1.0 Introduction

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 development of the Miami Valley Regional Intelligent Transportation System (ITS) Architecture in September 2003. The Miami Valley Regional ITS Architecture effort is built on a strong ITS interest in the region and some recent signature ITS projects which have brought the need for a Regional ITS Architecture to the forefront.

The region's initial ITS efforts began in 1997 with the region's early deployment study. The Miami Valley Early Deployment Plan (EDP) 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. The EDP documents several regional goals for improving the efficiency of the Miami Valley transportation system.

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 (GDRTA) fixed route 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. In addition, ODOT's Freeway Reference Marker program provides critical location information to travelers in the Dayton area when reporting incidents along the regional freeways. Conduit and pullbox installation for future communications networks will also be 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 anticipation of soliciting 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.

MVRPC and CCSTCC have participated in ITS workshops in an effort to further regional projects. In 2002, two workshops were sponsored by the FHWA to assist the agencies 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 workshop held on November 13-14, 2002. In 2003, stakeholders from the Miami Valley region attended a Turbo Architecture class in preparation of the development of the Regional ITS Architecture. All of these workshops will enhance the region's efforts in developing an ITS Architecture for the region.

Furthermore, no Regional ITS Architecture 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.

In 2000, with ODOT's focus moving toward improving incident management and congestion mitigation, ITS strategies became an option toward achieving ODOT's goals. As a result, the ITS Program Office was created, which in turn prepared a Best ITS Management Practices and Technologies for Ohio report completed in July 2001. It is important for the Miami Valley Regional ITS Architecture 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. The Miami Valley Regional ITS Architecture also adheres to the state perspective and will continue to do so as the ITS projects in the region are developed.

Finally, the region recently completed a detailed project plan for the Dayton/ Springfield Freeway Management System (D/SFMS). This system will provide the capability of operating the freeways in the Miami Valley region more effectively by leveraging detection and surveillance technologies to enhance safety, reduce congestion and facilitate multi-agency coordination. The system includes closed circuit televisions (CCTV) for incident detection and verification, dynamic message signs (DMS) to inform the public of travel conditions ahead and highway advisory radios (HAR) to provide more detailed traveler information in the region. Furthermore, it utilizes a hybrid approach to communications, using a mix of fiber optic, wireless and broadband technologies, to determine the most cost effective method to connect its field devices.

The ITS Management Committee was reconvened for the D/SFMS study, which was the first regional ITS effort undertaken as a result of the EDP. Committee members provided feedback throughout the development of the D/SFMS. The support and contribution of the Committee members on the D/SFMS also provides continuity to the previous ITS planning efforts and reenergizes the ITS program in the region.

With this strong foundation in mind, the Miami Valley region next initiated the development a Regional ITS Architecture for the region. This Architecture would not only meet the federal guidelines but provide a mechanism for a truly regional ITS system to be developed. The Regional ITS Architecture would promote the sharing of data and information, minimizing project duplication and stand-alone systems.

1.1 Goals, Needs and Services

The goal of this effort is to develop a Miami Valley Regional ITS Architecture for the Miami Valley Region in accordance with Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) policies.

Section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21) requires that all ITS projects funded through the Highway Trust Fund be in conformance with the National ITS Architecture and applicable standards. In 1998, the United States Department of Transportation (USDOT) issued interim guidance for this effort. During that time, FHWA and FTA established a common policy on architecture conformity. The National ITS Architecture is a common framework for ITS interoperability based on a set of user services and defines functions and information exchanges. The National ITS Architecture is maintained by USDOT. Section 2 provides an overview of the National ITS Architecture. The section also describes the background and framework for the Miami Valley Regional ITS Architecture.

On January 8, 2001, FHWA issued an ITS Architecture and Standards regulation and FTA issued a parallel policy. They both became effective April 8, 2001. These two “policies” are virtually identical in content. Separate policies were needed because of the differences in the way that FHWA and FTA administers projects. Their intent was to foster integration (and proper consideration of integration) of ITS systems being deployed in a region.

The policy and rule states: *ITS projects shall conform to the National ITS Architecture and standards in accordance with the requirements contained in the rule. Conformance with the National ITS Architecture is interpreted to mean the use of the National ITS Architecture to develop a Regional ITS Architecture.*

The FHWA Rule and FTA Policy require that a region that is currently implementing ITS projects must develop a Regional ITS Architecture to guide their deployment by April 8, 2005. Regions without ITS will have to meet this requirement within four years of their first ITS project advancing to final design. The National ITS Architecture is used as a resource in developing the regional architecture. A Regional ITS Architecture should be on a scale commensurate with ITS investment in the region.

Therefore, based on this guidance the Miami Valley Regional ITS Architecture contains:

- Description of the region,
- Identification of the participating agencies and stakeholders
- An operational concept that identifies goals and objectives of the system and the roles and responsibilities of stakeholders
- Any agreements required for operations
- System functional requirements (high level) to address the needs of the region
- Interface requirements and information exchanges with planned and existing systems and subsystems
- Identification of ITS standards supporting interoperability
- Sequence of projects required for implementation

The Miami Valley Regional ITS Architecture is intended to provide the basis for the ongoing planning of ITS integration in the region.

As with most regions around the country, funds for transportation improvements are becoming scarce. Correspondingly, the competition for those funds is increasing. Furthermore, increases in miles-traveled have raised concerns about safety as well as how the current system will be able to meet the anticipated future demand. Therefore the overall goal of ITS in the region is to leverage technology to improve the current infrastructure to save lives, time and money.

1.2 Approach

Successful Regional ITS Architectures are only developed with the input from a wide range of regional stakeholders. The approach toward developing the Miami Valley Regional ITS Architecture was designed specifically to involve many stakeholders from the region while leveraging the existing ITS Management Committee as a baseline. This methodology reaches out to not only traditional transportation agencies and organizations but to safety, emergency management, homeland security, and the media as well. The planning horizon for this architecture is 20 years.

User Requirement Committee Structure

A key component in the development of the Miami Valley Regional ITS Architecture was the formation of a series of functionally based working groups. The functional groups' goal was to map out detailed architectural flows and data exchanges that comprise the Regional ITS Architecture. The number of these working groups is

based on the various ITS functions in the region. A detailed listing of participating stakeholders can be found in Section 3.

These working groups, empanelled primarily with technical level staff, met several times throughout the project. During each meeting, the stakeholders worked on the ITS integration and development plans for their specific functional area. By keeping the focus of each working group tight, the study team was able to utilize the stakeholders to their greatest potential. Each participant contributed their own agency's requirements to the regional effort while not spending time on elements of the architecture outside their field of expertise. Other groups such as the media and special event management met once during the later part of the study. By presenting the Regional ITS Architecture to the media and special event managers later on in the process, a more structured presentation of the primary data flows had been created. Care was taken to present the Regional ITS Architecture information in such a way that the media recognized the need to participate with data sharing in the region.

Each working group's final product is a series of functional flow diagrams developed by the study team from the input gathered at each meeting. These diagrams are based on the Functional Flow Diagrams in the National ITS Architecture Version 5.0 and similar to the concept utilized in the D/SFMS Project ITS Architecture, are tailored flow diagrams illustrating exchange of data and functionality. To help tailor these specifically to this region, a narrative accompanies each diagram explaining the flow of information and offering real world examples of existing systems or descriptions of systems in the future. Readers will be able to clearly understand the interactions within the region through these diagrams better than reviewing a generic Functional Flow Diagram drawing from the National ITS Architecture. The functional flow diagrams appear in Section 5 of this report.

MVRPC developed the Regional ITS Architecture database, utilizing the Turbo Architecture Version 3.0 software, from the functional flow diagrams created by the regional stakeholders.

Project Inventory

One outcome of the committee efforts was a complete picture of all the ITS related projects in the region. As part of the Regional ITS Architecture effort, the stakeholders and geographic boundaries for the region were defined. Based on the agreed parameters of the architecture, the study team compiled an inventory of all ITS related projects in the region, indicating the responsible agency and divided them into current, short term (within 3 years) or long term (over 3 years) projects. The functional flow diagrams developed as part of the outreach effort document how these projects currently or plan to integrate.

Agreement Inventory

A second outcome of the committee effort was a complete list of the agreements potentially required to make the integration outlined in the functional flow diagrams a reality. In some cases, mutual aid agreements currently exist in the region, specifically in the safety sector. These as well as future agreements will be included in this list along with which agency needs to be involved and any timeframe if known.

Concept of Operations and Functional Requirements

Finally, a concept of operations was developed based on the projects and functional flow diagrams identified. The study team developed a concept of operations for the Miami Valley Regional ITS Architecture that addresses all of the elements identified through the outreach effort and documented in the functional flow diagrams. This concept of operations outlines the critical operational or functional needs and provides, in an easy-to-read narrative format with illustrations, how ITS operations in the region will function with respect to data collection, processing, and dissemination. Section 4 details the concept of operations for the Miami Valley ITS Regional ITS Architecture.

2.0 National ITS Architecture Overview

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. This section explains the essential terminology and concepts needed to understand the National ITS Architecture and illustrates how Regional ITS Architectures fit into the National ITS Architecture framework. In order for projects in the Miami Valley to move forward in the programming process, a Regional 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

2.1 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 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 33 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.

2.2 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 Regional ITS 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 2.1 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

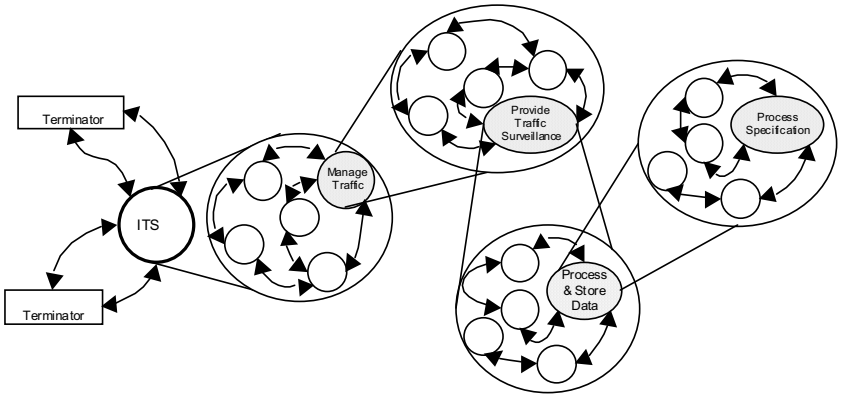

Figure 2.1 National ITS Architecture Logical Architecture

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. These flows represent the various types of information that the advanced traffic management system both receives (i.e. road sensor and CCTV information) and disseminates (i.e. highway

advisory radio (HAR), dynamic message signs (DMS) messages). The rectangles are called terminators and represent interaction and data flows between the ITS project 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.

2.3 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 planned D/SFMS and the regional Public Service Answering Points (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 Miami Valley Regional ITS Architecture is developed. Using the National ITS Architecture physical architecture framework as a guide, the study team with input from Miami Valley stakeholders, mapped out the connections that are current and planned for the region.

The physical architecture of the National ITS Architecture is defined with architecture entities (subsystems and terminators), functional flow diagrams, 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. Examples of subsystems in the Miami Valley Regional ITS Architecture include: the D/SFMS, PSAP centers, local traffic control systems, and ODOT district

systems. 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.

- Functional Flow Diagrams – Functional flow diagrams 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 functional flow diagram for the Miami Valley Regional ITS Architecture is how the region would use surveillance on the freeways for enhanced traffic and incident management. The functional flow diagrams 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 functional flow diagrams. Examples of an equipment package for the Miami Valley Regional ITS Architecture 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 among regional agencies.

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 is critical in ensuring any system operates efficiently.

2.4 Interconnect Diagram

In this section, the interactions discussed generically in the previous narrative begin to take shape in the context of the region. Figure 2.2 illustrates the National ITS

Architecture macro view of all the possible interactions between ITS elements. Note that the National ITS Architecture contains four possible entities for information connection: travelers, centers, vehicles and field elements. Boxes within these four centers are called subsystems. The rounded rectangles in the middle represent communications between the elements.

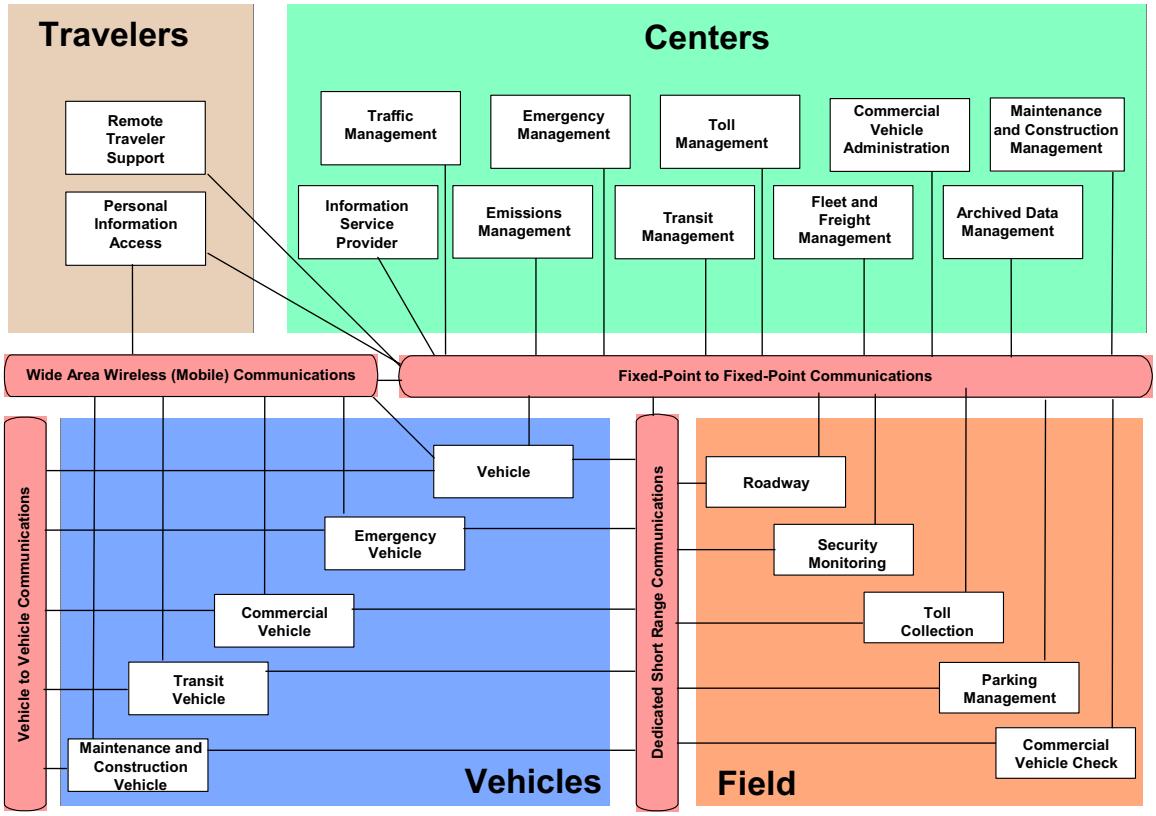

Figure 2.2 National ITS Architecture Summary Diagram

The next step takes this "all possibilities" diagram and cuts out what is not relevant to the region and augments what is. The result of this effort is Figure 2.3, which is a custom tailored summary diagram for the Miami Valley region based on the information obtained from regional stakeholders and converting it into the National ITS Architecture format.

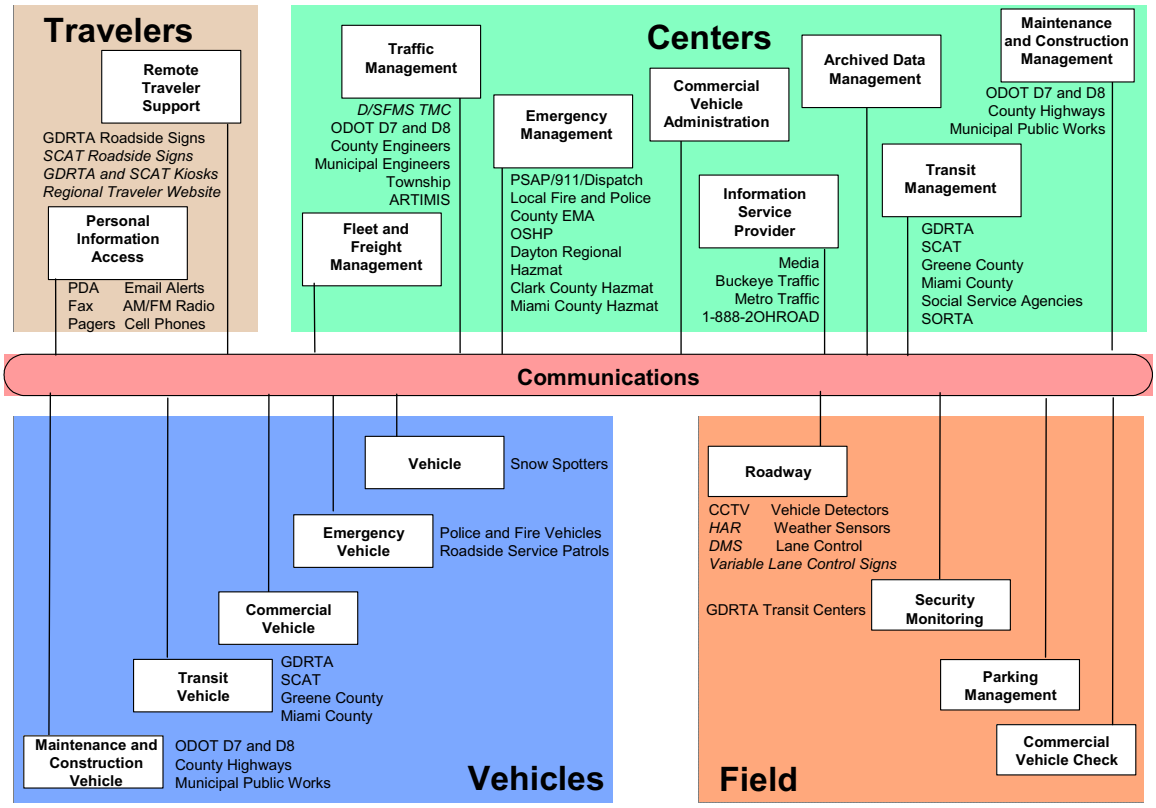

Figure 2.3 Miami Valley Regional ITS Architecture Summary Diagram