Central Ohio Regional ITS Architecture

April 2010

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Acknowledgements

MORPC would like to express their thanks to all the stakeholders involved for their time and valuable input in developing this document and for supporting ITS integration in our region. The various jurisdictions, governments, and agencies were very much engaged in the long process of updating the regional ITS architecture.

Glossary / Definitions

Components

The sausage diagrams are organized into four components: Center, Vehicles, Travelers, and Roadside. Each component represents a possible information connection between ITS technology, information, services, and stakeholders.

Elements

Elements are the basic building blocks of the overall ITS Architecture and represent pieces of each subsystem. An element is defined as a physical entity that performs a particular function, such as a 511 call center or dynamic message signs. The different stakeholders own, maintain, and operate each element.

Functional Requirements

Functional requirements are high-level functions, tasks, activities, or services to be performed by systems to address the needs or problems of the region. The stakeholders define the level of detail.

Information or Architecture Flows

Information or architecture flows are developed based on market packages. The flow diagrams define the information shared between elements and subsystems and show specifically how that information *should* flow between them in order to provide the most efficient and effective transportation service. Page 36 illustrates such a flow diagram and how to read it.

Market Packages

Market Packages identify the pieces of the physical ITS Architecture required to implement a particular service. Market packages consider all the elements and information connections and organize them to provide the most effective transportation service. Market packages are organized by the service they provide.

Operational Concept

The operational concept provides for a "big picture" view of the goals, objectives, and desired capabilities of each system (existing or planned) in a region, without indicating how the systems will or can be implemented. An operational concept documents the stakeholders' *roles and responsibilities* in the implementation and operation of regional ITS elements and services.

Sausage Diagram

A sausage diagram represents an overview diagram which depicts all possible ITS subsystems that can be deployed onboard a vehicle, at central locations, along the roadside, and at remote sites. The “sausages” in the diagram describe communications technologies and how subsystems in the architecture are connected. Page 33 illustrates such a diagram.

Sequencing of Projects

The scheduling of projects is necessary to successfully implement the regional ITS architecture. The sequencing recognizes that in order to initiate some projects, other projects may have to be completed first. Understanding project sequencing also helps stakeholders to visualize how the region’s ITS projects will fit together over time, and to visualize their interdependencies.

Subsystems

Subsystems are pieces of the ITS Architecture that provide a particular transportation service, such as managing traffic or responding to emergencies. They are not physical entities such as Traffic Management Centers; instead, they are groupings of *elements* that all provide a particular service.

Terminators

Terminators are physical entities, representing people, systems, and the general environment that interface with intelligent transportation systems. A terminator defines the architecture boundaries, meaning it is either the beginning or the end of the line for the information or service that is being conveyed by the system. Terminators communicate with the system, provide and/or receive data, but are not themselves part of the system. Examples could be the weather service, which would provide data to the Highway Traffic Management Center for incident management but doesn’t request data from the center.

Acronyms

AASHTO	American Association of State Highway and Transportation Officials
APC	Automatic Passenger Counter
ATIS	Advanced Traveler Information System
AVL	Automatic Vehicle Location
CAD	Computer-Aided Dispatching
CCTV	Closed-Circuit Television
CMAQ	Congestion Management and Air Quality Program
CMFMS	Columbus Metropolitan Freeway Management System
COMBAT	Central Ohio Management Based Applied Technology Program
COTA	Central Ohio Transit Authority
CRAA	Columbus Regional Airport Authority
CTSS	Columbus Computerized Traffic Signal System
DMS	Dynamic Message Signs
DOT	(United States) Department of Transportation
EMA	Emergency Management Agency
FCEO	Franklin County Engineers Office
FHWA	Federal Highway Administration
FIRST	Columbus Freeway Incident Response Service Team
FMS	Freeway Management System
GIS	Geographic Management System
GPS	Global Positioning System
HAR	Hazard Advisory Radio
HazMat	Hazardous Materials
HOV	High Occupancy Vehicle
HRI	Highway Rail Intersection
ISAP	Isolated Signal Assessment Project
ISTEA	Intermodal Surface Transportation Efficiency Act

ITS	Intelligent Transportation Systems
JPO	Joint Programs Office for Intelligent Transportation Systems
LCATS	Licking County Area Transportation Study
MORPC	Mid-Ohio Regional Planning Commission
MPO	Metropolitan Planning Organization
MSA	Columbus Metropolitan Statistical Area
ODOT	Ohio Department of Transportation
ODOT	Ohio Department of Transportation
ODPS	Ohio Department of Public Safety
OEPA	Ohio Environmental Protection Agency
ORDC	Ohio Rail Development Commission
OSC	Ohio Supercomputing Center
OSU	Ohio State University
PUCO	Public Utilities Commission of Ohio
RWIS	Road & Weather Information System
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SOV	Single Occupancy Vehicle
STIP	Statewide Transportation Improvement Plan
T&P	Transportation and Parking
TEA 21	Transportation Efficiency Act for the 21st Century
TERT	City of Columbus Traffic Emergency Response Team
TIP	Transportation Improvement Plan
TMC	Traffic Management Center
TTI	Texas Transportation Institute
VMT	Vehicle Miles Traveled

The ITS Architecture document is structured into three main sections, plus appendices:

PART I: Background

Table of Contents

1. Introduction

In May 2006, the U.S. Department of Transportation (DOT) announced the *National Strategy to Reduce Congestion on America's Transportation Network*, which provides the framework for government officials, the private sector, and most importantly, the citizen, to take the necessary steps to make today's congestion a thing of the past. The objective of the initiative is to reduce congestion, not simply to slow its increase. The U.S. DOT developed a six-point plan for addressing congestion relief that can be found on the DOT Web Site (http://isddc.dot.gov/OLPFiles/OST/012988.pdf). With this initiative, the Federal Highway Administration (FHWA) focuses on a number of high-priority efforts to help reduce congestion and to improve coordination between the different transportation systems and agencies. The components that are aimed at addressing the topic of congestion relief are often related to the application of Intelligent Transportation Systems (ITS). Intelligent Transportation Systems refer to an assortment of technologies, systems, and transportation management concepts that collectively aim to save time, lives, and money.[1]

The current transportation bill SAFETEA-LU continues to place much emphasis on ITS as an alternative solution to reduce congestion, increase traffic flow, and improve air quality. Because congestion levels in central Ohio have not yet reached the same level as in metro areas of similar size, it is even more imperative to act now to avoid these issues in the future. Increasing growth in population and land use will inevitably lead to more traffic and worsened travel conditions. Most travelers are unconcerned by who owns and operates the various components of the transportation system; they only want it to work seamlessly and efficiently. Consequently it is important that the operation of the transportation system be as integrated as possible. In order to foster system integration and agency cooperation, MORPC has taken on the role to house, update, and maintain the regional ITS architecture for central Ohio.

1.1 Need for ITS in Central Ohio

The Columbus metropolitan area has been the fastest growing metropolitan area in Ohio for some time. In fact, Delaware County, north of Columbus, was the 10th fastest growing county in the nation over the last decade. Commute patterns connect this county to Franklin County and the City of Columbus, resulting in urban sprawl. Today, central Ohio continues to battle the growth patterns established by the interstate system's presence. Currently, the population of the 12-county central Ohio region is just over 2 million and it is expected that over 235,000 new people will be added to the region by the year 2030 (MORPC population priojections; 2008 Census data). Based on national transportation trends, these new community members will likely use personal vehicles as their major mode of transportation, leading to additional vehicles on the roadways. The continued spatial diffusion and specialization of facilities results in people covering greater distances to reach shopping, educational, and entertainment centers. Spare-time activities, for example, play an important role in today's life-style and result in additional travel complexity and an expansion of activity space. Due to the growing demand for space, more and more recreation centers and shopping malls are being built in suburban areas.

Overall, travel times are increasing and more people are experiencing traffic congestion as they travel further distances to outlying low density residential developments. The growth in central Ohio continues to exceed forecasts and expectations in both land expansion and travel projections. According to the Texas Transportation Institute (TTI) vehicle miles traveled (VMT) increased by 53 percent on the

[1] http://www.fhwa.dot.gov/congestion/index.htm

freeways and by 60 percent on the principal arterials between 1985 and 2005. The growth is important, but so, too, is the portion of the travel that is congested. In 2005, nearly 59 percent of drivers in central Ohio were driving on congested roadways during peak travel times. Table 1 lists various statistics related to travel growth in central Ohio.

Table 1: Columbus, OH Urban Area Traveler Statistics

Freeway	1985	1990	1995	2000	2005	Increase 1985-2005	
						Value	%
Daily VMT (1000s)	6,960	9,030	10,650	12,000	14,960	8,000	53%
Lane Miles	750	770	810	860	955	205	21%
Principal Arterial							
Daily VMT (1000s)	4,175	5,810	7,735	9,300	10,440	6,265	60%
Lane Miles	1,085	1,245	1,365	1,685	2,120	1,035	49%
Other Measures							
Congested Travel (% of peak VMT)	14	30	43	43	59	45	76%
Fuel Consumed (1000s of Gallons)	1,490	4,752	8,938	10,677	15,513	14,104	91%
Fuel Consumed per Person (Gallons)	4	12	18	18	24	20	83%
Congestion Cost ($ Million)	23	89	188	266	409	386	94%
Congestion Cost per Person ($)	65	230	389	461	620	555	90%

Source: TTI, Urban Mobility Report 2007

These statistics show the importance of curbing congestion levels. Unfortunately, as growth continues and needed expansion of transportation infrastructure spreads beyond the core of the city, the ability to meet the region's infrastructure needs falls behind. New roadways are not being built fast enough, nor are they financially feasible. The region has therefore turned planning efforts towards ITS.

1.2 Benefits of ITS for Central Ohio

Traffic congestion results in lost productivity, money, time, and fuel inefficiency. ITS technologies are developed in an effort to relieve congestion issues. Implementing ITS can result in innumerable benefits. Listing all of them is well beyond the scope of this document.[2] However, key benefits of ITS relating to central Ohio include: A) Enhanced Safety; B) Reduced Congestion; and C) Improved Air Quality and Reduced Fuel Waste. It is important to note that many of these benefits are a result of coordination between various ITS elements. Systems operating independently would not have the same level of impact as integrated systems sharing resources and information.

[2] A more in-depth breakdown of the benefits of ITS can be found on the ITS Benefits and Costs Database: http://www.benefitcost.its.dot.gov.

A. Enhanced Safety

Safety is not only a major objective of ITS but also a way to evaluate ITS performance (FHWA 2005). According to the FHWA ITS Benefits and Costs Database, freeway management systems can reduce crashes by 15 to 50 percent. This significant reduction in incidents results from the integration of various ITS systems. According to FHWA, which surveys cities that deploy ITS, this type of safety-enhancing technology results in the greatest safety improvements. For example, closed circuit television (CCTV) cameras allow Freeway Management System (FMS) operators to detect crashes and stalled vehicles swiftly and provide fire and police dispatchers with accurate incident location information. Similarly, freeway reference markers allow motorists who are reporting a crash to provide precise location details, decreasing emergency response time.

A study conducted by FHWA shows that secondary incidents account for 20 percent of all crashes (ODOT, 2007). Because the majority of freeway crashes are secondary, meaning they occur due to congestion caused by an earlier crash, decreasing incident clearance time even by as little as one minute can have significant safety impacts. Ohio QuickClear is a committee formed by the Ohio Departments of Public Safety and Transportation with the objective to quickly react to roadway incidents in order to maintain the safe and effective flow of traffic during emergencies, and to prevent further damage, injury, or undue delay of the motoring public.

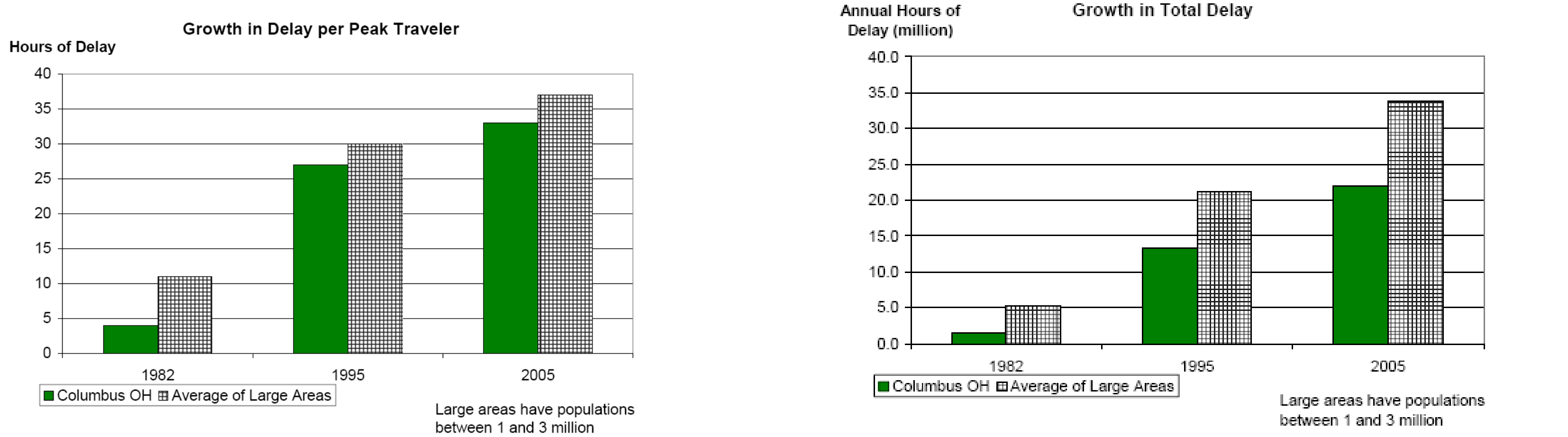
Dissemination of timely traveler information can also help reduce secondary crashes. QuickClear demonstrates the benefits of ITS by using technology like real time photo images to coordinate response agencies to clear incidents. Computer Aided Dispatch (CAD) and Global Positioning Systems (GPS) located on police, fire, and maintenance and construction vehicles also help clear incidents and roadway debris more quickly.

B. Reduced Congestion

The number of vehicles on roadways is rapidly increasing across America, and it is no longer practical or feasible to build our way out of the growing congestion problem. Despite newly constructed roadways, traffic delays continue to grow. According to the Urban Mobility Study, travelers in Columbus experienced 30 hours of traffic delay due to congestion in 2007.

Figure 1 compares the growth in total delay to the growth in delay per traveler. As mentioned before, growing congestion means that transportation funding that is spent on expansion will “buy less capacity than in the past” (Patrick Conroy, 2000). We therefore need to look towards managing our traffic by organizing the flow of our current road systems with ITS technologies for all modes of transportation (Patrick Conroy, 2000).

Figure 1: Growth in Delay per Peak Traveler and Growth in Total Delay



Source: TTI, Urban Mobility Report 2007

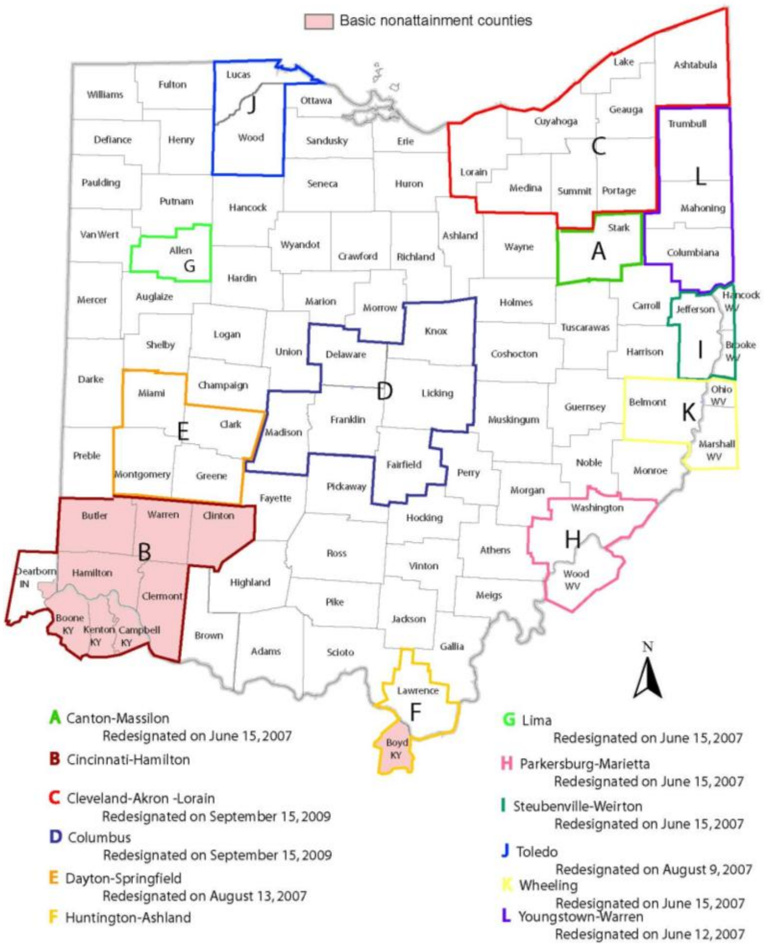
By using lower cost technology, ITS systems battle congestion in the region by managing and organizing roadway demands. Central Ohio has deployed several ITS technologies such as AVL, signal synchronization, and ramp meters. According to ITS America[3], congestion reduction has been a significant national benefit of ITS technology. For example, traffic signal control saved drivers between 8 and 20 percent in delay time, and roadway sensors cut travel time between 10 and 45 percent during congestion periods (ITS America, 2007).

C. *Improved Air Quality and Reduced Fuel Waste*

A major environmental challenge facing many large cities is the need to improve air quality to meet Environmental Protection Agency (EPA) standards and protect citizens' health. In order to comply with EPA emission standards, many regions, including central Ohio, have placed importance on projects that mitigate bad air quality. In 1997, the U.S. EPA declared 12 metro areas in Ohio to be in "non-attainment" of air quality standards, as shown in Map 1. This designation declares that the air does not meet the minimum national ambient air quality standards set by the U.S. EPA to protect public health and, therefore, is hazardous to the population. However, by the end of 2009 all counties in Ohio except those in the Cincinnati metro area had been redesignated as being in attainment. The Columbus metro area was redesignated on September 15, 2009.

[3] ITS America is a not-for-profit organization representing over 400 private and public sector organizations involved in the development and deployment of ITS technologies (http://www.itsa.org/).

Map 1: Ohio 1997 Eight-Hour Ozone Nonattainment Areas, with status as of May 2010



Source: Ohio EPA

There are two main factors that contribute to the air pollution in central Ohio: ozone and fine particles. Ozone is a gas and a component of smog. Ozone pollution is mostly caused by cars, lawnmowers and other gasoline-burning engines. Ozone pollution occurs when the chemical emissions from these sources combine with sunlight.

Unlike ozone pollution, particles do not need sunlight to form. Fine particles are tiny solid particles and liquid droplets measuring less than 2.5 micrometers in size, or 1/20th the width of a human hair. Particle pollution comes from motor vehicles, power plants, industrial facilities and residential fireplaces. Excess fuel burned in cars due to traffic delays is a leading cause of poor air quality. According to the 2009 Urban Mobility Report, the Columbus urban area wasted over 14.5 million gallons of gas due to traffic delays in 2007. Strategies such as encouraging travelers to use transit, reducing vehicle idle time at intersections through signal coordination, and improving incident clearance time have been implemented in central Ohio to reduce fuel consumption and its negative impact on air quality.

ITS systems are vital to meeting emissions standards because the technology can improve traffic flow and, therefore, reduce excess fuel consumption. The fact that the Congestion Mitigation and Air Quality Improvement Program (CMAQ) currently provides all funding for ITS projects demonstrates the direct, positive impact ITS systems have on our air quality, reduced fuel consumption, and travel costs.

There are numerous sources of funding that have traditionally been used to finance transportation from a variety of federal, state, and local funds; however, MORPC's practice is to fund ITS projects with Congestion Mitigation and Air Quality Improvement Program (CMAQ) funds, demonstrating the direct correlation between ITS and its positive impact on Central Ohio's air, and allowing Surface Transportation Program dollars to be used for other projects (MORPC 2007).

1.3 MORPC's Role in ITS Planning

One of the most obvious differences between ITS and conventional transportation solutions is the level of interdependency that exists between projects, and the degree to which information, facilities, and infrastructure can be shared with mutual benefit. Since opportunities for system integration and operational coordination extend beyond jurisdictional boundaries, it is important to have the metropolitan planning organization (MPO) involved in planning for both system and inter-jurisdictional integration.

MORPC has been involved in ITS planning for a long time and has conducted a number of studies regarding the application of ITS systems in the region. These efforts include the involvement in Operation TimeSaver (1993), the Central Ohio ITS Early Deployment Study (1997), the development of the Integration Strategy for Central Ohio (1999), a program assessment for Paving The Way (2007), a feasibility study of an Advanced Traveler Information System (ATIS) (2009), as well as project specific studies related to a centralized transportation/emergency management center, and freeway management and signal system operational analyses. ITS has been and will continue to be an integral part of transportation planning in central Ohio. The goal of the planning process is to ensure that there is informed decision making pertaining to the investment of public funds for regional transportation systems and services. Through the use of the region's ITS architecture, MORPC is empowered to do this. Projects and activities in which MORPC is or has recently been involved include participation in regional and local ITS meetings, such as the Freeway Management System Policy Committee; ; assisting the city of Columbus with their Traffic Signal Assessment; working on implementing a regional multi-modal traveler information system; and highlighting ITS projects in the TIP to ensure that funding is adequately addressed.

1.4 Funding Opportunities for ITS

Communities throughout the United States are facing hard decisions on how to preserve and improve their transportation systems, and the Columbus area is no exception. There are numerous sources of funding that have traditionally been used to finance transportation from a variety of federal, state, and local funds. In central Ohio, the ITS projects are generally funded with CMAQ funds. The maintenance of these systems, however, is financed through other funding sources.

All ITS projects using federal funding in central Ohio must conform to the Regional ITS Architecture. According to FHWA rule 23 CFR 940.9, any agency requesting federal dollars for an ITS project through MORPC or the state must conform to the regional architecture before funding will be allocated. ODOT and the Ohio Division of FHWA recently developed a document titled "Ohio Procedures for Implementing ITS Regulations (23 CFR 940)" which describes the various steps an agency needs to follow when designing and implementing ITS projects funded through federal dollars.[4] Table 2 provides examples of major, minor, and non-ITS projects. One of the project sponsor's responsibilities would be to ensure that a systems engineering process is used in addition to the architecture conformity requirement. This approach will permit ODOT and FHWA to establish concurrence in the level of ITS assessment and documentation needed. As part of this process, MORPC will provide ODOT district offices every two years with regionally planned ITS projects identified through the Transportation

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[4] http://www.dot.state.oh.us/engineering/OTEC/2008%20Presentations/12B.pdf

Improvement Program. In return, the project sponsors have to notify MORPC of any changes or updates to the architecture. This updating procedure will help with the maintenance of the document.

Table 2: Examples of major, minor and non-ITS projects

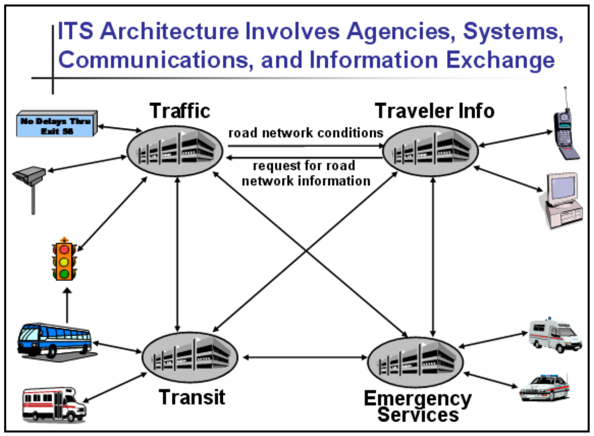
Major ITS	▪ Freeway Management Systems (FMS) ▪ Traffic Signal systems scoped to be centrally controlled ▪ Integration of ramp meters with traffic signals on adjacent arterials ▪ Automated Vehicle Location (AVL) systems ▪ Automated toll collection systems ▪ Integrated Transit Corridors ▪ Traffic signal projects that require the integration of signal systems with FMS or RWIS systems ▪ An ITS system that involves multiple political jurisdictions ▪ An ITS project that involves interagency systems
Minor ITS	▪ Roadway Weather Information System (RWIS) ▪ Roadgrip Sensor System ▪ Transit Signal Priority Systems ▪ Various surveillance or control systems that could functionally be integrated into a FMS ▪ Highway Rail Intersection (HRI) warning systems ▪ Emergency vehicle preemption systems ▪ Parking Management Systems
Non ITS	▪ System expansions that do not add new functionality ▪ Closed loop signal systems not integrated with other devices or systems (Emergency vehicle preemption is considered to be another system) ▪ Routine maintenance and operation of existing systems ▪ Signal retiming even if multi-agency or multi-jurisdictional ▪ Traffic signals which are either isolated, time based coordinated, or interconnected but not centrally controlled ▪ Speeding or red-light running electronic enforcement systems ▪ Cameras installed solely for the purpose of traffic or data collection (except if it could functionally be integrated into a system for surveillance purposes) ▪ Weigh-in-motion systems (unless integrated into an FMS) ▪ Count and classification systems (unless integrated into an FMS)

Source: Based on ODOT's Traffic Engineering Manual, Part 13 2007

2. About the Regional ITS Architecture

Although central Ohio is divided between numerous jurisdictions and agencies, MORPC's vision is to establish ONE transportation network in which all stakeholders share an interest. In order to accomplish this objective, we need to ensure that ITS systems are integrated. The regional architecture helps to facilitate integrated ITS deployment and serves as a regional framework that ensures that there are institutional agreements as well as technical integration for the implementation of ITS projects in a region. The ITS architecture identifies the organizations that provide ITS or those that have an interest in them. The architecture also defines the different operating systems, the functions they perform, what information is exchanged, and how it is exchanged. The document is based on the national ITS architecture which identifies the appropriate ITS standards. A regional architecture is necessary not only for the receipt of highway trust fund dollars, but also for successful regional ITS integration. Figure 2 illustrates the various functions described in the ITS architecture.

Figure 2: Functions described in the ITS Architecture



Source: FHWA 2007

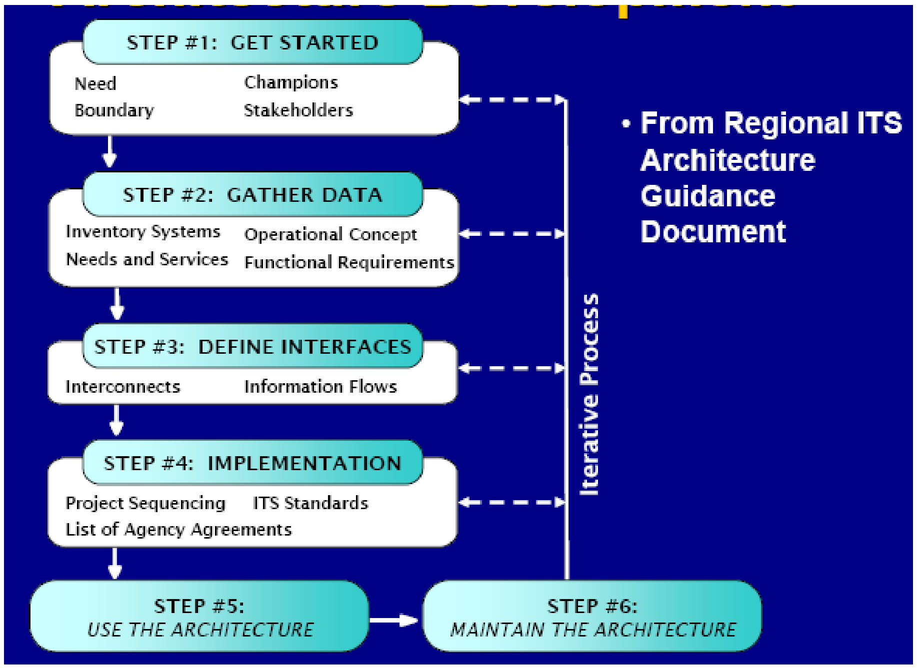
The national ITS architecture was developed to provide a unifying framework for ITS infrastructure deployment to ensure that technologies can work together smoothly and effectively. Likewise, standards are being developed to support interoperability by specifying how systems and components interconnect. Appropriate guidance, training, and technical assistance are necessary to promote understanding and effective use of these tools, and ultimately, to achieve integrated ITS deployment.

A regional ITS architecture is developed and maintained for a variety of reasons. Such a document can, for example, help detect and ensure integration opportunities among regional transportation systems and encourage stakeholder buy-in. By knowing which types of IT systems are in place, gaps in the exchange of information can be identified. A document that lists all existing and planned systems and demonstrates the information flow between them can also help with the estimation of funding needs. Implementations of projects can then be efficiently structured. In addition, the regional ITS architecture often serves as a tool to educate both public and members of the importance of ITS and to help with good information exchange.

2.1 History of ITS Architecture in Central Ohio

In 1999, MORPC completed the first regional ITS architecture-type documentation for central Ohio, entitled *ITS Integration Strategy for Central Ohio*. The report was developed prior to FHWA's decision to require "architecture" documents for metropolitan areas implementing ITS projects. Paying close attention to federal recommendations made for the *Integration Strategy*, as well as to the needs of central Ohio, an updated ITS Architecture was developed. In April 2004, five years later, MORPC developed a formal regional ITS architecture that focused on integration strategies for central Ohio in compliance with the FHWA's ruling. The regional ITS architecture guidance document, *Developing, Using, and Maintaining an ITS Architecture for Your Region*, was used as a tool in establishing a process and ensuring that federal requirements were met. Included as part of MORPC's update to the ITS *Integration Strategy* for central Ohio was the updated software called "Turbo Architecture" (FHWA, Turbo Architecture 4.0, 2007). MORPC utilized this software package to generate more detailed listings of the system inventory and system interconnections. This tool also helped to identify relevant standards for the region.

Figure 3: Process of Regional ITS Architecture Development



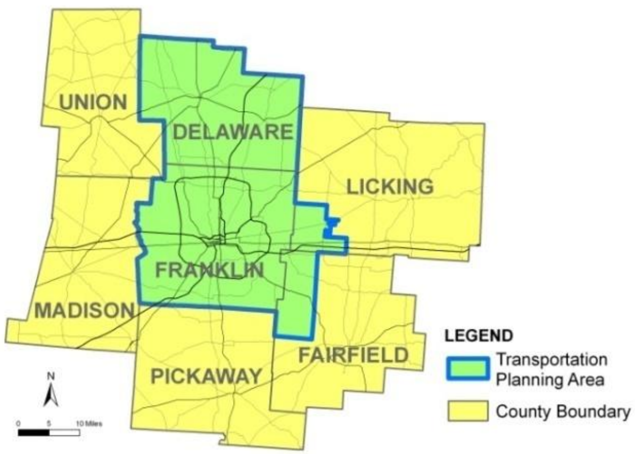
Source: FHWA, Regional ITS Architecture Guidance 2006

This updated document also utilizes the Turbo Architecture software (version 4.0) and is based on National ITS Architecture Version 6.0. The information included in this document was collected via both stakeholder interviews and an extensive online survey (see Appendix A).

2.2 Geographic Scope

The regional ITS architecture is based on the MPO transportation planning area. This area includes Franklin and Delaware counties as well as part of Licking and Fairfield counties, as shown in Map 1. The major interstate and state routes through the region include I-71, I-70, I-270, I-670, and SR 315. However, the identification of ITS projects expands beyond these boundaries to ensure that operational needs for integration and information sharing are met on a regional basis. The Columbus Metropolitan Statistical Area (MSA) encompasses an eight-county region and members of this region were interviewed for the update of this document.

Map 1: Central Ohio Geographic Boundaries



Source: MORPC, 2007

This document is intended to address regional ITS needs and goals over a 10-year horizon. MORPC feels this is a sufficient time period to include most of the region's integration opportunities. Because a 10-year forecast is likely to change, the regional architecture will be reevaluated as part of the 4-year development of the transportation plan.

While this regional ITS architecture is built only around the central Ohio region, ITS systems might go beyond the geographic scope of this area and extend into regions with their own ITS architecture. The Licking County Area Transportation Study (LCATS) currently does not hold a regional ITS architecture for the Newark area. In the future, MORPC could collaborate with LCATS to create a regional ITS architecture together.

2.3 Regional Stakeholders

All members of the MPO planning area are considered immediate ITS stakeholders. Of these members there are four "core" stakeholders who have invested a large amount of time and money in local ITS efforts in the past and have expressed an interest in regional ITS integration. These agencies are: ODOT, the city of Columbus, Central Ohio Transit Authority (COTA) and Franklin County. The expansive group of stakeholders with existing or potential ITS needs include all other counties, cities, and villages, safety and security agencies, and the Columbus Regional Airport Authority (CRAA), among others. Appendix B: Central Ohio ITS Stakeholders includes a list of all stakeholders and associated elements that were included in this version of the regional ITS architecture.

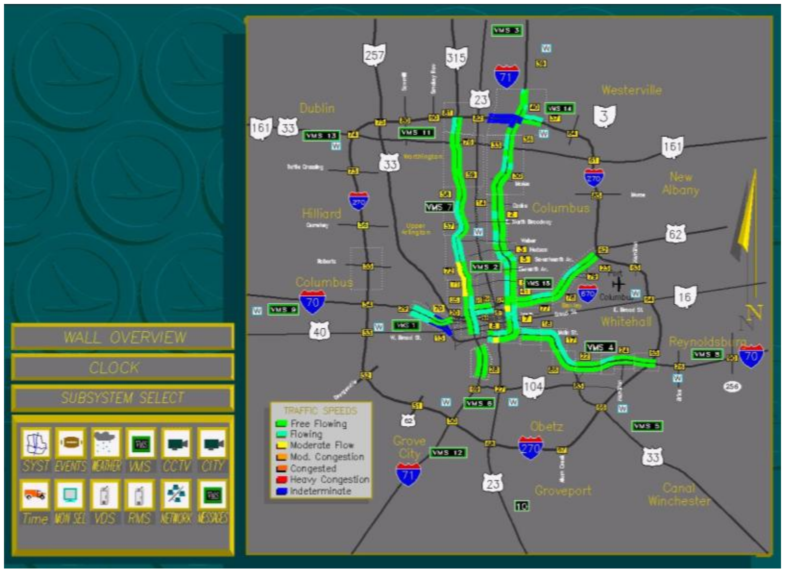
3. Member Project Spotlight

The goal of this section is to highlight some agencies that have successfully integrated ITS projects with other central Ohio stakeholders. As mentioned previously, it is essential to deliver/implement ITS while integrating projects with one another. The following projects illustrate how system integration and inter-agency cooperation can lead to a more effective transportation system.

3.1 ODOT Project: Columbus Metropolitan Freeway Management System

ODOT, based on their knowledge and vision of the Ohio freeway system, developed solutions to traffic management that were ITS in nature. Their data analysis supports the idea that congestion will continue to grow, and that roadway expansion is no longer the solution. As an alternative to road construction, ODOT is a strong supporter of using ITS to solve congestion problems. Their objective in creating the Columbus Metropolitan Freeway Management System (CMFMS) was to focus on incident-related congestion rather than congestion due to chronic capacity issues.

Figure 4: Screenshot of ODOT's FMS Technologies



Source: ODOT 2007

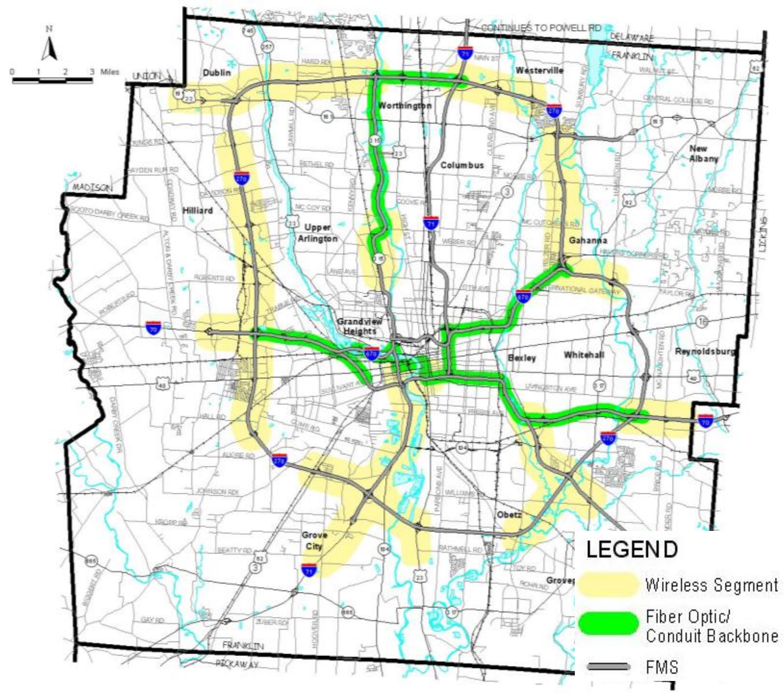
The CMFMS is arguably the most visible ITS project in the region. It is designed to enhance incident management, traveler information, traffic management, and traffic data collection. The CMFMS essentially influences all transportation and emergency management operations in central Ohio. It utilizes ITS elements, such as remote cameras, freeway service patrols, variable message signs, ramp meters, vehicle detectors, and a feed from the Columbus Police CAD system to provide a complete picture of traffic status in the region (see Figure 4). These elements are all aimed at reducing congestion, decreasing the number of crashes, and reducing the response time to incidents. All phases of the CMFMS were completed in 2007. In addition, ODOT makes the information available to the public via an online portal called "BuckeyeTraffic."

As part of the CMFMS, ODOT has implemented a Freeway Incident Response Service Team (FIRST) to detect and respond to minor incidents in the Columbus area, such as property damage crashes, flat tires, stalled cars, and debris in the roadway. Utilizing ITS technology, these vehicles help detect and clear roadside incidents, allowing motorists to reach their destinations quickly and safely. The FIRST team is an excellent example of how ITS integration can benefit both the general public and stakeholders.

3.2 City of Columbus Project: Computerized Traffic Signal System Upgrades

The City of Columbus Public Service Department strives to make roadways more efficient and to reduce gas consumption, auto emissions, and traffic stops. It is the Department's objective to reduce the number of traffic crashes on area roads and freeways. To accomplish this goal, the city utilizes ITS, such as traffic signal computers, to manage, coordinate, and operate its traffic signals.

Figure 5: City of Columbus Signal System



Source: City of Columbus 2004

The City of Columbus Computerized Traffic Signal System (CTSS) was established in the 1980's and has control of nearly 1,000 intersections in Columbus and the surrounding areas (see Figure 5). This Columbus system is a backbone ITS system for the central Ohio region and is made up of several components. The heart of system operations lies in the COMPUTRAN central control system, and secondary pieces of the system include the numerous closed-loop operations throughout the region.

The Columbus system is unique because it utilizes CCTV to monitor downtown intersections and corridors paralleling freeway sections, and shares these images with ODOT. The City's system is one project in the region that has potential for cross-jurisdictional and cross-agency coordination: the CTSS is currently co-located in the city of Columbus Traffic Management Center with ODOT's CMFMS, and the City also has established design, monitoring, and maintenance relationships with several jurisdictions with which it shares borders.

Together with MORPC, the City of Columbus assessed its signal operations in 2005. Based on the results, the city is now upgrading the signal technology to move from a proprietary system to an open architecture, which allows for better signal coordination across jurisdictions. Within this effort, Columbus will be replacing coaxial cables with both wireless and fiber optic technology. The construction of this large ITS project is 100 percent funded through MORPC. Construction of the first phase of the system is beginning in 2010. The City has recently hired a consultant to conduct the design of the second phase of the system.

3.3 COTA Projects: AVL, Real-Time Information, SMART Card, Automated Passenger Counters

Central Ohio's population is projected to grow by 36 percent by 2030, and public transit needs to be prepared to accommodate such growth. COTA has recognized that they have not been able to keep pace with population and job growth in the last few years. COTA sees the implementation of ITS as a major part of their solution to provide effective and efficient transit. From 2005 to 2006, COTA sought input from all levels of government, the community, and planning agencies to plan for future transit needs. Their summary of this input and the goals of COTA are outlined in their Long-Range Transit Plan which includes many ITS components (COTA, 2006). Some of these components are profiled in the following paragraphs.

3.3.1 Transit Automatic Vehicle Locator System

Automatic Vehicle Location (AVL) systems use on-board computers and a Global Positioning System (GPS) to monitor vehicle locations. Because of its ability to provide exact vehicle locations in real time, the AVL system is considered the nexus for the implementation of most other transit ITS systems. One important aspect of obtaining exact vehicle locations in real time is the ability to use this information to monitor the vehicles' schedule adherence in real time. The drivers are constantly aware if they are running late, early, or on time; thus, they can instantly adjust their speeds to maintain schedule adherence. By maintaining schedule adherence, buses are then able to reach their stops on time, allowing timely transfers. This will translate into convenient, efficient, and reliable transit. Transit vehicles equipped with AVL technologies have the ability to function as traffic probes, as their location and speed information is instantaneously shared with traffic engineers.

Figure 6: COTA Radio Room

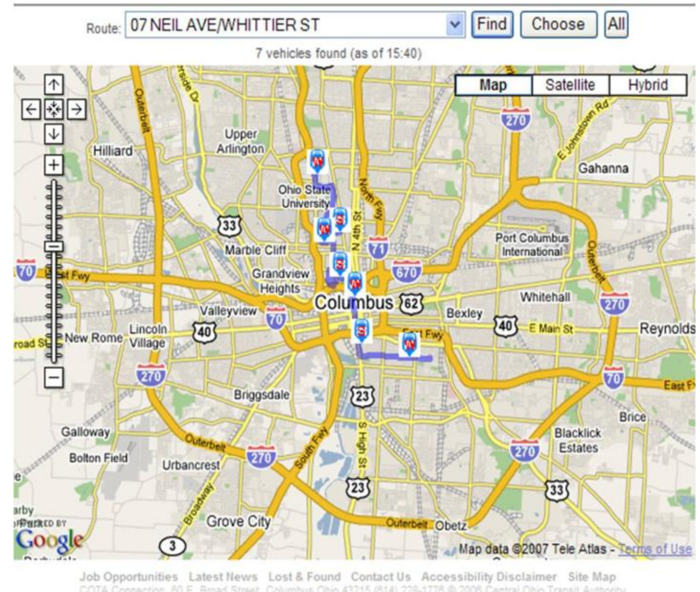
Source: COTA 2006 Short Range Transit Plan

COTA has equipped 100 percent of its fleet with AVL capability and is currently utilizing this technology in conjunction with its dispatching service to improve performance and schedule adherence. Recently, this system established geographic coordinates for all stops in the system, which facilitated the implementation of automated vehicle annunciators. The AVL system will also facilitate the implementation of "real-time" information terminals at key transit locations and "next bus" arrival message signs at park-n-rides and selected bus shelters. COTA's AVL system is proprietary and cannot be shared with other entities. In order to allow for an open architecture and future sharing of data with other systems, COTA is updating the system to use newer web-based technology.

3.3.2 Real-Time Bus Arrival Information System

The purpose of bus information systems is to communicate bus arrival times using AVL/GIS technology to the general public at bus stops. COTA is currently planning for dynamic message signs at selected bus shelters and transit centers that display the estimated arrival times of each line. COTA already provides its passengers with a real-time Bus Tracker system on their website at http://www.cota.com/Bus-Tracker.aspx (also see Map 2).

Map 2: Screenshot of COTA's Real-Time Location Map



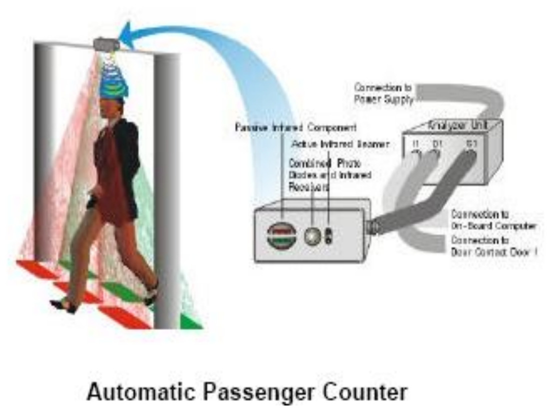
Source: COTA 2007 http://cota.com/realtime.asp

Travelers can see exactly how far the bus is from the target bus stop and calculate arrival time. This information is used to assist riders in making pre-trip and en-route (including in-vehicle) trip decisions. A significant advantage of real-time bus arrival information systems is that most passengers believe that their waiting time has been reduced, resulting in improved perception of transit reliability.

3.3.3 SMART Cards and Automatic Passenger Counters

SMART Cards are a substitute for paper money that utilizes ITS technology. Instead of paying cash while boarding, passengers can load their cards with coins or paper money at various kiosk locations and then use the magnetic stripe cards like a credit card. Offering smart cards quickens boarding times and reduces fare box maintenance. COTA is currently studying this payment method to make it available in the near future.

Figure 7: Automatic Passenger Counter



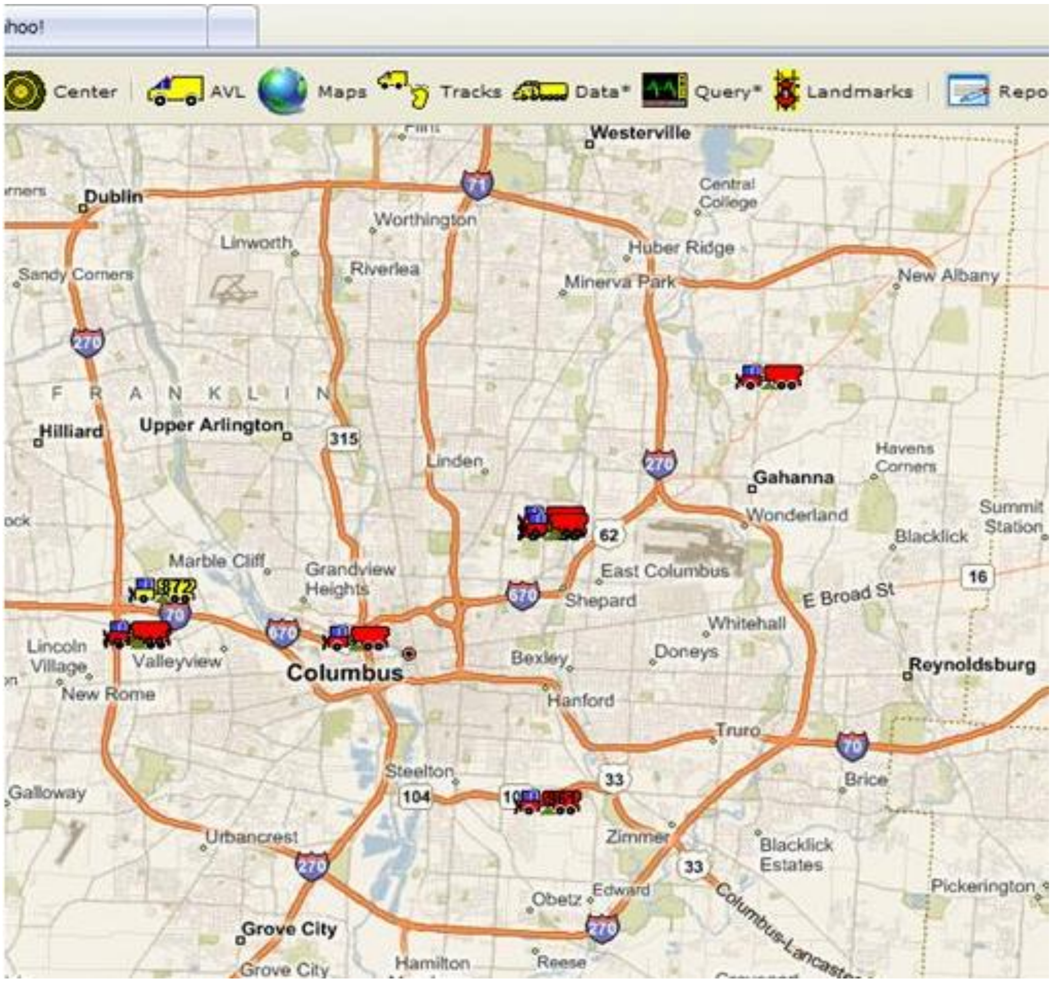
Source: COTA Long-Range Transit Plan 2006

Automatic Passenger Counters are another application of ITS providing a valuable service for the transit system. Using sensors, the program identifies the passengers at boarding and alighting, allowing COTA to plan bus routes that meet passenger demands and to make necessary adjustments for service frequency. The use of Automated Passenger Counters enables COTA planners to increase the level of service without increasing operating expense (see Figure 7) . A sensor-based technology is currently deployed on COTA buses.

3.4 Franklin County Project: COMBAT

The Franklin County Engineer's Office, together with the city of Columbus, has implemented the jointly operated Central Ohio Management Based Applied Technology (COMBAT) program. COMBAT tracks city and county vehicles (see Figure 8).

Figure 8: Screenshot of COMBAT's vehicle tracking system



Source: Franklin County Engineer's Office 2007

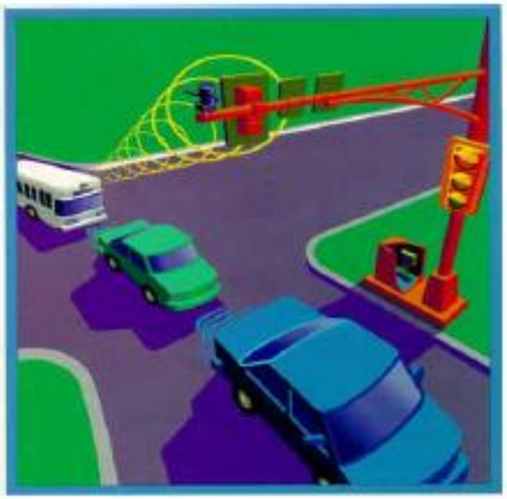
This innovative vehicle management system is vital to know the location and progress of all maintenance trucks, particularly during a snow emergency, so that forces can be coordinated and mobilized jointly. COMBAT equipment provides snow plow dispatchers with the following information: Unit and driver identification; Vehicle location (within three feet); Speed; Rate of salt application; Rate of de-icing liquid application; Plow up or down position; Pavement and air temperatures; and Emergencies.

COMBAT has been fully active since 2009 and involves 75 city and 34 county snow plows, 24 city street sweepers, and nine city and 16 county mowers. The Franklin County Engineer's Office has supervised the $4.1 million start of COMBAT, which was installed by Interfleet, Inc. of Toronto, Canada. Funding was provided by the FHWA, the city of Columbus, and Franklin County.

3.5 Cross-Jurisdictional and Cross-Agency Project: Signal Priority / Signal Pre-emption

A traffic signal preemption system is an electrical device that allows a traffic control signal to respond uniquely to the approach of a particular type of vehicle or the occurrence of an unusual condition at or near a highway intersection. Such systems are designed to increase safety, reduce emergency response times and enhance public transit operations. These systems may be used for the preemption of normal traffic control signal operation by the approach of emergency vehicles, or may be used to modify the length of the green light time to allow for more efficient transit operation.

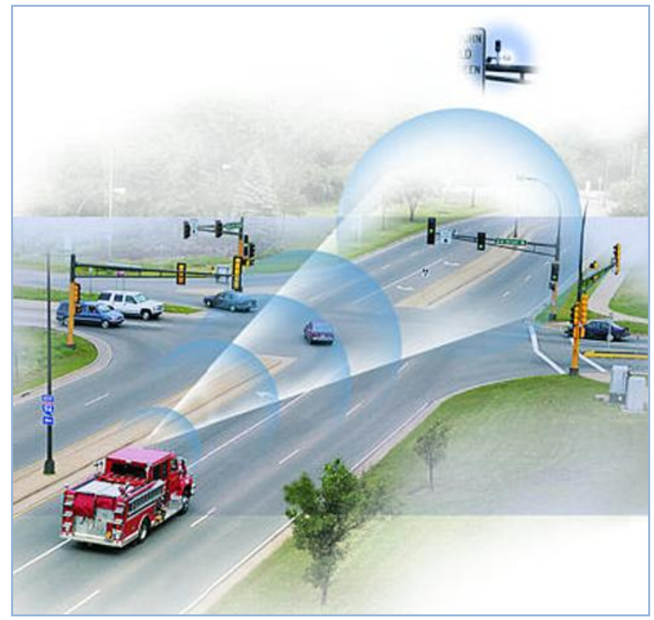
Figure 9: Transit Signal Priority



Source: COTA 2007 Short Range Transit Plan

Signal preemption interrupts normal signal operations to transfer right of way to the direction of an approaching emergency vehicle, but a green indication is not always guaranteed immediately after preemption is requested.

Figure 10: Signal Pre-emption for Emergency Vehicles



Source: FHWA 2009, http://ops.fhwa.dot.gov

By giving signal priority to transit, travel time and delay are shortened, translating into improved passenger convenience and cost savings. Once COTA has updated their AVL systems, the agency plans to work with the individual jurisdictions to allow for signal priority.

This ITS-based project benefits not only the public and COTA, but also integrates COTA into the city of Columbus and other local agencies through coordination of traffic signal operations.

How fast this technology can be implemented depends primarily on Columbus' time schedule to upgrade the current signal system and to develop the capability to program these features. COTA continues to maintain a working relationship with Columbus that will foster this development when the appropriate resources become available.

4. Deployment Trends

The Federal Highway Administration has been collecting information on ITS deployment and integration since 1996, with the most recent data available from 2007. The FHWA's report *Tracking the Deployment of the Integrated Metropolitan Intelligent Transportation Systems Infrastructure in Columbus* is an important tool in measuring the efficiency of transportation systems in central Ohio. Surveys were administered to 108 large metropolitan areas (including Columbus, Ohio), state departments of transportation, and over 2,300 local agencies regarding the deployment of their ITS. The results of the 2007 Deployment Tracking Survey, as well as previous surveys, can be accessed via the FHWA website: http://www.itsdeployment.its.dot.gov/about.asp. These results are used to report deployment progress across the nation for a variety of purposes including program management, research, outreach, and education.

The survey was broken down into eight ITS component areas to match the ITS taxonomy, as shown below. The bold highlighted "**Electronic Toll Collection**" component does not apply to central Ohio and was therefore left out of the deployment and integration calculations for all listed cities in Figure 11 and Figure 12.

- Arterial Management
- Emergency Management
- Freeway Management
- Highway Rail Intersections
- Electronic Fare Payment
- Incident Management
- **Electronic Toll Collection**
- Transit Management

The city of Columbus is ranked the 16th largest city in the nation with a population of 754,885 (U.S. Census Population Estimates, 2008). In order to establish realistic goals for the region, central Ohio deployment trends will be compared to cities of similar size based on population estimates from the U.S. Census. These cities are shown in Table 3.

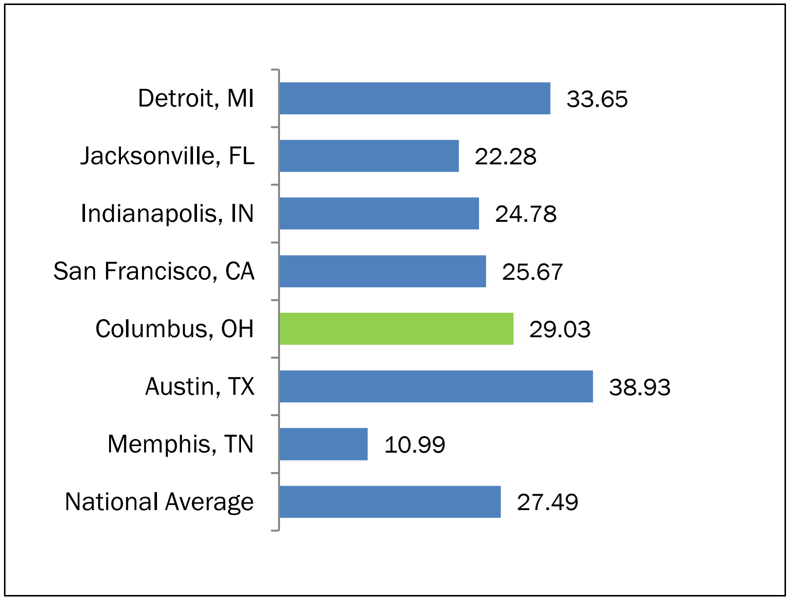
Table 3: US Cities Ranked by Population

Rank	Geographic Area		Population Estimates
	City	*State*	*As of July 2008*
13	Jacksonville	Florida	807,815
14	Indianapolis	Indiana	798,382
15	Austin	Texas	757,688
16	**Columbus**	**Ohio**	**754,885**
17	Fort Worth	Texas	703,073
18	Charlotte	N.C.	687,456
19	Memphis	Tennessee	669,651

Source: US Census Bureau, 2008 Population Estimates

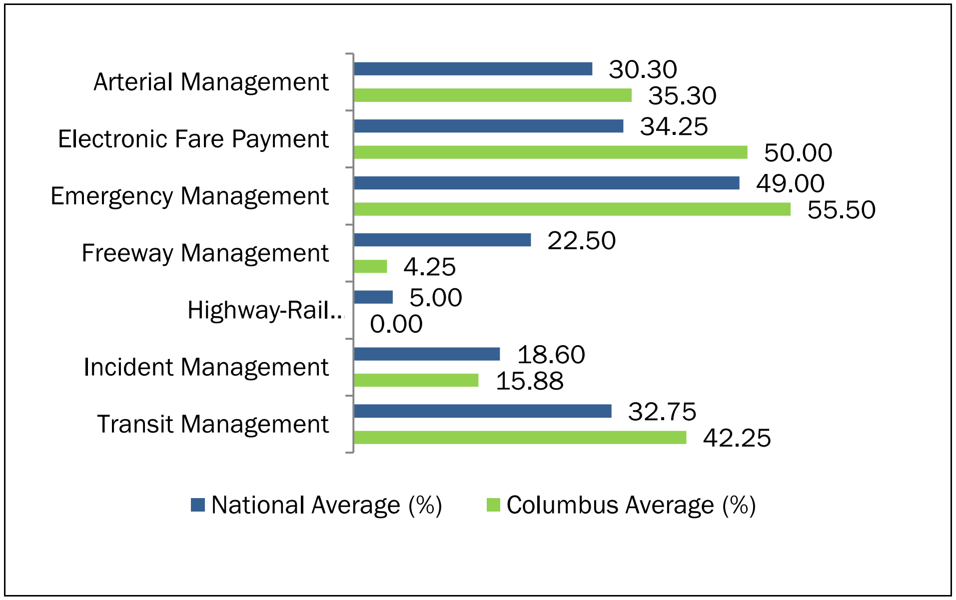
The 2005 results of the deployment survey placed central Ohio above the national average in deployment (see Figure 11). All of the following deployment averages were calculated using data from the Texas Transportation Institute's Annual Urban Mobility Report. Despite the fact that Columbus is 1.5 percent above the national average in deployment, current ITS deployment fulfills less than one-third of its potential. Austin, the city closest in population to Columbus, exceeds central Ohio's deployment average by nearly 10 percent.

Figure 11: Average ITS Deployment in Large US Cities in 2005 (%)



Source: TTI, Urban Mobility Report 2007

Figure 12: Average ITS Deployment in Columbus (2005)

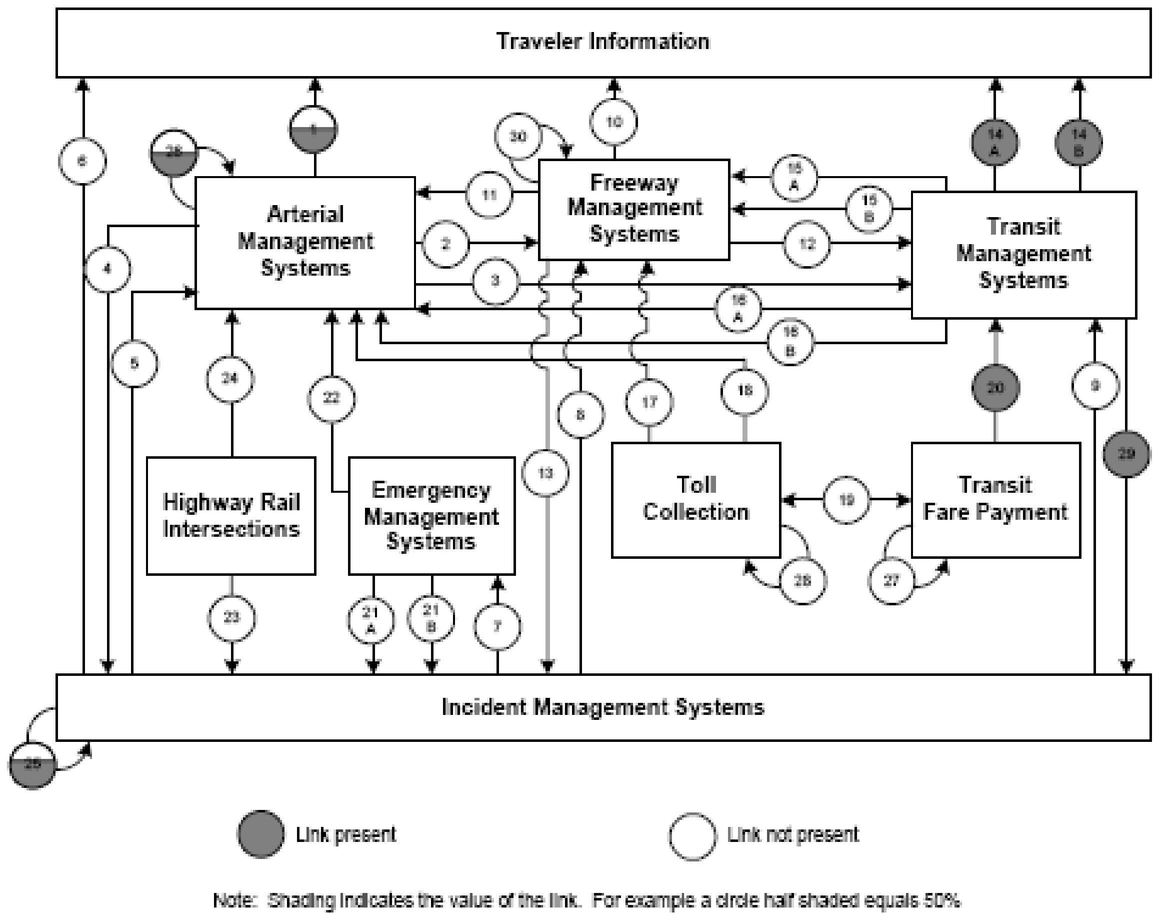


Source: FHWA, ITS Deployment Tracking 2005

To better understand where specifically Columbus can improve on ITS deployment, Figure 12 breaks down the Columbus average into the seven components listed on the previous page. One area for improvement lies in the field of Incident Management, where Columbus lags three percent behind the national average and is reaching only 15 percent of its full deployment potential. Freeway management holds the greatest possibility for improvement.

Understanding ITS integration is particularly important when creating an ITS architecture. MORPC staff can use the FHWA study results to establish what critical integration links are missing in the region and to plan for future ITS projects to fill those gaps. Figure 13 was created by FHWA and illustrates the amount of integration present between ITS components in central Ohio based on the 2006 study results. The shading in the diagram quantifies the amount of integration present between components. For example, a half-shaded circle represents a 50 percent level of integration. The overall integration rating for Columbus has improved. Since 1996, the U.S. DOT has produced four reports rating the ITS integrated deployment in the metropolitan surveyed metropolitan areas. Ratings are determined by assigning a high, medium, or low rating to both deployment and integration, then combining the two for an overall rating. In 2002, Columbus was classified as having a low level of integrated ITS deployment, but since 2003, the rating has changed to medium. A medium rating is awarded if three to five integration links are present between the different systems such as Freeway Management or Emergency Management.

Figure 13: Columbus Integration Links from FHWA 2007



Source: FHWA, Tracking ITS Deployment 2007

PART II: Update and Usage of the ITS Architecture

Table of Contents

5. Approach

In 1999, MORPC created the first *ITS Integration Strategy for Central Ohio*. Although this document successfully served as a framework for regional ITS integration, there were key elements missing in order to classify it as a true Regional ITS Architecture. The FHWA reviewed MORPC's Integration Strategy in 2002 and offered recommendations for upgrading the Integration Strategy to a Regional ITS Architecture in their *Architecture Assessment* document. The next version of the Central Ohio Regional ITS Architecture in 2004 was created using the 1999 ITS Integration Strategy as a template and customizing it to better fit the changing needs of the region while addressing the FHWA Architecture Assessment recommendations. Version 5.0 of the National ITS Architecture was not released until the latter stages of developing this document, therefore the Central Ohio Regional ITS Architecture conformed to version 4.0 and utilized Turbo Architecture Version 2.0. The new assessment provided by FHWA for the updated architecture was again considered when writing this version of the regional architecture.

5.1 Updating the ITS Architecture and Addressing Member Recommendations

As the MPO for the region, MORPC has assumed the role of developing and maintaining the Central Ohio Regional ITS Architecture. MORPC fits the role of champion based on the following characteristics:

- Understanding of the subject (regional ITS architecture including familiarity with the National ITS Architecture);
- Knowledge of local ITS systems and projects;
- Vision for interconnectivity, partnership, and regional integration;
- Consensus builder (facilitator); and
- Executive level access to resources to gain support for various regional efforts.

MORPC develops, maintains and houses the regional ITS architecture. However, the regional core stakeholders assist in updating the document. Core stakeholders are those agencies which have invested a large amount of time and money in local ITS efforts and have expressed interest in regional ITS integration. For central Ohio, those agencies include the Ohio Department of Transportation (ODOT), the Franklin County Engineer's Office (FCEO), the Central Ohio Transit Authority (COTA), and the city of Columbus. Once updated, the ITS Architecture needs to be approved by the policy board by resolution. The 2010 Central Ohio Regional ITS Architecture is now the third update to the document, which was first initiated by MORPC in 1999. The architecture is a living document and MORPC updates it every 4 years in conjunction with Transportation Plan. The process of how to develop such a document is demonstrated in Figure 3.

The first step to creating the update to the regional ITS architecture was to identify the various stakeholders and the existing and planned ITS systems in the region. All MORPC members and regional transportation agencies were surveyed via an online questionnaire (see Appendix A). The core stakeholders were interviewed separately since they hold the major ITS technologies and projects in the region. However, other agencies were interviewed via phone as a follow-up to the survey.

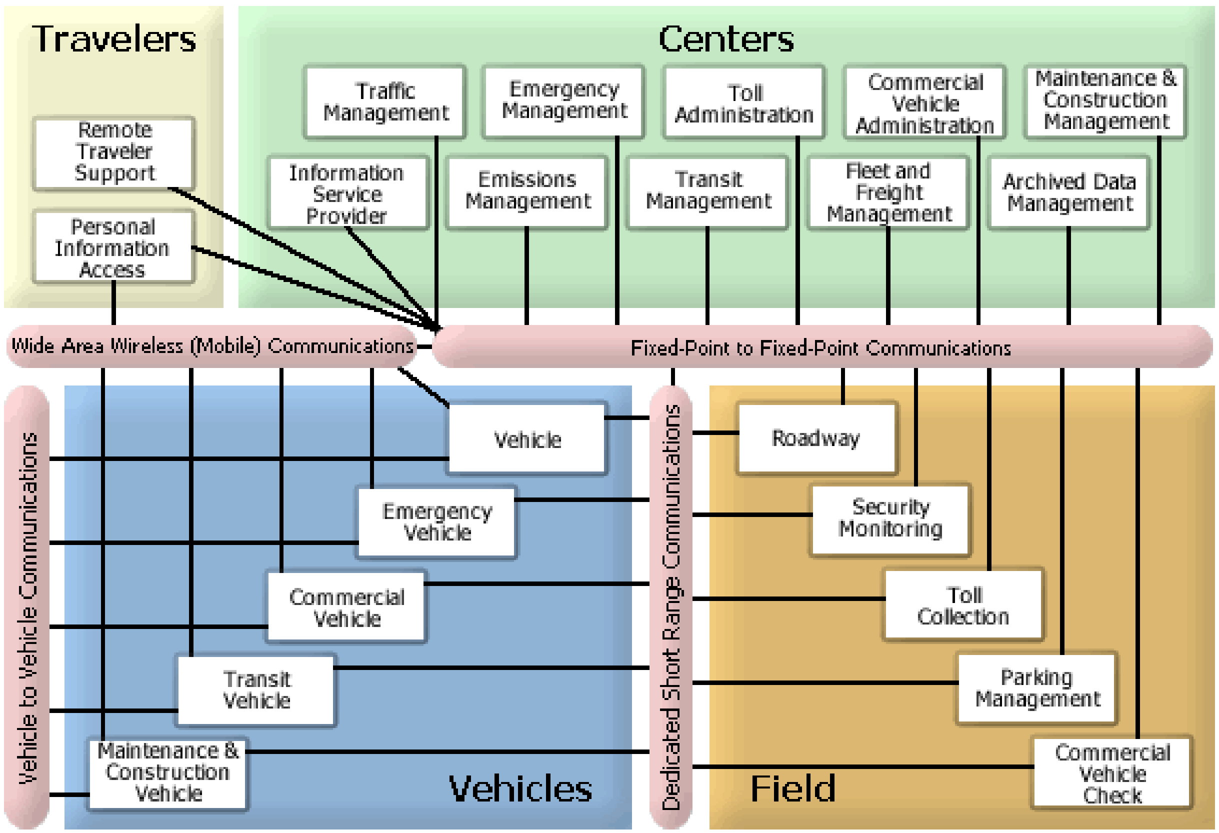
The various stakeholders and ITS elements were then inserted into the Turbo Architecture, version 4. Turbo Architecture is a software application that aids in the creation of regional and project architectures using the National ITS Architecture as a starting point. Not only is use of the software highly recommended by FHWA, but Turbo Architecture will also ease the process of future updates. The software can help greatly in determining the local needs to be addressed in the document. Many of the needs outlined in the 2004 regional architecture were still apparent during the update process and were therefore included in this updated version.

After all existing and planned stakeholders and ITS elements in the region were entered into the electronic Turbo Architecture file, the data were shared with all Central Ohio agencies via the Internet for feedback. Following the comment period, existing and planned market packages were developed with the help of a consultant team and made available online. A one-day workshop was held at the beginning of 2009 to discuss the drafted market packages and finalize flow diagrams based on the feedback of each stakeholder. The operational concepts and functional requirements were also described. All this information, including project documents and interagency ITS agreements, is online at http://www.morpc.org/transportation/highway/its.asp. The sequencing of projects was completed by referencing the latest Transportation Improvement Plan (TIP) and is listed below.

6. The Sausage Diagram

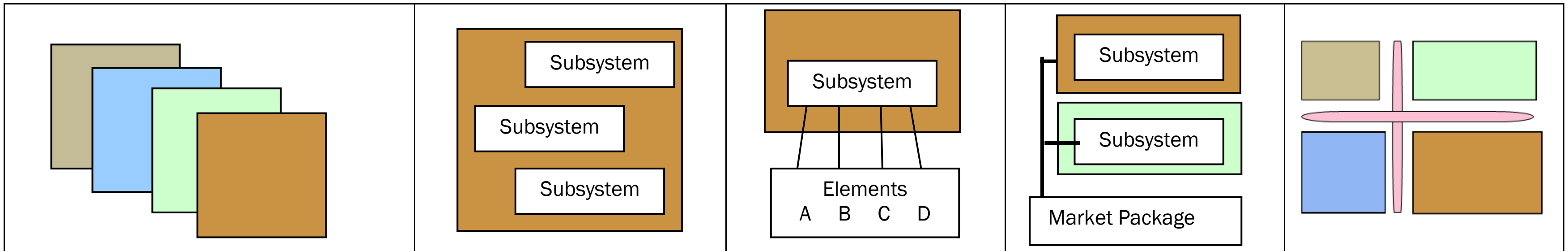
One of the most recognized architecture representations is the so-called *Sausage Diagram* as shown below. This overview diagram depicts all possible ITS subsystems that can be deployed onboard a vehicle, at central locations, along the roadside, and at remote sites. The "sausages" in the diagram describe communications technologies and how subsystems in the architecture are connected. It is therefore also often referred to as the interconnect diagram that illustrates the four subsystems: Travelers, Centers, Vehicles, and Roadsides. Each component of the diagram and its meaning is described in greater detail in Figure 15.

Figure 14: National ITS Architecture Sausage Diagram Version 4.0



Source: US DOT 2006 Turbo Architecture

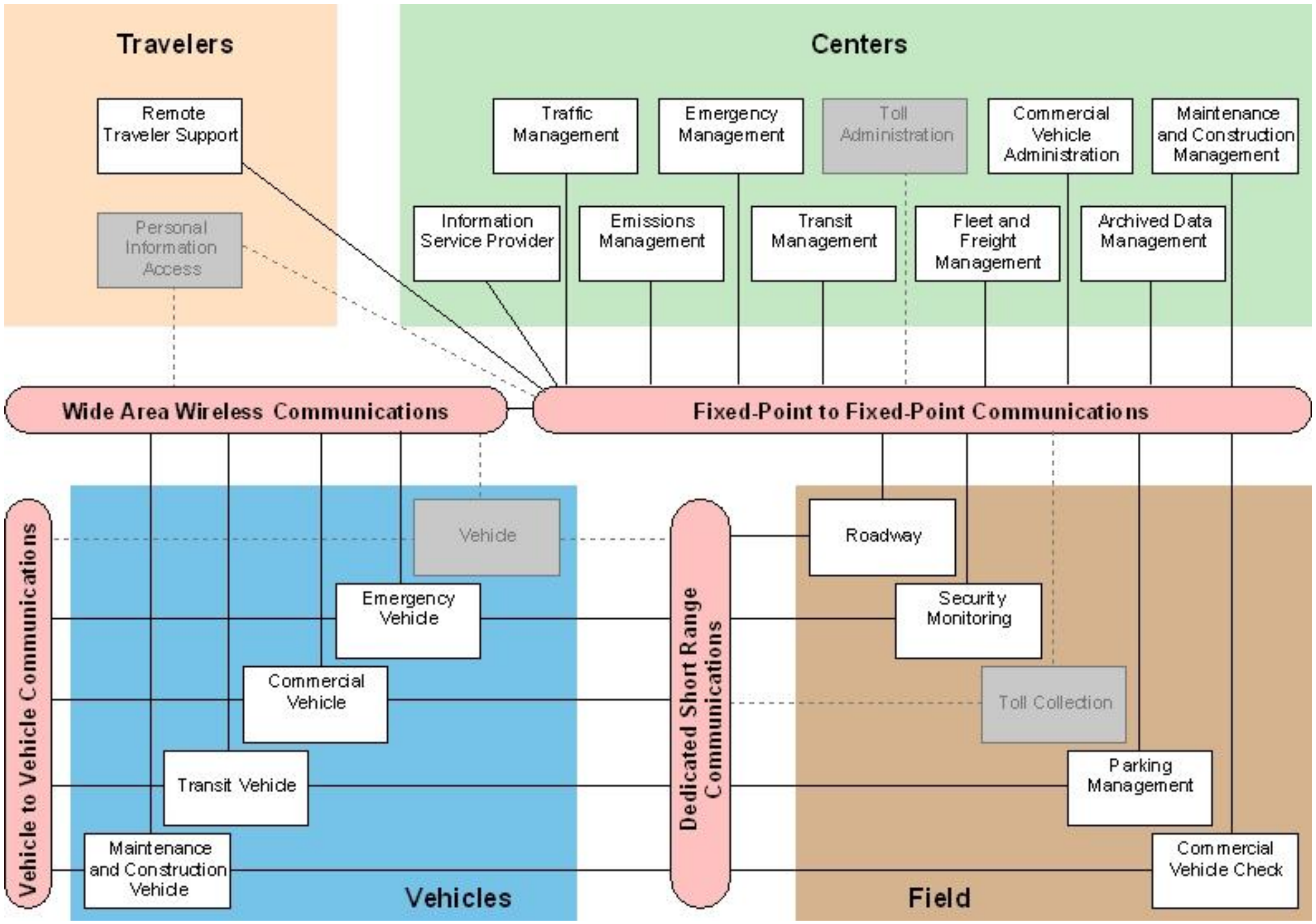
Figure 15: Defining the Sausage Diagram



The Sausage Diagram is made up of **4 components**. These components illustrate the possible entities for information connections between ITS systems. The components are: **Travelers.** *Equipment used by travelers to access ITS services pre-trip and en-route. These are owned and operated by the traveler and/or owned by transportation and information providers.* **Centers.** *Centers provide management, administrative, and support functions for the transportation system. They each communicate with other centers to enable coordination between modes and across jurisdictions.* **Vehicles.** *ITS related elements on vehicle platforms. These are general driver information and safety systems applicable to all vehicle types. The four fleet vehicle subsystems add ITS capabilities unique to these special vehicle types.* **Roadside** = *Intelligent infrastructure distributed along the transportation network that performs surveillance, information provision, and plan execution control functions and whose operation is governed by center subsystems. Roadside subsystems also directly interface to vehicle subsystems.*	Each component has several **subsystems.** Subsystems can be defined as pieces of ITS that perform a particular function or provide a particular service. Examples of subsystems are Remote Traveler Support as part of the Traveler component; Traffic Management as part of the Center component; Emergency Vehicle as part of the Vehicle component; and Parking Management as part of the Roadside component.	Each subsystem consists of several **elements**. Elements are often referred to as the building blocks of ITS Architecture. They are pieces and technologies of the architecture that perform the function of their subsystem. Examples of elements are AVL technologies, 511 systems, or transit smart cards.	Different elements of the various subsystems communicate with each other to perform a specific function or transportation service. These are referred to as **Market Packages.** Market Packages organize the various elements and information connections in such a way as to provide the most efficient transportation service. Examples of Market Packages are Archived Data Management, Transit Management, Commercial Vehicle Operations, or Traffic Management.	The various subsystems and elements not only communicate with each other within their component but also with elements of other components. These **information connections** are illustrated in the sausage diagram as long pink bars. These connections can be established through various ways: wireless communication; vehicle to vehicle communication; or dedicated short-range communication.

The central Ohio ITS sausage diagram is a tailored version of the National ITS sausage diagram, altered to custom fit the needs of the region. The connections developed provide a framework for the exchange of information between stakeholders. A complete list of all connections can be found on the MORPC ITS Architecture website.

Figure 16: Central Ohio ITS Sausage Diagram, 2007



Source: Central Ohio ITS Turbo Architecture Image

6.1 Central Ohio Market Packages

The market packages of the National ITS Architecture were customized to reflect the unique systems and connections of the Central Ohio region. Each market package is shown graphically, with the market package name, the entity from the National ITS Architecture, and the specific Central Ohio elements associated with the entity. In addition, the market packages show the information flows that move between elements.

Figure 17: Example Customized Market Package

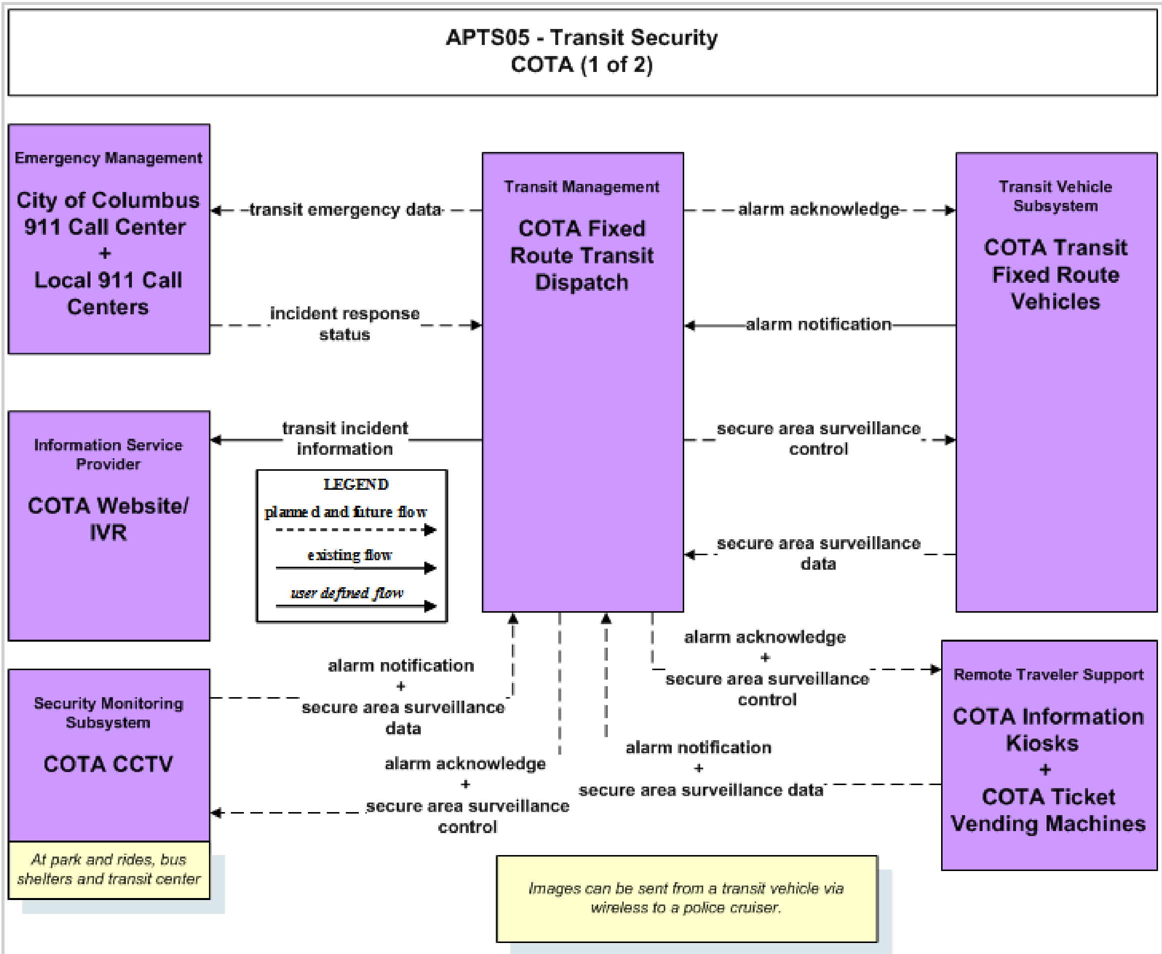


Figure 17 is an example of a market package for Transit Security that has been customized for the Central Ohio Region. This market package shows the 6 subsystems (Emergency Management, Information Service Provider, Transit Management, Transit Vehicle Subsystem, Remote Traveler Support, and Security Monitoring) and the associated elements. Information flows between the subsystems indicate what information is being shared.

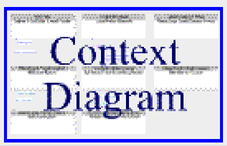
The market packages can be found on the MORPC web page by visiting: http://www.morpc.org/its.

Market packages are grouped by functional areas (e.g. Traffic Management, Maintenance and Construction, Public Transportation) and each set of customized market packages can be viewed by clicking on the Market Package Identifier under the Market Package heading. It is important to note that while the market package table on the web page shows all of the market packages from the National ITS Architecture, only those selected for the Central Ohio region are hyperlinked.

6.2 Regional Architecture Information Flows

While it is important to identify the various systems and stakeholders as part of a regional ITS architecture, a primary purpose of the architecture is to identify the connectivity between transportation systems in the region. The customized market packages represent services that can be deployed as an integrated capability, and the market package diagrams show the information flows between the subsystems and terminators (elements within the region) that are most important to the operation of the market packages. How these systems interface with each other is an integral part of the overall architecture.

Figure 18: Example of element detail showing interfaces

ITS Element: City of Columbus CCTV	Send Your Comments
Description:	Closed Circuit Television (CCTV) refers to a surveillance system using cameras that transmits visual information over a closed circuit through an electrically conducting cable or wireless transmitter and receiver. It is both used for security purposes and traffic observation. The city of Columbus has cameras installed along its routes. The cameras are connected to their Traffic Management Center and help with observing traffic conditions, detecting incidents, or identifying security related issues.
Status:	Existing
Stakeholder:	City of Columbus Department of Public Service
Mapping:	Roadway Subsystem
Interfaces: 	Columbus Traffic Management Center ODOT District Offices
Market Packages:	ATMS01 - Network Surveillance - City of Columbus / ODOT MC07 - Roadway Maintenance and Construction - City of Columbus
Equipment Packages:	Roadway Basic Surveillance Roadway Equipment Coordination Roadway Field Device Monitoring

There are 126 different elements identified as part of the Central Ohio Regional ITS Architecture. These elements include city, county, and state traffic operations centers, transit centers, transit vehicles, public safety dispatch centers, media outlets, and others. Interfaces have been defined for each element in the architecture.

For example, the Columbus Traffic Management Center interfaces with 43 other elements in the region ranging from field equipment to transit centers. Some of the interfaces are far less complex. For example, the City of Columbus CCTV has interfaces with only two other elements in the architecture (see Figure 18).

Elements and their interfaces are accessible via the MORPC ITS Architecture web page (www.morpc.org/its) by clicking on the “Inventory by Entity” button. Elements will be listed alphabetically in the column on the right. By clicking on an element, the element is described in greater detail, including element definition, stakeholder information, current element status, and interfaces.

Architecture flows between the elements define specific information that is exchanged by the elements. Each architecture flow has a direction, name, and definition. Most of the architecture flows match one from the National ITS Architecture. In some cases, new "user defined" flows have been created for interfaces or connections that are not expressed in the National ITS Architecture. These architecture flows define the interface requirements between the various elements in the regional architecture.

An example of the architecture flows between two elements is shown in Figure 19. In this interface, the flows that go between the Columbus Traffic Management Center and the Buckeye Traffic Website are shown. The architecture flows on this interface are shown as existing, signifying that these two elements currently share information.

Figure 19: Example of architecture flows between elements

Columbus Traffic Management Center and Buckeye Traffic Website

Send Your Comments

(E) = Existing Flow
(P) = Planned/Future Flow
(E/P) = Existing and Planned Flow - Flow appears as Existing and Planned

Source	Architecture Flows	Destination
Columbus Traffic Management Center	traffic images. (E) road network conditions (E)	Buckeye Traffic Website
Buckeye Traffic Website		Columbus Traffic Management Center

Each of the individual element interfaces can be accessed on the MORPC Regional ITS Architecture web page (www.morpc.org/its) by clicking on the "Inventory by Entity" link. Select the element whose interfaces the entity reviews in order to bring up the ITS element detail page.

Once on the ITS element detail page, scrolling down to the "Interfaces" and clicking on an interfacing element leads to a page with more detailed information about the particular interface (including links to pages describing the architecture flows). Clicking on an element listed in the "interfaces" section of any ITS element page will lead to a set of interfaces to that element similar to the example diagram shown above. Each architecture flow is defined, and any standards associated with that architecture flow are noted.

7. Regional Projects

The regional ITS architecture defines a number of planned elements, interfaces, and information flows. As regional plans are developed, these parts of the regional ITS architecture will be implemented by a series of projects. Table 4 provides a summary of regional projects that have been identified. These represent a very small percentage of the interfaces of the Regional ITS Architecture. Over time, additional projects will be developed to address further aspects of the architecture. In general terms, the projects listed in the table are not implemented independently of each other but have a sequencing that relates to the dependencies of the projects.

The H/M/L column represents the following information about the importance in sequencing of the project:

- H = High Priority
- M = Medium Priority
- L = Low Priority

Table 4: Regional Projects

Primary Project Type	TIP ID	AGENCY	Project Description	Priority
Signal Phase A	931	Columbus	Install fiber-optic cable, conduit, and field devices along the interstate system to serve as a communications backbone for the new traffic signal system in the region.	H
Signal Phase B	151	Columbus	Following the framework laid out in the CTSS study, replace the CTSS central computer system and central control software adding up to 350 intersections and installing up to 20 new pan-tilt-zoom surveillance cameras to the new system. Construction of ADA ramps.	H
COTA 1 Bus Purchase	729	COTA	Transit Purchase of replacement bus (old COTA ITS for $160,000 with MORPC CMAQ).	H
Computer Aided Dispatch / Transit	N/A	COTA	Computer Aided Dispatch/Advanced Vehicle Location includes Electronic Manifest Interface, Vehicle Component Monitoring and Common Logon. This project needs to be completed to support future ITS projects.	H
CAD/AVL Enhancement	N/A	COTA	Consulting Services for Systems Engineering Design and Specifications for the ITS Communications System (CAD/AVL) replacement project.	H
Paving the Way	1376	Columbus	SFY08-11, Program Administration, to keep motorists informed on the progress of transportation construction throughout Central Ohio and to improve planning and communication of construction projects.	H
On-Board Computers	N/A	DATA	Install On-board computers in each bus. This will allow for expansion of the system to provide: 1) Real-time dispatching, 2) On-board mapping, 3) Electronic fare collection, 4) AVL, 5) Passenger information regarding community services available.	H

Primary Project Type	TIP ID	AGENCY	Project Description	Priority
Regional Advanced Traveler Information System (ATIS)	N/A	MORPC, ODOT, and others	Implement a regional traveler information system for the central Ohio region that provides information on transportation modes, routes, times, and costs	H
Signal Phase C	102	Columbus	Expand the CTSS to include up to 235 additional intersections and up to 12 new pan-tilt-zoom surveillance cameras. Some coaxial cable will be replaced with fiber-optic cable throughout the system. Construction of ADA ramps.	M
Signal Phase D	932	Columbus	Following the framework laid out in the CTSS study, continue the transition of traffic signals on the CTSS from coaxial communications to the proposed fiber-optic communications network. Major work components are the construction of fiber-optic network along the arterials for the communications network to outlying intersections. Any remaining intersections should be migrated to the new system. Construction of ADA ramps.	M
COTA Smart Card-Assessment	N/A	COTA	Smart Card/Electronic Fare Payment Preliminary Engineering Design Study.	M
COTA Smart Card	N/A	COTA	Smart Card implementation and Fare Box replacement	M
Regional Signal System Timing Upgrade	1373	Franklin County	Conduct timing studies on major signal locations to improve signalization within Franklin County.	M
US-40 at Columbia Rd Signalization	1755	ODOT 5	Project includes signalization of another intersection outside the planning area, on SR-37 in Fairfield County.	M
US-62 at Walton Parkway Signalization	N/A	New Albany	Install new traffic signalization system including posts and mast arms and associated pavement improvements.	M
COTA Traveler Information	N/A	COTA	Dynamic Message Signs at Park-n-Rides and Transit Centers with bus arrival information.	L
Signal Assessment	N/A	Franklin County	Isolated Signal Assessment Project (ISAP)	L
Access to Intersection Information	N/A	OSU T&P	Install Econolite Software to provide read-only access of intersection information back to OSU T&P and Public Safety dispatch areas.	L
Signalization interconnect	N/A	New Albany	Project proposes to interconnect 21 signalized intersections on New Albany's arterial street system, install a traffic signal master computer and closed circuit television monitoring at select locations.	L

8. Using the Regional ITS Architecture

MORPC's primary planning document is its2030 Regional Transportation Plan. Last updated in 2008, the plan is the long-range, comprehensive multimodal transportation-planning document for the Central Ohio region. It defines the overarching goals for transportation in the region, establishes the existing and future transportation needs of the region, and allocates projected revenue to transportation programs and projects that address those needs. The plan functions in the long-range in that it recommends major projects, systems, policies, and strategies designed to maintain the existing transportation system and serve the region's future travel needs.

The MORPC Regional ITS Architecture defines and supports the ITS project development cycle. This cycle begins with project definition, followed by procurement, leading to implementation. Properly maintained, the information in the Regional ITS Architecture can assist in all three of these cycles of the project development process.

Project definition may occur at several levels of detail. Early in the planning process, a project may be defined only in terms of the transportation services it will provide, or by the major system pieces it contains. Prior to the beginning of implementation, the details of the project must be developed. The detailed system definition will also include the interface with the systems or parts of systems which will make up the project, establish the interconnections the project entails, and define the informational flows across the system. The definition may go through multiple levels of detail, starting with a very high-level description of project functions and moving toward system specifications. By identifying the portions of the Regional ITS Architecture that define the project, the Regional ITS Architecture outputs can be used to create key aspects of the project definition.

A Regional ITS Architecture can assist in the following areas of project definition:

- The identification of agency roles and responsibilities (including inter-agency cooperation). The operational concept developed as part of the Regional ITS Architecture can establish these goals. This operational concept can either serve as a starting point for a more detailed definition, or possibly provide all the needed information.

- Requirements definition. This can be completely or partly defined by using the Regional ITS Architecture functional requirements applicable to the project.

- ITS standards. Project mapping to the Regional ITS Architecture can extract the applicable ITS standards for the project.

Once a project is defined and funding for it is committed, the implementation process can commence with the generation of a Request for Proposal (RFP), which is the common governmental practice for initiating a contract with the private sector to implement the project. Once a contract is in place, project implementation begins and moves through design, development, integration, and testing.

The Regional ITS Architecture and the products produced during its development can support this RFP generation. First, the project definition described above forms the basis for what is being procured. Mapping the project to the Regional ITS Architecture allows bidders to have a clear understanding of the scope of the project and of the interfaces that need to be developed. The functional requirements created as part of the Regional ITS Architecture can be used to describe the functional requirements for the project. In addition, a subset of the ITS Standards identified as part of the Regional ITS Architecture development can be specified in the RFP. Because ITS projects involve systems and their interconnections, it is very important to follow a systems engineering approach in designing and implementing the project. While the exact process followed is at the discretion of the local agency, the ITS projects funded through the highway trust fund must follow their specific procedures.

The required systems engineering analysis steps are:

- Identifications of portions of the Regional ITS Architecture being implemented
- Identification of participating agencies' roles and responsibilities
- Requirements of definitions
- Analysis of alternative system configurations and technology options to meet requirements
- Procurement options
- Identification of applicable ITS standards and testing procedures
- Procedures and resources necessary for operations and management of the system

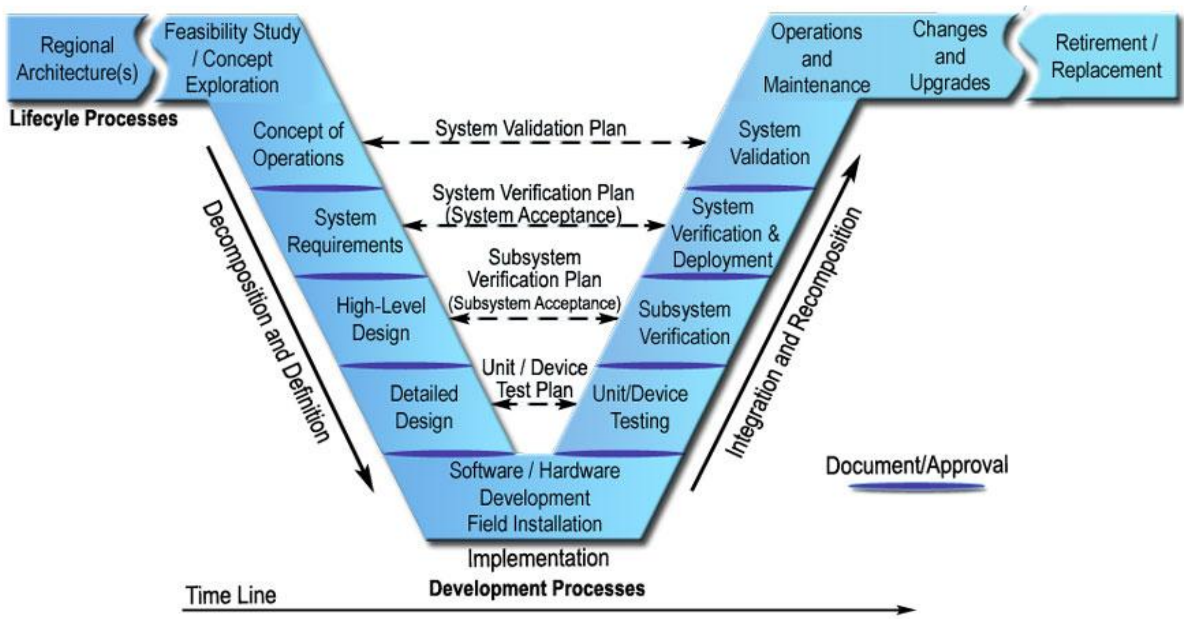
In summary, the Regional ITS Architecture represents a detailed plan for the evolution of the ITS systems in the region and will be used to support regional transportation planning efforts and project development efforts.

8.1 Using ITS Architecture in Project Definition

Projects that emerge from the planning process can benefit from the use of the regional ITS architecture in their definition and development. Project implementation should follow a systems engineering process. Figure 20 shows a typical project implementation process for deploying ITS projects, called a systems engineering process. It is a process that can be used to systematically deploy ITS while reducing the risks associated with deployments. The process recognizes that many projects are deployed incrementally and expand over time. US DOT Rule 940 requires that the systems engineering process be used for ITS projects that are funded with federal funds. Applying the systems engineering process to ITS project development is a new key requirement that must be addressed by stakeholders using federal funds.

There are similarities between the systems engineering process and the project development process generally used by transportation agencies. The project development process is probably similar to the following:

Figure 20: Project Implementation Process



- Project Selection
- Authorization to Proceed
- Project Definition
    - Purpose and Need
    - Project Scoping
    - Conceptual Design
- Project Design
    - Preliminary Plan Development
    - Semi-Final Plan Development
    - Final Plan Development
- Construction
    - Testing
- Operation and Maintenance

The ITS architecture can be used to support development of the concept of operations, requirements, and high level design in the systems engineering process. In deploying an ITS related project, the ITS architecture should be used as the starting point for developing a project concept of operations (not to be confused with an operational concept, which defines the roles and responsibilities of the stakeholders). The concept of operations shows at a high level how the systems involved in a project operate in conjunction with the other systems of the region. According to the National Highway Institute course “Introduction to Systems Engineering for Advanced Transportation”, a concept of operations includes the following information: **A.** Identification of stakeholders; **B.** Development of a vision for the project; **C.** Description of where the system(s) will be used; **D.** Description of organizational procedures or practices appropriate to the system(s), definition of critical performance parameters associated with the systems(s); **E.** Description of the utilization environment (conditions under which various parts of the system(s) will be used); **F.** Definition of performance measures used to evaluate the effectiveness of the system(s); **G.** Considerations of life cycle expectations; and **H.** Conditions under which the system(s) must operate (e.g. environmental conditions).

The MORPC Regional ITS Architecture provides inputs to a number of the systems engineering analysis steps as shown in Table 5.

Table 5: Systems Engineering Requirements supported by ITS Architecture

Systems Engineering Requirements	ITS Architecture Output
Identification of portions of the regional ITS architecture being implemented	Mapping project to the elements and interfaces of the regional ITS architecture
Identification of participating agencies' roles and responsibilities (this relates to the Concept of Operations described earlier)	Use operational concepts as a starting point
Requirements definitions	Use functional requirements as a starting point
Identification of applicable ITS standards and testing procedures	Use regional architecture standards outputs as a starting point for the standards definition

8.2 Issues/Challenges

One of the challenges of using the ITS architecture to facilitate the systems engineering process in the implementation of a project is educating stakeholders about the benefits of the process and the process itself. The systems engineering process is not a new process to many organizations. It may not be called the systems engineering process, but various stakeholders' processes may map to the systems engineering process very well. Making these types of linkages between processes makes it easier to incorporate the ITS architecture as a tool in the process.

Another challenge is engaging a broader stakeholder base on a project when the ITS architecture indicates that possibility. For example, a project might map to a specific customized market package that contains ten elements owned by eight stakeholders. Yet the initial project definition is for three elements owned by two stakeholders. The entire activity of seeking integration opportunities is more institutional than technical. There will be instances where getting more stakeholders involved in a project will increase its complexity or cross jurisdictional boundaries that may not have been considered in the initial scope. It is important to explore these integration opportunities so that, at the very least, they are accounted for and supported in the project design even though they may not be implemented with that specific project. The ultimate goal is to make ITS deployment as economical as possible. One way this can be accomplished is by deploying projects across institutional boundaries where different stakeholders benefit from the ITS deployment.

8.3 Improve Communication

During a two-day regional ITS architecture maintenance workshop in fall 2007, central Ohio ITS stakeholders came together to discuss making the Regional ITS Architecture more user-friendly and improving the outreach efforts of the architecture. Recommendations made to achieve these goals included the following:

- Develop a marketing tool that encourages stakeholder buy-in and can help communicate the benefits of ITS projects and ITS integration more clearly to policy members. A summary sheet of ITS and the Architecture was designed to serve as such a marketing tool (see Appendix E).
- Create a mechanism to track implementation and status of regional ITS projects. Since this recommendation, ODOT and the Ohio Division of FHWA have developed a document that requires all ITS project sponsors to conform to the regional ITS architecture when designing and implementing ITS projects, and to inform MORPC about any changes (see Table 2).
- Improve information sharing by developing a regional maintenance plan. The following section provides the outline of such a plan and working group.

Another all-day ITS architecture workshop was held in February 2009, in which most of the market packages were discussed in a meaningful way. This allowed the consultant to update their website and ITS database based on the information collected at the workshop. In addition, it provided another opportunity to educate stakeholders in the region about the importance and benefits of ITS and to share projects with one another.

PART III: Maintenance Plan

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9. Maintenance Plan

Regional ITS Architectures are dynamic and must change as ITS projects are implemented and new ITS needs and services evolve in the region. The maintenance plan covers four main areas:

- *Who will be involved in the maintenance of the architecture;*
- *When will the architecture be updated;*
- *What will be maintained; and*
- *How it will be maintained* (i.e. what configuration control process will be used).

There are different types of changes, which may include changes for project definition, for project addition or deletion, in project priority, and in regional needs. Each category is explained in greater detail below.

- **Changes for Project Definition.** As projects may add, subtract, or modify elements, interfaces, or information flows, the Regional ITS Architecture must be updated to correctly reflect how the developed projects integrate within the region.
- **Changes for Project Addition/Deletion.** Occasionally a project will be added or deleted through the planning process and some aspects of the Regional ITS Architecture that are associated with the project may be expanded, changed, or removed.
- **Changes in Project Priority.** Due to funding constraints, or other considerations, the planned project sequencing may change. Delaying a project may have a ripple effect on other projects that depend on it. Raising the priority for a project's implementation may also impact the priority of other projects that are dependent upon it.
- **Changes in Regional Needs.** Transportation planning is done to address regional needs. Over time these needs can change and the corresponding aspects of the Regional ITS Architecture that addresses these needs may need to be updated.
- **New Stakeholders.** When new stakeholders come to the table, the Regional ITS Architecture will need to be updated to reflect their place in the regional view of ITS elements, interfaces, and information flows.
- **New User Services.** The National ITS Architecture may be expanded and updated from time to time to include new user services or better define how existing elements satisfy the user services. These changes should also be considered as the Regional ITS Architecture is updated. The National ITS Architecture may have expanded to include a user service that has been discussed in a region, but not been included in the Regional ITS Architecture, or been included in only a very cursory manner.

9.1 Roles and Responsibilities for Maintenance

The responsibility for maintaining the Central Ohio ITS Architecture lies with the Mid-Ohio Regional Planning Commission (MORPC) since they are the primary planning organization for the region and can easily work with the different ITS stakeholders on updating the architecture. A group of core stakeholders will act as an “institutional framework” to review proposed changes to the architecture. This group of core stakeholders is important because the Regional ITS Architecture is a consensus framework for integrating ITS systems. As it was a consensus driven product in its initial creation, so it should remain a consensus driven product as it is maintained. This section defines the stakeholders and their roles and responsibilities for the maintenance of the Central Ohio Regional ITS Architecture.

9.1.1 Definitions

The following groups or persons have a role in the maintenance of the architecture:

- **Stakeholders** – Any government agency or private organization that has a role in providing transportation services in the region.
- **Maintenance Working Group** – A group of stakeholder representatives who are responsible for the technical review of updates/changes to the Central Ohio Regional ITS Architecture and for approving changes to the architecture.
- **Responsible Agency** – The stakeholder agency with primary responsibility for maintenance of the architecture.
- **Maintenance Manager** – The person responsible for overseeing and guiding the maintenance efforts for the Regional ITS Architecture.

9.1.2 Stakeholders

Stakeholders are any government agency or private organization that is involved with or has an interest in providing transportation services in the region. Each stakeholder owns, operates, and/or maintains one or more ITS element(s) in the region and therefore has a role in the maintenance of the architecture.

The success of the change management process outlined in this Maintenance Plan is highly dependent on the participation of the stakeholders identified in the architecture. Without stakeholders’ participation in tracking the development of their ITS systems and properly updating the architecture, the change management process will not succeed and the usefulness of the architecture will diminish over time.

The primary responsibility of the stakeholder agencies is to submit changes to the Central Ohio ITS Architecture that are brought on by new plans or projects that are being planned or deployed for the stakeholder agency. The stakeholder agency must submit the changes in the Regional ITS Architecture to the Maintenance Working Group. If stakeholders desire more involvement in the architecture review process, they can get involved through voluntary representation in the Maintenance Working Group.

9.1.3 Maintenance Working Group

The Central Ohio Maintenance Working Group has the following responsibilities:

- Collecting and compiling proposed changes and updates to the architecture from stakeholder agencies.
- Evaluating each proposed change from a technical standpoint, and reaching a consensus on the proposed change (this may require contacting additional stakeholders if one or more of their systems are affected).
- Approving changes to the architecture.
- Making any institutional or policy related decisions that arise in the maintenance of the architecture.

The logical composition of the maintenance working group for Central Ohio are the members of the Freeway Management System (FMS) policy committee, which meets on a quarterly basis throughout the year. The key agencies represented at the meeting are ODOT, city of Columbus, FHWA, Franklin County, and MORPC. The regional ITS architecture will be a regular business item on the agenda to discuss possible changes to the architecture. Each agency receives one "vote."

9.1.4 Responsible Agency

The Responsible Agency is MORPC as it formally maintains the architecture. MORPC assigns resources for making the physical changes to the architecture baseline and for coordinating the maintenance of the architecture.

9.1.5 Maintenance Manager

MORPC will appoint a person to the role of Maintenance Manager to coordinate the maintenance activities of the Central Ohio Regional ITS Architecture. The Maintenance Manager is the coordinator and main point of contact for all maintenance activities, including receiving Change Requests forms, tracking Change Requests, and distributing documentation.

The Maintenance Manager has the following responsibilities:

- Coordinate the activities of the Maintenance Working Group related to the ITS architecture;
- Receive Change Request forms and requests for documentation from stakeholders;
- Distribute the baseline documents and outputs of the architecture to stakeholders;
- Maintain the official records of the Central Ohio Regional ITS Architecture, including the baseline documents and the Change Request Database with points of contacts; and Ensure the status of each Change Request is properly updated in the Change Request Database.

Some of these responsibilities may be delegated to staff or consultants.

9.2 Timetable for Maintenance

There are two basic approaches that MORPC will utilize for maintaining the architecture:

- **Periodic Maintenance** – Update the architecture based upon one of the recurring activities of the transportation planning process, such as with the Transportation Plan.
- **Exception Maintenance** – This approach will be followed if there is an urgent need to make a change or if a minor change is desired to address some stakeholder need. In this case the change can be initiated as needed.

9.2.1 Major Updates

A comprehensive architecture update will occur every four years, concurrent with the formal update of the Transportation Plan since the Central Ohio Regional ITS Architecture is a component of the regional transportation planning process. The update is necessary to ensure that the architecture continues to accurately represent the regional view of ITS Systems. The comprehensive update may include adding new stakeholders, reviewing transportation needs and services for the region, updating the status of projects, and reflecting new goals and strategies, as appropriate. Operational concepts, system functional requirements, project sequencing, ITS standards, and lists of agency agreements may also be updated at this time.

9.2.2 Event-Driven Updates

Between major updates of the architecture, the following interim update actions will be performed:

- **On an annual basis**, the Maintenance Manager will actively solicit a set of needed updates from each key stakeholder and inquire if the stakeholder has any changes to the Regional ITS Architecture. It is the responsibility of the stakeholders to complete and submit the Change Request Forms to the Maintenance Manager for consideration. Within a defined period, the submitted Change Request Forms will be collected and reviewed by the Maintenance Working Group for consideration in the next minor update of the Regional ITS Architecture.

  The Maintenance Plan will also be reviewed at the annual updates for required changes to the Maintenance Plan. Use of the Regional ITS Architecture and modifications to it may differ from what was anticipated during the initial development of the Maintenance Plan. Revising the Maintenance Plan will ensure that the change management process defined is effective.

- **Between the annual updates**, a stakeholder may submit a Change Request Form to the Maintenance Manager and request that the Maintenance Working Group review and approve the change request prior to the next scheduled update of the Regional ITS Architecture. This may be necessary if a stakeholder suddenly requires federal funding for a previously unplanned ITS project and needs the ITS project to be included in the Regional ITS Architecture.

9.3 Architecture Baseline

Establishing an architecture baseline requires clear identification of the architecture products to be maintained, including specific format and version information. For the Central Ohio Regional ITS Architecture, the following are identified as the architecture baseline:

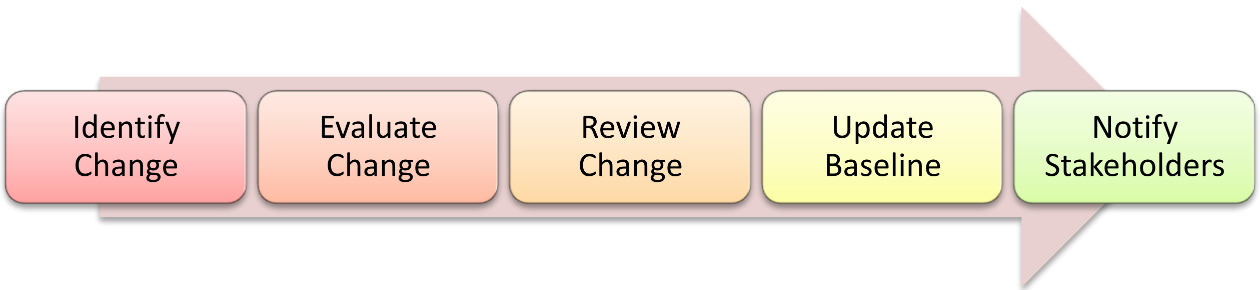
- 2010 Central Ohio ITS Architecture Document (this document)
- Turbo Architecture Database (www.morpc.org/its)
- Central Ohio ITS Architecture Web pages (www.morpc.org/its)
- Change Request Database

Regarding the Architecture document, it is recommended that the source document, in Microsoft Word format, will be held by the maintenance manager, while a PDF version of the document will be made available online. Regarding the Turbo Architecture Database, the maintenance manager will maintain a version of the final delivered Central Ohio Regional ITS Architecture database.

9.4 Change Management Process

This change management process specifies how changes are identified, how often changes will be made, and how the changes will be reviewed, implemented, and released. The 5-step basic process for change management is shown in Figure 21.

Figure 21: Change Management Process



Step 1: Identify Change. Any Stakeholder identified in the Regional ITS Architecture is allowed to submit Change Requests. This effectively indicates that all changes have the approval of an existing, defined Stakeholder in the ITS Architecture. If the Change Request is to add a new Stakeholder and its Stakeholder's ITS Elements and Interfaces, the Responsible Agency for the architecture must submit the Change Request.

A Change Request Form will be used to submit changes for review. The Change Request Form for the Central Ohio Regional ITS Architecture can be found in Appendix D and online (www.morpc.org/its). The Change Request Form includes the following:

- Name of change
- Description of change
- Part of baseline affected
- Rationale for change
- Originator name or agency
- Date of origination

This information entered on the Change Request Form will be added to a change database, maintained by the Responsible Agency. The change database will include following additional fields of information:

- Change number (some unique identifier)
- Change disposition (accepted, rejected, deferred)
- Change type (minor or significant)
- Disposition comment
- Disposition date

Step 2: Evaluate Change. Upon receiving a Change Request by the Maintenance Manager, an initial evaluation of the Change Request will be made for the impact to the overall architecture or the affected document. The purpose of the evaluation is two-fold:

- Verify that the Change Request form and supporting materials are complete and correct.
- Compare with other Change Request forms and determine if there are any conflicts.

If the proposal for architecture modification has an impact on other stakeholders, the evaluator(s) will contact the Stakeholders to confirm their agreement with the modification. All Stakeholders directly affected by the proposed change(s) must approve and sign-off the Change Request before the Maintenance Working Group considers the Change Request.

Step 3: Review Change. Upon completing the initial assessment, the Change Request form will be reviewed by the Maintenance Working Group, in this case, the FMS Policy Committee, or via email to the committee members.

At these meetings, Change Request Forms that were submitted to MORPC are reviewed, The maintenance manager will distribute copies of all Change Request Forms submitted and all supporting materials to all stakeholders prior to the meeting for their review, and will assemble an agenda. Maintenance Working Group meetings can also be requested by one of the stakeholders if there is an urgent need to update the architecture quickly.

The Maintenance Working Group will be provided sufficient time to review the Change Requests before the meeting. During the meeting, the Maintenance Working Group will review the proposed changes and offer any comments. After each Change Request is reviewed, if no further comments are offered by the Maintenance Working Group, the Change Request will be considered approved, and the maintenance manager will sign off on the Change Request. If additional comments are made that require action, those comments will be noted on the Change Request form. Where comments (or changes required) are minor in nature, they can be made by the submitter of the Change Request form and the maintenance manager can approve them directly. In the case of major comments or changes to the Change Request, the approval of the change will need to be made by the Maintenance Working Group. If a Change Request is to be withdrawn from consideration, the Maintenance Manager will be required to sign-off on the Change Request Form to close out the Change Request.

At the end of the meeting, the Maintenance Working Group will agree as to whether all the approved changes to the architecture necessitate an immediate update to the baseline, or whether the update should await either additional changes or the next major revision. The decision should be based on the number of Change Requests approved and the nature of the approved changes.

Minutes will be kept for all Maintenance Working Group meetings. Minutes will include, at a minimum, an attendance list, comments made on each Change Request, and the disposition of each Change Request Form (Approved/Withdrawn/Deferred/Request More Information).

Step 4: Update Baseline. Upon approvals of the Change Request Forms, the decision agreed upon by the Maintenance Working Group is implemented. If the decision is to accept the change and update the baseline, then the appropriate portions of the architecture baseline are updated and an updated architecture baseline is defined. In addition to updating the baseline documents, databases, or other outputs, the configuration status will be updated.

Step 5: Notify Stakeholders. All stakeholders will be notified by e-mail from the Maintenance Manager when baseline documents have been updated. All baseline documents will also be available to stakeholders from a website or other electronic location, such as an ftp site. It is the responsibility of the Maintenance Manager to ensure the most recent document is available from the website.

Appendices

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Appendix A: Central Ohio ITS Architecture Survey (November 2007)

Dear Central Ohio Stakeholder:

As you are well aware, most travelers are unconcerned by who owns and operates the various components of the transportation system; they only want it to work seamlessly and efficiently. Consequently it is important that the operation of the transportation system be as integrated as possible.

To further this concept of system integration, MORPC has taken on the role to house, maintain and update a "plan," called the Regional ITS Architecture, for the various Intelligent Transportation System (ITS) components in use or planned to be in use in central Ohio. The Central Ohio Regional ITS Architecture is based on the National ITS Architecture developed by FHWA. The ITS architecture identifies the organizations that provide ITS or those that have an interest in them. It also defines the different operating systems, the functions they perform, and what and how the information is exchanged (see the 2004 version: http://www.morpc.org/web/transportation/its/regITS.html).

Intelligent Transportation Systems refer to communication tools and technologies that help the roadway system operators to operate the system more safely and efficiently and in real-time, and to provide information to the public. Examples of such systems include freeway management systems, arterial management systems, coordinated signal systems, incident management systems, and others. Components of these systems that you are probably most familiar with are dynamic message signs, ramp meters and cameras. ITS is often seen as an alternative solution to reduce congestion, increase traffic flow, and improve air quality.

While we understand that some of our larger transportation stakeholders in the region, such as ODOT, COTA or the City of Columbus, operate many of these systems and technologies, we believe that ITS projects of smaller agencies can also have a great impact on travel flow and travel information for Central Ohio. In our effort to update the regional ITS architecture in accordance with our long-range transportation plan, we are currently collecting information of any type of ITS-related project that exists or is planned in our region. An efficient way to do so is to survey you, our member, who works for one of the many central Ohio jurisdictions and agencies responsible for some portion of the transportation system.

Once we have a complete picture of the various ITS technologies and projects in central Ohio, we can work with you to identify future ITS projects that you might want to undertake, and look at possible funding sources to implement these. Your completion of the survey can also help in identifying collaboration opportunities between your agency and other agencies' systems in the region. To achieve our common goal of improving travel conditions in central Ohio, data and information sharing play an important role.

We will greatly appreciate if you, or someone in your agency who deals with ITS, could complete our survey, which will take only about 10-15 minutes of your time. The deadline to complete this survey is November 23rd 2007.

Please return the completed survey to Kerstin Carr either via email or regular mail:

Kerstin Carr, MORPC, Transportation Department

111 Liberty St, Suite 100, Columbus, OH 43215

Email: kcarr@morpc.org ~ Phone: 614-233-4163

THANK YOU for all the work you are doing to reduce congestion, increase safety, and improve transportation for any type of mode in the region.

~MORPC Transportation Staff

YOUR ORGANIZATION / AGENCY

What is the name of your agency?

____

____

Please provide us with your name, title, email address and phone number so that we can follow up with you in case we have any questions.

____

____

1. *How familiar are you with Intelligent Transportation Systems (ITS) deployment in Central Ohio?*
   □ Very familiar □ Somewhat familiar □ Not familiar at all
2. *How familiar are you with the Central Ohio Regional ITS architecture?*
   □ Very familiar □ Somewhat familiar □ Not familiar at all
3. *Is your agency/organization currently carrying out any projects related to ITS, such as signal pre-emption, traffic control centers, radio communication, signal coordination, dynamic message signs, traffic cameras, etc.?*

   □ YES □ NO

   If Yes: Please list the various systems:

____

____

____

____

4. *Within the next 10 years, is your agency/organization planning any ITS-related projects?*
   □ YES □ NO

If Yes: Pease describe the project(s) and/or provide project name(s), available documentation source(s), expected date, and funding source – if available.

____

____

____

____

5. *Do you share any type of data or information with the following agencies?*

	YES	NO	Planned
Ohio Department of Transportation (ODOT)			
Ohio Rail Development Commission (ORDC)			
Central Ohio Transit Authority (COTA)			
County Emergency Management Agency (EMA)			
Columbus Regional Airport Authority (CRAA)			
City of Columbus			
Other (specify who) ____________________			

6. *Please list the specific types of data or information you share with the above organizations / agencies?*

____

____

____

7. *In regard to Emergency Management, are you currently connected to any systems of your county EMA?*
   □ YES □ NO

   If Yes: Which information do you share?

   ____
   ____
   ____

   If No: Are you interested in sharing information in the near future? If so, which type?

   ____
   ____
   ____

8. *Does your agency/organization use (or plan to use) vehicle maintenance scheduling software to manage both routine and corrective maintenance activities on vehicles.*
   □ YES (existing) □ YES (planned) □ NO

9. *Does your agency/organization use (or plan to use) an Automated Vehicle Locator (AVL) system?*
   □ YES (existing) □ YES (planned) □ NO

10. *Does your agency/organization operate (or plan to operate) a dispatch facility?*
    □ YES (existing) □ YES (planned) □ NO

11. *Does your agency/organization currently perform (or plan to perform) Computer-Aid Dispatch (CAD) of your vehicles?*
    □ YES (existing) □ YES (planned) □ NO

12. *Does your agency/organization use Geographic Information Systems (GIS)?*
    □ YES □ NO

    If Yes:

    What is the GIS used for?

    ____

    What type of software (ESRI, Meta Map, etc.) do you use?

    ____

13. *What type of radio communications system, if any, does your agency/organization currently operate?*

    ____
    ____
    ____

TRAVELER INFORMATION

14. *Does your agency/organization receive (or plan to receive) information from the National Weather Service, either directly or indirectly via the NOAA weather radio?*
    □ Currently receives □ Plans to receive □ NO

15. *Does your agency/organization receive (or plan to receive) surface transportation specific weather information from a private vendor?*
    □ Currently receives □ Plans to receive □ NO

16. *Does your agency/organization use (or plan to use) any of the following real-time traffic data collection technologies?*

	Existing	Planned	N/A
Vehicle detectors			
Video detection			
Vehicle probe readers			
Surveillance cameras			
Road weather information systems			
Overheight vehicle detection			
Other: ______________________________			

17. *Does your agency/organization process and store (or plan to process and store) collected traffic data for use in operations or for dissemination to the traveling public?*
    □ YES (existing) □ YES (planned) □ NO

18. *Does your agency/organization disseminate (or plan to disseminate) traffic condition information in any of the following ways?*

	Existing	Planned	N/A
TV / Radio			
Internet			
Emails			
Pagers / PDAs			
Paving the Way			
Hazard Advisory Radio (HAR)			
Dynamic Message Signs			
Traveler Kiosks			
Route Guidance			
Personalized Traffic Information			
511 or other telephone			
Other: ______________________________			

19. *Do you feel that your agency/organization collects transportation information that could be included in a region-wide traveler information outlet, such as an Internet website or a 511 Traveler Information System?*
    □ YES □ NO

    If Yes: Please describe the information:

ROADWAY OPERATIONS

20. *Does your agency/organization use (or plan to use) weather data or information or have sensors to detect hazards such as icy road conditions, high winds, or dense fog?*
    □ YES (existing) □ YES (planned) □ NO

21. *Does your agency/organization detect and verify (or plan to detect and verify) traffic incidents?*
    □ YES (existing) □ YES (planned) □ NO

22. *Does your agency/organization control (or plan to control) any signalized intersections?*
    □ YES (existing) □ YES (planned) □ NO

If Yes: Do any of your signalized intersections have (or plan to have):

	Existing	Planned	N/A
Signal Pre-Emption			
Closed Loop Operation			
Transit priority			
Adaptive traffic control			
Wireless communication			
Other: ______________________			

23. *Does your agency/organization monitor highway-rail intersections with any of the following technologies?*

	Yes	No	N/A
Vehicle Detectors			
Video Detection			
Train Arrival Prediction			
Electronic Traffic Violator Devices			
Other: ______________________________			

24. *Does your agency/organization use any of the technologies listed below to manage roadway work zone activities?*

	Existing	Planned	N/A
Dynamic Message Signs			
Closed Camera TVs			
Vehicle Speed Monitoring			
Work Zone Intrusion Alarms			
Other: ______________________			

REGIONAL ITS OPPORTUNITIES

25. Based on your understanding of technology in transportation, what opportunities do you see for the application of ITS technologies in your area?

____
____
____
____

26. How can the update of the Central Ohio ITS architecture be useful to you?

____
____
____
____

27. Which changes would you like to see from the previous Central Ohio Regional ITS Architecture (2004): http://www.morpc.org/web/transportation/its/regITS.html?

____
____
____
____

Thank you very much for taking the time to complete this survey!

Appendix B: Central Ohio ITS Stakeholders

State Agencies

Agency	Description	Departments Surveyed
Federal Highway Administration (FHWA)	Represents agency coordination, federal funding, official guidelines, and data management.	
Ohio Department of Administrative Services	Operates and maintains state of Ohio telecom infrastructure.	
Ohio Department of Public Safety (ODPS)	ODPS Provides for the protection of the public through education, prevention, technology and enforcement activities.	
Ohio Department of Transportation (ODOT)	ODOT is concerned with building and maintaining a safe and efficient transportation network in Ohio.	Central Office, District 6, Highway Management, IT, Traffic Planning
Ohio Environmental Protection Agency (OEPA)	OEPA works to o protect the environment and public health by ensuring compliance with environmental laws.	
Ohio State Highway Patrol	Provides law enforcement and emergency management for the region.	
Public Utilities Commission of Ohio (PUCO)	PUCO regulates providers of utility services, telephone companies, water and wastewater companies, and rail and trucking companies in Ohio.	

MPO Members

→ Departments surveyed: Public Service, Public Safety, Technology, Development, Police, Fire, Transportation, Auditor

Cities		Villages	Townships
Bexley	Washington	Brice	Bloom (Fairfield County)
Columbus	Westerville	Canal Winchester	Etna (Licking County)
Delaware	Whitehall	Groveport	Violet (Fairfield County)
Dublin	Worthington	Harrisburg	
Gahanna		Lockbourne	
Grandview Heights		Marble Cliff	
Grove City		Minerva Park	
Hilliard		Mount Sterling	
London		New Albany	
Marysville		New Rome	
Pataskala		Obetz	
Pickerington		Riverlea	
Powell		Urbancrest	
Reynoldsburg		Valley View	
Upper Arlington		West Jefferson	

Counties
Delaware
Fairfield
Franklin
Licking
Ross

Other Agencies

Agency	Description	Departments Surveyed
Central Ohio Transit Authority (COTA)	Public transportation provider for the central Ohio region. COTA currently provides bus services and paratransit service.	Transportation, Finance, Planning, Communications, Marketing, Traveler Support
Columbus Regional Airport Authority (CRAA)	CRAA is responsible for the operation of Port Columbus International, Rickenbacker International and Bolton Field airports.	
Delaware Area Transit Authority	DATA is the public transportation agency that provides bus transit service to Delaware County.	
Franklin County Township Trustees Association		
Media (NBC, ONN)	Television, radio, and print media are used to disseminate information to the public.	
Mid-Ohio Regional Planning Commission (MORPC)	MORPC is the Metropolitan Planning Organization (MPO) for the central Ohio region.	
The Ohio State University	OSU is by far the largest educational institution in the region, with over 50,000 students and 40,000 employees.	

For more information on these agencies, please visit: the Stakeholders tab at http://www.consystec.com/ohio/morpc/web/.

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Appendix D: MORPC Regional ITS Architecture Change Request (CR) Form

To Be Completed By Stakeholder(s) Requesting Changes		
Originator Name:		Date Submitted:
Originator Telephone:	Originator Fax:	Originator E-Mail:
Originator Agency:		Functional Area:
Agency Authorized Signature:		Signature Date:
Description of Proposed Change:		
Rationale for Proposed Change:		
Affected Agency:	Authorized Signature:	Signature Date:
Affected Agency:	Authorized Signature:	Signature Date:
List Attachments:		
Baseline Documents Affected: ☐ Website ☐ Turbo Architecture ☐ Market Package Diagram ☐ Architecture Document ☐ Other (describe)		

To Be Completed By Maintenance Manager		
Change Request Number:	Date CR Received:	Date CR Logged:
Date Initially Discussed:	Disposition: ☐ Accepted ☐ Rejected ☐ More Info	Disposition Comments:
Date Discussed:	Disposition: ☐ Accepted ☐ Rejected ☐ More Info	Disposition Comments:
Date Discussed:	Disposition: ☐ Accepted ☐ Rejected ☐ More Info	Disposition Comments:
Date of Maintenance Working Group Approval (If Applicable):		
Baseline Documents Affected/Version implemented ☐ Turbo Architecture Date: _______ Version: _____ ☐ Website Date: _______ Version: ____ ☐ Market Package Date: _______ Version: _____ ☐ Other Date: _______ Version: ____ ☐ Architecture Doc Date: _______ Version: _____		

Appendix E: ITS Architecture Summary

ITS Definition

ITS Stands for "Intelligent Transportation Systems" and refers to a concept that uses detection and communication tools or technologies to help the roadway system operators to operate the system more safely and efficiently and in real-time, and to provide information to the public – all in an effort to improve the safety and efficiency of the transportation system.

Instead of building more and wider highways, ITS is often seen as an alternative solution to reduce congestion, increase traffic flow, and improve air quality.

Examples of ITS projects in our transportation area

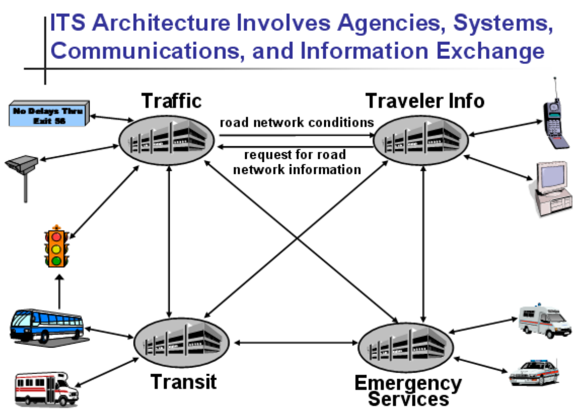
- Columbus Metropolitan Freeway Management System (CMFMS), including their dynamic message signs, the circuit closed TV cameras or the ramp meters on the entrance lanes to freeways.
- Transit Automatic Vehicle Locator Systems (AVL)
- Traffic signal coordination (and signal priority for transit within the City of Columbus)

Although central Ohio is divided between numerous jurisdictions and agencies, MORPC's vision is to establish a single transportation network in which all stakeholders share an interest, making the integration between systems a cornerstone of the program. This is where the ITS architecture comes into play.

Definition of a Regional ITS Architecture

The ITS Architecture Document serves as "a regional framework that ensures that there are institutional agreements as well as technical integration for the implementation of ITS projects in a region."

The ITS Architecture Document identifies the organizations that provide ITS systems and those that have an interest in them. It also defines the different operating systems, the functions they perform, what information is exchanged, and how it is exchanged.



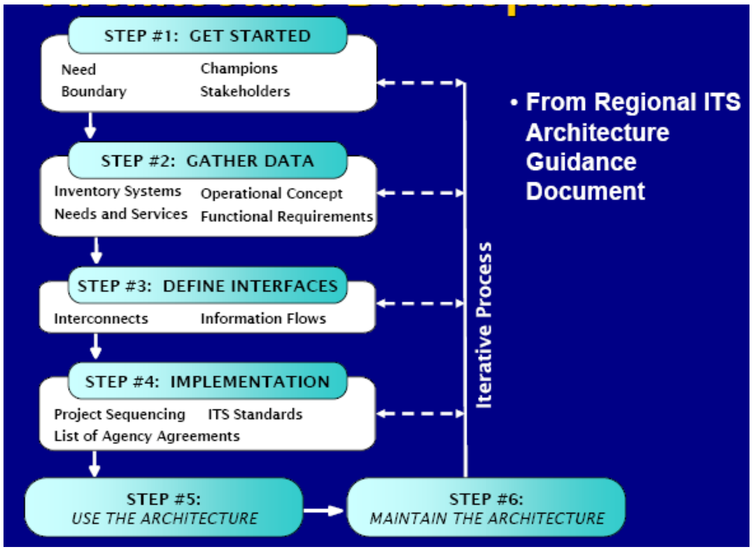
The ITS Architecture is a "living" document and MORPC has made the commitment to update it every 4 years in conjunction with the long-range transportation plan.

The core stakeholders in our region assist MORPC in updating the document. Core stakeholders are those agencies which have invested a large amount of time and money in local ITS efforts and have expressed interest in regional ITS integration. For central Ohio, those agencies include, besides MORPC, the Ohio Department of Transportation (ODOT), the Franklin County Engineer's Office (FCEO), the Central Ohio Transit Authority (COTA), and the City of Columbus.

Once updated, the ITS Architecture needs then to be approved by the policy board by resolution.

The process chart below gives a better understanding of how the ITS architecture is developed.

Process of regional ITS architecture development



Step 1: Identify regional needs, define core stakeholders (who own & operate ITS systems & who have interest in regional transportation issues) and decide on the champion (=MORPC).

Step 2: Collect all the info of existing systems, the needs for systems and the services that could address them, the roles and responsibilities of each agency/stakeholder and the primary functions of the ITS systems.

Step 3: Define how the different projects/systems interact with each other and how & which info is disseminated between the systems and to the users.

Step 4: Evaluate projects & develop priorities of how & when projects get implemented. List of agency agreements.

Step 5: Use in transportation planning process (T-Plan, TIP)

Primary reasons for developing and maintaining a regional ITS Architecture

- To identify and ensure the integration opportunities among regional transportation systems
- To encourage stakeholder involvement and interest in participation
- To assist in identifying gaps in existing services that might need to be addressed
- To assist in estimating the amount of funding needed and help with prioritizing the various projects as well as the efficient structuring of project implementation
- To serve as an educational tool and improve stakeholder information exchange
- To ensure that when using the TIP to list ITS projects that they are clearly described in the architecture
- The architecture is a federally mandated document. For any ITS project to receive federal funding through MORPC (CMAQ), it *must* conform to the architecture.

Maintaining and updating the regional ITS Architecture

MORPC is responsible for maintaining and updating the regional ITS architecture. Every time an ITS project is implemented, the responsible agency must inform MORPC about how the project fits into the ITS architecture. A change request form will be submitted and shared with the members of the Freeway Management System (FMS) Policy Committee who serve as the maintenance working group. MORPC, together with the working group members, make the decision about approving a change request.

A full update of the regional ITS architecture is conducted every 4 years in conjunction with the long-range transportation plan. At that point, MORPC surveys all members to identify new and upcoming projects and makes the changes to the ITS database as requested during the years.