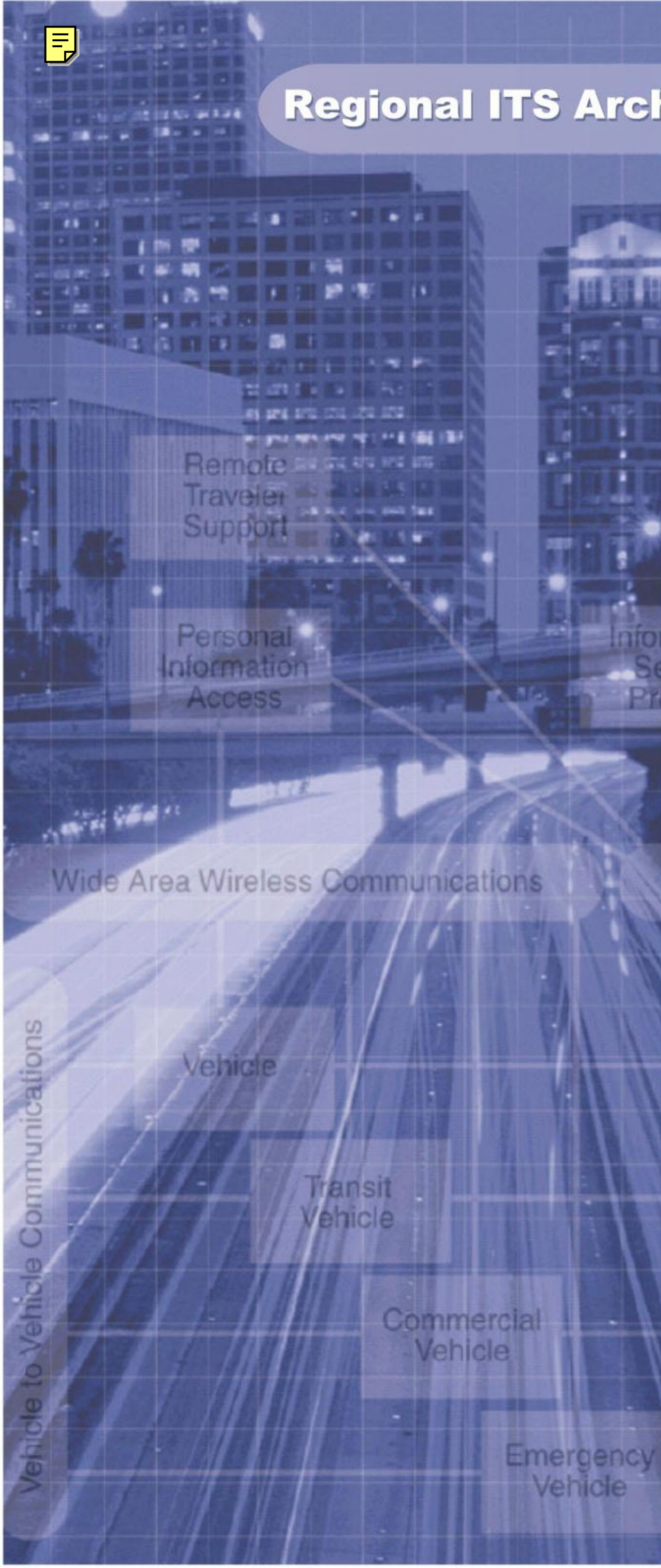
Regional ITS Architecture Guidance



Developing, Using, and Maintaining an ITS Architecture for Your Region

Prepared by:
National ITS Architecture Team

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U.S. Department of Transportation

Executive Summary

Rapid advances in technology have created many new opportunities for transportation professionals to deliver safer and more efficient transportation services, and to respond proactively to increasing demand for transportation services in many areas and mounting customer expectations from coast to coast. However, many of these new opportunities are predicated upon effective coordination between organizations - at both an institutional and technical level. To encourage this coordination, the USDOT has developed the National ITS Architecture and related tools to help identify and exploit these opportunities for cost-effective cooperation. This document is one such tool -- it describes how to develop a regional ITS architecture, which will be a cornerstone of planning for effective inter-agency coordination during deployment and operation of technology-based projects.

In 1997, Congress passed the Transportation Equity Act for the 21st Century (TEA-21) to address the need to begin to work toward regionally integrated transportation systems. In January 2001, FHWA published a rule (ITS Architecture and Standards) and FTA published a companion policy to implement section 5206(e) of TEA-21. This Rule/Policy seeks to foster regional integration by requiring that all ITS projects funded from the Highway Trust Fund be in conformance with the National ITS Architecture and appropriate standards. “Conformance with the National ITS Architecture” is defined in the final Rule/Policy as using the National ITS Architecture to develop a “regional ITS architecture” that would be tailored to address the local situation and ITS investment needs, and the subsequent adherence of ITS projects to the regional ITS architecture.

This document is a guide for transportation professionals who are involved in the development, use, or maintenance of regional ITS architectures. The document describes a process for creating a regional ITS architecture with supporting examples of each architecture product. In its discussion of the uses of the regional ITS architecture, the document presents an approach for mainstreaming ITS into the transportation planning and project development processes.

The guidance is structured around the process shown in Figure ES-1. Within the document, section 2 provides an overview of the process and sections 3 through 6 describe the regional ITS architecture development process in detail. The use and maintenance of the regional ITS architecture is discussed in section 7.

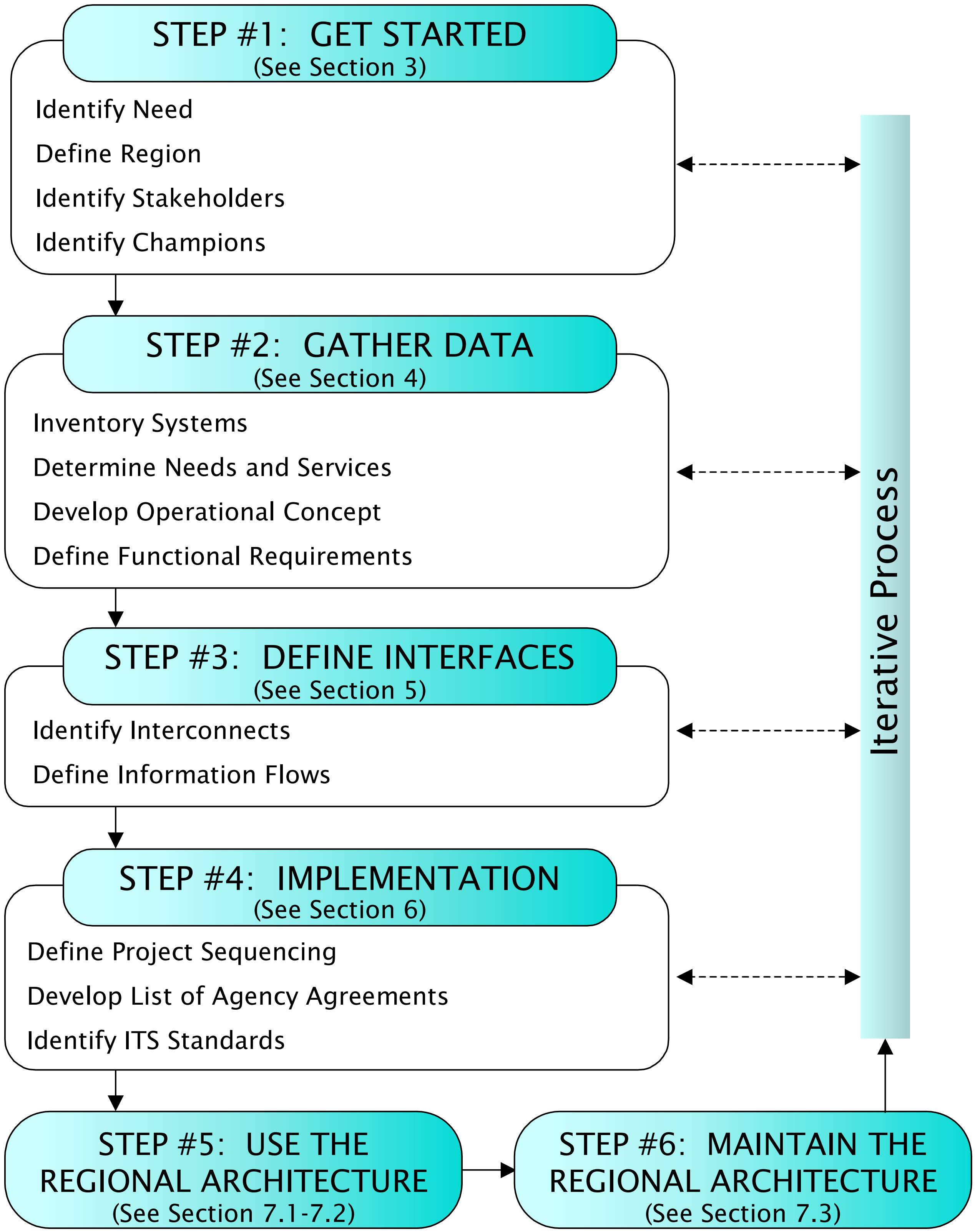

Figure ES-1: Regional ITS Architecture Development, Use, and Maintenance

The guidance covers each of the major steps shown in the figure:

Get Started: The regional ITS architecture effort begins with a focus on the institutions and people involved. Based on the scope of the region, the relevant stakeholders and one or more champions are identified, the team that will be involved in architecture development is organized, and the overall development effort is planned.

Gather Data: Once the stakeholders are involved and a plan is in place for assembling their input into a consensus regional ITS architecture, the focus shifts to the ITS systems in the region. At this step, the existing and planned ITS systems in the region are inventoried, the roles and responsibilities of each stakeholder in developing, operating, and maintaining these ITS systems are defined, the ITS services that should be provided in the region are identified, and the contribution (in terms of functionality) that each system will make to provide these ITS services is documented.

Define Interfaces: Once the ITS systems in the region are identified and functionally defined, the existing and planned interfaces between these systems are defined. First, the connections (or “Interconnects”) between systems are identified, and then the information that will be exchanged on each of the interfaces is defined.

Implementation: Once the system interfaces are defined, additional products can be defined that will guide implementation of the projects that will flow from the regional ITS architecture. These include a sequence of projects, a list of needed agency agreements, and a list of standards that can be considered for project implementation.

Use the Regional ITS Architecture: The real success of the regional ITS architecture effort hinges on effective use of the architecture once it is developed. The regional ITS architecture is an important tool for use in transportation planning and project implementation. It can identify opportunities for making ITS investments in a more cost-effective fashion. This step is where the benefits are realized.

The results of the transportation planning process - the plans and programs - are an important input to the development of a regional ITS architecture. Once a regional ITS architecture is created, it can by used by stakeholders in planning their ITS projects to support regional goals. It can be used to maximize appropriate integration of projects identified by the planning process.

For the region’s Metropolitan Planning Organization (MPO) and for other area-wide and statewide planning agencies, the regional ITS architecture will provide information for updating both the Transportation Plan and the Transportation Improvement Program (TIP). It will also provide information for use in other planning studies and activities, including the Congestion Management Plan, Corridor and Sub-Area Studies, performance-monitoring activities, transit development plans, and other locally defined studies or plans. For statewide planning agencies, it will provide information for updating the Statewide TIP, the State Implementation Plan (SIP), and other statewide or multi-region plans and studies.

Maintain the Regional ITS Architecture: As ITS projects are implemented, new ITS priorities and strategies emerge through the transportation planning process, and the scope of ITS expands and evolves to incorporate new ideas, the regional ITS architecture will need to be updated. A maintenance plan is used to guide controlled updates to the regional ITS architecture baseline so that it continues to accurately reflect the region's existing ITS capabilities and future plans.

Two appendices provide additional background information that may be useful to some readers. Appendix A discusses the tools that may be useful in developing the regional ITS architecture, and Appendix B is a glossary of terminology used in this document.

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Section 1

Introduction

Intelligent Transportation Systems have been defined as: "the application of advanced sensor, computer, electronics, and communication technologies and management strategies—in an integrated manner—to improve the safety and efficiency of the surface transportation system". This definition encompasses a broad array of systems and technologies. In order to fully incorporate ITS into the surface transportation network, ITS must be "mainstreamed" into the overall transportation planning and project development processes that exist in each state and metropolitan region of the country.

In 1997, Congress passed the Transportation Equity Act for the 21st Century (TEA-21) to address the need to begin to work toward regionally integrated transportation systems. In January 2001, FHWA published a rule, and FTA published a companion policy, to implement section 5206(e) of TEA-21. This Rule/Policy seeks to foster regional integration by requiring that all ITS projects funded from the Highway Trust Fund be in conformance with the National ITS Architecture and appropriate standards. "Conformance with the National ITS Architecture" is defined in the final Rule/Policy as using the National ITS Architecture to develop a "regional ITS architecture" that would be tailored to address the local situation and ITS investment needs, and the subsequent adherence of ITS projects to the regional ITS architecture.

The objective of this document is to provide guidance on the development, use, and maintenance of regional ITS architectures. The document presents a process for creating a regional ITS architecture and provides sample outputs of each aspect of the regional ITS architecture. In its discussion of the uses of the regional ITS architecture the document presents an approach for mainstreaming ITS into the planning and project development processes. Although this document focuses on regional ITS architecture it recognizes that the real value of this architecture is as a tool to support the planning and project development processes.

Transportation planning is an ongoing, iterative process, whose goal is making quality, informed decisions pertaining to the investment of public funds for regional transportation systems and services. A regional ITS architecture (created with the use of the planning information already developed) can be a powerful tool for planning the regional integration of transportation systems. Indeed the very process of creating a regional ITS architecture can enhance regional planning by bringing together a diverse array of agencies and stakeholders to discuss future transportation needs and how these needs might be met by ITS.

This document is intended for anyone who is involved, or will be involved in the development, use or maintenance of regional ITS architectures. Because of the detailed nature of the discussion of the architecture development process and architecture outputs, the document is most applicable for those transportation professionals who will lead or play a key role in the development or use of a regional ITS architecture.

Although this document provides guidance on the entire process, those that have already accomplished many of the process steps, including those that already have completed a regional ITS architecture, may also find the document to be useful. Stakeholders who are coming in at a later step will find a wealth of best practices information and examples from around the country that may influence their on-going regional ITS architecture-related activities.

Is knowledge of architecture in general or the National ITS Architecture in specific required to read and use this document? Not if the reader wishes to gain a general understanding of the process of developing and using a regional ITS Architecture. But to understand the details of the process of developing an architecture, and to actually develop a regional ITS architecture using the process, the reader should have some baseline knowledge of the National ITS Architecture.

1.1 What is an ITS Architecture?

An **architecture** defines a framework within which a system can be built. It functionally defines what the pieces of the system are and the information that is exchanged between them. An architecture is important because it allows integration options to be considered prior to investment in the design and development of the pieces of the system. An architecture is functionally oriented and not technology specific, which allows the architecture to remain effective over time. It defines "what" must be done, not "how" it will be done. The functions the system performs remain the same while technology evolves.

Intelligent Transportation Systems (ITS) are interrelated systems that work together to deliver transportation services. Integration of these systems requires an architecture to illustrate and gain consensus on the approach to be taken by a group of stakeholders regarding their particular systems. An **ITS Architecture** defines the systems and the interconnections and information exchanges between these systems.

The primary components of an ITS Architecture are Subsystems and Information Flows:

- **Subsystems** are individual pieces of the overall Intelligent Transportation ***System*** that perform particular functions such as managing traffic, providing traveler information, or responding to emergencies. Subsystems can be associated with particular organizations such as departments of transportation, information service providers, or public safety agencies. They are sources and/or users of information provided by other subsystems within or on the boundary of the ITS Architecture. Subsystems include center systems, roadside components, vehicle equipment, and traveler devices that participate in ITS.

- **Information flows** define information that is exchanged between subsystems such as traffic information, incident information, or surveillance and sensor control data. They depict ITS integration by illustrating the information links between subsystems. In ITS, this integration is not only technical but institutional as well. The system interfaces that are defined require cooperation and shared responsibilities on the part of the owners and operators of each participating system.

Two different types of ITS Architectures are discussed in this document:

- **National ITS Architecture:** The National ITS Architecture is a general framework for planning, defining, and integrating ITS. It was developed to support ITS implementations over a 20-year time period in urban, interurban, and rural environments across the country. The National ITS Architecture is available as a resource for any region and is maintained by the USDOT independently of any specific system design or region in the nation.

- **Regional ITS Architecture:** A regional ITS architecture is a specific regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects in a particular region.

This document describes a process for defining a regional ITS architecture using the National ITS Architecture as a resource. There are numerous advantages to using the National ITS Architecture as the basis for creating a regional ITS Architecture. Primary among these is a significant savings of time and cost because the National ITS Architecture represents a very complete framework of ITS services, has already undergone considerable stakeholder review, and has a variety of tools to assist the user in creating a regional ITS architecture. These tools will be further discussed in later sections of this document.

A thorough understanding of the terms and concepts of the National ITS Architecture is important to key stakeholders who are involved in the creation of a regional ITS architecture using the process described in this document. In providing guidance on this process, the document makes liberal use of these terms and concepts, so this knowledge is required for the reader to fully understand the guidance provided.

For those readers who are unfamiliar with the National ITS Architecture, all the terms that are used in this document are defined in Appendix B. This is probably sufficient for the reader who wishes to gain a general understanding of the process of developing and using a regional ITS Architecture. To understand the details of the process of developing an architecture, and to actually develop a regional ITS architecture using the process, the reader should have some baseline knowledge of the National ITS Architecture. Additional information on the National ITS Architecture as well as information on available training can be found at the FHWA's ITS Joint Program Office website: http://www.its.dot.gov/arch/arch.htm.

1.2 The Goal of a Regional ITS Architecture

State and local governments and transportation organizations apply transportation tools to address transportation issues on a regional basis. Each region has unique needs and is affected, in some manner, by neighboring regions. ITS is one of these transportation tools. It harnesses the valuable information generated by various subsystems within and around a region to better manage and operate the transportation system as a whole.

The purpose of developing a regional ITS architecture is to illustrate and document regional integration so that planning and deployment can take place in an organized and coordinated fashion. Typically, a region contains multiple transportation agencies and jurisdictions. These may have both adjoining and overlapping geographies, but the common thread for all of the agencies is the need to provide ITS solutions to transportation problems such as traffic congestion and safety hazards. It is important that these solutions be provided economically, utilizing public funds in a responsible manner.

Regional integration allows for the sharing of information and coordination of activities among regional transportation systems to efficiently and effectively operate. Regional integration may also have a synergistic effect on transportation systems (e.g. Information from one system may be used by another system for a different purpose. An example of this would be transit AVL data being used by a freeway management center as probe data to obtain speed information on freeway segments traveled by the transit vehicles.) A regional ITS architecture illustrates this integration and provides the basis for planning the evolution of existing systems and the definition of future systems that facilitate the integration over time.

For the private sector, opportunities exist to develop information systems providing value-added services to the traveling public. Participating in the development of a regional ITS architecture can highlight needs for data integration between public and private partners. It can also identify ways in which public sector agencies can benefit from information that the private sector has.

This regional integration can only take place with the participation and cooperation of the organizations within a region. These stakeholders must work together to establish a regional ITS architecture that reflects a consensus view of the parties involved. A regional ITS architecture's most important goal is institutional integration; providing a framework within which regional stakeholders can address transportation issues together.

1.3 Using a Regional ITS Architecture

A regional ITS architecture is a useful tool for planning and implementing ITS within a region. From a planning perspective, the regional ITS architecture defines the ITS that the regional stakeholders wish to realize over a given timeframe. This plan for ITS in the region will be realized in an incremental fashion as funding and/or technology is available and institutional issues are resolved. ITS projects are defined to achieve the regional plan, using the regional ITS architecture framework to properly and efficiently define projects so that they build upon one another.

A regional ITS architecture can identify opportunities for making ITS investments in a more cost-effective fashion, by utilizing inter-agency cooperation during planning, implementation, and operation of these ITS projects.

Where does the Regional ITS Architecture fit within Transportation Planning?

Transportation planning is an ongoing, iterative activity. The results of the transportation planning process - the plans and programs - are an important input to the development of a regional ITS architecture. Once a regional ITS architecture is created, it can assist stakeholders in planning their ITS projects to support regional goals. It is a tool for use in the planning process to maximize appropriate integration of projects identified by the planning process.

Due to the regional and local variations in the practice of transportation planning, local stakeholders must decide how best to incorporate the regional ITS architecture and the products produced during its development into the Transportation Planning Process, and vice versa.

For the region's Metropolitan Planning Organization (MPO) and for other area-wide and statewide planning agencies, the regional ITS architecture will provide information for updating both the Transportation Plan and the Transportation Improvement Program (TIP). It will also provide information for use in other planning studies and activities, including the Congestion Management Plan, Corridor and Sub-Area Studies, performance-monitoring activities, transit development plans, and other locally defined studies or plans. For statewide planning agencies, it will provide information for updating the Statewide TIP, the State Implementation Plan (SIP), and other statewide or multi-region plans and studies. The regional ITS architecture can also be useful to private companies contemplating ITS investments, by helping them understand long-range and short-range ITS planning goals of the local public sector agencies, plus the technical and institutional context in which any private investments would be made.

In Transportation Planning, a regional ITS architecture has its greatest impact on institutional integration. It provides a structure around which discussions can take place among regional stakeholders to gain consensus on the direction of ITS. It implies roles and responsibilities for each stakeholder involved to realize the benefits of ITS within the region.

1.4 USDOT Policy

On January 8, 2001, the US Department of Transportation published the FHWA Final Rule and FTA Policy, which implement section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21). The Final Rule/Policy, effective April 8, 2001, explains and defines how Section 5206(e) is to be implemented. TEA-21 required ITS projects funded through the highway trust fund to conform to the National ITS Architecture and applicable standards. The intention of the Rule/Policy is to foster the deployment of integrated regional ITS systems.

Because it is highly unlikely that the entire National ITS Architecture would be fully implemented by any single metropolitan area or State, the Rule/Policy requires that the National ITS Architecture be used to develop a local implementation or "regional ITS architecture" that would be tailored to address the local situation and ITS investment needs. The region is defined by local participants and is based on the needs for information sharing and coordination. It can be a metropolitan area, a state, a multi-state area, or a corridor.

The Rule/Policy requires that if a region is already deploying ITS projects, then a regional ITS architecture must be developed within four years of the effective date of the Rule/Policy. If a region has not yet deployed an ITS project then a regional ITS architecture must be developed within four years of the deployment of the initial ITS project in the region. The intention of the new Rule/Policy is to foster integration of the deployment of regional ITS systems.

This guide makes frequent reference to the Rule/Policy requirements for regional ITS architectures, describing how the specific process steps and products relate to the Rule/Policy. In addition to the regional ITS architecture requirements, the Rule/Policy also includes requirements for ITS Project Implementation and Project Administration, which are not addressed in detail by this document.

Further information on the Intelligent Transportation System Architecture and Standards Policy/Rule can be found at http://www.its.dot.gov/itsweb/aconform/aconform.htm.

1.5 How This Document is Organized

Section 2 of the document identifies a candidate regional ITS architecture development process. Sections 3 through 6 elaborate on steps within the overall process and identify examples of the products of the process. Section 7 discusses the use and maintenance of a regional ITS architecture.

About the Examples

The examples that are used throughout the document were drawn from actual regional ITS architectures that have been developed for small, medium, and large metropolitan areas and rural regions around the country. In a few cases, examples were created to illustrate a process step or output when a real example was not available. The real world examples were all created prior to publication of the Rule/Policy on Architecture and Standards, but the examples that are included very closely match the intent of the guidance.

About the Icons

This document uses icons to highlight different kinds of information. The icons can help you find particular types of information within the document.

This icon identifies suggestions that may improve the regional ITS architecture development effort or the quality of the products that are generated. Usually based on actual experience, these are ideas that have worked in the past.

This icon flags warnings. In contrast to tips, these are problems that have been encountered that you should avoid. Also frequently based on actual experience, these are ideas that have NOT worked in the past.

This icon signals ITS resources that offer additional information related to regional ITS architectures. Normally, a specific web site address and/or an Electronic Document Library number are provided for these resources. If you don't find the resources you need here, the "ITS Resource Guide" is an excellent general source of information. It is available on-line at http://www.its.dot.gov/itsweb/guide.html .

This icon highlights references to the FHWA Final Rule and FTA Policy on ITS Architecture and Standards. These are normally specific references to paragraphs that are most relevant to the particular process step or product. Additional information on the Rule/Policy is available at: http://www.its.dot.gov/itsweb/aconform/aconform.htm.

This icon identifies information about the National ITS Architecture. Specific information is provided on different parts of the National ITS Architecture and how they apply to particular regional ITS architecture development steps. Visit http://www.its.dot.gov/itsweb/arch/arch.htm for information on how to order a CD-ROM and a variety of other links and current National ITS Architecture news and information. An on-line version of the Architecture is available at www.iteris.com/itsarch. Several training courses on the National ITS Architecture are available from the National Highway Institute. See http://www.nhi.fhwa.dot.gov/ for more information.

This icon is associated with specific information on the Turbo Architecture software tool. Normally, the passage explains how Turbo Architecture can be used to support a particular step in the regional ITS architecture development process.

Turbo Architecture is an interactive software program that allows transportation professionals to use the information defined in the National ITS Architecture to create a regional or project architecture that reflects the transportation needs of the region. Additional information about Turbo Architecture, including information on how to obtain a copy, is contained in Appendix A. A Turbo Architecture training course will be offered through the National Highway Institute. See http://www.nhi.fhwa.dot.gov/ for more information.

Section 2

Developing a Regional ITS Architecture

This section provides an overview of a representative regional ITS architecture development process. In subsequent sections, each step in the process is described in more detail, defining the major activities, identifying the important inputs and outputs, and providing tips, resources, and cautionary advice that reflect lessons that have been learned in development of many regional ITS architectures over the past several years.

Development of a regional ITS architecture actually occurs in the context of broader regional planning and project development processes. The relationship between the regional ITS architecture development process described in this section and the regional planning process is described in detail in section 7.1. The relationship between the regional ITS architecture and the project implementation process is described in section 7.2.

Many different processes can be used to develop a regional ITS architecture. The objective of this section is NOT to define a single process that should be universally adopted. If you have a process that works, and it generates all the products that are required by the final rule/policy, then feel free to continue to use your process. If you don't have an existing process, then the process described in this section can be a good starting point for tailoring a regional ITS architecture development process that best meets your needs.

Figure 1 shows six general steps in the "lifecycle" of a regional ITS architecture. In the first four steps, the regional ITS architecture products are developed and then these products 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 products that will guide the "implementation" of the regional ITS architecture. An overview of each step in the process follows:

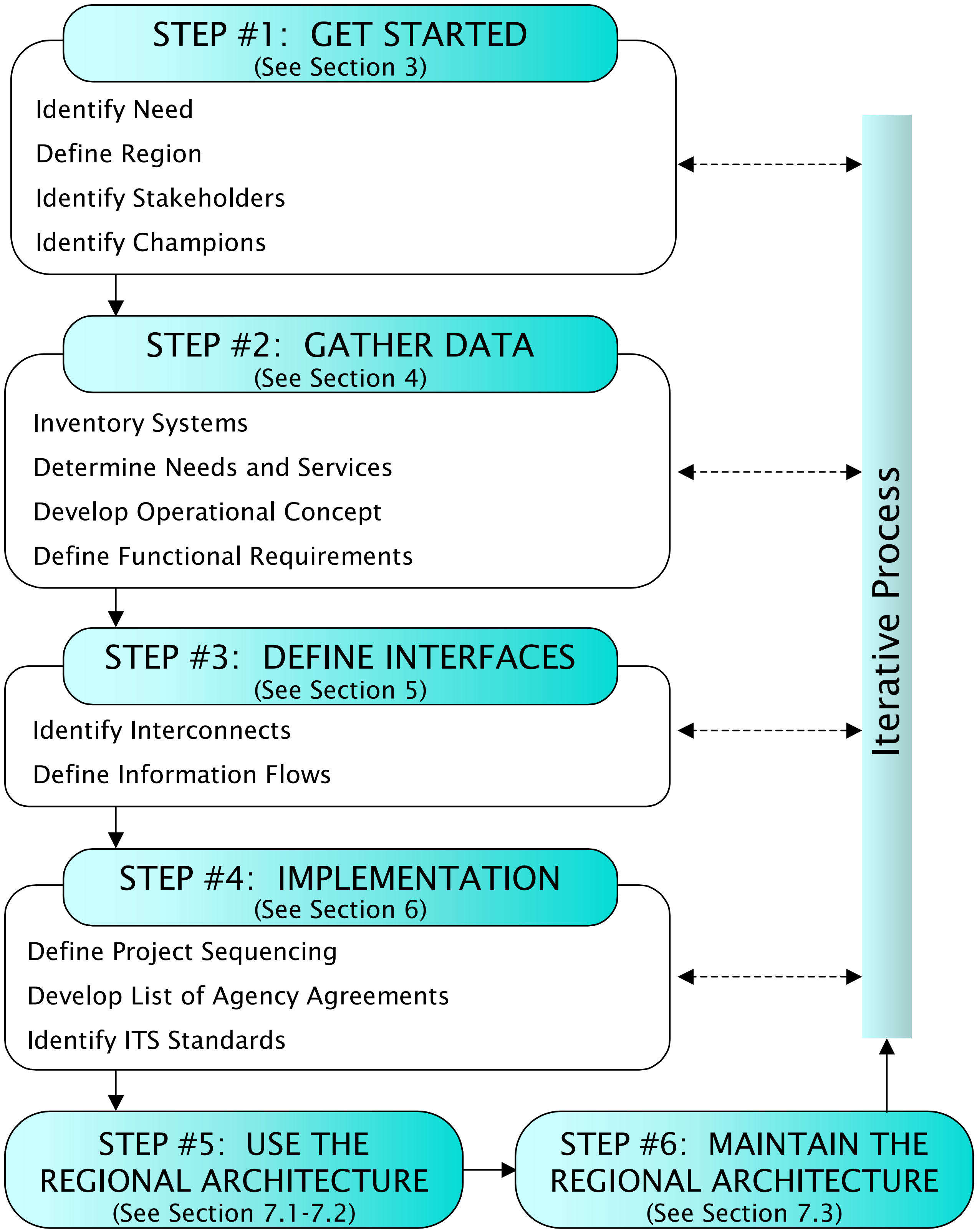


Figure 1: Regional ITS Architecture Development Process

Get Started: The regional ITS architecture effort begins with a focus on the institutions and people involved. Based on the scope of the region, the relevant stakeholders are identified, one or more champions are identified, the team that will be involved in architecture development is organized, and the overall development effort is planned. This step defines “who” will be involved with (and served by) the architecture and how the regional ITS architecture development will be structured.

Although a regional ITS architecture development effort is much smaller than a major construction project in terms of financial expenditure, an architecture development effort is institutionally complex because it is so inclusive. Architecture development planning, particularly for outreach and consensus building, is an important factor in a successful regional ITS architecture development. Allow sufficient time for this outreach and consensus building when planning the overall effort.

Gather Data: Once the stakeholders are involved and a plan is in place for assembling their input into a consensus regional ITS architecture, the focus shifts to the ITS systems in the region. At this step, the existing and planned ITS systems in the region are inventoried, the roles and responsibilities of each stakeholder in developing, operating, and maintaining these ITS systems are defined, the ITS services that should be provided in the region are identified, and the contribution (in terms of functionality) that each system will make to provide these ITS services is documented.

Define Interfaces: Once the ITS systems in the region are identified and functionally defined, the existing and planned interfaces between these systems are defined. First, the connections (or “Interconnects”) between systems are identified, and then the information that will be exchanged on each of the interfaces is defined.

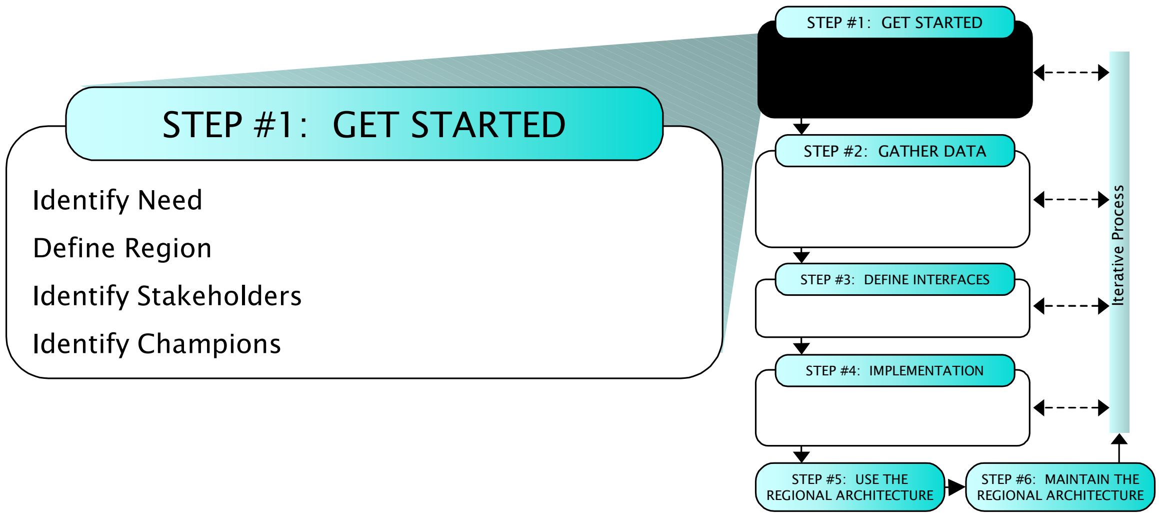
Implementation: Once the system interfaces are defined, additional products can be defined that will guide implementation of the projects that will flow from the regional ITS architecture. These include a sequence of projects, a list of needed agency agreements, and a list of standards that can be considered for project implementation.

Use the Regional ITS Architecture: The real success of the regional ITS architecture effort hinges on effective use of the architecture once it is developed. The regional ITS architecture is an important tool for use in transportation planning and project implementation. It can identify opportunities for making ITS investments in a more cost-effective fashion. This step is where the benefits are realized.

Maintain the Regional ITS Architecture: As ITS projects are implemented, new ITS priorities and strategies emerge through the transportation planning process, and the scope of ITS expands and evolves to incorporate new ideas, the regional ITS architecture will need to be updated. A maintenance plan is used to guide controlled updates to the regional ITS architecture baseline so that it continues to accurately reflect the region's existing ITS capabilities and future plans.

While this may look like a sequential process where each step is completed before beginning the next, the actual development process is normally iterative and tasks will frequently be performed in parallel. For example, in step #1, the scope of the region may be adjusted as new stakeholders are identified and they begin to suggest changes to the regional boundary. Similarly, new stakeholders are frequently identified as the inventory for the region is defined, causing iteration between step #2 and step #1. It is also common for changes to the inventory to be made as interfaces are defined, causing iteration between steps #3 and #2. This "two steps forward and one step back" progression is a normal part of the process.

Section 3 Get Started



This section describes the first step in the regional ITS architecture development process – "Get Started".

The regional ITS architecture effort begins with a focus on the institutions and people involved. Based on the scope of the region, the relevant stakeholders are identified and a plan to engage them is developed, one or more champions are identified, the team that will be involved in architecture development is organized, and the overall development effort is planned with particular focus on outreach and consensus building.

In this section, the four "Get Started" process tasks are described in more detail. Each task description begins with a one page summary that is followed by additional detail on the process, relevant resources and tools, a general description of the associated outputs, and example outputs where they are available. Each task description also includes tips and cautionary advice that reflect lessons that have been learned in development of regional ITS architectures over the past several years.

STEP #1: GET STARTED – Identify Need

These tasks may be performed in parallel.	• **Identify Need** • Define Region • Identify Stakeholders • Identify Champion(s)
OBJECTIVES	• Assess need for regional ITS architecture • Define regional ITS architecture boundaries
PROCESS *Key Activities*	<u>Assess Need and Ability</u> • Determine if ITS technologies are being implemented. • Determine if ITS projects are planned for the region. • Evaluate system integration opportunities in the region • If a regional ITS architecture is needed, assess in-house skills and determine if additional assistance is required. • Build awareness in the region of the benefits of a regional ITS architecture through outreach and education and garner support for its development. <u>Build Consensus</u> • Build consensus in the region on the decision to develop a regional ITS architecture • Emphasize the benefits, rather than the rule/policy requirements
INPUT *Sources of Information*	• Transportation Improvement Program (TIP) • The Long Range Transportation Plan ("*the Plan*") • Early Deployment Plans (EDPs) and other ITS Plans • ITS Outreach and Educational Resources
OUTPUT *Results from Process*	• Decision to initiate a regional ITS architecture development effort.

3.1 Identify Need

In this step, the decision to develop a regional ITS architecture is made. Through this decision process, the development and maintenance of a regional ITS architecture is established as a shared objective by the transportation planning and operating agencies in the region.

Requirements for developing a regional ITS architecture are identified by FHWA Rule 940.9 and FTA National ITS Architecture Policy Section 5.

3.1.1 Process

A regional ITS architecture is required by the FHWA Rule/FTA Policy for regions that have deployed, or will be deploying, ITS projects. An examination of the deployed ITS systems, the plans for future ITS deployments, and system integration opportunities in the region will establish if the rule/policy applies and a regional ITS architecture is required. While the rule/policy establishes a clear "requirement" for a regional ITS architecture for many regions, the real "need" for a regional ITS architecture is based more on its utility in ITS project planning and implementation.

The most important reason to develop a regional ITS architecture is that it can help the region to efficiently plan for and implement more effective ITS systems. Thus, the ultimate objective is not to develop a regional ITS architecture that complies with a federal rule or policy, but to develop an architecture that can really be used by the region to guide ITS implementation. A regional ITS architecture that includes all the products specified by the rule/policy but is never used by the region is not of real benefit to the region or US DOT. To meet the requirements of the rule/policy, the regional ITS architecture must be used to measure conformance of ITS projects on an on-going basis and be maintained as regional ITS requirements evolve.

The decision to proceed then should actually be based on a clear understanding and commitment by planning agencies, operating agencies, and key decision makers in the region that a regional ITS architecture is needed and will be put to good use. This implies that a decision to proceed should be accompanied by significant outreach and education on the benefits of ITS and system integration and the important role that a regional ITS architecture can play in developing these integrated systems.

3.1.2 Resources and Tools

There are many good resources available that can support the outreach and education effort that may be required to realize the benefits of a regional ITS architecture. USDOT has published an "ITS Resource Guide" that lists over

300 documents, web sites, training courses, software tools, and points of contact covering all aspects of ITS, including the National ITS Architecture and regional ITS architectures. An online version of this guide is available at http://www.its.dot.gov/itsweb/guide.html.

STEP #1: GET STARTED – Define Region

These tasks may be performed in parallel.	• Identify Need • **Define Region** • Identify Stakeholders • Identify Champion(s)
OBJECTIVES	• Define the general scope of the regional ITS architecture.
PROCESS *Key Activities*	<u>Define the Region</u> • Review geographic boundaries of key stakeholders, major ITS projects and special "air quality conformity" issues. Consider the Metropolitan Planning Area boundary in metropolitan areas. • Provide boundary information to the stakeholders for consideration • Collect information on surrounding regional ITS architectures and consider how this regional ITS architecture will fit with others in the area. • Define a timeframe for what will be included in the regional ITS architecture (*e.g., five, ten, or twenty year planning horizon).* • Determine the basic scope of the services that will be covered. For example, determine if the regional ITS architecture should define commercial vehicle related services. <u>Build Consensus</u> • Actively solicit feedback on preliminary regional ITS architecture boundary, timeframe, and service scope decisions. • Agree on preliminary scope in order to begin the process. *Remember, the scope can be refined as you proceed*.
INPUT *Sources of Information*	• Geographic boundaries for key regional transportation projects and/or services that utilize ITS. • Stakeholder(s) agency "operational or service area" boundaries. • Transportation Improvement Program (TIP) • The Long Range Transportation Plan ("*the Plan*") • Geographic boundaries of surrounding Regional Architectures.
OUTPUT *Results from Process*	• A description of the region including geographic boundaries, timeframe, and service scope.

3.2 Define Region

The process of developing a regional ITS architecture begins with a definition of the region. The fundamental scope for the regional ITS architecture is established with the definition produced in this step.

3.2.1 Process

The general scope of a regional ITS architecture can be defined in three ways:

1) Geographic Area: Define the geographic area covered by the architecture. What cities, counties, states, corridors, or other special areas does it include?
2) Timeframe: Define the planning timeframe that the regional ITS architecture will address. Should the architecture encompass systems and services that are implemented over the next five, ten, or twenty years?
3) Service Scope: Specify the general categories of services that are included. For example, should the architecture cover commercial vehicle services?

Don't invest too much time trying to define the region perfectly the first time. Remember that developing a regional ITS architecture is an iterative process, and the definition of the region can be adjusted as the regional ITS architecture begins to take shape. The stakeholders should make a first cut at defining the region and then update the geographic area, timeframe, and service scope as new stakeholders are identified, new integration opportunities are considered, and the ultimate uses for the regional ITS architecture are discussed in more detail.

Geographic Area

Ideally, the geographic scope of a region should be established so that it encompasses all systems that should be integrated together. In practice, it is sometimes difficult to determine where to draw the line so that the architecture is inclusive without expanding to the point that the effort becomes unmanageable and consensus is difficult to achieve. While this is frequently called a "geographic" area, it is usually a political map that is being partitioned, defining a region along existing institutional boundaries.

The rule/policy states that metropolitan areas must consider the metropolitan planning area (MPA) as a minimum size for a region. The MPA is a good place to start since this boundary normally encompasses most integration opportunities and it coincides with the geographic region used for transportation planning. If the MPA is not the right boundary for a metropolitan regional ITS architecture, than a different geographic area can be specified, with rationale.

Service boundaries and special conformity boundaries should also be taken into consideration when determining the regional boundary:

Service Boundaries: Regional transportation agencies and other stakeholders each have geographic areas that they serve (e.g., transit services, toll authorities, etc.). These service boundaries should be considered when defining the geographic boundary for the regional ITS architecture. In metropolitan areas, these service boundaries may go outside the metropolitan planning area and influence the regional ITS architecture boundary.

Special Conformity Boundaries: In regions where there are special conformity issues like Air Quality, special conformity boundaries may also be considered. For example, ITS projects that are implemented to meet air quality goals within an air quality conformance boundary may require integration with other projects in the region. This suggests that the air quality conformance boundary may also be considered in establishing the geographic area covered by the regional ITS architecture.

Also consider the scope of other regional ITS architectures when defining the boundary. Where there are adjoining or overlapping regional ITS architectures, coordinate with the other region(s) to reach agreement on how common systems or interfaces will be represented in the two (or more) architectures.

Special care is required when regional ITS architectures do overlap. Caution should be used whenever the same system or interface is included in more than one architecture. Unless automated methods like a relational database or Turbo Architecture are used, it is almost certain that some difference or ambiguity will arise in the two (or more) representations of the same architecture definition. Whenever possible, it is a good idea to define the system or interface in one architecture and reference the one "authoritative" definition in all other architectures.

Timeframe

The regional ITS architecture should look far enough into the future so that it serves its primary purpose of guiding the efficient integration of ITS systems over time. While there is no required minimum, the most appropriate timeframe can be established based on how the regional ITS architecture will be used. Making the timeframe too short reduces the value of the regional ITS architecture as a planning tool. Making the timeframe too long increases the effort involved since very long range forecasts are difficult to make and subject to reevaluation and change.

- <u>5 Year Horizon</u>: An architecture with a five year horizon will likely be easier to bound and define, but this relatively short timeframe may not

include significant system integration opportunities that can be anticipated by the region's stakeholders and should be considered in future projects.
- 10-Year Horizon: A ten-year horizon is long enough to include most of the system integration opportunities that can be clearly anticipated by the region's stakeholders. This timeframe is sufficient to support Transportation Improvement Program (TIP) generation and guide project implementation.
- 20-Year Horizon: A 20-year time horizon is long enough to include all integration opportunities that may be included in the long range Transportation Plan.

A rough 5-, 10-, or 20-year approximation of the timeframe is enough to begin the process. The initial timeframe can then be reevaluated and changed as the regional ITS architecture takes shape.

As the architecture is defined, the timeframe is normally a secondary consideration when determining whether to include a particular system or interface. It is usually best to include the interfaces that are clearly supported by the stakeholders, even if these consensus interfaces push the envelope of the timeframe that was initially selected. In other words, the timeframe should be adjusted as necessary to match the vision of the stakeholders. It shouldn't be used to precisely constrain the stakeholders to near-term options since it is difficult to anticipate exactly when a well-supported idea will be implemented. Viable integration opportunities should be included in the regional ITS architecture and then reevaluated periodically as the architecture is maintained over time.

Service Scope

While specific identification of ITS services occurs later in the process, general decisions can be made immediately based on the scope of other regional ITS architectures. For example, if a statewide ITS architecture is defining commercial vehicle services, the 511 traveler information system, and the electronic toll collection system for the state, then any other regional ITS architectures in the state may decide to reference the statewide architecture for these services.

3.2.2 Region Definition Output

The definition of a region will specify the geographic area of coverage, typically using a map and a supporting textual description. The timeframe and service scope of the regional ITS architecture can also be defined to more completely document the scope of the region.

3.2.3 Region Definition Examples

Many different types of "regions" have been defined in the regional ITS architectures that have been developed to date. Architectures have been developed for all of the following types of geographic areas:

- One or more counties or equivalent state political subdivisions.
- One or more municipalities (e.g. cities, townships, etc.)
- State DOT District(s)
- Metropolitan Planning Areas
- A corridor (or Thruway or Turnpike)
- One or more states
- A specific "service region".

The last category is defined by a particular service or group of services. Service regions include tourist areas like the Greater Yellowstone region and international border areas like Western New York and Southern Ontario. The service region may have a specific scope of ITS Services; for example, a larger regional ITS architecture that focuses on traveler information.

Two examples illustrate some of the types of regions that can be defined. The first example region was defined by the Delaware Valley Regional Planning Commission (DVRPC), which is the Metropolitan Planning Organization for the nine-county Philadelphia region. The region is essentially the nine-county MPO region expanded to include interfaces to ITS systems outside the region. The region is shown in the map in Figure 2.

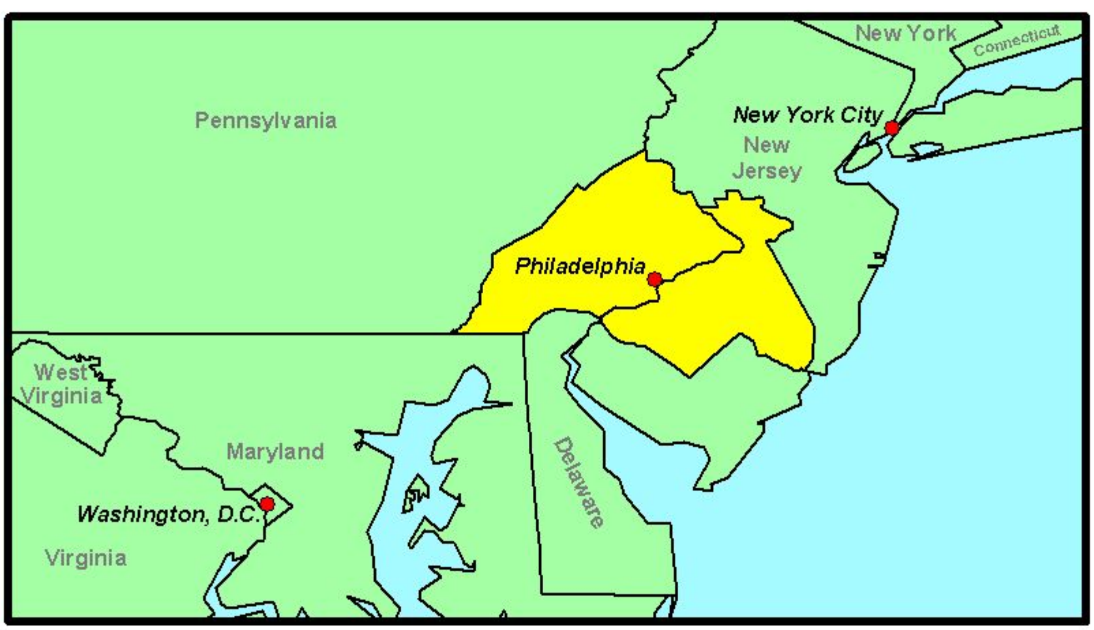


Figure 2: Regional ITS Architecture scope for the Delaware Valley RPC

The second example, illustrated in Figure 3, shows the approximate geographic scope of three regional ITS architectures under development in the central valley in Northern California and adjacent mountain regions. The Sacramento Regional ITS Architecture covers the Sacramento metropolitan area and surrounding cities including all of Sacramento County, portions of Yolo County and portions of Placer County. The Tahoe Gateway Counties ITS Strategic Deployment Plan includes Nevada County, Sierra County, Placer County and El Dorado County. The Tahoe Basin ITS Strategic Plan incorporates parts of two states (California and Nevada) and five counties (Carson City, Douglas, El Dorado, Placer and Washoe) and the town of Truckee, located in Nevada County. The boundaries of these architectures overlap, requiring a commitment and open lines of communication between the three projects.

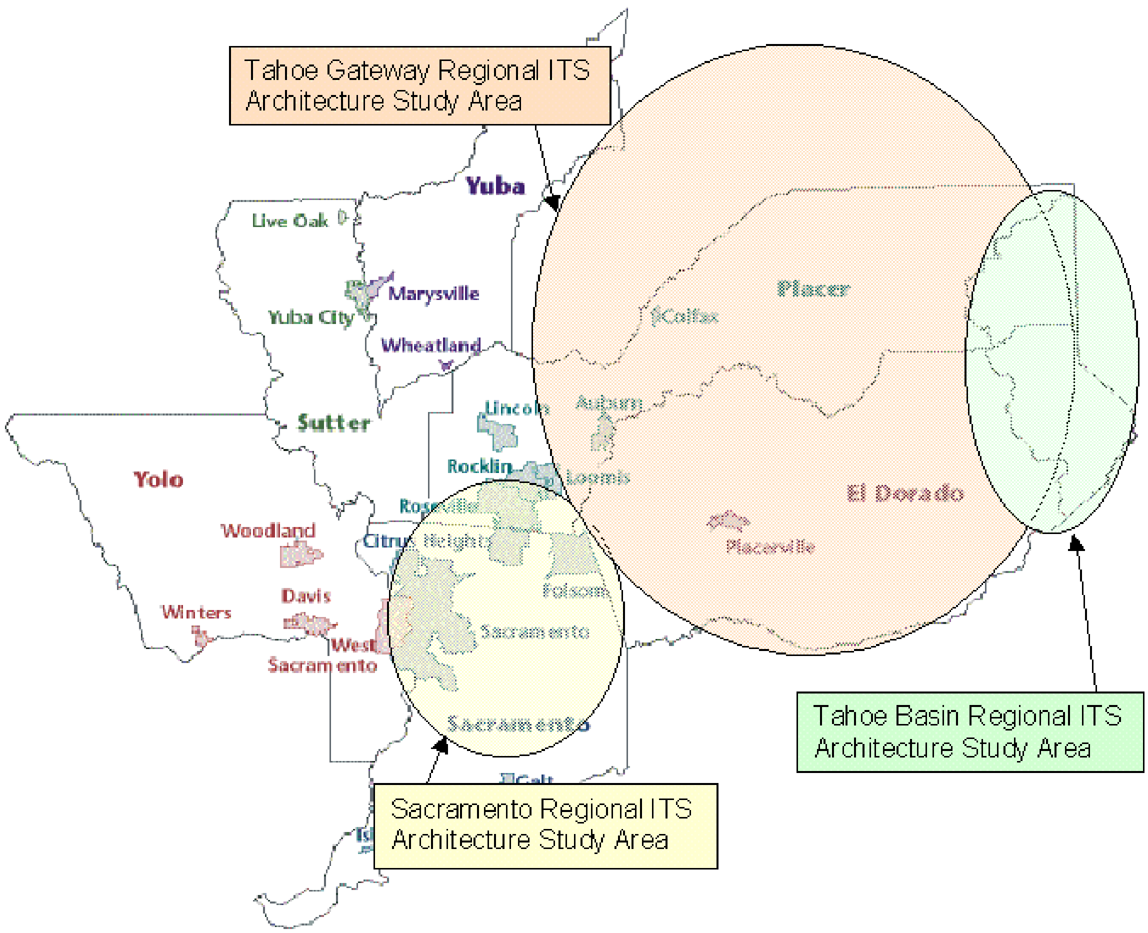


Figure 3: Adjacent/Overlapping Regions

STEP #1: GET STARTED – Identify Stakeholders

These tasks may be performed in parallel.	• Identify Need • Define Region • **Identify Stakeholders** • Identify Champion(s)
OBJECTIVES	• Identify and engage stakeholders that own or operate ITS systems and other agencies that have an interest in regional transportation issues (*e.g., MPOs, etc*) • Build broad-based support for the regional ITS architecture.
PROCESS *Key Activities*	<u>Outreach to Stakeholders</u> • Prepare educational materials that provide examples of successful ITS projects and benefits of ITS and ITS architecture. These materials will help you demonstrate benefits to stakeholders and gain support for the regional ITS architecture. • Use ITS working groups already in place to engage potential stakeholders. Facilitate initial meetings among core stakeholders involved in surface transportation and regional planning. • Look outside immediate peers to identify new stakeholders. • Identify additional stakeholders from referrals by stakeholders already participating in the process. <u>Build Consensus</u> • Schedule ongoing meetings and/or provide a consistent mechanism for communication to/from agencies responsible for the overall transportation program. • Address issues as they arise by using the consensus building process to make decisions about projects, ITS regional goals, etc.
INPUT *Sources of Information*	• ITS educational and outreach resources • Existing working group rosters, various participant lists • Key stakeholders from local transportation departments (cities, counties, states), public safety agencies, private companies, …
OUTPUT *Results of Process*	• Identification of participating agencies and other stakeholders

3.3 Identify Stakeholders

The success of the regional ITS architecture depends on participation by a diverse set of stakeholders. In this step, the stakeholders in the regional surface transportation system are identified and the process of encouraging their participation in the regional ITS architecture development process is initiated.

Identification of participating agencies and stakeholders is one of the required components of a regional ITS architecture as identified in FHWA Rule 940.9(d)2 and FTA National ITS Architecture Policy Section 5.d.2.

3.3.1 Stakeholder Identification Process

Regions will vary dramatically in the degree to which the surface transportation system stakeholders are aware of ITS. In regions that have already implemented substantial ITS systems, the stakeholders have already been working together on many of the issues that will be addressed during regional ITS architecture development. As a result, these regions usually have existing ITS committees that will be a natural forum to kick-off the regional ITS architecture development.

Other regions will require more significant education and outreach efforts about ITS in general and the merits of a regional ITS architecture in particular to assemble and motivate enough stakeholders. When preparing education and outreach material to introduce stakeholders to the regional ITS architecture, it is a good idea to use local project examples that may already be familiar. If local examples are not available, a variety of excellent material is available from USDOT and other sources.

Educating the right people is important – frequently the education and outreach efforts will target the management levels in an organization where decisions can be made to commit valuable personnel resources to support the architecture development effort. Without management support, it will be difficult or impossible for those with a working knowledge of ITS in the region to participate effectively in the regional ITS architecture effort.

It is often best to start with a core stakeholder group and then add participants to the core group over time. The core stakeholder group would itself be a diverse group with representation from each major agency and from both planners and system operators. This core group provides continuity to the development effort and an important set of contacts for the champion(s) and architecture developer(s). Including too many stakeholders at the start can hinder regional ITS architecture development progress and discourage people with limited vested interest in the process. Although the architecture effort should be very inclusive, a region may have better initial success if they are able to build consensus among the stakeholders that plan/own/operate ITS systems first before adding others into the decision making process.

Figure 4 shows a conceptual view of how stakeholders are added over time to the core stakeholder group. The core group is used to kick-off the effort. The number of active, participating stakeholders increases as the architecture development effort begins to generate more detailed and varied products that require broad review and support. The number of active stakeholders may then begin to taper off as stakeholder reviews are completed, comments are incorporated, and “completed” regional ITS architecture products are published. This same strategy of stakeholder engagement can be used, but probably on a smaller scale, for periodic maintenance activities that follow.

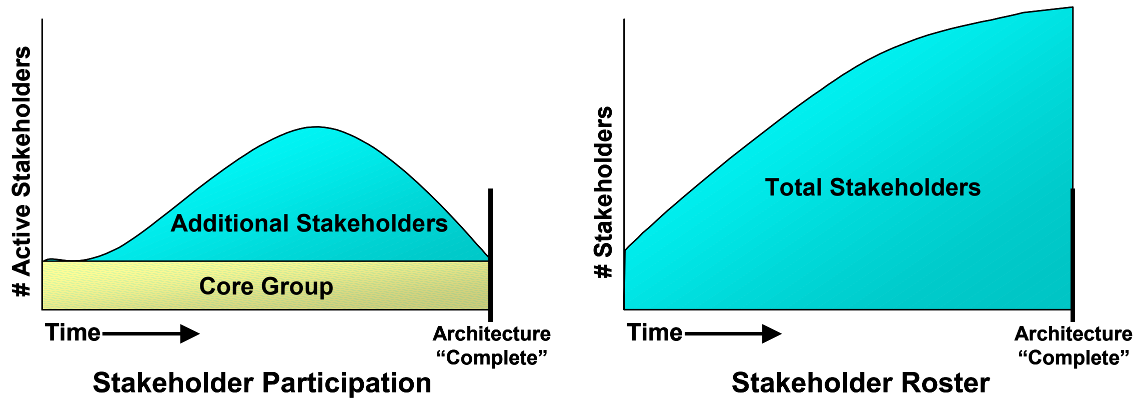


Figure 4: Stakeholder Identification and Involvement Over Time

While the number of active stakeholders begins to taper as the workload is reduced, the graph on the right shows that the total number of stakeholders will continue to increase over time, as different specialties and agencies participate in different parts of the architecture and different steps in the process. The perspective of the graph on the right is that once you are a stakeholder, you are always a stakeholder, although you may not actively participate beyond a specific milestone in the process. Over time, all relevant stakeholders in the region are engaged, just not all at once at the beginning of the architecture development effort.

If it is decided to initially limit the number of participants to a core group as depicted in Figure 4, set a timeframe to add others so that the architecture reflects the broader interests of the region. Table 1 in section 3.3.2 provides a list of potential stakeholders to consider.

As additional stakeholders are added to the process, it may be a good idea to retain a core group that meets regularly and have a broader group that is included at selected milestones in the regional ITS architecture development. It is critical that all stakeholders participate enough in the process that they understand the architecture and feel some ownership of the process and the regional ITS architecture that is developed. It is important to continually encourage and validate participation of stakeholders in the development process.

It is also important to focus stakeholder participation appropriately. For example, both planners and system operators will participate in the process, but with substantially different focus. System operators may be more interested in the operational concepts, functional requirements, and interface definitions, while the planners may have more substantial input while identifying transportation needs and services and project sequencing. Other individuals with specialized knowledge will be needed to assist in development of the list of agreements and list of required ITS standards. As the "stakeholder roster" is developed, consider the various areas of expertise that are required and use your stakeholder resources selectively. Different stakeholders should be engaged in different parts of the process, consistent with their expertise and interests.

Encouraging broad participation from many agencies, companies, and special interests in the region will occasionally bring people into the process who aren't really stakeholders in the regional transportation system. If the representative doesn't have, or plan to have, a system that should be integrated within the architecture timeframe or an interest in the surface transportation system as a whole (e.g., planners, the tourist industry, other special interests), then the representative is probably NOT really a stakeholder, will have little to contribute, and may ultimately grow frustrated with the process. It is best to understand the role of each potential new stakeholder in the surface transportation system at the outset and determine how they may contribute before significant time is invested. The objective is to be inclusive without wasting the time of those who do not have a vested interest.

Recognize and respect that everyone's time is limited. Draw participants into the process without bogging them down. Some useful techniques to encourage people with demanding schedules to participate are to make sure everyone gets plenty of time to review documents, and schedule short meetings with teleconferencing options. This will help retain participants that may otherwise give up on the architecture effort due to other commitments.

3.3.2 Tools and Resources

Many good education and outreach resources are available to support efforts to encourage stakeholder participation in ITS-related efforts. USDOT has published an "ITS Resource Guide" that lists over 300 documents, web sites, training courses, software tools, and points of contact covering all aspects of ITS, including ITS architecture. An online version of this guide is available at http://www.its.dot.gov/itsweb/guide.html.

Applicable National ITS Architecture resources include a training course and technical information that has been used to assist in identification of stakeholders in the past. The National ITS Architecture training course is provided by the National Highway Institute (Course # 137013, http://www.nhi.dot.gov/137013.html). The subsystems and terminators defined in the physical architecture provide a good categorization of the various systems and stakeholders that can be considered in developing a list of stakeholders for the regional ITS architecture development. To access an on-line version of the Architecture, visit www.iteris.com/itsarch.

Stakeholder lists may be entered directly into Turbo Architecture. Each stakeholder includes a name and a description and a variety of other information. Turbo can generate a stakeholder report and export stakeholder information to support the stakeholder output described in section 3.3.3.

The list of stakeholders identified in Table 1 includes the range of stakeholders that have participated in regional ITS architecture development efforts around the country. The table makes a good checklist of *possible* stakeholders that may be involved in your regional ITS architecture.

Table 1: Candidate Stakeholders

Transportation Agencies	• State Departments of Transportation (DOT)
	• Local Agencies (City & County)
	    ○ Department of Transportation
	    ○ Department of Public Works
	• Federal Highway Administration (FHWA)
	• State Motor Carrier Agencies
	• Toll/Turnpike Authorities
	• Bridge/Tunnel Authorities
	• Port Authorities
	• Department of Airport or Airport Authority

Transit Agencies/Other Transit Providers	• Local Transit (City/County/Regional) • Federal Transit Administration • Paratransit Providers (e.g., Private Providers, Health/Human Services Agencies) • Rail Services (e.g., AMTRAK) • Intercity Transportation Services (e.g., Greyhound)
Planning Organizations	• Metropolitan Planning Organizations (MPOs) • Council of Governments (COGs) • Regional Transportation Planning Agency (RTPA)

Public Safety Agencies	• Law Enforcement
	    ○ State Police and/or Highway Patrol
	    ○ County Sheriff Department
	    ○ City/Local Police Departments
	• Fire Departments
	    ○ County/City/Local
	• Emergency Medical Services
	• Hazardous Materials (HazMat) Teams
	• 911 Services

Other Agency Departments	• Information Technology (IT) • Planning • Telecommunications • Legal/Contracts

Activity Centers	• Event Centers (e.g. sports, concerts, festivals, ski resorts, casinos, etc.) • National Park & US Forest Services • Major Employers • Airport Operators

Fleet Operators	• Commercial Vehicle Operators (CVO
	  o Long-Haul Trucking Firms
	  o Local Delivery Services
	• Courier Fleets (e.g., US Postal Services, Federal Express, UPS, etc.)
	• Taxi Companies

Travelers	• Commuters, residents, bicyclists/pedestrians • Tourists/Visitors • Transit Riders, others
Private Sector	• Traffic Reporting Services • Local TV & Radio Stations • Travel Demand Management Industry • Telecommunications Industry • Automotive Industry • Private Towing/Recovery Business • Mining, Timber or Local Industry Interest
Other Agencies	• Tourism Boards/Visitors Associations • School Districts • Local Business Leagues/Associations • Local Chambers of Commerce • National Weather Services (NWS) • Air & Water Quality Coalitions • Bureau of Land Management (BLM) • Academia Interests, local Universities • National and Statewide ITS Associations (e.g. ITS America, ITE ITS members, etc.) • Military

3.3.3 Stakeholder Identification Output

This output identifies stakeholders who participated in the development of the regional ITS architecture by:

- Participating in stakeholder meetings and workshops.
- Reviewing and commenting on draft documents.
- Providing input to describe their systems and future plans.
- Participating in earlier regional ITS architecture activities whose products were used in the development of the current regional ITS architecture.

The purpose of this output is to record the stakeholder participation in the development of the regional ITS architecture and document the consensus process that was used in the regional ITS architecture development.

The actual documentation can take many forms, but a straightforward approach is to build a simple table or database with fields identifying the agency, company or interest group, transportation area, and possibly key participant contact information. This table can then be sorted by agency, company or interest group to check if each agency, company or interest group has adequate representation in the regional ITS architecture consensus development process.

3.3.4 Stakeholder Identification Example

Table 2 is a basic list of stakeholders that was prepared for an ITS architecture for the Franklin Tennessee Traffic Operations Center (TOC). It identifies each stakeholder agency that is related to the TOC and the systems that relate to each stakeholder agency. This is the complete stakeholder list for this small regional ITS architecture. The list of stakeholders will be considerably larger than this for most metropolitan regions.

Table 2: Franklin, TN TOC Stakeholders

Stakeholder Name	Responsible for these systems in the Architecture
City of Franklin Engineering Department	Storm Water Management System
	Franklin TOC_Personnel
	Franklin TOC_Roadside Equipment
	Franklin Parking Management System
	Franklin TOC
Franklin Police Department	Emergency Vehicles
	Franklin Police Dispatch_Personnel
	Weather Service
	Franklin Police Dispatch
Tennessee DOT	Nashville Regional Transportation Management Center
Franklin Transit	Franklin Transit System
	Transit Vehicles
TMA Group	Franklin TMA Kiosks
City of Franklin Streets Department	Construction and Maintenance
Community Access Television	Media
City of Franklin	Event Promoters
	Franklin Website
City of Murfreesboro	Murfreesboro TOC
Traveling Public	User Personal Computing Devices
Williamson County	Williamson County Emergency Management System
Nashville MPO	Regional Planning System

STEP #1: GET STARTED – Identify Champion(s)

<table>
<tr><td>These tasks may be performed in parallel.</td><td>Identify Need
Define Region
Identify Stakeholders
Identify Champion(s)</td></tr>
<tr><td>OBJECTIVES</td><td>Identify one or more key persons to lead the regional ITS architecture development.
Obtain broad-based buy in and support from stakeholders.</td></tr>
<tr><td>PROCESS
Key Activities</td><td><u>Looking for Champion(s)</u>
Champions for the region are probably already visible because they are proactive in the field of ITS, visionary about the future of ITS, and frequently already manage ITS projects.
Champion must be a stakeholder, so they have a vested interest in the outcome.
More than one champion can be identified from different agencies or stakeholder groups:
Transportation agencies (Traffic, transit, toll authorities, etc.) that support ITS because it meets their operational needs.
Public safety agencies who can bring in other public safety stakeholders.
<u>Champion Skills</u>
Understanding of the subject (regional ITS architecture including familiarity with the National ITS Architecture),
Knowledge of local ITS systems and projects
Vision for interconnectivity, partnership, and regional integration,
Consensus builder (facilitator), and
Executive level access to resources to gain support for various regional efforts.
<u>Building Consensus</u>
Initiate a scheduled meeting time and place to work on the Regional Architecture, set agendas for meetings and allow opportunity for each stakeholder to provide input to the process.</td></tr>
<tr><td>INPUT
Sources of Information</td><td>Not Applicable.</td></tr>
<tr><td>OUTPUT
Results of Process</td><td>Strong leadership that has broad-based regional stakeholder support and an effective problem resolution mechanism for ITS projects.</td></tr>
</table>

3.4 Identify Champion(s)

In this step, the champion(s) that will lead the regional ITS architecture development effort are identified. The champion(s) drive the process that must occur in order to develop a regional ITS architecture and build consensus at each step of the development. Without strong leadership, consistent meetings and a plan for completion of tasks, many of the participants will quickly become busy with other daily responsibilities.

3.4.1 Process of Identifying Champions

Many regions have already developed a team of ITS stakeholders that meet on a regular basis. Chances are that the champion(s) have already been identified by the fact that they are leading the regional efforts through an ITS Task Force, Technical Advisory Committee or the fact that they are already leading a major ITS project in the region. Adding regional ITS architecture consensus building to whatever "hat" these people are already wearing will be a natural transition. The process of identifying a champion or champion(s), and developing a task force to put the regional ITS architecture together should be woven into the existing regional planning process for ITS if one is already underway.

Champions are usually not voted-in; they are selected "on the job" in the course of working together. In many regions, a single champion will be identified. If there are several people who rise to the occasion, several champions can be identified that take turns leading the meetings or agree upon some shared responsibilities that will keep everyone engaged. A champion's skills include:

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

The skill level that is needed in each area will vary depending on the technical and institutional maturity of the region. A more technically mature region may have many people with existing knowledge of the National ITS Architecture, but require increased skills in consensus building to pull various interests together. In institutionally mature areas that are growing in ITS technology, it may be a strong vision that guides the process. All of the identified skills are important for a strong successful champion along with the knowledge of when to use them.

No one individual is likely to possess all the knowledge and skills required to develop a regional ITS architecture. To be successful, the champion(s) must draw on the knowledge and skills of a diverse set of stakeholders. The champion is primarily a facilitator and manager and is not normally the one that actually defines the architecture – the stakeholders are.

A Champion must be a Stakeholder. It would be very difficult, if not impossible, for someone who did not have a vested interest in the outcome to be the champion for a regional ITS architecture development effort. A stakeholder who is already recognized in the region will best be able to take ownership and invest the time necessary to manage the regional ITS architecture development. FHWA, FTA, consultants, vendors and others are great participants, consultants may even do a lot of the detailed analysis and legwork in a regional architecture effort, but for regional long-term benefit, they should not be champions.

Identifying more than one Champion from varying backgrounds and disciplines (e.g., public safety, transit, state DOT, city and/or county traffic engineering) can be a benefit. A small group of people with diverse backgrounds and contacts can strengthen the regional ITS architecture product by improving stakeholder participation, encouraging agency buy-in, and facilitating access to the information and resources necessary to support architecture development. Where several champions are identified, they may form a steering committee (which could also include representation from others such as FHWA/FTA) that manages by consensus or advises and supports a leader who actually manages the development and maintenance effort.

Section 3.3.1 introduced the idea of a core stakeholder group that would be involved throughout the architecture development effort. This group might be the small group of "champions" described in the previous paragraph, or it could be a larger group. No one model will encompass all regional ITS architecture development efforts. Each region must decide how they wish to organize their efforts. The key is that there is a group of stakeholders who plays a key role throughout the architecture development effort.

Champions will probably come and go over the evolution of developing and maintaining the regional ITS architecture, and certainly will change over the life of regional ITS system implementation and expansion. The task of the Champion, like other leadership responsibilities, takes significant time. Dividing the work among a few champions will limit the turnover and ease the transition when one person leaves. It is important that good meeting minutes and records of action items are kept so that new champions will have some guidance regarding when, where, and why decisions were made.

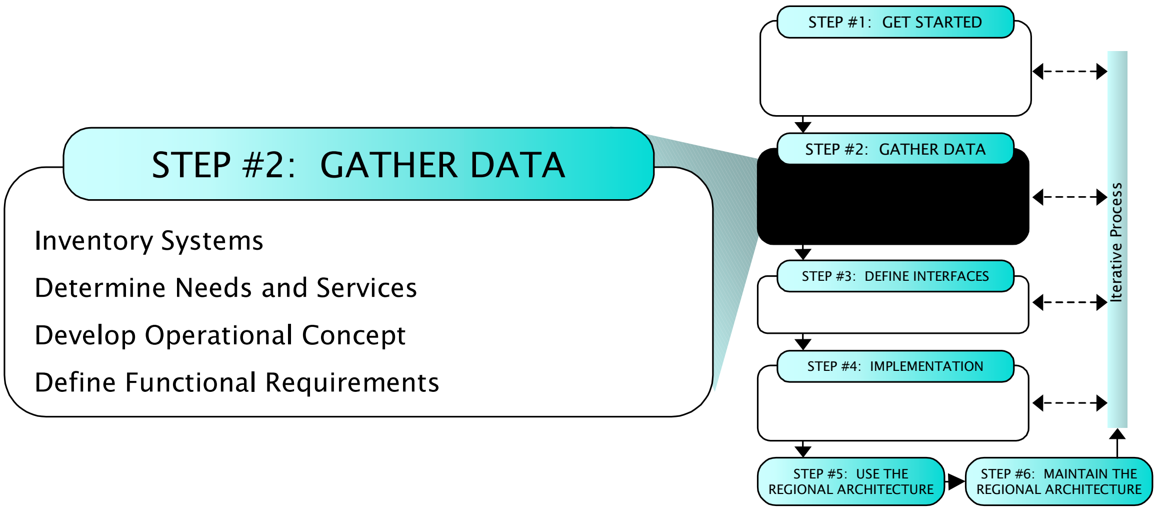
3.4.2 Examples

Champions are identified based on the people involved, the priorities of the participating agencies, and a range of other factors that are unique to each region. Because the factors involved are so specific to a region, it is unlikely that information on past champions will influence the selection of future champions in other regions. Nevertheless, it is interesting to look at the agency affiliation and titles of champions that have been identified. Table 3 shows some of the champions that have supported regional ITS architecture efforts in recent years. The table shows that a significant majority of champions have worked for either the state DOT or MPO.

Table 3: Regional ITS Architecture Champions

Region	Champion
Albany, NY	Assistant Regional Traffic Engineer – NYSDOT
Atlanta, GA	Senior Planner - Atlanta Regional Commission
Austin, TX	Traffic Engineer – TXDOT Austin
Chicago, IL	ITS Program Manager – IDOT
Cleveland, OH	Work Zone & Traffic Control Engineer – Ohio DOT
Detroit, MI	Senior Engineer – SEMCOG
Hartford, CT	Supervising Engineer - ConnDOT
Honolulu, HI	Executive Director - Oahu Metropolitan Planning Organization
Indianapolis, IN	INDOT
Kansas City, KS	Manager, Transportation Programs - Mid-America Regional Council
Little Rock, AR	Engineer - Metroplan
Long Island, NY	Inform ODS Director - NYSDOT R-10
Milwaukee, WI	TOC Assistant Manager, WisDOT
Oklahoma City, OK	Associate Planner, ACOG
Omaha, NE	Transportation Technology Engineer - Nebraska Department of Roads
Pittsburgh, PA	Transportation Planner, Southwestern Pennsylvania Regional Planning Commission
Portland, OR	Regional Traffic Engineer – ODOT
Providence, RI	TMC Manager – RIDOT
Rochester, NY	ITS Coordinator - NYSDOT
Sacramento, CA	Senior Analyst - Sacramento Council of Governments
St. Louis, MO	TIC Manager - MoDOT
State College, PA	Risk Management/ITS Administrator - PennDOT 2-0

Section 4 Gather Data



This section describes the second step in the regional ITS architecture development process – “Gather Data”.

In this step, the data necessary to build a regional ITS architecture is assembled. An inventory of the ITS systems in the region is taken, the roles and responsibilities of each stakeholder in developing, operating, and maintaining the systems is documented, the ITS services that should be provided in the region are identified, and the contribution (in terms of functionality) that each system will make to provide these ITS services is documented.

In this section, the four “Gather Data” process tasks are described in more detail. Each task description begins with a one page summary that is followed by additional detail on the process, relevant resources and tools, a general description of the associated outputs, and example outputs where they are available. Each task description also includes tips and cautionary advice that reflect lessons that have been learned in development of regional ITS architectures over the past several years.

STEP #2: GATHER DATA – Inventory Systems

These tasks may be performed in parallel.	• **Inventory Systems** • Determine Needs and Services • Develop Operational Concept • Define Functional Requirements
OBJECTIVES	• Identify existing and planned ITS systems in the region. • Build stakeholder awareness of these systems.
PROCESS *Key Activities*	Prepare • Locate inventory data that may already be documented in Regional ITS Plans (e.g., EDPs), ITS studies, ITS Project documentation, RFPs, and any other relevant documents. Define Inventory • Use collected inventory data to create an initial inventory. Focus on the "centers" first. • Review the initial inventory with key stakeholders and collect additional inventory information. • Document the associated organization(s), high-level status (e.g., existing or planned), and a brief description for each element in the inventory, • Map each inventory element to the National ITS Architecture subsystems and terminators. • Use the National ITS Architecture mapping to identify inventory gaps and identify additional inventory items to fill the gaps. Build Consensus • Facilitate a broad review of the draft inventory and incorporate comments. • Stakeholders can check with other departments in their agencies to verify the inventory for their agency is complete and accurate.
INPUT *Sources of Information*	• Stakeholders • ITS Plans and Studies (Various) • TIP, STIP, SIP, Transportation Plan, Congestion Management Plan, Commercial Vehicle Safety Plan, etc.
OUTPUT *Results of Process*	• Inventory of existing and planned ITS systems in the region.

4.1 Inventory Systems

Each stakeholder agency, company, or group owns, operates, or maintains ITS systems in the region. In this step, a comprehensive inventory of these existing and planned systems is developed based on existing inventories and stakeholder input.

An inventory of existing and planned systems supports development of interface requirements and information exchanges with these systems as required in FHWA Rule 940.9(d)6 and FTA National ITS Architecture Policy Section 5.d.6.

4.1.1 Inventory Process

The process of creating an inventory of ITS systems starts with collecting existing inventory information. This can often provide an excellent jumpstart to the inventory definition. In addition to existing plans, studies, and project documentation, adjacent or overlapping regional ITS architectures are a good source for inventory information. A portion of the inventory in these architectures will often be relevant, saving time and improving consistency between adjacent or overlapping architectures. It is best to develop a partial inventory based on these resources prior to engaging a large number of stakeholders to make best use of stakeholder time.

It is best to establish a few naming conventions before the inventory is assembled. For example, the names that are used in the inventory should start with a standard prefix since the inventory will frequently be viewed and managed as an alphabetized list of names. Prefixes can be a concise reference to the stakeholder (e.g., XYZ Transit), a reference to the location (City ABC), or any other standard prefix that will group similar systems when the inventory is sorted by name. By establishing a few naming conventions at the outset, the inventory will be easier to read and manage, and there will be less rework later to rename and reorganize the inventory after it is assembled.

When building an inventory, focus first on the “centers” since they are typically involved in the majority of inter-agency and public/private interfaces that need the most attention. Focus next on the roadside systems, vehicle systems, and traveler systems where there is some opportunity for integration. Unless the region has unique needs, don’t include people (e.g., traffic operations personnel) in the inventory.

Working closely with the stakeholders as the inventory is expanded and refined improves the quality of the inventory and increases stakeholder awareness of the existing and planned transportation systems in the region. Many different mechanisms may be used to gather stakeholder input including workshops, smaller meetings, telephone surveys, e-mail, and web-based interactions. Plan to use one or more of these mechanisms to verify and improve the inventory with stakeholder feedback. It may be helpful to engage a few key stakeholders initially and then encourage a broader review once the inventory is substantially complete.

The inventory should cover the geographic area and timeframe specified for the region. The inventory, representing many existing and planned systems that may be implemented over five, ten or even twenty years, can be developed in a single pass or in multiple passes. For example, you might start with an inventory of existing systems, then add planned systems, and finally add future systems that may be implemented towards the end of the established timeframe.

4.1.2 Inventory Resources and Tools

In addition to existing plans, studies, and project documentation that may be available in the region, the ITS Deployment Tracking Database (http://www.itsdeployment.its.dot.gov) may also be used as a source of existing ITS inventory information. This database contains information on ITS deployments in metropolitan areas based on surveys of metropolitan areas and states.

The National ITS Architecture subsystems and terminators can be used to organize the systems in the inventory. For example, Traffic Operations Centers and Public Safety Communications Centers may be associated with the Traffic Management Subsystem and Emergency Management Subsystem respectively. This association, or "mapping" to the National ITS Architecture establishes an important connection between the regional ITS architecture and the National ITS Architecture. The subsystems and terminators can also serve as a checklist that may be used to identify gaps in the inventory. The subsystems and terminators are defined in the Physical Architecture on the architecture CD-ROM and web sites.

Turbo Architecture was specifically designed to support development of ITS inventories. Turbo provides interview questions and forms that can be used to rapidly develop an ITS Inventory for a region.

4.1.3 Inventory Output

A regional ITS architecture inventory is a list of all existing and planned ITS systems in a region as well as non-ITS systems that provide information to or get information from the ITS systems. The focus should be on those systems that support, or may support, interfaces that cross stakeholder boundaries (e.g., inter-agency interfaces, public/private interfaces).

This section uses Turbo Architecture terminology where each item in an inventory is an "element". This terminology reflects the fact that an inventory may include other resources (e.g., people) in addition to systems. Each ITS-relevant system in a region is represented by an element in a regional ITS architecture inventory.

There is wide latitude in the types of systems that may be included and the level of granularity that should be specified in an inventory. Although every inventory will vary based on the unique needs of the region, several general "best practices" guidelines can be offered to those preparing an inventory.

In general, the inventory should be managed so that it is as small as possible while still supporting the goal of identifying all key integration opportunities in the region. For example, instead of identifying separate inventory elements for each individual roadside system (e.g., separate elements for VMS, signals, cameras, etc.), consider identifying a single inventory element that includes all of these systems as depicted in Figure 5.

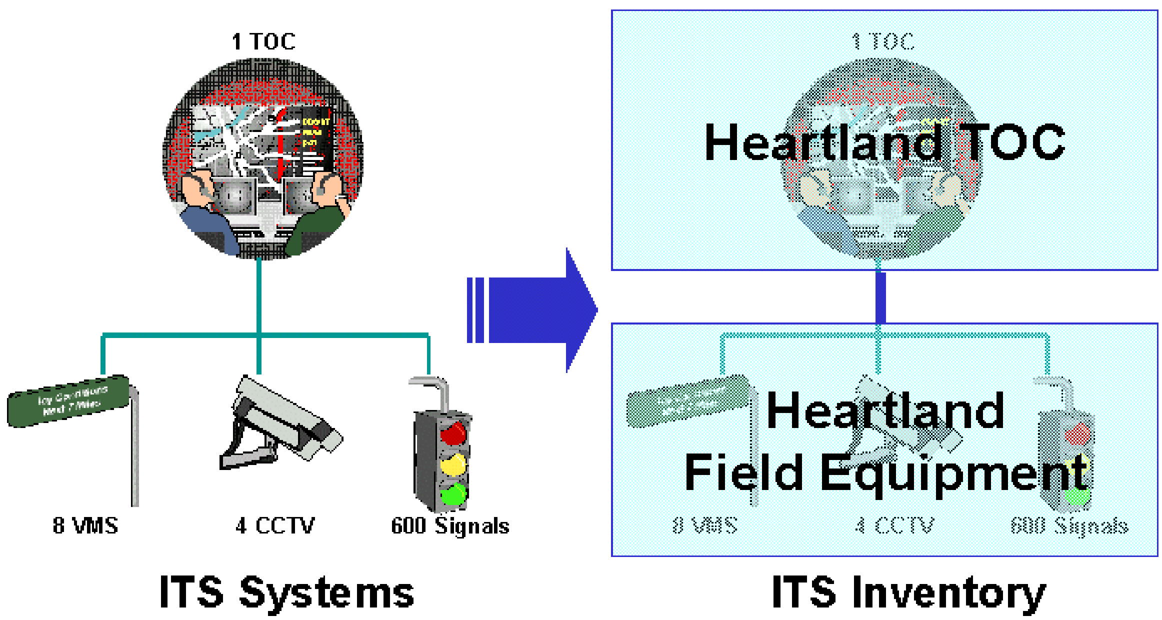


Figure 5: Grouping ITS Systems into General Inventory Elements

Of course, ITS systems cannot be grouped into general elements indiscriminately. Multiple systems can be safely grouped into a single inventory element if they exchange the same types of information with the same systems. The grouping works in Figure 5 because all the Heartland field equipment interfaces exclusively with the Heartland TOC. If some of the field equipment was actually owned and operated by another agency, then it would be best to identify a separate element for that equipment. Another consideration is that when ITS systems are grouped in the inventory, the potential interfaces between these systems are lost (e.g., any potential interface between different types of Heartland field equipment is lost with the grouping in Figure 5). Again, the grouping in Figure 5 is acceptable because the interface between field equipment is (presumably) not a significant regional interface. The last issue is the affect that that grouping has on ITS standards identification later in the process. Due to the grouping, the combination of ITS standards that support Dynamic Message Signs, CCTV Control, and Signal Control will all be associated with the interface to the combined Field Equipment Element. This means that the ITS standards information for the element must be interpreted and used carefully to ensure that device-specific standards are identified and used properly later in the process. As long as the ITS system grouping is done with these issues in mind, recent experience indicates that grouping will save regional ITS architecture development time with little or no impact to the quality and utility of the final architecture.

The level of granularity in the inventory can vary within a single regional ITS architecture. For example, larger systems in a major metropolitan area may be explicitly identified, but smaller systems may be represented more broadly with a few general elements (e.g., “Municipal Police Dispatch Systems”). The approach of “rolling up” smaller systems into a general inventory element suggests that these systems should integrate with other regional systems in a consistent fashion. A detailed list of the agencies/systems represented by the general element can be included in the definition for the element.

An inventory may include a few elements that are outside the defined scope of the region. For example, a Statewide ITS Architecture inventory may include element(s) representing operations centers in adjacent states where there are important interfaces to these operations centers. These “inter-regional” interfaces should be coordinated across regional ITS architectures to avoid duplicate and/or conflicting definitions of the same interface.

Each element in an inventory will normally include a name, associated stakeholder(s), a concise description, general status, and the associated subsystems or terminators from the National ITS Architecture. This core information may be supplemented with specific location information, points of contact, other references, and various implementation details as needs dictate. The region should establish the information that is required for each inventory element based on the needs of the region and available resources.

The fields that are normally included for each inventory element are described in the following paragraphs.

Element Name: Each element name should be selected with several criteria in mind. Most importantly, the selected name should be easily recognizable by the stakeholders. Preferably, the name will be the "common usage" name for the system in question, or at least be in terms that are familiar to the stakeholders.

While they may not seem important at the outset, naming conventions are a big help, particularly for large inventories. As discussed earlier, standard prefixes (e.g., "City ABC" or "County") ensure that related elements are sorted together when the inventory is alphabetized. The name of the system (or a brief descriptive phrase if the stakeholders do not have a name) immediately follows the prefix to complete the element name. It is best to use the same names when referring to the same types of systems or equipment. For example, avoid using "roadside assets", "field equipment", and "roadway systems" for three different inventory elements covering similar field equipment for three different traffic agencies. Pick a name (e.g., "Field Equipment") that the stakeholders like, and then use it consistently where possible (e.g., "City ABC Field Equipment", "City XYZ Field Equipment", "XDOT Field Equipment"). Consistent names make the architecture easier to understand, maintain, and use.

Including a prefix and name in each element name can make the names fairly long. Abbreviations and acronyms are a big help in keeping the names short enough so that they fit in the various diagrams and tables that will be used to publish the inventory. Care should be taken, though, to ensure that all of the abbreviations and acronyms make sense to the stakeholders.

Associated Stakeholders: While stakeholders can participate in the consensus of any part of the regional ITS architecture, they often are most interested in the inventory elements that they own, operate, or maintain. Documenting the association between stakeholders and elements is useful since it allows stakeholders to rapidly identify the elements that are most relevant. This association can help individual stakeholders make the most effective use of their time. If individual stakeholders don't have time to review the entire regional ITS architecture, they might still be able to review all sections that involve their associated agency, company or interest group, as identified by the associated stakeholder.

Description: While it may be tempting to include very detailed information in the element description when it is available (e.g., the numbers and types of controllers used by a particular system), remember that this level of detail will increase the level of effort required to maintain the regional ITS architecture later. In general, the architecture inventory should not specify technologies or manufacturers since this information is subject to change and incidental to the purpose of the architecture. Limit the information to what is required for the stakeholders to recognize the element and its role (i.e., "what does it do?") in the regional ITS architecture. Where a general element is used to represent many systems, the description should include an explicit list of these systems. Additional detailed information that is compiled can be archived separately for later use.

Associated Subsystems/Terminators: Each regional ITS architecture inventory element should be mapped to one or more National ITS Architecture subsystems or terminators. This association must be created because it will lead to identification of architecture flows and supporting ITS standards for the element in later steps. The association can also provide a head start in functional requirements definition. Occasionally, an element will be truly unique and not represented in the National ITS Architecture at all. In this case, no National ITS Architecture association is created. This is a perfectly valid approach, but it does mean that the functionality, architecture flows, and standards that are identified later for the element will not have a basis in the National ITS Architecture.

4.1.4 Inventory Examples

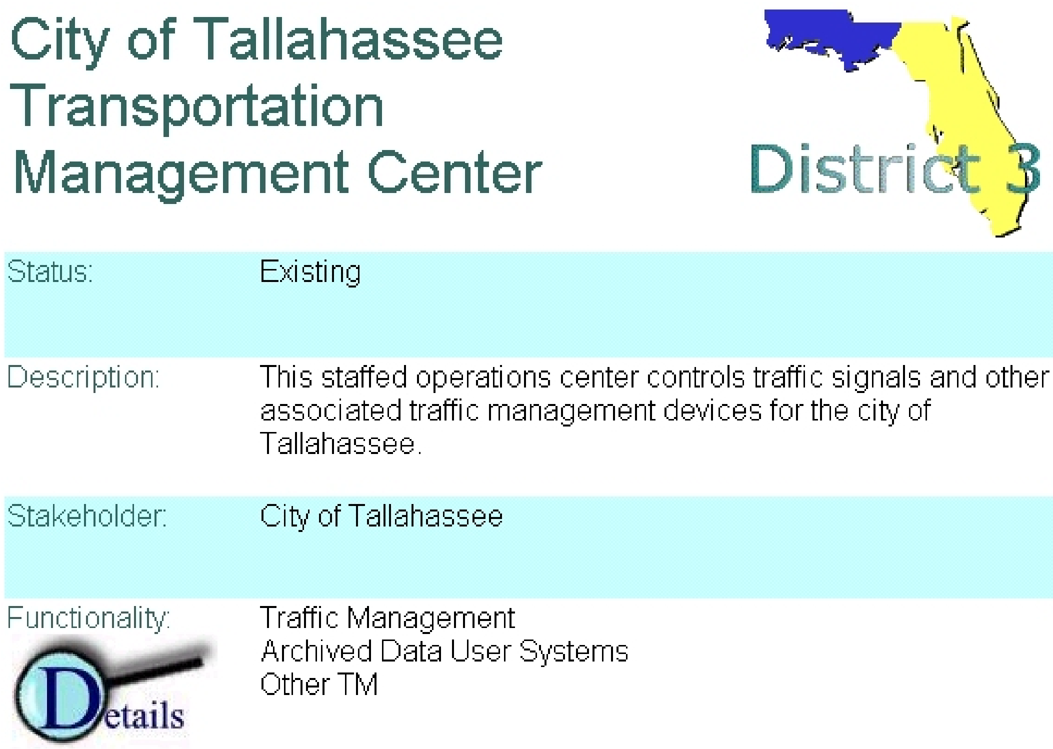
Although inventories all tend to include approximately the same information, many different ways to document this information have been devised. Excerpts from four different inventory presentations are included in this section that illustrate some of the ways that inventories have been documented.

Example 1: Inventory Summary Sorted by Stakeholder Name
An inventory summary can be presented in tabular form as shown in an excerpt from the Florida District 3 regional ITS architecture in Figure 6. The table is sorted by stakeholder name so that stakeholders can easily find the elements that are associated with their agency, company or user group. For example, a City of Pensacola employee could rapidly see that there are four elements in the regional ITS architecture that are associated with his or her agency: Air Freight Terminals; City of Pensacola Field Equipment; City of Pensacola Traffic Management Center; and Pensacola Regional Airport.

Stakeholder	Element
Amtrak	Amtrak Passenger Train Terminal
Apalachee Regional Planning Council	Apalachee RPC Traffic Database
Archived Data Users	Archived Data User Systems
Capitol City TMA	Tallahassee Commuter Assistance Program
Cellular Provider	Cellular Probe Monitoring System
CHEMTREC	CHEMTREC
City of Fort Walton Beach/Okaloosa County	Okaloosa County Field Equipment
City of Fort Walton Beach/Okaloosa County	Okaloosa County Transportation Management Center
City of Pensacola	Air Freight Terminals
City of Pensacola	City of Pensacola Field Equipment
City of Pensacola	City of Pensacola Traffic Management Center
City of Pensacola	Pensacola Regional Airport
City of Tallahassee	City of Tallahassee Field Equipment
City of Tallahassee	City of Tallahassee Transportation Management Center
City of Tallahassee	Tallahassee Flood Warning System
City of Tallahassee	Tallahassee Regional Airport
Commercial Vehicle Fleet Operators	Automated Collision Notification System
Commercial Vehicle Fleet Operators	Commercial Vehicles
Commission for the Transportation Disadvantaged	Demand-Response/Rural Transit Database

Figure 6: FDOT District 3 Regional ITS Architecture Inventory Excerpt

Example 2: Detailed Inventory Information Presentation
Figure 7 shows more comprehensive inventory information for a particular "City of Tallahassee Transportation Management Center" element in the District 3 architecture. This figure shows the element status, a brief description of the element, who the owning/operating stakeholder is, and a brief listing of the National ITS Architecture subsystems and terminators that the element is mapped to.


City of Tallahassee Transportation Management Center

District 3

Status:	Existing
Description:	This staffed operations center controls traffic signals and other associated traffic management devices for the city of Tallahassee.
Stakeholder:	City of Tallahassee
Functionality: Details	Traffic Management Archived Data User Systems Other TM

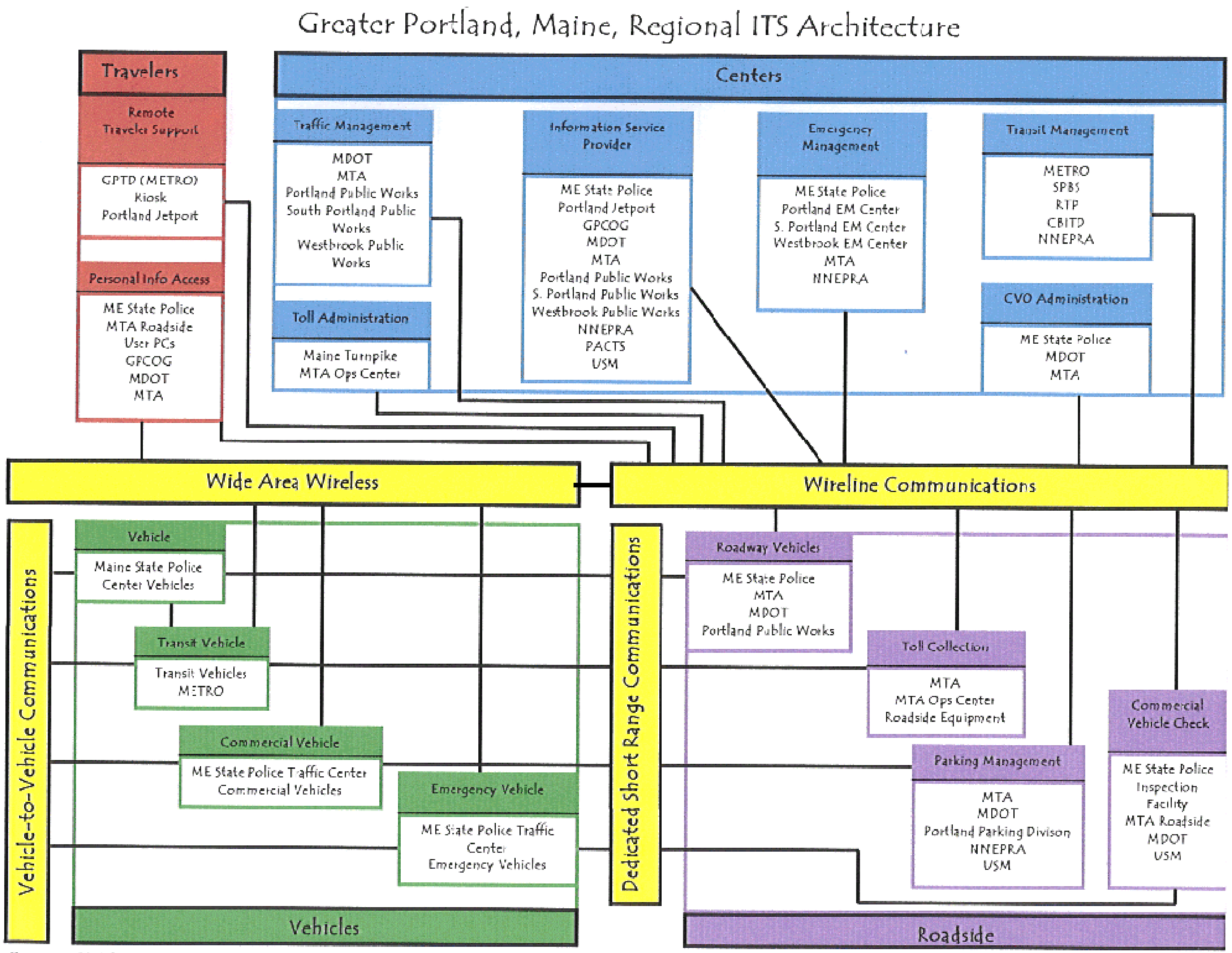
Figure 7: Inventory Details for an FDOT District 3 Element

Example 3: Comprehensive Tabular Presentation
Table 4 shows a tabular presentation of similar inventory information that was developed for the Staunton Virginia regional ITS architecture. In this case, a table is used to present comprehensive inventory information alphabetized by system name.

Example 4: Sausage Diagram Inventory Presentation
The association or mapping between regional ITS architecture elements and the National ITS Architecture is also frequently depicted in an extended version of the "Sausage Diagram" as illustrated in Figure 8. This diagram is taken from the Greater Portland, Maine regional ITS architecture developed by the local MPO, the Greater Portland Council Of Governments (GPCOG). Here, the generic sausage diagram is expanded so that each subsystem is associated with specific inventory elements in the Greater Portland region.

Table 4: Staunton, VA Regional ITS Architecture Inventory Excerpt

System Name	Description	Status	Architecture Mapping	Associated Stakeholder
Afton Mountain Fog Warning System	Fog Warning System on Afton Mountain. Consists of Fog Detection System, VMS, Strip Lighting along roadway. Currently under control of Verona Residency. DOC will have control in future	Existing	Roadway Subsystem	Virginia DOT
District Administration	The District Public Relations Office handles administrative activities for public relations issues. They will have a terminal in thier facility providing them with information from the DOC.	Existing	Other Traffic Management	District Public Relations Office
Local 911/EOC	Local 911 Emergency Operations Centers are tied into the TEOC. They have VOIS terminals only and will be connected to the DOC.	Existing	Emergency Management	Local Emergency Response Agencies
Maintenance Vehicles	VDOT maintenance vehicles will be equipped with AVL for management.	Existing	Vehicle	VDOT Residency
Maryland CHART II	Maryland State Highway Administration traffic management system that will coordinate incidents and traffic management activities.	Planned	Other Traffic Management	Maryland SHA
Other DOC	Other DOCs include Salem and Culpeper for example.	Planned	Other Traffic Management	Virginia DOT
Other Local Traffic Management	City or local traffic management or signal systems.	Existing	Other Traffic Management	Local Traffic Agencies
Other Smart Traffic Centers	NOVA, Richmond, and Hampton Roads STCs.	Planned	Other Traffic Management	Virginia DOT
Pennsylvania TMC	PennDOT traffic management systems that will coordinate incidents and traffic management activities.	Existing	Other Traffic Management	PennDOT



Source: GPCOG, May 2000

Figure 8: Portland, ME Extended Sausage Diagram

STEP #2: GATHER DATA – Needs and Services

These tasks may be performed in parallel.	• Inventory Systems • **Determine Needs and Services** • Develop Operational Concept • Define Functional Requirements
OBJECTIVES	• Identify regional needs and determine the ITS services that should be implemented to address those needs. • Build consensus on regional needs and service priorities.
PROCESS *Key Activities*	<u>Prepare</u> • Review regional needs and ITS services data that may be documented in ITS Plans (e.g., EDPs), ITS studies, transportation plans, ITS Project documentation, etc.) • Collect needs from key stakeholders including operators, maintainers, and users of the transportation system. <u>Document Needs and Services</u> • Document regional needs • Identify candidate services that will address those needs. • Schedule and conduct reviews to review the needs and candidate services • Document the needs and services for the region. • Associate services with each element in the ITS inventory. <u>Building Consensus</u> • Build consensus on needs and services for the region. • Focus discussions on those services that require group buy-in.
INPUT *Sources of Information*	• Stakeholders • Planning Studies (e.g., transportation plans, ITS Early Deployment Plans, other ITS plans, etc.) • TIP, STIP, SIP, Congestion Management Plan, Commercial Vehicle Safety Plan, etc.
OUTPUT *Results of Process*	• Documented regional needs and ITS service priorities • The association between specific ITS services and supporting systems in the region.

4.2 Determine Needs and Services

In the previous step, an inventory of the existing and planned ITS systems in the region was developed. In this step, the ITS services that should be provided by these systems to address regional needs are identified. This is the first step in determining what the system should do tomorrow that it doesn't do today. It provides each agency an opportunity to look at the region's transportation system from the highest level and confirm that their goals and desires are consistent with the rest of the transportation community.

An understanding of the regional needs and ITS services supports development of interface requirements and information exchanges with planned and existing systems and subsystems as required in FHWA Rule 940.9(d)6 and FTA National ITS Architecture Policy Section 5.d.6.

4.2.1 Needs and Services Definition Process

Identify Needs

Before ITS services can be prioritized for the region, the problems with the regional transportation system and the associated needs of the operators, maintainers, and users of the system must be understood. In many cases, regional needs will already be documented in one or more existing plans or studies. Even when they are not formally documented in one place, the operators, maintainers, and users of the system understand the region's needs. Needs are identified by collecting this information from existing documents and supplementing this information with stakeholder input.

Both ITS plans and traditional transportation plans should be reviewed for needs and services information. Transportation long range plans typically discuss economic and social trends and how the infrastructure should be built to meet the region's needs. Many of these long term policies and goals are directly related to the needs and services that guide a regional ITS architecture. For example, if major new facilities are planned for the region, then it is appropriate to plan to add ITS services into those new facilities. If the region is making major investments in enhancing transit service, these enhanced services should be reflected in the regional ITS architecture.

The needs collected from this documentation review can then be reviewed and refined with key stakeholders in the region. It is best to start with a candidate list of needs when gathering stakeholder input. If a set of needs for the region has not been documented, a representative list of candidate needs can be used to start the discussion. Based on stakeholder input, the region's needs are documented before ITS services are considered.

Determine Services
ITS services are the things that can be done to improve the efficiency, safety, and convenience of the regional transportation system through better information, advanced systems and new technologies. ITS services are prioritized for the region based on the documented regional needs.

The first task is to determine the initial list of ITS services that will be reviewed and prioritized for the region. ITS services can be described in a variety of ways – the most common lists of ITS services are the "User Services" and "market packages".

Thirty-two User Services covering a wide breadth of surface transportation needs have been defined. The first 29 of these are defined in Volume II of the National ITS Program Plan. Two of the newer User Services, Highway Rail Intersection and Archived Data are defined in an August 2000 update to the Program Plan. The 32^{nd} User Service, Maintenance and Construction Operations, is documented on the USDOT's Electronic Data Library.

Market packages have been used as the initial list of ITS services by most regional ITS architectures in recent years. Market packages provide a service-oriented view of the National ITS Architecture that identify the pieces of the architecture that are required to implement a particular service. There are a few compelling reasons to use market packages:

1. They are well documented, including high-level graphics, brief descriptions, and detailed definitions based on the National ITS Architecture physical architecture.
2. They offer more granularity than User Services, allowing more precise service choices to be made.
3. Turbo Architecture uses market packages, so transition to Turbo Architecture is much easier if market packages are used.

While market packages are a good place to start, it would be a mistake to limit the ITS service choices to the list of predefined market packages since some services that are important to the region may not be defined in the market packages. For example, in the Greater Yellowstone regional ITS architecture development, "custom" market packages were developed for six additional rural ITS services that were important to the Yellowstone region but not represented in the National ITS Architecture (e.g., Animal-Vehicle Collision Counter Measures, Road Closure Management). Other regions have added services like red light enforcement, flood monitoring, and over-dimension vehicle permitting coordination to the basic services identified by the National ITS Architecture.

Beginning with an augmented list of market packages or an alternative list of ITS services, services should be identified that:

1. Are currently provided by the systems in the region,
2. Will be provided once planned projects are implemented, or
3. Address regional needs and may be implemented in the future.

Stakeholder input on each of these choices should be actively solicited, preferably in a direct forum like a brainstorming session or workshop. Remember that the focus for this task is on identifying the important ITS services; avoid getting bogged down in the specifics of how those services will be provided in this process step.

To make best use of stakeholder time, focus group discussion on ITS services that require group buy-in. ITS services that can be implemented by a single agency require less discussion than ITS services that require integration between different stakeholders' systems. For example, the decision to deploy a Surface Street Control service is an individual decision for a particular traffic agency, and may not be a priority for group discussion. In contrast, the decision to deploy Transit Signal Priority requires consensus by traffic and transit agencies and should be agreed to by all parties. Individual agency service choices can be coordinated offline if time is short.

It is usually appropriate to focus the discussion on services that have public sector involvement. Market packages that are exclusively private sector with no public sector interfaces (e.g., some autonomous vehicle safety and guidance market packages) can normally be excluded.

Every ITS service selected for the region should be associated with one or more regional systems that supports or will support that service. Each of these assignments should be reviewed and approved by stakeholders associated with the regional system. This association between ITS services and organizations will be the starting point for operational concepts, which will be defined in the next process task.

4.2.2 Tools and Resources

Many different resources discuss "needs" in the context of ITS and surface transportation planning. One such source is "Integrating Intelligent Transportation Systems within the Transportation Planning Process" (EDL #3903, http://www.itsdocs.fhwa.dot.gov/\JPODOCS\REPTS_TE/30F01!.PDF) This document discusses the relationship between transportation goals, problems, and needs. Other resources provided detailed information on the benefits of ITS that can be used to determine the ITS services that will address regional needs. For example, "Intelligent Transportation Systems Benefits: 1999 Update" provides an overview of ITS benefits (EDL # 8323, http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE/6F701!.PDF).

Both Market Packages and User Services provide a service-oriented view of ITS that can be used to support ITS service selection. Both are included in the National ITS Architecture documentation. The "Market Packages" document provides a wealth of information that can support market package selection including tables that relate user services to market packages, problems to market packages, and analyses that identify key institutional and technical issues associated with each market package.

The original 29 ITS User Services are documented in Volume II of the National ITS Program Plan which is available at:
http://www.itsdocs.fhwa.dot.gov//jpodocs/repts_pr//2x601!.pdf
The Highway Rail Intersection and Archive Data User Services are described in The National Intelligent Transportation Systems Program Plan, Five-Year Horizon, which is available at:
http://www.itsdocs.fhwa.dot.gov//jpodocs/repts_pr/97r01!.pdf
The most recent User Service, Maintenance and Construction Operations User Service is available at:
http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_pr/13465.pdf

Turbo Architecture directly supports market package selection and identification of inventory elements (systems) that support the market package. Turbo uses these choices to generate an initial architecture based on the underlying National ITS Architecture definition for each market package. Turbo can also generate or export market package choice information consistent with the output guidelines provided below.

4.2.3 Needs and Services Output

The output of this process step is a list of regional needs and the ITS services that will be implemented in the region.

Needs

Needs should be documented completely, including a record of the agencies and/or areas(s) in the region that have the need. For example, specify "alleviate congestion in work zones, freeway interchanges, and CBD" rather than simply identifying "alleviate traffic congestion" as a regional need. This detail will be helpful when assigning ITS services to inventory elements.

Even more detail could be added at the discretion of the region (e.g., "alleviate recurring congestion on SB I-5 to SB SR-55 interchange during morning peak"), but remember that this additional detail will be subject to change and increase maintenance. This level of detail is not necessary for the regional ITS architecture where needs and services only have to be isolated to the agency or system level. This level of detail would be necessary to support more detailed project definitions.

ITS Services

This documentation identifies each ITS service that is, or will be implemented in the region. For example, if market packages are used, the output would identify each market package name, its status in the region (e.g., existing, planned, or not planned), a list of the regional systems that will implement the market package, and any special notes concerning tailoring or issues associated with the market package. Some regions have added a priority rating to the market package that reflects the stakeholders' prioritization of the various service options.

4.2.4 Needs and Services Examples

Many existing regional ITS architectures include tables that document the ITS services (typically market packages) that were selected for the region. The following two tables are taken from work performed by Western Transportation Institute (WTI) for the Greater Yellowstone Rural ITS (GYRITS) Priority Corridor regional ITS architecture. They are example outputs of market package analysis that is based on an assessment of the fundamental transportation needs (identified as “challenges” by WTI) of the region.

Table 5 identifies the regional challenges including the general geographic area of focus and Table 6 identifies each priority market package beneath the challenge that it addresses and relates the market packages to the Rural Critical Program Areas. Note that several of the market packages identified by WTI were not defined by the National ITS Architecture; if the market packages included in the National ITS Architecture do not offer the services that the region requires, custom ITS service descriptions may be developed.

Table 5: GYRITS Regional Challenges

Challenge	Geographic Area of Focus
Inclement Weather	Regional, travel impacts due to severe winter weather are Corridor-wide.
Unsafe Speed	Regional, several areas within the Corridor have restrictive horizontal alignment, drivers over-driving the abilities of their vehicle and their skills are a problem throughout the Corridor.
Safety Problems Relating to Commercial Vehicles	Area-specific, of primary concern in the mountain passes in the Corridor, three geographic locations have been identified such as US 191 through Gallatin Canyon.
Hazardous Materials	Regional, transport of hazardous materials is a very environmentally sensitive topic throughout the Corridor, due to a moratorium on transport through YNP, portions of US 89 and US 191 have very limited exposure to HAZMAT.
Emergency Response	Time Area-specific, overlapping jurisdictions, long distances between emergency response centers, and long notification times pose the problem, geographical areas of focus are near the Montana/Idaho border on Idaho 20, near the Idaho/Wyoming border on US89, and Interstate 15 near Idaho Falls, Idaho.
Lack of Traveler/Tourist Information	Regional, the traveler needs survey indicated a lack of available traveler and tourist information throughout the region, the information that is available is often incomplete, inaccurate, or too general in nature.
Failure to Yield Right-of-way or Disregard for Traffic Control	Area-specific, traffic control and access control have large impacts on these types of conflicts, US 191 through Bozeman, Montana and the suburban areas outside Idaho Falls, Idaho on Routes 20 and 26 were identified as the geographical areas of focus.
Rear-end Collisions	Area-specific, U.S. 191 through Bozeman, Montana and the suburban areas outside Idaho Falls, Idaho served by routes Idaho 20, and 26
Animal Encroachment on the Roadway	Area-specific, conflicts were concentrated due to animal numbers and migration patterns, geographic areas of focus areas most of US 191 through Montana and US 89 from Jackson, Wyoming to Livingston, Montana.
Snowmobile Crashes	Area-specific, Yellowstone National Park has been identified as the geographic area of focus; snowmobile incidents and conflicts are concentrated in this area.
Commercial Vehicle Efficiency	Area-specific, geographic areas of focus center in and around the several weigh stations located in or near the GYRITS Corridor
Traveler Mobility	Regional, solutions should focus on improving operations of the existing transit and paratransit services supplied by various agencies within the Corridor.
Congestion at Yellowstone National Park Entrances	Area-specific, three entrances to Yellowstone National Park including Gardiner, Montana; West Yellowstone, Montana; and Jackson, Wyoming may be the focus.
Congestion at Construction Zones	Area-specific, specific to planned construction projects that will affect travel within the Corridor.
Tourism and Economic Development	Regional, affects the entire Corridor, solutions should focus on long-term applications

Table 6: Summary of GYRITS Priority Market Packages (Excerpt)

Critical Program Areas / Market Packages	Traveler Safety and Security	Emergency Services	Tourism and Travel Information Services	Public Traveler Services/Public Mobility Services	Commercial Vehicle Operations	Infrastructure Operations and Maintenance	Fleet Operations and Maintenance
INCLEMENT WEATHER CHALLENGE							
Broadcast Traveler Information			√			√	
Interactive Traveler Information			√				
Network Surveillance	√					√	
Probe Surveillance						√	
Safe Speed Advisory	√				√		
Traffic Information Dissemination	√		√			√	
UNSAFE SPEED CHALLENGE							
Dynamic Warning System	√						
Mobile Traffic Management/Enforcement	√						
Safe Speed Advisory	√				√		
Traction Control	√						
COMMERCIAL VEHICLE SAFETY CHALLENGE							
CVO Fleet Maintenance					√		√
Driver Safety Monitoring	√				√		√
Mobile Traffic Management/Enforcement	√						
On-board CVO Safety					√		√
Roadside CVO Safety					√	√	√
Weigh-in-motion					√	√	

STEP #2: GATHER DATA – Operational Concept

These tasks may be performed in parallel.	• Inventory Systems • Determine Needs and Services • **Develop Operational Concept** • Define Functional Requirements
OBJECTIVES	• Identify current and future stakeholder roles and responsibilities in the implementation and operation of regional systems. • Achieve buy-in on these roles/responsibilities, laying groundwork for future agency agreements.
PROCESS *Key Activities*	<u>Prepare</u> • Gather existing documents that identify responsibilities in multi-agency scenarios. For example, Incident Management Plans. <u>Develop Operational Concept</u> • Build on the ITS Inventory by identifying the agency, company, or institution that currently implements, operates, and maintains each inventory element that will support inter-agency or public/private interfaces. Augment the stakeholder list where necessary. • Develop several relevant operational scenarios that require cooperation among a broad array of stakeholders. Major incidents and special events are good scenarios that involve a majority of stakeholders. • Convene a meeting/workshop where stakeholders can walk through prepared scenarios and identify current roles and opportunities for enhanced cooperation/integration in the future. • Document each stakeholder's current and future responsibilities in each scenario • Collect key findings into a high level Operational Concept <u>Build Consensus</u> • Issues will surface during operational concept development. Identify and document key issues that can't be resolved.
INPUT *Sources of Information*	• Inventory and Needs and Services from previous task. • Any documents that identify roles and responsibilities

Output
Results of Process
	• Operational Concept documentation for the region.
	  • Overview of How ITS services are Provided
	  • Roles and Responsibilities

4.3 Develop Operational Concept

The inventory identifies the stakeholders that are associated with each system in the region. In this step, each stakeholder's current and future roles and responsibilities in the implementation and operation of the regional systems are defined in more detail. The operational concept documents these roles and responsibilities for selected transportation services in specific operational scenarios. It provides an "executive summary" view of the way the region's systems will work together to provide ITS services.

Rule/Policy

An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders is one of the required components of a regional ITS architecture as identified in FHWA Rule 940.9(d)3 and FTA National ITS Architecture Policy Section 5.d.3.

4.3.1 Operational Concept Development Process

This is the process step where integration opportunities in the region are first discussed and documented, with particular focus on stakeholder involvement. The objective is not to formally define each system or specify detailed integration requirements yet. This will come in later steps. The objective in this step is to identify current and future organizational roles in the regional transportation system. As with the other regional ITS architecture products, exactly how the operational concept information is gathered and expressed will vary from region to region.

The level of detail that is included in the operational concept will also vary from region to region. Some operational concepts will focus on a definition of each stakeholder's general role in providing the transportation services in the region. More detailed operational concepts may include a more detailed discussion of how stakeholders will interact to provide specific transportation services. Iteration is an important part of the process as initial concepts are expanded and refined over time.

Perhaps the most critical factor in the success of the Operational Concept process step is stakeholder involvement. The ultimate objective is not to create a table of roles and responsibilities, but to have the stakeholders suggest, review and tangibly buy in to these decisions so that they are owners of the operational concept. In later steps, these roles and responsibilities will form a basis for inter-agency agreements.

One of the significant challenges in developing an operational concept for a regional ITS architecture is the sheer scale and diversity of the systems and organizations that are included. It would be almost impossible to write a single contiguous operational concept that covers "a day in the life" of the regional surface transportation system.

One way to meet this challenge is to define several operational concepts, each one covering a particular aspect of the transportation system. For example, a series of focused operational concepts could be developed that each address a particular ITS service.

In most cases, you will want to use the same structure in your operational concept that you used to determine services and needs for the region. For example, if market packages were used to prioritize services and needs, then operational concepts should be developed for the market packages that were identified as important to the region. A concise operational concept could be developed for each selected market package with emphasis on those market packages that require broad coordination across organizations. For example, "Incident Management" and "Regional Traffic Control" both require broad inter-agency coordination and may require more focus in the operational concept than a market package like "Network Surveillance", since the latter has comparatively few inter-agency interfaces and a narrower focus.

A common source of frustration when discussing roles and responsibilities with stakeholders at this early stage is that the discussions can be too conceptual to really engage many people. To better engage stakeholders in the process, consider using real operational situations, or scenarios, to guide the discussion. For example, a large winter storm or hazardous material spill can provide vivid context to a discussion of the roles and responsibilities of stakeholders in the region. Create a scenario or scenarios that the stakeholders in the region are vitally interested in and then use the scenarios to encourage discussion and make the operational concept documentation more accessible.

One way to use a scenario-based approach is to organize a meeting where a facilitator walks key stakeholders through the events of a prepared scenario. At each step in the scenario, the facilitator works with the group to determine:

1. Current roles and responsibilities. For example, the state DOT currently faxes daily lane closure information to the counties, the major metropolitan city in the region, and the media.
2. What are the problems? For example, lane closure information tends to be very dynamic. Many agencies that could use the data don't receive it (e.g., emergency medical services).
3. What are the opportunities? For example, enhance coordination of longer-term closures between agencies. Collect closure information for the region in one place and make this available to operating agencies and the traveling public.

The facilitator should be prepared for more "opportunities" to be identified than can be thoroughly addressed in real-time. A common approach is to list all the ideas and then prioritize a few to flesh out with an operational concept. To finish the above example, the facilitator might follow up and determine who would implement and operate the proposed road closure information system, who would be its customers, and who would provide closure information to it.

A forum like this is a good opportunity to verify that the stakeholders are supportive and prepared for the changes that will occur if the operational concepts are implemented.   A range of issues, mostly non-technical, will often arise during the development of an operational concept, and they should be documented and resolved if possible. Among many effective strategies for issue resolution, it is often worthwhile to select a facilitator who has no vested interest in the issue to help steer those involved towards a win-win solution.

4.3.2 Operational Concept Resources and Tools

User Services are service-oriented descriptions of ITS that include some information that may be relevant to regional ITS architecture operational concepts. For example, the user service documentation includes a high-level operational concept for each user service. The first 29 User Services are documented in Volume II of the National Program Plan (available in the Electronic Document Library at EDL#3786).   Additional user services (HRI and ADUS) are found in Appendix C of the National ITS Program Plan, Five-Year Horizon dated August 2000 (see EDL#11943). Other resources provided detailed information on the benefits of ITS including "Intelligent Transportation Systems Benefits: 1999 Update" (EDL # 8323).

The National ITS Architecture includes Market Packages, which can also be used as a basis for operational concept development. Basic market package information is readily accessible in hypertext format. More detailed application information is available in the "Market Packages" document. The National ITS Architecture documentation set also includes a "Theory of Operations" that describes in detail how transportation services are provided by the National ITS Architecture. This document is also a good resource for those developing operational concepts for a region.

4.3.3 Operational Concept Output

The operational concept for a regional ITS architecture has two components: 1) a technical component that identifies operational roles and responsibilities and 2) an institutional component that identifies implementation roles and responsibilities.

It is usually best to keep the operational concept at a fairly high level, assigning general roles and responsibilities to organizations rather than specific departments or individuals. If the operational concept is too detailed, it can actually hinder efforts since the more detailed data will be less certain and subject to change at this early stage. The more detailed concepts should be deferred until the implementation phase of a specific project.

Operational Roles and Responsibilities
One effective way to organize the operational roles and responsibilities is by ITS service – using either user services or market packages to structure the output. For each ITS service, the operational concept provides a general view of how the service will be performed in the region and each stakeholder's roles and responsibilities in providing that service. In addition, the major areas of coordination between stakeholders can be documented. This is helpful because it will support the interface definitions and institutional agreements that are identified in later steps.

When documenting the roles and responsibilities for each ITS Service, it's important to realize that an ITS service can often be implemented in several different ways. For example, emergency vehicle signal preemption can be implemented in at least two ways:

- An emergency vehicle can directly preempt a signal using direct communications between the vehicle and equipment at the intersection.
- Alternatively, the dispatch center associated with the emergency vehicle can communicate with the traffic management center that controls the signal and request preemption on behalf of the vehicle. The traffic management center can then remotely preempt the signal.

While the first alternative is more commonly implemented, the second alternative could be attractive to regions that already have AVL implemented in their emergency vehicles and have a closed-loop signal control system in place. The operational concept should explore alternative concepts like this example and document choices for the region. For example, an operational concept for emergency vehicle signal preemption might select the first alternative, and then identify the roles and responsibilities of the public safety and traffic management agencies that would participate in the service. Where a firm choice cannot be made, several alternative concepts can be retained for future analysis.

Implementation Roles and Responsibilities
This portion of the operational concept includes a clear identification of the implementation and maintenance responsibilities for each of the systems in the region.

Tips

More detailed information can be provided where the systems are shared and the lines of responsibility are more complicated. For example, roles and responsibilities could be documented in a *responsibility matrix* showing shared resources on one axis and stakeholders on the other. Each cell would identify the stakeholder's responsibility for the shared resource.

4.3.4 Operational Concept Examples

Operational concepts can be documented in many different formats including textual descriptions, tables, and graphics. Prior to publication of the

Rule/Policy, relatively few regional ITS architectures actually included an operational concept. Hence, there are few examples to draw on, and significant variation in the approaches that have been taken to date. Three substantially different operational concept examples – including very different levels of detail – are presented in this section. Two of the examples have been augmented with role and responsibility information that is required by the Rule/Policy, but was not explicitly documented in the source architectures. Each region is encouraged to review these examples and identify an approach that best meets their needs.

Example 1: COATS Scenario-Based Approach
One of the real benefits of an operational concept is that it brings stakeholders together very early in the process and encourages them to reach a common understanding of each organizations participation in the overall ITS system before the regional ITS architecture is defined in detail. As suggested earlier, scenarios provide an excellent way to bring stakeholders together and elicit discussion and decisions on roles and responsibilities.

The first example begins with a diagram from the California Oregon Advanced Transportation System (COATS) regional ITS architecture in Figure 9. An animated version of this diagram was used to walk through a winter storm scenario and elicit discussion and feedback from stakeholders in workshops in the COATS study area.

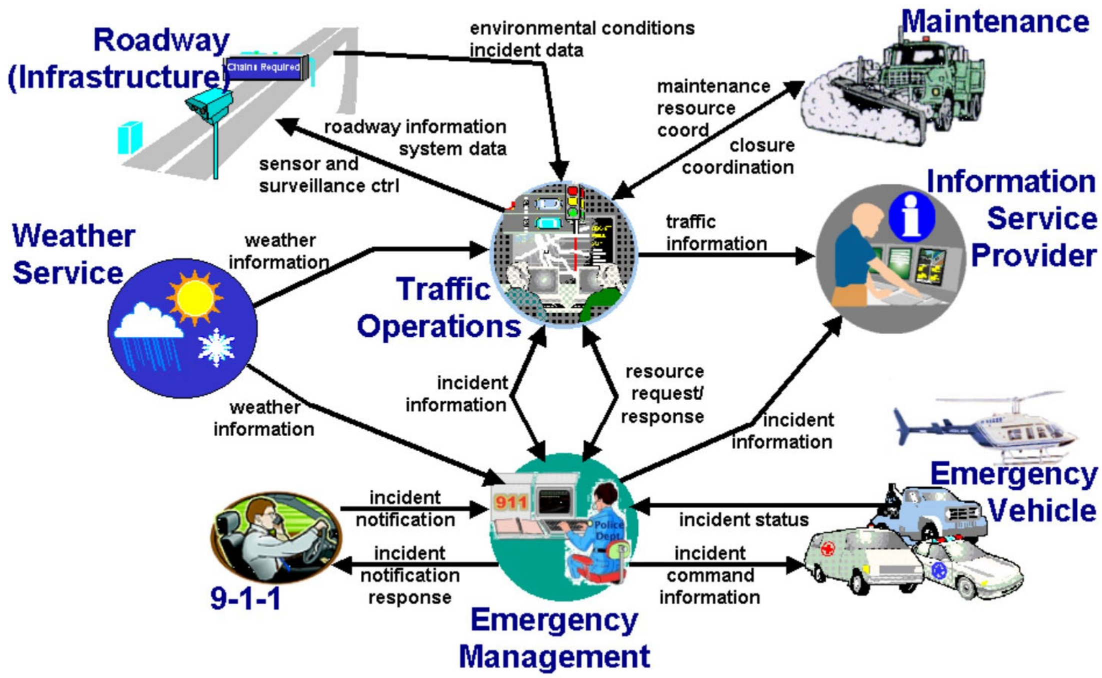


Figure 9: Example Operational Concept Scenario: "COATS Winter Scenario"

The workshops provided an opportunity for agencies in the region to see (and clarify) where they fit in the regional transportation system and discuss their roles in more detail against the backdrop of a major winter storm scenario. Based on input from these workshops, an operational concept depicting the high-level roles and responsibilities of each organization could have been documented, consistent with the Rule/Policy. Table 7 is a generic table that illustrates a reasonable level of detail that might be specified for a winter storm scenario operational concept based on workshops like the COATS workshops. Note that high-level roles and responsibilities are identified for the fictional organizations in this example, with focus on those roles and responsibilities that have inter-jurisdictional impact. Also note that organizations are grouped where their high-level roles and responsibilities are identical for a particular service or scenario.

Table 7: Winter Storm Roles and Responsibilities (Conceptual)

System Category	Organization	Representative Roles/Responsibilities
Traffic Operations And Maintenance	**State DOT**	• Monitor and provide road weather information to other operating agencies • Share forecasts with county and city maintenance departments • Maintain "*StormWatch*" Web Site and 511 Traveler Information Center • Operate maintenance resource database
	Wasatch County **Highland County**	• Monitor and provide county road condition info to county sheriff and State DOT • Provide snow plow operations info to county sheriff and State DOT • Subscribe/keep maintenance resource database up to date
	City of Wasatch Falls **City of Highview**	• Provide snow plow operations info to city police and county sheriff • Subscribe/keep maintenance resource database up to date
Emergency Management	**State Police**	• Statewide radio system O&M • State highway road closures – report to all operating agencies, Media • Incident response – first responder
	Wasatch County Sheriff **Highland County Sheriff**	• County road closures – report to State DOT, state police, and county sheriff • Incident response – first responder
	. . .	•

Example 2: Puget Sound Market Package Based Approach
The Puget Sound Regional ITS Architecture uses market packages as a basis for operational concepts. In this architecture, the market packages that were selected by each agency in the region were evaluated, and operational concepts were developed for market packages that required jurisdictional coordination. Market packages that did not require coordination between organizations were judged to constitute operational concepts in of themselves for each individual agency that selected the market package.

Of the selected market packages, nine were identified as requiring jurisdictional coordination and detailed operational concepts. In addition, operational concepts were developed for several other overarching projects including an ITS Backbone Project and a Regional Multi-Modal Traveler Information Center Project. An example of an operational concept that was based on the "Transit Passenger and Fare Management" market package is shown in Figure 10.

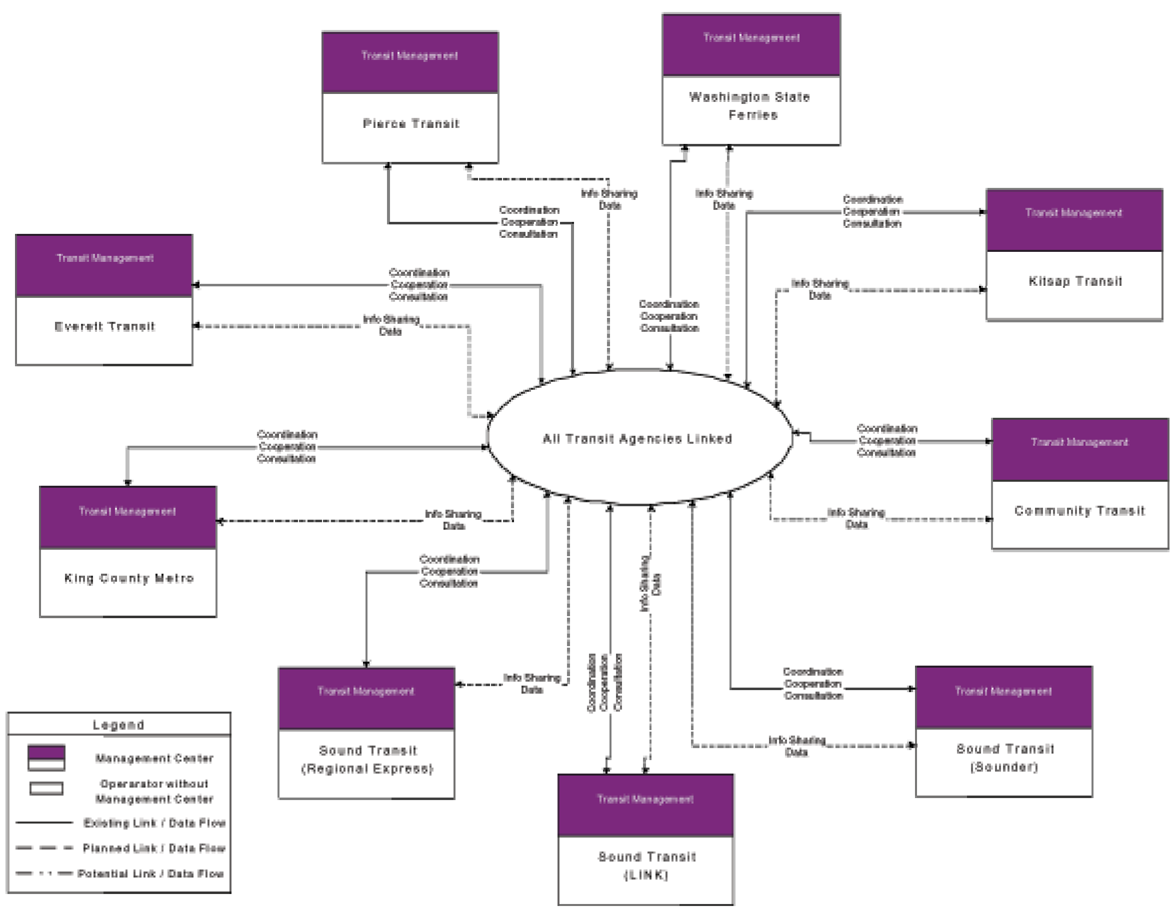


Figure 10: Puget Sound Transit Fare Management Operational Concept

The figure identifies all transit agencies that will be involved in coordinated management of transit fares in the region. As shown, the existing coordination, cooperation, and consultation between transit agencies will be supplemented by information sharing (the exchange of data) in the future. The figure is also supported by a brief textual description of the concept:

Transit Fare Management
The implementation of a Regional Smart Card based system will allow customers to use one fare card on multiple systems throughout the region and will support linked trips between transit, ferries and rail alike. The smart card based system will utilize a wireless data communications process at applicable operating bases and a central clearinghouse where all smart card-generated trip data and revenue are reconciled for the region. Transit fare payment data will be collected from vehicles at the maintenance bases for each transit agency, passed to the regional clearinghouse for processing, and then returned to each transit agency for their internal use. The current plans for the Regional Smart Card will support common equipment throughout the region.

Example 3: New York and Southern Ontario Custom Market Packages
The New York and Southern Ontario regional ITS architecture includes customized market packages that define operational concepts for each stakeholder organization and every market package that was selected for the region. Figure 11 is a customized market package that was developed for the Niagara Frontier Transportation Authority (NFTA) that defines the operational concept for transit signal priority for its fixed route busses.

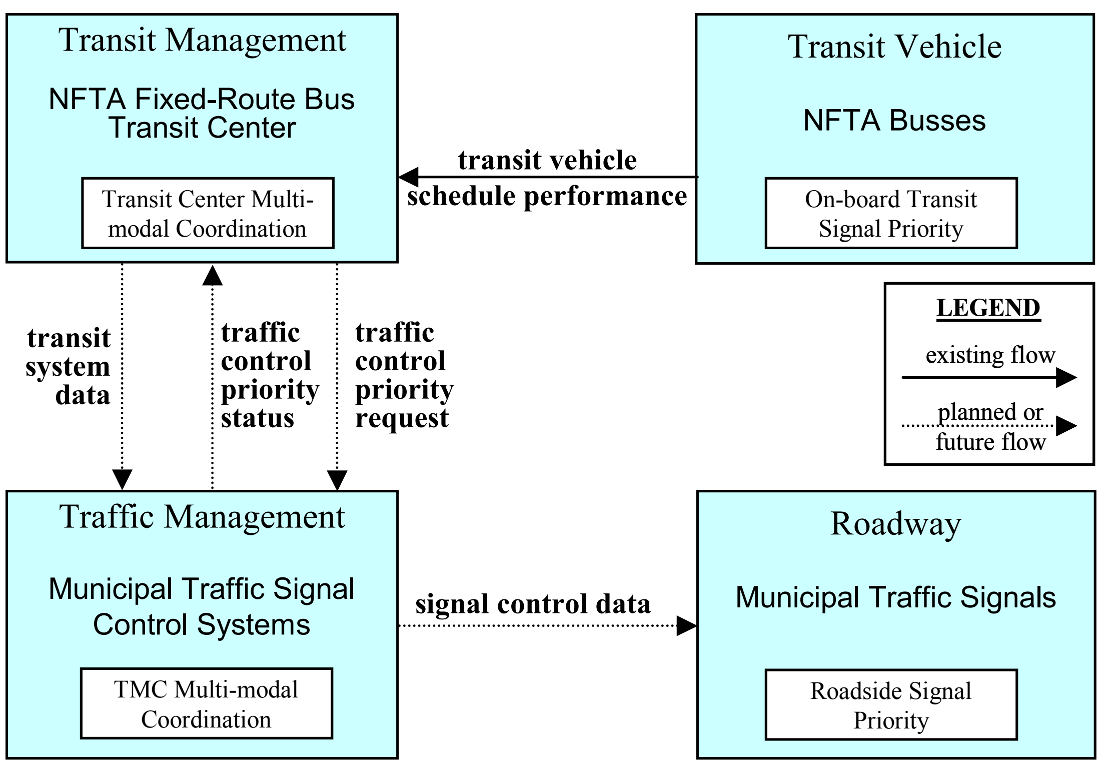


Figure 11: Niagara Frontier Transportation Authority Signal Priority

The customized market package documents a consensus decision by the NFTA and the affected municipalities to use center-to-center communications to support signal priority. Under this concept, the NFTA Fixed Route Bus Transit Center will monitor bus schedule performance and passenger occupancy. The transit center will identify busses that are behind schedule and have sufficient occupancy to warrant a request to the relevant Municipal Traffic Signal Control System(s) for signal priority.

The stakeholders considered other operational concepts for transit signal priority, such as an architecture based on direct dedicated short-range communications from the busses to the roadway signal control equipment. The decision to use the center-to-center approach was made to avoid additional equipment on the busses and signal control equipment, given the existing commitment to transit automated vehicle location (AVL) and closed loop signal control for the municipal traffic signal control systems in the region.

The operational roles and responsibilities identified in the customized market package graphic can also be presented as shown in Table 8. Institutional roles and responsibilities are also implied since the agency identified in each row will procure, operate and maintain the associated equipment. Note that the roles and responsibilities are defined at a more detailed level in this example, reflecting additional analysis and architectural precision than previous examples.

Table 8: Roles and Responsibilities for NFTA Fixed Route Bus Signal Priority

ITS Element	Agency	Role/Responsibility
Fixed Route Busses	NFTA	• Determine vehicle location • Send location to NFTA Fixed Route Bus Transit Center • Maintain Passenger Count • Send Passenger Count to NFTA Fixed Route Bus Transit Center
Fixed Route Bus Transit Center	NFTA	• Receive Bus location and occupancy information from busses • Determine which busses are behind schedule and which need to be brought back into schedule conformity • Where appropriate (based on schedule slippage and "sufficient" passenger occupancy), issue an message to the appropriate Municipal Traffic Signal Control System to extend the green cycle

Table 8: Roles and Responsibilities for NFTA Fixed Route Bus Signal Priority

ITS Element	Agency	Role/Responsibility
		for the busses anticipated turning movements at the intersection(s) the bus is approaching.
Signal Control System	Municipal Agencies in NFTA service area	• Receive requests for alternative traffic signal control cycle timings from NFTA, and direct appropriate field equipment to execute said timings when appropriate. *Note: Municipal Agencies have the prerogative to ignore signal priority requests where they deem that the negative impact on opposing traffic justifies ignoring the request.* • Advise the NFTA Transit Center of action taken.
Traffic Signals	Municipal Agencies in NFTA service area	• Receive requests for alternative traffic signal control cycle timings, and execute said timings as directed.

STEP #2: GATHER DATA –Functional Requirements

These tasks may be performed in parallel.	• Inventory Systems • Determine Needs and Services • Develop Operational Concept • **Define Functional Requirements**
OBJECTIVES	• Develop a high-level description of the required functionality for each system in the inventory.
PROCESS *Key Activities*	• Determine the level of functional requirements specification that is appropriate for the region. • Identify the systems that require functional requirements definition. Systems that are on the boundary of ITS (e.g., financial institutions) do not have to be functionally defined since they are not bound by (or even aware of) the regional ITS architecture. • Build on the ITS service choices and operational concept to define functional requirements, focusing on those with regional implications. • Use the National ITS Architecture (Subsystems, market packages, equipment packages, process specifications) if desired to support the functional requirements development. • Using the information gathered in the previous steps, document the functions required to support the services the stakeholders decided to provide for the region. <u>Building Consensus</u> • Stakeholders should participate in the functional requirements development so that the functions are accurately defined and the stakeholders support the requirements that will be levied on their systems.
INPUT *Sources of Information*	• Inventory, ITS services, and operational concept identified in previous steps. • Information exchanges defined in following steps if more detailed functional requirements are to be defined.
OUTPUT *Results of Process*	• Documented system functional requirements for each ITS system in the inventory

4.4 Define Functional Requirements

In this step, the tasks or activities (the “functions”) that are performed by each system in the region are defined, documenting the share of the work that each system in the region will do to provide the ITS services.

System functional requirements are one of the required components of a regional ITS architecture as identified in FHWA Rule 940.9(d)5 and FTA National ITS Architecture Policy Section 5.d.5.

Don’t assume that the federal requirement for “system functional requirements” is an implied mandate to use structured analysis methods to develop each system in the region. The functional requirements are high-level descriptions of what the systems will do, not detailed design requirements. A region can choose to develop their systems using object-oriented analysis, functional analysis, or whatever methodology they choose. The real objective of a regional ITS architecture is to clearly define interfaces and the responsibilities on both sides of the interface, and keep the implementation details (and methodology) used by any particular system as transparent as possible.

4.4.1 Functional Requirements Process

Before writing the first functional requirement, determine the appropriate level of detail for the functional requirements. The level of detail is established for each regional ITS architecture based on the needs of the region. It’s up to you!

While some regions may have unique objectives that demand more detailed specifications, very detailed functional requirements specifications within a regional ITS architecture can be counterproductive. Detailed specifications will increase the regional ITS architecture development and maintenance effort and they aren’t really required until project definition begins. Unless there are special circumstances in your region, consider keeping the functional requirements specifications at a high level in the regional ITS architecture, and let the experts in the particular application area develop more detailed specifications when it is time to actually design and build projects.

In general, the functional requirements should be easy to write because they should follow directly from the ITS service decisions, operational concept, and interface choices made in other process steps. If many arbitrary decisions are required to complete the functional requirements, there is probably excessive detail in the requirements.

To begin to zero in on the right level of detail, think about the motivation for writing the functional requirements in the first place. You are trying to specify the things that a system must do in order to “hold up its end of the bargain” in the regional ITS architecture. Even if it is high-level, the specification must still be complete. That is, it must list all the things that the system must do. Also, it shouldn't list things that the system is not required to do.

Let's consider an example where the stakeholders have decided that the State DOT system will make CCTV camera images available to several different operational users in the region. An extremely high level specification for the state DOT system could be that the system "shall manage traffic". This functional requirement is clearly too vague because it doesn't tell the State DOT that it has to share CCTV camera images, and it may also imply that the State DOT should perform traffic management functions that were never intended. On the other extreme, the specification might go too far and start to identify performance requirements or specify technology. The functional requirements should only specify WHAT the system has to do; they should not specify performance (how fast, how many) or how the system will implement this capability. An appropriate set of functional requirements for this example might be:

- The system shall make CCTV camera images available to operational users (list here) and the media.
- The system shall provide the capability to selectively disable camera images, preventing their distribution to the media in special circumstances.
- The system shall selectively provide access to camera control (pan, tilt, zoom) to the operational users.

Another consideration is the scope or visibility of the requirements. Consider limiting the requirements to functions that have regional impact. Returning to the CCTV camera image example, the state DOT may also want to save camera images for a limited time for its own internal purposes and then discard them. This functionality does not have to be specified in the regional ITS architecture because it has no impact beyond the State DOT. If the State DOT does not implement this function, there will be no negative impact on the ITS integration for the region. Following this guideline, most of the functions that will be specified will focus on supporting interfaces between systems.

As a rule of thumb, a system's functional requirements and interface definition should be specified at about the same level of detail. For example, a system that generates and receives 10 different information flows might include about the same number of functional requirements that describe the high-level functions the system performs to exchange this information. As will be seen in section 5, the architecture flows defined by the National ITS Architecture represent the typical level of detail used in regional ITS architecture interface definitions. For example, "incident information" is an architecture flow that is used in most regional ITS architectures. Since the architecture flow identifies incident information in general, the functional requirements should be at about the same level of detail and generally specify each system's responsibility for incident information sharing. The requirements need not specify more detailed functions (e.g., who will time stamp the incident, how will a measure of incident severity be assigned and modified) that deal with more detailed components of a particular information flow. To improve consistency in the level of detail between functional requirements and interface definition, the architect may iterate between the two process steps. This iteration is a normal part of the process.

Functional requirements do not have to be written for every system in the inventory. As discussed in section 4.1, an inventory will normally include ITS systems (systems that implement ITS functions) and systems on the boundary of ITS that don't directly provide transportation services, but do exchange information with ITS systems. The classic example of a system that is on the boundary is a financial institution that interfaces with ITS systems to support financial transactions. In general, a regional ITS architecture should include functions for ITS systems and should not include functions for systems on the boundary.

This implies that an architectural boundary must be established to determine where functional requirements are needed. There are several ways to establish this boundary.

1. Perhaps the best approach is to consider whether each system in the inventory will be implemented or enhanced with ITS projects implemented by the region's stakeholders. Systems that are implemented or enhanced with ITS projects are inside the ITS boundary and should include functional requirements. This may be the most definitive criteria for a regional ITS architecture boundary since this reflects one of the best uses for functional requirements…they are a starting point for ITS project specification.
2. Is the system in this region, or in another region that is subject to the requirements of another regional ITS architecture? Systems in other regions probably should not be functionally specified.
3. Consider the services that are provided by the system. If the system provides surface transportation-related services, then it is probably inside the architecture boundary and should be supported by functional requirements.
4. Review how the system was mapped to the National ITS Architecture. Systems that map only to National ITS Architecture terminators may be on the boundary; systems that map to National ITS Architecture subsystems may be inside the boundary and include functional requirements. This approach works as long as the regional ITS architecture boundary exactly coincides with the National ITS Architecture boundary, but this is sometimes not the case. Apply this rule only in conjunction with the above criteria.

4.4.2 Functional Requirements Resources and Tools

Nat'l Arch

The National ITS Architecture is a good source for functional requirements that may be selectively used in a regional ITS architecture. The physical architecture includes general descriptions for each subsystem that provide an overall summary of what ITS systems do. At the next level of detail, equipment package descriptions include slightly more precise descriptions for a particular subsystem that is supporting a particular service. Very detailed functional process specifications are available in the Logical Architecture. All levels of descriptions are linked in the hypertext architecture on the web site and CD, allowing easy navigation between the levels of detail. The National ITS Architecture is available on CD-ROM and on-line at http://www.iteris.com/itsarch.

Although Turbo Architecture does not directly support functional requirements specification, it does provide several related features that may be of use. Each inventory element includes a description field that could be used to hold functional requirements entered by the user. Turbo also allows the user to associate each inventory element with National ITS Architecture subsystems and market packages. By directly accessing the Turbo Architecture Microsoft Access database, those familiar with Microsoft Access and the National ITS Architecture databases can use the relationships created by Turbo to generate initial specifications based on subsystem descriptions, equipment package descriptions, or even Logical Architecture process specifications.

4.4.3 Functional Requirements Outputs

Basic Approach

High-level textual functional requirements can be prepared that describe WHAT each ITS system does to support the ITS services that have been selected for the region. The requirements would be a list of "shall statements" that define each major function that is performed by the system, focusing on those functions that have implications for regional integration. Systems that are on the boundary of the regional ITS architecture and have no functional requirements specification would also be identified

Using the National ITS Architecture

The rich set of textual descriptions and functional requirements included in the National ITS Architecture can be used to support the system functional requirements specified for each system.

For example, a region could use market packages to identify at a high level the services and functions that will be provided by each element in the inventory. Following this approach, equipment packages, which include the functions that must be performed by a particular subsystem to support a particular market package, would be used to identify high-level functions for each element in the inventory that maps to a subsystem.

If more detailed specifications are required, the analyst can use the Logical Architecture of the National ITS Architecture to support an ITS Functional Requirements analysis. Each stakeholder element mapped to a National ITS Architecture subsystem can have its input, processing and output relationships described based on National ITS Architecture Process Specifications. The Process Specifications should be selected, tailored, and augmented so that the functional requirements represent precisely what the system will do.

4.4.4 Functional Requirements Examples

There are relatively few examples of functional requirements that have been developed specifically for regional ITS architectures. This section presents a few of the best existing examples, and then augments these examples to illustrate some of the ways that functional requirements may be specified.

Example 1: High-Level Functional Requirements

A functional requirements example output from the Florida District 3 regional ITS architecture is shown in Figure 12. The equipment package names and descriptions from the National ITS Architecture describe the overall functionality of the Tallahassee Transportation Management Center. The equipment packages were identified based on the market package and subsystem associations that were originally created in Turbo Architecture.

While they are not written in formal requirements “shall” language, the equipment packages define high-level capabilities that provide an excellent starting point for development of top-level functional requirements. It is relatively straightforward to take the definitions of the Equipment Packages from the National ITS Architecture and construct high level, but still formal, functional requirements "shall" language. Building on the equipment package descriptions in Figure 12, the high-level functional requirements might be:

Functional Requirements for the City of Tallahassee Transportation Management Center (TMC)

- The TMC shall collect, store, and provide electronic access to the traffic surveillance data.
- The TMC shall monitor highway-rail intersection (HRI) equipment at the roadside, which manages highway traffic.
- The TMC shall provide strategic coordination with rail operations
- The TMC shall provide the capability for its traffic managers to detect and verify incidents. This capability includes analyzing and reducing the collected data from traffic surveillance equipment, including planned incidents and hazardous conditions.
- The TMC shall provide the capability for an incident response formulation function minimizing the incident potential, incident impacts, and/or resources required for incident management including proposing and facilitating the dispatch of emergency response and service vehicles as well as coordinating response with all appropriate cooperating agencies.
- …

City of Tallahassee Transportation Management Center Equipment Packages

District 3

The following National ITS Architecture equipment packages are associated with the "City of Tallahassee Transportation Management Center" element. Select the "Details" icon to see the detailed process specifications that support each equipment package, or consult the National ITS Architecture web site for more information.

Collect Traffic Surveillance Details
This Equipment package collects, stores, and provides electronic access to the traffic surveillance data.

HRI Traffic Management Details
This equipment package monitors highway-rail intersection (HRI) equipment at the roadside which manages highway traffic. Various levels of roadside equipment may be interfaced to, and supported by, this equipment package to include standard speed active warning systems and high speed systems which provide additional information on approaching trains and detect and report on obstructions in the HRI. This equipment package remotely monitors and reports the status of this roadside equipment. A two way interface supports explicitly status requests or remote control plan updates to be generated by this equipment package. Status may also be received periodically in the absence of a request or asynchronously in the event of a detected failure or other unsafe condition at the intersection.

Rail Operations Coordination Details
This equipment package provides strategic coordination between rail operations and traffic management centers. It receives train schedules, maintenance schedules, and any other forecast events which will result in highway-rail intersection (HRI) closures from Rail Operations. The provided information is used to develop forecast HRI closure times and durations which may be applied in advanced traffic control strategies or delivered as enhanced traveler information. This equipment package includes the processing and algorithms necessary to derive HRI closure times and the communications capabilities necessary to communicate with rail operations and interface to the traffic control and information distribution capabilities included in other Traffic Management Subsystem equipment packages.

TMC Incident Detection Details
This Equipment package provides the capability to traffic managers to detect and verify incident. This capability includes analyzing and reducing the collected data from traffic surveillance equipment, including planned incidents and hazardous conditions.

TMC Incident Dispatch Coordination/Communication Details
This Equipment package provides the capability for an incident response formulation function minimizing the incident potential, incident impacts, and/or resources required for incident management including proposing and facilitating the dispatch of emergency response and service vehicles as well as coordinating response with all appropriate cooperating agencies.

Figure 12: Equipment Packages Define ITS System Functionality

Example 2: Detailed Functional Requirements

The region may decide to define more detailed functional requirements. Figure 13 shows the next level of detail that is provided in the Florida District 3 architecture for each equipment package. The figure shows the equipment package name, its description, which other ITS elements in the regional ITS architecture also use the same equipment package, and a listing of the Logical Architecture processes that are allocated to the equipment package. This example illustrates that fairly detailed functional requirements from the process specifications in the National ITS Architecture could be incorporated into a regional ITS architecture.

Collect Traffic Surveillance Equipment Package

District 3

Description:	This Equipment package collects, stores, and provides electronic access to the traffic surveillance data.
Included in:	Bay County Transportation Management Center City of Pensacola Traffic Management Center City of Tallahassee Transportation Management Center Escambia County Traffic Management Center Escambia/Santa Rosa County Multimodal Transportation Operations Center FDOT District 3 Tallahassee Transportation Management Center FDOT District 3/FHP Pensacola Transportation Management Center Okaloosa County Transportation Management Center Traffic Signal Control Systems Turnpike Traffic Management Centers Walton County Transportation Management Center
Processes:	1.1.2.1 Process Traffic Data for Storage 1.1.2.2 Process Traffic Data 1.1.2.3 Update Data Source Static Data 1.1.4.1 Retrieve Traffic Data 1.1.4.2 Provide Traffic Operations Personnel Traffic Data Interface 1.1.4.4 Update Traffic Display Map Data

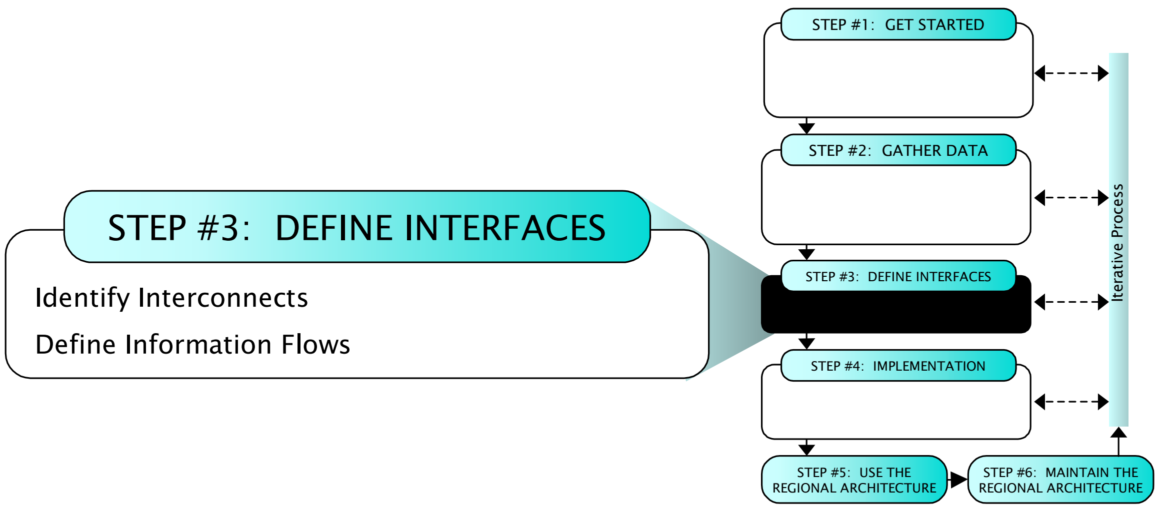
Figure 13: Example Equipment Package Presentation with Processes

Building on Figure 13, the detailed requirements contained in the process specifications can be copied from the National ITS Architecture. The actual "shall" language in the body of one of the Process Specifications referenced in Figure 13 is as follows:

> 1.1.2.2---Process Traffic Data (PSpec)
> Overview: This process shall receive and process data from sensors (both traffic and environmental) at the roadway. The process distributes data to Provide Device Control processes that are responsible for freeway, highway rail intersections, parking lot, surface street and freeway management. It also sends the data to another Provide Traffic Surveillance process for loading into the stores of current and long term data. Information about the various sensors to aid in this processing and distribution of data is accessed from the data store static_data_for_sensor_processing…

Like any part of the National ITS Architecture, the specific language in these detailed Process Specifications must be reviewed and edited when necessary for local stakeholder requirements. This detailed analysis of Process Specifications is usually best deferred to project design.

Section 5 Define Interfaces



This section describes the "Define Interfaces" step in the regional ITS architecture development process.

At this point, the ITS systems in the region have been identified and defined in terms of the functions that they perform. In the "Define Interfaces" step, these systems are interconnected and the information that flows between the systems is defined. These interface definitions build on the general integration strategy that was described in the operational concept developed in the previous step.

In this section, the "Identify Interconnects" and "Define Information Flows" process tasks are described in detail. Each task description begins with a one page summary that is followed by additional detail on the process, relevant resources and tools, a general description of the associated outputs, and example outputs where they are available. Each task description also includes tips and cautionary advice that reflect lessons that have been learned in development of regional ITS architectures over the past several years.

STEP #3: DEFINE INTERFACES –Interconnects

These tasks may be performed in parallel or in sequence.	• **Identify Interconnects** • Define Information Flows
OBJECTIVES	• Identify and document the existing and planned connections between systems in the region. • Ensure the stakeholders associated with each interface agree with the connections that are identified.
PROCESS *Key Activities*	<u>Prepare</u> • Review existing connections between ITS Systems <u>Identify Connections</u> • Based on the inventory, services, operational concept, and functional requirements, identify inventory elements that will exchange information. • Consider whether existing person-to-person connections may evolve into automated interfaces between ITS systems. • Document the high-level status for each connection (existing or planned). • Use the National ITS Architecture to identify potential connections; add custom connections as necessary. <u>Build Consensus</u> • Review connections and ensure stakeholders agree with the identified interfaces for their ITS systems. • Change connections and iterate until stakeholders are satisfied with the interconnections.
INPUT *Sources of Information*	• Stakeholders • Current regional communications or network architecture strategy, ITS Plans and Studies, TIP, STIP, SIP, etc. • Inventory of existing and planned ITS elements in the region (from Step #2). • Regional needs and services, operational concept, and functional requirements (from Step #2)
OUTPUT *Results of Process*	• List of existing and planned interconnects in the region.

5.1 Identify Interconnects

This is one of the defining moments in the regional ITS architecture development process. The region's systems have been defined, the regional needs and services are understood, and an operational concept has identified the integration opportunities in the region in a broad sense. In this step, the connections between ITS systems are identified, creating a "framework for integration" that will support the exchange of information between ITS systems.

Interface requirements and information exchanges with planned and existing systems are a required component of the regional ITS architecture as identified in FHWA Rule 940.9(d)6 and FTA National ITS Architecture Policy Section 5.d.6.

5.1.1 Interconnect Process

The inventory, needs and services, operational concept, and functional requirements lay the groundwork for evaluation of which ITS Systems should connect to each other. Based on this information and any documentation that may describe existing communications in the region, a preliminary set of connections can be identified.

All that is being identified at this point are connections or "interconnects" between ITS systems. The specific information that is exchanged on each interconnect is not defined until the next step in the process.

While this two-step "interconnects and then information flows" process for defining interfaces is not mandatory, experience shows that it is usually faster and easier to define interconnects first before specifying information exchanges. One reason to start with interconnects is that there are many more potential information exchanges than there are interconnects. The difference may be an order of magnitude – for example, 1000 potential interconnects vs. 10,000 potential information flows in a large regional ITS architecture. Typically, only 20-30% (or approximately 200 to 300) of the valid interconnects will actually be selected for the region, effectively reducing the number of information flows that must be considered by 70-80%. Clearly, it is an iterative process, but use this Interconnect step to filter out all of the unwanted connections as early in the process as possible.

Beginning with a preliminary set of interconnects, the stakeholders involved assess whether the interconnects would help support the needs and services of the region. Consider whether the connection exists today, or whether it is planned for the future. Often, a communications or network architecture is already in place between major "centers" in the region. Make sure the network can accommodate the connections identified in this step.

When most of the major stakeholders are present, concentrate primarily on evaluating the potential connections between centers, as those are most likely to cross agency or public/private boundaries. Since an agency typically owns its own center and respective roadside or vehicle assets, the connections to those items really require only the evaluation of the affected stakeholder, and not the stakeholder group at large. Consider handling these non center-to-center interconnections outside of general region-wide meetings.

Consider the existing connections between various stakeholder agencies, companies, or groups as the regional ITS architecture interconnects are defined. Many of these existing connections will be voice communications between people, either by telephone or face-to-face due to co-location of agencies such as public safety and traffic management agencies. There are two different schools of thought on how these interconnects between people should be shown in the regional ITS architecture:

1. Some regional ITS architectures only show the exchange of data between systems. These architectures focus on technical integration of systems, so they do not include voice interfaces that have no potential for conversion to, or augmentation with, data communications between two systems. In this case, only voice connections between people that may someday be supplanted or supported by data connections between systems are shown in the architecture as planned interconnects.
2. In other regional ITS architectures, the stakeholders have decided to show existing voice communications between systems, even where those connections will not be replaced by, or supplemented with, data communications in the foreseeable future. These architectures document the institutional integration as well as the technical integration in the region.

Each region should decide how voice communications should be handled in the architecture. If voice-only connections are identified in the architecture, then they should be distinguished from the data connections to avoid confusion. When voice communications are identified that "will never be replaced with data communications", the benefits of data communications can be discussed with the group – the speed, reliability, and ability to distribute data to many points are powerful motivations for augmenting voice communications with data communications on many interfaces over time.

5.1.2 Interconnect Tools

The National ITS Architecture identifies connections between architecture entities (subsystems and terminators). Since the ITS System Inventory created in Step #2 included the mapping of each system to a National ITS Architecture entity, the framework of interconnects offered by the National ITS Architecture can serve as a starting point by identifying potential connections between each of those ITS systems. It is recommended that these connections be evaluated based on the services, or "market packages", the region desires to support.

Turbo Architecture was designed to identify connections between ITS systems or "elements" in the inventory that support selected services or "market packages". Although the tool identifies all potential connections between ITS systems based on the National ITS Architecture, it pre-selects those connections required to support the desired services. The tool facilitates selection or elimination of connections during stakeholder meetings by providing customization tables with a checkbox for each potential connection. Careful assignment of ITS systems to market packages assists Turbo Architecture in pre-selecting interconnects more accurately. In general, the more closely the market package matches the desired regional service, the better Turbo's interconnect pre-selection algorithms will work.

5.1.3 Interconnect Output

A regional ITS architecture set of interconnects is a collection of all existing and planned interconnects between ITS Systems in the region. This output should include each pair of interconnected ITS Systems, together with the high-level status of that interconnection (e.g., existing or planned). A brief description or assumptions may be added if desired.

Regional ITS architecture interconnects can be shown as a list of ITS system pairs, indicating those that are included in the regional architecture, or as a diagram that allows one to see the connections "at a glance". Since maintenance of the regional ITS architecture is important, it's advisable to select a form that is easily maintained.

A particularly useful means for displaying the interconnections is a diagram showing all of the connections between ITS Systems in the region. For large inventories, this may prove too cumbersome to maintain and for these, consider including only "center" type ITS Systems (Traffic Operations Center, Transit Operations Center, etc.) in the diagram.

A subset of the interconnect list can be presented as a diagram for each stakeholder, illustrating all of the connections between the stakeholder's system(s) and other ITS Systems in the region. This has proven to be an invaluable explanatory tool for illustrating the benefits of creating a regional ITS architecture to agency or company executives.

5.1.4 Interconnect Examples

Regional ITS architecture interconnects have been published in a variety of tabular and graphical formats. The range of outputs that have been published reflect a spectrum of choices in the tradeoff between output legibility/ accessibility and ease of development and maintenance. Custom diagrams are easy to understand, but somewhat difficult to develop and maintain. On the other end of the spectrum, a simple list of interconnects is easy to generate, but somewhat difficult to decipher for the uninitiated. The following examples illustrate the range of interconnect outputs that can be generated.

Example 1: Sausage Diagram

Figure 14 shows an example high-level interconnect diagram for the Greater Yellowstone Rural ITS (GYRITS) Priority Corridor. The diagram presents the key interconnects in the region in an easy-to-understand “sausage diagram” format. A format like this is attractive and accessible to stakeholders, but it requires more development and maintenance effort than the computer-generated examples that follow.

As with all “sausage diagram” presentations of interconnects, **Figure 14** also may imply more connectivity than will actually be used in a region. For example, a reader might infer that “transit operations centers” can communicate with “emergency vehicle systems” because the “Trunked/Dedicated Radio Systems” sausage is shown as a common wide area wireless resource for the region. Of course, the regional implementation will not include (and may actively preclude) this option. As long as care is taken in interpreting a sausage diagram, they have proven to be one of the most useful top-level explanations of architecture connectivity.

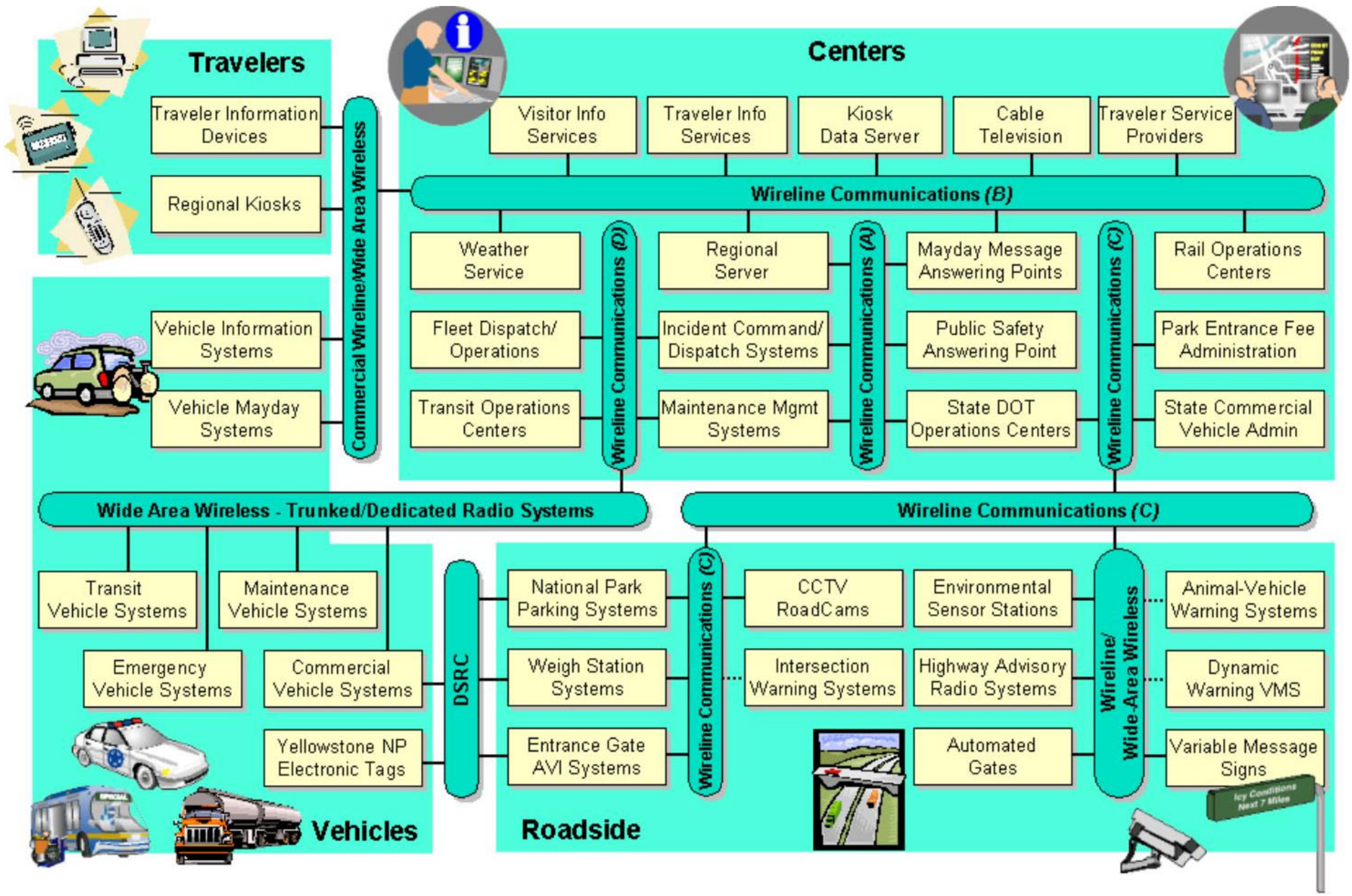


Figure 14: Greater Yellowstone Rural ITS Architecture Interconnect Diagram

Example 2: Architecture Interconnect Diagram
A representation of the Albuquerque regional ITS architecture interconnects for the Albuquerque Police Department that was generated using the Turbo Architecture tool is shown in Figure 15. Each block represents an ITS inventory element, including the name of the stakeholder in the top shaded portion. The interconnect lines between elements are solid or dashed, indicating existing or planned connections. A diagram like this works well as long as a limited number of interconnects will be shown. Where twenty or more interconnects must be displayed, the diagrams become quite complex and can be difficult to read.

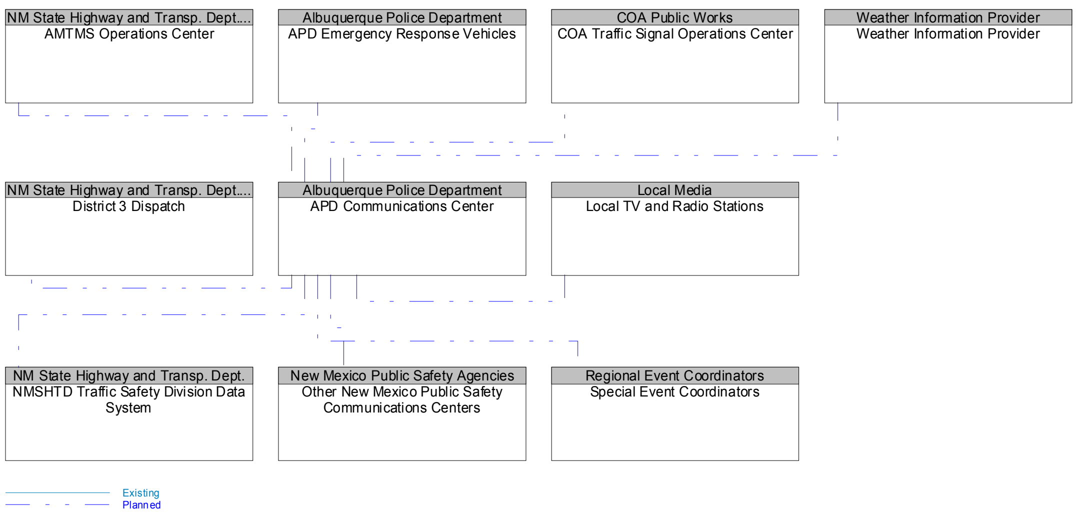


Figure 15: Albuquerque Regional ITS Architecture Interconnect Diagram

Example 3: Tabular List of Interconnects
A tabular list of interconnects also works well, particularly when many interconnects must be documented. An example of an interconnect table for the Metro TMC that is included in the Minnesota Statewide Architecture is shown in Table 9. This output was generated by extracting information from the Turbo Architecture Microsoft Access database and formatting it into a table. Note that an interconnect table does not show source and destination because interconnects are bi-directional. For example, the second row of the table shows an interconnect between Data Center and Metro TMC. Information may move in one direction (either Data Center to Metro TMC or Metro TMC to Data Center) or in both directions on this interconnect.

Table 9: Minnesota Statewide Architecture Metro TMC Interconnects (Draft)

Element	Element	Status
Broadcast Information Providers	Metro TMC	Existing
Data Center	Metro TMC	Planned
Division of Emergency Management Center	Metro TMC	Planned
Electrical Services Center	Metro TMC	Existing
Emergency Management Vehicle	Metro TMC	Existing
Event Promoters	Metro TMC	Existing
Inter-jurisdictional Traffic Management System	Metro TMC	Existing
Local Signal Center	Metro TMC	Planned
Maintenance Dispatch Center	Metro TMC	Existing
Metro TMC	Metro TMC_Roadside Equipment	Existing
Metro TMC	Metro Traffic Engineering Center	Existing
Metro TMC	National Weather Service	Existing
Metro TMC	Road Weather Information Center	Existing
Metro TMC	State Patrol Dispatch Centers	Planned
Metro TMC	TOCC	Existing
Metro TMC	Traveler Information Center	Planned

STEP #3: DEFINE INTERFACES –Information Flows

These tasks may be performed in parallel or in sequence.	• Identify Interconnects • **Define Information Flows**
OBJECTIVES	• Identify the information to be exchanged between systems. • Verify that the stakeholders that provide and consume the information agree with the identified information exchanges.
PROCESS *Key Activities*	Define Information Flows • Based on the interconnect decisions made by the stakeholders and the services, operational concept, and functional requirements created in Step #2, define the actual information content (information flows) exchanged on each interface. • Document the high-level status for each information flow (existing or planned). • Use the National ITS Architecture to identify potential information to be exchanged (termed “architecture flows”). • Identify auxiliary information flows that are not defined in the National ITS Architecture, but are important to your region. Validate Operational Concepts and Functional Requirements • While discussing the actual information to be exchanged, verify that assumptions made during creation of the initial operational concept and functional requirements remain valid.
INPUT *Sources of Information*	• Stakeholders • Interface Communications Documents (ICD) from all stakeholders’ systems, ITS Plans and Studies, project design documentation, etc. • Regional services and needs, operational concept, and functional requirements (from Step #2) • Interconnections (from Step #3)
OUTPUT *Results of Process*	• Definition of Information to be exchanged between ITS systems in the region.

5.2 Define Information Flows

Once stakeholders have agreed to exchange information between their respective ITS systems, the next step is to define the actual information that flows between the ITS systems in order to support the region's desired services.

Interface requirements and information exchanges with planned and existing systems is a required component of the regional ITS architecture as identified in FHWA Rule 940.9(d)6 and FTA National ITS Architecture Policy Section 5.d.6.

5.2.1 Information Flow Process

Now that the stakeholders have reached consensus on the interconnectivity of the ITS Systems in the inventory, they must define the information that must be exchanged, given the services to be supported.

Each information flow is fully described by a source element (where the information originates), a destination element (where the information is sent) and a descriptive name for the information itself. The high-level status of the information flow (e.g., existing or planned) should also be documented.

In addition to the timeframe specified earlier in the process, stakeholders should discuss the criteria that will be used to make information flow status assignments. What is the status assignment if…

- the information flow will evolve from voice to data exchange in the desired timeframe?
- the design (including specification of ITS standards) is complete, but actual deployment has not begun?
- funding is already programmed (assured)?

Although each region can define their own criteria for flow status assignments, a reasonable approach is to consider whether the regional ITS architecture will have any impact on the information flows that are somewhere between "existing" and "planned" because implementation has started. For example, if the interface design is complete and ITS standards decisions have already been made, then the information flow may be considered to be "existing" with respect to the regional ITS architecture, even if the interface may not yet be operational. Following this criteria, information flows that can be influenced by the regional ITS architecture are designated as planned. Flows for interfaces that have already been designed are identified as existing. This approach has the added benefit of extending the "grace period" after the architecture is completed when the flow status will still be accurate when compared to criteria that only consider whether the interface is operational.

For flows that do not exist, consider including gradations of “planned” flows. For example, “planned within 5 years”, “planned within 10 years”, and so forth.

It is often helpful to review the operational concept and services established earlier, and envision the possible scenarios in which information is exchanged. This exercise often brings to light any gaps in understanding the operational concept since it reconciles the information sent by the source ITS System with the information expected by the destination ITS System.

When most of the stakeholders are present, concentrate primarily on evaluating the information flows between centers, as those are most likely to cross agency or public/private boundaries. Since an agency typically owns its own center and respective roadside or vehicle assets, the information flows on those internal agency interfaces really require only the evaluation of the affected stakeholder, and not the stakeholder group at large. Consider handling these non center-to-center information flows outside the general meeting.

Many regions use “hubs” to tie centers together that share information. For example, all public safety agencies in a region might be connected to an “incident information and mutual aid” network. All information exchanges between the public safety agency systems would go through this hub, facilitating region-wide sharing of information between agencies.

In some regions, the stakeholders think of the hub as a key component of the regional transportation system and feel it is important to include the hub in the regional ITS architecture. Explicitly including hubs in the regional ITS architecture has an ancillary benefit in that architectures that include hubs normally have fewer connections and information flows to define and maintain than equivalent architectures that depict point to point connections between all systems served by a hub. Other regions may decide that a “hub” is really a part of the communications infrastructure implementation and therefore should not be reflected in the interfaces defined in the architecture. Both views are valid. The region’s stakeholders must decide which interpretation is best for their architecture.

There are a couple of factors to consider when deciding whether hubs should be included in the regional ITS architecture. One factor to consider is the functionality that the hub includes; a hub that implements ITS functions (e.g., data fusion) should probably be included in the regional ITS architecture while hubs that only implement communications functions (e.g., routing, protocol conversion, and data security) may be excluded at the stakeholders’ discretion. This brings us to the most important factor in making this decision: Meeting stakeholders' expectations for the architecture by making sure that it reflects the stakeholder's "natural" view of the systems in the region. If the hub is largely transparent to the transportation professionals and other stakeholders, then it probably should be transparent in the architecture. If it is viewed as an integral part of the overall regional system, then it should be included as an important part of the architecture.

When hubs are included in a regional ITS architecture, a few key points should be documented. First, clearly define the system as a hub and include the functions that it performs in the definition. Second, document any specific interconnectivity constraints (e.g., a given public safety agency can NOT talk to another public safety agency using the hub in the above example) so that these selective connectivity requirements are not masked by the broad general connectivity that is suggested by a hub.

5.2.2 Information Flow Resources and Tools

The National ITS Architecture identifies information flows between architecture entities (subsystems and terminators). In the National ITS Architecture terminology, information flows are referred to as "architecture flows". Since the ITS System Inventory created in Step #2 of the regional ITS architecture development process included the mapping of each system to a National ITS Architecture entity, the framework of architecture flows offered by the National ITS Architecture can serve as a starting point by identifying information to be potentially exchanged between each of those ITS systems. It is recommended that these information flows be evaluated based on the market packages, or services, the region desires to support.

Where architecture flows from the National ITS Architecture are not adequate to reflect stakeholder requirements, create new stakeholder-defined architecture flows.

Turbo Architecture identifies potential architecture flows, just as it created interconnects for the previous process step. The tool will identify (but not necessarily select) all potential architecture flows between ITS Systems based on the National ITS Architecture. Turbo Architecture will also select a set of architecture flows based upon the market packages selected. Careful assignment of ITS systems to market packages assists Turbo Architecture in selecting architecture flows more accurately. In general, the more closely the market package matches the desired regional service, the better the architecture flow selection. The tool facilitates selection or elimination of architecture flows during stakeholder meetings by providing customization tables with a checkbox for each potential flow.

5.2.3 Information Flow Output

A regional ITS architecture defines all existing and planned information flows between ITS Systems in the region. The information flow output should include all connected source and destination ITS elements, a descriptive name for the information flowing between them, and a high-level status of that information flow (existing or planned). A brief description or assumptions may be added if desired.

The diagram formats that work well for interconnects generally also work well for information flows, except that the number of ITS systems shown in the diagram will need to be limited to ensure legibility. There is no one-size-fits-all formula for picking the elements that should go on a particular diagram. The key is to pick natural subsets of the regional ITS architecture that are of a manageable (and presentable) size and then generate diagrams for those subsets. There are three types of subsets of information flows that have proven to be most useful in recent regional ITS architecture work:

1. Show flows between all of a particular stakeholder's ITS elements, such as a Traffic Operations Center, Roadside Field Equipment, Traffic Report Website, and Operations Personnel.
2. Show flows between a given stakeholder's "center" element and all other elements in the regional inventory.
3. Show all flows between "center" elements in the inventory. Large or highly interconnected inventories should be broken down into small subsets so that the diagrams are legible.

5.2.4 Information Flow Examples

Information flows for a regional ITS architecture can be shown as a list of source, destination, and information flow "triplets" or as a diagram that shows the same information exchanges as directed flows. In developing information flow outputs, the developer is faced with a classic "ease of development" versus "ease of use" decision. Since regional ITS architectures include many information flows, it is important to make the outputs as easy to develop and maintain as possible. The trade-off is that more automated outputs (tables or auto-generated diagrams) may be more difficult to use, particularly for the uninitiated, than custom crafted diagrams. The appropriate output format should be decided by balancing these considerations against the available resources and the amount and type of use that is anticipated for each output.

Example 1: Custom Information Flow "Context" Diagram

Figure 16 is an example of an information flow diagram taken from the Delaware Valley Regional Planning Commission (DVRPC) regional ITS architecture. The diagram shows the PENNDOT District Traffic Control Center in the "context" of all the interfaces and information flows that it will support. The shapes each represent a National ITS Architecture entity (subsystems in squares, terminators in ovals), and the lines connecting them are labeled architecture flows; the DVPRC opted to identify high priority flows (solid lines) and medium priority flows (dashed lines). Note that once the inventory elements and information flows have been mapped to National ITS Architecture entities and architecture flows, the latter terminology is typically used; therefore, these “information flow diagrams” are often called “architecture flow diagrams”. This diagram represents an investment of some time to handcraft the connections and add color to make the diagram attractive and easy to understand.

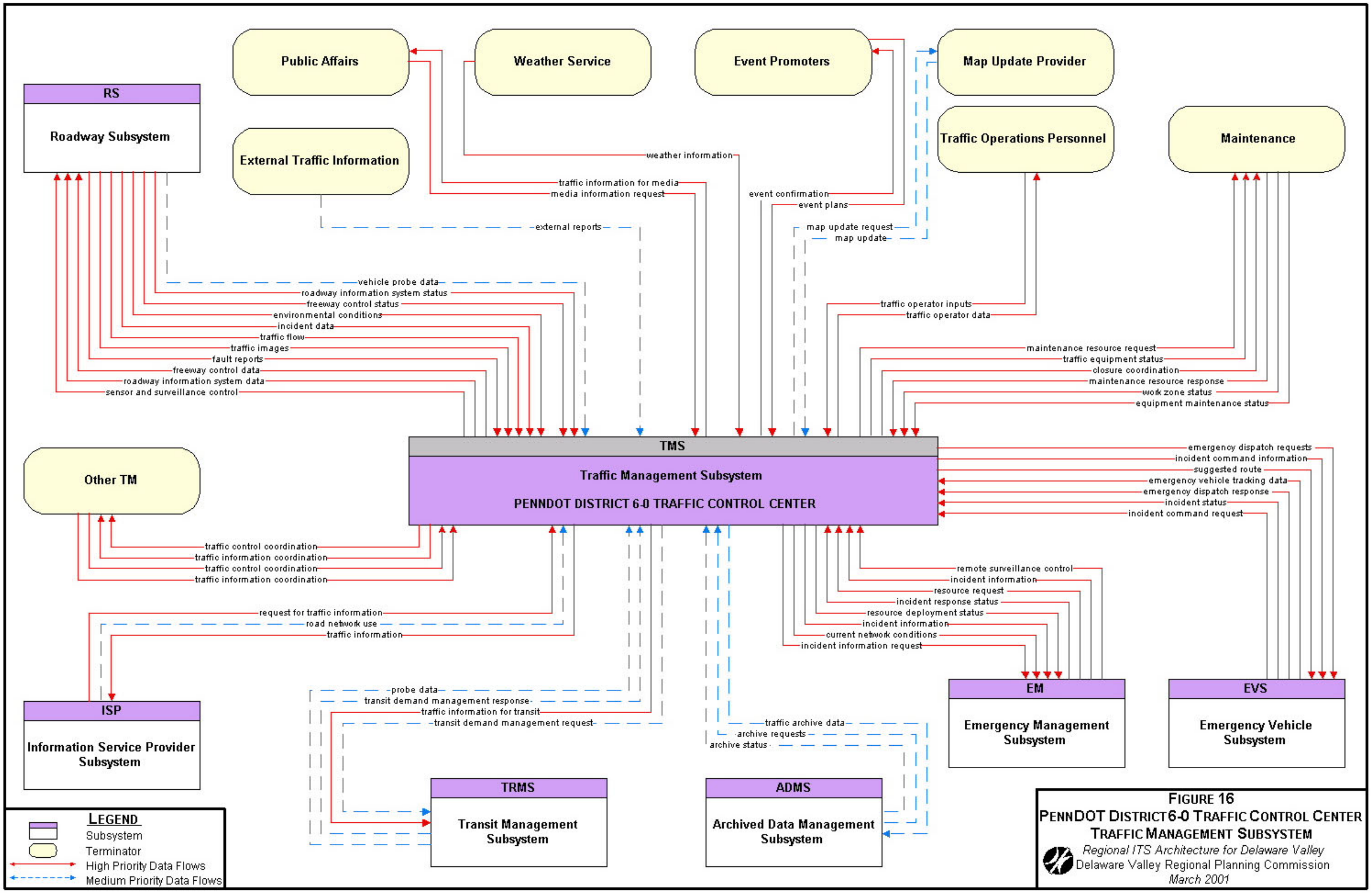


Figure 16: DVRPC Regional ITS Architecture Flow Diagram

Example 2: Auto-Generated Interface Specification Diagram
The example from the FDOT District 3 regional ITS architecture in Figure 17 shows the interface between the County Emergency Operations Centers and the City of Tallahassee Transportation Management Center. Note that each architecture flow is indicated as existing or planned using the solid/dashed line convention, and completely defined below the diagram as well. The diagram in this case is a standard Turbo Architecture diagram that can be automatically generated for any two systems in the Turbo inventory.

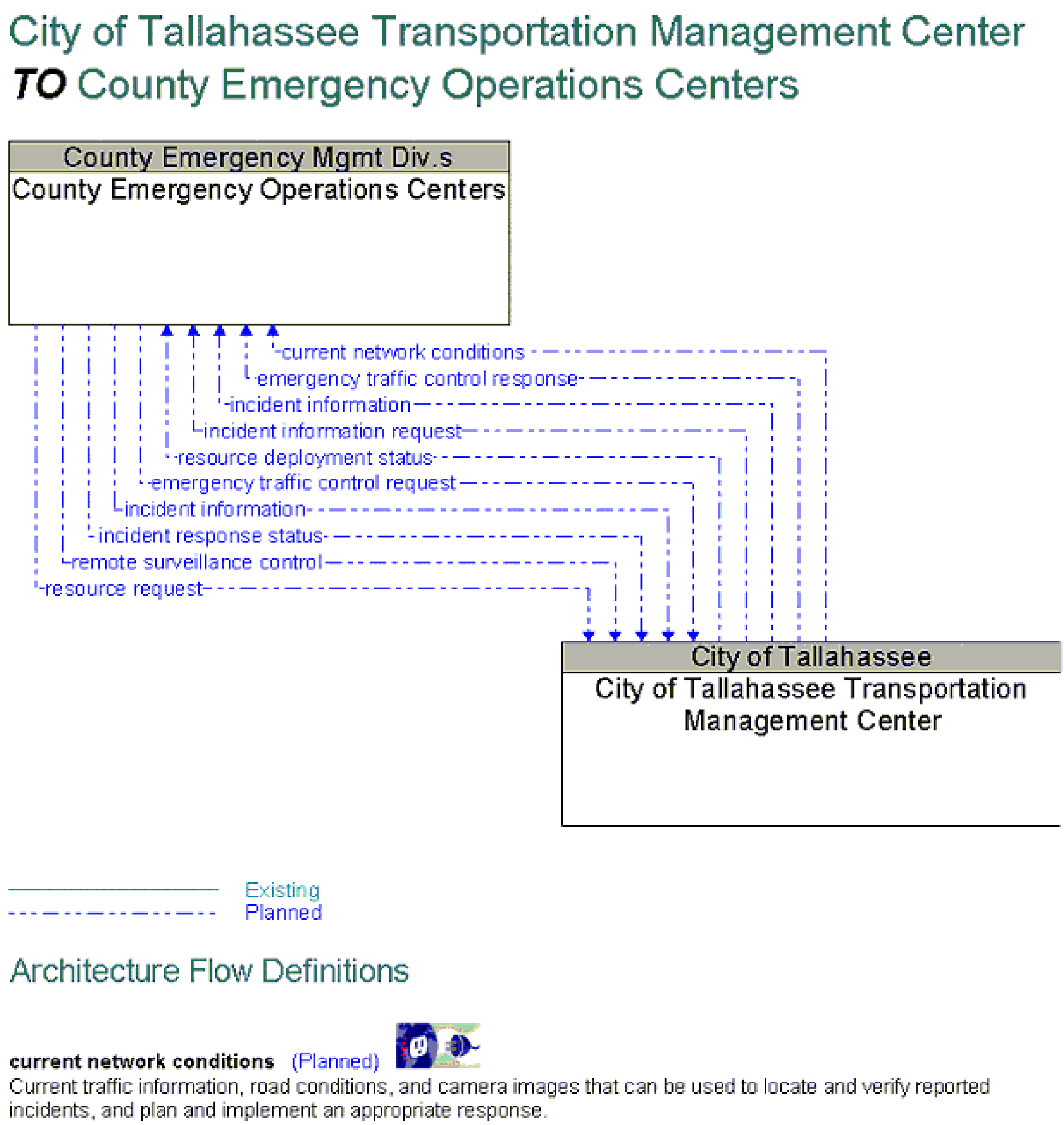


Figure 17: Example of an Architecture Flow Diagram Interface Specification

Example 3: Tabular Presentation of Information Flows
Information flows can also be presented in a table, as shown in the example from the Minnesota Statewide Architecture in Table 10. The table shows the source, destination, information flow name, and flow status for information flows that will be received by the Metro TMC. The table also includes a flow description derived from the architecture flow descriptions in the National ITS Architecture. This table was generated from a Turbo Architecture database.

Table 10: Minnesota Statewide Architecture Information Flows (Draft)

Source	FlowName	FlowDescription	Destination	Status
Broadcast Information Providers	external reports	Traffic and incident information that is collected by the media through a variety of mechanisms (e.g., radio station call-in programs, air surveillance).	Metro TMC	Existing
Broadcast Information Providers	media information request	Request from the media for current transportation information.	Metro TMC	Existing
Data Center	archive coordination	Catalog data, meta data, published data, and other information exchanged between archives to support data synchronization and satisfy user data requests.	Metro TMC	Planned
Data Center	archive requests	A request to a data source for information on available data (i.e. "catalog") or a request that defines the data to be archived. The request can be a general subscription intended to initiate a continuous or regular data stream or a specific request intended to initiate a one-time response from the recipient.	Metro TMC	Planned
Data Center	archive status	Notification that data provided to an archive contains erroneous, missing, or suspicious data or verification that the data provided appears valid. If an error has been detected, the offending data and the nature of the potential problem are identified.	Metro TMC	Planned
Division of Emergency Management Center	incident response coordination	Incident response procedures, resource coordination, and current incident response status that are shared between allied response agencies to support a coordinated response to incidents. This flow also coordinates a positive hand off of responsibility for all or part of an incident response between agencies.	Metro TMC	Planned
Division of Emergency Management Center	incident response status	Status of the current incident response including traffic management strategies implemented at the site (e.g., closures, diversions, traffic signal control overrides).	Metro TMC	Planned
Electrical Services Center	work zone status	Status of maintenance work zone.	Metro TMC	Existing
Emergency Management Vehicle	emergency dispatch response	Request for additional emergency dispatch information (e.g., a suggested route) and provision of en-route status.	Metro TMC	Existing
Emergency Management Vehicle	emergency vehicle tracking data	The current location and operating status of the emergency vehicle.	Metro TMC	Planned
Emergency Management Vehicle	incident command request	Request for resources, commands for relay to other allied response agencies, and other requests that reflect local command of an evolving incident response.	Metro TMC	Existing
Emergency Management Vehicle	incident status	Information gathered at the incident site that more completely characterizes the incident and provides current incident response status.	Metro TMC	Existing
Event Promoters	event plans	Plans for major events possibly impacting traffic.	Metro TMC	Existing
Inter-jurisdictional Traffic Management System	incident information	Notification of existence of incident and expected severity, location, time and nature of incident.	Metro TMC	Existing
Inter-jurisdictional Traffic Management System	incident information request	Request for incident information, clearing time, severity. The request can be a subscription that initiates as-needed information updates as well as a one-time request for information.	Metro TMC	Existing
Inter-jurisdictional Traffic Management System	traffic information	Current and forecasted traffic information, road and weather conditions, incident information, and pricing data. Either raw data, processed data, or some combination of both may be provided by this architecture flow.	Metro TMC	Existing

Example 4: Custom Market Package Diagrams

An alternative method for identifying information flows between ITS Systems is to use the National ITS Architecture market package diagrams and delete the undesired flows and add stakeholder-defined flows. This is a helpful approach when used in conjunction with the Operational Concepts because it places the information flows in the context of a service to be provided. Many market packages illustrate multiple architectural operational concepts to address a particular service, and therefore, the packages must be customized to illustrate only the option selected by the stakeholders. Figure 18 shows how Florida DOT District 3 customized the "*ATMS18 - Road Weather Information System"* market package by adding a Fog and Smoke Detection/Warning System and supporting architecture flows. Although these flows already existed elsewhere in the National ITS Architecture, they were not included in this market package.

Added Flow	Source	Destination
roadway information system status	District 3 Field Equipment	FDOT District 3/FHP Pensacola Transportation Management Center
roadway information system data	FDOT District 3//FHP Pensacola Transportation Management Center	District 3 Field Equipment
driver information	District 3 Field Equipment	Driver

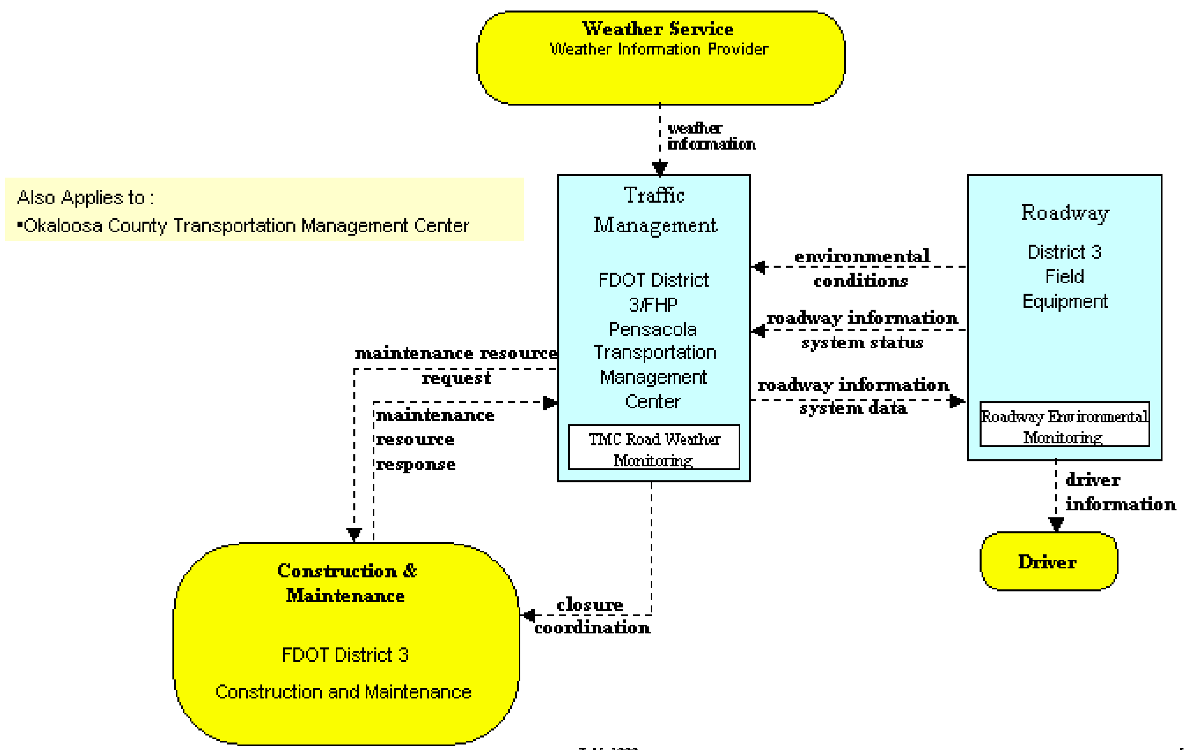
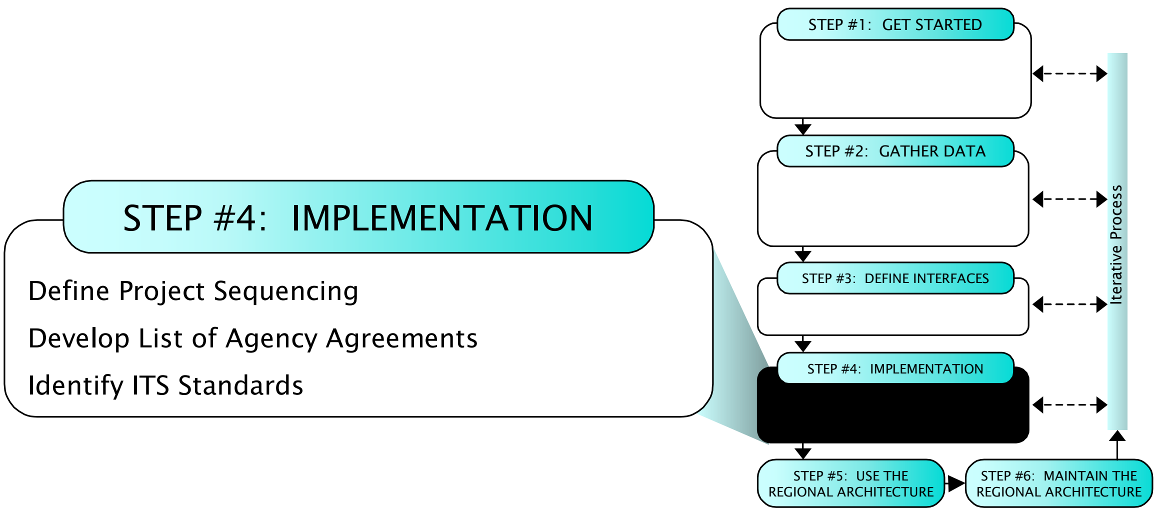


Figure 18: Information Flows in a Customized Market Package

Section
6

Implementation



This section describes the "Implementation" step in the regional ITS architecture development process.

In the "Implementation" step, the regional ITS architecture framework is used to define several additional products that will bridge the gap between regional ITS architecture and regional ITS implementation. These products define the series of staged projects, enabling agency agreements, and supporting ITS standards that will support progressive, efficient implementation of ITS in the region.

In this section, the three "Implementation" process tasks are described in more detail. Each task description begins with a one page summary that is followed by additional detail on the process, relevant resources and tools, a general description of the associated outputs, and example outputs where they are available. Each task description also includes tips and cautionary advice that reflect lessons that have been learned in development of regional ITS architectures over the past several years.

STEP #4: IMPLEMENTATION –Project Sequencing

These tasks may be performed in parallel	• **Define Project Sequencing** • Develop List of Agency Agreements • Identify ITS Standards
OBJECTIVES	• Create an efficient sequence of ITS projects based on regional needs and project readiness. • Build consensus around the defined project sequence

PROCESS
Key Activities
	<u>Define Project Sequence</u>
	• Gather initial project sequence information from existing regional planning documents
	• Define the ITS projects for the region in terms of the regional ITS architecture prepared in previous steps.
	• Evaluate each ITS project, considering:
	  ○ Costs and Benefits
	  ○ Technical Feasibility
	  ○ Institutional Issues
	  ○ Readiness (agreements in place, funding available...)
	• Identify the dependencies between ITS projects based on the inventory, functional requirements, and system interfaces. Identify projects that must be implemented before other projects can begin.
	• Develop an efficient project sequence that takes the feasibility, benefits, and dependencies of each project into account.
	
	<u>Build Consensus</u>
	• Similar to traditional planning, project sequencing is a consensus building process and should not be viewed as a ranking of projects. Stakeholders should begin with existing planning documents and focus on short, medium and long term planning decisions.

INPUT *Sources of Information*	• Regional planning documents: TIP, STIP, SIP, short-range stakeholder agency plans, the regional Long Range Plan, ITS Plans. • ITS project dependency chart for the region or by agency if available.
OUTPUT *Results of Process*	• A documented sequence of projects

6.1 Project Sequencing

The regional ITS architecture is "implemented" with many individual ITS projects and private sector initiatives that occur over years, or even decades. In this process step, a sequence, or ordering, of ITS projects that will contribute to the integrated regional transportation system depicted in the regional ITS architecture is defined.

Both the traditional planning process and the regional ITS architecture process have the same goal: to use a local knowledge, consensus process to determine the best sequence of projects to create a transportation network that best meets the needs of the people of the region.

A sequence of projects required for implementation is required in FHWA Rule 940.9(d)6 and FTA National ITS Architecture Policy Section 5.d.6.

6.1.1 Project Sequencing Process

Collect Existing ITS Project Sequencing Data
Projects are currently sequenced, or ordered, in traditional planning documents like the TIP, STIP, SIP, and other regional plans that contain short, medium and long-term project decisions for a region. These plans are based on regional goals, agency priorities, costs and benefits, and a host of other standard planning factors that are applied to each project. The first step in the ITS project sequencing process is to review these regional plans, identify the ITS projects that are already prioritized as short, medium and long term, and then use this as a starting point.

Beginning the ITS project sequencing task with the sequence already included in the applicable transportation plans is the best way to make sure that the completed project sequencing product will be relevant to planners and factored into future transportation plans. This two-way relationship between the regional ITS architecture products and the applicable regional planning documents is critical to mainstreaming the regional ITS architecture into the transportation planning process. The relationship between the regional ITS architecture and the transportation planning process is described in more detail in section 7.1

One of the significant differences between ITS projects and conventional transportation projects is the degree to which information, facilities, and infrastructure can be shared between ITS projects. The regional ITS architecture provides a new way to look at these ITS project relationships or "dependencies". Project dependencies can be used to identify project elements that must be implemented before other projects can begin. By taking these dependencies into account, an efficient sequence can be developed so that projects incrementally build on each other, saving money and time as the region invests in future ITS systems.

Define ITS Projects

Before the regional ITS architecture can be used to identify project dependencies, each ITS project must be defined in terms of the regional ITS architecture. This means that the systems, the functional requirements, the interfaces, and the information flows from the regional ITS architecture that are relevant to the ITS project must be identified.

The regional ITS architecture can be used to address many of the requirements associated with the systems engineering analysis for projects. Essentially, the part of the regional ITS architecture that will be implemented with each project is carved out, providing a head start for project definition:

- The identification of agency roles and responsibilities can come from the operational concept developed as part of the regional ITS architecture. This operational concept can either serve as a starting point for a more detailed definition, or possibly provide all the needed information.
- Requirements definition can be completely or partly defined by using the regional ITS architecture functional requirements applicable to the project.
- The regional ITS architecture includes a map to ITS standards and the project mapping to the regional ITS architecture can extract the applicable ITS standards for the project.

The use of the regional ITS architecture to support ITS project definition is further discussed in section 7.

The systems engineering analysis required for ITS projects is defined in FHWA Rule 940.11 and FTA National ITS Architecture Policy Section 6.

Evaluate ITS Projects

Each ITS Project should be evaluated in terms of anticipated cost and benefits and to determine whether there are any institutional or technical issues that will impede implementation. In addition, the evaluation may take into account the funding availability, agency and public support for each project, and other qualitative factors that will impact the actual sequence in which projects are deployed.

Cost: Rough cost estimates for each planned project are an input to a realistic project sequence that takes financial constraints into account. Cost estimates should include both non-recurring (capital costs) and recurring (operations and maintenance) costs. Where possible, regions should use their own cost data as a basis. Cost basis information and assumptions should be documented to facilitate adjustment as additional data becomes available.

Benefits: The anticipated benefits for the planned projects can also be used as an input to project sequencing. An estimate of benefits normalized by anticipated costs is a common figure of merit that can be used to identify ITS Projects that are the best candidates for early implementation.
Both qualitative and quantitative safety and efficiency benefits may be estimated based on previous experience either within the region or in other regions that have implemented similar projects.

Technical and Institutional Feasibility: Each project can be evaluated to determine whether it depends on untested technologies or requires institutional change. Any impediments should be factored into the project sequence.

Documentation and tools are available to support analysis of benefits and costs to support ITS project sequencing. The USDOT JPO has an ITS Benefits Database and Unit Cost Database website that can be found at http://www.benefitcost.its.dot.gov/. In addition to the databases, this website contains several documents highlighting ITS benefits.

Identify Project Dependencies
With each ITS project defined in terms of the regional ITS architecture, the relationships between projects can be more easily identified:

- Where ITS projects share an information flow, there is an “information dependency” between the project that generates the information and the project that receives the information.
- Where ITS projects implement related functions on the same system, there may be a “functional dependency” between the two projects. For example, certain core functions (e.g., surveillance) must be implemented before more advanced functions (e.g., incident verification).

In addition to the dependencies identified in the regional ITS architecture, ITS projects are also dependent on many other factors including the data or policy decisions that support the projects. For example, transit applications may be held up by the development of a bus stop inventory. A regional traveler information system may be held up by the lack of a regional base map. A regional fare system may be held up by a lack of consensus on regional fare policies. These types of dependencies should also be recognized and factored into the project sequence.

Define Project Sequence
A project sequence defines the order in which ITS projects should be implemented. A good sequence is based on a combination of transportation planning factors that are used to prioritize projects (e.g., identify early winners) and the project dependencies that show how successive ITS projects can build on one another.

In most cases, the first projects in the project sequence will already be programmed and will 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.

As the sequence is developed, also consider opportunities for including ITS projects in traditional transportation construction and maintenance projects that are planned for the region. Frequently, ITS elements can be efficiently included in traditional transportation projects; these potential efficiencies should be considered and reflected in the ITS project sequencing. For example, dependencies between the traditional transportation project and the ITS projects can be identified and the sequence can be aligned so that the ITS project is deployed at the same time as the associated construction and maintenance project.

The real objective in defining a project sequence is to use the sequence as an aid in developing a more efficient sequence of projects in the transportation planning process. The project sequence documentation must be coordinated with the transportation planners and factored into the various transportation plans for the region for it to be of benefit. Additional information on use of the project sequencing output is presented in section 7.

6.1.2 Project Sequencing Resources and Tools

The National ITS Architecture “Market Packages” document includes an extensive market package dependency analysis that identifies the important functional and information dependencies between market packages. This analysis may be a useful reference when performing the similar project dependency analysis discussed in this section. A discussion of “Early Winner” market packages is also included in the same document. In this discussion, market packages are evaluated for technical and institutional feasibility, general costs and benefits, and several other criteria that may be consulted as projects are sequenced based on similar factors.

For more information on coordinating ITS projects with traditional transportation projects, see "Guidance on Including ITS Elements in Transportation Projects" from FHWA’s Office of Travel Management (EDL document #13467).

Turbo Architecture simplifies the task of relating regional ITS architectures and ITS projects. Turbo assists the operator by maintaining the detailed relationships between the region and supporting projects. It includes a report that identifies differences between the regional ITS architecture and related projects, and tools that automate the migration of changes between regional and project ITS architectures.

6.1.3 Project Sequencing Output

Identification of Project Sequencing Dependencies

It is beneficial to document the ITS project dependencies that influence the project sequencing. This analysis identifies the information and functional dependencies between projects based on the regional ITS architecture and any other external dependencies that affect the project sequence. Each project should list all other projects that it is dependent on and describe the nature of the dependency. The dependency description could be a narrative description, a categorization (e.g., functional or information dependency), or both.

Identification of Project Sequencing based on Local Priorities

Building on the project dependencies, this output defines an actual sequence of projects by factoring in local priorities, financial constraints, special requirements and objectives (e.g. modal shift priorities) that will influence the actual sequencing of projects. The project sequence can be documented in a variety of forms ranging from a simple listing of projects categorized as short, medium, and long-term through PERT charts that provide a detailed accounting of all project dependencies with a timescale overlay that indicates when projects will be implemented.

6.1.4 Project Sequencing Examples

At present, there are limited real world examples of project sequencing outputs to reference. The following two examples each address one key aspect of project sequencing.

Example 1: Portland TransPort Project Dependencies

Table 11, extracted from the Portland TransPort program documentation, provides a list of ITS projects with a narrative statement for each that describes each project's basic capabilities and dependencies on other projects, where applicable. For example, the entry for project OR0193 indicates that it depends on several other systems/projects to be in place. Although the project dependencies are described in narrative form in this example, project dependencies may also be described graphically using PERT charts or other diagrams that can be generated by various project management software packages.

Example 2: California Central Coast Project Sequencing:

Table 12, extracted from the California Central Coast regional ITS architecture, identifies the ITS projects for the region and allocates them to short, medium, and long-range implementation horizons. The market packages that are most closely associated with each project are included in the table as an aide in understanding the general nature of each planned ITS project.

Table 11: TransPort Project Sequencing and Dependencies (Excerpt)

Project #	Project Title	Assumptions and Project Sequencing Dependency by Implementation Stages
OR0208	**Multi-Jurisdictional Regional Arterial Management**	Includes RAMS element of COP System, additional ROI deployment/integration, and communication linkage with additional regional partners. Future stages will increase functionality and integration with other regional signal control systems
OR0158	**Transit Buses as Traffic Probes**	Includes vehicle & central based firmware modifications to extract travel time data and transmit standardized data for 3 demonstration street segments to regional partners.
OR0212	**City of Portland-- Traffic Management and Control**	Includes freeway integration, basic/adaptive signal control and CCU replacement.
OR0193	**Multi-Jurisdictional Regional Freeway Management**	Assumes VMS & BiTrans driver development and remote operator interface for ODOT ATMS firmware, additional VMS (WSDOT), communications from Interstate bridge to WSDOT.
OR0204	**Regional ATIS Sustainable Business Model Deployment**	Assumes 2-3 year program. Limited activity in Year 2000 as supporting integration & infrastructure is put in place. Program management only to solicit/negotiate with vendor.
OR0217	**Regional Transportation Status Web Site**	Stage 1 development includes base site development, data links (FTP, WAN or other) to regional data sources (ODOT/COP/Tri-Met) Infrastructure to support ORO216 CVO and ORO195 Airport Stage 1 Year 2000 elements.
OR0186	**Mt. Hood Recreational Corridor Traffic Management**	Stage 1 includes additional web based CCTV, ODOT funded demo detection and enhanced web data.
OR0188	**Metro Regional ITS Planning Subsystem**	Stage 1 includes firmware enhancements to regional systems to provide archive ITS data to Metro. Metro linkage and limited customization included with limited funding in Year 2000.
OR0211	**Arterial-Based Network Surveillance**	Stage 1 focused on Barbur Boulevard, Sandy Boulevard, Halsey, Powell Boulevard
OR0194	**Regional Multi-Jurisdictional Transit Scheduling and Dispatch**	Stage 1 includes a joint demonstration study and analysis between C-TRAN and Tri-Met, leading to preliminary prototyping and engineering of a C-TRAN/Orbital system.
OR0206	**Regional Inter-Modal Transit Traveler Information and Security System**	Stage 1 includes a single high-volume bus stop and eight rail platforms. Costs include central software development.
OR0210	**City of Portland - City Center Advance Parking Information System**	Stage based on limited deployment for 3 garage system with Morrison bridge approach.

Table 12: Central Coast ITS Project Sequencing (Excerpt)

RECOMMENDED CENTRAL COAST ITS PROJECTS
POSSIBLE LOCATIONS AND RESPONSIBLE AGENCIES
SHORT (S), MEDIUM (M), AND LONG RANGE (L) TIME FRAME PROJECTIONS

Note: Due to space limitations, this table only includes a sampling of the overall list of projects.

Market Package	Specific Locations/Areas	Time Frame (S/M/L)	Possible Responsible Agencies
TRAFFIC MANAGEMENT AND SAFETY			
Surface Street Control ***Basic Synchronization/ Coordination*** - typical urban traffic signal systems coordinated to allow for smooth traffic flow	***Santa Barbara County:***		
	Hollister Ave.	S	Santa Barbara County
	Upper State Street	S	Santa Barbara City
	Carrillo Blvd.	S	Santa Barbara City
	Main Street	S	Santa Maria
	Broadway	S	Santa Maria/Caltrans
	Central	S	Lompoc
	North H Street	S	Lompoc/Caltrans
	SR 246 - Solvang city limits	S	Solvang/Caltrans
	San Luis Obispo County:		
	Grand Avenue - Arroyo Grande/Grover Beach	S	Local Agencies
	El Camino - Atascadero	S	Atascadero
	San Benito County:		
	SR 25 and SR 156 Near Hollister	S	Caltrans
TRANSIT MANAGEMENT			
Transit Vehicle Tracking - includes vehicle tracking and real-time schedule updating	***Region:***		
	All transit systems	S/M	Transit Agencies
	Santa Barbara County:		
	SBMTD	S/M	SBMTD
	SMAT	S/M	SMAT
	San Luis Obispo County:		
	CCAT	S/M	CCAT
	SLO Transit	S/M	SLO Transit
	PRCATS	L	PRCATS
	SCAT	S/M	SCAT
	Ride-On	S/M	Ride-On
	San Benito County:		
	SBCE	L	SBCE
	Monterey County:		
	MST	S/M	MST
Transit Fixed-Route Operations ***Off-Line Route/ Schedule Management*** - vehicle routing and scheduling for fixed-route services	***Santa Barbara County:***		
	SBMTD	S/M	SBMTD
	SMAT	S/M	SMAT
	San Luis Obispo County:		
	CCAT	M	CCAT
	SLO Transit	S/M	SLO Transit
	PRCATS	M	PRCATS
	SCAT	M	SCAT
	San Benito County:		
	SBCE	L	SBCE
EMERGENCY MANAGEMENT AND ENFORCEMENT			
Emergency Routing ***Signal Pre-emption for Emergency Vehicles*** - gives traffic signal priority to the emergency vehicle	***Santa Barbara County:***		
	State Street	M	Santa Barbara
	San Luis Obispo County:		
	Higuera Avenue (SLO)	M	San Luis Obispo
	SR 1 & 227 (SLO)	M	San Luis Obispo/Caltrans
	Grand Ave. (Arroyo Grande/Grover Beach)	M	AG/GB
	El Camino Real (Atascadero)	M	Atascadero

STEP #4: IMPLEMENTATION – Agency Agreements

These tasks may be performed in parallel	• Define Project Sequencing • **Develop List of Agency Agreements** • Identify ITS Standards
OBJECTIVES	• Develop a list of required agreements between agencies. • Ensure all stakeholders are aware of the required agreements and their status.

PROCESS
Key Activities
	Prepare
	• Research each agency's records to determine if there are agreements in place that can be amended to include specific ITS operations.
	Create List of Agreements
	• Whenever possible, utilize existing standard agreements for operations, integration, funding, etc.
	• Evaluate what kind of agreement is needed and build consensus with each of the stakeholders involved:
	  ○ Handshake Agreement
	  ○ Memorandum of Understanding
	  ○ Interagency Agreements
	  ○ Intergovernmental Agreements
	  ○ Operational Agreements
	  ○ Funding Agreement w/ project scope and operations.
	Build Consensus
	• Agreements take a long time to execute. Build consensus early with simple agreements like MOUs while final agreements are being developed.

INPUT *Sources of Information*	• Existing operational, intergovernmental, interagency and/or funding agreements between ITS element operating and user stakeholders. • Existing process and procedures for executing agreements between agencies. • Operational concept, interconnects, and project sequencing outputs from the regional ITS architecture.
OUTPUT *Results of Process*	A list of agreements (*existing and new*) required for operations, including those affecting ITS project interoperability.

6.2 Develop List of Agency Agreements

Agreements among the different stakeholder agencies and organizations are required to realize the integration shown in the regional ITS architecture. In this step, a list of the required agreements is compiled and new agreements that must be created are identified, augmenting agreements that are already in place.

Any agreements (existing or new) required for operations, including at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operation of the projects identified in the regional ITS architecture are required in FHWA Rule 940.9(d)4 and FTA National ITS Architecture Policy Section 5.d.4.

6.2.1 List of Agreements Process

Each connection between systems in the regional ITS architecture represents cooperation between stakeholders and a potential requirement for an agreement. Of course, this doesn't mean that hundreds of connections in the architecture will require hundreds of new agreements. One agreement may accomplish what is necessary to support many (or possibly even all) of the interfaces identified in the architecture. The number of agreements and the level of formality and structure of each agreement will be determined by the agencies and organizations involved. In many cases, agreements will already exist that can be extended and used to support the cooperative implementation and operation of ITS systems in the region.

At this step, a list of required agreements is compiled. Note that all that is required at this point is a list of the agreements, not the agreements themselves. The detailed work, including the preparation and execution of the identified agreements will be performed to support ITS project implementation later in the process. Although the agreements are not actually developed at this point, a fairly detailed understanding of the existing agreements in the region and the various options for structuring new agreements are critical to composing a realistic list of agreements.

Start by gathering existing stakeholder agreements that support sharing of information, funding, or specific ITS projects. Review each agreement and determine whether the existing agreement can be amended or modified to include additional new requirements for cooperation identified in the regional ITS Architecture. Decide if current agreements are sufficient until more specific operational agreements are identified in the future. If not, perhaps a handshake agreement or a simple Memorandum of Understanding (MOU) will suffice in the interim.

Armed with the operational concept, knowledge of the types of ITS systems scheduled for deployment (based on the TIP and the Project Sequencing from the regional ITS Architecture) and the information that needs to be exchanged, stakeholders should coordinate with other stakeholders with whom they are planning to exchange information and reach consensus on the agreements that will be required. Compile a list of the required agreements and prioritize those agreements that support near-term implementations.

The owners or operators of the systems that will be integrated should determine the types of agreements that are needed. Most organizations have a legal department or contracts division that already has approved operational agreements, funding agreements, etc. When possible, try to use an approved process to reduce the time needed to develop, review, and execute agreements.

In an emerging trend in ITS project implementation, many public agencies are working together with private companies (e.g., Information Service Providers and the media) to deliver services to the public. Responding to this trend, agreements needed for implementation of ITS projects aren't limited to agreements between public agencies. In many regions, agreements make public sector CCTV camera images available to the private sector for media use in traffic reporting. In other regions, agreements allow private sector CCTV camera images to be made available to the public sector for incident detection and surveillance, saving the public sector the cost of the cameras and their maintenance. These cameras may be located on public right-of-way, which also requires agreements for use of right-of-way.

There is considerable variation between regions and among stakeholders regarding the types of agreements that are created to support ITS integration. Some common types of agreements include:

Type of Agreement	Description
Handshake Agreement.	• Early agreement between one or more partners • Not recommended for long term operations.
Memorandum of Understanding.	• Initial agreement used to provide minimal detail and usually demonstrating a general consensus. • Used to expand a more detailed agreement like a Interagency Agreement which 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 thoughout the region and the MOUs to specifiy the scope and differences between the projects.

Type of Agreement	Description
Interagency Agreement	• Between public agencies (e.g., transit authorities, cities, counties, etc.) for operations, services or funding • Documents responsibility, functions and liability, at a minimum.
Intergovernmental Agreement.	• Between governmental agencies *(e.g., 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 (e.g., cities and counties) to have one *Master Agreement* that uses smaller agreements *(e.g., 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.

Avoid being "technology prescriptive" in the initial agreements whenever possible since technology changes rapidly. The technology selected during the planning phase may well change as the project nears the final design phases. Being too specific regarding technology can require numerous changes to any agreement throughout the life of the project. Of course, there are times when technology is non-negotiable – a legacy system must continue to be supported or the region has already made significant investments in a particular technology. In such cases, the agreements should reflect the technology decisions that have been made.

Rather than a focus on technology in early cooperative agreements, the focus should be on the scope-of-service and specific agency responsibilities for various components of the service. Describe the high-level information that each agency needs to exchange in order to meet the goals and expectations of the other rather than defining how the delivery of that information will occur.

The process may begin with something as simple as a handshake agreement. But, once interconnections and integration of systems begin, agencies may want to have something more substantial 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 are necessary where funding or financial arrangements are defined or participation in large regionally significant projects is required.

Agreements take a long time to execute. Many regions have reported that three years is the average amount of time to build consensus, develop the contract(s), gather signatures, and execute the agreement. Plan accordingly. Begin the agreement process early, even if it is just a Memorandum of Understanding, while a more robust agreement is being developed. Agreements are time sensitive. Gain consensus and a commitment to schedule before the Agreement is circulated. This is especially important when executive-level changes impact the agencies strategic direction. One administration may be supportive and committed to sign a regional agreement and the next may not understand or simply may have a different funding agenda. Educating new stakeholders to the regional integration of ITS project process can take valuable time that has a domino affect on other agencies with regard to executing an Agreement.

6.2.2 List of Agreements Output

This output will be a list of required agreements, including both existing and planned agreements. Each list entry identifies the agreement title, the stakeholders involved, the type of agreement that is anticipated, high level status (existing or planned), and a detailed and concise statement of the purpose of the agreement. Each entry should also reference the regional ITS architecture in some way. For example, identify the name of a project that is mapped to the regional ITS architecture for project level agreements, an interface or set of interfaces for a specific information exchange agreement, or possibly an ITS system in the inventory. The exact nature of the reference to the regional ITS architecture is highly dependent on the nature and scope of the agreement. If specific ITS standards are being considered for the interface, it’s helpful to include this information as well. In many cases, a general commitment to “compatible interfaces” and use of a general standards family is sufficient for initial agreements.

6.2.3 List of Agreements Examples

At present, there are few real world examples of a "List of Agreements". The following example, shown in Table 13, is taken from the Puget Sound Regional ITS Architecture. The Puget Sound architecture identifies required agreements based on the operational concepts that were developed for the region. As described in section **4.3.4**, operational concepts were developed for areas (market packages and projects) that required significant jurisdictional coordination. The references in the table to Section 4.x are to the relevant operational concept for the initiative or project in the Puget Sound regional ITS architecture documentation.

Table 13: Puget Sound Summary of Interagency Agreement Status (Excerpt)

<table>
<tr><th>AREA</th><th>EXISTING</th><th>PLANNED</th><th>POTENTIAL</th><th>ISSUES</th></tr>
<tr><td>Regional Traffic Control</td><td>King County, Snohomish County, Pierce County, Bremerton, and Lynnwood have agreements for operations and maintenance with multiple jurisdictions

WSDOT, Seattle, and Bellevue have agreements for data and video sharing.</td><td>WSDOT is planning additional links to multiple jurisdictions for data and video sharing.</td><td>Regional Traffic Control Ops Concept identifies potential future links, which will require agreements.</td><td>Agreements on shared control will need to be developed for relevant jurisdiction-to-jurisdiction operations. An agreement pertaining to the specific NTCIP Center-to-Center Protocol to deploy will be needed.</td></tr>
<tr><td>Multi-Modal Coordination</td><td colspan="2">Agreements are in place or under development for the deployment of transit signal priority in all regional counties.</td><td>Additional agreements will be required when the Light Rail System is operational.</td><td>Technology agreements may be required in the longer term to meet dedicated short-range communication standards for transit signal priority applications.</td></tr>
<tr><td>Regional Parking Management</td><td>N/A</td><td>Seattle is working with venue operators to provide information to the public.</td><td>The sharing of parking condition information could develop around existing and planned park-and-ride and transit station parking facilities.</td><td></td></tr>
<tr><td>Transit Fare Management</td><td colspan="2">Regional Fare Coordination Project provides the agreement structure.</td><td>N/A</td><td></td></tr>
<tr><td>Transit Traveler Information</td><td>Current transit information system provides framework.</td><td colspan="2">Should be able to expand on current arrangement.</td><td></td></tr>
<tr><td>Transit Data Management</td><td>N/A</td><td>Agreements on format, access and use are needed for regional sharing of information.</td><td></td><td></td></tr>
<tr><td>ITS Backbone</td><td>Working agreements exist for WSDOT and King County.</td><td colspan="3">Expectations for suppliers and users of the ITS Backbone should be established as a terms of use notification.</td></tr>
</table>

STEP #4: IMPLEMENTATION – Identify ITS Standards

These tasks may be performed in parallel	• Define Project Sequencing • Develop List of Agency Agreements • **Identify ITS Standards**
OBJECTIVES	• Identify the ITS Standards that support the interfaces identified in the regional ITS architecture. • Educate stakeholders on the use of ITS Standards.
PROCESS *Key Activities*	• Using the Information Flows identified in Step #3, identify the relevant ITS standards for the region • Assess ITS standard maturity and establish agreements for use of interim standards where necessary • Identify other regional standards that might apply Building Consensus • Educate stakeholders on the importance of standards, especially with respect to cost, risk, and interoperability issues both within a region and when connecting to neighboring regions. • Build regional commitment to deploy ITS standards-conformant system interfaces.
INPUT *Sources of Information*	• Regional Information Flows (Step #3) • USDOT web site (http://www.its-standards.net/) that provides ITS Standards status, deployment-based outreach information, and lessons learned. • Standards Development Organizations (AASHTO, ITE, NEMA, SAE, IEEE, CEA, ANSI), including websites, online technical discussions, and lessons learned • Interface Control Documents (ICD) from all stakeholders' systems to identify standards currently in place.
OUTPUT *Results of Process*	• Report of ITS Standards (or interim standards if needed) selected for each information flow in the regional architecture

6.3 Identify ITS Standards

In this step, ITS standards (or interim standards) are identified for each information flow in the regional ITS architecture. Establishing regional and national standards for exchanging information among ITS Systems is important not only from an interoperability point of view; it also reduces risk and cost since a region can select among multiple vendors for deployment products. The ITS community recognized these advantages and therefore encouraged Standards Development Organizations (SDOs) to create ITS standards between the most critical ITS system interfaces.

A report identifying ITS Standards supporting regional and national interoperability is a required component of the regional ITS architecture as identified in FWHA Rule 940.9(d)7 and FTA National ITS Architecture Policy Section 5.d.7.

6.3.1 ITS Standards Process

ITS Standards address interfaces between ITS systems, so prior to this step, the stakeholders should have reached consensus on the information flows between each pair of ITS systems in the region. A set of standards can be identified for many of these information flows.

The first step is to educate the stakeholders regarding ITS Standards. Consider arranging an ITS Standards training course for the region. Take a look at the ITS Standards that are currently in development; descriptions and monthly status for each ITS Standard can be found at the USDOT ITS website at http://www.its-standards.net/. Also included on this website are contact numbers, two-page fact sheets, deployment lessons learned, peer-to-peer support, and outreach material as well as links to websites maintained by the various Standards Development Organizations.

There are some basics to know prior to examining the list of ITS Standards. In general, each information flow has up to three types of standards that are relevant: a message set standard, a data element standard, and one or more communications protocol standards. Especially in the area of communications protocols, there are various technology choices that a region can make. Making the best choices depends on multiple factors, including throughput (how much data must be transmitted or received on the interface), network topology (how the ITS systems are connected together), and infrastructure (fiber optic lines, leased land lines, etc.), among others. At this point in the process, educate the stakeholders sufficiently to identify the potential ITS Standards for each interface, but leave final technology choices to the communications experts during project implementation. Typically, these decisions are made as part of the Plans, Specifications and Estimates (PS&E) for each project.

Review the standards currently used by the stakeholders. It's possible that many industry standards are already in use in the region. Encourage stakeholders to examine their existing interfaces and determine whether this is indeed the case. Discuss options for converting these interfaces to ITS standards over time.

In determining when and how to incorporate ITS standards for a given interface, it's critical to understand the relative maturity of the standards. For each potential standard, consider asking:

- Has the ITS standard been approved or published by the SDOs?
- Has the ITS standard been adopted by multiple vendors?
- Has the ITS standard been tested, whether informally by the vendor, or through the formal ITS Standards Testing Program funded by FHWA?
- Is there an amendment to the ITS standard currently in the works, and if so, how much of the standard will change as a result?

Although regions should create a plan to migrate toward ITS standards conformance, stakeholders should reach consensus on an interim approach if the ITS standards applicable to the region's interfaces are not yet mature.

Schedule meetings to keep stakeholders informed regarding Standards. Assign various Stakeholders to report on different Standards so that it isn't too much a burden on one stakeholder or the champion(s). Build consensus and support for sharing this task and document stakeholder responsibilities.

In addition to the interface standards that are being defined for ITS, a range of other regional standards may be considered that would facilitate interoperability and implementation of the regional ITS architecture . For example, standard base maps, naming conventions, measurement & location standards, and organizational structure identifiers can all facilitate the meaningful exchange of information between systems in the region. These types of regional standards should also be considered and can be included in the standards documentation at the discretion of the region.

The Rule/Policy requires, where appropriate, that federally funded ITS projects use ITS standards that are adopted by the USDOT. No ITS standards have been adopted by the USDOT as of August 2001 but over 80 ITS standards are in development by various Standards Development Organizations (SDO). As an SDO-approved standard matures and its market expands, USDOT may decide to adopt it through a formal rulemaking process. Consult the USDOT web sites on ITS standards (http://www.its-standards.net/) and ITS architecture and standards conformity (http://www.its.dot.gov/aconform/aconform.htm) sites for the latest information.

6.3.2 ITS Standards Resources and Tools

The National ITS Architecture provides a list of all ITS Standards applicable to each information flow (or "architecture flow"). The title, document number, and responsible SDO are included for each flow.

Turbo Architecture provides an ITS Standards Report based on all of the architecture flows selected in the region. The report lists all standards associated with each architecture flow, either sorted by standard or by interface. When using Turbo Architecture, try to minimize the number of stakeholder-defined architecture flows unique to the region. Since ITS Standards were created using the National ITS Architecture as a framework, ITS Standards were only created for the interfaces identified by that framework. As a result, you'll be on your own when you need to determine how to standardize those user-defined interfaces.

Many of the Standards Development Organizations maintain websites where you can download interim copies or order published copies of ITS standards, obtain status information, take a look at other regions in the midst of deploying ITS standards, obtain contact numbers, and participate in various technical question and answer groups. The USDOT ITS website contains links to the majority of these sites.

6.3.3 ITS Standards Output

The ITS Standards report should include all selected Standards for each information flow in the region. Interim approaches should also be documented for interfaces that will not be supported by mature ITS standards in the deployment timeframe. For example, the interim approach could identify current regional standards and show a migration path toward use of ITS standards once they are available.

6.3.4 ITS Standards Examples

ITS standards reports are a common component of regional ITS architecture documentation. One of the key challenges for this particular output is finding a way to present this large body of information (multiple standards for every information flow) in a concise, useful format. Two example outputs are presented in this section.

The first example is an excerpt from an "Applicable Standards" report from the Franklin, Tennessee TOC ITS architecture, shown in Table 14. In this output, each relevant ITS standard is identified along with the interfaces that it supports. By listing interfaces rather than individual information flows, the length of the report is reduced considerably. The more detailed information flow to standards mapping information is maintained in a Turbo Architecture database.

Table 14: Franklin TOC Applicable Standards Excerpt

SDO	Standard Title	Source	Destination
SAE	Advanced Traveler Information System (ATIS) Data Dictionary	Franklin TOC	Franklin Parking Management System
		Franklin TOC	Franklin TMA Kiosks
		Franklin TOC	Franklin Transit System
		Franklin TOC	Franklin Website
		Franklin TOC	Media
		Franklin TOC	User Personal Computing Devices
SAE	Advanced Traveler Information System (ATIS) Message Set	Franklin TOC	Franklin Parking Management System
		Franklin TOC	Franklin TMA Kiosks
		Franklin TOC	Franklin Transit System
		Franklin TOC	Franklin Website
		Franklin TOC	Media
		Franklin TOC	User Personal Computing Devices
ITE	Message Set for External TMC Communication (MS/ETMCC)	Franklin TOC	Construction and Maintenance
		Franklin TOC	Event Promoters
		Franklin TOC	Franklin Police Dispatch
		Franklin TOC	Franklin Transit System
		Franklin TOC	Franklin Website
		Franklin TOC	Media
		Franklin TOC	Murfreesboro TOC
		Franklin TOC	Nashville RTMC

In the second example, shown in Figure 19, an on-line hypertext presentation is used to organize the standards information for the FDOT District 3 regional ITS architecture. The standards information for the “current network conditions” information flow is presented on a separate web page. The hypertext presentation allows rapid access to a concise report of the standards associated with each information flow.

Standards Support For current network conditions

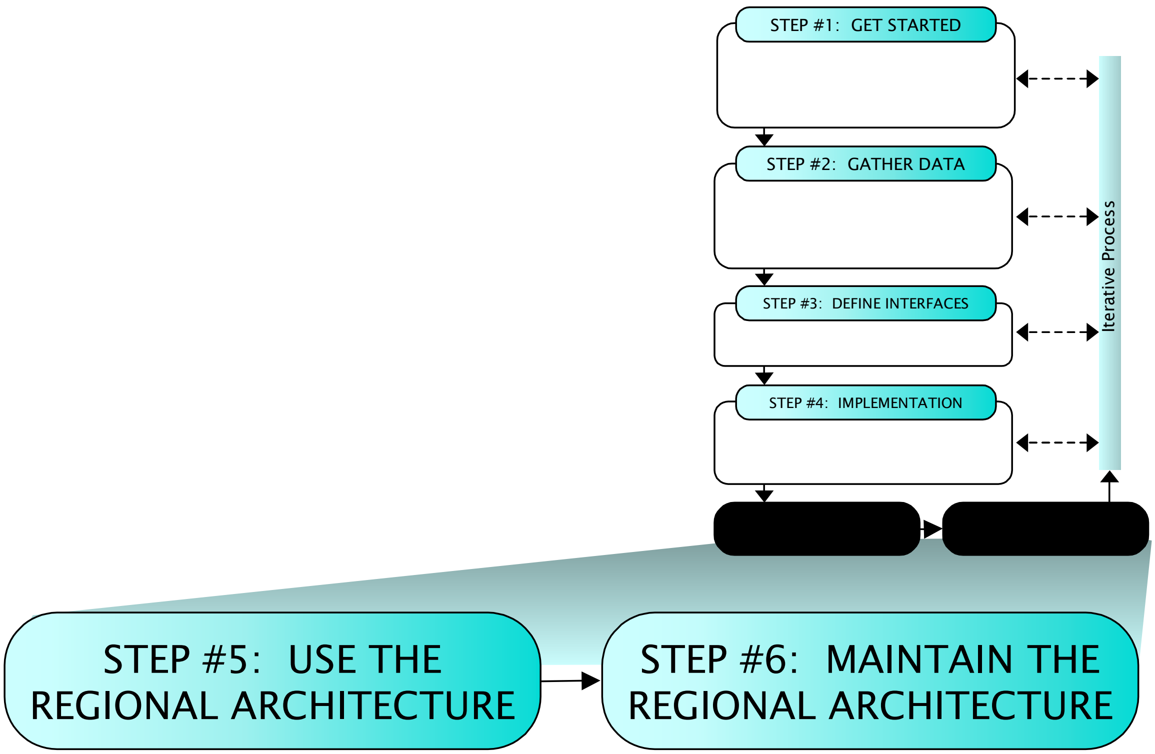
District 3

Type	SDO	Title	Document ID
Message Sets	ITE	Message Set for External TMC Communication (MS/ETMCC)	TM 2.01
Data Elements	ITE	Standard for Functional Level Traffic Management Data Dictionary (TMDD)	TM 1.03
Communications	AASHTO	NTCIP - Applications Profile for Common Object Request Broker Architecture (CORBA)	2305
	AASHTO	NTCIP - Applications Profile for Data Exchange ASN.1 (DATEX)	2304
	AASHTO	NTCIP - Application Profile for File Transfer Protocol (FTP)	2303
	AASHTO	NTCIP - Internet (TCP/IP and UDP/IP) Transport Profile	2202
	AASHTO	NTCIP - Subnetwork Profile for Ethernet	2104
	AASHTO	NTCIP - Base Standard: Octet Encoding Rules (OER)	1102

Figure 19: Candidate ITS Standards for *current network conditions*

Section 7

Use and Maintenance of the Architecture



The regional ITS architecture was developed in the previous four sections. Now that you have a regional ITS architecture, this section describes ways that the architecture can be used. The section also discusses various options and considerations associated with on-going maintenance of the architecture products.

In earlier sections, as the regional ITS architecture was developed, the transportation planning process and planning documents were key inputs at each step in the architecture development process. In Section 7.1, ways that transportation planners can use the regional ITS architecture as an integral part of the transportation planning process are discussed. For transportation planners, designers and implementers, ways that the regional ITS architecture can be used to support the implementation of transportation projects that involve ITS elements are covered in Section 7.2. These sections are intended for use by transportation planners, so they assume the reader is familiar with the transportation planning process and its products.

In Section 7.3, the responsibilities and procedures associated with maintaining the regional ITS architecture are discussed.

STEP #5: USE THE REGIONAL ARCHITECTURE

	• Support Transportation Planning • Support Project Definition
OBJECTIVES	• Fully incorporate ITS elements into the region's transportation planning and programming process, which is known as "mainstreaming" ITS. • Support the definition of ITS projects that fully consider the integration opportunities defined in the regional ITS architecture.
PROCESS *Key Activities*	<u>Support the Planning Process</u> • *Transportation Plan*: A regional ITS architecture can support this effort by promoting increased stakeholder participation and promoting system and inter-jurisdictional integration. • *Transportation Improvement Program*: The regional ITS architecture can support the selection of projects through its project definition and sequencing recommendations. • *ITS Strategic Plan*: Outputs of a regional ITS architecture can serve as the basis for this plan, with additional effort required to define issues such as funding, system management and operation, and regional technology trends. • *Corridor/Sub-Area Study*: The regional ITS Architecture can play a role in defining and evaluating alternatives that include ITS elements. <u>Support Project Implementation</u> • *Project Definition*: The regional ITS architecture can support through its project sequencing output. • *RFP Generation*: The regional ITS architecture can support through its functional requirements and mapping of project to the regional architecture. • *Project Implementation*: The regional ITS architecture can support definition of key system engineering analysis activities.
INPUT *Sources of Information*	• Regional ITS Architecture • Project Architectures or ITS Project Plans
OUTPUT *Results of Process*	• Planning products that fully incorporate ITS elements into the overall regional and statewide plans. • Project definition products that identify how the project fits into the overall regional ITS architecture and consider the integration opportunities inherent in the architecture.

7.1 Using the Regional ITS Architecture to Support the Planning Process

The following section provides guidance on using a regional ITS architecture as part of the overall Transportation Planning Process. Due to the regional and local variations in the practice of transportation planning, this guidance represents a wide range of options available to each state, region, or locality rather than a single recommendation. These options support the overall Transportation Planning Process and are not meant to compete with it. Local stakeholders must decide how best to incorporate the regional ITS architecture and the products produced during its development into the Transportation Planning Process, and vice versa.

The goal of the planning process is on making quality, informed decisions pertaining to the investment of public funds for regional transportation systems and services. Using the regional ITS architecture to support these planning activities is an important step in the mainstreaming of ITS into the traditional decision-making of planners and other transportation professionals. As shown in the previous steps in the architecture development process, transportation plans and programs are important input to the development of a regional ITS architecture. Once an architecture is complete, it can feed information back into the planning process.

The planning process has as its overall output two primary planning and programming documents: the Transportation Plan and the TIP. Numerous transportation planning activities on a regional and local level feed information to the development of the Transportation Plan and TIP. These planning activities include ITS Strategic Plans, Corridor and Sub-area Studies, Major Investment Studies, Congestion Management Plans and others. A brief description of how a regional ITS architecture can be of use in these activities is given below:

- The Transportation Plan: The Transportation Plan is the product of the process for long-range planning. Across the country, this plan is called various names including Regional Transportation Plan (RTP), Long-range Plan (LRP) and Long-range Transportation Plan (LRTP). In this document it will be referred to as the "Transportation Plan" or "The Plan". The Plan documents the policy direction for the region and describes how transportation projects and programs will be implemented over a 20-year (or longer) period. It must be updated periodically by each state and metropolitan area. The regional ITS architecture can serve as a direct input to the plan. Section 7.1.1 will detail effective strategies for doing this.
- Transportation Improvement Program (TIP): The TIP must be prepared periodically by each metropolitan area and state. It describes specific

projects that will be deployed and/or operated over the next three years at a minimum. Some areas include additional years in their program. ITS projects need to be included in this document to receive Federal funds. The regional ITS architecture development process not only defines ITS projects, but defines the preferred sequencing of these projects, which can form a part of the overall project prioritization effort required to complete a TIP. Section 7.1.2 will discuss the use of a regional ITS architecture process and products in creating a TIP.

- Transportation Planning Activities: There is a broad array of activities that ultimately result in a set of recommended, fundable transportation projects and programs in a region. The regional ITS architecture can be used to create an ITS Strategic Assessment/Plan, or can be used as input to other plans such as corridor/ sub-area studies. Section 7.1.3 covers the use of the regional ITS architecture in these kinds of planning activities.

7.1.1 Using the Regional ITS Architecture in Developing the Transportation Plan

The transportation plan is one of the principal products of the planning process. It is the expression of a state or metropolitan area's long-range approach to constructing, operating, and maintaining the multimodal transportation system. It is the policy forum for balancing transportation investments among modes, geographic areas, and institutions. A regional ITS architecture is related to both the statewide transportation plan and the metropolitan transportation plan. The Federal regulation on Statewide and Metropolitan Transportation Planning (23 CFR, part 450) specifies requirements for transportation plans. Table 15 and Table 16 indicate those requirements and highlight some of the associated considerations for using the regional ITS architecture to support the Statewide Transportation Plan and the Metropolitan Transportation Plan respectively.

Table 15: Comparison of Statewide Transportation Plan and Regional ITS Architecture

Statewide Transportation Plan Requirements	Considerations for Regional ITS Architecture
Be intermodal and statewide in scope in order to facilitate the efficient movement of people and goods	The regional ITS architecture includes intermodal and multimodal services provided or planned in the region (or state).
Be reasonably consistent in time horizon among its elements, but cover a period of at least 20 years.	The regional ITS architecture can be created to support whatever time horizon is necessary. If its primary role is to support the Transportation Plan then that would be 20 years.
Contain, as an element, a plan for bicycle transportation, pedestrian walkways and trails which is appropriately interconnected with other modes.	The regional ITS architecture probably doesn’t have much coverage related to this requirement, other than the traveler information aspect that assists in multimodal trips.

Statewide Transportation Plan Requirements	Considerations for Regional ITS Architecture
Be coordinated with metropolitan transportation plans	A regional ITS architecture covering an entire state can be created to coordinate with a metropolitan or other regional ITS architectures.
Reference, summarize or contain any applicable short range planning studies, strategic planning and/or policy studies, transportation need studies, management system reports and any statement of policies, goals and objectives regarding issues such as transportation, economic development, housing, social and environmental effects, energy, etc., that were significant to the development of the plan.	The regional ITS architecture can be a basis for some of the transportation studies that must be referenced.
Reference, summarize or contain information on the availability of financial and other resources needed to carry out the plan	The regional ITS architecture does not directly support this requirement.

Table 16: Comparison of Metropolitan Transportation Plan and Regional ITS Architecture

Metropolitan Transportation Plan Requirements	Considerations for Regional ITS Architecture
Include both long-range and short-range strategies/actions that lead to the development of an integrated intermodal transportation system that facilitates the efficient movement of people and goods.	The regional ITS architecture considers both short-range and long-range services/ projects and takes a multi-modal view.
Identify the projected transportation demand of persons and goods in the metropolitan planning area over the period of the plan	This is an evaluation effort that does not relate to the regional ITS architecture
Identify pedestrian walkway and bicycle transportation facilities	Regional ITS architecture probably doesn't have much coverage related to this requirement.
Reflect the consideration given to the results of the management systems	This is an evaluation effort that does not directly relate to the regional ITS architecture.

Metropolitan Transportation Plan Requirements	Considerations for Regional ITS Architecture
Assess capital investment and other measures necessary to preserve existing transportation system and make the most efficient use of existing transportation facilities to relieve vehicular congestion and enhance the mobility of people and goods.	Systems/Services described by the regional ITS architecture have as their key goal and attribute improving the efficiency of the existing transportation network.
Include design concept and scope descriptions of all existing and proposed transportation facilities in sufficient detail in nonattainment and maintenance areas to permit (air quality) conformity determinations.	Information from the Project Sequencing can be used to address some of this requirement.
Reflect a multimodal evaluation of the transportation, socioeconomic, environmental, and financial impact of the overall plan, including all major transportation investments.	This is an evaluation effort that does not relate to the regional ITS architecture
Include a financial plan that demonstrates the consistency of proposed transportation investments with already available and projected sources of revenue.	Information from the Project Sequencing in the regional ITS architecture can be used to address some of this requirement.

A regional ITS architecture can also support the long range planning that goes into development of the Transportation Plan by promoting increased stakeholder participation and promoting system and inter-jurisdictional integration.

Promoting Increased Stakeholder Participation
Although the central purpose of a regional ITS architecture is to provide structure to the technical components and allow the interdependencies between systems to be identified, a regional ITS architecture can also make a significant contribution to mobilizing stakeholders. One reason for this is that a regional ITS architecture serves as a visible demonstration of the institutional dependencies that exist in a region and how agencies can benefit from each other's activities.

Since the regional architecture includes a complete accounting of the current and proposed ITS inventory, it can serve as a discussion point for all stakeholders to gain buy-in and make their needs known and accommodated. Since effective applications of ITS often cross modal or institutional boundaries, an architecture can help stakeholders identify areas where resources and funding can be leveraged via inter-agency cooperation.

To the extent that transportation planning including the architecture encourages team building and dialogue, it is likely that the collaboration established through the architecture effort could be used to address other, non-architecture related issues. In addition to further motivating traditional planning participants, a regional ITS architecture can help identify and engage new participants. In particular, planning and operations personnel within one organization sometimes meet for the first time in ITS activities, since they tend to cut across several departments within an organization.

Promoting System and Inter-Jurisdictional Integration
One of the clearest differences between ITS and conventional transportation solutions is the level of interdependency that exists between projects and the degree to which information, facilities, and infrastructure can be shared with mutual benefit. A regional ITS architecture provides the framework for analyzing how ITS elements (e.g. management centers, roadside elements, vehicles, and travelers) are related and thereby, identify the areas for potential cooperation. Since opportunities for system integration and operational coordination extend beyond jurisdictional boundaries, development of a regional ITS architecture can serve to promote both system and inter-jurisdictional integration.

7.1.2 Using the Regional ITS Architecture in Developing the TIP/STIP

The Transportation Improvement Program (TIP) is a staged, multiyear, intermodal program of transportation projects that is consistent with the Metropolitan Transportation Plan. At the statewide level there is a corresponding Statewide Transportation Improvement Program (STIP) that is consistent with the Statewide Transportation Plan. The TIP must include a prioritized list of specific projects to be constructed over a several-year (often three) period after its approval.

ITS projects included in the TIP could be defined by several sources:

- An action plan or set of projects recommended in a ITS Strategic Plan or other mechanism. Using the regional ITS architecture to generate such an assessment is described in Section 7.1.3.
- An action plan or set of projects recommended in a corridor or sub-area study (of which ITS is often a part). Using the regional ITS architecture to support such a study is described in Section 7.1.3.
- Other plans and planning activities performed by local transportation agencies (municipal/county agencies, transit operators, etc.).

As part of the TIP preparation, a project prioritization and selection process is conducted. Some of the factors that are typically used in developing project priorities include:

- Urgency of need for the project
- Project effectiveness versus cost
- Sequencing as related to other projects
- Type of funds available and their applicability

A regional ITS architecture can play a key role in the project prioritization and selection process. The Project Sequencing output from the regional ITS architecture effort can be a major input to prioritization. In addition, integration opportunities identified in the regional ITS architecture can be used to better define the full benefits of ITS projects.

Project Description

Project descriptions for the TIP are more extensive than those associated with the Transportation Plan. The following information would typically be included for each TIP project:

- Sufficient descriptive material (i.e. type of work, termini, length, etc.) to identify the project or phase
- Estimated total cost
- The amount of Federal funds proposed to be obligated during each program year
- For the first year, the proposed category of Federal funds and source(s) of non-Federal funds
- For the subsequent years, the likely category or possible categories of Federal funds and sources of non-Federal funds
- Identification of the agencies responsible for carrying out the project

Some of this project description information might be available from the outputs of the regional ITS architecture effort, specifically the Project Sequencing output.

7.1.3 Using the Regional ITS Architecture in Transportation Planning Activities

A number of different planning studies and activities are performed by local transportation planners. This section will discuss how the regional ITS architecture and its outputs can support two of these planning efforts, ITS Strategic Plans and Corridor/Sub-area Studies. The concepts applied to these two types of studies are applicable to other types of planning activities.

ITS Strategic Plan

The planning effort that has the closest connection to the regional ITS architecture and its outputs is an ITS Strategic Plan (sometimes known as a Strategic Assessment). An ITS Strategic Plan for a state, metropolitan area, or region is a guide for long term implementation of ITS in the area. There is currently no planning requirement for an ITS Strategic Plan, but many regions have found this a useful way to define their ITS needs and provide input to the formal planning process.

There are a variety of ways to develop an ITS Strategic Plan, but since there is no formal guidance on what the plan should contain, there is no single approach that is the “right” approach. A strategic plan will normally include identifying regional transportation needs and then defining ITS elements to be implemented over time, aimed at meeting the needs. An ITS Strategic Plan will usually include recommendations for funding, phasing, managing, integrating, and operating the ITS elements that are to be implemented within the region. A key element of all ITS Strategic Plans is the development of a framework for ITS deployment in the area or region. *This framework is the regional ITS architecture that is the topic of this guidance*. The regional ITS architecture outputs that are described in this guide are a subset of the outputs that could be expected for an ITS Strategic Plan.

An ITS Strategic Plan is most effective when considered as an integral part of the metropolitan or statewide transportation planning processes. An ITS Strategic Plan must both feed and be fed by other transportation planning and programming activities (e.g. transportation plan, corridor/sub-areas studies). The regional ITS architecture is a core part of the plan that provides a blueprint for deploying ITS elements in an integrated manner as an effective, integral part of the total transportation system.

Most existing strategic plans were developed prior to the FHWA Final Rule and FTA Policy on ITS Architecture and Standards. Frequently, these strategic plans included elements of a regional ITS architecture or were linked to a separate architecture effort. Today, an ITS Strategic Planning effort will almost certainly include regional ITS architecture development based on the final rule/policy. Table 17 provides a more detailed look at how the regional ITS architecture process and its products can be included in an ITS Strategic Plan.

Table 17: Using Regional ITS Architecture Outputs in an ITS Strategic Plan

Regional ITS Architecture Process Step	Considerations for use in ITS Strategic Plan
Define Region	The region covered by the ITS Strategic Plan should match the region covered by the regional ITS architecture. Can use process step output directly in Plan.
Identify Stakeholders	Both efforts are based upon outreach, education and consensus of the same (or very similar) set of ITS stakeholders. Both need to document the stakeholders, so the output of process step is directly useable in plan
Inventory Systems	ITS Strategic Plan will include a system inventory; however, an additional level of detail may be desired in the plan (e.g. not just field elements, but how many and what type).
Determine Needs and Services	User needs must be identified for the development of the regional ITS architecture. These are certainly a part of ITS Strategic Plan. Output of architecture effort should be directly usable in plan.
Develop Operational Concept	The results of this process step can be used to support definition of system management and operations. The level of detail in the operational concept can be adjusted to meet the strategic planning needs of the region.

Regional ITS Architecture Process Step	Considerations for use in ITS Strategic Plan
Define Functional Requirements	These high level requirements are often covered in ITS Strategic Plans, and if so the outputs of this architecture step will be directly applicable.
Define Interfaces	A definition of interfaces and information flows (the result of this step in architecture development) is an important part of an ITS Strategic Plan. The outputs of this step will be directly applicable to the ITS Strategic Plan.
Define Project Sequencing	The Identification of Early Winners (from a project standpoint) is often included in ITS Strategic Plans. This is similar to the Sequencing of Regional Projects step in the architecture development. The identification of early winners may include additional factors, depending on the analysis that was done to support Project Sequencing.
Develop List of Agency Agreements.	Describing the needed institutional arrangements necessary to deploy ITS systems is a key aspect of an ITS Strategic Plan. The regional ITS architecture list of agreements can be expanded to a broader discussion of the institutional arrangements in the region.
Identify ITS standards	A general discussion of how ITS standards will be approached and key areas for standardization are applicable outputs to include in the ITS Strategic Plan. This information provides important context for the list of ITS standards that are defined in the regional ITS architecture.

As seen in Table 17 above, each of the eight basic outputs of the regional ITS architecture development process are directly applicable to the development of an ITS Strategic Plan.

Are there additional topics that typically are included in ITS Strategic Plans? The answer is yes. Some of the most common are discussions of funding, regional technology trends, and operations and maintenance. Since the goal of the ITS Strategic Plan is to define ITS elements for introduction into the planning process, inclusion of information regarding funding sources and funding requirements is necessary. In order to make these funding assessments, some deployment considerations must be evaluated. One key consideration is regional technology trends. Choices that have already been made in such areas as communications infrastructure must be factored into deployment plans. Issues of system operations and maintenance are especially important to ITS deployments, and consideration of this topic (beyond the Operational Concept discussed above) is important.

This discussion has highlighted the close relationship between an ITS Strategic Plan and a regional ITS architecture. The discussion of what "typically" appears in an ITS Strategic Plan is based upon plans developed prior to the delineation of regional ITS architecture outputs of this guide. It can be expected that these two products (the ITS Strategic Plan and the regional ITS architecture) will grow even closer to each other in the future since they both have similar goals-- defining ITS needs and serving as an input into the transportation planning process.

Corridor/ Sub-area Study

Corridor/sub-area studies (also known as "Major Investment Studies") are used to flesh out transportation strategy and project recommendations on a geographic basis. A corridor or sub-area is a context for evaluating how specific transportation conditions, problems, and needs should be addressed within the defined geographic area. A wide range of multimodal strategies, including ITS, are considered as candidate solutions for those problems.

A corridor/sub-area study addresses problems and needs in greater detail than is possible in a Transportation Plan. The project(s) resulting from the study are provided for consideration in the development of the Transportation Plan and TIP/STIP. Thus, corridor/sub-area studies both provide information to and use information from the Transportation Plan.

A study usually involves identifying the corridor, defining a set of alternatives to meet the transportation needs, analyzing these alternatives (for things such as benefits, costs, and environmental impacts), revising alternatives as needed, and selecting the desired alternative(s), which are then recommended for inclusion in the Transportation Plan or TIP.

The regional ITS architecture can play a role in defining and evaluating alternatives in a planning study. Elements of the corridor/ sub-area that are in the architecture can be identified, and options for integration within or between projects can be created. This supports defining study alternatives or portions of alternatives. The definition of interfaces that are assigned to projects/ alternatives can be an input to the evaluation process. Project Sequencing can also provide important input to the evaluation by defining key enabling projects or projects that are prerequisites to other projects. The definition of needed institutional agreements can also be an input to the evaluation.

7.2 Using the Regional ITS Architecture to Support Project Implementation

Projects have a typical life cycle that begins in the planning/programming phase and moves through implementation and into operations and maintenance. Figure 20 below shows an example of a project life cycle and where a regional ITS architecture can be of use. The use of the regional ITS architecture as part of regional planning has been discussed above in Sections 7.1.1 and 7.1.2. This section will discuss those uses from Project Definition through to the early stages of project implementation as shown highlighted in the figure.

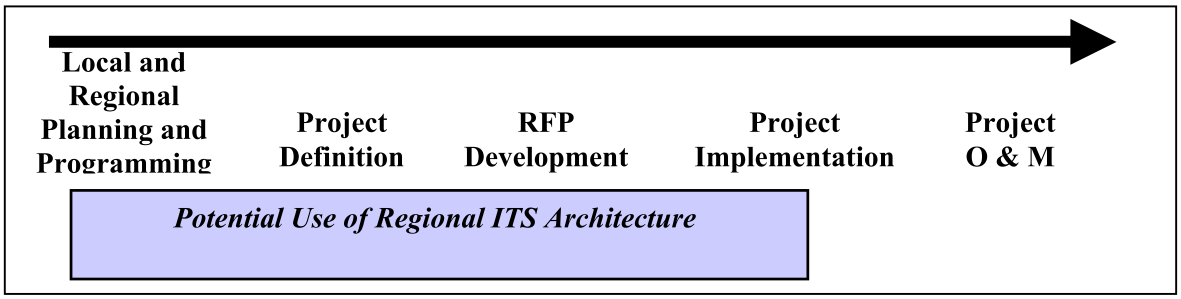


Figure 20: Regional ITS Architecture Use in the Project Life Cycle

7.2.1 Project Definition

Project Definition may occur at several levels of detail. Early in the planning process a project may be defined only in terms of the transportation services it will provide, or by the major system pieces it contains. At some point prior to the beginning of implementation the details of the project must be developed. This could include further system definition and interface definition including exactly what systems or parts of systems will make up the project, what interconnections the project entails, and what information needs to flow across the system interconnections. Requirements definition may go through similar levels of detail, starting with very high level description of project functions and moving toward system specifications. By identifying the portions of the regional ITS architecture that define the project, the regional ITS architecture outputs can be used to create key aspects of the project definition.

The areas that a regional ITS architecture can assist in project definition are:

- The identification of agency roles and responsibilities (including any inter-agency cooperation) can come from the operational concept developed as part of the regional ITS architecture. This operational concept can either serve as a starting point for a more detailed definition, or possibly provide all the needed information.
- Requirements definition can be completely or partly defined by using the regional ITS architecture functional requirements applicable to the project.

- The regional ITS architecture includes a map to ITS standards and the project mapping to the regional ITS architecture can extract the applicable ITS standards for the project.

7.2.2 RFP Generation

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

The regional ITS architecture, and the products produced during its development, can support this RFP generation. First the project definition described above forms the basis for what is being procured. Mapping the project to the regional ITS architecture allows bidders to have a clear understanding of the scope of the project and of the interfaces that need to be developed. The functional requirements created as part of the regional ITS architecture can be used to describe the functional requirements for the project. In addition a subset of the ITS Standards identified as part of the regional ITS architecture development can be specified in the RFP.

7.2.3 Project Implementation

Because ITS projects involve systems and their interconnections, it is very important to follow a system engineering approach to designing and implementing the project. While the exact process followed is at the discretion of the local agency, the ITS Architecture and Standards Rule/Policy lay out a set of required system engineering analyses for ITS projects funded through the highway trust fund. Some of the system engineering analyses that relate to the Regional ITS Architecture include:

(1) Identification of portions of the regional ITS architecture being implemented (or if a regional ITS architecture does not exist, the applicable portions of the National ITS Architecture);
(2) Identification of participating agencies roles and responsibilities including any inter-jurisdictional matters;
(3) Requirements definitions;
(4) Identification of applicable ITS standards and testing procedures; and

Several of these analysis activities may have already been completed in project definition and RFP generation, and the sections above illustrate how the regional ITS architecture can support these activities. Alternatively, the activities can be initially performed at a high level and carried to a greater level of detail in this step in the life cycle.

Rule/Policy

The complete systems engineering analysis required for ITS projects is defined in FHWA Rule 940.11 and FTA National ITS Architecture Policy Section 6.

Following a system engineering approach during implementation of ITS projects is a key requirement of the Rule/Policy. However, providing a definition and explanation of system engineering is outside the scope of this document. For additional resources or training on system engineering, refer to the ITS Resource guide, (http://www.its.dot.gov/itsweb/guide.htm) or the NHI website: http://www.nhi.fhwa.dot.gov/ for more information.

STEP #6: MAINTAIN THE REGIONAL ARCHITECTURE

OBJECTIVES	Develop and implement procedures and responsibilities for maintaining regional ITS architecture in the region.
PROCESS *Key Activities*	• Determine who will be responsible for architecture maintenance. What individual or group of individuals will be responsible for maintaining the architecture? Also who will support the effort, and who will manage or have oversight for the maintenance effort? • Define the architecture baseline. What outputs/ documents will be maintained? Will you maintain only the databases or the graphic representations of the architecture as well? • Define the Change Management Process. How will changes be introduced and by whom? How often will changes to the architecture baseline be performed? Who will evaluate the changes for inclusion into the baseline? What group will review the change recommendations and make the decisions on what changes are accepted and which are not? Who will actually modify the architecture baseline? • Develop an Architecture Maintenance Plan. This plan will document the process and provide a framework for the architecture maintenance activity.
INPUT *Sources of Information*	• Last approved version of the regional ITS architecture
OUTPUT *Results of Process*	• Architecture Maintenance Plan • Updated architecture baseline.

7.3 Maintaining the Regional ITS Architecture

The regional ITS architecture is not a static set of outputs. It must change as plans change, ITS projects are implemented, and the ITS needs and services evolve in the region.

Much as ITS systems require planning for operations and maintenance, a plan should be put in place during the original development of the regional ITS architecture to keep it up to date.

7.3.1 Process

The regional ITS architecture is described by a set of outputs that have been described in Sections 3 through 6 of this document. These sections have suggested a process for creating the original set of outputs that represent the regional ITS architecture. This section will examine the process of maintaining the architecture. This process is really one of Configuration Control and Change Management. Some of the key aspects of the process, which are covered in more detail below are:

- Determine who will be responsible for architecture maintenance
- Define the architecture baseline
- Define the change management process
- Document the process in a Maintenance Plan. This will be discussed in the following Outputs section.

Determine who will be responsible for architecture maintenance

Just as a Champion (or group of champions) is key to development of the regional ITS architecture, some person, or group of people, need to be assigned responsibility for maintaining the architecture. Who should perform this role? The answer to this question will vary from region to region, but in general the organization that led the creation of the original products will most likely be the agency charged with maintaining the architecture. In many cases this will be the responsibility of the MPO. In other cases it may be the state or local Department of Transportation or a shared responsibility. Very often, the Champion will assume leadership in the task of architecture maintenance.

Because changes can arise from many sources (see discussion below), and very likely will arise from some sources outside the technical expertise of a single champion, it is a good idea for a group of people from different stakeholder areas to be involved in architecture maintenance. Representatives from traffic, transit, public safety, commercial vehicles, traveler information, and any other key stakeholders from the team that developed the architecture are good candidates for the architecture maintenance team. Ultimate responsibility may reside with one person or organization, but the team of representatives from the different stakeholder groups should assist in the effort.

It is also recommended that the person (or persons) responsible for the architecture maintenance be formally tasked by their agencies. This will increase accountability and provide focus to the effort.

Define the Architecture Baseline

Establishing an architecture baseline requires clear identification of the architecture products that will be maintained, including specific format and version information. While this decision may be affected by how the regional ITS architecture is being used (as discussed in sections 7.1 and 7.2), all of the outputs defined in sections 3 through 6 should be considered for inclusion in the architecture baseline that will be maintained. The outputs include:

1. Description of the Region
2. List of Stakeholders, including key contact information
3. Inventory of existing and planned ITS systems in the region
4. Documented regional needs and ITS services associated with supporting systems in the region
5. Operational Concepts
6. System functional requirements
7. Documentation of existing and planned interconnects and information flows for the region
8. Documentation of project sequencing
9. List of Agency Agreements
10. Documentation of applicable, in use, or planned ITS Standards.

Additional documentation such as a map of each project to the regional ITS architecture could also be considered for addition to the architecture baseline.

The architecture baseline definition includes the form of each output that will be maintained. For example, under the existing and planned interconnections and information flows, the documentation may take several forms— tabular outputs, databases, various graphical outputs (both detailed and summary forms) or hyperlinked CD-ROMS. Will all of these output forms be maintained or just the database representation? The answer to this question will probably be affected by how the regional ITS architecture will be used. For example, if continued outreach to stakeholders is anticipated, then various graphical representations will need to be maintained. Regarding the list of agency agreements, as these are developed will the agreements themselves form a part of the baseline, or just the list of actual vs. planned agreements?

Of course, in order to maintain an architecture baseline, the electronic data – the databases, graphics, and document files that constitute the baseline must be available to the organization doing the maintenance. Where the regional ITS architecture is developed under contract, the contract should require delivery of all electronic deliverables that will be necessary to support on-going architecture maintenance. If only hard copy reports are delivered, the region will be reliant on the contractor for architecture maintenance, or possibly even have to recreate the underlying electronic data in order to revise the architecture.

Ultimately the definition of the architecture baseline will include a set of outputs (such as documents, databases, etc.) with the date and/or revision number identified. This constitutes the baseline of architecture information that is being maintained. Over time this baseline will change- documents may be deleted or added to the list and changes will be make to the various outputs resulting in updated dates or revision levels on them.

Define the Change Management Process

Once the baseline is defined, the process for making changes to this baseline is established. The change management process specifies how changes are identified, how often they will be made, and how the changes will be reviewed, implemented, and released.

How Changes are Identified

The regional ITS architecture is created as a consensus view of what ITS systems the stakeholders in the region have currently implemented and what systems they plan to implement in the future. The regional ITS architecture will need to be updated to reflect changes resulting from project implementation or resulting from the planning process itself.

- Changes for Project Definition. When actually defined, a project may add, subtract or modify elements, interfaces, or information flows from the regional ITS architecture. Because the regional ITS architecture is meant to describe the current (as well as future) regional implementation of ITS, it must be updated to correctly reflect how the developed projects integrate into the region.
- Changes for Project Addition/Deletion. Occasionally a project will be added or deleted through the planning process and some aspects of the regional ITS architecture that are associated with the project may be expanded, changed or removed.
- Changes in Project Priority. Due to funding constraints, or other considerations, the planned project sequencing may change. Delaying a project may have a ripple effect on other projects that depend on it. Raising the priority for a project's implementation may impact the priority of other projects that are dependent upon it.
- Changes in Regional Needs. Transportation planning is done to address regional needs. Over time these needs can change and the corresponding aspects of the regional ITS architecture that addresses these needs may need to be updated.

In addition, new stakeholders may come to the table and the regional ITS architecture should be updated to reflect their place in the regional view of ITS elements, interfaces, and information flows.

Finally, the National ITS Architecture may be expanded and updated from time to time to include new user services or better define how existing elements satisfy the user services. These changes should also be considered as the regional ITS architecture is updated. The National ITS Architecture may have expanded to include a user service that has been discussed in a region, but not been included in the regional ITS architecture, or been included in only a very cursory manner.

How often Changes are Made.
This will vary by region and will depend upon who the maintaining organization is and how the architecture is being used. For example, if the architecture is used primarily to support TIP development, then an update cycle that corresponds to the TIP update cycle is appropriate. If the architecture is used primarily as an input to the Transportation Plan, then an update to match the transportation planning cycle may be appropriate. More frequent, but smaller updates to reflect project development, or changes in the stakeholders/ element definition are also possible. The key is to define the factors that will drive the update cycle as part of the initial development.

Change Review, Implementation, and Release
The actual change management process could be handled with varying degrees of formality depending upon the complexity (both technical and institutional) of the regional ITS architecture. In general, the more complex the architecture, the greater the need for formality in the handling of changes.

The general steps in the process are:

1. Define changes. In developing the process a key question to answer is- who can create changes? Can anyone suggest a change to the regional ITS architecture baseline, or must suggested changes go through certain specified channels or organizations? Does any paperwork need to accompany a change request? Here the process might be formal, with change request forms, or informal, with requests taking the form of emails or other non standardized inputs.
2. Assess the impact of the change. Someone needs to evaluate the change and determine what impact it has upon the architecture baseline. This evaluation could be required of the person proposing the change, or it could be performed by someone else (possibly the person, or group of people responsible for maintaining the architecture).
3. Provide a recommendation to the Change Control Group. For proper change control some group (or individual in less complex cases) should be assigned responsibility for reviewing and approving changes to the baseline. This Change Control Group (sometimes referred to as a Configuration Control Board) should be lead by the individual responsible for maintaining the architecture (or by one of the individuals if it is a group activity). The job of the Group is to decide what changes go into the architecture baseline. The level of formality (and the size of the Group) will depend upon the size and complexity of the architecture. On one end of the spectrum a single person may perform the entire function for very simple architectures. On the other

end of the spectrum a committee of key representatives from each stakeholder area or key stakeholder may be involved.

4. The Change Control Group makes a decision. Either it accepts the change, rejects it, or asks for additional evaluation.
5. The decision is implemented. If the decision is to accept the change, then the appropriate portions of the architecture baseline are updated and an updated architecture baseline is defined.

This may seem like a rather formal process to suggest for maintaining the architecture, but it really does have a lot of flexibility, and can be as simple or as structured as the need dictates.

7.3.2 Outputs

There are several key outputs resulting from architecture maintenance. The first of these is an Architecture Maintenance Plan. This plan should be developed prior to completing the initial regional ITS architecture development effort and should document the process that the region will put in place to manage change to the architecture. The level of formality of the plan should be adapted for the size and complexity of the region. The following provides some high level sections to consider along with a checklist of some information to include in each section:

1. Responsibility for maintaining the architecture
   - Who will be in charge of maintaining the regional ITS architecture?
   - Who (or what organizations) will support the maintenance effort?
   - Who will these people report their activities to? Or who will hold them accountable?

2. Definition of the architecture baseline.
   - What outputs or documents will be controlled?
   - How will different versions of the documents be identified (date, version number, etc.)?
   - What information will be made available to the wider range of stakeholders in the region?

3. Process to be used for Change Management.
   - Who can introduce changes?
   - How must the changes be documented?
   - Who will evaluate prospective changes?
   - Who will make the decision to incorporate changes? Will there be a Change Control Group? Who will be its members?
   - How will the decisions of the Group be documented?
   - Who will incorporate accepted changes?

4. Notifying the region of changes
   - Who will be notified of changes?
   - How will this be done?

The Maintenance Plan should be reviewed periodically for needed changes. Why? Because sometimes things don't work as you originally intended and you need to change the responsibilities, the definition of baseline, or the process of managing change. The status of maintenance activities (e.g. status of changes accepted or rejected) should also be presented periodically to whatever agency, steering committee, or group is responsible for managing those performing the maintenance.

The other primary output of the Maintaining the Architecture step is, of course, the updated Architecture Baseline. The end goal of this step is to have a complete and up-to-date definition of the regional ITS architecture in whatever form the region decides to define its baseline (e.g. documents, databases, CD-ROMS, websites, etc.).

Appendix A Regional ITS Architecture Tools

Several tools are available that make the job of developing a regional ITS architecture easier. This appendix describes three of the tools that are most frequently used in regional ITS architecture development: the National ITS Architecture Hypertext View, National ITS Architecture Databases, and Turbo Architecture.

Gone are the days when you needed a bookshelf full of documents to access the information in the National ITS Architecture. Today, the National ITS Architecture is published on a widely distributed CD-ROM and on the web. Both the CD-ROM and the Web Site still contain the National ITS Architecture documents - as PDF formatted electronic documents - but the really useful "tools" to the regional ITS architecture developer are two additional views of the Architecture that are also included on the CD-ROM and Web Site: a Hypertext View and a Database view. Both of these views include all of the National ITS Architecture elements, including the subsystems, terminators, equipment packages, market packages, and architecture flows that are used to support regional ITS architecture development.

While the architecture hypertext and database views provide very efficient and powerful ways to access the National ITS Architecture information, they are general-purpose tools that include no built-in features specifically for regional ITS architecture development. Turbo Architecture is a software tool that was developed specifically to support regional ITS architecture and project architecture development and maintenance.

Obtaining the Tools and Training: The National ITS Architecture Hypertext View and Databases are available on CD-ROM and on the Internet at http://www.iteris.com/itsarch/ . The National ITS Architecture CD-ROM can be ordered by emailing ITSPUBS@igate.fhwa.dot.gov. There is no charge for this CD. The Turbo Architecture software tool can be obtained from McTrans by visiting their web site at http://www-mctrans.ce.ufl.edu/featured/turbo/ or by calling (352) 392-0378, leaving voice mail at (800) 226-1013, or sending e-mail to mctrans@ce.ufl.edu. National ITS Architecture and Turbo Architecture training courses are offered by the National Highway Institute (NHI). Visit the NHI web site (http://www.nhi.fhwa.dot.gov/) for more information.

A.1 Hypertext View

The Hypertext View of the National ITS Architecture provides immediate, interconnected access to all the elements of the National ITS Architecture definition. The same Hypertext View is included on both the CD-ROM and the Web Site. The Web Site always presents the latest official version of the National ITS Architecture. The CD provides convenient access to a specific version of the National ITS Architecture hypertext.

The Hypertext view is the first (default) view that is presented on the Web Site. The same view is accessed on the CD-ROM by selecting the **`index.htm`** file from the top-level directory on the CD. The system will then bring up the default web browser software and present a window that resembles the one shown in Figure 21.

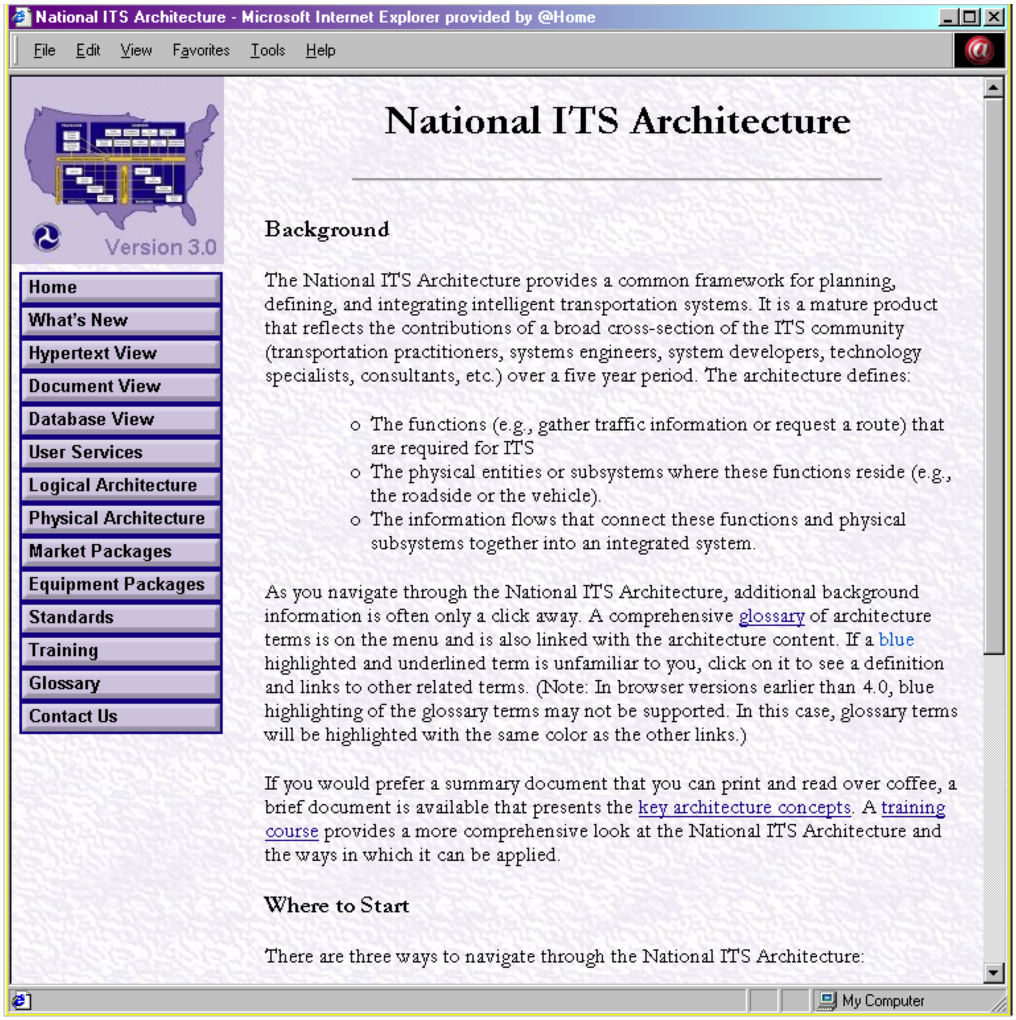


Figure 21: Index Page of the National ITS Architecture Hypertext View

By clicking on the `Hypertext View`, a diagram is provided (as shown in Figure 22), that identifies each of the components of the National ITS Architecture. Users may select any aspect of the Architecture by clicking on the various highlighted parts of the diagram: `User Services`, `Processes`, Data Flows, Subsystems, Architecture Flows, Equipment Packages, Market Packages, and Standards Requirements.

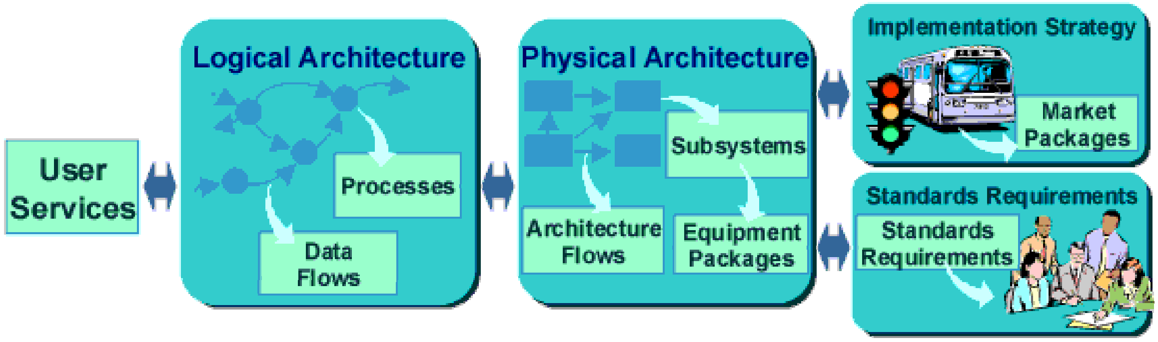


Figure 22: Diagram of Entry Points to the National ITS Architecture

The Hypertext view defines all of the components of the architecture, including textual descriptions that are accompanied by graphics for many of the components. For example, Figure 23 shows a graphical representation of a market package for multi-modal coordination. Both text and graphics (in EMF format) can be copied and pasted to support regional ITS architecture definition. The real power of the hypertext view is in the thousands of links between components that allow the user to easily move from one component to any related component with a click of the mouse. For example, the definitions of all architecture flows, equipment packages, and subsystems that are associated with a particular market package are just a click away.

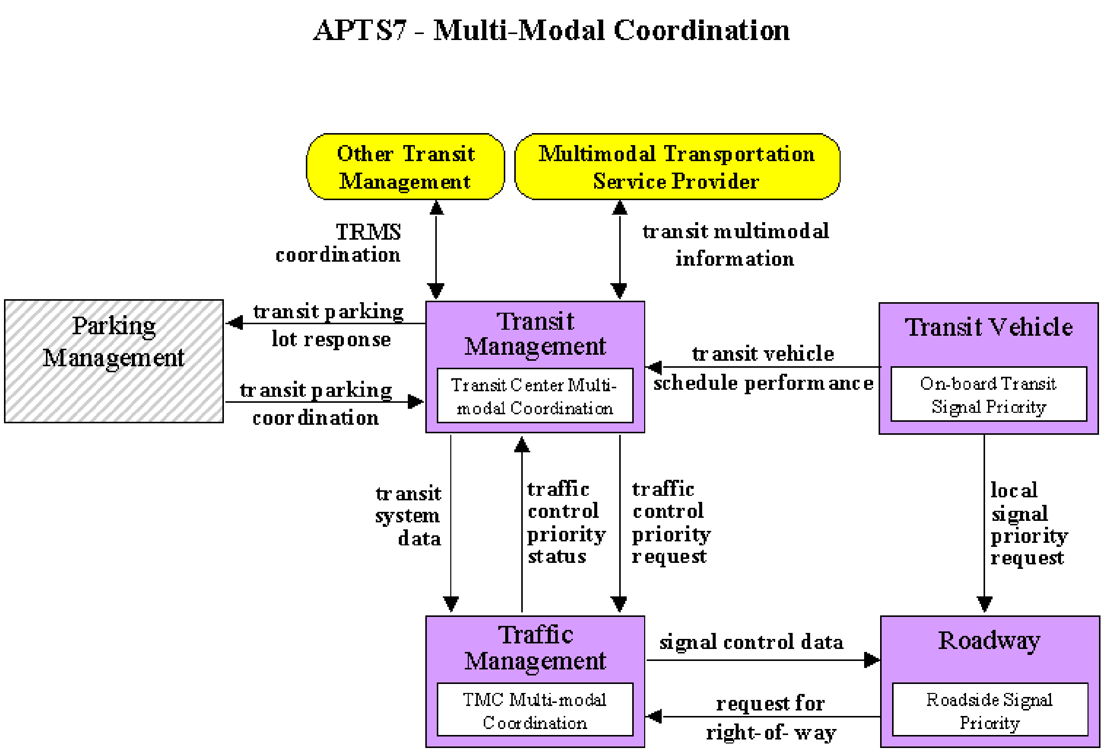


Figure 23: Representative Market Package Graphic.

The Hypertext view is easy to navigate through and provides a familiar web browser interface. Its extensive linked presentation of the National ITS Architecture provides a quick reference guide for use when developing a regional ITS architecture.

A.2 Databases

For those stakeholders that are familiar with Microsoft® Access, the database view of the National ITS Architecture provides several databases that contain the same content as the hypertext view. The databases that are available on the web site and the CD-ROM are shown in Table 18. Using Microsoft® Access, specialized queries, forms, and reports can be developed to select relevant portions of the Architecture and to display the selected portions in various formats. This is the Architecture in its raw form without the benefit of formatting and linkage contained in the Hypertext version. The databases can be the most flexible and powerful tools available to the regional ITS architecture developer, but they require significant knowledge of Microsoft Access and the underlying National ITS Architecture database schemas.

Table 18: National ITS Architecture Databases

Database	*Description*
Logical Architecture	Defines all the processes, data flows, and data stores in the Logical Architecture.
Physical Architecture	Defines all subsystems, equipment packages, and architecture flows in the Physical Architecture and their connection with the Logical Architecture components.
Traceability	The authoritative source for the relationships between the architecture and the user service requirements.
Standards Requirements	Defines all standards requirements (leveled data items) and their relationship to the Logical and Physical Architecture.
Market Packages	Defines market packages, the elements of the physical architecture that comprise each market package, and the relationships between market packages.
SDOMAP	Defines the relationship between ITS standards and the Physical Architecture. Each ITS standard is identified and mapped to all related architecture flows in this database.

A.3 Turbo Architecture

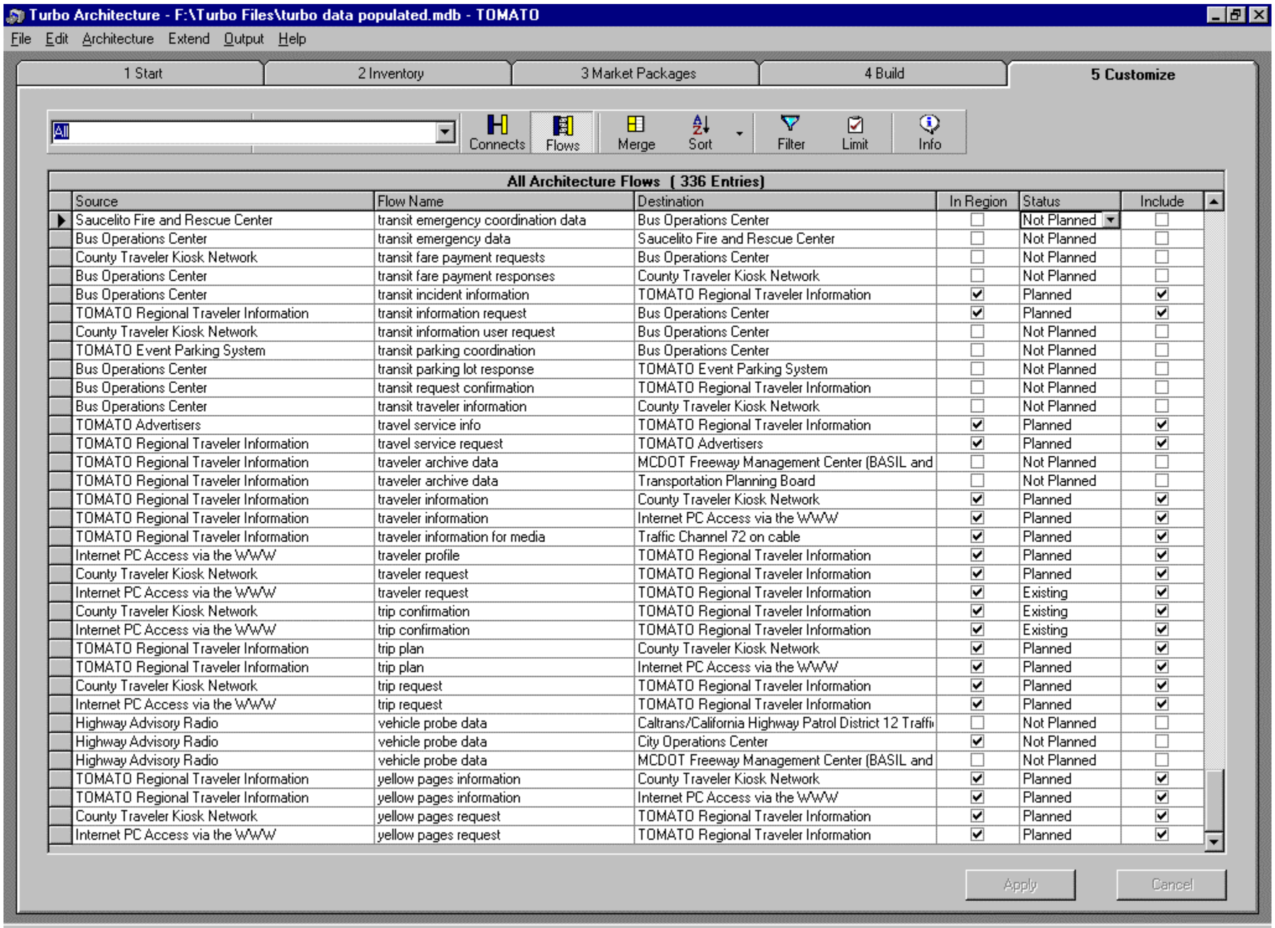
The Turbo Architecture™ tool is a high-level, interactive software program that assists transportation planners and system integrators, both in the public and private sectors, in the development of regional and project architectures using the National ITS Architecture as a reference. Turbo Architecture™ allows a user to:

- create a Regional Architecture,
- create a Project Architecture when no Regional Architecture exists,
- create a Project Architecture from an existing Regional Architecture, and/or
- merge a previously-defined Project Architecture into an existing Regional Architecture.

Turbo Architecture™ helps the user integrate multiple project architectures both with each other and with a regional architecture. In addition, Turbo Architecture™ provides an *initial start* toward both architecture development and consistency with the National ITS Architecture. Proper use of the Turbo Architecture™ tool, however, requires the Turbo Architecture™ user to be familiar with the National ITS Architecture.

The user enters their region- or project-specific information into the tool, and generates an architecture that can be customized to their needs. There are two ways to initially enter information into Turbo Architecture™: via an interview or directly into tabular forms. The interview guides the user through a series of questions and options that result in the creation of a transportation systems inventory and a set of services. The user may also go directly to a pair of tabular forms to create this initial inventory and set of services. In either case, this information initiates the development of an ITS architecture.

Once this initial data input is complete, the user can begin to customize their architecture, which is a necessary next step. Both the interview and tabular forms help the user identify and extract the pertinent National ITS Architecture pieces they require. In addition, Turbo Architecture™ allows the user to map and tailor local system names and descriptions to match local needs, services and systems. The user can also extend their architecture beyond elements defined in the National ITS Architecture by adding their own information flows and transportation elements for those areas not covered by the National ITS Architecture. Figure 24 shows an example of the Customize Tab for a Project Architecture that is part of a larger Regional Architecture.



Source	Flow Name	Destination	In Region	Status	Include
Saucelito Fire and Rescue Center	transit emergency coordination data	Bus Operations Center	☐	Not Planned	☐
Bus Operations Center	transit emergency data	Saucelito Fire and Rescue Center	☐	Not Planned	☐
County Traveler Kiosk Network	transit fare payment requests	Bus Operations Center	☐	Not Planned	☐
Bus Operations Center	transit fare payment responses	County Traveler Kiosk Network	☐	Not Planned	☐
Bus Operations Center	transit incident information	TOMATO Regional Traveler Information	☑	Planned	☑
TOMATO Regional Traveler Information	transit information request	Bus Operations Center	☑	Planned	☑
County Traveler Kiosk Network	transit information user request	Bus Operations Center	☐	Not Planned	☐
TOMATO Event Parking System	transit parking coordination	Bus Operations Center	☐	Not Planned	☐
Bus Operations Center	transit parking lot response	TOMATO Event Parking System	☐	Not Planned	☐
Bus Operations Center	transit request confirmation	TOMATO Regional Traveler Information	☐	Not Planned	☐
Bus Operations Center	transit traveler information	County Traveler Kiosk Network	☐	Not Planned	☐
TOMATO Advertisers	travel service info	TOMATO Regional Traveler Information	☑	Planned	☑
TOMATO Regional Traveler Information	travel service request	TOMATO Advertisers	☑	Planned	☑
TOMATO Regional Traveler Information	traveler archive data	MCDOT Freeway Management Center (BASIL and	☐	Not Planned	☐
TOMATO Regional Traveler Information	traveler archive data	Transportation Planning Board	☐	Not Planned	☐
TOMATO Regional Traveler Information	traveler information	County Traveler Kiosk Network	☑	Planned	☑
TOMATO Regional Traveler Information	traveler information	Internet PC Access via the WWW	☑	Planned	☑
TOMATO Regional Traveler Information	traveler information for media	Traffic Channel 72 on cable	☑	Planned	☑
Internet PC Access via the WWW	traveler profile	TOMATO Regional Traveler Information	☑	Planned	☑
County Traveler Kiosk Network	traveler request	TOMATO Regional Traveler Information	☑	Planned	☑
Internet PC Access via the WWW	traveler request	TOMATO Regional Traveler Information	☑	Existing	☑
County Traveler Kiosk Network	trip confirmation	TOMATO Regional Traveler Information	☑	Existing	☑
Internet PC Access via the WWW	trip confirmation	TOMATO Regional Traveler Information	☑	Existing	☑
TOMATO Regional Traveler Information	trip plan	County Traveler Kiosk Network	☑	Planned	☑
TOMATO Regional Traveler Information	trip plan	Internet PC Access via the WWW	☑	Planned	☑
County Traveler Kiosk Network	trip request	TOMATO Regional Traveler Information	☑	Planned	☑
Internet PC Access via the WWW	trip request	TOMATO Regional Traveler Information	☑	Planned	☑
Highway Advisory Radio	vehicle probe data	Caltrans/California Highway Patrol District 12 Traffi	☐	Not Planned	☐
Highway Advisory Radio	vehicle probe data	City Operations Center	☑	Not Planned	☐
Highway Advisory Radio	vehicle probe data	MCDOT Freeway Management Center (BASIL and	☐	Not Planned	☐
TOMATO Regional Traveler Information	yellow pages information	County Traveler Kiosk Network	☑	Planned	☑
TOMATO Regional Traveler Information	yellow pages information	Internet PC Access via the WWW	☑	Planned	☑
County Traveler Kiosk Network	yellow pages request	TOMATO Regional Traveler Information	☑	Planned	☑
Internet PC Access via the WWW	yellow pages request	TOMATO Regional Traveler Information	☑	Planned	☑

Figure 24: Turbo Architecture Customize Tab

Once the architecture has been customized, there is the issue of how to present the information to stakeholders. Turbo Architecture^{TM} answers this need with multiple useful output reports and diagrams that are available for display and printing. The underlying information describing the architecture is also available for exporting as data sets, which can be further, analyzed. Figure 25 shows an example output—an Architecture Flow Diagram of the elements and information flows from a Regional Traveler Information Center to users and other centers in the region.

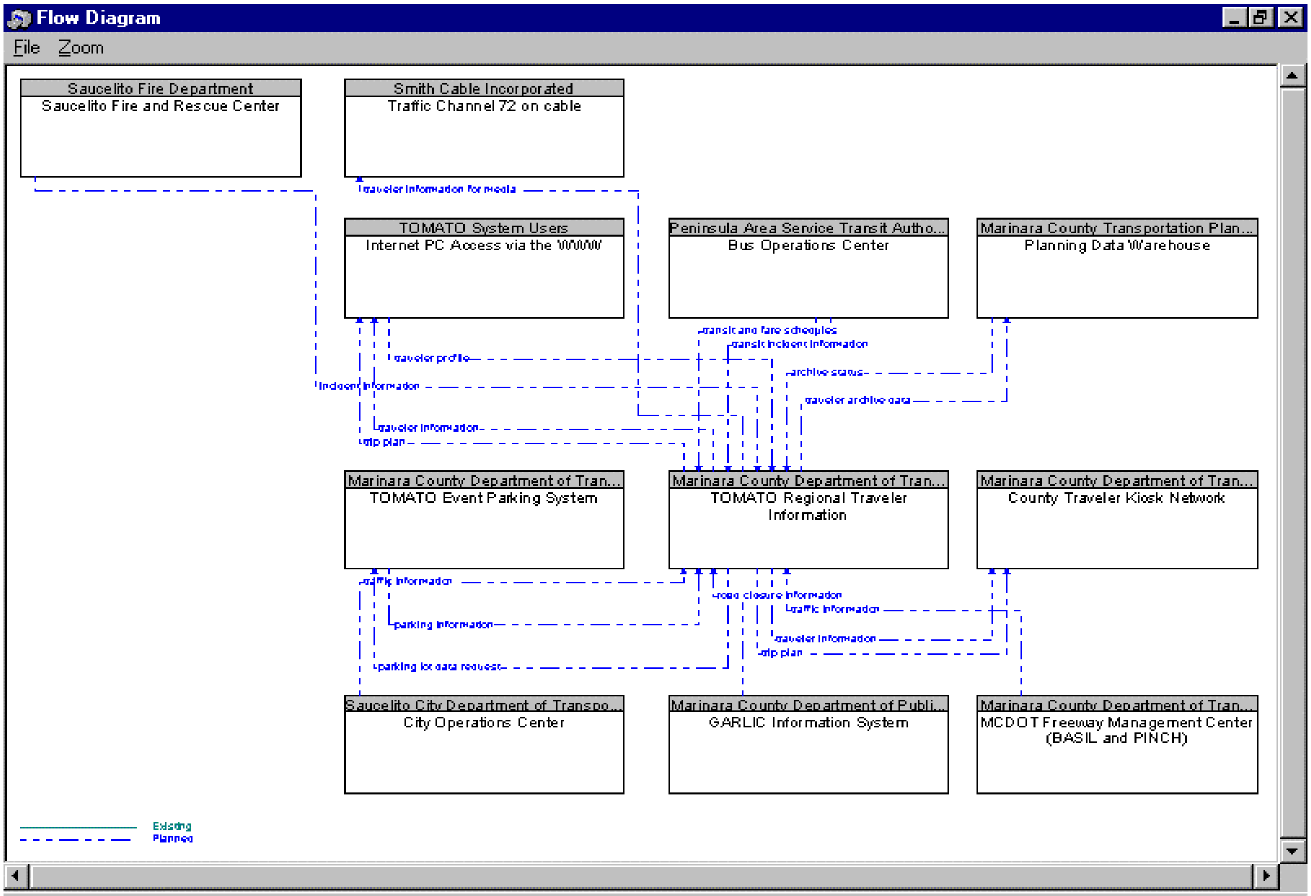
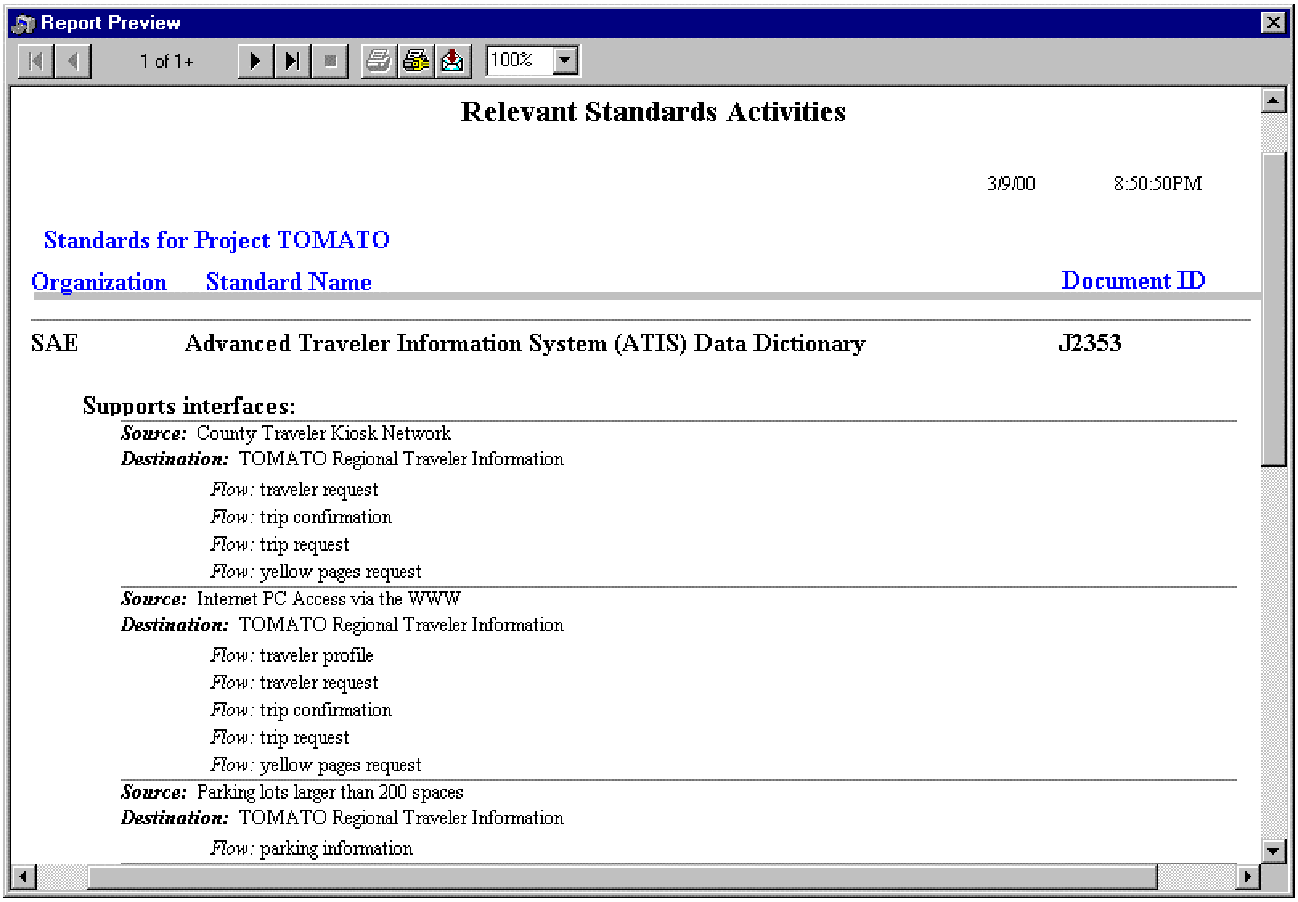


Figure 25: Sample Architecture Flow Diagram

Figure 26 shows an example report available from Turbo Architecture™. This particular report, Relevant Standards Activities, identifies which ITS standards the region or project may want to consider as they implement specific interfaces of their architecture.

Turbo Architecture™ helps the user integrate multiple project architectures with each other and with a regional architecture. In a single file the user can create a single regional architecture and multiple project architectures. Turbo Architecture™ is a standalone Windows application program that produces Microsoft Access 97-compatible data files that the user may further manipulate directly using Microsoft Access 97 or later.


Report Preview

1 of 1+

100%

Relevant Standards Activities

3/9/00 8:50:50PM

Standards for Project TOMATO

Organization	Standard Name	Document ID
SAE	**Advanced Traveler Information System (ATIS) Data Dictionary**	J2353

Supports interfaces:

Source: County Traveler Kiosk Network
Destination: TOMATO Regional Traveler Information
Flow: traveler request
Flow: trip confirmation
Flow: trip request
Flow: yellow pages request

Source: Internet PC Access via the WWW
Destination: TOMATO Regional Traveler Information
Flow: traveler profile
Flow: traveler request
Flow: trip confirmation
Flow: trip request
Flow: yellow pages request

Source: Parking lots larger than 200 spaces
Destination: TOMATO Regional Traveler Information
Flow: parking information

Figure 26: Sample Turbo Architecture Report

Appendix B Glossary

Architecture

A framework within which a system can be built. An Architecture functionally defines what the pieces of the system are and the information that is exchanged between them. An Architecture is not technology specific which allows the Architecture to remain effective over time. It defines "what must be done," not "how it will be done".

Architecture Baseline

The clear identification of the architecture products that will be maintained, including specific format and version information. Changes to the Architecture Baseline must follow an approved change management process typically documented in a Maintenance Plan. The Architecture Baseline will change over time as the Architecture is revised.

Architecture Flow

Information that is exchanged among Subsystems and between Subsystems and Terminators in the Physical Architecture view of the National ITS Architecture. Architecture Flows are the primary tool that is used to define the Regional ITS Architecture Interfaces. These Architecture Flows and their communication requirements define the Interfaces, which form the basis for much of the ongoing Standards work in the National ITS program. In this document, the terms "information flow" and "architecture flow" are used interchangeably.

Architecture Interconnect

Communications paths that carry information between Subsystems and Terminators in the Physical Architecture view of the National ITS Architecture. Several different types of Interconnects are defined in the National ITS Architecture to reflect the range of Interface requirements in ITS. Four different types of communications links are defined: Wireline, Wide Area Wireless, Dedicated Short Range Communications, and Vehicle to Vehicle communications. In addition to these types, several specialized Interconnects are also defined to reflect other Interface requirements, including human interface (e.g., what the system user sees and hears) and physical/environmental (e.g., what the ITS sensors sense).

Center Subsystems

Subsystems that provide 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. Some examples of center subsystems are Traffic Management, Transit Management, Commercial Vehicle Administration, Planning, Emissions Management, Toll Administration, Emergency Management, Information Service Provider, and Fleet and Freight Management. One of four general Subsystem classes defined in the National ITS Architecture.

Champion

Person or persons who serves as a point-of-contact and provides leadership in the development and maintenance of a Regional ITS Architecture.

Communications Hub

A communications hub facilitates communications connectivity between regional ITS architecture systems. Hubs normally provide communications and server functions and may or may not provide transportation-related functions such as data fusion.

Congestion Management Plan

Document that describes the strategy that will be used to prevent deterioration of Congestion Management System (CMS) performance.

Congestion Management System (CMS)

TEA-21 requires that each Transportation Management Area (see definition of TMA) develop a CMS that provides for effective management of new and existing transportation facilities through the use of travel demand reduction and operational management strategies.

Corridor/Sub-area Study

Also known as “Major Investment Studies,” these studies are used to flesh out transportation strategy and project recommendations on a geographic basis. A Corridor or Sub-area is a context for evaluating how specific transportation conditions, problems, and needs should be addressed within the defined geographic area. A wide range of multimodal strategies, including ITS, are considered as candidate solutions for those problems.

Data Dictionary Entry (DDE)

Every Data Flow included in the Logical Architecture view of the National ITS Architecture is defined in a Data Dictionary Entry (DDE). Each DDE contains a textual description of the Data Flow and identifies any lower level data elements that make up the Data Flow.

Data Flow

Data Flows are modeled in the Logical Architecture view of the National ITS Architecture. Data Flows represent data flowing between Processes or between a Process and a terminator. A Data Flow is shown as an arrow on a Data Flow Diagram and is defined in a Data Dictionary Entry in the Logical Architecture. Data flows are aggregated together to form high-level Architecture Flows in the Physical Architecture view of the National ITS Architecture.

Data Flow Diagram

The diagrams in the Logical Architecture view of the National ITS Architecture that show the functions that are required for ITS and the data that moves between these functions. Only four different symbols are used on the diagrams. Circles represent the Processes or functions that do the work. Arrows represent the Data Flows that show how data moves through the system. Parallel lines represent Data Stores that represent "data at rest" in the system. Finally, rectangles represent the terminators that define the Architecture boundary. A hierarchy of these diagrams depict the ITS functionality and Data Flow requirements in successively greater detail.

Data Store

A Data Store represents “data at rest” in a Data Flow Diagram. Data Stores represent data repositories that are required to support data aggregation or archival functions in the Logical Architecture.

Dedicated Short Range Communications (DSRC)

A wireless communications channel used for close-proximity communications between vehicles and the immediate infrastructure. It supports location-specific communications for ITS services such as toll collection, transit vehicle management, driver information, and automated commercial vehicle operations. One of the four types of Architecture Interconnects defined in the National ITS Architecture.

Element

This is the basic building block of a Regional ITS Architecture. It is the name used by the Stakeholders to describe a system or piece of a system.

Equipment Package

Equipment Packages are the building blocks of the Physical Architecture Subsystems. Equipment Packages group like Processes of a particular Subsystem together into an “implementable” package. The grouping also takes into account the User Services and the need to accommodate various levels of functionality. Since Equipment Packages are both the most detailed elements of the Physical Architecture view of the National ITS Architecture and tied to specific Market Packages, they provide the common link between the interface-oriented Architecture definition and the deployment-oriented Market Packages.

Federal Highway Administration (FHWA)

An agency of the United States Department of Transportation that funds highway planning and programs.

Federal Transit Administration (FTA)

An agency of the United States Department of Transportation that funds transit planning and programs.

Functional Requirements Specification

A description of WHAT a system must do to address the needs or provide the services that have been identified for the region. The description should use formal "shall" language and document the functions in terms that the stakeholders, particularly the system implementers, will understand. In a Regional ITS Architecture, the Functional Requirements focus on the high-level requirements that support regional integration.

Highway Trust Fund (HTF)

Established as a federal mechanism for financing the accelerated highway program, the HTF is a source of funds from which ISTEA and later TEA-21 authorizes expenditures.

Hub

See Communications Hub.

Information Flow

Information that is exchanged between Subsystems and Terminators in the Physical Architecture view of the National ITS Architecture. In this document, the terms "Information Flow" and "Architecture Flow" are used interchangeably.

Institutional Integration

Institutional Integration represents the process of combining existing and emerging institutional constraints and arrangements. Integration is at least two-fold in a region; technical integration involves the functional act of integration while institutional integration addresses the agency and/or regional environment for integration. Both are necessary components for interoperable systems.

Intelligent Transportation System (ITS)

Electronics, communications, and information processing that are integrated to improve the efficiency or safety of surface transportation.

ITS Architecture

Defines an Architecture of interrelated systems that work together to deliver transportation Services. An ITS Architecture defines how systems functionally operate and the interconnection of information exchanges that must take place between these systems to accomplish transportation Services.

ITS Project

Any project that in whole or in part funds the acquisition of technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS User Services.

ITS Strategic Plan

A guide for long term implementation of ITS in the state, metropolitan area, or region. A Strategic Plan will normally include identifying regional transportation needs and then defining ITS Elements to be implemented over time, aimed at meeting those needs. A regional ITS architecture is typically a core component of an ITS Strategic Plan.

Interconnect

See Architecture Interconnect.

Interface

The connection between two systems. In the regional ITS architecture, an interface is described by the architecture interconnect – the line of communications between the two systems – and the information flows that define the types of information that will be shared over the interconnect.

Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA)

Legislative initiative by the United States Congress that restructured funding for transportation programs. ISTEA authorized increased levels of highway and transportation funding and an increased role for regional planning commissions/MPOs in funding decisions. The Act also requires comprehensive Regional and Statewide long-term Transportation Plans and places an increased emphasis on public participation and transportation alternatives.

Inventory

See System Inventory.

Joint Program Office (JPO)

The office of the United States Department of Transportation established to oversee and guide the multi-modal National Intelligent Transportation Systems program.

Legacy System

Existing transportation systems, communications systems, or institutional processes.

Lifecycle

A term used when denoting the strategic cycle or sequencing of a specific process. The Guidance Document refers to the process steps as a “lifecycle”.

Logical Architecture

The Logical Architecture view of the National ITS Architecture defines what has to be done to support the ITS User Services. It defines the Processes that perform ITS functions and the information or Data Flows that are shared between these Processes. The Logical Architecture was developed using Structured Analysis techniques and consists of Data Flow Diagrams, Process Specifications, and Data Dictionary Entries. The Logical Architecture is not technology specific, nor does it dictate a particular implementation. This implementation independence makes the Logical Architecture accommodating to innovation, scaleable from small-scale implementations to large regional systems, and supportive of widely varied system designs.

Maintenance Plan

Description of configuration control and update guidelines for Regional and/or Project ITS Architectures. The primary purpose of the Maintenance Plan is to maintain an Architecture Baseline.

Major ITS Project

Any ITS project that implements part of a regional ITS initiative that is multi-jurisdictional, multi-modal, or otherwise affects regional integration of ITS systems.

Market Package

Market Packages identify the pieces of the Physical Architecture that are required to implement a particular transportation Service. They provide an accessible, service oriented, perspective to the National ITS Architecture. They are tailored to fit - separately or in combination - real world transportation problems and needs. Market Packages collect together one or more Equipment Packages that must work together to deliver a given transportation Service and the Architecture Flows that connect them and other important external systems.

Memorandum of Understanding (MOU)

Institutional agreement that contains a description of the level of effort and integration details necessary for sharing information between ITS elements. An MOU can also address sharing of equipment, maintenance, enforcement, operations, control, etc. An MOU can be used to create a more detailed agreement such as an Interagency, Intergovernmental, Operational, Funding or Master Agreement.

Metropolitan Planning Organization (MPO)

The forum for cooperative decision making for the metropolitan planning area.

Metropolitan Transportation Plan

This document is the official metropolitan, intermodal transportation plan that is developed through the regional transportation process.

National ITS Architecture

A common, established framework for developing integrated transportation systems. The National ITS Architecture is comprised of the Logical Architecture and Physical Architecture, which satisfy a defined set of User Services. The National ITS Architecture is maintained by the United States Department of Transportation (USDOT).

National Program Plan

Jointly developed by the USDOT and ITS America with substantial involvement from the broader ITS community. The purpose of the National Program Plan was to guide the development and deployment of ITS. It defined the first 28 User Services that were the basis for the National ITS Architecture development effort.

Operational Concept

An operational concept identifies the roles and responsibilities of participating agencies and stakeholders. It defines the institutional and technical vision for the region and describes how the system will work at a very high-level, frequently using operational scenarios as a basis.

Physical Architecture

The Physical Architecture is the part of the National ITS Architecture that provides agencies with a physical representation (though not a detailed design) of the important ITS Interfaces and major system components. The principal elements in the Physical Architecture are the Subsystems, Terminators and Architecture Flows that connect these Subsystems and Terminators into an overall framework. At the next level of detail, the Physical Architecture identifies Equipment Packages for each Subsystem and assigns Processes identified in the Logical Architecture to these Equipment Packages. Similarly, the Data Flows from the Logical Architecture are grouped together and assigned to Architecture Flows.

Process

A function or activity identified in the Logical Architecture view of the National ITS Architecture that is required to support the ITS User Services. The Logical Architecture presents Processes in a top-down fashion beginning with general Processes (e.g., "Manage Traffic") that are then decomposed into more detailed Processes (e.g., "Provide Traffic Surveillance", "Monitor HOV Lane Use"). General Processes are defined in terms of more detailed Processes using Data Flow Diagrams. The most detailed Processes are defined in Process Specifications (PSpecs).

Process Specification (PSpec)

The textual definition of the most detailed Processes identified in the Logical Architecture view of the National ITS Architecture. The Process Specification includes an overview, a set of functional requirements, a complete set of inputs and outputs, and a list of the User Service requirements that are satisfied by the PSpec.

Project ITS Architecture

A framework that identifies the institutional agreement and technical integration necessary to define an ITS project and its interfaces with other ITS projects and systems.

Project Sequencing

The order in which projects are deployed. An important part of the transportation planning process is the sequence or order that ITS projects are deployed. The Regional ITS Architecture provides a new way to look at these ITS projects relationships or “dependencies”. By taking these dependencies into account, an efficient sequence can be developed so that projects incrementally build on each other.

PSpec

Abbreviation for Process Specification.

Region

The geographical area that identifies the boundaries of the Regional ITS Architecture and is defined by and based on the needs of the participating agencies and other Stakeholders. In metropolitan areas, a Region should be no less than the boundaries of the metropolitan planning area.

Regional ITS Architecture

A specific, tailored framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects in a particular Region. It functionally defines what pieces of the system are linked to others and what information is exchanged between them.

Roadside Subsystems

One of four general classes of Subsystems defined in the National ITS Architecture. This class includes the intelligent infrastructure distributed along the transportation network which perform surveillance, information provision, and control functions. This includes ITS field equipment on roadway facilities as well as ITS equipment at parking facilities, toll systems, and commercial vehicle check systems that are also at or near the roadside.

Sausage Diagram

A diagram which depicts all Subsystems in the National ITS Architecture and the basic communication channels between these Subsystems. The "Sausage Diagram" is a top-level Architecture Interconnect diagram. Variations of the Sausage Diagram are sometimes used to depict Regional ITS Architectures at a high level.

Service Boundaries

The geographic boundary of a specific service or agency that provides a service. An example is the service area of a transit agency. The transit agency provides services only within the defined boundary.

Stakeholders

Anyone with a vested interest or “stake” in the regional ITS architecture. This includes public agencies, private organizations, special interests, and the traveling public.

Standards

Documented technical specifications sponsored by a Standards Development Organization (SDO) to be used consistently as rules, guidelines, or definitions of characteristics for the interchange of data. A broad array of ITS Standards is currently under development that will specifically define the Interfaces identified in the National ITS Architecture.

Statewide Implementation Plan (SIP)

A document required to be prepared periodically by each state that contain one or more “air-quality non-attainment” areas that describes specific projects that will be constructed and/or operated over the next several years (minimum three years, some areas include additional years). ISTEA/TEA-21 and the Clean Air Act (CAA) require that these states demonstrate in the SIP that planned transportation programs will not exacerbate the existing air-quality problem.

Statewide Transportation Improvement Program (STIP)

This is a document prepared by each state that is a staged, multi-year, statewide, intermodal program of transportation projects which is consistent with the Statewide Transportation Plan and planning processes and Metropolitan Transportation Plans, TIPs and processes.

Statewide Transportation Plan

This document is the official statewide, intermodal transportation plan that is developed through the statewide transportation process.

Subsystem

The principal structural element of the Physical Architecture view of the National ITS Architecture. Subsystems are individual pieces of the Intelligent Transportation System defined by the National ITS Architecture. Subsystems are grouped into four classes: Centers, Roadside, Vehicles, and Travelers. Example Subsystems are the Traffic Management Subsystem, the Vehicle Subsystem, and the Roadway Subsystem. These correspond to the physical world: respectively traffic operations centers, automobiles, and roadside signal controllers. Due to this close correspondence between the physical world and the Subsystems, the Subsystem interfaces are prime candidates for standardization.

Systems Engineering

A structured process for arriving at a final design of a system. The final design is selected from a number of alternatives that would accomplish the same objectives and considers the total Life-Cycle of the project including not only the technical merits of potential solutions but also the costs and relative value of alternatives.

System Inventory

The collection of all ITS-related Elements in a Regional ITS Architecture.

Terminator

Terminators define the boundary of an Architecture. The National ITS Architecture Terminators represent the people, systems, and general environment that interface to ITS. The Interfaces between Terminators and the Subsystems and Processes within the National ITS Architecture are defined, but no functional requirements are allocated to Terminators. The Logical and Physical Architecture views of the National ITS Architecture both have exactly the same set of Terminators.

Transit Development Plan

This document is prepared by the transit agency and identifies transit needs and the changes in services and systems that are recommended to better meet those needs. It will feed information to both the Transportation Plan and the Transportation Improvement Program (TIP).

Transportation Equity Act for the 21st Century (TEA-21)

Passed in 1997 by Congress to address the need to begin work toward regional integration of transportation systems. TEA-21 is the successor reauthorization of the ISTEA legislation.

Transportation Improvement Program (TIP)

This is a document prepared by each Metropolitan Planning Organization (MPO) listing projects to be funded with FHWA/FTA funds for the next one to three year period. It is consistent with the Metropolitan Transportation Plan.

Transportation Management Area (TMA)

All urbanized areas over 200,000 in population and all other areas that request designation.

Transportation Plan

Also called the “Long Range Transportation Plan”, this plan defines the state or metropolitan area's long-term approach to constructing, operating, and maintaining the multi-modal transportation system.

Traveler Subsystems

Equipment used by travelers to access ITS services pre-trip and en-route. This includes services that are owned and operated by the traveler as well as services that are owned by transportation and information providers. One of four general Subsystem classes defined in the National ITS Architecture.

Turbo Architecture

An automated software tool used to input and manage System Inventory, Market Packages, Interconnects and Architecture Flows with regard to a Regional ITS Architecture.

United States Department of Transportation (USDOT)

The principal direct Federal funding agency for transportation facilities and programs. Includes the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), the Federal Railroad Administration (FRA), the Federal Motor Carrier Safety Administration (FMCSA), and others.

User Service

User Services document what ITS should do from the user's perspective. A broad range of users are considered, including the traveling public as well as many different types of system operators. User Services form the basis for the National ITS Architecture development effort. The initial User Services were jointly defined by USDOT and ITS America with significant Stakeholder input and documented in the National Program Plan (NPP). Over time, new or updated User Services will continue to be developed and the National ITS Architecture will be updated to support these User Service changes.

User Service Requirement

A specific functional requirement statement of what must be done to support the ITS User Services. The User Service Requirements were developed specifically to serve as a requirements baseline to drive National ITS Architecture development. The User Service Requirements are not requirements to system/architecture implementers, but rather are directions to the National ITS Architecture development team.

Vehicle Subsystems

Covers ITS related elements on vehicle platforms. Vehicle Subsystems include general driver information and safety systems applicable to all vehicle types. Three fleet Vehicle Subsystems (Transit, Emergency, and Commercial Vehicles) add ITS capabilities unique to these special vehicle types. One of four general Subsystem classes defined in the National ITS Architecture.

Vehicle-to-Vehicle Communications

Dedicated wireless system handling high data rate, low probability of error, line of sight communications between vehicles. Advanced vehicle services may use this link in the future to support advanced collision avoidance implementations, road condition information sharing, and active coordination to advanced control systems. One of the four types of Architecture Interconnects defined in the National ITS Architecture.

Wide Area Wireless Communications

A communications link that provides communications via a wireless device between user and an infrastructure based system. Both broadcast (one-way) and interactive (two-way) communications services are grouped into wide-area wireless communications in the National ITS Architecture. These links support a range of services in the National ITS Architecture including real-time traveler information and various forms of fleet communications. One of the four types of Architecture Interconnects defined in the National ITS Architecture.

Wireline Communications

A communications link serving fixed locations. It may be implemented using a variety of public or private communications networks that may physically include wireless (e.g., microwave) as well as wireline infrastructure. Both dedicated and shared communications resources may be used. One of the four types of Architecture Interconnects defined in the National ITS Architecture.