25,000.00</td>
<td></td>
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<tr>
<td></td>
<td>WAN &amp; LAN Equip.</td>
<td>EA</td>
<td>1</td>
<td>$12,500.00</td>
<td>$12,500.00</td>
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<tr>
<td></td>
<td>Control System Software</td>
<td>LS</td>
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<td>$50,000.00</td>
<td>$50,000.00</td>
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<tr>
<td></td>
<td>Color Printer/Color</td>
<td>EA</td>
<td>1</td>
<td>$4,500.00</td>
<td>$4,500.00</td>
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<td></td>
<td>DMS</td>
<td>EA</td>
<td>8</td>
<td>$91,000.00</td>
<td>$728,000.00</td>
<td>Cantilever structure, LED technology</td>
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<td></td>
<td>CCTV</td>
<td>EA</td>
<td>33</td>
<td>$23,000.00</td>
<td>$759,000.00</td>
<td>w/40’ concrete pole, foundation, &amp; pole mounted cabinet</td>
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<td></td>
<td>HAR</td>
<td>EA</td>
<td>6</td>
<td>$65,000.00</td>
<td>$390,000.00</td>
<td>w/40’ wood pole, grounding system, and 4 static signs with flashing beacons</td>
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<td>Electrical</td>
<td>EA</td>
<td>45</td>
<td>$7,500.00</td>
<td>$337,500.00</td>
<td>Assumes electrical service is within 300 feet of field device</td>
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<td><strong>Field Equipment</strong></td>
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<td>LF</td>
<td>52,800</td>
<td>$40.00</td>
<td>$2,112,000.00</td>
<td>Assumes 72 SMFO cable, pullbox every half mile, 2 1.25” HDPE conduits</td>
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<td>Wireless Radios</td>
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<td>installation charge</td>
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Subtotal: $4,676,900.00

25% Construction Contingency: $1,169,225.00

Engineering Design Cost (15%): $876,918.75

CE&I Cost (8%): $467,690.00

Total Project Cost Except Monthly Reoc: $7,190,733.75

**Monthly Reoccurring Charges**

- **Monthly CDPD Charge**
  - EA 5: $35.00 - $175.00 Monthly cost

- **Monthly Time Warner Charge Field Locations**
  - EA 21: $55.00 - $1,155.00 Monthly cost

- **Monthly Time Warner Charge TMC Location**
  - EA 1: $1,500.00 - $1,500.00 Monthly cost

- **Monthly O&M (Staff and Facility) based on standard guide of 10% of Construction Costs**
  - $59,333 Monthly cost

Operating Monthly Cost: $62,163.00
7.0 RECOMMENDATIONS AND NEXT STEPS

This report documents the planning efforts for a FMS in the Miami Valley region. It outlines the study’s data collection efforts, presents a concept of operations for the system and details a project ITS architecture upon all of which, a conceptual design was developed.

Highlights of this system include:

- CCTV cameras to provide incident validation and verification;
- DMS and HAR systems to provide traveler information;
- Incident detection through integration with local PSAPs;
- Freeway Service Patrols to assist in small and large-scale incident and construction management activities;
- Integration with major regional stakeholders including the City of Dayton, the City of Springfield, GDRTA and others;
- Integration with the media to provide timely and accurate traveler information to the public.

Overall recommendations based on this study are:

- Utilize this report and its findings to continue project development with ODOT (Central Office and Districts).
- Work with ODOT Central Office on developing a funding strategy that could include TRAC and local funding sources.
- Maintain momentum of the ITS Management Group by involving them as an active participant in MVRPC’s efforts to develop a regional ITS architecture.
- Utilize the project ITS architecture, developed as part of this study, as a baseline for MVRPC’s efforts to develop a regional ITS architecture.
- Strengthen and formalize relationships with local PSAPs based on the initial efforts accomplished by this study.
As this project advances in the planning and design process, several factors and assumptions need to be kept at the forefront to ensure success.

The first factor is the role of the media. The media are a critical factor to the success of this project and efforts should be initiated at the next phase to involve them. The system should ensure that traveler information is structured in a format and mechanism that supports their traffic reporting efforts to make their traffic reports more valuable and help meet the goals of the this system.

It is also important to remember that the construction of this system is linked to the major reconstruction projects in the region (i.e. I-75 and the I-70/I75 interchange). The cost estimates presented herein assume that conduit and pullboxes will be included as part of the reconstruction effort. If that is not the case, the cost of this system will escalate significantly using the current design concept. However, alternative designs could be developed to offset those costs and achieve most of the desired functionality before the major reconstruction is complete.

Finally, if due to budgetary constraints, the cost estimate outlined in this report exceeds available funding, certain field devices could be deferred to a later phase. Again, the color-coding of the field devices in the figures of this report, illustrate the relative priority of first and second priority field devices. This determination was based on the data collection effort in an effort to place field devices where they are most needed.
Appendix A
D/SFMS Draft Project ITS Architecture
A.1 **DRAFT PROJECT ITS ARCHITECTURE**

This brief technical memo documents the initial draft Dayton/Springfield Freeway Management System (D/SFMS) Project Architecture using the National ITS Architecture format. This technical memo highlights the background and history of the D/SFMS, introduces the concept of freeway management systems as well as the regional coordination efforts that are taking place as part of the project development. A brief discussion of the National ITS Architecture, its purpose, structure, and how it can be applied to a specific ITS project is then presented. Finally, this section presents the D/SFMS’ Project ITS Architecture in the proper National ITS Architecture format.

A.1.1 **BACKGROUND**

The Miami Valley Regional Planning Commission (MVRPC), in conjunction with the Clark County Springfield Transportation Coordinating Committee (CCSTCC) and the Ohio Department of Transportation (ODOT), initiated the D/SFMS study in September 2002. The study will develop a framework for building a freeway management system to mitigate traffic congestion due to the coming regional construction projects within the Miami Valley Region. The main goal of implementing the D/SFMS is to improve traffic management along the freeways during incidents and provide better traveler information to motorists in the region.

The Miami Valley Early Deployment Plan (EDP) completed in 1997 established a prioritized list of Intelligent Transportation System (ITS) goals for the Miami Valley region. The EDP was the first major effort the Miami Valley region made towards developing an ITS for the region. The EDP also documents several regional goals for improving the efficiency of the Miami Valley transportation system. As the D/SFMS ranked as a regional priority, this study will provide the framework for implementing ITS strategies along the region’s freeways while meeting the regional transportation system improvement goals.

In addition, this study will adhere to the guidelines of ODOT’s Best ITS Management Practices and Technologies Report dated July 2001. It is important for the D/SFMS to be consistent with ODOT’s goals so that regional goals are consistent with statewide and other regional efforts. Thus, the focus of this study is to address the following points.

- Incident Management
- Multi-agency Coordination
• Traffic Monitoring and Surveillance
• Traffic Control and Traveler Information
• Low cost/operationally effective
• Operations based
• Hybrid approach to communications
• Minimize detection by the roadside and leverage PSAP call centers

Regional integration and cooperation will facilitate the development of the D/SFMS effort and enhance opportunities to integrate with surrounding regions to one day establish a seamless statewide FMS.

A.1.2 Freeway Management System Overview

Freeway management systems (FMS) are a structure by which technology and operational procedures address the functional aspects of traffic management along freeways and adjacent arterials. A FMS is typically composed of a variety of technology components. However, the key to developing a successful FMS is to identify the unique needs of the region and apply the appropriate technology and operations to meet the region’s needs.

The D/SFMS will possess the following functionality
• Traffic Management
• Maintenance of Traffic
• Incident Management
• Traveler Information

The vast array of ITS technologies and systems provides a wealth of opportunity for the Miami Valley region. Some of the ITS elements that may be included in the D/SFMS are:

• Dynamic Message Signs (DMS)
• Closed circuit television (CCTV)
• Detection stations
• Highway Advisory Radio (HAR)

While not all of these technologies and systems may be selected for the D/SFMS, the final product will reflect regional stakeholder and traveler needs. The D/SFMS will be designed to include monitoring and communication systems for the real-time detection
of traffic volumes and speeds, incident response and management, video monitoring at critical / strategic locations, traveler information and route diversion. In light of anticipated reconstruction of interstates within the region, consideration will be afforded to phased implementation of the system, flexibility, cost and future design compatibility.

In order to accomplish this goal, the ITS Stakeholders Group, established as a result of the Miami Valley EDP, will provide critical input throughout the study. The Group will be able to draw on a number of best practices as many FMS and ITS projects are operational or underway throughout the region, state, and nation. The key to the D/SFMS will be the level of regional integration that is achieved.

**A.1.3 REGIONAL INTEGRATION**

Regional priorities play a significant role in developing the D/SFMS. An assessment of the current traffic conditions and traffic management practices of the stakeholders will be documented as part of this study. In this way, common data and protocols can be realized across various stakeholder operations. While many regional stakeholders may operate within their own jurisdiction and / or discipline, management of traffic during incidents will become increasingly more effective with coordinated information sharing.

The D/SFMS study will bring the many regional partners together to continue developing the communication channels established with the EDP. Specifically, the stakeholders’ role in freeway management will be investigated and documented into a comprehensive D/SFMS plan. This study was initiated with a workshop to introduce FMS strategies to the regional stakeholders involved in freeway management in the Miami Valley.

The stakeholders who participated in the initial workshop include the following local, county, regional, state and federal agencies:

- Clark County Springfield TCC
- City of Dayton Civil Engineering
- Clark County Sheriff's Office
- Federal Highway Administration
- Jet Express, Inc.
- Miami County Engineers
- Montgomery County Sheriff's Office
- Miami Valley Regional Planning Commission
Traffic and safety agencies comprise the majority of the current stakeholders. While this list is not exhaustive of the stakeholders in the region, it is a solid basis for building the D/SFMS. The majority of stakeholders’ functions can be classified under either safety or traffic. For example, information gathered by a safety related agency will be sent to the D/SFMS where that data will be processed, packaged and relayed to appropriate traffic and safety agencies involved with the D/SFMS.

The main points highlighted by the ITS Stakeholders Group discussions are listed below:

- Support use of DMS and CCTV
- Develop a simple, affordable and efficient FMS
- Develop a structured, comprehensive communication system
- Provide accurate, timely traffic and travel information
- Sharing PSAP information with the D/SFMS for incident detection
- Focus on identified “hot spots”
- Freeway service patrols
- Develop diversion routes in coordination with local agencies
- Media participation

Data sharing and integration opportunities will be derived from the feedback of stakeholders throughout the study. Refining the goal of the D/SFMS will be dependent upon the level of regional integration and participation desired by the participants.

The D/SFMS will be the center point for the regional stakeholders in regard to traffic, incident and travel information. Figure A.1.1 is
a diagram that shows the basic relationship that the Miami Valley regional stakeholders will have once the D/SFMS is established.

Figure A.1.1 Daytont/Springfield FMS Regional Integration Diagram

The D/SFMS will provide the opportunity for these related but separate regional functions to coordinate. Data from a variety of means (i.e. CCTV images, sensor data) and agencies will be linked to the D/SFMS and will provide better and more accurate information to enhance response to incidents thereby improving traffic flow and traveler information. Data sharing will be critical to the mission of the D/SFMS. This study will assess the current information that is handled by the stakeholders and suggest the most appropriate information flows and devices. To do this, the National ITS Architecture will be used in structuring the D/SFMS.

A.4 NATIONAL ITS ARCHITECTURE KEY CONCEPTS/PRODUCTS

The Transportation Equity Act for the 21st Century (TEA-21) requires that ITS projects using Federal funds conform to Regional ITS Architectures developed from the National ITS Architecture. The National ITS Architecture is a tool to help identify and plan for system functionality, information sharing and component interoperability. A Regional ITS Architecture guides stakeholders in integrating various project systems and components. A Project ITS Architecture guides stakeholders in integrating various components of a single effort, as is the case with the D/SFMS. This section explains the essential terminology and concepts needed to understand the National ITS Architecture.
and illustrates how Project Architectures, such as the one to be developed for the D/SFMS, fit into the National ITS Architecture framework. In order for the D/SFMS project to move forward in the programming process, a Project ITS Architecture must be developed. The following concepts and terms are explained in this section:

- User Services and User Service Requirements
- Logical Architecture
- Physical Architecture

A.1.4.1 User Services and User Service Requirements

User services define what ITS should do from the user's perspective. The concept of user services captures the problems, issues, objectives and needs to be addressed by deploying ITS. An example in the D/SFMS project would be the region's desire to coordinate information among agencies during freeway incidents. In many ways, the stakeholder input obtained for the D/SFMS project capture what the National ITS Architecture would call user services or needs to be addressed by the system. Currently, there are 32 user services defined by the National ITS Architecture. These user services were logically grouped into eight bundles: Travel and Traffic Management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle Safety Systems, Information Management and Maintenance and Construction Management. Each user service contains a series of user service requirements. User service requirements are specific functional statements of what must be done to support the ITS User Services.

A.1.4.2 Logical Architecture

A logical architecture is a technology-independent view of the final architecture. It shows the data and information processing that is required to satisfy all of the user services and highlights the data flows that should be supported between processes to ensure that the whole system works as a single unit. The logical architecture, although not directly used in developing the D/SFMS Project Architecture, is the foundation upon which all the more concrete or physical aspects of the National ITS Architecture are based. The Logical Architecture specifies the most efficient grouping of processes. This assists in organizing the functional processes and data flows of a system and is a valuable step towards the definition of a physical architecture.
Figure A.1.2 depicts a section of the National ITS Architecture logical architecture to illustrate processes and data flows. The bubble labeled “ITS” is a process. A process is defined as the work required to convert the data that flows into the bubble, into data that flows out of the bubble. For example, an advanced traffic management subsystem program that takes information from vehicle detectors on the road, monitors and processes that information, indicates a traffic jam and sets off an alarm at appropriate stakeholder workstations. A Process Specification is a succinct summary of the processing that takes place inside the bubble. The curved arrows are data flows both into and out of the processes or bubbles. Basically, the various types of information that the advanced traffic management system both receives (i.e. road sensor and CCTV information) and disseminates (i.e. HAR, DMS messages). The rectangles are called terminators and represent interaction and data flows between the ITS under consideration and the rest of the regional transportation context. Terminators represent other systems and entities that one ITS system has to relate to, but over which it may have no control (i.e. traveler information web pages and radio and television traffic reports). Charts composed of multiple bubbles and data flows are used to depict a system’s logical architecture.

The logical architecture helps to identify the system functions and information flows and guide development of functional requirements to meet specific user service requirements. The logical architecture is independent of institutions and technology, but can provide an excellent starting point for the definition and description of optimum institutional/organizational arrangements to support the technical aspects of the ITS.
The logical architecture of the National ITS Architecture defines a set of processes and data flows that respond to the user services. Processes and data flows are grouped to form particular transportation management functions, which break down into several levels of detail. At the lowest level of detail are the process specifications. These process specifications can be thought of as the elemental functions to be performed in order to satisfy the user service requirements.

A.1.4.3 Physical Architecture

The physical architecture builds on the logical architecture by adding real world systems and operations. The physical architecture identifies the desired communications and interactions (interfaces) between different transportation management organizations, i.e. between the D/SFMS and the regional PSAP centers. This provides agencies with a physical representation (though not a detailed design) of how the system should provide the required functionality (processes) identified in the logical architecture. This is the level at which the D/SFMS Project Architecture will be developed. Using the National ITS Architecture physical architecture framework as a guide, the DMJM+HARRIS Team will begin mapping out the connections that are current and planned for the D/SFMS.

The physical architecture of National ITS Architecture is defined with architecture entities (subsystems and terminators), market packages, equipment packages, architecture flows and data flows.

- Architecture Entities – These are the subsystems and terminators of the National ITS Architecture. The subsystems are the principle structural element of the physical architecture, which correspond to existing things in the physical world, such as traffic operations centers, automobiles and roadside signal controllers. The terminators define the boundary of the National ITS Architecture, or of the regional or project architecture. The terminators represent the people, systems and general environment that interface with ITS, but no functional requirements are allocated to terminators as no design control is assumed. Examples of subsystems in the D/SFMS Architecture include: the D/SFMS, PSAP centers, local traffic control systems and ODOT district systems.

- Market Packages – Market packages identify the system components required for the delivery of user services. They are groupings of technologies that when implemented perform a measurable service or tangible
benefit. An example of a market package for the D/SFMS Project Architecture is how the region would use surveillance on the freeways for enhanced traffic and incident management. The market packages also define the information flows between the different subsystems and terminators. These information flows are a collection of data flows and are referred to as architecture flows.

- Equipment Packages – Equipment packages are the basic elements of market packages. Examples of an equipment package for the D/SFMS include the roadway equipment to be deployed by ODOT such as CCTV and DMS. Equipment Packages could be considered the building blocks of the ITS architecture from an engineering perspective as they support the definition of projects and the detailed design of the implementations required to deploy the entire architecture.

- Architecture Flows/Data Flows – The data flows between the logical processes (from the logical architecture) that originate at one subsystem and end at another are grouped together into physical architecture flows. In other words, one architecture flow may contain a number of more detailed data flows. These architecture flows and their communication requirements define the interfaces required between subsystems. The flows mapped at this level provide a non-systems reader with an easier understanding of the types of interactions possible within the D/SFMS.

In addition, the National ITS Architecture allows for each agency’s field equipment (detectors or DMS) to be classified under the roadway subsystem entity. However, the National ITS Architecture does not consider architecture flows between traffic management subsystems that fail to consider jurisdiction boundaries within a region. Tackling these jurisdictional boundaries that translate into institutional boundaries are critical in ensuring any system operates efficiently.

A.1.4.4D/SFMS INTERCONNECT DIAGRAM

In this section, the interactions discussed generically in the previous narrative begin to take shape in the context of the D/SFMS. Figure A.1.3 illustrates the National ITS Architecture macro view of all the possible interactions between ITS elements. Note that the National ITS Architecture contains four different possible entities for information connection: centers, travelers, vehicles and roadside elements. Boxes within these four centers
are called subsystems. The rounded rectangles in the middle represent communications between the elements.

**Figure A.1.3 National ITS Architecture Summary Diagram**

The next step is to take this “all possibilities” diagram and cut out what is not relevant to the D/SFMS and augment what is. The result of this effort is Figure A.1.4, which is a custom tailored summary diagram for the D/SFMS based on the information in Figure A.1.1 - FMS Regional Integration Diagram and converting it into the National ITS Architecture format.

Please note that this is an evolving figure at this time and will be modified as more information is gathered as part of this study, it does however begin to illustrate how the regional stakeholders and system begin to fit into the overall National ITS Architecture structure.
Figure A.1.4 D/SFMS ITS Architecture Summary Diagram

A.1.5 D/SFMS Market Packages

The market packages developed for the D/SFMS provide a more detailed look at the communications and data flows. Table 1.1 lists all available market packages as defined in the National ITS Architecture. Of the 75 market packages in the National ITS Architecture, 14 were initially selected as pertinent to the D/SFMS Project ITS Architecture. The market packages in bold are those that identify the various system components the D/SFMS will utilize.

Market Packages tailored specifically to the D/SFMS will follow in later versions of this document and the final report. Diagrams for each market package are presented below along with a brief description from the National ITS Architecture of what each market package addresses.

As the regional ITS infrastructure develops, these market packages can be modified and additional market packages can be incorporated. Please note, for this effort, only the connections with the D/SFMS were considered to illustrate the “Project” slice of the Architecture or specifically how the other regional stakeholders and their ITS efforts would interconnect with the D/SFMS. A larger Regional ITS Architecture is needed to take a system wide approach for the entire Miami Valley region.
<table>
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<tr>
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**Vehicle Safety**

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</table>

Table A.1.1 National ITS Architecture Market Packages
A.1.5.1 Market Package ATMS01: Network Surveillance

This market package includes traffic detectors, other surveillance equipment, the supporting field equipment, and wireline communications to transmit the collected data back to the D/SFMS Traffic Management Subsystem. The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Subsystem). The data generated by this market package enables traffic managers to monitor traffic and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The collected data can also be analyzed and made available to motorists and the Information Service Provider Subsystem.

When applied to the D/SFMS Project Architecture, the following market package is produced:

**Figure A.1.5 D/SFMS Network Surveillance Market Package**
A.1.5.2 Market Package ATMS 06: Traffic Information Dissemination

This market package allows traffic information to be disseminated to drivers and vehicles using roadway equipment such as dynamic message signs or highway advisory radio. This package provides a tool that can be used to notify drivers of incidents; careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media (for instance via a direct tie-in between a traffic management center and radio or television station computer systems), Transit Management, Emergency Management, and Information Service Providers. A link to the Maintenance and Construction Management subsystem allows real time information on road/bridge closures due to maintenance and construction activities to be disseminated.

When applied to the D/SFMS Project Architecture, the following market package is produced:

**ATMS06: Traffic Information Dissemination**

![Diagram: ATMS06 Traffic Information Dissemination Market Package]

*Figure A.1.6 D/SFMS Traffic Information Dissemination Market Package*
A.1.5.3 MARKET PACKAGE ATMS07: REGIONAL TRAFFIC CONTROL

This market package provides for the sharing of traffic information and control among traffic management centers to support a regional control strategy. This market package advances the Surface Street Control and Freeway Control Market Packages by adding the communications links and integrated control strategies that enable integrated interjurisdictional traffic control. For example, the D/SFMS and ARTIMIS could share traffic information as it relates to travel in the I-75 corridor. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. This package relies principally on roadside instrumentation supported by the Surface Street Control and Freeway Control Market Packages and adds hardware, software, and wireline communications capabilities to implement traffic management strategies that are coordinated between allied traffic management centers. Several levels of coordination are supported from sharing of information through sharing of control between traffic management centers.

When applied to the D/SFMS Project Architecture, the following market package is produced:

**ATMS07: Regional Traffic Control**

![Diagram of ATMS07: Regional Traffic Control Market Package](image)

*Figure A.1.7 D/SFMS Regional Traffic Control Market Package*
A.1.5.4 Market Package ATMS08: Incident Management System

This market package manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The market package includes incident detection capabilities through roadside surveillance devices (e.g. CCTV) and through regional coordination with other traffic management, maintenance and construction management and emergency management centers as well as weather service entities and event promoters. Information from these diverse sources are collected and correlated by this market package to detect and verify incidents and implement an appropriate response. This market package supports traffic operations personnel in developing an appropriate response in coordination with emergency management, maintenance and construction management, and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications or resource coordination between center subsystems. Incident response also includes presentation of information to affected travelers using the Traffic Information Dissemination market package and dissemination of incident information to travelers through the Broadcast Traveler Information or Interactive Traveler Information market packages. The roadside equipment used to detect and verify incidents also allows the operator to monitor incident status as the response unfolds. The coordination with emergency management might be through a CAD system or through other communication with emergency field personnel. The coordination can also extend to tow trucks and other allied response agencies and field service personnel.

When applied to the D/SFMS Project Architecture, the following market package is produced:
Figure A.1.8  D/SFMS Incident Management System Market Package
A.1.5.5 MARKET PACKAGE ATMS09: TRAFFIC FORECAST AND DEMAND MANAGEMENT

This market package includes advanced algorithms, processing, and mass storage capabilities that support historical evaluation, real-time assessment, and forecast of the roadway network performance. This includes the prediction of travel demand patterns to support better link travel time forecasts. The source data would come from the D/SFMS Traffic Management Subsystem itself as well as other traffic management centers and forecasted traffic loads derived from route plans supplied by the Information Service Provider Subsystem. This market package provides data that supports the implementation of TDM programs, and policies managing both traffic and the environment. The package collects information on vehicle pollution levels, parking availability, usage levels, and vehicle occupancy to support these functions. Demand management requests can also be made to Toll Administration, Transit Management, and Parking Management Subsystems.

When applied to the D/SFMS Project Architecture, the following market package is produced:

*Figure A.1.9 D/SFMS Traffic Forecast and Demand Management Market Package*
A.1.5.6 Market Package CVO10: HAZMAT Management

This market package integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents. HAZMAT tracking is performed by the Fleet and Freight Management Subsystem. The Emergency Management subsystem is notified by the Commercial Vehicle if an incident occurs and coordinates the response. The response is tailored based on information that is provided as part of the original incident notification or derived from supplemental information provided by the Fleet and Freight Management Subsystem. The latter information can be provided prior to the beginning of the trip or gathered following the incident depending on the selected policy and implementation.

When applied to the D/SFMS Project Architecture, the following market package is produced:

CVO10: HAZMAT Management

Figure A.1.10 D/SFMS HAZMAT Management Market Package
A.1.5.7 Market Package EM01: Emergency Response

This market package includes emergency vehicle equipment, equipment used to receive and route emergency calls, and wireless communications that enable safe and rapid deployment of appropriate resources to an emergency. Coordination between Emergency Management Subsystems supports emergency notification and coordinated response between agencies. Existing wide area wireless communications would be utilized between the Emergency Management Subsystem and an Emergency Vehicle to enable an incident command system to be established and supported at the emergency location. Public safety, traffic management, and many other allied agencies may each participate in the coordinated response managed by this package.

When applied to the D/SFMS Project Architecture, the following market package is produced:

Figure A.1.11 D/SFMS Emergency Response Market Package
A.1.5.8 MARKET PACKAGE EM04: ROADWAY SERVICE PATROLS

This market package supports roadway service patrol vehicles that monitor roads that typically have incidents, offering rapid response to minor incidents (flat tire, accidents, out of gas) to minimize disruption to the traffic stream. If problems are detected, the roadway service patrol vehicles will provide assistance to the motorist (e.g., push a vehicle to the shoulder or median).

When applied to the D/SFMS Project Architecture, the following market package is produced:

**EM4: Roadway Service Patrols**

![Diagram of EM4 Roadway Service Patrols](image)

*Figure A.1.12 D/SFMS Roadway Service Patrols Market Package*
A.1.5.9 Market Package MC07: Roadway Maintenance and Construction

This market package supports numerous services for scheduled and unscheduled maintenance and construction on a roadway system or right-of-way. Maintenance services would include landscape maintenance, hazard removal (roadway debris, dead animals), routine maintenance activities (roadway cleaning, grass cutting), and repair and maintenance of both ITS and non-ITS equipment on the roadway (e.g., signs, traffic controllers, traffic detectors, dynamic message signs, traffic signals, CCTV, etc.). Environmental conditions information is also received from various weather sources to aid in scheduling maintenance and construction activities.

When applied to the D/SFMS Project Architecture, the following market package is produced:

![MC07: Roadway Maintenance and Construction](image)

*Figure A.1.13 D/SFMS Roadway Maintenance and Construction Market Package*
A.1.5.10 **MARKET PACKAGE MC08: WORK ZONE MANAGEMENT**

This market package directs activity in work zones, controlling traffic through portable dynamic message signs (DMS) and informing other groups of activity (e.g., ISP, TM, other maintenance and construction centers) for better coordination management. Work zone speeds and delays are provided to the motorist prior to the work zones.

When applied to the D/SFMS Project Architecture, the following market package is produced:

**MC08: Work Zone Management and Coordination**

![Diagram of MC08: Work Zone Management and Coordination](image)

*Figure A.1.14 D/SFMS Work Zone Management Market Package*
A.1.5.11 MARKET PACKAGE ATIS1: BROADCAST TRAVELER INFORMATION

This market package collects traffic conditions, advisories, general public transportation, toll and parking information, incident information, air quality and weather information, and broadly disseminates this information through existing infrastructures and low cost user equipment (e.g., FM subcarrier, cellular data broadcast). The information may be provided directly to travelers or provided to merchants and other traveler service providers so that they can better inform their customers of travel conditions. Different from the market package ATMS6 - Traffic Information Dissemination, which provides localized HAR and DMS information capabilities, ATIS1 provides a wide area digital broadcast service. Successful deployment of this market package relies on availability of real-time traveler information from roadway instrumentation, probe vehicles or other sources.

When applied to the D/SFMS Project Architecture, the following market package is produced:

**ATIS1: Broadcast Traveler Information**

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*Figure A.1.17 D/SFMS Broadcast Traveler Information Market Package*
A.1.5.12 MARKET PACKAGE ATIS2: INTERACTIVE TRAVELER INFORMATION

This market package provides tailored information in response to a traveler request. Both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding traffic conditions, transit services, ride share/ride match, parking management, and pricing information. A range of two-way wide-area wireless and wireline communications systems may be used to support the required data communications between the traveler and Information Service Provider. A variety of interactive devices may be used by the traveler to access information prior to a trip or en route including phone, kiosk, Personal Digital Assistant, personal computer, and a variety of in-vehicle devices. This market package also allows merchants to receive traffic information to their personal devices or remote traveler systems to better inform customers of road travel conditions. Successful deployment of this market package relies on availability of real-time transportation data from roadway instrumentation, probe vehicles or other means. A traveler may also input personal preferences and identification information via a "traveler card" that can convey information to the system about the traveler as well as receive updates from the system so the card can be updated over time.

When applied to the D/SFMS Project Architecture, the following market package is produced:
ATIS2: Interactive Traveler Information

Figure A.1.18 D/SFMS Interactive Traveler Information Market Package
Appendix B
D/SFMS Implementation Plan
B.1 INTRODUCTION

ITS projects, using federal funds, must prepare an implementation plan in accordance with the guidelines developed by the FHWA: Federal Aid Policy Guide – Part 940 Intelligent Transportation System Architecture and Standards, Section 11 Project Implementation (23 CFR 940.11). The implementation plan must be completed prior to the authorization of construction for the D/SFMS to ensure that the project is designed, built, operated and maintained in the most efficient manner possible.

The plan will address all implementation activities prior to, during and after construction. Specifically, the plan highlights the legislative issues, system design, procurement methods, construction management procedures, the system start-up plan, system operations and maintenance, institutional arrangements and budgetary resources.

The implementation plan for the D/SFMS will also include the draft intergovernmental agreements and contracts. The following discussion highlights key components of the D/SFMS implementation plan. This is a preliminary version of the D/SFMS implementation plan and is an expanded outlined at this stage. As the project is in the conceptual design phase, many of the components have yet to be addressed.

B.2 IMPLEMENTATION PLAN

The implementation plan is composed of several major sections that are discussed separately in this document. The first section details the system engineering analysis that includes the functional and facility requirements for the D/SFMS. This section examines how the stakeholders will coordinate traffic and incident information among Dayton and Springfield area traffic and emergency operations agencies. In addition, agency roles and responsibilities, the project ITS architecture, and information exchanges is documented.

The D/SFMS system architecture section details the hardware and software components. This section documents specific requirements that must be completed to achieve the project goals. The plan will also address any integration strategies that must be followed to create a seamless system. ITS standards and testing procedures are also specified. As the D/SFMS is in the conceptual design phase, specific standards and procedures have not yet been selected. As the project proceeds to design, standards, procedures, and documentation practices will be identified and documented.
Several procurement options are available for ODOT to utilize. Once design is underway, an appropriate procurement method can be selected.

The D/SFMS implementation plan will consider the relationship to other roadway, bridge and utility construction projects so that the D/SFMS components can be mainstreamed into interstate reconstruction contracts to address congestion (i.e., recurring and non-recurring congestion) and traffic safety (number and severity of accidents).

**B.3 SYSTEMS ENGINEERING ANALYSIS**

The systems engineering analysis conducted for the D/SFMS is based on the scale of the planned system. The scale for the system is determined based on the functional and facility requirements analyses that take place during the preliminary design of the system. The following discussion highlights the main components of the systems engineering analysis.

**B.3.1 NATIONAL ITS ARCHITECTURE**

In developing the goals of the D/SFMS, the National ITS Architecture was used as a baseline for describing the functionality of the proposed system. Of the 75 National ITS Architecture market packages, 12 were selected as applicable to the transportation system functions in the study area. The following table lists the market packages pertinent to the D/SFMS.

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These market packages address the functionality of the D/SFMS and structure the functional flows of all participating agencies. As the D/SFMS is the initial major ITS effort for the region, it will serve as the foundation for project and regional ITS architecture for the area. Through this project, functional flows and agency roles and responsibilities related to the ITS project will be refined.

### B.3.2 INTERFACE REQUIREMENTS AND INFORMATION EXCHANGES

The D/SFMS project architecture will be coordinated with the development of the regional ITS architecture to be developed. Any D/SFMS system design will be consistent with the regional ITS architecture in the Miami Valley. The system will also be designed to integrate with other regional ITS architectures particularly those for the Cincinnati and Columbus regions.

The D/SFMS project ITS architecture was initially developed based on the Early Deployment Plan for the Miami Valley region. Input from the ITS Management Committee was also used in establishing specific functions that the D/SFMS will perform. Again, the project ITS architecture reflects the results of the systems engineering analysis. By incorporating the functions which the ITS Management Committee prioritizes, a complete project ITS architecture can be developed. Considering that the D/SFMS project is the first major ITS project in the region, the project ITS architecture is used as a requirement. Once the Miami Valley develops a regional ITS architecture the D/SFMS project ITS architecture will be updated to be consistent with the goals of the regional ITS architecture.

### B.3.3 FUNCTIONAL REQUIREMENTS

The D/SFMS will operate during the peak rush hours and the TOC will serve as an operations center for collecting, disseminating and coordinating transportation information among regional transportation and emergency agencies along the Miami Valley regional freeway system. The system will be owned, operated and maintained by ODOT. It is anticipated that the system could be operated with one to two operators. Key regional stakeholders, such as the City of Dayton, the City of Springfield and the GDRTA will share transportation information with the D/SFMS. This concept of operations is based on the Project ITS Architecture presented in Appendix A, and has been developed with the

<table>
<thead>
<tr>
<th>Maintenance and Construction Operations</th>
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<tbody>
<tr>
<td>MC07</td>
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<td>MC08</td>
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assistance of the ITS Management Committee. The D/SFMS will provide the following user services or functional capabilities.

- Traffic Management
- Maintenance of Traffic
- Incident Management
- Traveler Information
- Multimodal Integration

Operational elements anticipated to be key components of the D/SFMS include: Freeway Management, Emergency Management, Maintenance and Construction Management, Traveler Information Operations, and Regional Transportation Coordination Operations. These elements, as summarized below, define the concept of operations for the facility. These descriptions will be further refined during the D/SFMS design phase.

B.3.3.1 Freeway Operations Management

The D/SFMS system will enhance incident detection, traffic monitoring, maintenance of traffic and traffic information dissemination for the major freeways in the region including I-70, I-75 and SR-4. Traffic and incident information will be collected from the CCTV system and cell phone calls from the traveling public via PSAPs in the region. The D/SFMS will operate weekdays during the peak hours to monitor and detect traffic incidents along the freeways. During off-peak hours, the system will have the capability to be controlled by other ODOT facilities such as ARTIMIS or the Columbus FMS. Furthermore, the D/SFMS will dispatch and communicate with Freeway Service Patrols operated by ODOT in the region. Dispatching responsibilities will be coordinated with the local district radio operations.

B.3.3.2 Emergency Management

The D/SFMS will provide the Miami Valley emergency agencies with improved traffic and incident information. The D/SFMS will receive incident notification through a software connection with local PSAPs in the area. D/SFMS operators will be able to verify and validate the nature and severity of the incident and transmit traveler information alerts through the DMS and HAR. Furthermore, video information will be shared with interested local emergency dispatching operators so they can utilize the CCTV images in dispatching the appropriate resources to the scene. The D/SFMS will also share video feeds with the local county Emergency Management Agencies so they could utilize the surveillance capabilities during any large-scale incidents. Finally, video information shared with the media will be designed such that
D/SFMS operators could blankout images that the media should not receive i.e. during a serious personal injury or fatality. These ITS applications will allow motorists the opportunity to select diversionary routes to avoid the incident.

**B.3.3.3 Maintenance and Construction Management**

Maintenance and construction along freeways can be a major source of congestion for a region. The implementation of the D/SFMS will realize several benefits to the ODOT highway maintenance and construction crews as well as regional travelers. First, during weather emergencies, CCTV images in conjunction with ODOT’s freeway weather stations may assist in the distribution of service crews. Secondly, during reconstruction efforts, DMS and HAR if updated in a timely manner, can be utilized to inform travelers of the length and travel restrictions of the given project. In addition, with the traveler information devices in use, worker safety is improved. Lastly during an incident which might require removal of debris, the D/SFMS’ CCTV will be used to verify the location and type of debris thereby ensuring the proper maintenance assets are dispatched.

**B.3.3.4 Traveler Information Operations**

Information that is collected from the field devices will be directed to the D/SFMS TOC where the data will be processed and packaged into traveler information. This information will be distributed to the motorists in their vehicles through DMS and HAR messages. Motorists will also be able to receive more accurate and timely traveler information from local radio stations that will be developing their traffic reports based on information shared from the D/SFMS. This link with the media is critical to the success of the system in providing useful traveler information.

The D/SFMS will have its own regionally based traveler information web site providing pre-trip traveler information. This webpage will be a critical component to Buckeye Traffic, ODOT’s soon to be operational statewide traveler information webpage.

**B.3.3.5 Regional Transportation Coordination Operations**

An important aspect in a developing regional FMS is the opportunity to share traveler information with surrounding systems, in particular construction and incident information. A contiguous information stream will provide through travelers with seamless information. The D/SFMS will share incident information and video images with other regional and ODOT control centers.

**B.3.4 Agency Roles and Responsibilities**
The roles and responsibilities of the agencies depend upon the desired involvement of the agency. For example, ODOT and PSAPs in the region will have a significant role where MVRPC, CCSTCC, and city engineering departments will have lesser involvement. However, all stakeholders will have access to the D/SFMS if so desired in the future. It is important to be mindful of future development and involvement of regional agencies in the D/SFMS. During D/SFMS design, institutional arrangements and policies need to be reviewed so that integration of stakeholder policies proceeds as efficiently as possible. Any policies developed will be included in the operation and maintenance of the D/SFMS.

Currently, the D/SFMS is a cooperative effort among the following stakeholders:

- ODOT Central Office
- ODOT District 7
- ODOT District 8
- Miami Valley Regional Planning Commission
- Clark County Springfield TCC
- Ohio State Highway Patrol
- Clark County Sheriff's Office
- Montgomery County Sheriff's Office
- Montgomery County Engineers Office
- City of Dayton
- City of Kettering
- Springfield Police
- Regional Transit Authority

Specific roles and responsibilities of these stakeholders, and others as they join the effort, will be developed in the design phase.

**B.3.5 FACILITY REQUIREMENTS**

The D/SFMS facility requirements are derived from the functional requirements. A space plan for the D/SFMS facility is the product of this effort. This plan will provide the baseline for the architectural design of the facility and assure that the selected location has the appropriate physical features. The facility requirements will include the following components.

- Area - Square Footage
- Height / Interior Design
- System Displays
- System Communications
• Building Control Systems

The location of the D/SFMS will be determined based on the amount of space required to accommodate the D/SFMS. Both current and future needs of the D/SFMS will play a role in the site selection process. Some factors that are relevant in selecting a TOC location are the following.

• Availability of an Existing Public-Owned Facility
• Communications Impacts
• Growth Potential
• Emphasis on Functionality

The ITS Management Committee will participate in the site selection analysis.

B.3.6 LEGISLATION

Finally, existing laws, regulations and policies affecting the project need to be reviewed and assessed. In addition, state or local legislative changes such as authority for video surveillance; enforcement authority and roadway clearance policies; and intellectual property rights, particularly for the development of computer and system integration software programs must be addressed, if applicable to the project. For example, the use of video surveillance to monitor traffic will be a major part of the D/SFMS operations, as CCTV cameras are deployed along the freeways. The use of video monitoring must follow strict guidelines so that individual rights are not violated. Operating procedures for the video system will be defined to ensure that there are no potential legal problems.

B.4 SYSTEM DESIGN

A freeway management system contains elements which monitor, guide and/or control traffic along the surface streets and/or freeways. System design consists of taking the recommendations from the planning phase, converting those needs into hardware/software requirements and formulating the equipment needs into contract documents.

System design of the D/SFMS will be outlined in preliminary engineering documents (both architecture and systems) and will be the basis for the overall system design. The implementation plan will outline the system design elements including the following elements.

• Design life
• System coverage
• Design and operations/maintenance philosophies
• Overall system architecture

ODOT will be the lead agency during the final design phase of the D/SFMS and will be responsible for the development, award and management of all design related contracts. System design of the D/SFMS outlined in the preliminary engineering documents will be the basis for the overall system design.

B.4.1 SYSTEM ARCHITECTURE

The system architecture demonstrates the data flows between the D/SFMS and the other key regional stakeholders. Elements of this system architecture include the utilization of an existing communication infrastructure and an understanding of the user needs and system requirements. The system architecture addresses, at a high level, an advanced freeway management system, emergency management, maintenance and construction management, and traveler information dissemination.

The conceptual design of the D/SFMS includes several field device options and integration opportunities. In developing the conceptual design plan, several technology options were reviewed. The preliminary configuration of field equipment for the D/SFMS is subject to further study during the design phase. The following technology options have been recommended.

• DMS system
• HAR system
• PSAP integration
• CCTV system

The D/SFMS architecture will be developed in detail during the design of the system. The final design will document the specifications for hardware and software for the D/SFMS.

B.4.2 ITS STANDARDS AND TESTING PROCEDURES

The D/SFMS will adhere to all applicable ITS standards. Testing procedures will be drafted based upon the equipment and system integration level desired by the stakeholders. All applicable ITS standards and interoperability tests that have been officially adopted by the DOT will also be identified during final design. Documentation of standards and test will be included in later versions of this plan.

B.4.3 SOFTWARE ACCEPTANCE TESTS
Any D/SFMS design will be tested based on officially adopted DOT rulemaking guidance. Interoperability tests will ensure proper integration of all regional systems. Systems that will require testing include communications, software, and hardware systems.

System acceptance tests will be required for all systems components that will be monitored and controlled by the D/SFMS. Other subsystems will be integrated into the facility at the time of construction.

B.4.4 DOCUMENTATION

Necessary documentation will be completed regarding software and system tests throughout the duration of the contract. The documentation will provide a comparison of minimum performance requirements versus actual test results for each subsystem as well as the integrated system. The format of the documentation shall be carefully structured to differentiate the satisfactory performance of existing systems external to the D/SFMS versus the required integrated functions of the facility.

B.5 PROCUREMENT OPTIONS

ODOT has several options in regard to how to procure the services necessary for the D/SFMS components; they include traditional, design/implement and system manager.

One of the challenges for deploying ITS facilities is the selection of a procurement method that best suits the system being deployed within the context of the procuring agency or agencies.

A number of previously conducted studies have analyzed the applicability of certain procurement methods to this type of facility. This section summarizes the “lessons learned” from these studies as well as references the “FHWA Federal-Aid ITS Procurement Regulations and Contracting Options” document. The following presentation of procurement options considers alternative procurement strategies and alternative bidding methods.

The primary procurement strategies used for ITS projects include the traditional “Engineer/Contractor” approach, the “System Manager” approach, the “Program Manager” approach and the “Design/Build” approach as described below:

*Engineer/Contractor Approach*

The “Engineer/Contractor” approach is the traditional procurement method used by Departments of Transportation (DOTs) contracting for roadway and facility
projects. The product of the consultant is a Plans, Specifications & Estimate package that the owner then uses to select the lowest responsible bidder to perform the contract tasks, such as construction, system acquisition and integration and testing. Typically both the consultant and the contractor are accountable to the client/owner, with the consultant providing advice to the owner during the bidding and construction phases.

Many ITS projects around the nation have been completed using this methodology. However, due to the nature of software development, most efforts encountered costly change orders and schedule delays. FHWA is moving away from this approach for ITS related projects.

*System Manager Approach*

The System Manager approach delegates some of the authority of the client/owner with regard to project administration to the System Manager. While the actual levels of delegation are negotiated between the System Manager and the client/owner, typical tasks that may be delegated to a System Manager include: preliminary engineering, specifications preparation, supervision of final design, construction engineering, software development or acquisition, system integration and testing. Actual final design and construction are still under the control of the client/owner. The System Manager approach allows the owner to realize the benefits of competitive bidding for the facility and hardware components of the program, while maintaining accountability in the System Manager for integration and testing.

This approach allows the client/owner to have greater control over the software development effort by allowing it to be supervised directly by the owner and not buried under a construction effort. The System Manager is on the hook to ensure the system operates as designed. Many times the contract is designed as a “task order” type with the final design of the facility plans, software, communication and hardware specifications as the initial task. Software development, testing and integration are usually let as separate tasks as the project proceeds and funding becomes available. If executed with task orders, it allows the system to be developed incrementally thereby minimizing risk. This type of work is usually selected on pre-qualifications and then negotiated for price.

*Design/Build Approach*

The “Design/Build” option, similar to the System Manager approach, simplifies the client/owner role by providing a single point of responsibility for all of the work associated with the
deployment. However, this option places more responsibility on the client/owner to ensure the delivery of a quality product. The Design/Build approach must be carefully controlled and monitored. The traditional autonomy afforded to design/builders to deliver the project on budget may be in contrast to the owner’s best interests in a high technology acquisition. This method may be appropriate for field hardware devices, cabling or other definable physical components such as TOC buildings. Since the contract is structured for a fixed price, the contractor is striving to minimize costs and will develop software in accordance with minimum specifications. If specifications are vague or poorly developed, some features that were anticipated to be included will be considered change orders to the contractor. It should be noted that in Ohio this method of procurement is not preferred for ITS projects.

B.5.1 BIDDING METHODS

While procurement strategies address the type of organizational structure used to manage the implementation of the project, bidding methods pertain to the guidelines used by the client/owner to bid the project and the procedures used to select the contractor.

Lump Sum

A lump sum contract is a statement provided by ODOT indicating that the contractor will complete a project for an established sum of money. An advantage that lump sum contracts have is that a price ceiling is established.

Two-Step Procurement

The “Two-Step” procurement process begins with a pre-qualification of contractors who have a previous track record of building similar facilities. These teams are then requested to submit a bid based on Plans, Specifications & Estimates documents for the project. An advantage of this method is that the owner is assured that the contractor is qualified to complete the work. The owner is then able to determine the best pricing package among all of the available firms.

Incentive/Disincentive

This bidding alternative provides an incentive for the early completion of projects as well as a disincentive for late completion or for slowed work on a project. There are two types of the Incentive/Disincentive process:
Linear Incentive, in which work has to be completed before the end of the contract time to receive a bonus, and

Non-Linear Incentive, where the incentives are tied into the contractor’s schedule and controlling items of work must be clearly defined. The contractor must work continuously to avoid being penalized.

Qualifications Based Selection

The “Qualifications Based Selection” (QBS) Process follows these steps: First, design/build teams are shortlisted based on qualifications. Second, the short listed teams are interviewed and a rank order is established to select a team to enter negotiations. The selected team then negotiates a contract with the owner based on professional fees for the pre-construction/design phase of services, with a guaranteed maximum price and guaranteed delivery date to be established after design development. The design process is highly interactive with the owner. Subcontracts publicly bid on an “open book” basis, allowing the owner to pre-screen bidders and to review the bid results. The design/build team is ultimately responsible to deliver in accordance with the agreed upon design, schedule and price.

The QBS process requires that ODOT has on staff, or retain, a design professional appropriate to the project to serve as the agency’s representative for the project. The “agency representative” is responsible to ensure that what is promised is delivered. They may assist the owner in interpreting needs, but their role is not to design the project nor in any way duplicate the services of the design/build team professionals.

B.6 OPERATIONS AND MAINTENANCE PLAN

The operations and maintenance of the D/SFMS will be developed as the final system design is being completed. The operations and maintenance of the D/SFMS will be a combined effort of the stakeholders. The D/SFMS operations and maintenance plan will be completed through a structured process of stakeholder interviews.

Freeway management systems require active management to be effective, including periodic re-assessment of the control strategies used. In order to have a system that is operated and maintained properly, there must be staff and funding commitments by the operating agency. The process of defining system operations and maintenance activities during the preparation of the implementation plan may expose issues and allow time for their resolution prior to system implementation.
A Standard Operating Guidelines document will also be developed for the D/SFMS. The Standard Operating Guidelines will include the following elements:

- Identifying staff that has access to the TOC.
- Clearly delineating the roles of the personnel working within the TOC.
- Clearly stating which agency has exclusive or primary responsibility for certain actions necessary for traffic operations and management, and where supporting roles are planned (i.e., operation of the other agency's equipment when they are not present);
- Establishing detailed guidelines for personnel to manage or respond to incidents and events as they occur; and
- Clearly delineating the roles, responsibilities and access of other parties sharing in the operation of the D/SFMS (i.e., Police, the media and other potential public and private sector partners).

ODOT’s operations and maintenance goals guide the development of the D/SFMS operations and maintenance plan. These goals focus on the following priorities.

- Incident Management;
- Multi-agency coordination;
- Traffic Monitoring and Surveillance;
- Traffic Control and Traveler Information;
- Low cost/operationally effective;
- Operations based;
- Hybrid approach to communications;
- Minimize detection by the roadside and leverage PSAP call centers.

### B.6.1 OPERATIONS GUIDELINES

Operation guidelines will be developed for all implemented hardware, software and operational procedures. For example, the implementation of CCTV monitoring raises some legal questions with regard to civil rights of individuals. Subsequently, operator guidelines will be developed during final design to be compatible with ODOT policy. These guidelines would address:

- Camera guidelines;
- CCTV monitoring assistance requests;
• Other information requests and
• Videotaping.

Procedures for sharing video feeds among the D/SFMS stakeholders will also be documented so software design incorporates the hierarchy of control rights of the cameras. As CCTV is deployed throughout the region, coordination with the D/SFMS stakeholders is paramount to coordinating freeway management throughout the study area.

B.6.2 INSTITUTIONAL ARRANGEMENTS

The project involves multiple government agencies that approach the project from various perspectives. This mix of organizations has the potential for difficulties in the following areas: overlapping responsibilities; lack of understanding; conflicting priorities and policies. To avoid problems in these areas, it is important to establish close coordination early in the planning process. This coordination permits the stakeholders to develop a better understanding of the system alternatives and the recommended features and functions.

A series of agreements will be developed for the D/SFMS and signed by participating agencies and organizations that establish the framework for the funding, design, construction, operations and maintenance of the D/SFMS. The parties to these agreements will concur that the concept and operation of this system will serve the public purpose by efficiently combining the appropriate capital expenses in a coordinated fashion with operational activities of the parties in this joint program.

B.6.3 PERSONNEL AND BUDGET RESOURCES

Staffing for operations and maintenance of systems is a function of system complexity, hours of operation and activities supported by the system. Staffing responsibility for operating and maintaining a system is normally integrated into the operating agency’s existing organization structure. The D/SFMS implementation plan will include the following elements for the personnel and budget resources section:

• Staffing plan
• Provisions for training new staff
• Sources of budgetary resources, including Federal, and their committed contributions
B.7  PROJECT PHASING / SCHEDULING

Project phasing and scheduling for the D/SFMS will be completed once design and TOC site selection are finalized.

B.8  COST ESTIMATE

A detailed cost estimate for the D/SFMS will be revisited once design and TOC site selection are finalized.
Appendix C
TOC Location Analysis Methodology
C.1 TRANSPORTATION OPERATION CENTER

The location of the D/SFMS operating facility will be determined based on a site selection methodology agreed upon by the ITS Management Committee. The Study Team developed decision criteria to determine the best location for the facility. These factors will be weighted to each potential location along with a cost for preparing the site for D/SFMS operation. It is a quantitative/qualitative approach meant to provide insights into each candidate site, provide a process by which the ITS Management Committee could contribute their issues and concerns and reach a preferred alternative by a logical and structured methodology.

C.2 SITE SELECTION METHODOLOGY

One of the first steps in the site selection methodology is the development of decision or evaluation criteria. The final criteria selected will focus on various discriminating attributes between the different sites.

C.2.1 APPROACH

The site selection methodology developed for the D/SFMS is designed to provide the ITS Management Committee with a mechanism by which they would be able to understand the critical issues surrounding the selection of a site conducive for the TOC. It is a quantitative/qualitative approach meant to provide insights into each potential site, provide a process by which all stakeholders could contribute their issues and concerns and reach a preferred alternative by a logical and structured means.

Public sector decision makers are often faced with the problem of making choices from among a number of alternatives of which there is no clear quantitative method for resolving the problem. Decision Analysis, a field within the larger study of Operations Research/Systems Analysis, attempts to provide tools by which decision makers can clearly understand all the issues surrounding complex problems. The Study Team, using a subset of Decision Analysis known as Multi-Attribute Utility Theory, developed a methodology that would generate an utility/cost ratio for each potential site for ranking purposes. This procedure provides a straightforward structured process that allows decision makers the ability to describe what attributes or criteria are important to them in making a decision, quantify which criteria are most important in making that decision and develop measures by which each alternative can be scored against each criterion. Finally, each
alternative’s relative worth, as developed by the process just
described, is contrasted with its relative cost to implement. This
process is detailed in the paragraphs that follow. The site
selection methodology begins with the development of criteria.
These criteria are attributes by which each alternative will be
judged; therefore they must describe the critical discriminating
factors for the decision being made. For example, if one is buying
a new car, the criteria in that decision might include: safety
features, gas mileage or even the color of the car.

Once the criteria are developed, they are ranked in relative
importance to each other to determine which criteria are most
important. Although all the criteria are part of making the decision,
some will be more critical than others. For instance, in the car
example above, safety features would usually be more important
than the color of the car. By this means, the methodology can
demonstrate the preferences of the decision makers, in this case
the ITS Management Committee members, and illustrate which
criteria are most important.

The third step is the development of measures by which each
alternative’s worth or utility can be assessed. The value of each
criterion will be demonstrated by the use of utility charts. Utility
charts, as seen in Figure C.1 below, are a mechanism by which
each alternative can be measured. Please note that the utility
range in this methodology is on a scale of 0.0 to 1.0 with 1.0

![Utility Chart Example](image-url)

**Figure C.1** Example of Utility Chart

representing the maximum utility or value to the decision maker.
Again in the car example, if the car has certain safety features it
should receive a relatively higher value or score because, to the decision maker, it has greater value or utility.

In this way, scores can be assigned for each alternative for each criterion. If we were to step through this entire process using the car example, it would look something like Figure C.2 in which Alternative #1 is described by the four criteria of safety features, color, gas mileage and engine size.

![Figure C.2 Example of Criteria Structure](image)

The decision maker involved in this decision has assigned relative weights (the number below the criteria label) to each criterion. Please note that the weights sum to 100, and therefore, can be thought of in percentage terms. In this example, safety features are five times as important than color. Finally, each criterion is scored for each alternative. These numbers are seen on the far right of the figure. These again were derived from utility charts by which each alternative is being judged. Each criteria’s maximum score is 1.0 therefore, in this example, Alternative #1 must have had many safety features since it scored .9 out of a total possible 1.0 points. To generate the overall utility score for Alternative #1 in this example, one would multiply the score for each criterion (the numbers on the far right side of Figure C.3) by the weight of the criterion. Those numbers are added to get the overall utility score for that alternative. Figure C.3 demonstrates this process.
Finally, the cost of the alternative is factored into the decision by dividing the overall utility score by the cost of the alternative. Table C.1 demonstrates this final step and illustrates that in this example, Alternative #3 is the preferred alternative.

This subsection presented a quick overview of the methodology that could be used in evaluating sites for the D/SFMS. Obviously, there will be more detailed criteria and cost components than in the simple example provided, but the approach is the same.

<table>
<thead>
<tr>
<th>Alternative Utility</th>
<th>Alternative #1</th>
<th>Alternative #2</th>
<th>Alternative #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost in Thousands</td>
<td>16</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td>Utility/Cost Ratio</td>
<td>3.81</td>
<td>3.00</td>
<td>4.31</td>
</tr>
</tbody>
</table>

Table C.1 Example of Utility/Cost Analysis

It is important to note that the ITS Management Committee will be a critical component to this process by providing technical input into the selection process structure, criteria definitions and criteria.
weighting. The TOC site selection methodology will be used to analyze the trade-offs of the various candidate sites and to facilitate consensus building among the project stakeholders. The following subsection details the methodology for the TOC site selection analysis.

C.2.2 SITE EVALUATION CRITERIA DEFINITIONS

As described above, one of the first steps in the site selection methodology is the development of decision or evaluation criteria. The ITS Management Committee members will have an opportunity to revise, delete and develop new definitions. The final criteria selected will focus on various discriminating attributes between the different sites. As a starting point, the following definitions of suggested criterion are described below.

C.2.2.1 SITE SIZE

The site size criterion measures whether a site is sufficient and flexible enough to accommodate all facility and site requirements as well as future expansion of the D/SFMS TOC facility. The ITS Management Committee will assist in the development of facility requirements during preliminary design of the D/SFMS.

Definition:
The Site Size criterion measures whether a site is sufficient and flexible enough to accommodate facility requirements and future expansion of the D/SFMS TOC facility.

How it will be measured:
Sites will be rated according to the available square footage of each candidate site within a range, to be determined, with the facility having the most square footage receiving a higher score.

<table>
<thead>
<tr>
<th>Lower Score</th>
<th>Higher Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Square Footage</td>
<td>High Square Footage</td>
</tr>
</tbody>
</table>

C.2.2.2 PROXIMITY TO INFRASTRUCTURE

The Proximity to Infrastructure criterion focuses on the proximity of the TOC site to the planned D/SFMS infrastructure. It is meant to illustrate the preference for a site that is close to equipment, so as to reduce cost of connecting the site to the existing infrastructure.

Sites will be scored by taking inventory of the number of infrastructure components within a 10-mile radius around each
candidate site. The sites with the higher frequency of infrastructure components nearby will receive a higher score.

**Definition:**
The proximity to infrastructure criterion measures the distance of current and planned ITS infrastructure (conduit, existing CCTV and communications) to the potential TOC sites.

*How it will be measured:* Sites will be ranked based on the proximity of each site to the planned D/SFMS infrastructure.

<table>
<thead>
<tr>
<th>Lower Score</th>
<th>Higher Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 10 miles from Infrastructure</td>
<td>Less than 10 miles from Infrastructure</td>
</tr>
</tbody>
</table>

**C.2.3 SELECTION CRITERIA WEIGHTING**

The following chart provides the ITS Management Committee members the opportunity to weigh the site evaluation criteria. A quantitative weighting assigned to each criterion where the total for all three criteria adds up to 100 points represents the relative importance. Each committee member will complete the matrix of pair wise comparisons for all three criteria shown in Figure C.4.
The totals for each criterion will be summed and the percentage of each criterion calculated and used to assign the score for each of the criteria. The average weightings serve as the maximum score for each criterion and will be used in developing the utility scores for each candidate site.

C.2.4 COST DEFINITIONS

Cost measures associated with the site selection process include the following:

- **Building/Construction**: The Building / Construction cost includes the estimated construction costs for retrofitting an existing building.
- **Communications**: The Communications cost includes anticipated costs to link the TOC to the proposed D/SFMS communications infrastructure.

The overall cost estimates are then utilized in the utility/cost analysis to represent the “value” per economic dollar of each candidate site being considered.

C.3.0 CANDIDATE SITE EVALUATION

The purpose of the Candidate Site Evaluation is to apply the methodology developed in the previous section to the candidate site alternatives. ODOT and the ITS Management Committee will select candidate sites in the next phase of the D/SFMS’ development. An initial list of TOC locations were discussed during the second Workshop of this study.

C.3.2 UTILITY ANALYSIS

The site selection methodology discussed above outlines the site selection definitions, weightings and rating scale selected for analysis of the candidate sites. Based on this approach, each site will be assigned a rating for each site selection measure based on the site’s compliance to the measure. The results for each site selection criterion are then summarized. The ratings will be multiplied by the appropriate criteria weighting and summed to provide a total composite utility score for each candidate site.