LEXINGTON AREA
Metropolitan Planning Organization

LEXINGTON AREA ITS ARCHITECTURE REPORT

PREPARED BY

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A. Executive Summary

1. Introduction

The Lexington Area Intelligent Transportation Systems (ITS) Architecture is a roadmap for the deployment and integration of ITS in the Lexington Area Metropolitan Planning Organization (MPO) planning area for the next ten years. The Lexington Area MPO planning area, defined as the region in this Architecture, geographically covers Fayette County, Jessamine County, and a very small portion of Scott County in central Kentucky. The Lexington Area ITS Architecture provides a framework for institutional agreements and technical integration of ITS implementation projects in the region. It describes the "big picture" for ITS deployment in terms of individual ITS components that will perform the functions necessary to deliver the desired needs. It supports effective and efficient deployment of transportation and ITS projects that address the transportation problems and needs in the region.

The Lexington Area ITS Architecture is an open and integrated ITS architecture that is compliant with the Federal Highway Administration (FHWA) Final Rule and Federal Transit Administration (FTA) Policy on ITS Architecture and Standards. The Architecture has been developed through a cooperative effort by the highway, transit, law enforcement, emergency management, commercial vehicle, and freight management agencies. It represents a shared vision of how each agency's systems work together by sharing information and resources to enhance transportation safety, efficiency, capacity, mobility, reliability, and security.

2. Purpose

The purpose of the Lexington Area ITS Architecture is to illustrate and document the integration of regional ITS systems to allow planning and deployment to occur in an organized and coordinated process. The Architecture helps guide the planning, implementation, and integration of ITS devices deployed and managed by multiple types of agencies that provide transportation services within the region.

The Architecture helps to accomplish the following objectives for ITS deployment in the region:

- Facilitate stakeholder coordination in ITS planning, deployment and operations;
- Reflect the current state of ITS planning and deployment within a region;
- Provide high-level planning for enhancing regional transportation systems using current and future ITS technologies; and
- Conform with the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) and FHWA Final Rule 940 and FTA Final Policy on ITS Architecture and Standards.

3. Lexington Area ITS Architecture

The Lexington Area ITS Architecture describes coordination of overall system operations by defining interfaces between equipment and systems which have been or will be deployed by different organizational or operating agencies in the region. The Architecture identifies the current ITS deployment and how these systems interact and integrate with each other. It also builds on the existing systems and addresses the additional components deemed necessary to grow the ITS systems in the region over the next 10 years to accommodate specific needs and issues of participating stakeholders.

A high-level interconnect diagram for the Lexington Area ITS Architecture, often referred to as a "sausage diagram" as shown below, illustrates the architecture subsystems and primary types of interconnections (or communications) between these subsystems. The sausage diagram was customized to reflect the systems of the Lexington Area ITS Architecture. The areas highlighted with red boxes indicate the functions and services that are currently existing and planned in the region.

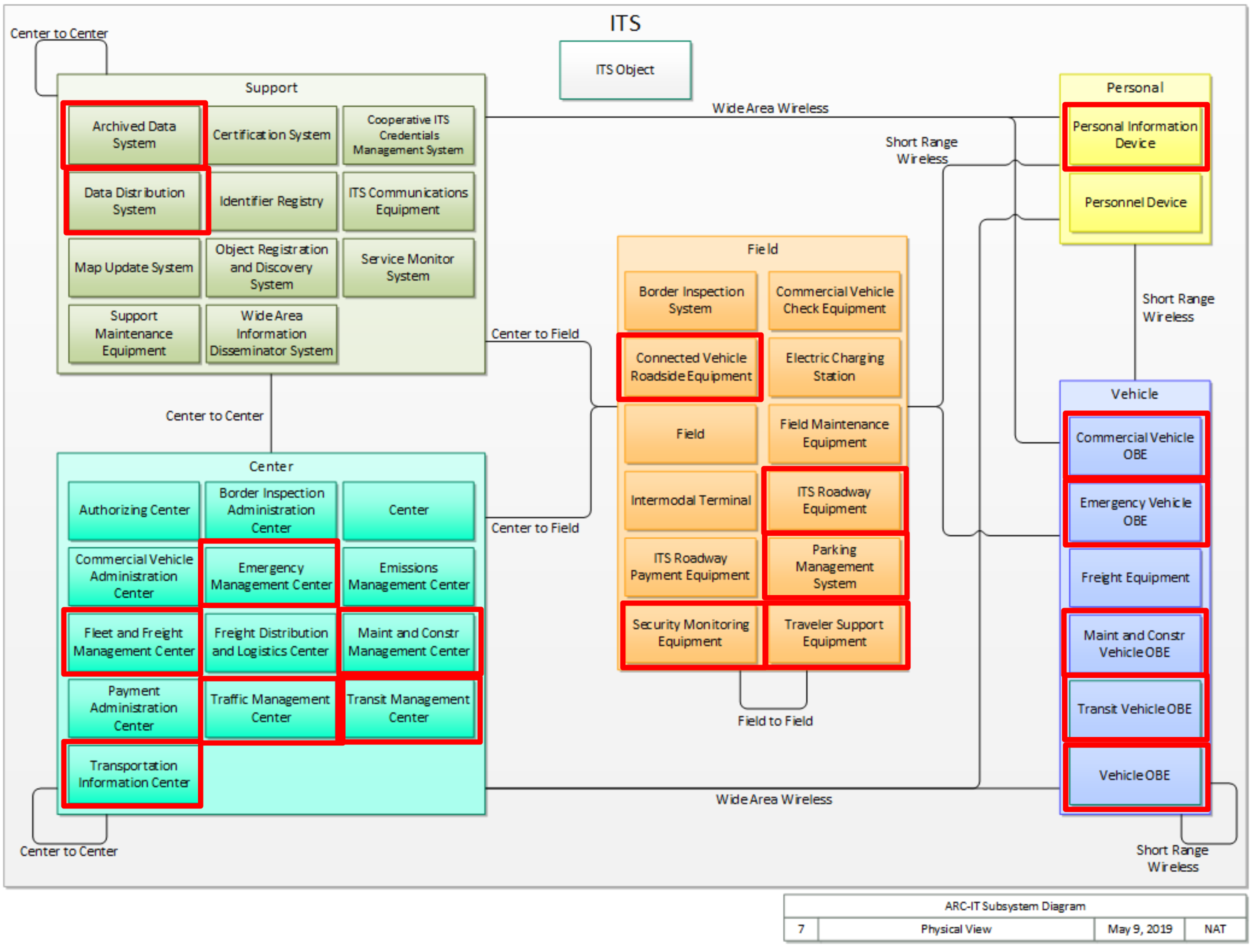

Figure 1. High-Level Interconnect Diagram

4. Applicable ITS Standards

ITS Standards are fundamental to the establishment of an open ITS environment that achieves the goals originally envisioned by the United States Department of Transportation (USDOT). Standards facilitate deployment of interoperable systems at local, regional, and national levels without impeding innovation as technology advances and new approaches evolve. Standards can be thought of as the glue that holds the various pieces of architecture together. They define how the communications within an ITS environment take place.

While the Lexington Area ITS Architecture includes various ITS applications, it does not cover every conceivable ITS technology. As such, not all ITS standards will be applicable to the existing ITS component and future deployment. Fifty-eight (58) ITS standards were identified as standards supporting the ITS projects in the region.

It is important that stakeholders are aware of the importance of ITS standards, especially with respect to cost, risk, and interoperability issues both within the region and when connecting with other ITS architecture regions. These standards can save money in the long run, and make sure that various devices and systems "play well together".

5. Recommended ITS Projects and Implementation Sequencing

The Lexington Area ITS Architecture identifies a list of ITS projects for considering and recommends a sequence in which those projects may be implemented. The project implementation sequence is based on a combination of two factors:

- **Prioritization of projects based on existing conditions and stakeholder needs.** ITS projects were prioritized to reflect a deployment path (sequence) of stakeholder needs. As technology, funding opportunities and requirements continue to evolve, it is expected that stakeholders will reevaluate and reprioritize projects periodically.
- **Project dependencies, based on how successive ITS projects can build upon one another.** Project dependencies influence the project sequencing. It is beneficial to identify the information and functional dependencies between projects.

6. Documentation of ITS Architecture

The Lexington Area ITS Architecture is documented in four forms. The first is a non-technical executive summary that provides high-level summary of the Architecture that is suitable for agency executives, non-technical readers, and general public. The second form is this report which provides more detailed, technical-oriented information regarding various aspects of the Architecture. The third form is an Architecture website that provides detailed architecture outputs in an organized web environment. The fourth is the Architecture database that is prepared using the Regional Architecture Development for Intelligent Transportation (RAD-IT) software, which is developed by FHWA for developing ITS architectures. The details of the Lexington Area ITS Architecture, including definitions of stakeholders, ITS inventory, projects, stakeholder roles and responsibilities, ITS services, interfaces among ITS systems, functional requirements, standards and agreements, are captured in the RAD-IT database, the Architecture website, as well as in the Appendix of this report.

7. Architecture Maintenance

By its nature, an ITS architecture is not a static set of outputs. The Lexington Area ITS Architecture is a living document and should be modified as plans and priorities change, ITS projects are implemented, and ITS needs and services evolve in the region. An architecture maintenance plan is developed to address the needs for maintenance and updates.

The Lexington Area ITS Working Group (LAIWG), comprised of representatives from Lexington Area MPO, Lexington-Fayette Urban County Government (LFUCG) Traffic Engineering, Lextran and Kentucky Transportation Cabinet (KYTC), will be responsible for housing and maintaining the ITS Architecture.

The general steps for architecture maintenance are:

1. Stakeholders identify changes, notify the LAIWG of changes and submit it to the LAIWG.
2. The LAIWG reviews the proposed changes, offers comments, and/or asks for additional information.

3. The LAIWG, in coordination with the appropriate stakeholders affected by the proposed changes, evaluates the changes and determine what impact they may have on the Architecture and/or associated documentation.
4. Upon its evaluation, the LAIWG makes a decision to accept the change, reject it, or ask for additional information.
5. If the decision is to accept the change, then the appropriate portions of the architecture baseline are updated by a designated member of the LAIWG.
6. Once the ITS Architecture has been modified, the LAIWG publishes the updated architecture documentation, database and website.
7. The LAIWG also notifies all stakeholders of architecture updates and provides information on how to obtain the latest version of the Architecture.

B. Technical Report

1. Regional ITS Architecture Overview

An Intelligent Transportation Systems (ITS) architecture describes the "big picture" for ITS deployment in terms of individual components (i.e. subsystems) that will perform the functions necessary to deliver the desired needs. It describes what is to be deployed but not how those systems are to be deployed. An ITS architecture defines the components and subsystems that must interface with each other, the functions to be performed by those subsystems and the data flows among these subsystems.

The region covered by the Lexington Area ITS Architecture is the entire Lexington Area Metropolitan Planning Organization (MPO) planning area. As illustrated in Figure 2, the Lexington Area MPO planning area covers Fayette County, Jessamine County and a very small portion of Scott County, encompassing local, regional and state transportation agencies and transportation stakeholders.

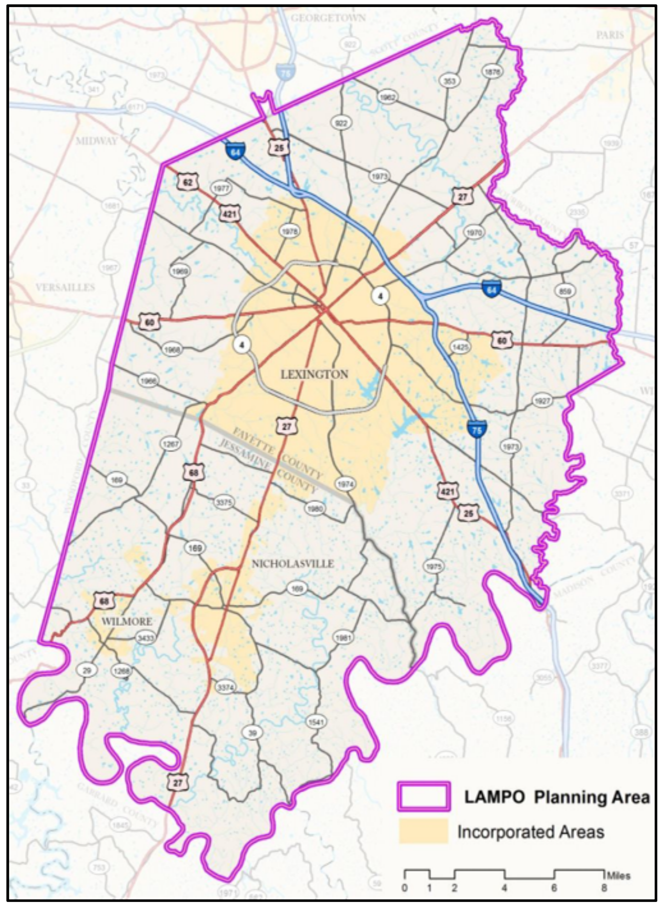

Figure 2. Lexington Area ITS Architecture Boundary

The Architecture is a roadmap for the deployment and integration of transportation systems in the region over the next 10 years. The architecture has been developed through a cooperative effort by the transportation, transit, law enforcement, emergency management, commercial vehicle and freight management agencies. It represents a shared vision of how each agency's systems work together by sharing information and resources to enhance transportation safety, efficiency, capacity, mobility, reliability, and security. The collaboration and information sharing among transportation stakeholders in the region helps illustrate integration options and gain consensus on systematic and cost-effective implementation of ITS technologies and systems in the region. It should also be noted that the Lexington Area ITS Architecture is a living document and will evolve as needs, technology, stakeholders, and funding streams change.

1.1 Purpose of a Regional ITS Architecture

The purpose of the Lexington Area ITS Architecture is to illustrate and document the integration of regional ITS systems to allow planning and deployment to occur in an organized and coordinated process. The Architecture helps guide the planning, implementation, and integration of ITS devices deployed and managed by multiple types of agencies that provide transportation services within the region. More specifically, the Architecture helps to accomplish the following objectives for ITS deployment in the region:

- Facilitate stakeholder coordination in ITS planning, deployment and operations;
- Reflect the current state of ITS planning and deployment within a region;
- Provide high-level planning for enhancing regional transportation systems using current and future ITS technologies; and
- Conform with ARC-IT and the Federal Highway Administration (FHWA) Final Rule 940[1] and Federal Transit Administration (FTA) Final Policy on ITS Architecture and Standards.

The Final Rule and the Final Policy provide policies and procedures for implementing Section 5206(e) of the Transportation Equity Act for the 21st Century (TEA–21), pertaining to conformance with ARC-IT and Standards. The Final Rule and the Final Policy ensure that ITS projects carried out using funds from the Highway Trust Fund including the Mass Transit Account conform to ARC-IT and applicable ITS standards.

The ARC-IT is a tool to guide the development of regional ITS architectures. It is a common framework that guides agencies in establishing ITS interoperability and helps them choose the most appropriate strategies for processing transportation information, implementing and integrating ITS components and systems, and improving operations. The Lexington Area ITS Architecture is a specific application of the framework specified in the ARC-IT, tailored to the needs of the transportation stakeholders in the Lexington Area MPO region.

1.2 Architecture Development Process

The process used to develop the Lexington Area ITS Architecture is illustrated in Figure 3. This figure shows six general steps in the "life-cycle" of an ITS architecture. In the first four steps, the ITS architecture components are developed and then these components are used and maintained in steps 5 and 6. The development process begins with basic scope definition and team building and moves through increasingly detailed steps, culminating in specific architecture outputs and documents that will guide the "implementation" of the ITS architecture.

The key to the ITS architecture development process is to identify stakeholder needs, identify ITS projects to address those needs, and define project sequencing. The project definition outlines the project concepts and the associated details including project title, stakeholder, project scope, costs, benefits and the service packages defined in the Lexington Area ITS Architecture. The project sequencing provides an approximate timeframe in which an ITS project may be implemented based on the understanding of the projects, project dependencies of the project, as well as other existing or planned ITS systems.

[1] FHWA Final Rule 940 is available at http://ops.fhwa.dot.gov/its_arch_imp/docs/20010108.pdf

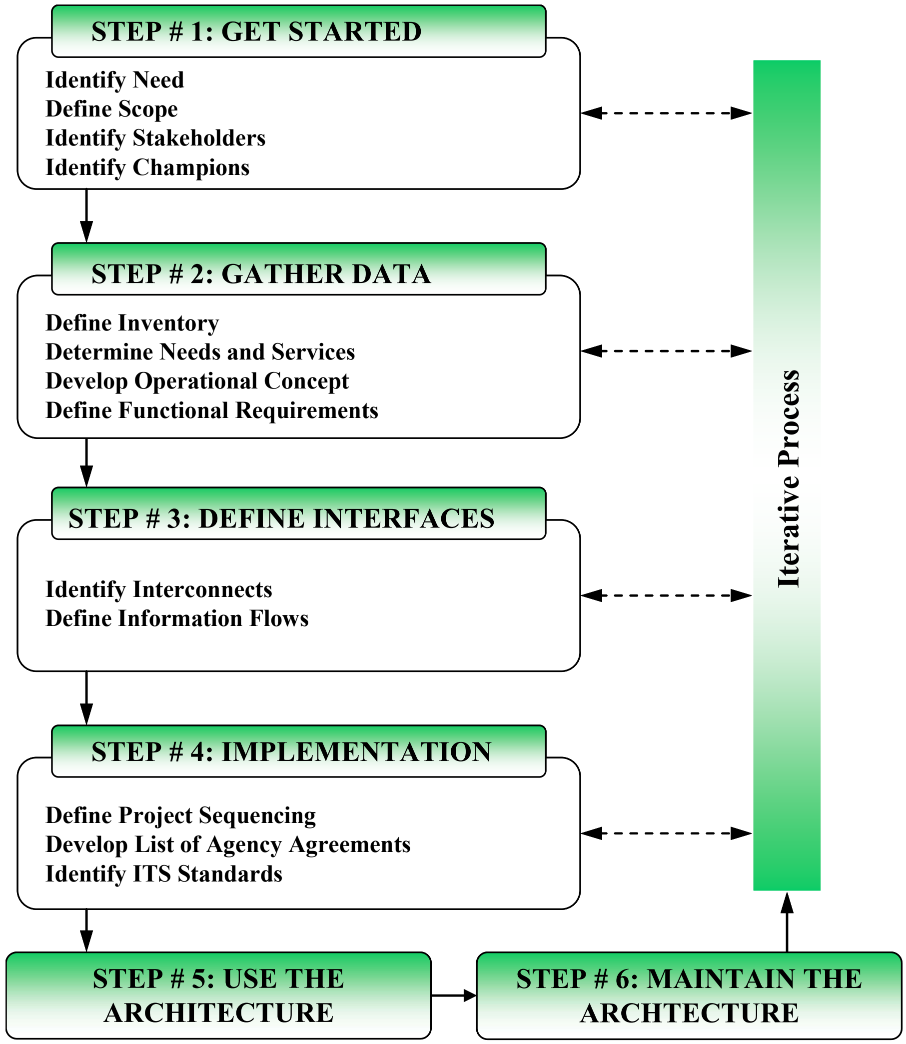

Figure 3. ITS Architecture Development Process

1.3 Systems Engineering

Systems Engineering is a phrase used to describe a cyclical process of planning, designing, implementing, testing, operating, and maintaining an ITS system. Essentially, this process covers the entire useful life of the system. Systems Engineering is a multi-step process that requires agencies to ask critical questions about how the technical aspects of the system will work together. This is often overlooked in complex systems. Figure 4 graphically illustrates the Systems Engineering process in what is often referred to as the "Vee" diagram. The purpose of a "V" in the diagram is to show how the final deliverables relate back to the early decisions (The right side relates directly back to the left side). That way there are no surprises when the system if finally delivered. For example, while a system is being designed the various functions are documented as requirements, and then when the system is being built, these same functional requirements are compared to what was actually delivered.

The Systems Engineering process shows how each step of the process builds on the previous one and is reliant on a system of back checking to ensure that the project is being designed and constructed based on its originally intended purpose. Systems Engineering is a risk management tool that sets expectations and then verifies that those expectations are met. It also enables a change management system so that unexpected issues can be incorporated into the process.

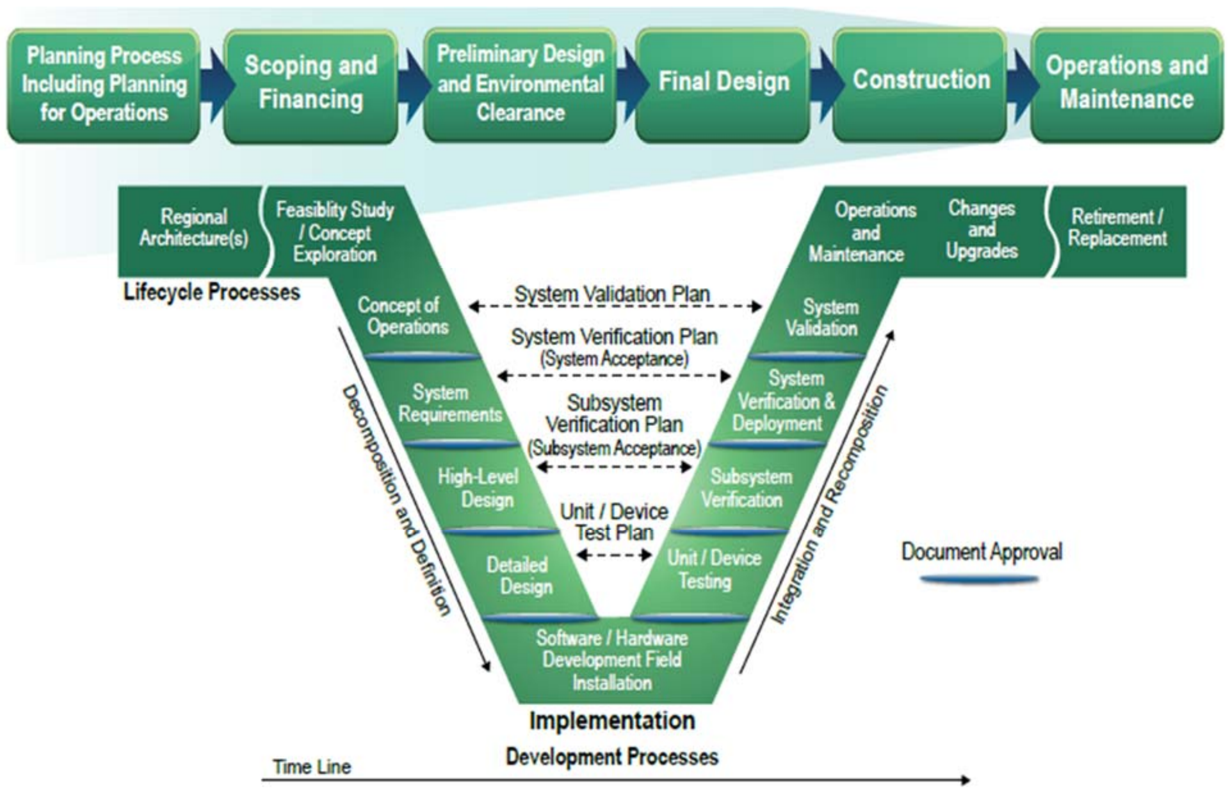

Figure 4. Systems Engineering V-Diagram

1.4 FHWA and FTA Requirements on ITS Architectures

FHWA Rule 940 (http://ops.fhwa.dot.gov/its_arch_imp/docs/20010108.pdf) provides policies and procedures for implementing Section 5206(e) of the Transportation Equity Act for the 21st Century (TEA–21), Public Law 105–178, 112 Stat. 457, pertaining to conformance with ARC-IT and Standards. The rule states, in part, that the final design of all ITS projects funded with Highway Trust Funds must accommodate the interface requirements and information exchanges as specified in the regional ITS architecture.

For federally funded ITS projects, several steps need to be followed as part of the systems engineering analysis and Rule 940 requirements. Rule 940 states that the systems engineering analysis shall include, at a minimum:

- Identification of portions of the regional ITS architecture being implemented (or if a regional ITS architecture does not exist, the applicable portions of ARC-IT)
- Identification of participating agencies roles and responsibilities
- Requirements 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

The rule requirements are applicable for all ITS projects funded through the Highway Trust Fund account. Conformity with the Rule 940 requirements is required for both routine and non-routine projects. However, with routine projects, the effort and the scope of systems engineering analysis should be minimal. For non-routine projects, the scale of the systems engineering analysis depends on the scope of the project.

While the use of the architecture and the systems engineering approach is mandatory for federally funded projects, project developers are encouraged to use this approach for any ITS project using state or local funds, especially for projects that integrate with other systems in the region.

The Lexington Area ITS Architecture is a specific application of the framework specified in ARC-IT, tailored to the needs of the transportation stakeholders in the region. The Architecture was developed following the systems engineering approach and the requirements set forth in FHWA Final Rule 940.

2. Stakeholder Involvement

Stakeholders are commonly considered to be those who own or operate ITS systems in the region as well as those who have an interest in regional transportation issues. Stakeholders provide crucial input regarding the region's transportation investment and ITS deployments, therefore, stakeholder participation and coordination is critical to the success of the ITS architecture development.

The Lexington Area ITS Architecture includes a wide range of stakeholders, and key stakeholders were identified early in the architecture development process. Information on current and potential ITS deployment was gathered at a stakeholder meeting in February 2020, through surveys distributed at the meeting and via email to other stakeholders. These surveys presented stakeholders with a list of common transportation issues/needs that can be addressed through the use of ITS technologies, and asked stakeholders to rank the severity of the issue as High, Medium, Low, or Not Applicable in the region. The surveys also asked stakeholders to list the top 5 needs and challenges that would like to see addressed by the update to the Lexington Area ITS Architecture. A total of 24 surveys were completed by stakeholders at the meeting as well as via email after the meeting. In addition, facilitators guided stakeholders through a listing of ITS projects identified in 2015 to determine the current status of those projects, identified additional projects, and discussed implementation timeline and strategies.

In May 2020, stakeholders were again invited to a second stakeholder meeting where they were presented with the draft architecture and encouraged to review, provide comments and add missing information. Facilitators guided stakeholders through updates made to the Lexington Area ITS Architecture through review of the updated web pages that were made available for review prior to the second stakeholder meeting.

3. Regional ITS Architecture Components

This section describes the following processes that were followed in developing the Lexington Area ITS Architecture through the use of RAD-IT software. Part D – Appendix contains the detailed report generated by the RAD-IT software.

3.1 Inventory

The inventory of the Lexington Area ITS Architecture contains all of the existing and future elements of ITS technology within the region. An inventory of elements was previously defined for the Lexington region in 2015 was used as a starting point in developing this inventory. These elements were updated and modified based on information gathered through reading survey responses provided at the first stakeholder meeting and received via email, as well as open discussion held at the first meeting.

ITS elements within the Inventory represent the range of ITS devices and systems. Figure 5 displays that the five types of inventory elements that can exist within an ITS Architecture (represented by the five colored boxes in Fig. 4 below). ITS elements can exist:

- On vehicles (i.e. police cars, snow plows, etc.)
- In the field (i.e. traffic signals)
- At a center (i.e. Traffic Management Center)
- Personally in the hands of travelers (i.e. computers, smartphones, etc.)
- As support systems (i.e. back-office map systems, etc.)

The technical functions that each of these elements perform are defined by ARC-IT as Subsystems and illustrated in Figure 5.

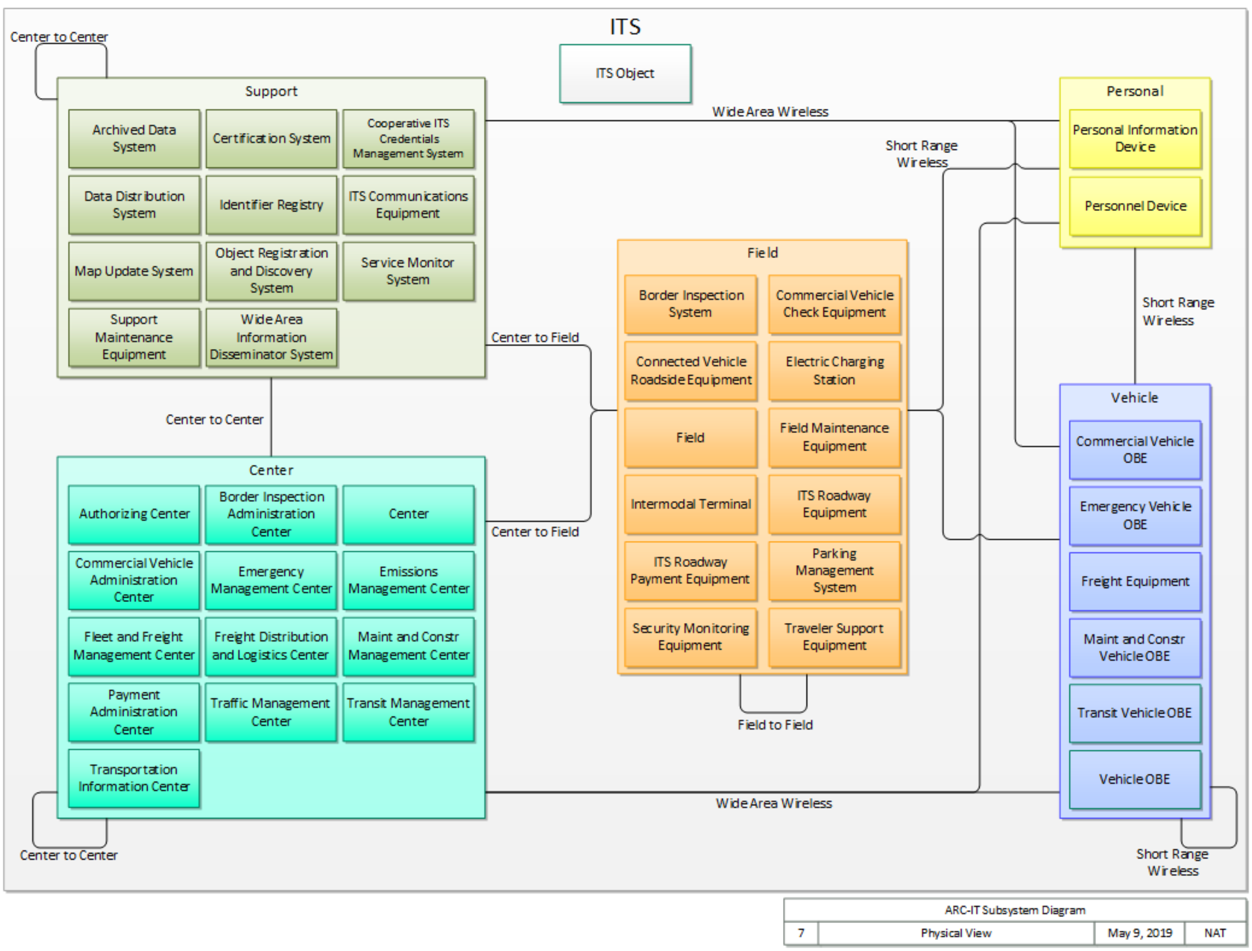

Figure 5. ARC-IT Subsystems and Interconnections

In addition to Subsystem elements, there are additional elements added to the Inventory defined by ARC-IT as Terminators. These represent the people, systems, and general environment that interface with the

Subsystem elements. Terminators typically represent the beginning or end of a flow of information in the ITS Architecture. No technical or functional requirements are assigned to terminators because they are the points outside the system boundaries where the architecture "plugs in" to the outside world.

A detailed listing of all the ITS elements in the Lexington Area MPO region can be found in Section 4 of the RAD-IT Report in the Appendix. Each ITS element is documented, at a high level, by the associated stakeholder(s), its status (e.g. existing or planned), and a brief description for each element in the ITS inventory. Each element is also mapped to the various types of subsystems and terminators defined by ARC-IT.

3.2 Service Packages

The service packages of an ITS Architecture define a "service-oriented" perspective of how an ITS Architecture can be structured. Service packages are a convenient way to assemble ITS components to address frequently needed services without having to itemize the components. This can be compared to buying a car. In one purchase you acquire a complex set of systems such as engine, drive train, suspension, cargo handling, etc.) In the same way, service packages present how the ITS elements (and their assigned subsystems and terminators) work together to deliver a given ITS service, as well as the flows of information that connect those ITS elements with other important external systems. They are tailored to fit real world transportation problems and needs. Service packages enable transportation planners and decision makers to select appropriate ITS services that satisfy local and statewide needs.

All 141 service packages in ARC-IT (Version 8.3) were considered for their applicability to the Lexington Area MPO region. Table 1 below summarizes the status of ITS deployment with respect to service packages in the region. A detailed list of applicable service packages is presented in Section 5 of the RAD-IT Report in the Appendix.

Table 1. Service Packages for the Lexington Area ITS Architecture

Service Package	Service Package Name	Service Package Status
CVO01	Carrier Operations and Fleet Management	Existing
CVO12	HAZMAT Management	Existing
DM01	ITS Data Warehouse	Existing
DM02	Performance Monitoring	Planned
MC01	Maintenance and Construction Vehicle and Equipment Tracking	Existing
MC02	Maintenance and Construction Vehicle Maintenance	Existing
MC04	Winter Maintenance	Existing
MC05	Roadway Maintenance and Construction	Existing
MC06	Work Zone Management	Existing
MC07	Work Zone Safety Monitoring	Existing
MC08	Maintenance and Construction Activity Coordination	Existing
PM01	Parking Space Management	Existing
PM03	Parking Electronic Payment	Existing
PM04	Regional Parking Management	Planned
PM05	Parking Reservations	Existing
PS01	Emergency Call-Taking and Dispatch	Existing

Service Package	Service Package Name	Service Package Status
PS02	Emergency Response	Existing
PS03	Emergency Vehicle Preemption	Planned
PS08	Roadway Service Patrols	Existing
PS10	Wide-Area Alert	Existing
PS11	Early Warning System	Existing
PS12	Disaster Response and Recovery	Existing
PS13	Evacuation and Reentry Management	Existing
PT01	Transit Vehicle Tracking	Existing
PT02	Transit Fixed-Route Operations	Existing
PT03	Dynamic Transit Operations	Existing
PT04	Transit Fare Collection Management	Existing
PT05	Transit Security	Existing
PT06	Transit Fleet Management	Existing
PT07	Transit Passenger Counting	Existing
PT08	Transit Traveler Information	Existing
PT09	Transit Signal Priority	Planned
ST04	Roadside Lighting	Planned
SU03	Data Distribution	Planned
TI01	Broadcast Traveler Information	Existing
TI02	Personalized Traveler Information	Planned
TM01	Infrastructure-Based Traffic Surveillance	Existing
TM02	Vehicle-Based Traffic Surveillance	Existing
TM03	Traffic Signal Control	Existing
TM05	Traffic Metering	Planned
TM06	Traffic Information Dissemination	Existing
TM08	Traffic Incident Management System	Existing
TM09	Integrated Decision Support and Demand Management	Planned
TM12	Dynamic Roadway Warning	Existing
TM13	Standard Railroad Grade Crossing	Existing
TM16	Reversible Lane Management	Existing
TM17	Speed Warning and Enforcement	Existing
TM20	Variable Speed Limits	Planned
VS03	Situational Awareness	Planned
VS05	Curve Speed Warning	Planned
VS07	Road Weather Motorist Alert and Warning	Planned
VS08	Queue Warning	Planned
VS09	Reduced Speed Zone Warning / Lane Closure	Planned
VS11	Oversize Vehicle Warning	Planned
VS12	Pedestrian and Cyclist Safety	Existing
VS13	Intersection Safety Warning and Collision Avoidance	Planned
WX01	Weather Data Collection	Existing

3.3 Stakeholders' Operational Roles and Responsibilities

An operational concept defines each stakeholder's current and future roles and responsibilities within the Lexington area ITS systems. Defining the roles and responsibilities of the participating stakeholders in the region is an important step in realizing the common goal of an interoperable ITS system throughout the region.

A detailed list of the stakeholders' operational roles and responsibilities is contained in Section 6 of the RAD-IT Report in the Appendix. These roles and responsibilities have been defined based on existing documents (for existing ITS systems), as well as responses contained within the surveys (for proposed systems). Together, these roles and responsibilities define the Operational Concept for the ITS Architecture, and provide an overview how ITS services operate within the region.

3.4 Functional Requirements

A functional requirement is a task or activity that is currently performed or is planned to be performed by each system in the region to provide the required regional ITS services. The ARC-IT has pre-defined all possible functional requirements (i.e. equipment packages) that are associated with respective subsystems in each service package. The regional architecture is created through selecting those functional requirements that apply from this master list of functional requirements.

The process of selecting the functional requirements for the Lexington Area ITS Architecture began with the mapping of functional areas (equipment packages) to service packages and associated ITS elements. The functional requirements of each equipment package were then tailored to represent the specific local agency functions performed. RAD-IT software is then used to produce lists and graphics that can be easily interpreted by the end users.

A detailed summary of the Functional Requirements of all ITS Inventory elements in the Lexington Area MPO region is contained in Section 7 of the RAD-IT Report in the Appendix.

3.5 Interfaces

While it is important to identify the various ITS systems and stakeholders as part of the Architecture, a primary purpose of the Lexington Area ITS Architecture is to identify the connectivity between systems. The two ways to describe this connectivity are:

- **Architecture Interconnects** define the connections between equipment and systems which may be deployed by the agencies throughout the region. In other words, what entities interact with each other.
- **Architecture (Information) Flows** define a high-level information exchange associated with each interconnect between equipment and systems. In other words, what information is passed along the interconnect paths.

An example of an interconnect diagram is illustrated in Figure 6.

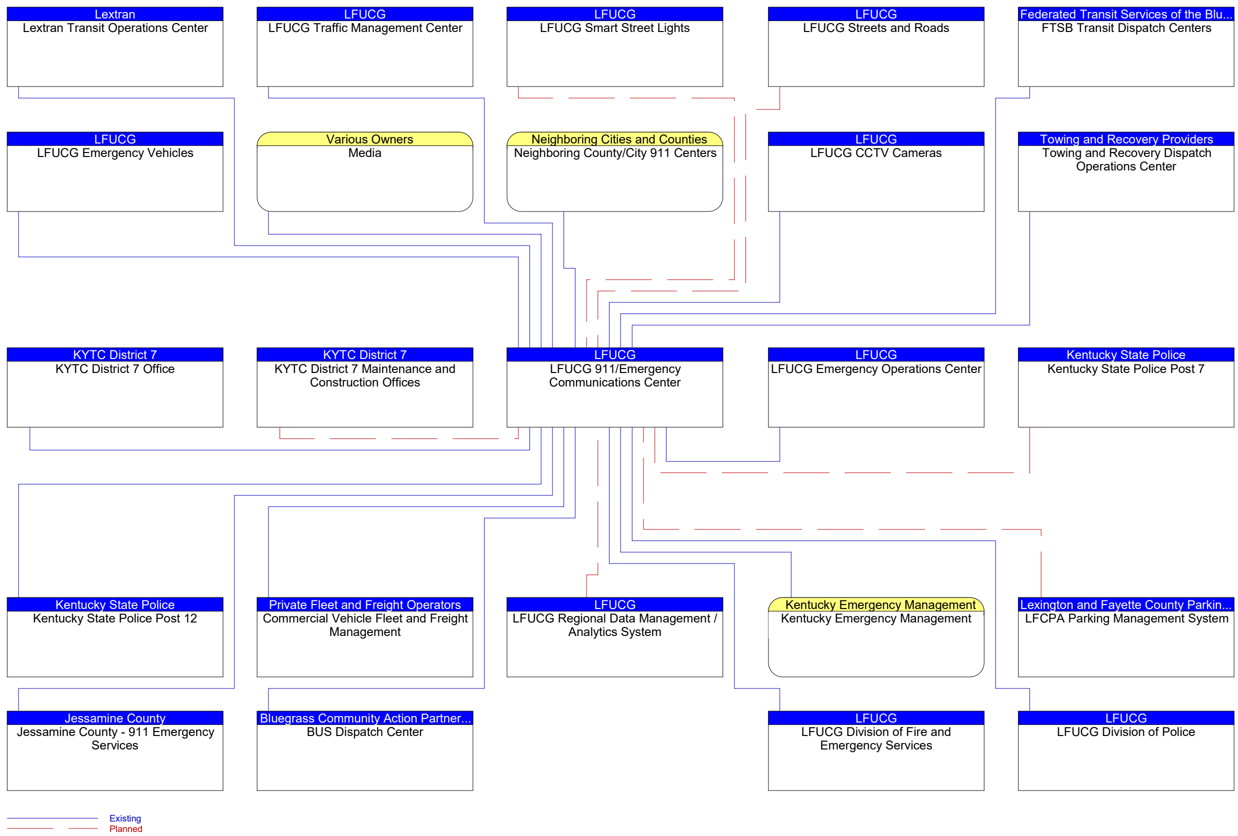

Figure 6. Interconnect Diagram Example: LFUCG Emergency Communications (E-911) Center

Figure 7 illustrates the architecture flow diagram for the LFUCG Traffic Management Center for the Traffic Signal Control function. Architecture (information) flows provide a high-level description of information exchanges associated with each interconnect path between equipment and systems. From these diagrams the stakeholders can easily identify the existing or potential information exchange between agencies and systems. This provides a framework for analyzing how elements are related and thus identifies the areas for potential coordination and cooperation among agencies. Quite often, from these diagrams agencies can identify missing communication flows that should occur, leading to refinements during the lifecycle of the system.

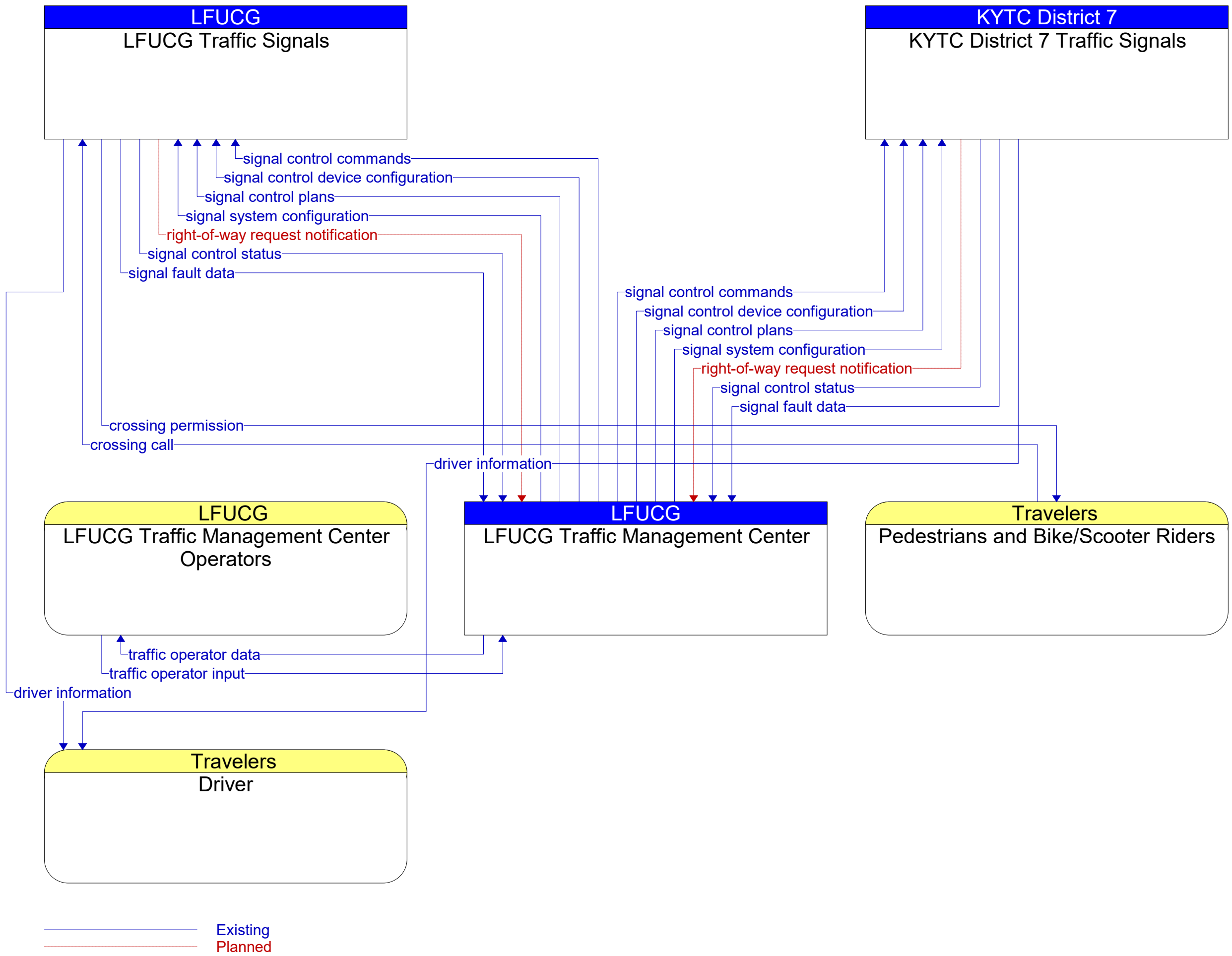

Figure 7. Architecture Flow Diagram: LFUCG TMC Traffic Signal Control

The ARC-IT provides guidance in identifying potential information to be exchanged between commonly used ITS elements in the Inventory, and the RAD-IT software is used to generate the architecture flow diagrams between ITS elements in the Inventory.

A detailed listing of the interconnects and architecture flows of all ITS Inventory elements in the Lexington Area MPO region is contained in Section 8 of the RAD-IT Report in the Appendix.

3.6 Standards

Identification of ITS technical standards that support interfaces in the regional ITS architecture are often not understood by stakeholders, so ARC-IT was created to provide the stakeholders with easy access to appropriate ITS standards that can be specifically applied to an ITS project. A summary of this task process is as follows:

- Using information flows identified in Step 3, identify relevant ITS standards for the region.
- Assess the ITS standard maturity and develop agreements for use of interim standards when determined necessary.
- Identify other regional and/or statewide standards that might apply.

As previously noted, it is important that stakeholders are aware of the importance of ITS standards, especially with respect to cost, risk, and interoperability issues both within the region and when connecting with other ITS architecture regions. These standards can save money in the long run, and make sure that various devices and systems "play well together".

A list of ITS Standards identified by the RAD-IT as applicable to the Lexington Area MPO region is contained in the RAD-IT Report in the Appendix.

3.7 Agreements

The Lexington Area ITS Architecture also provides an institutional framework for the deployment of ITS in the region. Institutional interoperability involves cooperation and coordination between various agencies and jurisdictions to achieve seamless functionality, regardless of agency boundaries or differences in neighboring agency systems.

Because the regional architecture identifies systems that require agencies to contribute resources and manpower to operate, inter-agency agreements are often needed to define the roles and responsibilities of each party.

There are several types of arrangements associated with the interfaces identified in the Lexington Area ITS Architecture:

- Information sharing and exchanges between systems require knowledge of the transmission protocol and data formats to ensure compatibility.
- Coordinating field device operations owned by different agencies requires defined procedures for submitting message requests and rules governing when such requests can be honored. Such coordination may be done with informal arrangements such as a Memoranda of Understanding (MOU).
- Sharing control of field devices operated by different agencies sometimes involves liability issues, which leads to more formal agreements.
- Coordinated incident response may also require formal agreements, but also requires group training of personnel from various agencies.

In general, agreements may be obtained for data sharing, establishing common procedures, supporting regional operations, cost effective maintenance arrangements, and personnel training.

Some common types of agreements are listed in Table 2. The agreement process may begin with something as simple as a handshake agreement. However, once interconnections and integration of systems begin, agencies may want to have more formalized agreements in place. A documented agreement will aid agencies in planning their operational costs, understanding their respective roles and responsibilities, and build trust for future projects. Formal agreements may be necessary where funding or financial arrangements are defined or participation in large regionally significant projects is required. Formal agreements also provide a means for sustaining the stakeholders' expectations when personnel and administration changes occur.

Table 2. Common Types of Agreements for ITS

Type of Agreement	Description
Handshake Agreement	▪ Early agreement between one or more partners ▪ Not recommended for long term operations.
Memorandum of Understanding (MOU)	▪ Initial agreement used to provide minimal detail and usually demonstrating a general consensus. ▪ Used to expand a more detailed agreement like an Interagency Agreement that may be broad in scope but contains all of the standard contract clauses required by a specific agency. ▪ May serve as a means to modify a much broader Master Funding Agreement, allowing the master agreement to cover various ITS projects throughout the region and the MOUs to specify the scope and differences between the projects.
Interagency Agreement	▪ Between public agencies (i.e., transit authorities, cities, counties, etc.) for operations, services or funding ▪ Documents responsibility, functions and liability at a minimum.
Intergovernmental Agreement	▪ Between governmental agencies (i.e., Agreements between universities and State DOT, MPOs and State DOT, etc.)
Operational Agreement	▪ Between any agency involved in funding, operating, maintaining or using the right of way of another public or private agency. ▪ Identifies respective responsibilities for all activities associated with shared systems being operated and / or maintained.
Funding Agreement	▪ Documents the funding arrangements for ITS projects (and other projects) ▪ Includes at a minimum standard funding clauses, detailed scope, services to be performed, detailed project budgets, etc.
Master Agreements	▪ Standard contract and / or legal verbiage for a specific agency and serving as a master agreement by which all business is done. These agreements can be found in the legal department of many public agencies. ▪ Allows states, cities, transit agencies and other public agencies that do business with the same agencies over and over (i.e., cities and counties) to have one Master Agreement that uses smaller agreements (i.e., MOUs, Scope of Work and Budget Modifications, Funding Agreements, Project Agreements, etc.) to modify or expand the boundaries of the larger agreement to include more specific language.

A summary of the ITS Agreements for the region that were previously identified through survey feedback and stakeholder meetings has been documented in the RAD-IT database and can be found in Section 10 of the RAD-IT Report in the Appendix.

4. RECOMMENDED ITS PROJECTS AND IMPLEMENTATION SEQUENCING

The ITS projects included in the Lexington Area ITS Architecture were identified based on the following sources:

- Lexington Area ITS Architecture Report and RAD-IT Database
- Stakeholder surveys, inputs and feedback
- Lexington Area MPO 2040 Metropolitan Transportation Plan
- Lexington Area MPO Transportation Improvement Program

A project sequence defines the order in which ITS projects may be implemented. A good sequence is based on a combination of two factors:

- Prioritization of projects based on existing conditions and stakeholder needs. The ITS projects were prioritized to reflect a deployment path (sequence). Although the information collected through stakeholder surveys and meetings was the basis of the ITS Architecture, real world conditions of changing technology, funding opportunities and public demand continue to evolve. It is expected that the stakeholders will reevaluate and reprioritize projects frequently to keep up with these imposed changes.
- Projects often depend on prior projects being completed. For example, a fiber optic network would need to be in place before a set of detectors are constructed to provide a means to communicate with the detection system. These project dependencies influence the project sequencing. Therefore, it is important to identify these dependencies between projects during the planning stages.

In most cases, the sequence of currently planned projects has already been programmed and can simply be extracted from existing transportation plans. Successive projects will then be added to the sequence based on the project dependencies and other planning factors.

The project timeframes provide a means to position each project along the architecture's lifetime. This enables the scheduling of funds and resources to deliver the projects in an appropriate sequence. Three timeframe categories are used, and their definitions are described below:

Table 3. Project Implementation Timeframes

Category	Time Frame	Year of Deployment
Short Term	0 – 3 years	2020 – 2023
Medium Term	4 – 6 years	2024 – 2026
Long Term	7 years and beyond	2027 and beyond

The Lexington Area ITS Architecture represents a roadmap for transportation systems deployment and integration in the region over the next 10 years. A list of ITS projects that have currently been planned or considered over the next 10 years is identified in Table 4. Through the above process, the recommended ITS project sequencing was determined. The list was further refined to establish which projects were allocated to the short term (within 3 years), medium term (4 to 6 years), and long term (over 7 years). This provided a priority for the list of projects denoting a general order for project implementation.

In addition, the description for each ITS project architecture in Table 4 includes a note with some potential funding sources that could be utilized to support the implementation of each ITS project. Each source includes a hyperlink to a page that provides further information on the funding sources. Further description of these funding sources is also provided within Section 3.3 of this report.

Table 4. List of Future Projects / Initiatives for Consideration

Project	Project Description	Project Timeframe	Lead Agency
Short Term Projects			
Transit Vehicle Security Cameras	This project represents the installation of security cameras on transit vehicles operated by the Bluegrass Community Action Partnership (BGCAP). Security camera recordings can be accessed in real-time provided that cellular communications is enabled with the vehicles, or accessed at the end of the vehicle shift at the transit garage. *Potential Funding Sources*: Transit Funding (5307), Transportation Security Funds	Short Term (0-3 Years)	BGCAP
AVL Expansion on Snow Plows	This project will facilitate the expansion of AVL equipment on KYTC District 7 snow plows that enables monitoring of vehicle locations and real-time communications with KYTC District 7 Maintenance and Construction Offices. KYTC District 7 currently utilizes Maintenance Decision Support Systems (MDSS) for the real-time communications of recommended roadway treatments based on environmental conditions gathered from roadside weather observation stations and sensors on board the snow plows. *Potential Funding Sources*: Technology and Innovation Deployment Program (TIDP), Congestion Mitigation and Air Quality (CMAQ)	Short Term (0-3 Years)	KYTC
Expansion of Real-Time Transit Information Dissemination at Transit Stations	This project represents the installation of information displays/signs at the Transit Center and major transit stations. The information displays/signs will display transit arrival / departure information that is estimated based on information from Automated Vehicle Locator (AVL) equipment on Lextran buses. *Potential Funding Sources*: Transit Funding (5307), Congestion Mitigation and Air Quality (CMAQ)	Short Term (0-3 Years)	Lextran

Project	Project Description	Project Timeframe	Lead Agency
Parking Availability Information Sharing with Other Agencies and Third-Party Information Providers	This project will implement a live feed of parking space availability information to other agencies in the region for use in corridor management activities during special events. This also includes sharing parking availability information to the third-party traveler information providers such as WAZE. *Potential Funding Sources*: Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Short Term (0-3 Years)	LFCPA
Short to Medium/Long Term Projects			
Transit Electronic Fare Payment System	This project represents the installation of electronic fare collection equipment on transit vehicles operated by the Bluegrass Community Action Partnership (BGCAP). Equipment would be able to read magnetic stripe cards or other transit cards via Radio Frequency ID (RFID) chips installed within the transit card. BGCAP will also install software to communicate with vehicle equipment for the purposes of fare payment collection and analysis. *Potential Funding Sources*: Transit Funding (5311)	Short to Medium Term (0-6 Years)	BGCAP
Work Zone ITS Deployment	This project represents the deployment of a group of ITS solutions to improve traffic and work zone safety and efficiency in the region. ITS solutions can include work zone travel times detection and information dissemination, work zone queue detection, work zone speed enforcement, errant vehicle detection in work zones, and other systems that can improve worker safety in the work zones. *Potential Funding Sources*: Technology and Innovation Deployment Program (TIDP), Intelligent Transportation Systems (ITS) Program	Short to Medium Term (0-6 Years)	KYTC
Truck Parking Space Availability Systems	This project represents the deployment of a truck parking space availability system that can detect space availability at select parking locations for trucks and communicate the available spaces in a lot either via DMS in advance of the parking facility or via internet webpage. *Potential Funding Sources*: National Highway Freight Program, Highway Safety Improvement Program (HSIP), National Highway Performance Program (NHPP), Congestion Mitigation and Air Quality (CMAQ), Surface Transportation Block Grant Program (STBG)	Short to Medium Term (0-6 Years)	KYTC

Project	Project Description	Project Timeframe	Lead Agency
Overheight Truck Detection Systems	This project represents the deployment of an overheight detection system that can provide warnings to trucks of low clearances ahead that could be hit by the trucks. Alternate routes for the trucks could be recommended to trucks so they can alter the travel around the low clearance overpasses. *Potential Funding Sources*: Surface Transportation Block Grant Program (STBG), National Highway Freight Program, Highway Safety Improvement Program (HSIP), National Highway Performance Program (NHPP), Congestion Mitigation and Air Quality (CMAQ)	Short to Medium Term (0-6 Years)	KYTC
ITS Signalization to Improve Safety and Efficiency at Interstate Interchanges	The project represents a group of ITS solutions to improve the safety and operational efficiency of signalized intersections of freeway ramps and arterials. ITS solutions will include but not be limited to signal timing adjustments and coordination, advance dynamic warnings on freeway mainlines and/or arterial approaches to freeway ramps, and ramp meters. This will also include queue detection of traffic along exit ramps from mainline roads to reduce the potential of traffic backup on mainline roads. Queue detection has been installed at two exit ramp locations and will be expanded as needed. *Potential Funding Sources*: Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Short to Medium Term (0-6 Years)	KYTC and LFUCG (Traffic)
Wrong Way Vehicle Detection System	This project represents a system that senses a wrong–way driver and then activates the flashing beacons near static Wrong Way signs on an exit ramp of an Interstate Highway. Nearby cameras take timestamped photos of the vehicle going the wrong way to send to law enforcement. *Potential Funding Sources*: Highway Safety Improvement Program (HSIP), Highway Research Development Program (HRDP), Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ), Advanced Transportation and Congestion Management Technologies Deployment Program (ATCMTD)	Short to Medium Term (0-6 Years)	KYTC and LFUCG (Traffic/ Public Safety)

Project	Project Description	Project Timeframe	Lead Agency
Transit System Technology Enhancements	This project reflects upgrades to the transit technology systems used by Lextran for fixed route and demand response transit operations. Systems include AVL for vehicle monitoring and diagnostics, fare collection systems, and automated passenger counting systems. *Potential Funding Sources*: Transit Funding (5307), Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Short to Medium Term (0-6 Years)	Lextran
Multimodal Vehicle Detection System	The project represents installation of a multimodal vehicle detection system at additional intersections to improve safety and reduce collisions. System is able to detect vehicles as well as bicycles, scooters, and pedestrians that enter the range of detection. The system provides safer traffic signal operations and help reduce the potential for collisions. A video-based detection system has been installed at selected intersections in Lexington. Future system deployments will use the most appropriate technology for vehicle detection in the given conditions. This technology could include video, radar, lidar, thermal, or other forms of detection. This project will expand the installation of the system and technology to other key locations. *Potential Funding Sources*: Technology and Innovation Deployment Program (TIDP), Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Short to Medium Term (0-6 Years)	LFUCG (Traffic)
Fiber Communications Upgrade and Expansion	This project will upgrade the current fiber communications as well as expand the fiber network to establish redundancy. The upgrade and expansion will improve the use and reliability of fiber network for the communication of transportation data between the LFUCG Traffic Management Center (TMC) and ITS field equipment (i.e. traffic signals, CCTV, etc.). *Potential Funding Sources*: Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Short to Medium Term (0-6 Years)	LFUCG (Traffic)

Project	Project Description	Project Timeframe	Lead Agency
LFUCG Traffic Information Website Enhancements	This project will upgrade the current LFUCG traffic information website to provide both real-time and static information to the public. Information presented on the website may include: a traffic congestion map, estimated travel time, road conditions, incident information, road construction and closure information, live CCTV camera images, and links to other information websites (e.g. GoKY). Integration with Waze for sending and receiving information on traffic incidents is planned. A component of pushing travel-related information to people who subscribe to the set of desired information could also be implemented. *Potential Funding Sources*: Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Short to Medium Term (0-6 Years)	LFUCG (Traffic)
Road Weather Information Systems (RWIS) Deployment	This project represents the installation of a Road Weather Information System (RWIS). The system can be operated either by the LFUCG TMC or the LFUCG Streets & Roads office. RWIS Stations will be installed strategically at locations prone with weather issues and/or to provide regional coverage. The current KYTC RWIS station in Lexington can feed information to this system. This system can also be integrated with the current KYTC RWIS. *Potential Funding Sources*: Advanced Transportation and Congestion Management Technologies Deployment Program (ATCMTD)	Short to Medium Term (0-6 Years)	LFUCG (Traffic)
Traffic Incident Detection System	This project represents future deployment of a central software-based system that can use video analytics to detect the occurrence of traffic incidents (i.e. stopped vehicles, slow vehicles, wrong way vehicles on local streets, etc.) in real-time and communicate the incident to the LFUCG Traffic Management Center (or other emergency management agencies) of an incident requiring incident and emergency response. *Potential Funding Sources*: Highway Safety Improvement Program (HSIP), Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Short to Medium Term (0-6 Years)	LFUCG (Traffic)

Project	Project Description	Project Timeframe	Lead Agency
Transit Signal Priority	This project represents the installation of roadside equipment at traffic signals that receives requests from Lextran Transit Vehicles approaching the intersection for an extension (or side street truncation) of the current signal timing plan. US Route 60 is proposed as an initial corridor for TSP deployment. Green lights will be extended for the approaching transit vehicle, or red lights would be shortened by ending the green phase of the side street. Corresponding equipment will be installed on Lextran buses to enable signal priority requests. *Potential Funding Sources*: Transit Funding (5307), Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Short to Medium Term (0-6 Years)	LFUCG (Traffic) / Lextran
Alternate Route Traffic Management	The project will include two phases: Phase 1 – develop an alternate route traffic management plan which identifies alternate routes and required sources and defines traffic management strategies, roles and responsibilities, etc. Plans would identify thresholds for when a specific segment of the roadway is considered affected, which alternate route(s) to implement, which agencies should be involved, how they communicate, and their roles and responsibilities in traffic control, timing adjustments, and traveler information. The plan will also define what ITS assets (CCTV, DMS, etc.) should be utilized to monitor the situation and provide en-route traveler information. Phase 2 is implementation of the system. *Potential Funding Sources*: Highway Research Development Program, Transportation Security Funds, Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Short to Medium Term (0-6 Years)	LFUCG (Traffic) and KYTC

Project	Project Description	Project Timeframe	Lead Agency
Curve Speed Warning System	The project will deploy a curve speed warning system that assists drivers in avoiding crashes. The system includes roadside speed detection and warning devices to present warnings to drivers. When the speeds of approaching vehicles are above a certain threshold, the system provides alerts to drivers who are approaching a curve at an unsafe speed. Alerts are based on the location of the vehicle within the curve and the vehicle speed and may also include pavement conditions as a factor in assessing when to provide alerts for unsafe speeds. *Potential Funding Sources*: Highway Safety Improvement Program (HSIP), Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Short to Medium Term (0-6 Years)	LFUCG (Traffic/ Public Safety)
Traffic Signal System Optimization Program	This project represents updates to arterial traffic signal system timings and coordination within and across jurisdictions in the region. Traffic signal timing and coordination improvements can reduce congestion and delays on arterial roads. *Potential Funding Sources*: Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Short to Long Term (0-10 Years)	LFUCG (Traffic)
Medium to Long Term Projects			
Bus Rapid Transit (BRT) System	This project represents the implementation of a bus rapid transit (BRT) system in Lexington. The ITS components for the BRT system will include installation of AVL, mobile data terminals, passenger counters, electronic fare payment equipment, security cameras, enunciators, and signal priority emitters on BRT vehicles and information display signs at bus stops / shelters and preferential treatments such as transit signal priority and queue jump lanes at signalized intersections and the entrance and exit at the downtown transit center. *Potential Funding Sources*: Transit Funding (5307), BUILD Grant Program, Advanced Transportation and Congestion Management Technologies Deployment Program (ATCMTD)	Medium to Long Term (4-10 Years)	Lextran

Project	Project Description	Project Timeframe	Lead Agency
Variable Speed Limit (VSL) Signs	This project represents the installation of Variable Speed Limit (VSL) signs by LFUCG. VSL signs will be operated from the LFUCG Traffic Management Center. Speed limits will either be updated from the TMC based on known traffic conditions or on an automated basis from roadside detection equipment. Legislative statute enabling variable speed limits will need to be further discussed and established prior to design and implementation. *Potential Funding Sources*: Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ), Advanced Transportation and Congestion Management Technologies Deployment Program (ATCMTD)	Medium to Long Term (4-10 Years)	LFUCG (Traffic)
Regional Data Management / Analytics System	This project represents a regional data management / analytics system that is capable of storing, managing and analyzing large data sets from various regional agencies. The system will have tools for regional analysis, including data analytics tools allowing agencies to analyze transportation system performance, identify patterns and trends, and predict the system performance and impacts of events such as incidents. For example, when and where traffic incidents may be occurring on the roadway and when traffic congestion is expected are among some of the recommendations that could be made. *Potential Funding Sources*: Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Medium to Long Term (4-10 Years)	LFUCG (Traffic/ Public Safety)
LFUCG Automated Traffic Signal Performance Measures	Automated Traffic Signal Performance Measures (ATSPM) is defined as a suite of performance measures, data collection and data analysis tools to support objectives and performance-based approaches to traffic signal operations, maintenance, management and design of the signal system. The purpose of the application is to improve the overall safety, mobility and efficiency of signalized intersections for all system users. The technology allows for agencies responsible for traffic signal timing updates to use the data provided through ATSPM to determine how best to optimize traffic signal timings based on the collected data. *Potential Funding Sources*: Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Medium to Long Term (4-10 Years)	LFUCG Traffic

Project	Project Description	Project Timeframe	Lead Agency
Long Term Projects			
Freeway Ramp Meters Feasibility Study and Deployment	The first phase of the project will include a study to investigate the feasibility of installing meters on freeway on-ramps to improve traffic flows and safety of interstate highways in the region. The study will provide recommendations on whether ramp metering is a viable traffic management strategy for the region as well as locations for deployment. If deemed feasible, deployment of ramp meters will be carried out in the subsequent phase of the project. *Potential Funding Sources*: Highway Research Development Program, Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Long Term (7 Years and Beyond)	KYTC
Integrated Corridor Management (ICM) System	The project represents a future concept/feasibility study and subsequent deployment of an Integrated Corridor Management (ICM) system in the Lexington metropolitan area. The vision of this project is that transportation networks will realize significant improvements in the efficient movement of people and goods through institutional collaboration and proactive integration of existing infrastructure along major corridors. The ICM system will enable the Lexington TMC to manage the corridor as a multimodal system and make operational decisions for the benefit of the corridor. *Potential Funding Sources*: Advanced Transportation and Congestion Management Technologies Deployment Program (ATCMTD), Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Long Term (7 Years and Beyond)	LFUCG (Traffic)

Project	Project Description	Project Timeframe	Lead Agency
Emergency Vehicle Pre-emption	This project represents the installation of roadside equipment at LFUCG traffic signals that receives requests from emergency vehicles approaching the intersections for signal pre-emption and provides a green light for the approaching phase of the emergency vehicle. Corresponding equipment will be installed on LFUCG emergency vehicles to enable the pre-emption of the signal timing. The same roadside equipment may also be utilized for signal priority for Lextran's buses. It is recommended to perform a feasibility study first. *Potential Funding Sources*: Intelligent Transportation Systems (ITS) Program, Congestion Mitigation and Air Quality (CMAQ)	Long Term (7 Years and Beyond)	LFUCG (Traffic/ Public Safety)
Connected Vehicle Pilot/ Demonstration Projects	This project represents several potential Connected Vehicle Pilot / Demonstration projects for the region. One project could use roadside equipment to sense wrong–way drivers and activate the flashing beacons near static Wrong Way signs on an exit ramp. A second project could feature a Curve Speed Warning application to provide alerts to drivers approaching a curve at high speeds. A third system would provide connected vehicles near a reduced speed zone (i.e. school zones or work zones) or closed lane with information on the zone's posted speed limit and/or the configuration of the roadway. A fourth application would communicate messages from a central traffic management software directly to vehicles that inform drivers about roadway traffic incidents, weather conditions specific to a location on the roadway, and upcoming road closures / lane restrictions / work zones. *Potential Funding Sources*: Intelligent Transportation Systems (ITS) Program, Advanced Transportation and Congestion Management Technologies Deployment Program (ATCMTD)	Long Term (7 Years and Beyond)	LFUCG (Traffic/ Public Safety)

C. User Reference Guide

1. Glossary of Terms

Adaptive Traffic Signal System
A system that automatically adjusts traffic signal green times to improve the flow of vehicles as conditions change. The system monitors current traffic conditions, demand and capacity.

Architecture Flow
Architecture Flows (also referred to as "information flows") refer to information that moves between the components of the physical architecture view of ARC-IT. Architecture flows are the primary tool that is used to define the Regional ITS Architecture interfaces. These architecture flows define what types of information is transferred and how that transfer should occur. For example, one architecture flow would be a dispatcher communicating information to an emergency vehicle responding to an incident.

Architecture Interconnect
Interconnects are communications paths that carry information between components of the physical architecture view of ARC-IT. Several different types of interconnects are defined in ARC-IT to reflect the range of interface requirements in ITS. Some common examples are vehicle to vehicle, point to point, and roadside to vehicle links.

Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)
ARC-IT is a reference architecture that reflects the contributions of a broad cross-section of the ITS community (transportation practitioners, systems engineers, system developers, technology specialists, consultants, etc.). It provides common basis for planners and engineers with differing concerns to conceive, design and implement systems using a common language as a basis for delivering ITS, but does not mandate any particular implementation.

Arterial (Non-Freeway) Traffic Management
Systems that monitor traffic conditions on roads other than freeways (ex. arterial streets and rural roads). The data collected is used to adjust traffic signal timing in order to improve traffic flow. The information is also used for incident management purposes and is distributed to the public in a variety of ways.

Automated Vehicle Maintenance
This technology performs vehicle maintenance scheduling and manages both routine and corrective maintenance activities on agency fleet and construction equipment. It includes on-board sensors capable of automatically performing diagnostics and using it to schedule and manage vehicle maintenance.

Automatic Vehicle Location (AVL)
AVL systems track the approximate location of vehicles moving within a transportation network. The most common applications of AVL technology are for dispatching emergency vehicles, tracking transit vehicles and providing passengers with arrival time estimations through information displays.

Closed-Loop System
A system in which a computer controls a process using information received from within the process itself (e.g., a closed loop coordinated traffic signal system uses data collected by traffic detectors and then uses this information to modify the traffic signal timing plans.)

Computer-Aided Dispatch (CAD)
"Intelligent" interactive mapping and data entry systems that assist in the process of dispatching, monitoring, and managing emergency services. Emergency-dispatching hubs use computers to store, use, and report on information such as incident histories, manpower activities, and other tasks in ways that are logical and simplify the dispatchers' tasks.

Commercial Vehicle Operations (CVO)
Automated and semi-automated systems that support administrative functions for processing many of the functions required of commercial vehicle operators. This includes acquiring credentials, paying taxes, complying with enforcement and safety regulations as well as oversize/overweight permits.

Dedicated Short Range Communications (DSRC)
A wireless communications channel used for close-proximity communications between vehicles and the roadway devices. It enables communications to occur between devices that are very near each other, usually within just a few feet. Examples include automated toll collection, transit vehicle electronic fare payments and equipment maintenance reporting. These systems can also deliver information to drivers and provide electronic transactions for automated vehicle operations.

Dynamic Message Sign (DMS)
Electronic signs that display traffic conditions, alerts or other useful information to motorists or pedestrians. The term is used interchangeably with previous terminology such as variable message signs (VMS) and changeable message signs (CMS).

Element
This is the basic building block of Regional and Project ITS Architectures. It is the name used by stakeholders to describe a system or piece of a system.

Emergency Vehicle Preemption (EVP)
This technology allows emergency vehicles (police, fire trucks, ambulances, etc.) to get priority treatment as they approach traffic signals. These systems can sense the location of the emergency vehicles and adjust the green times so they arrive at the incident sites faster and safer.

Environmental Sensor Stations
Technology that monitors, weather, roadway surface, vehicle emissions, and air/water quality conditions. The primary users of the information from these devices are roadway maintenance, driver information and traffic operations.

Fixed-Point to Fixed-Point Communications
A communication link serving stationary devices. It may operate using a variety of public or private communication networks and technologies. Examples include twisted pair, coaxial cable, fiber optic, microwave relay networks, and spread spectrum radio.

Freeway Management Systems
Freeway Management Systems provide real-time control, guidance, warning, and management of traffic in order to improve the flow of people and goods safely and efficiently.

Functional Object
Functional objects are the building blocks of the physical objects of the physical view. Functional objects group similar processes of a particular physical object together into an "implementable" package. The grouping also takes into account the need to accommodate various levels of functionality. Since functional objects are both the most detailed components of the physical view and tied to specific service packages, they provide the common link between the interface-oriented architecture definition and the deployment-oriented service packages.

Incident Detection
Incident Detection provides the capability for traffic managers to detect and verify that incidents have occurred. This includes analyzing data from traffic surveillance equipment, monitoring alerts from external reporting systems, collecting special event information, and responding to reports from their agency personnel in the field.

Incident/Emergency Management
Incident/Emergency Management enables communities to quickly identify any conditions that interrupt normal traffic flow such as crashes, vehicle breakdowns and debris in the roadway. The system also supports agency coordination to minimize clean-up and medical response time.

Intelligent Transportation Systems (ITS)
ITS applies state-of-the-art and emerging technologies to provide more efficient and effective solutions to current multimodal transportation problems. Some examples of ITS are dynamic message signs, closed-circuit television monitoring systems, and traffic signal systems.

ITS Architecture
A common framework for planning, defining, and integrating intelligent transportation systems. An architecture functionally defines what the pieces of the system are and the information that is exchanged between those pieces. Architecture is defined functionally and does not prescribe particular technologies. This allows the architecture to remain effective over time as technologies evolve. It defines "what must be done," not "how it will be done."

Lexington Area ITS Working Group (LAIWG)
The Lexington Area ITS Working Group (LAIWG) is comprised of representatives from Lexington Area Metropolitan Planning Organization (MPO), Lexington-Fayette Urban County Government (LFUCG) Traffic Engineering Division, Lextran, and Kentucky Transportation Cabinet (KYTC). LAIWG will be responsible for housing and maintaining the Lexington Area ITS Architecture.

Maintenance and Construction Operations (MCO)
These are functions that support monitoring, operating, maintaining, improving and managing the physical condition of roadways, roadside equipment, and required resources.

Mobile Data Terminal (MDT)
Mobile Data Terminals (MDTs) are computerized devices used in emergency, transit, patrol, maintenance, and other vehicles to communicate with a central dispatch. They feature a screen on which to view information and a keyboard or keypad for entering information, and may be connected to various peripheral devices, such as an AVL System.

On Board Security Monitoring System
On board security system for transit vehicles. This includes surveillance and sensors to monitor the on-board environment, silent alarms that can be activated by transit user or operator, and a remote vehicle disable function. The surveillance equipment includes video (e.g. CCTV cameras), audio systems and/or event recorder systems.

Ops Concept or Operational Concept
An Operational Concept describes the roles and responsibilities of stakeholders in providing the ITS services included in the ITS Architecture. For example, one of the roles and responsibilities of the LFUCG Traffic Engineering Division is to operate and maintain the traffic signal system.

Physical Object
Physical objects are systems or device that provide ITS functionality that makes up the ITS and the surrounding environment. They are defined in terms of the services they support, the processing they include, and their interfaces with other physical objects. They are grouped into six classes: Centers, Field, ITS, Support, Travelers, and Vehicles. Example physical objects are the Traffic Management Center, the Vehicle Onboard Equipment, and the ITS Roadway Equipment. These correspond to the physical world: respectively traffic operations centers, equipped connected automobiles, and roadside signal controllers. Due to this close correspondence between the physical world and the physical objects, the interfaces between them are prime candidates for standardization.

Public Transportation (PT)
A variety of technology applications that make public transportation more efficient and convenient. Some examples include automated fare payment systems, enunciators to inform people inside and outside the transit vehicles, smart phone APP's to track bus arrival times, and many other applications.

RAD-IT Software
The Regional Architecture Development for Intelligent Transportation (RAD-IT) is an automated software tool used to build and maintain an ITS Architecture. It provides a means to input and manage system inventory, service packages, architecture flows and interconnects with regard to a Regional ITS Architecture and/or multiple Project ITS Architectures.

Regional ITS Architecture
A local version of the ITS National Architecture that is tailored for a specific region. It can be used to produce project architecture reports for specific federally funded projects.

Road Weather Information System (RWIS)
A system consisting of roadside meteorological components strategically located to provide information about weather issues affecting transportation. The principal components of RWIS include pavement sensors, atmospheric sensors, remote processing units (RPU), and central processing units (CPU).

Security Sensors and Surveillance Equipment
This technology includes cameras and sensors to monitor transportation infrastructure (e.g., bridges, tunnels and management centers) to detect potential threats. Such equipment includes acoustic, environmental threat (nuclear, explosive, chemical), motion and object sensors, and video and audio surveillance devices.

Service Package
Service packages are a combination of ITS architecture components tailored to provide a specific ITS service. For example, the Traffic Incident Management System Service Package combines incident detection systems, roadside surveillance devices, and coordination of traffic management centers to fulfill a number of useful needs related to the rapid clearing of incidents.

Standards
Documented technical specifications sponsored by a Standards Development Organization (SDO) to be used consistently as rules, guidelines, or definitions of characteristics for data transactions.

Subsystem
The principle elements of the physical architecture view of ARC-IT. Subsystems are individual pieces of the Intelligent Transportation System defined by ARC-IT. Subsystems are grouped into five classes: Center, Field, Vehicle, Support, and Personal.

Terminator
Terminators define the boundary of an architecture. The ARC-IT terminators represent the people, systems, and general environment that connect to Intelligent Transportation Systems.

Traffic Management (TM)
A broad category of systems that collect and process information from sensors and CCTV cameras along major roadways. Once processed, the information is then used to manage traffic control devices such as ramp meters, traffic signals and other control devices. These systems are also the source of much of the data used to inform motorists through the Traveler Information systems listed below.

Transit Signal Priority
Transit signal priority refers to systems that usher transit vehicles through traffic-signal controlled intersections. Transit signal priority modifies the normal signal operation to better accommodate transit vehicles. Transit Signal Priority is similar to Emergency Vehicle Pre-emption, but is less invasive to the signal operation.

Traveler Information (TI)
A system, which distributes information to the traveling public over a variety of methods such as dynamic message sign, kiosks, Internet, cable television, smartphones, etc.

Wi-Fi
Wi-Fi is a short-hand generic term referring to the wireless interface of mobile computing devices, such as laptops in local area networks (LANs) and Internet access. Standards are in development that will allow Wi-Fi to be used by cars on highways in support of an Intelligent Transportation System to increase safety, gather statistics, and enable mobile commerce.

2. HOW TO NAVIGATE THE WEBSITE

The purpose of the Lexington Area ITS Architecture website is to organize the details of the architecture into a form that is more readily accessible to stakeholders. It provides a method for stakeholders to access the architecture information in order to encourage use of the architecture in both transportation planning and project implementation. The Lexington Area ITS Architecture website can be accessed via the Lexington Area MPO website at www.lexareampo.org.

The menu bar at the left provides access to different pages of the architecture. The pages to which each of these buttons lead are described below.

Home: This button takes the user to the homepage for the Lexington Area ITS Architectures. The homepage describes the purpose of the architecture.

Scope: This page provides the geographic scope and service scope of the architecture. It also provides the planning time frame for the architecture.

Stakeholders: This page presents the full list of regional stakeholders, along with descriptions for each.

Inventory: This page presents the inventory of ITS elements along with a brief description of each. The inventory of ITS elements is arranged in an alphabetic order. The list of inventory can also be viewed by entity (subsystems and terminators as defined by ARC-IT) or by stakeholder.

> **Inventory by Entity:** This page presents the inventory of ITS elements arranged by entity (subsystems and terminators). This allows all elements with related functions to be viewed simultaneously. Clicking on an element name opens a detail page that provides more information about the element, including a listing of all interfacing elements.
> **Inventory by Stakeholder:** This page presents the inventory of ITS elements arranged by stakeholder. This allows all the elements owned by a single stakeholder to be viewed simultaneously. Clicking on an element name leads to a detail page that provides more information about the element, including a listing of all interfacing elements.

Services: This page presents a list of relevant service packages for the region and their deployment status. Clicking on the service package name links to the definition of the service package, its deployment status in the region, and a list of ITS elements associated with the service package.

Ops Concept: This page presents a table of relevant ITS service areas for the region. Clicking on a service area links to a detailed page with a list of stakeholders providing the service and their roles and responsibilities in the operations of the relevant ITS systems in the region.

Requirements: The page presents a list of ITS functional areas for the region. Clicking on a functional area leads to a detailed page that provides a description of the functional area, a list of regional ITS elements supporting the functions, and a list of functional requirements.

Interfaces: This page presents a table that identifies interfaces among ITS elements for the region. Clicking on an element in the "Element" column leads to a context diagram that shows how the element interfaces with other elements in the region. Clicking on an element in the "Interfacing Element" column brings up a detailed page that shows an interface diagram between the two elements, along with the definitions of the architecture/information flows.

Standards: This page provides a list of ITS standards that are applicable to the region. Clicking on the title of a standard opens a page that identifies how the standard can be applied to facilitate communications and electronic information exchanges in the region.

Agreements: This page presents a list of agreements that support ITS in the region.

Projects: This page presents a list of potential ITS projects for the region, along with recommended implementation time frame and brief project descriptions. Clicking on a project title opens a detailed page that provides additional information on the project.

3. Uses for the Architecture

3.1 Project Planning

The Lexington Area ITS Working Group (LAIWG), comprised of representatives from Lexington Area MPO, LFUCG Traffic Engineering, Lextran, and KYTC, will be responsible for housing and maintaining the ITS Architecture. Being responsible for the architecture requires the LAIWG to be able to deliver a subset of the regional architecture that relates to specific projects. In other words, they must be able to produce a project architecture when a local agency is pursuing an ITS project. Typically, a Project Architecture can be created as an extract from the Regional Architecture if the elements were included in the Regional Architecture. The flow diagram in Figure 8 provides guidance on that process.

In order to produce a project architecture, the first step is to identify the type of service package(s) (e.g. transit, traveler information, emergency management, etc.) that are related to the project. Depending on the scope of the project, multiple types of service packages could be relevant and they should all be identified. For example, for a project involving the installation of dynamic message signs, the relevant service package types would be traveler information and emergency management. After service package types are identified, the specific service package(s) that describe the project must be identified. In continuing the example, the specific service packages that relate to dynamic message sign installation would be TM06 Traffic Information Dissemination, PS10 Wide-Area Alert, and MC06 Work Zone Management.

Once specific service packages have been identified, the service package diagrams must be reviewed to make sure they are correct and not duplicating functionality with another service package. For each project, the following items should be considered and inputted into RAD-IT:

- Make sure all specific service packages that relate to the project are identified (i.e. TM06, PS10, MC06, etc.);
- A specific service package may be relevant to multiple agencies. In this case, create multiple instances of that service package (i.e. an TM06 for LFUCG, and TM06 for KYTC District 7, etc.);
- Select the appropriate inventory items that are related to each specific service package;
- Select the appropriate stakeholder that owns the inventory item; and
- Check whether the data flow is planned or existing.

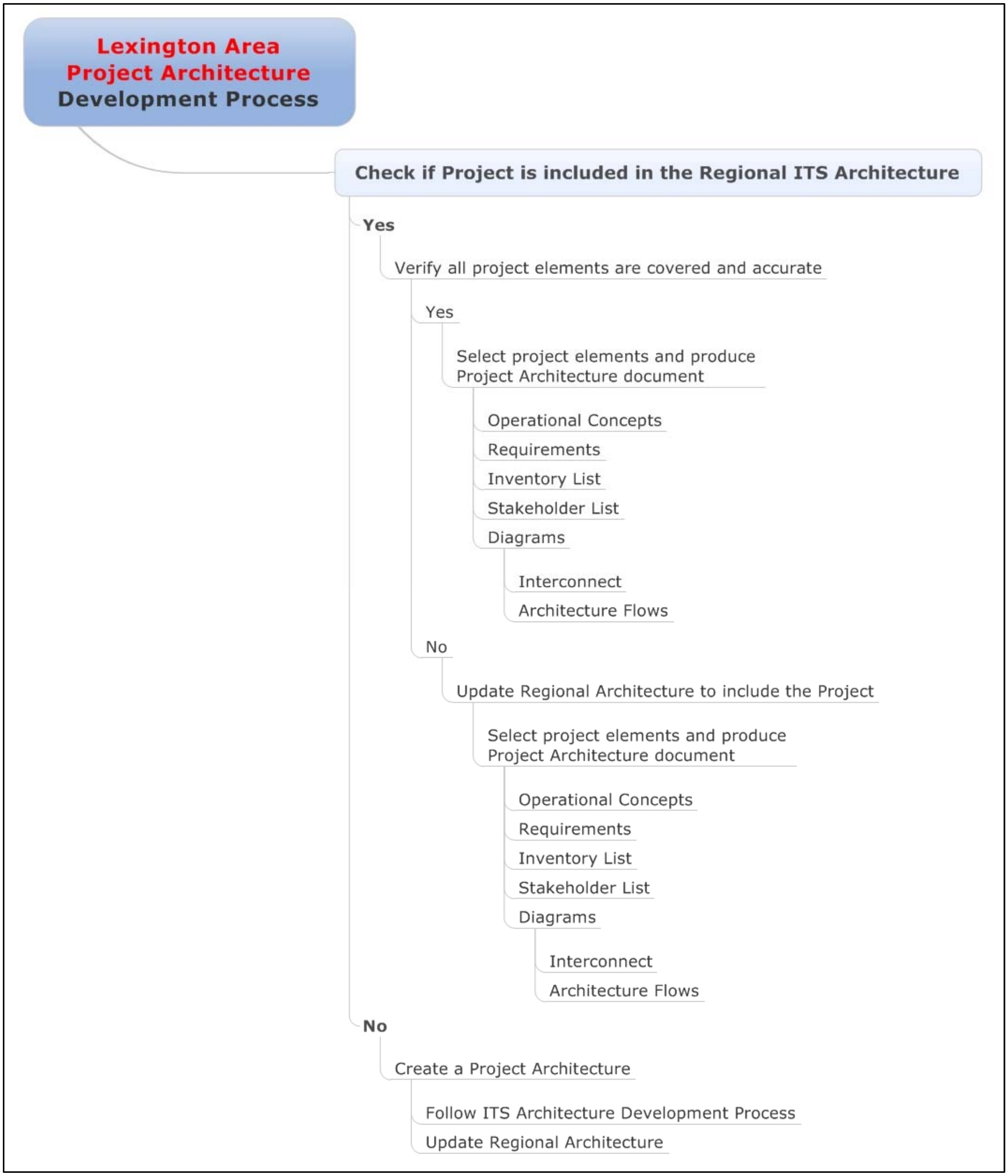

Figure 8. Project Architecture Development Process

Following review of the service package diagrams, the updated diagrams should be passed along to the agencies who are implementing the project to ensure all stakeholders are involved and they have the proper information to determine if it will impact other projects.

3.2 Project Programming

An up-to-date regional ITS architecture is important because projects must be aligned with the area's regional ITS architecture to receive federal funds. This section discusses how stakeholders can determine if a project is consistent with the architecture.

In order to use the Lexington Area ITS Architecture to support project development, the agency must identify how the project contributes to or aligns with a portion of the architecture. This is a key step when using the architecture because it requires the agency to view the ITS project in the broader context of the entire architecture. Having an agency consider the wider architecture while the project's scope is being defined, enables them to consider the services, functionality, and integration opportunities that are envisioned by the region as a whole. This step is also required to meet the FHWA Architecture Rule/FTA Architecture Policy.

The ITS Architecture should be used as early in the project development lifecycle as possible so that integration opportunities are considered. The architecture should be reviewed before firm project cost estimates are established so there is still opportunity to adjust the scope in order to accommodate the regional functionality and interfaces identified. This opportunity may occur before or after programming/budgeting, depending on how specifically the ITS project is defined in the programming/budget documents.

3.3 Funding for ITS Projects

ITS projects proposed for the Lexington Area MPO region would qualify for several categories of federal highway and transit funding. Each of these categories is discussed below with additional information on the location of these sources.

Highway-related ITS initiatives would likely be funded with STP funding dedicated to the Lexington area (SLX funds) or CMAQ funds. Transit-related ITS initiatives would be funded with 5307 and CMAQ funds. The Lexington Area MPO Transportation Improvement Program (TIP) includes "Grouped Projects" that allow these types of initiatives to be added to the TIP (and thus become eligible for federal funding) by Administrative Modification. The FY 2017-2020 TIP included $50,000 per year for each year from 2017-2020 for ITS projects.[2]

Increasingly, ITS elements are included as a component of broader-purposed KYTC sponsored highway improvement projects. In these cases the ITS elements would be included with the NHPP, STP, or HSIP funded project, and such projects would be added to the TIP by Update, Amendment, or Modification procedures, as appropriate (refer to the MPO TIP and Participation Plan documents, which can be found at www.lexareampo.org, for information on these procedures).

ITS projects and components may also be funded with, or included with projects funded with, state or local funds. State and locally funded projects are not required to be listed in the TIP unless they are deemed to be "regionally significant" (refer to the TIP for more discussion). It should also be noted that a re-authorization of federal transportation funding beyond the year 2020 will be required to support many of the grant programs described in this section.

[2] Lexington Area MPO Transportation Improvement Program, Table 6 – Grouped Projects ($1,000), page 34. Available at: https://lexareampo.org/wp-content/uploads/2020/05/FY2017-FY2020-TIP-Modification29.pdf.

FAST ACT (2015)

Most recently, the Fixing America's Surface Transportation (FAST) Act was signed into law in December 2015 for fiscal years 2016 through 2020. The previous federal transportation authorization program (Moving Ahead for Progress in the 21st Century (MAP-21)) included provisions to help make the delivery of transportation projects more streamlined and timelier while still meeting the requirements for planning, public outreach and engagement, and environmental review processes. The FAST Act builds on the efforts of MAP-21 and FHWA's *Every Day Counts* program to continue the acceleration of the delivery of complex but vital transportation projects.

The FAST Act authorizes a significant amount of funding for programs related to research, development, technology, and education. It also builds on MAP-21's transformation of the national transportation program to a performance and outcome-based program. The emphasis on performance management is intended to provide a means to more efficient investment of Federal transportation funds by focusing on national transportation goals, increasing the accountability and transparency of the Federal highway programs, and improving transportation investment decision making through performance-based planning and programming as DOTs incorporate performance goals, measures, and targets into the process of identifying needed transportation improvements and project selection. States will invest resources in projects to achieve individual targets that collectively will make progress toward national goals.

Federal and State Transportation Programs

A combination of federal and state funds is a likely scenario to pay for the implementation and operation of projects. Federal transportation authorization bills, including the FAST Act, continued or established a number of programs which are applicable to the deployment or operation of ITS technologies. Programs such as the National Highway System (NHS) and Surface Transportation Program (STP) can be used to support ITS solutions. In addition to those broader programs, there are several specific programs with potential to fund ITS projects:

- **Intelligent Transportation Systems (ITS) Program** – The ITS Program provides $100 million annually (FY2016-2020) for the research, development, and operational testing of ITS aimed at solving congestion and safety problems, improving operating efficiencies in transit and commercial vehicles, and reducing the environmental impact of growing travel demand (80% federal share).
- **Advanced Transportation and Congestion Management Technologies Deployment Program (ATCMTD)** – This program provides competitive grants for the development of model deployment sites for large scale installation and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment (50% federal share).
- **Congestion Mitigation and Air Quality (CMAQ)** – The FAST Act continues the CMAQ program from MAP-21. The program funds projects that help reduce emissions and traffic congestion in areas designated as nonattainment or maintenance areas for carbon monoxide, ozone or particulate matter. Eligible projects include projects to improve mobility such as through real-time traffic, transit and multimodal traveler information, or otherwise reduce demand for roads through means such as telecommuting, ridesharing, carsharing, and pricing. The FAST Act also specifically makes eligible the installation of vehicle-to-infrastructure communications equipment. The FAST Act also continues eligibility for electric vehicle and natural gas vehicle infrastructure and adds priority for infrastructure located on the corridors designated under 23 U.S.C. 151.

- **Surface Transportation Block Grant Program (STBG)** – Program provides flexible funding that may be used by States and localities for projects to preserve and improve the conditions and performance on any Federal-aid highway, bridge and tunnel projects on any public road, pedestrian and bicycle infrastructure, and transit capital projects, including intercity bus terminals.
- **National Highway Performance Program (NHPP)** - NHPP funds may be obligated for a project on an eligible facility that supports progress toward the achievement of national performance goals for improving infrastructure condition, safety, congestion reduction, system reliability, or freight movement on the NHS[5]. Eligible projects include highway safety improvements on the NHS, which may also include truck parking per 23 U.S.C. 148.
- **National Highway Freight Program (NHFP)** – The NHFP provides formula funds to States to improve the condition and performance of the National Highway Freight Network under 23 U.S.C. 167(i)(5)(C). Eligible activities include truck parking facilities and real-time traffic, truck parking, roadway condition, and multimodal transportation information systems. The NHFP funds are eligible for use on the National Highway Freight Network, as appropriate.
- **Highway Research and Development (HRD) program** – The HRD Program funds strategic investment in research activities that address current and emerging highway transportation needs, including activities to improve highway safety; activities to reduce congestion, improve highway operations, and enhance freight productivity; and exploratory advanced research (80% federal share).
- **Technology and Innovation Deployment Program (TIDP)** – The TIDP is focused on funding efforts to accelerate the implementation and delivery of new innovations and technologies that result from highway research and development to benefit all aspects of highway transportation (80% federal share).
- **FASTLANE (Fostering Advancements in Shipping and Transportation for the Long-term Achievement of National Efficiencies) grants** – The FAST Act establishes a discretionary competitive grant program of $4.5 billion over five years to provide financial assistance to nationally and regionally significant highway, rail, port, and intermodal freight and highway projects (maximum 60% federal share through this program).
- **Nationally Significant Freight and Highway Projects (NSFHP) program** – The NSFHP provides competitive grants, known as Infrastructure for Rebuilding America (INFRA) grants, or credit assistance to nationally and regionally significant freight and highway projects (maximum 60% federal share through this program).
- **Highway Safety Improvement Program (HSIP)** – The HSIP promotes reduced traffic fatalities and serious injuries on urban and rural public roads including work zones.
- **Railway/Highway Crossings** – The FAST Act authorized $1.3 billion over five years for this program, which promotes reductions in the number and severity of injuries at public highway-railroad crossings (90% federal share).
- **Training and Education Program** – Funding for training, education, and workforce development activities that promote and support national transportation programs and activities.

Federal Grants

The principal purpose of an award of financial assistance is to transfer a thing of value from a federal agency to a recipient to carry out a public purpose of support or stimulation authorized by a law of the United States. A grant differs from a contract, which is used to acquire property or services for the Federal government's direct benefit or use. Federal grant information is available electronically at www.grants.gov.

- **<u>BUILD Grant Program</u>** -- The Better Utilizing Investments to Leverage Development, or BUILD Transportation Discretionary Grant program, provides a unique opportunity for the DOT to invest in road, rail, transit and port projects that promise to achieve national objectives. Previously known as Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grants, the BUILD program enables DOTs to examine projects on their merits to help ensure that taxpayers are getting the highest value for every dollar invested.

  The eligibility requirements of BUILD allow project sponsors at the State and local levels to obtain funding for multi-modal, multi-jurisdictional projects that are more difficult to support through traditional DOT programs. BUILD can provide capital funding directly to any public entity, including municipalities, counties, port authorities, tribal governments, MPOs, or others in contrast to traditional Federal programs which provide funding to very specific groups of applicants (mostly State DOTs and transit agencies).

- **<u>Innovative Technology Deployment (ITD) Grant Program</u>** – The Federal Motor Carrier Safety Administration (FMCSA) offers additional funding opportunities through its Innovative Technology Deployment (ITD) Grant program. The program supports the deployment, operation, and maintenance aspects of the ITD program across the US.
- **<u>Motor Carrier Safety Assistance Program (MCSAP) Grants</u>** – The goal of the program is to improve motor carrier, commercial motor vehicle, and driver safety to support a safe and efficient surface transportation system. The program funds are eligible for deployment activities and activities to develop new and innovative advanced technology solutions that support commercial motor vehicle information systems and networks and for the operation and maintenance costs associated with innovative technology.

<u>Public/Private Partnerships (P3)</u>

A public-private partnership (commonly called a P3) is a contractual agreement between a public agency and a private entity that allows for greater private sector participation in the delivery and financing of a project. P3 arrangements provide the public sector with a proven tool to accelerate infrastructure delivery and contain costs. P3s provide a role for the private sector in solving public challenges, provide a variety of contract structures and financing, and are performance-based and outcome-focused. P3 delivery methods commonly fall into the following categories: design-build (DB), operate-maintain (OM), design-build-operate-maintain (DBOM), design-build-finance (DBF), and design-build-finance-operate-maintain (DBFOM). Each method can offer advantages or disadvantages, depending on the specific project and parties involved. Every transportation project is different and may or may not benefit from innovative delivery methods such as P3s.

<u>Transit Funding</u>

Federal transit funding is appropriated annually. Programs include: Urbanized Area Formula Program (5307), Rural Area Formula Program (5311, includes rural, small urban, and intercity bus), Enhanced Mobility of Seniors and Individuals with Disabilities Formula Program (5310), Metropolitan and Statewide Non-metropolitan Transportation Planning Formula Program (5303, 5304, 5305), State of Good Repair Grants (5337), and Bus and Bus Facilities Formula Grants (5339(a)).

The FAST Act continues several important goals established in MAP-21, including safety, state of good repair, and performance. It adds funding eligibility for the deployment of low or no emission vehicles, zero emission vehicles, or associated advanced technology. It continues to fund BRT projects in defined corridors that demonstrate substantial investment in fixed transit facilities including transit stations, ITS technology, traffic signal priority, and off-bard fare collection.

Transportation Security Funds

Transportation security funds are another opportunity for funding projects with security applications, such as surveillance cameras or communications devices. Transportation enhancements and ITS projects can address security concerns by detecting threats, maximizing the movement of people, goods, and services, and supporting response activities. Security funds could be available through the Department of Homeland Security, Department of Agriculture, or the Department of Energy, as well as other agencies.

One example of these sources through the Department of Homeland Security is through preparedness grants to improve the nation's readiness in preventing, protecting against, responding to, recovering from and mitigating terrorist attacks, major disasters and other emergencies. ITS technologies can be used for monitoring and surveillance of transportation infrastructure (e.g., bridges, tunnels and management centers) and help to mitigate the impact of an incident if it occurs. CCTV cameras are a common technology used by transportation agencies for this purpose, and thus preparedness grants through the department of homeland security are a potential funding source for this activity.

3.4 Project Design Concerns

When designing a project, functionality and ITS standards provide guidance and criteria to identify how the project will relate to the region's overall operations. As projects grow in size, the functions and standards become complex and sometimes require agreements between agencies. It is beneficial to identify the agencies involved and the type(s) of agreement(s) needed early on in the project design.

How ITS components are shown in the architecture

The ARC-IT uses service packages to depict the current and future functions of ITS systems. Entities that represent sources of information are called "subsystems", which are grouped into four classes: centers, fields, vehicles, and travelers as shown in Table 5 on the next page. Table 5 provides descriptions from ARC-IT for each subsystem and identifies examples of those subsystems in the region.

Table 5. Subsystem Definitions

Subsystem	Definition	Examples in Lexington Area MPO Region
Center	Provides management, administrative, and support functions for the transportation system. The center subsystems each communicate with other centers to enable coordination between modes and across jurisdictions.	Traffic Management Centers Emergency Operations Centers 911 Communications Centers
Field	Intelligent infrastructure distributed along the transportation network which perform surveillance, information gathering, and information dissemination and whose operation is governed by the center subsystem.	Traffic Signals CCTV Cameras Dynamic Message Signs Vehicle Detection
Vehicle	Covers ITS related elements on vehicle platforms such as automatic vehicle location equipment and operations capabilities for portable field equipment.	Maintenance and Construction Vehicles Public Safety Vehicles Incident Response Vehicles
Traveler	Equipment used by travelers to access ITS services prior to a trip, including information service providers.	Transit Bus Arrival/Departure Signs Smartphones Personal Computers

<u>How to find general functional requirements related to a proposed project</u>

Functional requirements explain how an inventory item provides the services described in their equipment packages. Equipment packages group inventory items together based on what overall function they serve and are listed in deployment-sized pieces (for example: emergency dispatch, roadway basic surveillance, traffic data collection, and transit center fixed-route operations).

The functional requirements can be found on the ARC-IT website (https://local.iteris.com/arc-it/index.html). The following process should be followed to access requirements for specific inventory items:

- Under the "Architecture" drop-down arrow in the top left corner of the Home Page of the ARC-IT website, select "Physical" that appears under "Views"
- Then click on the "Physical Objects" hyperlink that appears in the text on the Physical architecture web page
- Click on the "Subsystems" tab that will present all of the subsystems in ARC-IT, and then select the subsystem for which you are seeking functional requirements
- Click on the "Functionality" tab that will present the equipment packages associated with the subsystem
- Click on the "Requirements" tab, which will present a list of functionalities for each relevant equipment package.

How to obtain specific functional requirements from the Lexington Area ITS Architecture

The need to obtain specific functional requirements from the Lexington Area ITS Architecture related to a specific project can be found on the ITS Architecture website hosted by the Lexington Area MPO, following the instructions in Part C, Section 2 of this report.

A complete listing of functional requirements for the Lexington Area ITS Architecture can be found in Section 7 of the RAD-IT Report in the Appendix.

How to select communication standards that apply to the project

ITS standards define how system components interact within the overall framework of ARC-IT. The use of standards ensures interoperability amongst various functions of an ITS project so that components or technologies from various vendors and at different scales (local, regional, and national) are still compatible. Standards also facilitate innovation in technology development without necessitating replacement of hardware or software systems that are needed to operate the new technology. Other purposes for ITS standards include:

- ITS standards used in a deployment can greatly reduce component development costs;
- ITS standards are open and non-proprietary, helping state and local transportation managers avoid costly single-source procurements and locked-in maintenance relationships with vendors;
- ITS standards support the deployment of interoperable ITS systems, helping agencies link together different types of ITS technologies and making system expansions easier to plan and implement; and
- ITS standards are being developed for many different types of ITS technologies and their use in project deployment is a key aspect of conformity with the FHWA Final Rule 940.

New standards that are developed go through an approval process before they are included in documents as formalized standards. Existing standards are amended and modified as needed based on new standards development or new technology development. Several national and international standards organizations are working toward developing ITS standards for communications, field infrastructure, messages and data dictionaries, and other areas. The organizations participating in ITS standards activities include:

- AASHTO (American Association of State Highway and Transportation Officials)
- ANSI (American National Standards Institute)
- APTA (American Public Transportation Association)
- ASTM (American Society for Testing and Materials)
- IEEE (Institute of Electrical and Electronics Engineers)
- ITE (Institute of Transportation Engineers)
- NEMA (National Electrical Manufacturers Association)
- SAE (Society of Automotive Engineers)

A listing of ITS standards that are pertinent to the Lexington Area ITS Architecture is contained in Section 9 of the RAD-IT Report.

Why agreements may be needed to support a proposed project

Institutional agreements can support ITS functionality and project development in the region. Agreements allow agencies to document the roles and responsibilities of the particular service or function that is being agreed to, as well as any obligations each agency has for maintenance, operations, or financial support.

A listing of agreements based on the types of interfaces identified in the Lexington Area ITS Architecture is contained in Section 10 of the RAD-IT Report in the Appendix. It is important to note that as ITS services and systems are implemented or expanded in the region, part of the planning and review process for those projects should include a review of potential agreements that would be needed for implementation or operations. These additional agreements are not listed in the ITS Architecture for specific projects because the possibility of coordination/sharing/joint operations is unique and should be evaluated for every project.

4. Architecture Maintenance Plan

The Lexington Area ITS Architecture has been created as a consensus view of what ITS systems the stakeholders within the architecture boundary already have in place and what systems they plan to implement in the future. By its nature, the architecture is not a static set of outputs. The Architecture should be modified as plans and priorities change, ITS projects are implemented, and the ITS needs and services evolve in the region. There are many actions that may cause a need to update the architecture, including:

- **Changes in Project Definition.** When actually defined, a project may add, subtract or modify elements, interfaces, or information flows of the ITS Architecture. Because the architecture is meant to describe not only ITS planned, but also the current ITS implementations, it should be updated to correctly reflect the deployed projects.
- **Changes due to Project Addition/Deletion**. Occasionally a project will be added, deleted or modified during the planning process. When this occurs, the aspects of the ITS Architecture associated with the project should be added, deleted or modified.
- **Changes in Project Status.** As projects are deployed, the status of the architecture elements, services and flows that are part of the projects will have to be changed from planned to existing. Elements, services and flows should be considered to exist when they are substantially complete.
- **Changes in Project Priority.** Due to funding constraints, technological changes or other considerations, a project planned may be delayed or accelerated. Such changes should be reflected in the ITS Architecture.
- **Changes in Regional Needs.** Transportation planning is done to address regional transportation needs. Over time these needs change and the corresponding aspects of the ITS Architecture that addresses these needs should be updated.
- **Changes in Participating Stakeholders.** Stakeholder involvement can also change over time. The ITS Architecture should be updated to reflect the participating stakeholder roles in the statewide view of ITS elements, interfaces, and information flows.
- **Changes in Other Architectures.** The ITS Architecture includes not only elements and interfaces within the architecture boundary, but also interfaces to elements in adjacent and other areas in Kentucky. Changes in the Statewide ITS Architecture and ITS Architectures in adjacent areas may necessitate changes in the Lexington Area ITS Architecture to maintain consistency. A Regional ITS Architecture may overlap with the Statewide ITS Architecture, and a change in one architecture may necessitate a change in the other.
- **Changes in ARC-IT.** The ARC-IT will be expanded and evolved from time to time to include new user services or refine existing services. These changes should be considered as the ITS Architecture is updated. Updates to ARC-IT and RAD-IT will be publicized on the ITS Joint Program Office (JPO) Architecture website: https://www.its.dot.gov/index.htm.

4.1 Who Is Responsible for Architecture Maintenance?

Responsibility for maintaining the ITS Architecture will lie with the Lexington Area ITS Working Group (LAIWG). Members of this group will oversee all ITS activities in the region, including planning, architecture, design, implementation, operations, and maintenance, etc. The LAIWG should coordinate the maintenance activities and be the point of contact, including collecting, reviewing and evaluating change requests, tracking change requests, requesting additional information from stakeholders, distributing documentation, as well as calling meetings, making meeting arrangements, assembling an agenda, leading the meetings, and approving minutes. The LAIWG will make approved changes to the ITS Architecture and notify stakeholders of the changes.

4.2 What Will Be Maintained?

The following should be reviewed and updated at regular intervals:

- Description of the region
- Participating agencies and other stakeholders, including key contact information
- Inventory of existing and planned ITS systems in the region
- Operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems
- Agreements for operations and interoperability
- System functional requirements
- Interface requirements and information exchanges with planned and existing systems and subsystems
- Applicable ITS standards supporting regional and national interoperability
- Sequence of projects for implementation

There are several different components that make up the ITS Architecture. Some may require more frequent updates than others, but the entire architecture will need periodic review to ensure that it is consistent with the regional goals. The most current version of the Lexington Area ITS Architecture shall be the baseline architecture upon which future revisions are conducted as necessary.

The Lexington Area ITS Architecture was created based on ARC-IT Version 8.3 using RAD-IT Software Version 8.3.89. The Architecture was documented and stored in the following forms:

- Lexington Area ITS Architecture Report
- Lexington Area ITS Architecture Website
- Electronic RAD-IT database

The RAD-IT database can generate a set of outputs including various reports, tables, diagrams, and the architecture webpages. Such outputs include interconnect and architecture flow diagrams, inventory lists, stakeholder lists, service package lists, functional requirements, and other diagrams and reports. A generic ITS architecture report can also be generated directly from RAD-IT. At a minimum, the architecture should be maintained through updates in the database using the RAD-IT software.

4.3 How Changes Are Identified

Changes to the ITS Architecture may be identified by two channels. One is that stakeholders submit a request, and the second channel is actively soliciting changes from each stakeholder on an annual basis.

Stakeholders can contact the LAIWG to propose changes to the ITS Architecture. The LAIWG will perform an initial assessment of the proposed change for the impact to the ITS Architecture and/or the affected documentation. If the proposed change has an impact on other stakeholders, the LAIWG should contact those stakeholders to confirm their agreement with the proposed modification.

The second channel is for the MPO to distribute an annual survey to stakeholders to actively solicit the need for updating the architecture. This survey will contain a few basic questions for stakeholders to answer. A sample survey can be found in Table 6. If additional information is needed, the LAIWG will contact the stakeholder/s to identify the need for updating the architecture.

Table 6. Sample Architecture Maintenance Survey Questionnaire

Lexington Area ITS Architecture Maintenance Survey Questionnaire

1. Did your agency implement (including upgrade) any technology and communications related projects for transportation systems or emergency management in the past 12 months?

☐ Yes ☐ No

If YES, please describe the project(s) and/or provide project name(s) and available documentation source(s).

____
____
____
____
____
____

2. Do you plan to implement any technology or communications related projects in the next 5 years?

☐ Yes ☐ No

If YES, please describe the project(s) and/or provide project name(s) and available documentation source(s).

____
____
____
____
____
____

3. Please provide your contact information:

Name: ___________________________________
Agency: __________________________________
Phone: ___________________________________
Email: ___________________________________

Please submit this form to: XXXXXXXX, Email: XXXX, Phone: XXXX, Fax: XXXX. Thank you!

4.4 How Often Changes Are Made

A comprehensive, formal update of the ITS Architecture Baseline should be performed concurrently with the MPO's Metropolitan Transportation Plan (MTP) updates to ensure the architecture continues to accurately represent the regional goals. The transportation goals set forth in the 2045 MTP include:

- Provide for safe travel for all users
- Provide access, choices and equity
- Provide connectivity within and between modes
- Be efficient, reliable, resilient and well maintained
- Support economic vitality and competitiveness
- Contribute to community character
- Enhance the environment
- Support health and wellness

It is recommended that a comprehensive update of the architecture baseline is performed within 6 months prior to or in conjunction with the MTP update.

Between major updates of the architecture, minor or informal modifications may be made at the discretion of the LAIWG. The LAIWG will solicit changes from stakeholders of needed updates. The LAIWG will contact stakeholders, via e-mail, written correspondence, and/or by telephone, and inquire if the stakeholder has any changes to the ITS Architecture. The change requests will be collected and reviewed by the LAIWG for consideration in the next minor update.

In addition, this Maintenance Plan should also be reviewed and evaluated periodically for required changes to the maintenance process. The actual maintenance process and procedures may differ from those anticipated during the initial development of this Maintenance Plan. Revising the Maintenance Plan will ensure both an effective architecture maintenance process and a change management process.

4.5 Change Review, Implementation and Release

The general steps in the change management process are described below:

1. Stakeholders identify changes, notify the LAIWG of changes, (or complete the annual survey), and submit it to the LAIWG. If the initial information is gathered via the annual survey, the LAIWG contacts the stakeholder for more information.
2. The LAIWG reviews the proposed changes, offers comments, and/or asks for additional information.
3. The LAIWG, in coordination with the appropriate stakeholders affected by the proposed changes, evaluates the changes and determine what impact they may have on the Architecture and/or associated documentation.
4. Upon its evaluation, the LAIWG makes a decision to accept the change, reject it, or ask for additional information.
5. If the decision is to accept the change, then the appropriate portions of the architecture baseline are updated by a designated member of the LAIWG.
6. Once the ITS Architecture has been modified, the LAIWG publishes the updated architecture documentation, database and website.
7. The LAIWG also notifies all stakeholders of architecture updates and provides information on how to obtain the latest version of the Architecture.

D. APPENDIX: RAD-IT REPORT