Applying a

REGIONAL ITS ARCHITECTURE TO SUPPORT PLANNING FOR OPERATIONS

A PRIMER

U.S. Department of Transportation
Federal Highway Administration
Federal Transit Adminstration
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16. Abstract

This primer offers transportation planners and operations managers a menu of opportunities for applying the regional ITS architecture to enhance planning for operations. It provides specific entry points for leveraging the regional ITS architecture in integrating operations into the planning process. This primer centers on the use of an objectives-driven, performance-based approach to planning for operations; an approach that can leverage regional ITS architectures given the approach's emphasis on operational objectives and performance measures and the architecture's use of data and services to address operational needs. Additionally, the primer leads planners and operators through techniques to make a regional ITS architecture relevant and more accessible to practitioner needs in planning for operations.

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Dear Colleague,

The Federal Highway Administration's (FHWA) Office of Planning, Environment, and Realty, Office of Operations, the Federal Transit Administration's (FTA) Office of Planning and Environment, and the Research and Innovative Technology Administration ITS Joint Programs Office are pleased to present this primer on Applying the Regional ITS Architecture to Support Planning for Operations.

A number of resources have been produced over the last few years by FHWA and FTA to advance operations thinking in the transportation planning process. In particular, guidance, best practices, and examples have been developed and used to illustrate how an objectives-driven, performance-based approach could be applied to integrate management and operations strategies and programs into metropolitan and statewide transportation plans. This approach forms the basis for the Planning for Operations initiatives.

Another aspect of the joint FHWA and FTA guidance is to facilitate the sustained application and use of the Regional ITS Architectures. The Regional ITS Architectures are another tool that can be used to help mainstream operations into the planning process. 23 CFR 940.5 requires that Regional ITS Architectures be "consistent with the transportation planning process for Statewide and Metropolitan Transportation Planning" and that a broad cross section of agencies involved in transportation operations, including highway agencies, public safety agencies, transit operators, and others be included in the architecture development process. Since the Architecture requirement took effect in 2005, over 300 regional ITS Architectures have been developed and many continue to be updated in accordance with Federal requirements.

The benefits derived by agencies from coordinating elements of the planning for operations approach with regional ITS architectures are the motivation for this primer. The regional ITS architecture can provide a technical framework for regional operations integration, information sharing, and data to support performance monitoring. By reviewing architecture documents and conducting in-depth planning practitioner interviews, the primer offers transportation planners and operations managers a menu of opportunities for applying the regional ITS architecture to enhance planning for operations.

Some of the areas where Regional ITS Architectures can enhance planning for operations include: improving collaboration between regional planning and operations practitioners, improving project scoping, improving traceability between regional objectives and operational strategies, and improving integration and coordination across agencies and systems. This primer, which continues the strong collaboration among FHWA, FTA, and professionals in the planning and operations communities nationwide, can be accessed electronically by visiting the USDOT website on Planning for Operations at http://www.plan4operations.dot.gov.

We look forward to receiving your feedback, reactions, and experiences in implementing the recommendations in the Primer. Please direct any comments, questions, and suggestions to any of the following members of our staff:

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ACRONYMS

ADMS	Archived Data Management Subsystem
ATDM	Active Transportation and Demand Management
ATM	Active Traffic Management
CAD	Computer-Aided Dispatch
CCTV	Closed-Circuit Television
CFR	Code of Federal Regulations
CMP	Congestion Management Process
DOT	Department of Transportation
FHWA	Federal Highway Administration
FSP	Freeway Service Patrol
FTA	Federal Transit Administration
GPS	Global Positioning System
ICM	Integrated Corridor Management
ITS	Intelligent Transportation Systems
LRSTP	Long-Range Statewide Transportation Plan
M&O	Management and Operations
MPO	Metropolitan Planning Organization
MTP	Metropolitan Transportation Plan
RCTO	Regional Concept for Transportation Operations
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
STIP	Statewide Transportation Improvement Program
TIP	Transportation Improvement Program
TMC	Transportation Management Center
TOC	Traffic Operations Center
TSM&O	Transportation Systems Management and Operations

Executive Summary

Effectively integrating management and operations (M&O) into the metropolitan and statewide transportation planning processes requires significant inter-agency collaboration and a regional view of the area's multimodal transportation system. Because many M&O strategies are underpinned by intelligent transportation systems (ITS), the coordination of planning for ITS among agencies at the institutional and technical level is an essential element to planning for operations. The regional ITS architecture, with a focus on integrating transportation services supported by ITS, presents a significant opportunity to support the needs for effective planning for operations.

This primer offers transportation planners and operations managers a menu of opportunities for applying the regional ITS architecture to enhance planning for operations. It provides specific entry points for leveraging the regional ITS architecture in integrating operations into the planning process. This primer focuses on the use of an "objectives-driven, performance-based" approach to planning for operations; an approach that increases the potential support from the regional ITS architecture given the approach's emphasis on data and performance measures. Additionally, the primer leads planners and operators through techniques to make a regional ITS architecture relevant and easy-to-use in planning for operations.

THE REGIONAL ITS ARCHITECTURE HELPS ANSWER THE FOLLOWING IMPORTANT QUESTIONS:

- ☑ What M&O strategies supported by ITS may be available to help achieve our operations objectives?
- ☑ What data is available in our region to monitor transportation system performance and track progress toward operations objectives?
- ☑ What are the gaps in providing transportation system management and operations across our region?
- ☑ How can we most effectively integrate a new M&O strategy supported by ITS with other existing or planned technology deployments to provide a greater level of service for the customer?
- ☑ How can we define an M&O project or program in terms of functional requirements, operations concepts, supporting ITS standards, etc.?

Why leverage the regional ITS architecture for planning for operations?

Integrate and coordinate the technology underlying operations services: Planning for operations without the support of a regional ITS architecture risks poor integration of ITS across the region. The regional ITS architecture facilitates the integration and coordination of compatible ITS across a region so that related projects are implemented more efficiently and travelers experience seamless transportation services as they travel across multiple jurisdictions.

Align efforts to make greater progress in ITS and operations: By aligning the regional ITS architecture with the operations goals, operations objectives, and management and operations strategies in the metropolitan or statewide transportation plan, planning for operations and the regional ITS architecture can reinforce each other and make greater strides together toward improving safety, efficiency, and reliability.

Use existing resources smartly: A regional ITS architecture that does not support metropolitan or statewide planning, programming, and implementation of operations programs and projects has an extremely limited impact after the initial collaborative benefits of regional ITS architecture development fade. This represents a significant

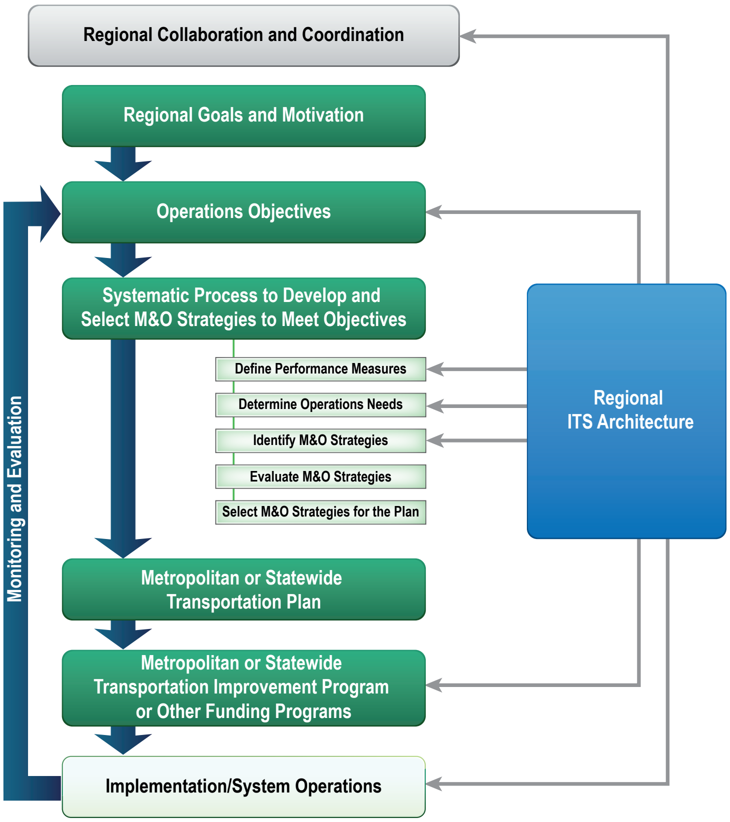


Figure 1: Regional ITS Architecture Use in Planning for Operations.

opportunity loss. Connecting the architecture to planning reduces the duplication of effort that goes into both developing the regional ITS architecture and planning for operations. This primer shows the parallels between the processes and how to take advantage of them. This is particularly important for smaller and less complex regions and regions with scarce resources.

How does the regional ITS architecture support planning for operations?

The regional ITS architecture can provide support in almost all areas of the objectives-driven, performance-based approach to planning for operations as shown in Figure 1. The Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) recommend the use of an objectives-driven, performance-based approach as an effective way to integrate operations in the metropolitan and statewide transportation planning processes. The approach focuses on the use of specific, measurable, and outcome-oriented operations objectives to guide the planning and programming of M&O.

Opportunities to leverage the regional ITS architecture in support of planning for operations include:

- Sustain and build on the collaborative relationships from the regional ITS architecture development.
- Consult the architecture to identify available sources of operations data to track measurable objectives.
- Gather information on operations needs from the architecture and ITS stakeholders.
- Examine service packages in architecture when identifying ITS-based M&O strategies.
- Include the architecture as part of the transportation improvement program (TIP) development process.
- Use the architecture's operational concepts, functional requirements, and other contents to kick-start project development.

In order to realize these opportunities and achieve the greatest benefit, the regional ITS architecture may require an update so that it is current and supports the intended use. Updating the regional ITS architecture to support planning for operations enables planners and operators to more easily access the relevant portions of the architecture and take advantage of the opportunities identified in this primer. Explicitly documenting the connections between the planning for operations and the regional ITS architecture will help link the efforts. Additionally, the development of an operations or ITS plan may be an effective way to bridge the gap between the metropolitan or statewide plans and the regional ITS architecture. An operations or ITS plan provides a collaborative strategy for implementing operations and ITS projects and programs over time and operating and maintaining an integrated transportation system. While there are a number of actions that a region can take to use the regional ITS architecture to support planning for operations, it is important to focus first on creating an architecture that is ready for use and taking steps toward those opportunities that will bring the greatest benefit to the region's planning for operations effort. Using the regional ITS architecture will result in more efficient, effective, and collaborative implementation of ITS-based operations strategies to improve transportation system performance.

1 Introduction

1.1 The Motivation

Transportation professionals find themselves under ever-increasing pressure to do more with less in the face of shrinking budgets, increasing demand for transportation services, and mounting customer expectations from coast to coast. At the same time, ongoing rapid advances in technology create new opportunities to operate the transportation system in a safer and more efficient manner. While technology represents tremendous opportunity for enhancing management and operation of the transportation system, it also entails challenges, particularly from a planning perspective. Planning efficient, collaborative operations strategies enabled by technology requires the use of a regional intelligent transportation system (ITS) architecture to provide the greatest level of customer service with cost-effective and regionally integrated solutions.

A REGIONAL ITS ARCHITECTURE is a framework for institutional agreement and technical integration in a particular region. The architecture defines the links between the pieces of the system and the information that is exchanged on each connection. Over 300 regional ITS architectures have been developed so chances are good that you already have one in your region.

A ***region*** is considered to be any multi-jurisdictional area defined by the needs of the collaborating agencies.

Planning for operations seeks to integrate management and operations (M&O) into the metropolitan and statewide transportation planning processes. It focuses on accomplishing consensus-based regional outcomes for the performance of the regional transportation system through the use of M&O rather than developing individual projects. Operations activities are moving from stand-alone, local projects to regional solutions that require collaboration and integration. Since many M&O strategies rely on technology, the regional ITS architecture is an essential tool in supporting the integration of M&O strategies across a region to accomplish these regional outcomes.

The architecture puts each of the strategies in a regional context, resulting in more cost-effective solutions and ultimately more seamless service across jurisdictional boundaries. It defines how a region can most effectively integrate new strategies that include ITS with other existing or planned technology deployments to provide a greater level of service for the customer.

Planning for technology-based operations activities is fundamentally different than planning for traditional capital infrastructure projects. No one has the foresight to accurately forecast progressive technology innovation over a 20-year timeframe in a metropolitan or statewide transportation plan, but we know that the technology innovation will occur. We also know that individual systems will become more intelligent and increasingly integrated over time. The most advanced systems that are

The architecture gets you one step ahead...The architecture has helped us build out projects here and I believe we have gotten far more than our money's worth out of it.

Peter Thompson
San Diego Association of Governments (California)

The architecture defines the value and degree of integration that is possible among stakeholders involved in planning and operations.

Nathen Masek
Mid Region Council of Governments
(Albuquerque, NM)

The ITS architecture, along with the ITS Strategic Plan, has assisted in defining projects and the connections between various projects and stakeholders.

Keith Nichols
Hampton Roads Transportation Planning Organization
(Hampton Roads, VA)

I think that one of the biggest benefits for us is seeing on paper how many different people are involved. We have been able to focus on what our end goal is as traffic engineers and have a roadmap of how to get from where we are to where we want to be. It is a constant reminder that more people need to be involved in the planning process than just us.

Debbie Albert
City of Glendale, AZ

The architecture is an inventory of elements, linkages of the elements and data exchanges, and stakeholders. All of this knowledge assists with improving planning, implementation and reducing project risk.

Tom Bruff
Southeast Michigan Council of Governments (Detroit, MI)

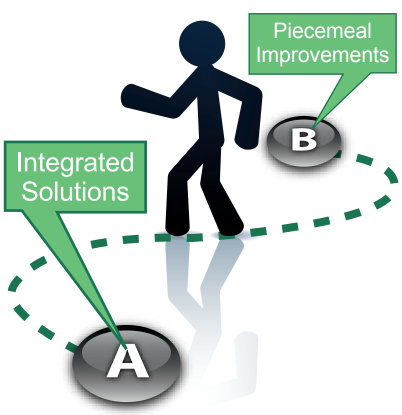


Figure 2: A regional ITS architecture helps move regions from piecemeal improvements to integrated transportation solutions.

currently being implemented – Active Transportation and Demand Management (ATDM), Integrated Corridor Management (ICM), and regional traveler information systems are all predicated upon effective integration between systems at a technical level and between organizations at an institutional level. Next generation systems will continue the progression toward increasing integration of intelligent systems, including mobile devices that will offer a better understanding of transportation operations performance and more effective communication with transportation customers. The regional ITS architecture is a tool that is specifically designed to support planning for integration among these intelligent systems, organizations, and customers. Even for smaller or less complex regions, using the regional ITS architecture to support planning for operations has substantial benefits including a reduction of duplicative efforts and increased leverage of existing and planned ITS and data resources across the region.

Using the regional ITS architecture results in a collaborative process for fitting the pieces of the transportation system together in a more integrated and compatible way. Building on the holistic "all modes and all roads" integrated framework of the architecture provides tangible benefits for planners, operators, and the transportation system. This primer provides useful guidance for how use of the regional ITS architecture can enrich that planning for operations activity and achieve the next big step in regional compatibility.

Lesson Learned. Several issues can result from NOT using the architecture. For example, a county road commission recognized the value of the architecture only after encountering a series of challenges in coordinating signal control along a major corridor between the county, the State and several cities. More proactive participation as the regional ITS architecture was developed would have better aligned individual agency plans and greatly facilitated this process.

A regional ITS architecture documents the interrelationships between ITS applications within a region and provides a structure for enhancing those relationships. By applying the regional ITS architecture in planning for operations, these interrelationships can be recognized and a more efficient and effective system of operational strategies achieved. Rather than competing for funding to implement piecemeal improvements, agencies can use the architecture to collaboratively develop a more integrated set of regional solutions.

The regional ITS architecture can also be used to identify the data that is available in the region to monitor transportation system performance and track progress toward operations objectives that are central to the objectives-driven, performance-based approach to planning for operations. The architecture provides an ideal framework for identifying these data sources and planning the monitoring systems that can be used to measure performance for the region's congestion management process or other data-driven transportation planning activity.

Although there are significant benefits, there can also be challenges in applying a regional ITS architecture in planning for operations. This primer provides useful

recommendations on how those challenges can be overcome. The professionals who are responsible for transportation planning in a region are often different than those who are responsible for operations, and using the architecture in transportation planning requires ongoing collaboration between these practitioners. Although the regional ITS architecture initially brought together the planning and operations professionals to work collaboratively in many regions, that working relationship has not always been sustained. In other regions, the regional ITS architecture was developed by a consultant with a regional committee providing oversight and so the collaboration may have been limited in scope. Other challenges for applying the regional ITS architecture in planning for operations may be limited resources for additional planning efforts in a region or differences in the timing of the cycles of operations planning and ITS architecture updates. This primer provides recommendations for how these types of challenges can be overcome.

One last bit of motivation: Recognizing the benefits of architecture use in planning, 23 CFR 450.306(f) states: “The metropolitan transportation planning process shall (to the maximum extent practicable) be consistent with the development of applicable regional intelligent transportation systems (ITS) architectures, as defined in 23 CFR part 940.”

23 CFR 450.208(f) levies a similar requirement on the statewide transportation planning process.

Finally, the regional ITS architecture can provide an entry point to project development and systems engineering and standards. For these implementation steps, developers of operational strategies within a region can draw on the architecture to provide initial input to these processes. While this primer is not intended as a guidance document for implementation of operational strategies, understanding the needs can help in seeing operational strategies though to successful programming, design, and integration. Referencing the regional ITS architecture can help provide that understanding.

1.2. How to Use This Primer

This primer includes five chapters that are organized to introduce you to the key concepts of planning for operations and regional ITS architectures and then to describe how the regional ITS architecture can be used to improve planning for operations. The primer is organized to be read front to back as each chapter builds on concepts presented in the previous chapter, but feel free to skip around and sample content, particularly if you already have some background in planning for operations and regional ITS architectures.

This primer is written for two audiences: 1) Transportation planning and operations staff and consultants who are involved in planning for operations and, 2) staff and consultants that are involved in regional ITS architecture development, use, and maintenance. In many cases, there is overlap between these audiences, and indeed, our intent is to increase the overlap since planning for operations and regional ITS architecture activities should build upon one another. To support the dual audience,

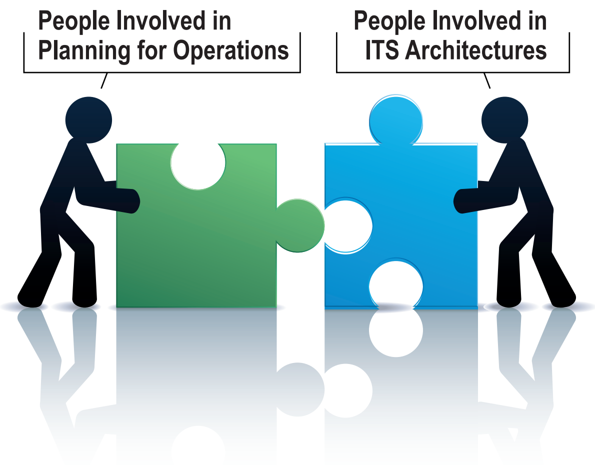


Figure 3: This Primer is Intended to Bring Together Two Audiences.

the primer bounces back and forth between the two perspectives. Whether you are a transportation planner, an ITS engineer, or an operations practitioner, this primer will help you to understand how a regional ITS architecture can be used to make planning for operations more effective and efficient.

Here is a breakdown of the remaining chapters and appendices and what you will find in each:

Chapter 2: Planning for Operations and Architecture – A Quick Tutorial – This is the place to start if you need some background in the objectives-driven, performance-based approach to planning for operations or the regional ITS architecture. The last part of this chapter explores the relationship between planning for operations and architecture, which is new material that may be helpful even for those who are well versed in both processes.

Chapter 3: Opportunities for Architecture Use – This chapter looks in detail at the opportunities to use the regional ITS architecture to support planning for operations. With a decided planning for operations perspective, the chapter steps through the planning for operations approach and identifies how the regional ITS architecture can be used at each step.

Chapter 4: Creating a Planning-Supportive Architecture – This chapter is written more from the regional ITS architecture perspective. Given the opportunities for architecture use explained in Chapter 3, this chapter identifies how the architecture can be improved to better support those opportunities. This chapter also covers ITS strategic plans and regional concepts for transportation operations (RCTOs) and their role in supporting planning for operations and architecture. Finally, this chapter provides guidance on the relative scheduling of transportation plan and architecture updates.

Chapter 5: Your Action Plan for More Productive Architecture Use – This chapter describes the process improvement steps that will institutionalize architecture use in the transportation planning process in your region. It defines a process that builds decisionmaker support, assesses current architecture use, and plans the necessary steps to make architecture use more efficient and productive.

Appendix A: Turbo Architecture – This appendix provides a quick introduction to the Turbo Architecture software that is used to create, maintain, and use regional ITS architectures with particular focus on the features in the software that support planning for operations.

Appendix B: Regulatory Requirements – This appendix includes excerpts from SAFETEA-LU,Title 23 CFR 450, and Title 23 CFR 940 that are related to management and operations planning and use of ITS architectures to support planning.

2 Planning for Operations and Architecture – A Quick Tutorial

2.1. Operations and ITS – A Unified View

Figure 4: ITS Technology Supports Operations.

Before delving into the opportunities to leverage the regional ITS architecture to enhance planning for operations, it is important to clarify what is meant by "ITS" and "operations." The relationship between ITS and operations is often defined in this way: **ITS is the enabling technology for operations**. ITS and operations both aim to address one or more of the major multimodal transportation system goal areas: efficiency, safety, reliability, security, and environmental quality. It should be acknowledged that the use of the terms "ITS" and "operations" can differ somewhat across communities and the relationship between the two has evolved over time. The term "operations" is used synonymously in this primer with "management and operations" and "M&O."

Management and operations (or operations) is defined as:

"A regionally integrated program to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal, cross-jurisdictional systems, services, and projects designed to preserve capacity and improved security, safety, and reliability of the regional transportation system; includes regional operations collaboration and coordination activities between transportation and public safety agencies." [1]

The term includes traffic detection and surveillance, arterial management, freeway management, transit operations, demand management, electronic toll collection, and many other strategies.

Intelligent transportation systems is defined as:

"Intelligent Transportation Systems represent the application of information processing, communications technologies, advanced control strategies, and electronics to the field of transportation." [2]

Despite the fairly narrow, technology-focused definition, the ITS program has historically looked beyond technology and addressed all aspects of intelligent transportation systems including their development (e.g., the systems engineering process), operation, and evaluation. The regional ITS architecture in particular takes a

[1] United States Code Title 23, Section 101(a) as amended by SAFETEA-LU Technical Corrections Act of 2008.

[2] United States Code Title 23 CFR 940: Intelligent Transportation System Architecture and Standards.

broader, systems perspective of ITS that includes other elements of a "system" involved in providing a transportation service, including the roles and responsibilities of operators, institutional coordination and agreements, and the flows of information between system elements. In fact, the regional ITS architecture is designed to be technology-independent, further blurring the distinction between "operations" and "ITS." This broader view of ITS overlaps with operations, which makes the regional ITS architecture a significant tool for supporting operations in the metropolitan/ statewide transportation planning process.

For the purposes of this primer, the terms ITS and operations will be used as defined above. ITS will be viewed as the systems involving electronics, communications, or information processing used to support management and operations.

2.2. What is Planning for Operations?

The transportation planning process includes development of a regional vision and goals, identification of alternate improvement strategies, evaluation and prioritization of strategies, development of the transportation plan and transportation improvement programs, project development, and systems operations.[3] It is a continuing, collaborative, and comprehensive process that includes the consideration of several critical factors: economic development, air quality, budgets, and others.

Planning for operations is a joint effort between planners and operators to support improved regional transportation systems management and operations. It requires coordination and collaboration between a number of regional partners, including planning staff and operations staff from metropolitan planning organizations (MPOs), State departments of transportation, transit agencies, highway agencies, toll authorities, and local governments. It involves the consideration of management and operations (M&O) strategies in transportation planning – including the integration of M&O strategies in metropolitan and statewide transportation plans.

The Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) recommend the use of an objectives-driven, performance-based approach to planning for operations as an effective way to integrate operations in the metropolitan and statewide transportation planning processes. An important U.S. DOT resource to consult for learning more about the approach is, *Advancing Metropolitan Planning for Operations: An Objectives-Driven, Performance-Based Approach - A Guidebook*.[4] This approach helps regions meet Federal transportation planning requirements for including "operational and management strategies to improve the performance of existing transportation facilities" in the metropolitan transportation plan (MTP)[5] and promoting "efficient system management and operation."[6]

3 U.S. Department of Transportation, Federal Highway Administration and Federal Transit Administration, The Transportation Planning Capacity Building Program, The Transportation Planning Process: Key Issues A Briefing Book for Transportation Decisionmakers, Officials, and Staff, Publication No. FHWA-HEP-07-039, *http://www.planning.dot.gov/documents/BriefingBook/BBook.htm*.

4 U.S. Department of Transportation, Federal Highway Administration and Federal Transit Administration, Advancing Metropolitan Planning for Operations: An Objectives-Driven, Performance-Based Approach - A Guidebook, Publication No. FHWA-HOP-10-026, *http://www.plan4operations.dot.gov/*.

5 Other common terms used for the "metropolitan transportation plan" are long-range transportation plan and regional transportation plan.

6 "Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)," Section 6001(i), 2005.

The recommended approach focuses on working toward desired system performance outcomes for transportation system users, such as increased travel time reliability, rather than just responding to problems. It acknowledges the widely-accepted principle that what is measured matters in decisionmaking, and setting specific, measurable performance objectives will facilitate incorporating operations strategies into the metropolitan and statewide transportation plans as well as agencies' operating budgets. Operations strategies take a variety of forms including programs or projects focused on managing and operating the transportation network, projects to deploy ITS infrastructure, programs that fund operating and maintaining new and existing ITS infrastructure, and operations elements of major capital projects.

Developing operations objectives that state what a region plans to achieve regarding the operational performance of the transportation system is the center of this approach to planning for operations. Operations objectives are included in the region's transportation plan and provide strategic direction for including operations programs and projects in the plan and statewide and metropolitan transportation improvement programs (STIP/TIP). These objectives provide specific, measurable, agreed-upon statements of system performance that can be tracked on the regional level and inform investment decisions. The approach provides a direct connection between operations objectives and investment decisions. Operations objectives may address concerns such as recurring and non-recurring congestion, access to traveler information, emergency response time, incident management coordination, and transit operations, among others. Regions create operations objectives that are tailored for their size, resource availability, political commitment for operations, and performance monitoring capabilities.

The following list gives the primary elements of the objectives-driven, performance-based approach to planning for operations.[7]

- **Regional Goals.** Establish one or more goals that focus on efficiently managing and operating the transportation system.
- **Operations Objectives.** Develop operations objectives— specific, measurable statements of performance— to include in the metropolitan or long-range statewide transportation plan (MTP/LRSTP) that will lead to accomplishing the goal or goals.
- **Performance Measures.** Using a systematic approach, develop performance measures, analyze transportation performance issues, and recommend M&O strategies.
- **M&O Strategies.** Select M&O strategies within fiscal constraints to meet operations objectives for inclusion in the MTP/LRSTP and STIP/TIP.
- **Investment and Implementation.** Implement strategies, including program investments, collaborative activities, and projects.
- **Monitoring and Evaluation.** Monitor and evaluate the effectiveness of implemented strategies and track progress toward meeting operations objectives.

7 U.S. Department of Transportation, Federal Highway Administration and Federal Transit Administration, Advancing Metropolitan Planning for Operations: The Building Blocks of a Model Transportation Plan Incorporating Operations – A Desk Reference, Publication No. FHWA-HOP-10-027, *http://www.ops.fhwa.dot.gov/publications/fhwahop10027/index.htm*.

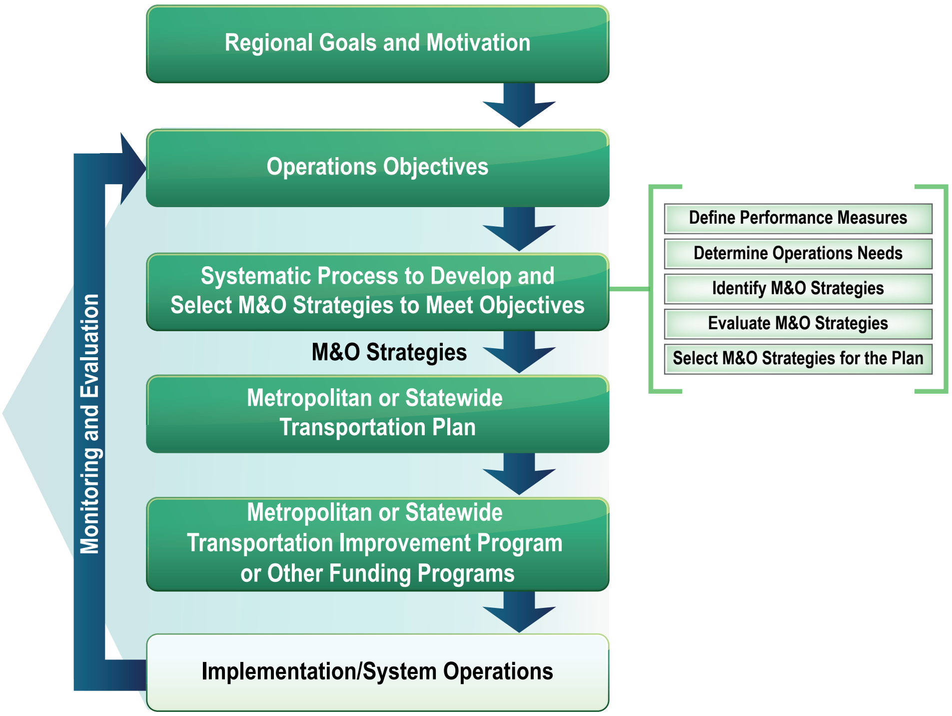


Figure 5: An Objectives-Driven, Performance-Based Approach to Planning for Operations.

The approach (shown in Figure 5) is iterative, with monitoring and evaluating used to refine and adjust operations objectives over time. Coordinating and collaborating among planners and operators is a critical component of the approach, which supports developing agreed-upon regional operations objectives, identifying strategies, and monitoring and evaluating system performance.

Figure 5 illustrates the approach to planning for operations guided by operations objectives and founded on performance measures and data. The figure shows the basic elements of the transportation planning process with a focus on management and operations.

When applied, the objectives-driven, performance-based approach to planning for operations is frequently integrated into the transportation planning process such that management and operations is combined with other types of regional needs and solutions such as safety, environment, accessibility, and security in the development of objectives and the systematic process to develop and select strategies for the plan and improvement program.

The congestion management process (CMP), as outlined in SAFETEA-LU, uses an objectives-driven, performance-based approach to address congestion in a region.[8] The CMP is a federally-required process for MPOs in areas with populations over 200,000. The CMP is used to identify congestion and its causes, propose mitigation strategies, and evaluate the effectiveness of implemented strategies. It is an integral part of the planning process that influences decisionmaking and feeds projects and strategies directly into the plan and TIP. In some metropolitan regions, this may be the primary use of the objectives-driven, performance-based approach to integrating operations into the metropolitan planning process.

In summary, a plan resulting from the objectives-driven, performance-based approach for operations should include the following:

- Goals and measurable objectives that advance operational performance outcomes for the regional transportation system;
- Performance measures that allow the region to track progress toward achieving its objectives; and
- Clearly defined M&O strategies backed by specific performance measures that allow for evaluation.

[8] See Appendix B

Additional Transportation Planning for Operations Resources

U.S. Department of Transportation, FHWA, *Advancing Metropolitan Planning for Operations: An Objectives-Driven, Performance-Based Approach – A Guidebook*, FHWA-HOP-10-026, 2010. Available at: *http://www.ops.fhwa.dot.gov/publications/fhwahop10026/index.htm*, last accessed August 29, 2011.

U.S. Department of Transportation, FHWA, *Advancing Metropolitan Planning for Operations: The Building Blocks of a Model Transportation Plan Incorporating Operations – A Desk Reference*, FHWA-HOP-10-027, 2010. Available at: *http://www.ops.fhwa.dot.gov/publications/fhwahop10027/index.htm*, last accessed August 29, 2011.

U.S. Department of Transportation, FHWA, *Congestion Management Process: A Guidebook*, FHWA-HEP-11-011, 2011. Available at: *http://www.fhwa.dot.gov/planning/congestion_management_process/cmp_guidebook/*, last accessed August 29, 2011.

U.S. Department of Transportation, FHWA, *Statewide Opportunities for Integrating Operations, Safety and Multimodal Planning: A Reference Manual*, FHWA-HOP-10-028, 2010. Available at: *http://www.fhwa.dot.gov/planning/statewide/manual/index.cfm*, last accessed August 29, 2011.

U.S. Department of Transportation, FHWA, *Regional Concept for Transportation Operations: The Blueprint for Action – A Primer*, FHWA-HOP-07-122, 2007. Available at: *http://www.ops.fhwa.dot.gov/publications/rctoprimer/index.htm*, last August 29, 2011.

2.3. What is a Regional ITS Architecture?

Ongoing rapid advances in information processing and communications technology create new opportunities for transportation professionals to deliver more efficient and effective transportation services. Many of these opportunities are predicated upon effective coordination between organizations— at both an institutional and technical level. To encourage and enable this coordination, the U.S. DOT has developed a set of tools that support development and use of a "regional ITS architecture" that is intended to help identify and exploit these opportunities for cost-effective cooperation. A regional ITS architecture is intended to be a cornerstone of planning for effective inter-agency integration and for deployment and operation of technology-based projects.

*A "**regional ITS architecture**" is defined as "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."*[9]

Complementing planning for operations, a regional ITS architecture supports planning for integration. On the next page, Figure 6 shows a notional view that includes many of the key components of a regional ITS architecture.

As shown, most of the regional ITS architecture is devoted to showing all of the existing and planned operational transportation systems in a region and how they will fit together. From a planning perspective, the regional ITS architecture should support the region's objectives and also support the specific needs of transportation planning agencies. It should show how data is collected, archived, and processed to support transportation planning and performance monitoring.

The regional ITS architecture consists of a number of components, including quite a few that are useful in transportation planning and referenced in later chapters of this primer. Each of the components answers one or more key questions about the integrated transportation system that is planned for the region. Let's take a minute to introduce you to the key components of a regional ITS architecture. For the most benefit, locate and open your regional ITS architecture (most regional ITS architectures are available on-line) and look at how it covers each of the following regional ITS architecture components.

9 U.S. Department of Transportation, FHWA, Regional ITS Architecture Guidance Document, FHWA-HOP-06-112, 2006. Available at: *http://www.ops.fhwa.dot.gov/publications/regitsarchguide/index.htm*, last accessed August 25, 2011.

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 Rule 940 (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 officially adopted 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 Rule/Policy continues under the current Federal transportation act.

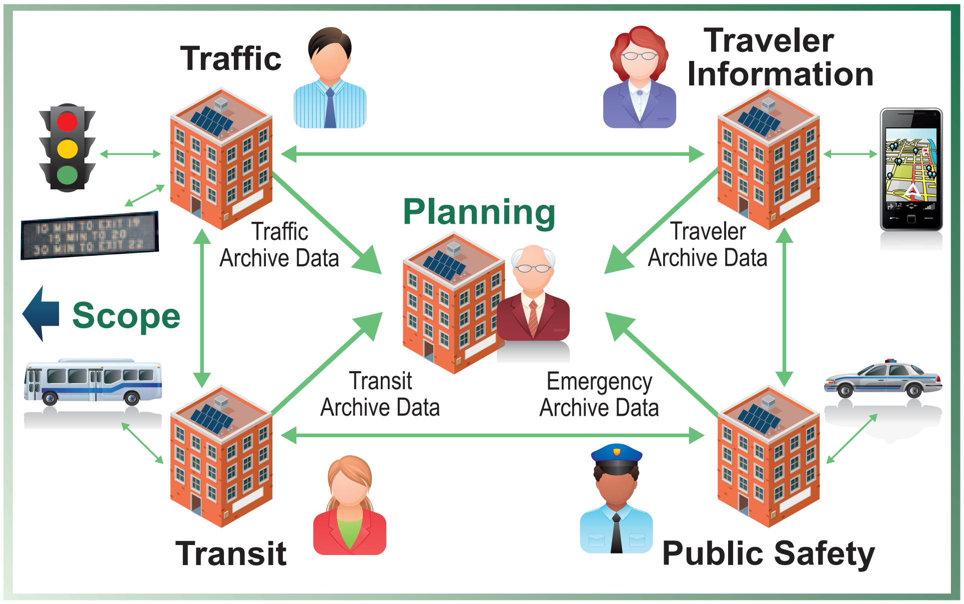
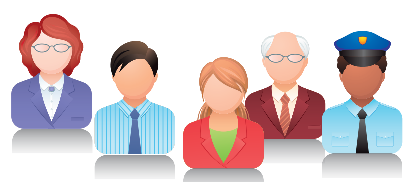


Figure 6: A High-Level ITS Architecture.

Scope: The regional ITS architecture definition begins with a clear statement of the geographic and jurisdictional boundaries, the time horizon, and the scope of transportation services that are covered by the architecture. The Rule/Policy leaves a lot of latitude to the region in defining the scope, but suggests that the regional ITS architecture cover the entire metropolitan area at a minimum. Transportation planners should make sure the scope is as consistent as possible with the scope of the regional transportation planning activities to facilitate use in planning for operations.



Stakeholders: A list of the traffic agencies, transit operators, public safety agencies, traveler information providers and other organizations and groups that plan, develop, operate, maintain, and use the regional transportation system is included in every regional ITS architecture. This broad stakeholder list should include all of the agencies that are involved in transportation planning, operations, and management as well as groups that use the transportation system (e.g., fleet operators) or impact its operation (e.g., special event venue owner/operators). A typical stakeholder list might include 50 agencies and other organizations by name, accompanied by a short description.

Roles and Responsibilities: The regional ITS architecture does more than list the stakeholders; it defines the high-level roles and responsibilities of each of the stakeholders that operate and manage the transportation system as part of an "operational concept" for the region. The roles and responsibilities are short statements like "Share CCTV video feeds with other agencies in the region" and "Share Fire CAD feeds with DOT."

Inventory: This is a list of the existing and planned components or "elements" of the regional transportation system. The inventory elements are frequently systems in their own right and include the operational centers (e.g., a State DOT Freeway Management Center), field equipment (e.g., the dynamic message signs, closed-circuit television (CCTV) cameras, and signal systems), vehicles (e.g., transit vehicles and public safety vehicles), and traveler equipment (i.e., the devices the traveler uses). Importantly for planning, the inventory should also include any monitoring and data collection systems that are used by transportation planners. The objective in defining the inventory is to include enough detail to identify the key integration points— the endpoints for the inter-agency interfaces and other interfaces that are prime candidates for standardization.

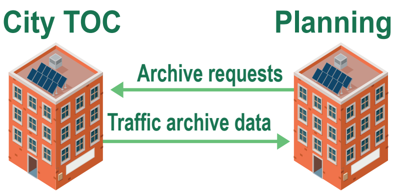


Figure 7: Example of Interfaces between Elements.

Interfaces: A definition of the interfaces between the inventory elements is a focal point of the regional ITS architecture. Each interface is represented as both an "Interconnect" (Is there a connection between the two elements?) and as a set of information flows or "architecture flows" that describe the information that is shared. The architecture flows are also associated with relevant ITS standards.

Services: The National ITS Architecture provides a menu of approximately 100 "Service Packages"[10] or ITS strategies that may be included in the regional ITS architecture. The list of services is comprehensive, covering all modes and all types of roads and reflecting the full breadth of ITS services that have been implemented to date (and a few that have yet to be implemented in an operational setting). ITS services are grouped into bundles. For example, the Archived Data (AD) bundle includes an "ITS Data Warehouse" service. Each ITS service is linked specifically to the ITS inventory elements and interfaces that are included in that service, effectively partitioning the regional ITS architecture based on the services that are provided. The ITS services that are included in the regional ITS architecture represent a consensus of the architecture stakeholders. The ITS services are linked to costs, benefits, and lessons learned, which can aid in evaluating the services that are most attractive for implementation in your region.[11]

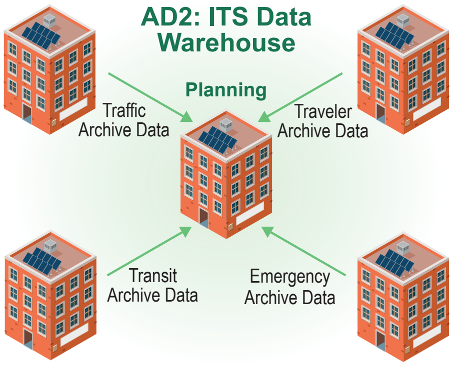


Figure 8: Illustration of a Service Package.

Project Sequencing: The regional ITS architecture is implemented through many transportation programs and projects that occur over years or even decades. The regional ITS architecture includes a sequence that allocates projects to broad timeframes like near- (0-3 years), mid- (3-7 years), and long-term (8+ years). The project sequencing often provides finer granularity than the ITS services, particularly for near-term projects.

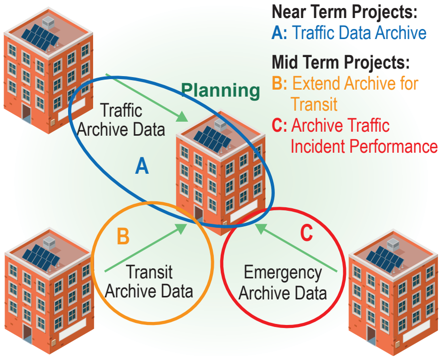


Figure 9: Illustration of Project Sequencing.

[10] The term "Market Package" is being replaced by "Service Package" in the upcoming release of the National ITS Architecture. We use "Service Package" here and throughout the primer to be consistent with the new terminology.

[11] The links to costs, benefits and lessons learned will be included in Version 7.0 of the National ITS Architecture expected in early 2012.

Agreements: The regional ITS architecture also includes a list of agreements, though it may not be fully populated in your regional ITS architecture. The idea is that institutional coordination is required to support the technical integration that is shown in the architecture. The list of agreements should identify the existing and planned agreements in the region that are needed to support an integrated transportation system. Note that the agreements should extend beyond implementation into operational agreements that define agency roles and responsibilities for system operation

Those are the regional ITS architecture components that are most central to planning for operations. Several other components of the regional ITS architecture are primarily oriented towards project development including functional requirements and identification of ITS standards. All of the architecture components are defined in more detail in the Regional ITS Architecture Guidance Document.[12]

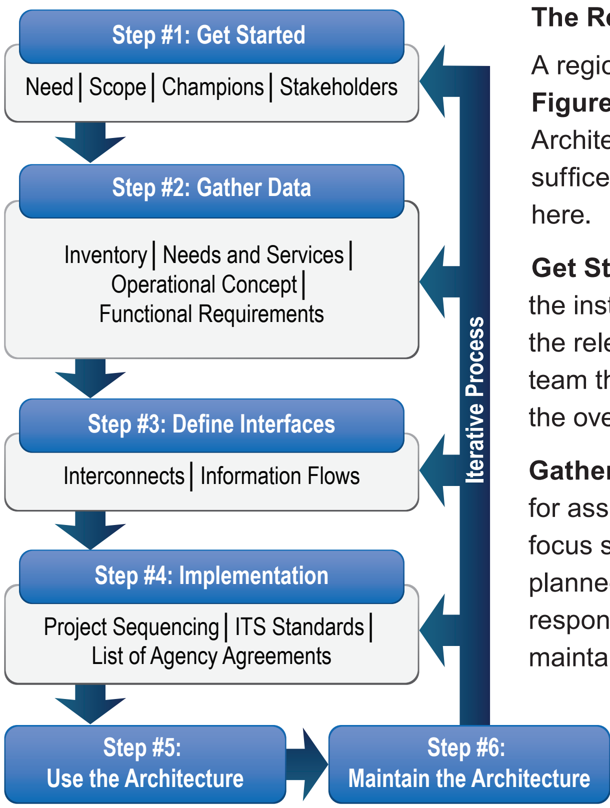


Figure 10: Regional ITS Architecture Development Process.

The Regional ITS Architecture Development Process

A regional ITS architecture is developed using the process shown in **Figure 10**. This process is defined in detail in the Regional ITS Architecture Guidance Document. A brief overview of the process will suffice for most readers of this primer. The key steps are summarized here.

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. In 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 connections is defined.

Implementation: Once the system interfaces are delineated, 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.

[12] U.S. Department of Transportation, FHWA, Regional ITS Architecture Guidance Document, FHWA-HOP-06-112. Available at: *http://www.ops.fhwa.dot.gov/publications/regitsarchguide/index.htm*, last accessed August 25, 2011.

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, programming, 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. This step is the focus of this primer.

Maintain the Regional ITS Architecture: The regional ITS architecture must be updated as ITS projects are implemented, new ITS priorities and strategies emerge through the transportation planning process, and the scope of ITS continues to evolve. 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. Chapter 4 includes ideas for enhancing your architecture so that it better supports planning for operations in your next architecture update.

Additional Regional ITS Architecture Resources

U.S. Department of Transportation, RITA, *U.S. National ITS Architecture Web Site*. Available at *http://www.its.dot.gov/arch*, last accessed August 25, 2011.

U.S. Department of Transportation, RITA, Turbo Architecture Web Site. Available at: *http://www.iteris.com/itsarch/html/turbo/turbomain.htm*, last accessed August 25, 2011.

U.S. Department of Transportation, FHWA, *Regional ITS Architecture Guidance Document*, FHWA-HOP-06-112, 2006. Available at: *http://www.ops.fhwa.dot.gov/publications/regitsarchguide/index.htm*, last accessed August 25, 2011.

U.S. Department of Transportation, FHWA, *Systems Engineering for ITS Handbook*, FHWA-HOP-07-069, 2007. Available at: *http://ops.fhwa.dot.gov/publications/seitsguide/index.htm*, last accessed August 25, 2011.

U.S. Department of Transportation, FHWA, *Systems Engineering Guidebook for ITS Web Site*. Available at: *http://www.fhwa.dot.gov/cadiv/segb/*, last accessed August 25, 2011.

2.4. Making the Connections

After reviewing the objectives-driven, performance-based approach for planning for operations in Section 2.2 and the development of the regional ITS architecture in Section 2.3, it is easy to see similarities between the two processes and get a sense that there is potential in leveraging a closer connection. This section looks at the potential connections between the two processes.

The objectives-driven, performance based approach for planning for operations and the regional ITS architecture process have complementary strengths. The architecture development process begins with an understanding of regional needs and the current state of the transportation system based on input from a broad coalition of stakeholders. It results in a planning framework (the regional ITS architecture) and a sequence of integrated projects that implement a portion of that framework. The strength of the regional ITS architecture process is its development of an integrated view of the regional transportation system based on a set of identified services or strategies. This complements the planning for operations approach, where the focus is on defining the most effective strategies for a region based on high-level goals and operational objectives. By connecting the two processes, you combine the strong basis for selecting strategies in planning for operations with the strength of the architecture development process in defining an integrated framework based on selected services.

Linking the regional ITS architecture and the process for integrating operations into transportation planning (i.e., "planning for operations") depends on factors such as the format of planning for operations in the region, the accuracy and thoroughness of the regional ITS architecture, and when the updates of the plan and architecture occur. **The next several pages show three alternative scenarios for connecting the architecture and planning for operations based on the relative timings of the updates.** The benefits and challenges associated with each scenario are listed in Section 4.4.

Scenario A: Regional ITS Architecture Updated **Prior to** the Metropolitan/Statewide Transportation Plan Update

In this scenario, an existing regional ITS architecture is used to support planning for operations as part of a metropolitan or statewide transportation plan update. The architecture is used as a resource that can provide useful input to incorporating operations into the planning and programming processes. This regional ITS architecture will not undergo a major update as part of this scenario.

Figure 11 shows seven opportunities for the regional ITS architecture to provide input to the objectives-driven, performance-based approach to planning for operations. Each numbered opportunity corresponds with a connection in the figure.

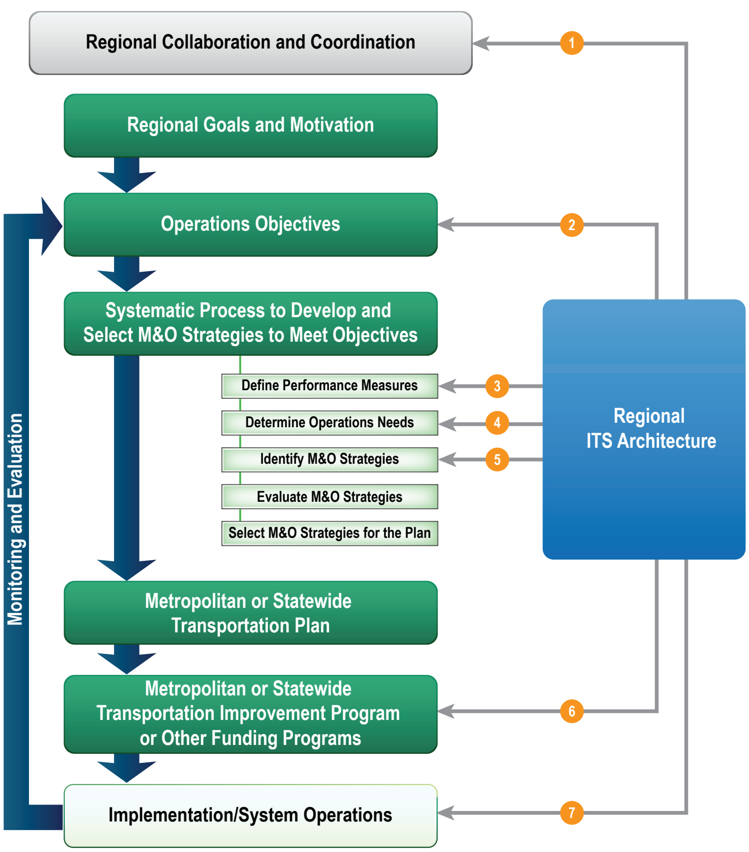
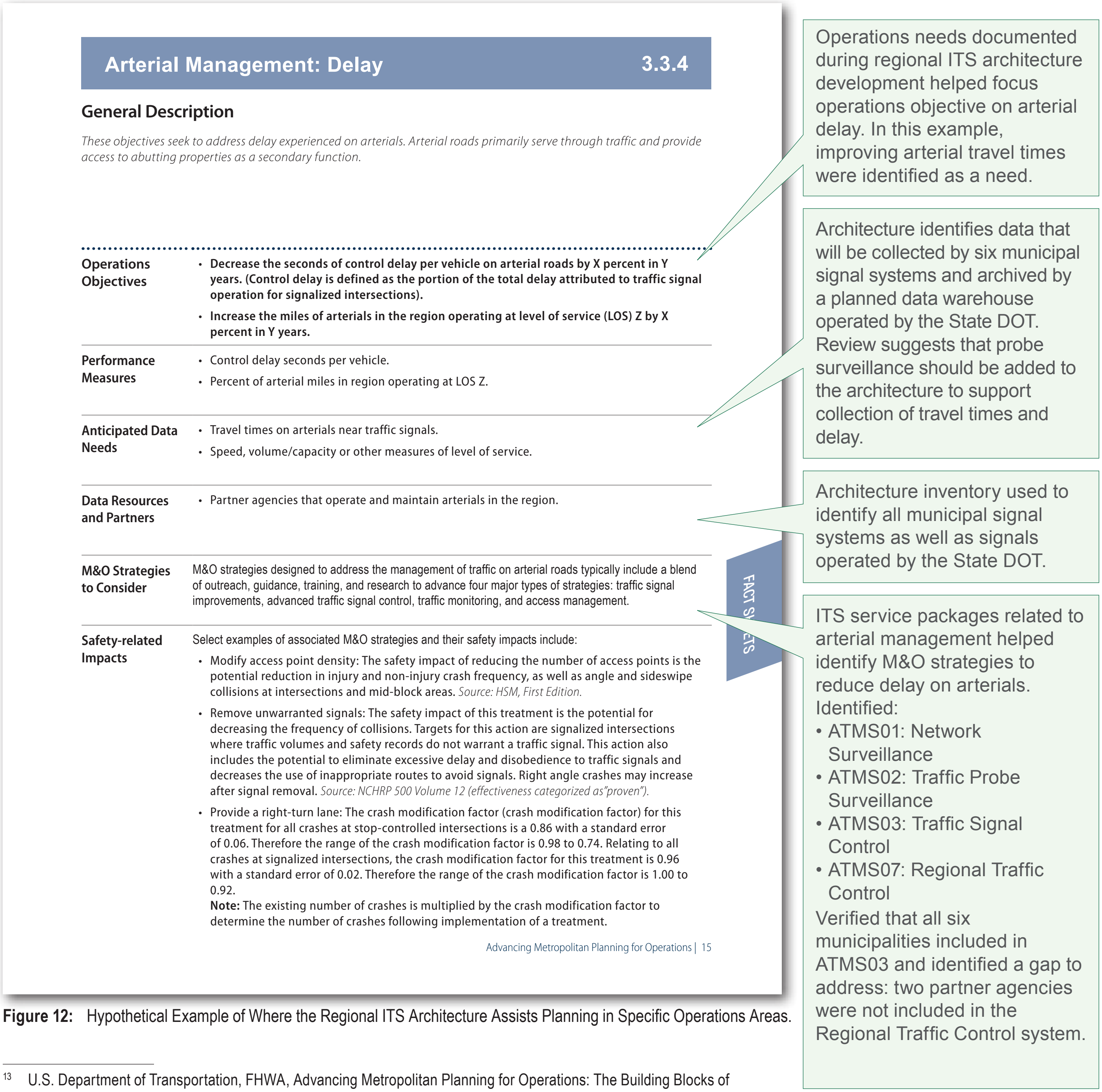


Figure 11: Diagram Depicting Scenario A: Regional ITS Architecture Updated Prior to the Metropolitan/Statewide Transportation Plan Update.

1. Leverage any existing collaborative ITS groups to assist with the integration of operations into the metropolitan or statewide transportation planning process.
2. Examine elements of ITS in the architecture such as the ITS needs and services to gain information on the operations issues and envisioned operational services for the development of operations objectives.
3. Identify data available to support performance measures for tracking objectives and monitoring system performance.
4. Obtain information on operations needs by looking for gaps in regional functionality of ITS services and stated operations needs. Examine the needs associated with operating and maintaining the ITS infrastructure already in place.
5. Gather ideas for potential M&O strategies by examining the ITS services or service packages selected for the architecture.
6. Examine the ITS inventory elements associated with ITS services/service packages that relate to M&O strategies in the plan to help define projects and programs that include both implementation and ongoing operations and maintenance of ITS. Use the list of projects in the ITS architecture to also provide input to project definition for the STIP/TIP. Select ITS-related activities to be funded that are consistent with the ITS architecture.
7. Mine information flows, ITS standards, and other information from the architecture to support project development and implementation.

Figure 12 provides an example of how the regional ITS architecture could be used to provide valuable input to the development of operations objectives and the identification of data sources and partners for tracking performance measures. The illustration also shows how the architecture could be used to identify M&O strategies for achieving an operations objective centered on arterial delay. The fact sheet used in the example is from a recent FHWA and FTA publication containing nearly 100 fact sheets highlighting operations objectives and performance measures across a spectrum of operations areas.[13]



Arterial Management: Delay 3.3.4

General Description

These objectives seek to address delay experienced on arterials. Arterial roads primarily serve through traffic and provide access to abutting properties as a secondary function.

Operations Objectives	• **Decrease the seconds of control delay per vehicle on arterial roads by X percent in Y years. (Control delay is defined as the portion of the total delay attributed to traffic signal operation for signalized intersections).** • **Increase the miles of arterials in the region operating at level of service (LOS) Z by X percent in Y years.**
Performance Measures	• Control delay seconds per vehicle. • Percent of arterial miles in region operating at LOS Z.
Anticipated Data Needs	• Travel times on arterials near traffic signals. • Speed, volume/capacity or other measures of level of service.
Data Resources and Partners	• Partner agencies that operate and maintain arterials in the region.
M&O Strategies to Consider	M&O strategies designed to address the management of traffic on arterial roads typically include a blend of outreach, guidance, training, and research to advance four major types of strategies: traffic signal improvements, advanced traffic signal control, traffic monitoring, and access management.
Safety-related Impacts	Select examples of associated M&O strategies and their safety impacts include: • Modify access point density: The safety impact of reducing the number of access points is the potential reduction in injury and non-injury crash frequency, as well as angle and sideswipe collisions at intersections and mid-block areas. *Source: HSM, First Edition.* • Remove unwarranted signals: The safety impact of this treatment is the potential for decreasing the frequency of collisions. Targets for this action are signalized intersections where traffic volumes and safety records do not warrant a traffic signal. This action also includes the potential to eliminate excessive delay and disobedience to traffic signals and decreases the use of inappropriate routes to avoid signals. Right angle crashes may increase after signal removal. *Source: NCHRP 500 Volume 12 (effectiveness categorized as"proven").* • Provide a right-turn lane: The crash modification factor (crash modification factor) for this treatment for all crashes at stop-controlled intersections is a 0.86 with a standard error of 0.06. Therefore the range of the crash modification factor is 0.98 to 0.74. Relating to all crashes at signalized intersections, the crash modification factor for this treatment is 0.96 with a standard error of 0.02. Therefore the range of the crash modification factor is 1.00 to 0.92. **Note:** The existing number of crashes is multiplied by the crash modification factor to determine the number of crashes following implementation of a treatment.

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Figure 12: Hypothetical Example of Where the Regional ITS Architecture Assists Planning in Specific Operations Areas.

[13] U.S. Department of Transportation, FHWA, Advancing Metropolitan Planning for Operations: The Building Blocks of a Model Transportation Plan Incorporating Operations – A Desk Reference, FHWA-HOP-10-027, 2010. Available at: http://www.ops.fhwa.dot.gov/publications/fhwahop10027/index.htm, last accessed August 29, 2011.

Scenario B: Regional ITS Architecture Updated **After** the Metropolitan/ Statewide Transportation Plan Update

When the regional ITS architecture is updated following the development of the metropolitan or statewide transportation plan, the architecture supports planning for operations by responding to the strategic direction set by the goals, objectives, and M&O strategies incorporated into the plan. The architecture is used to "drill down" into how the M&O strategies, programs, or projects can be regionally integrated into the transportation system and what ITS may be needed for implementation. This is illustrated in Figure 13 below. As above, each numbered opportunity listed corresponds with numbered connections in the figure.

1. Leverage any regional operations planning groups to support the ITS architecture update.
2. Identify goals and operations objectives from the transportation plan to direct the decisions made in the architecture update.
3. Adopt and update the system performance needs defined for the region during the development of the plan.
4. Select service packages or services that correspond to M&O strategies selected for the plan.
5. Incorporate archived data services and appropriate flows in the architecture to support performance measures selected to track operations objectives and system performance.
6. Update the ITS inventory, interconnects, and information flows to account for any newly planned M&O/ITS programs and projects.

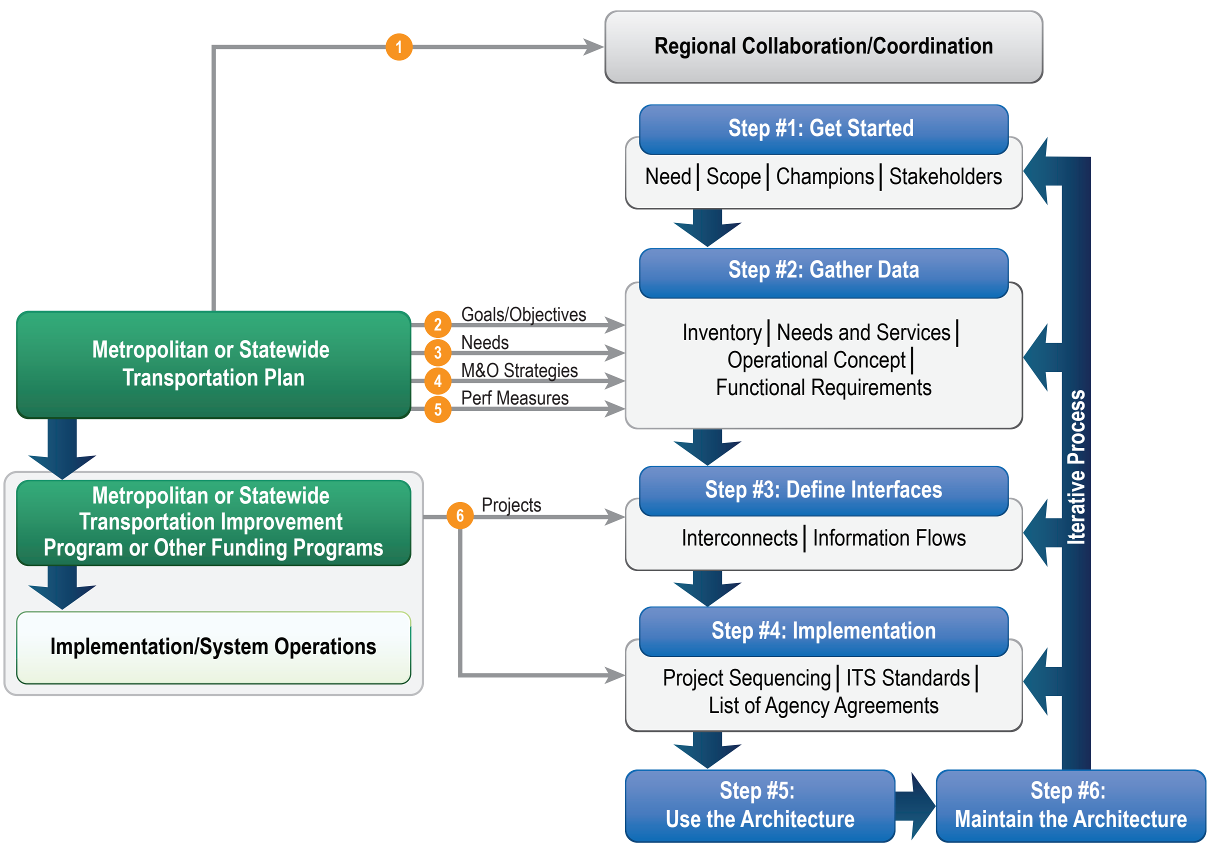


Figure 13: Diagram Depicting Scenario B: Regional ITS Architecture Updated After the Metropolitan/Statewide Transportation Plan Update.

Scenario C: Regional ITS Architecture Updated at the Same Time as the Metropolitan/Statewide Transportation Plan Update

A regional ITS architecture updated in conjunction with the transportation plan for the metropolitan area or State opens up the greatest opportunities for leveraging the synergies between the processes. There are opportunities to combine or closely associate steps in the planning for operations and ITS architecture update processes to eliminate duplicative efforts.

Figure 14 highlights five important connections that can be leveraged between the two processes for a more effective, coordinated transportation system. As an overview, these five primary areas of linkage are 1) regional collaboration and coordination across processes, 2) operations objectives and the overarching "gather data" step, 3) operations and system performance needs, 4) M&O strategies and ITS services, and 5) defining and implementing operations programs and projects in a regionally integrated context.

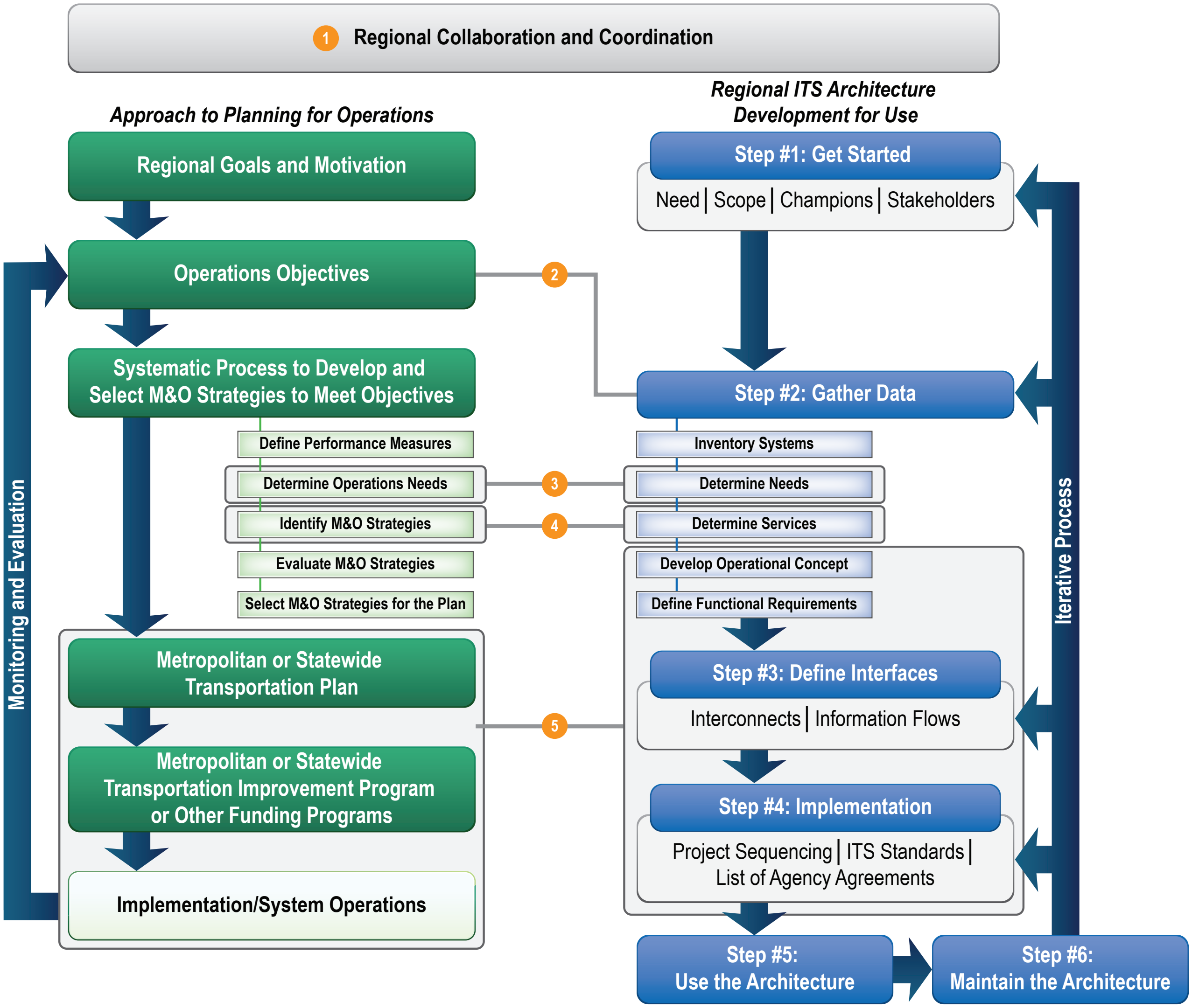


Figure 14: Diagram Depicting Scenario C: Regional ITS Architecture Updated at the Same Time as the Metropolitan/Statewide Transportation Plan Update.

1. **Regional collaboration and coordination.**

The processes are conducted by overlapping groups of transportation operations and ITS stakeholders including staff from planning agencies, State and local road operating agencies, transit agencies, public safety, and others. In many cases, the same regional committee that supports the regional ITS architecture can also support planning for operations, leveraging the overlaps and opportunity for synergy between the two activities. The composition of the staff may shift from management to technical as the work moves from strategic to implementation. In many regions, though, the same individuals at an agency focus on integrating operations into the planning process and developing the regional ITS architecture. Leveraging the same agencies, if not the same individuals, for both processes yields benefits in terms of knowledge transfer and outreach requirements.

2. **Operations objectives and gather data.**

In the second step of the regional ITS architecture development, gather data, several significant activities occur that should both influence and be influenced by the development of operations objectives. It is critically important for connecting the two processes that the operations objectives guide the identification of needs and services in the architecture. This will be discussed in several places in the primer. The systems inventory conducted early in the architecture development can provide useful information on the available sources of operations data that could be used to track measurable objectives. Data availability is a significant factor in establishing specific objectives. In addition, the operations expertise of the stakeholders brought together for the regional ITS architecture should be leveraged in setting the direction for operations in the region.

3. **Operations and system performance needs.**

The regional ITS architecture update calls for the stakeholders to "determine needs and services." This task is fundamentally a planning task that should be coordinated with the overall transportation planning process. When the plan and architecture are updated at the same time, these parallel activities can be combined for a more coherent and efficient process. When combined, the operations needs of the transportation system can be identified once based on the regional operations objectives and overall goals and used in both the update of the architecture and planning for operations to drive the identification of operations solutions.

4. M&O strategies and ITS services.

Identifying M&O strategies to include in the metropolitan or statewide transportation plan is parallel to the “Determine Services” task of the ITS architecture update. Many aspects of these two processes can and should be combined for the sake of efficiency and consistency. The ITS services identified for a regional ITS architecture are selected from a comprehensive menu of “service packages” and there is considerable overlap between service packages and M&O strategies. The exceptions include those M&O strategies that are not based on ITS and the ITS services for improved safety, environment, and others without an operations focus.

M&O strategies are evaluated and selected for inclusion in the transportation plan, at least at the metropolitan planning level. To enhance coordination with the overall planning process, the regional ITS architecture may include those services that are planned or currently existing. Where there are differences, the regional ITS architecture could indicate which services are explicitly included in a plan.

5. Defining and implementing operations programs and projects in a regionally integrated context.

The operational concept, functional requirements, and interfaces that are defined in the regional ITS architecture can be used to improve understanding of the integration needs and dependencies between projects. The detailed definition of each project in the regional ITS architecture helps to identify the scope of an operations project or program and the roles and responsibilities for implementing ITS as well as operating and maintaining it over the long-term.

Developing a schedule for program and project funding as part of the STIP or TIP development can also be performed in conjunction with project sequencing in the regional ITS architecture. The list of projects arising from the regional ITS architecture should be consistent with the sequence of projects and programs in the STIP/TIP.

During project development and implementation, the interconnects, information flows, list of agency agreements, and ITS standards of the regional ITS architecture should be mined for input.

3 Opportunities for Architecture Use

Effectively integrating management and operations (M&O) into the metropolitan and statewide transportation planning processes requires significant inter-agency collaboration and a regional view of the area's multimodal transportation system. Because many M&O strategies are underpinned by ITS, the coordination of planning for ITS among agencies at the institutional and technical level is an essential element to planning for operations. The regional ITS architecture, with a focus on integrating transportation services supported by ITS, presents a significant opportunity to support the needs for effective planning for operations. The shift in planning for operations to an objectives-driven, performance-based approach increases the value that could be leveraged from the regional ITS architecture given the architecture's emphasis on information flows.

This section identifies several opportunities among many regions in the United States to get more value from their regional ITS architectures through a greater connection to operations planning. The regional ITS architecture can strengthen the objectives-driven, performance-based approach to planning for operations in a region. By not taking advantage of the opportunities to connect the regional ITS architecture to planning for operations, regions risk duplicated effort, decreased planning efficiency, and fragmented operations services.

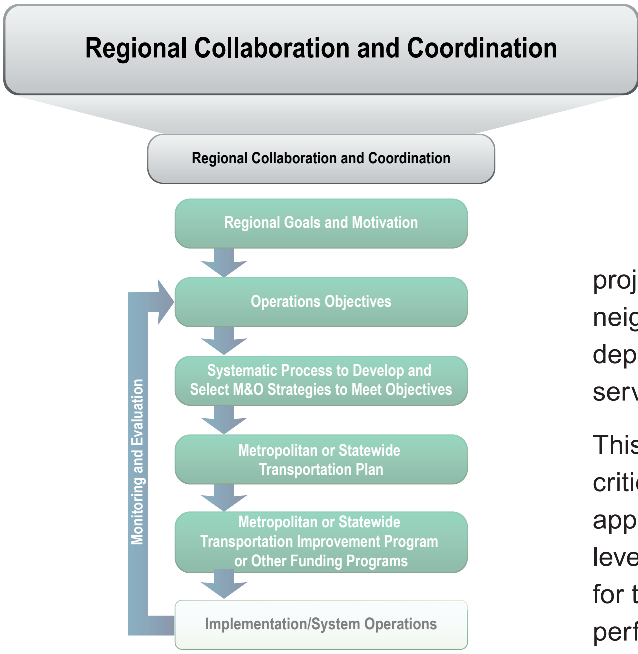
Each of the following sections highlights a step in the objectives-driven, performance-based approach and identifies ways in which a regional ITS architecture can support that step. It is important to note that "architecture use" is a two-way street— the architecture informs the planning process, but the planning process must also inform the development and use of the architecture at each step. Considering "use" in both directions will make the architecture more consistent with the transportation plan, more responsive to planning needs, and ultimately a more effective tool for planners.

At a fundamental level, the regional ITS architecture provides support to planning for operations by helping planners and operators answer the questions below. Small or less complex regions may want to focus their efforts on the using the architecture to address one or more of these basic questions. To find the opportunities associated with these questions, look for the "Addresses Core Question" call-out boxes in this chapter.

- ☑ What M&O strategies (supported by ITS) may be available to help achieve our operations objectives?
- ☑ What data is available in the region to monitor transportation system performance and track progress toward operations objectives?
- ☑ What are the gaps in providing transportation system management and operations across our region?
- ☑ How can we most effectively integrate a new M&O strategy (supported by ITS) with other existing or planned technology deployments to provide a greater level of service for the customer?
- ☑ How can we define this M&O project or program in terms of functional requirements, operations concepts, supporting ITS standards, etc.?

Read on to find out how the regional ITS architecture can help you respond to these questions and more.

3.1. Establishing Collaboration and Coordination



The regional ITS architecture is at its core a tool for collaboration and coordination among agencies involved with operations and ITS in a region. It contains information about existing and planned systems to increase regionwide visibility and coordination of all ITS deployments. Planners and implementing agencies use the architecture to identify which other agencies in the region need to be involved in a project, how ITS elements in a given project should interface with neighboring systems, and how the project can leverage other deployments to lower costs and provide travelers with seamless service.

This broad, integrated view of the regional transportation system is critically important to the objectives-driven, performance-based approach to planning for operations. This section will focus on leveraging the collaborative relationships and organization formed for the regional ITS architecture to support the objectives-driven, performance-based approach to planning for operations.

Sustain and build on the collaborative relationships from the regional ITS architecture

One of the early steps in the development of a regional ITS architecture is to assemble a team of stakeholders and "champions" relevant to and affected by the architecture. Planning organizations, operations agencies, and public safety agencies are typically important members. This group will build consensus on the ITS services to be put in place, understand what is already deployed, and specify how the planned and existing systems should interface.

Many of the agencies and individuals in this team should also be involved in the integration of operations into the planning process. The working groups and relationships founded for the architecture can be sustained and expanded to lead planning for operations. Several collaborative groups instrumental in folding operations into the planning process and coordinating operations efforts began as stakeholder groups for regional ITS architecture development efforts, including:

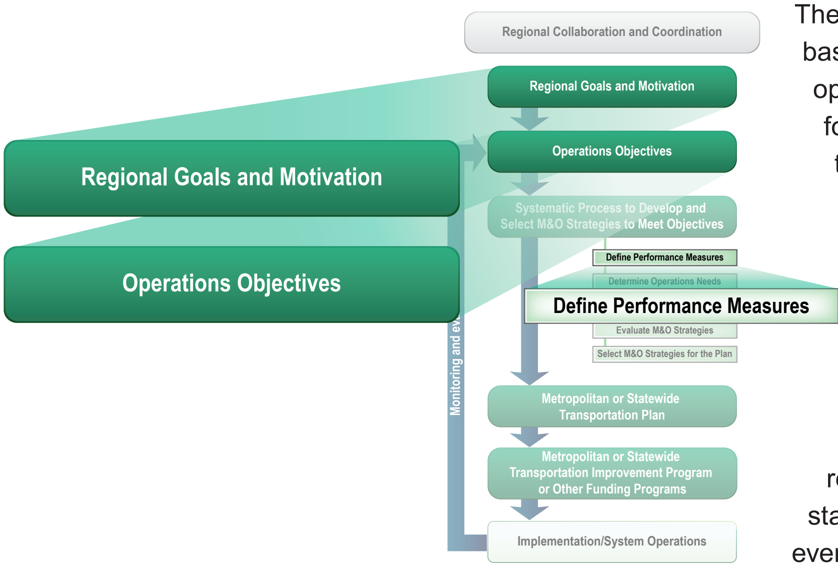
- Pima Association of Governments Transportation Systems Subcommittee
- Hampton Roads Transportation Operations Subcommittee
- Maricopa Association of Governments ITS Committee
- Metropolitan Washington Council of Governments Transportation Planning Board Management, Operations, and Intelligent Transportation Systems Policy Task Force and Technical Subcommittee
- Genesee Transportation Council Transportation Management Committee

In Hampton Roads, the leaders of the Transportation Operations Subcommittee credit the regional ITS architecture with bringing together planners and operators in the region. Thanks to the Transportation Operations Subcommittee's diverse group of stakeholders, including police, first responders, freight operators, and the military, the group's work on planning for operations has in turn made its architecture more robust and detailed.

In Rochester, New York, collaboration between planners and operators was formalized during the development of the region's ITS strategic plan. This group, now the Genesee Transportation Council's Transportation Management Committee, is now a forum for all operations planning. It is chaired by the MPO and includes operators at the local and State levels, as well as local elected officials.

A common challenge is maintaining collaboration after the development or update of a regional ITS architecture is finished. Defining a strategic plan for ITS or operations that sets out a common purpose and initiatives, can formally extend collaborative relationships beyond the lifespan of a single effort. Learn more about ITS and operations plans in Section 4.3 of this primer.

3.2. Developing Goals, Operations Objectives, and Performance Measures

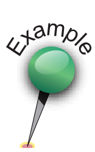


The initial step in the objectives-driven, performance-based approach is to establish regional goals and operations objectives. Goals and objectives that focus on the operational performance of the transportation system are included in the metropolitan or statewide transportation plan to guide the inclusion of operations into the planning process.

Operations objectives are specific, measurable, and agreed-upon statements of desired outcomes for regional system performance that support the plan's goals. They may be formed in response to influences such as ITS and operations staff, elected or appointed officials, or a significant event such as a blizzard or traffic incident that draws public attention to needed operational improvements.

Performance measures to track the achievement of operations objectives are identified during the development of the objectives and are typically embedded in operations objectives. For example, the operations objective: "Improve average travel time during peak periods by 5% by year 2018 on regionally significant arterials" is tracked by the performance measure "average travel time."

The regional ITS architecture can help regions realize these goals and operations objectives by using them to organize supportive ITS capabilities and select service packages, functional requirements, and project concepts that move the objectives toward success. Conversely, architectures and regional ITS strategic plans can help planning organizations define operations objectives that reflect available data and the expertise of operations staff for metropolitan or statewide transportation plans.



For example, the Champaign Urbana Urbanized Area Transportation Study (CUUATS) of Illinois, the transportation-focused arm of region's MPO, uses the objectives-driven, performance-based approach throughout its metropolitan transportation plan. The plan contains several operations objectives, performance measures, and strategies to reach those objectives. To use the region's regional ITS architecture to support the achievement of the plan's operations objectives, the region could select service packages for the regional ITS architecture that directly map to the strategies and operations objectives of the plan. The table below offers a hypothetical example of linking objectives and strategies from the CUUATS MTP to service packages:

Table 1: Hypothetical Example Showing Linkage Between Operations Objective and Strategies from *Choices 2035 Champaign Urbana Urbanized Area Transportation Study Long Range Transportation Plan* to Potential Regional ITS Architecture Service Packages.[14]

Objective	Strategies	Service Packages
Improve average vehicular travel time by at least 1.5 minutes during peak hour periods on major traffic corridors by 2035	Continue signal upgrades, periodic retiming, and coordination of all new and existing signalized intersections	ATMS03: Traffic Signal Control
	Utilize car sharing programs and park and ride facilities to remove vehicle trips from the roadway network	ATIS08: Dynamic Ridesharing ATMS16: Parking Facility Management
	Continue adding connected pedestrian, bicycle and transit facilities to the existing transportation network making these travel modes more efficient	APTS02: Transit Fixed Route Operations APTS03: Demand Response Transit Operations APTS07: Multimodal Coordination

Incorporate operations objectives from the transportation planning process into the regional ITS architecture

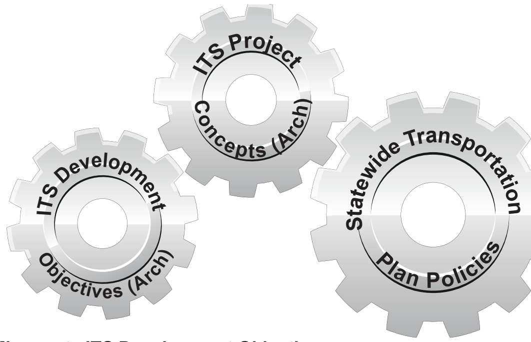
The regional ITS architecture is a tool to achieve operations objectives developed during metropolitan or statewide planning. Architecture stakeholders are asked to determine regional needs and the ITS services that address those needs. This process parallels the early steps of the objectives-driven, performance-based approach and may be combined with those steps. It is crucial that the architecture reflect the region's planning goals and operations objectives so it can effectively support the integration of M&O strategies into the planning process.

The Minnesota Statewide Regional ITS Architecture[15] is directly linked to the Minnesota statewide transportation plan through a table in the architecture that connects the goals and policies of the plan to the objectives developed for the ITS architecture. Minnesota views ITS as a tool to implement the goals and policies of the statewide plan and updates the architecture in coordination with the transportation plan. In connection to the transportation plan policies, a comprehensive set of high-level objectives and related performance measures have been defined as part of the Minnesota statewide ITS architecture. ITS Project Concepts have also been developed and specifically connected to the objectives in the ITS architecture.

[14] Champaign Urbana Urbanized Area Transportation Study, *Choices 2035 Champaign Urbana Urbanized Area Transportation Study Long Range Transportation Plan*, December 2009. Available at: *http://www.ccrpc.org/transportation/lrtp2*, last accessed August 29, 2011.

[15] Minnesota Department of Transportation, Minnesota Statewide Regional ITS Architecture, March 2009. Available at: *http://www.dot.state.mn.us/guidestar/2006_2010/regional_architecture/Volume%201%20-%20Overview.pdf*, last accessed August 29, 2011.

The following table is an excerpt from the architecture that shows the explicit links made between ITS development objectives and the policies from the statewide transportation plan.



Minnesota ITS Development Objectives		Policy 1. Traveler Safety				Policy 2. Infrastructure Preservation				Policy 3. Maintenance Security			
		1A. TZD and "The Four Es"	1B. System-wide, Cost-Effective Safety Enhancements	1C. Local Road Safety	1D. Air and Rail Safety	2A. State Highway Bridge Conditions	2B. State Highway Pavement Conditions	2C. Other State Highway Infrastructure	2D. Other Transportation Infrastructure	3A. Bridge Inspection, Follow-Up, and Preventative Maintenance	3B. Level of Highway Maintenance	3C. Efficiencies Across All Jurisdictions	…nce of Other Modes
O-1	Reduce crashes due to road weather conditions	x	x	x									
O-2	Reduce crashes due to unexpected congestion	x	x	x									
O-3	Reduce secondary crashes	x	x	x									
O-4	Reduce incident clearance time	x	x	x									
O-5	Reduce crashes due to red-light running	x	x	x	x								
O-6	Reduce crashes due to unsafe drivers, vehicles and cargo on the transportation system	x	x	x	x								
O-7	Reduce lane departure crashes	x	x	x									
O-8	Reduce crashes due to roadway/geometric restrictions	x	x	x	x								
O-9	Reduce crashes at railroad crossings	x	x	x	x								
O-10	Reduce crashes at intersections	x	x	x	x								
O-11	Reduce speed differential	x	x	x									

Figure 15: Minnesota Statewide Transportation Plan to Architecture Mapping.

Leverage the operations expertise of the regional ITS architecture stakeholders in developing objectives

Meaningful operations objectives for a region require the expertise, input, and commitment from operators and related stakeholders. The discussion of regional needs, desired systems, and operational concepts required for the regional ITS architecture provides a rich opportunity to also develop proposed operations objectives based on regional goals. These two steps (developing the regional ITS architecture and operations objectives) are not often performed at the same time; doing so would allow operators' on-the-ground knowledge of the transportation system to inform the strategic direction set by the region's leadership. The operators' knowledge of available resources to support potential operations objectives can support the development of realistic and achievable objectives. It would also help ITS architecture developers base their decisions on a common, specific set of performance outcomes to enhance the architecture's utility when including operations in the statewide or metropolitan planning process.

Even if ITS architecture stakeholders do not develop objectives, the needs and services they identify document regional transportation priorities and issues, which can be used as a starting point when developing operations objectives for the metropolitan or statewide transportation plan.

When a regional ITS strategic plan is developed alongside an ITS architecture, the plan may play an even more significant role in developing operations goals and objectives. The regional ITS strategic plan's goals and objectives may have come from the regional transportation planning process or may have been separately developed. In the latter case, they provide a starting point for the development of operations goals and objectives that will drive regional planning for operations.

Example

In 2010, the Genesee Transportation Council led the development of the ITS Strategic Plan for Greater Rochester. The Genesee Transportation Council and the other stakeholders developed goals and objectives for nine system management and operations initiatives to guide an ITS deployment strategy. An example goal for incident and emergency management was "Provide for prompt, safe response to traffic incidents and emergency management scenarios to increase safety and minimize congestion, disruptions, and loss of capacity associated with traffic incidents."[16] An objective for the public transportation management area was "Increase the quality, timeliness, breadth, and availability of transit traveler information, leveraging traveler information investments by regional partners." [17] Such goals and objectives in an ITS strategic plan should inform both the regional ITS architecture and the M&O component of a metropolitan transportation plan.

Consult the architecture to identify available sources of operations data to track measurable objectives

As emphasis increases on developing specific, measurable operations objectives when planning for operations, transportation system performance data has become more and more important. Identifying and collecting the data needed to track operations objectives is a major challenge for regions as they work to implement the objectives-driven, performance-based approach.

Regions are interested in forming operations objectives that they will be able to track with existing or planned data sources. Even as early as the definition of operations objectives, planners and operators can look to the ITS architecture to see where operations data is being generated, where it is compiled, and which agencies have access to it.

ADDRESSES CORE QUESTION:

What data is available in the region to monitor transportation system performance and track progress toward operations objectives?

The focal point in the ITS architecture for data collection to support performance monitoring is the Archived Data Management Subsystem (ADMS). The relevant areas in the regional ITS architecture can be identified by reviewing the architecture inventory to identify systems that are associated with the ADMS. These are the data collection points in the regional ITS architecture. Depending on how the architecture is organized, these data sources may be identified by reviewing interfaces to data collection points or the three related Archived Data service packages.

Additional potential data sources that could support operations objectives can also be identified by inspecting the Archived Data service packages using the Turbo Architecture software.[18] Untapped potential data sources can then be incorporated into the architecture in the next regional ITS architecture update.

Example

The following diagram from the Fayetteville-Springdale, Arkansas (Northwest Arkansas) regional ITS architecture is an example of information from a regional ITS architecture that could be used to support the identification of current and future data sources for tracking operations objectives. In this example, the MPO is potentially collecting data from more than 20 different planned data sources.

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[16] Genesee Transportation Council, *Intelligent Transportation Systems (ITS) Strategic Plan Greater Rochester*, February 2011. Available at: http://www.gtcmpo.org/Docs/PlansStudies/ITS_StrategicPlanUpdate.pdf, last accessed December 20, 2011.

[17] Ibid.

[18] Additional information about Turbo Architecture is available in Appendix A.

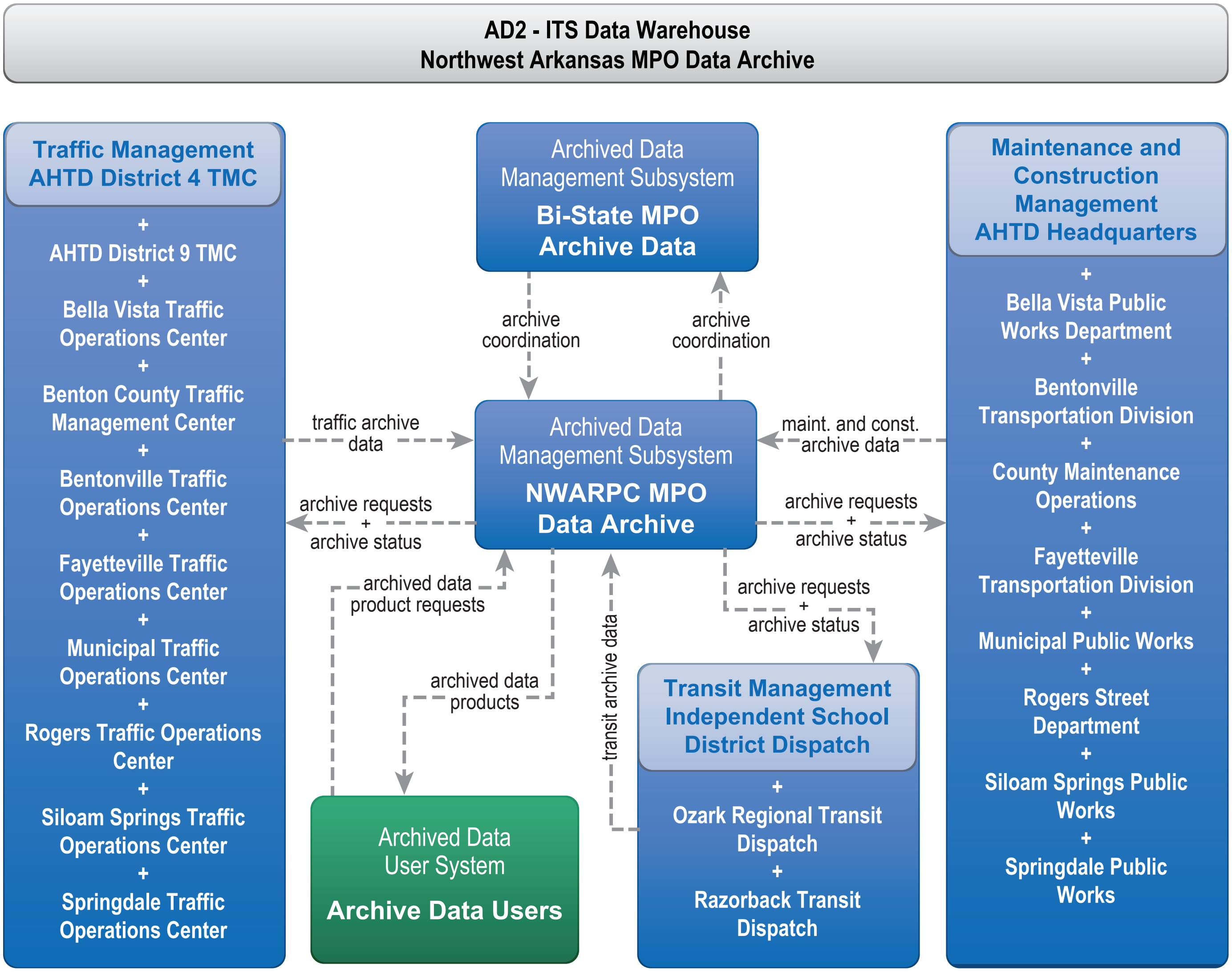
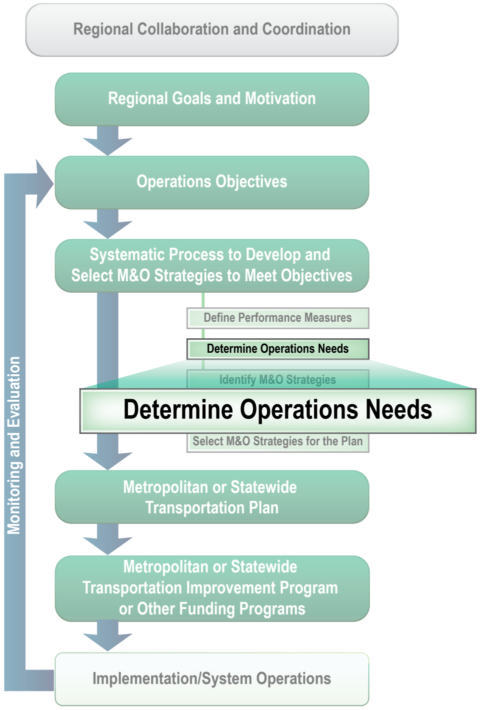


Figure 16: Diagram Illustrating the Potential Data Sources Available to the Northwest Arkansas MPO.[19]

[19] Northwest Arkansas Regional Planning Council, "Final Northwest Arkansas Regional ITS Architecture" Web Site, March 2007. Available at: http://www.consystec.com/arkansas/nwark/web/_regionhome.htm. Last accessed August 29, 2011.

3.3. Determining Operations Needs



Determining operations needs is critical to developing the most effective strategies to achieve operations objectives. This activity examines where, when, and why the transportation system is currently not meeting the objectives set forth by the region. Without this information, selection and application of M&O solutions risks being misdirected and ineffective.

Determining operations needs requires gathering information or data on the current state of the transportation system's performance and comparing it to the desired performance outcomes. Data is collected on the transportation system to identify the location, duration, and temporal extent of performance problems. When data collection is not feasible, regions may assess their operations needs by using the expertise of operators who are familiar with specific performance issues or deficiencies in operations activities, such as lack of retiming signals.

Data gathering may be performed regularly as part of a region's congestion management process. In transportation management areas (areas with populations over 200,000), MPOs are federally required to use a systematic process to monitor congestion and propose mitigation strategies that include M&O.

Gather information on needs from ITS stakeholders

The regional ITS architecture also requires the determination of regional needs. Because architecture development generally brings together planners and operators in the region, it can be an ideal opportunity for inventorying operations needs.

Needs are collected from existing documents and stakeholder input and include problems with the regional transportation system and the associated needs of the operators, maintainers, and users of the system. The list of needs in a regional ITS architecture may not be driven by the current regional operations objectives and should therefore be taken as input to a larger process of identifying needs. Determination of needs for the regional ITS architecture should be carefully integrated with other metropolitan and statewide transportation planning processes, including the congestion management process.

ITS stakeholders gathered for the architecture may also be able to contribute their expertise in identifying where, when, and why transportation system performance does not meet current operations objectives. This could serve as a low-cost substitute for data collection and may give ideas on issues to strategically study. Importantly, ITS stakeholders can provide information on needs related to the operation and maintenance of existing ITS, e.g., additional staff and data needed to make timely and necessary preventive or responsive maintenance to variable message signs or traffic signal infrastructure and communications.

Example

In the Hampton Roads region of Virginia, the regional ITS architecture committee used stakeholder meetings to help identify operations needs for the region. The Minnesota DOT used the architecture development process to identify and prioritize needs using a voting system among the committee members.

Look for available sources of data in the architecture to measure system deficiencies

The interfaces defined in the architecture can be used to identify data sources that can help determine operations needs. As mentioned in the section on developing goals, operations objectives, and performance measures, sources of data for diagnosing system performance issues can be found in the architecture.

ADDRESSES CORE QUESTION:

What are the gaps in providing transportation system management and operations across our region?

Identify gaps in coverage of ITS-supported services in the region

One of the primary purposes of a regional ITS architecture is to ensure that ITS elements in a region operate as a system rather than as individual, unrelated elements. By creating an inventory of existing and planned ITS deployments in a region and defining the connections among these deployments, planners can see where ITS elements could be more effective if linked and operated as a system. They can also identify geographic and functional gaps in the ITS system.

For example, data to supply traveler information may not be collected in one county within a three-county region. The operators may identify this lack of traveler information in one part of the region as a gap that needs to be addressed to meet a regional operations objective, such as “provide seamless traveler information to travelers on all freeways and significant arterials by 2014.” This type of information about gaps in ITS services can be helpful when determining operations needs.

Example

ITS stakeholders in Maricopa County have said that the mapping and discussion of ITS projects and deployments helped them identify gaps in their system. This was particularly useful for the identifying needs for interconnecting ITS deployments in the region.

Figure 17 was created from the Turbo Architecture database for the Maricopa Association of Governments Regional ITS Architecture.[20] The figure shows the cities in the Phoenix metropolitan area that are, or will be, sharing CCTV video on the existing metropolitan center-to-center network. As shown, four cities were not connected to the video sharing network (shown as dashed “Planned” connections in the diagram) when the architecture was last updated. The architecture further distinguishes between cities that had deployed CCTV cameras that were not yet shared on the network (e.g., City of Avondale) and cities that had not yet deployed CCTV cameras at the time the architecture was developed (e.g., City of Tempe). These missing connections (dashed lines in the diagram) represent gaps in CCTV deployment and traffic image sharing capability between cities that will be added in planned projects in Maricopa County.

[20] Maricopa Association of Governments, “Maricopa Association of Governments Regional ITS Architecture” Web Site, June 2010. Available at: http://www.consystec.com/mag/web/, last Accessed August 29, 2011.

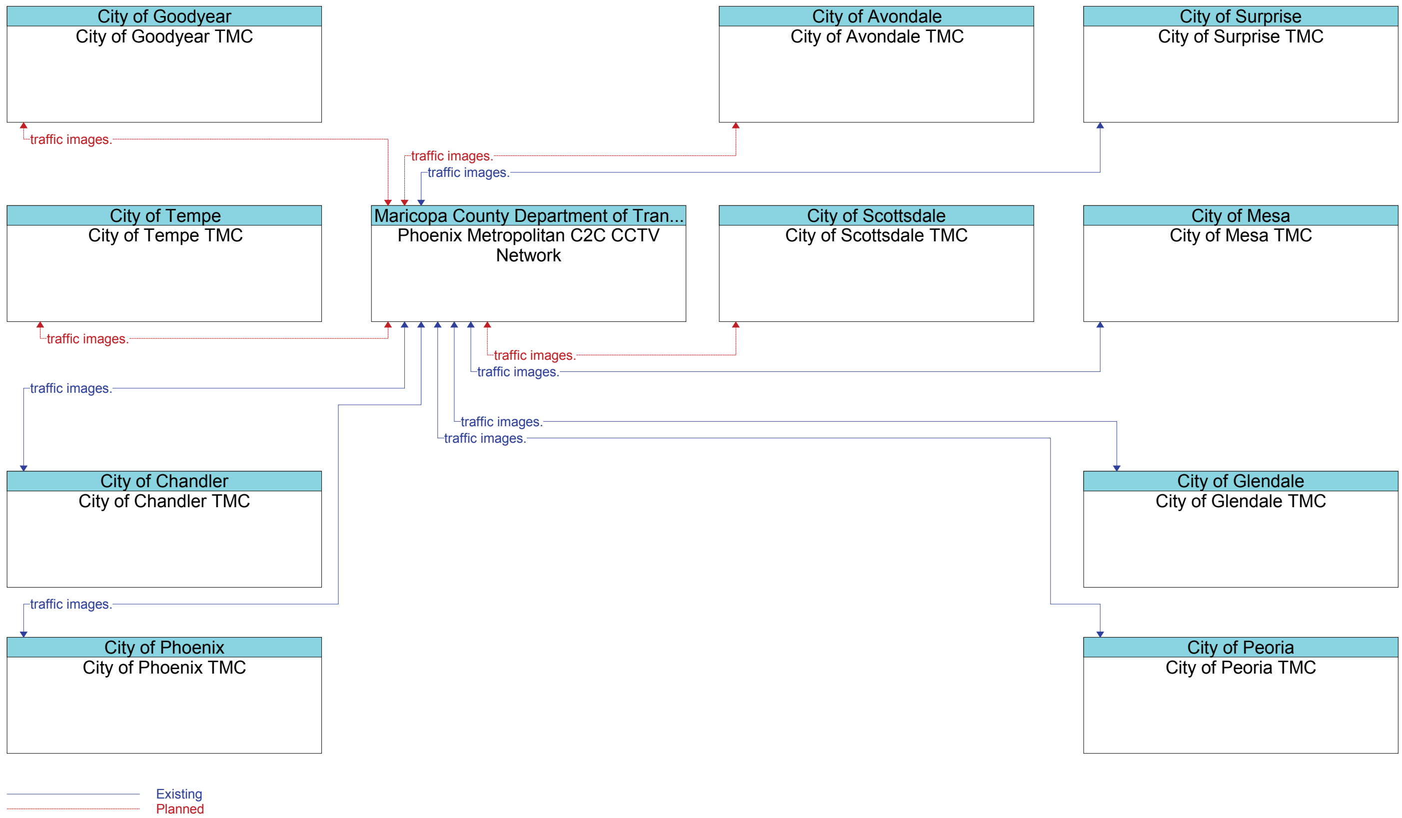
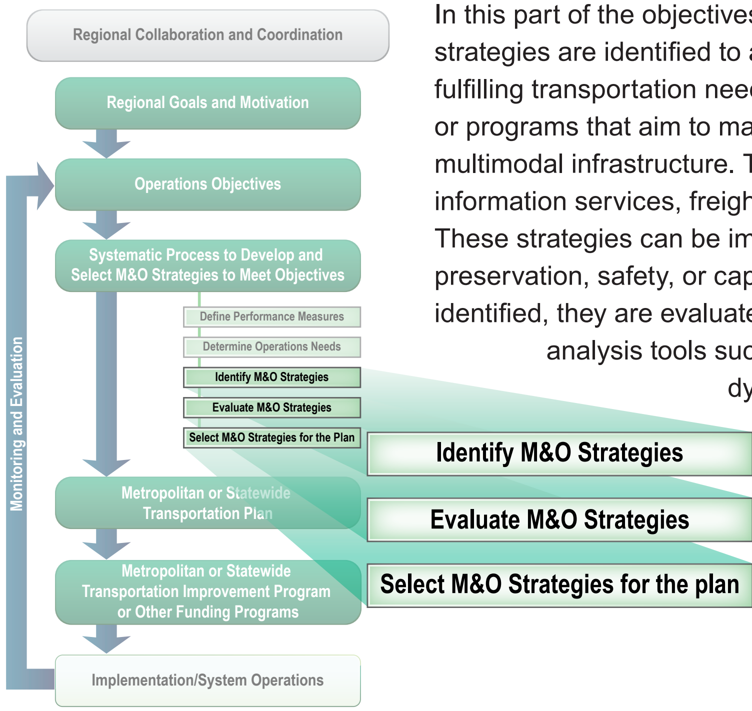


Figure 17: Identifying and Filling the Gaps in the Phoenix Metropolitan Center to Center CCTV Network.

3.4. Identifying, Evaluating, and Selecting M&O Strategies



In this part of the objectives-driven, performance-based approach, M&O strategies are identified to accomplish regional operations objectives aimed at fulfilling transportation needs. M&O strategies are systems, services, projects, or programs that aim to maximize the performance of existing and planned multimodal infrastructure. They include traffic incident management, traveler information services, freight mobility, and transit operations and management. These strategies can be implemented alone or as part of transportation preservation, safety, or capacity expansion projects. Once M&O strategies are identified, they are evaluated and prioritized for selection. Some regions use analysis tools such as the ITS Deployment Analysis System or dynamic traffic assignment models to quantitatively evaluate the proposed M&O strategies.

There is considerable overlap between the identification of M&O strategies and the identification and selection of service packages in the regional ITS architecture. This section focuses on highlighting the opportunity this overlap presents for reducing duplication by coordinating planning for operations with service package selection.

ADDRESSES CORE QUESTION:

What M&O strategies (supported by ITS) may be available to help achieve our operations objectives?

Examine service packages selected in current architectures for ITS-based M&O strategies

The regional ITS architecture can support the selection of M&O strategies by ensuring that planners and their regional operations partners examine the full set of available service packages and consider all possible ITS-based operations strategies to address needs and deficiencies. If the regional ITS architecture is current and developed collaboratively with input from primary operations stakeholders in the region, planners and operators can use the selected service packages as an initial foundation for the set of M&O strategies to be considered. Since the service packages may not have been selected with the regional operations objectives in mind, they will need to be evaluated for relevance. The Turbo Architecture Planning Tab[21] can be used to relate the operations objectives to service packages and identify any disconnects that should be addressed. Service package selections may be modified through this process, making the architecture more consistent with and useful to planning for operations.

The Southeast Michigan Council of Governments views its regional ITS architecture as useful information in identifying strategies during its planning for operations activities.

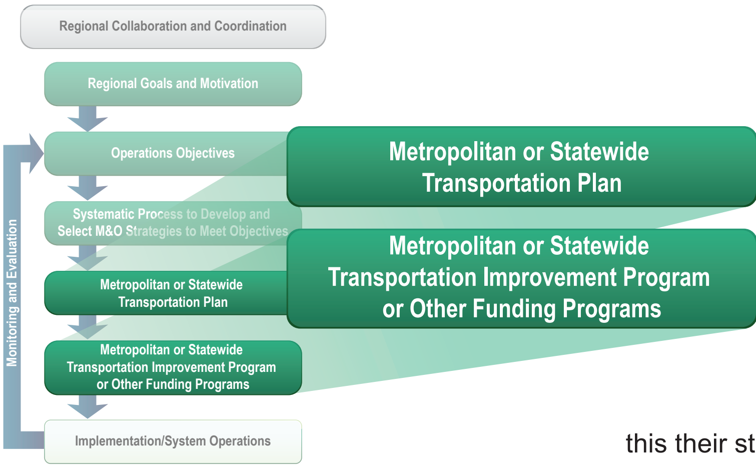
Select service packages in support of the overall metropolitan/statewide transportation planning process

If the region's architecture is not up to date, consider combining the identification of M&O strategies with the selection of service packages. Timing regional ITS architecture updates to coincide with integration of operations into a regional transportation plan using the objectives-driven, performance-based approach can help regions avoid duplicating these highly related activities.

Coordinating architecture updates with the region's overall planning for operations approach helps the architecture become a relevant and essential tool that supports operations objectives. With a coordinated approach, a single set of M&O strategies can be identified, selected, and recorded in both the transportation plan and regional ITS architecture.

[21] Additional information about Turbo Architecture and the planning tab is available in Appendix A.

3.5. Defining Programs and Projects



A transportation plan and transportation improvement program (TIP) resulting from the objectives-driven, performance-based approach to planning for operations contain programs and projects that directly support the achievement of the region's operations objectives through the use of M&O.

The merit of incorporating a regional ITS architecture into this approach is most commonly recognized in defining programs and projects; several metropolitan areas and States have made this their standard practice as a result. The architecture can provide a common reference that can transform a list of ITS-related programs and projects in a TIP or STIP into a coordinated set of projects that relate to each other and to the operations objectives and strategies defined in the transportation plan. (See Section 4.1 for more information.) The regional ITS architecture thus provides a regional context for local ITS and operations projects.

Define programs and major initiatives in a regional context

A regional program or initiative typically involves many partners and requires coordinated efforts to address transportation system operations. For example, a regional initiative may involve system operators and public safety agencies in collaborative development of an integrated incident management program. With its focus on integration, the regional ITS architecture is well-suited for defining broad programs and initiatives. It encompasses all of the partners in the regional transportation system and includes a high-level view of the systems they operate and the opportunities for integration among these systems.

The architecture can be used to identify all the partners that should be at the table when defining a regional transportation operations program, including potential stakeholders and systems that may have been missed in the initial vision for the program. Consulting the list of stakeholders in the architecture early in the definition of the program will help ensure that all relevant partners are included from the outset.

Once the stakeholders are identified, relevant inventory elements, service packages, and interfaces can be selected in collaboration with these partners. Using the ITS architecture to define a program is largely a matter of defining the applicable architecture subset. If the architecture is up to date, the program can be defined as a simple subset of the architecture. In other cases, additional definition will be required for concepts that were not envisioned in the original architecture, particularly for older regional ITS architectures.

The program definition process is likely to identify additional stakeholders and integration opportunities. Once created, the program definition will show how each partner fits in the overall program. It also provides a regional context for the program, identifying peripheral stakeholders and systems, including future systems that will be implemented through other programs and projects.

Example

For example, the San Diego Association of Governments (SANDAG) used its architecture to support the initial definition and development of its Integrated Corridor Management (ICM) program. In turn, the decision support system defined for the ICM program helped the regional ITS architecture better reflect the use of decision support systems to support regional traffic management. Figure 18 shows a high-level architectural view of the Intermodal Transportation Management System, the heart of the regional ITS architecture and the basis of San Diego's ICM program.

The architecture has been very beneficial in the implementation of our 511 system and what we are doing for ICM. It provided a sound foundation and building block for innovative and cost-effective concepts.

Samuel Johnson
SANDAG

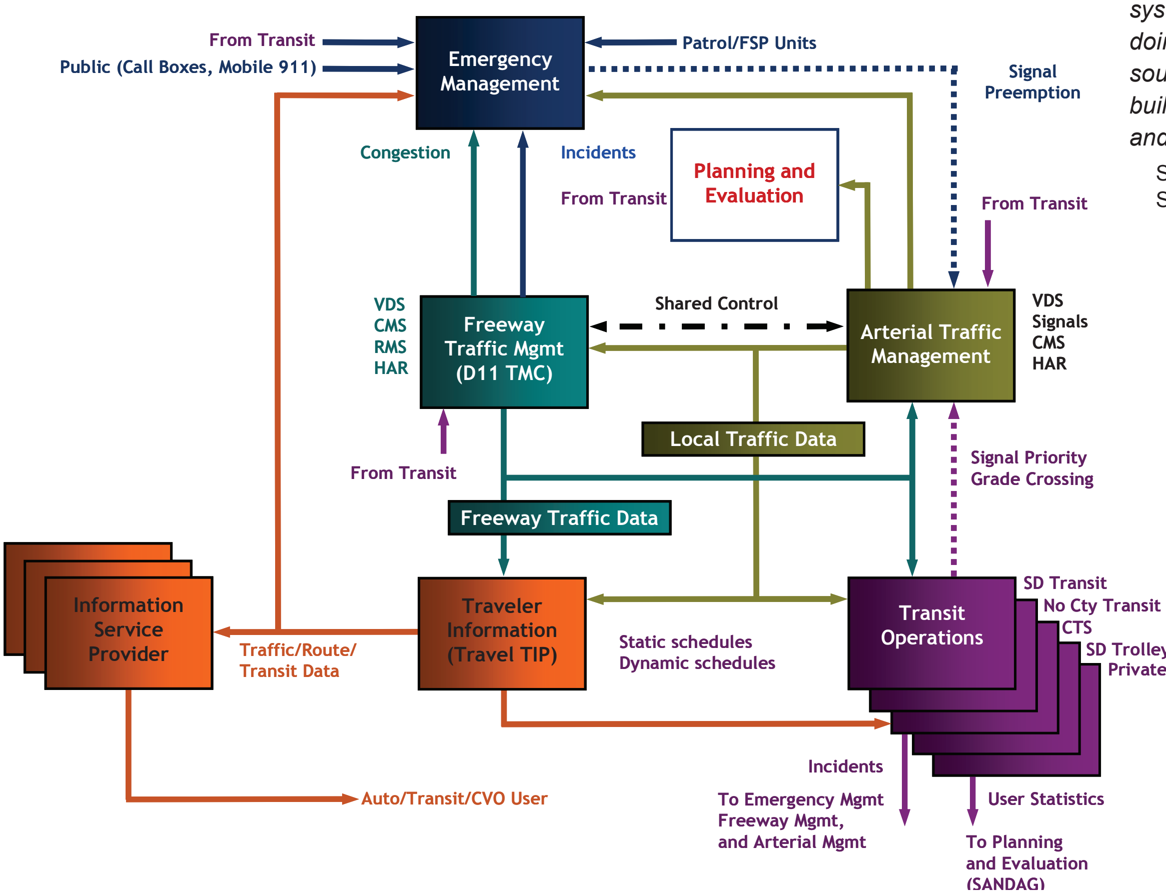


Figure 18: San Diego Intermodal Transportation Management System High-Level Architecture.[22]

[22] San Diego Association of Governments, San Diego I-15 Integrated Corridor Management (ICM) System: Final ICM Concept of Operations, May 2009.

ADDRESSES CORE QUESTION:

How can we most effectively integrate a new M&O strategy (supported by ITS) with other existing or planned technology deployments to provide a greater level of service for the customer?

Define project scope and identify integration opportunities

A primary goal of planning is to ensure that project money is spent wisely. This means that projects defined and developed by different local agencies should be compatible, working together as a cohesive regional system. There should also be a mechanism to ensure that local projects accomplish the regional objectives defined in the transportation plan. The regional ITS architecture can help planners and their operations partners meet these goals.

Using an ITS architecture for project scoping is not markedly different than using it for program definition. The difference is the breadth and level of detail— projects tend to be more narrowly focused and more specific than programs. The architecture subset selected for a project will typically include fewer stakeholders, systems, and interfaces than the subset for a program and will require a relatively minor time investment to create.

As individual projects are independently scoped and defined, there is a risk of fragmentation and disconnects from other projects and regional objectives. Defining every ITS project in terms of the same regional ITS architecture helps integrate new projects (and related M&O strategies) with existing and planned deployments, minimizing the risk of disconnects and ultimately improving the level of service offered by the transportation system when the projects are implemented.

The approach to defining a project using the regional ITS architecture depends on how the architecture is defined. In the simplest case, the project will already be defined in the architecture documentation, and the relevant portion of the architecture can be extracted directly from its documentation. Figure 15 shows an example project diagram taken directly from the Maricopa County Association of Governments Regional ITS Architecture.[23]

If the desired project is not already defined, the project sponsor will need to scan the regional ITS architecture to find the stakeholders, inventory elements, service packages, and interfaces the project will need. It is strongly recommended that project sponsors include peripheral interfaces that show how the project fits into the broader regional transportation system in their project definitions. This process results in a project scope that considers the context of all of the other systems in the region, resulting in an initial project scope that is more accurate and less subject to change. For example, the use of the regional ITS architecture to scope the flood monitoring project in Figure 19 would result in early analysis to determine whether the interface to the National Weather Service should be included. Using the architecture results in more accurate scope for the projects included in the TIP, minimizing later amendments to the TIP to add more funding to projects that were not sufficiently scoped in planning.

23 Maricopa Association of Governments, "Maricopa Association of Governments Regional ITS Architecture" Web Site, June 2010. Available at: http://www.consystec.com/mag/web/, last accessed August 29, 2011.

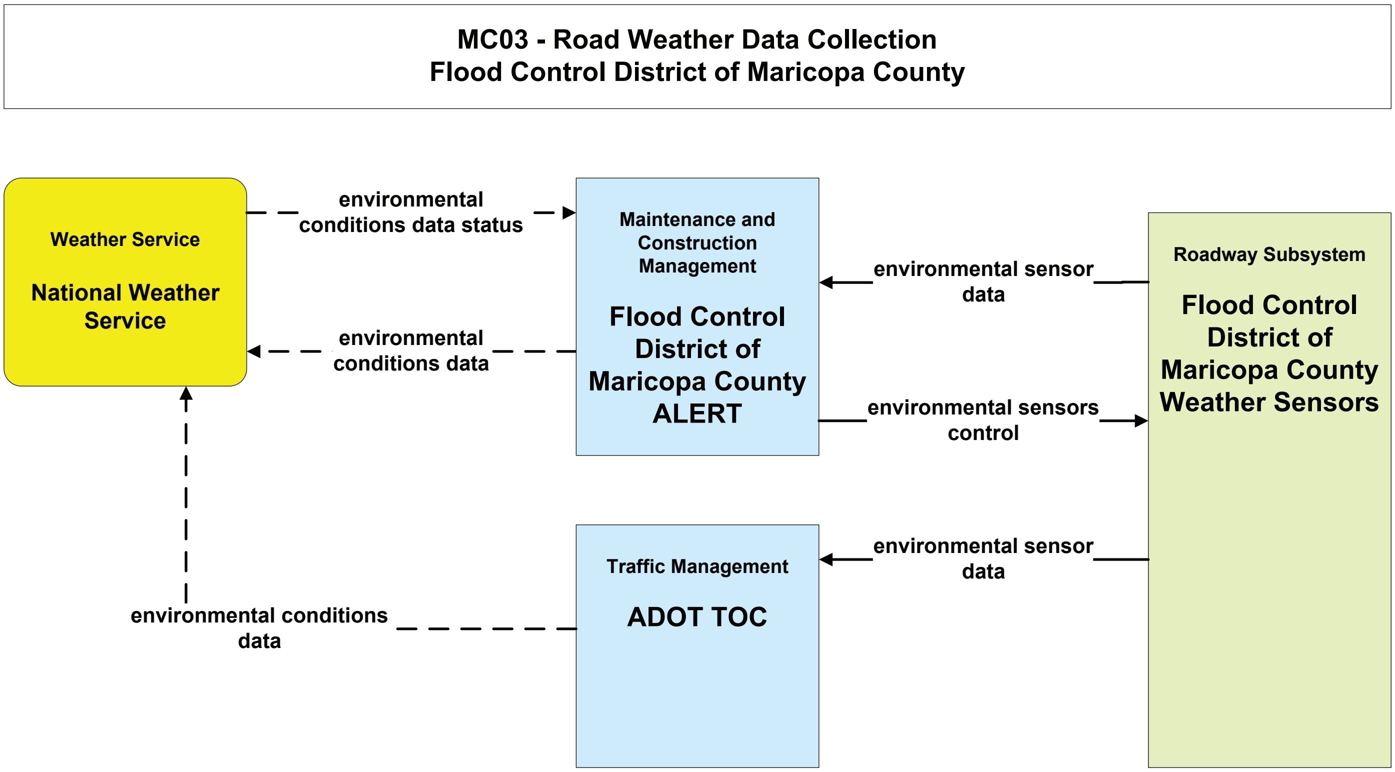
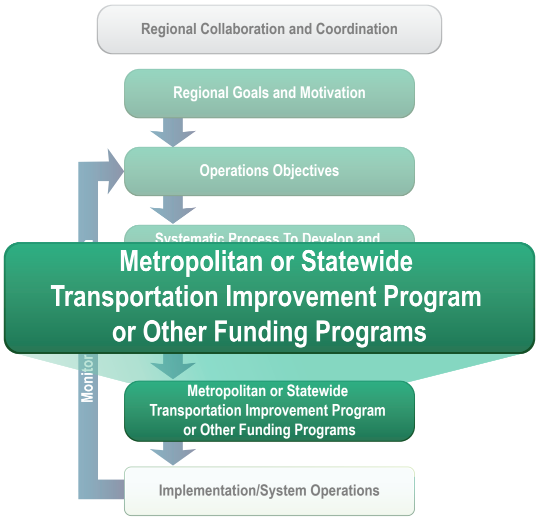


Figure 19: Using Service Package Customization to Define Projects in the Maricopa Association of Governments Regional ITS Architecture.

3.6. Selecting and Prioritizing Projects



The objectives-driven, performance-based process flow diagram depicts direct top-down flow from the transportation plan to the S/TIP. In the objectives-driven, performance-based approach M&O project selection and prioritization is based on the ability of the project to fulfill the area's operations objectives. Typically, there are many other factors and influences in the project selection process including funding and staff required for ongoing operations. The regional ITS architecture provides an important tool for ensuring that M&O projects support a regionally integrated vision for operations and its enabling technology. If the architecture was constructed or updated in response to the operations objectives from the region's transportation plan, the architecture can also help to link project selection and prioritization to the region's objectives. The architecture can help provide continuity between the transportation plan and the transportation improvement program.

Define an efficient timeline for project implementation

One of the significant differences between operations/ITS projects and conventional transportation projects is the degree to which information, facilities, and infrastructure can be shared among the projects. For example, a 511 traveler information system project may use traffic information collected by previous instrumentation projects and incident information from a CAD integration project. The regional ITS architecture provides a new way to look at these ITS project relationships or "dependencies." Project dependencies can identify projects that must be implemented before other projects can begin. Taking these dependencies into account enables an efficient sequence to be developed so that projects build incrementally on each other, saving money and time as the region invests in future ITS projects.

Project sequencing is a basic component of most regional ITS architectures. Commonly, regional ITS architectures include a list of short-, medium-, and long-range projects. To better support the programming of operations/ITS project, the project sequencing in the architecture should take dependencies between projects into account. It also should reflect the real-world sequencing already defined in programming documents.

Example

The Memphis, Tennessee regional ITS architecture presents projects by market package; grouping projects that contribute to a common service. The table below, extracted from the Memphis regional ITS architecture, illustrates both recommended and supporting projects for a "high priority" market package: Traffic Incident Management System (ATMS08). These tables can assist the Memphis region in developing a sequence of projects for implementation with the "recommended projects" occurring prior to the "additional supporting projects."

Table 2: Memphis Regional ITS Architecture Projects Related to Incident Management.[24]

Traffic Incident Management System (ATMS08)	High Priority
Manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. This market package includes incident detection capabilities and coordination with other agencies. It supports traffic operations personnel in developing an appropriate response in coordination with emergency management, maintenance and construction management, and other incident response personnel.	
Recommended Projects • Municipal TOC Coordination with TDOT Region 4 SmartWay TMC • Municipal/County TOC • Municipal/County TOC Coordination with Municipal/County Public Safety Dispatch • TDOT Region 4 SmartWay TMC Coordination with MDOT Northwest Regional TMC • TDOT SmartWay Information System Modification for Municipal Traffic Information Input	
Additional Supporting Projects • Municipal Service Patrol Implementation • Municipal/County Portable DMS • TDOT HELP Service Patrol Expansion • TDOT Region 4 SmartWay ITS I-40 Extension • TDOT Region 4 SmartWay ITS SR 385 Extension • TDOT Region 4 SmartWay ITS SR 385/I-269 (North) Implementation • TDOT Region 4 SmartWay ITS SR 385/I-269 (South) Implementation	

Example

Because project sequences are closely related to the TIP or STIP, they have a shorter shelf life than the rest of the architecture and should be updated in conjunction with major TIP or STIP updates. In Albuquerque, New Mexico, the Mid-Region Council of Governments and New Mexico DOT have developed an efficient approach to capturing project-level updates in their regional ITS architecture. They release an architecture addendum with each release of the TIP that shows the TIP projects in the architecture context. The baseline regional ITS architecture document is updated less frequently.

Include the architecture as part of the TIP or STIP project application process

Once the scope of each project has been defined, there must be a regional mechanism to examine the scope of each project and identify potential disconnects and missed opportunities. In effect, local agency project sponsors define the pieces of the puzzle in their project applications. Planning and operations staff must work together to look across the pieces and verify that they will fit together. The MPO frequently provides this regional oversight in a metropolitan area, as the State DOT does at the State level. The TIP or STIP project application should provide the information necessary to understand how a given project fits into the regional context.

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[24] Memphis Urban Area MPO and Tennessee Department of Transportation, Memphis Urban Area Regional ITS Architecture: Regional ITS Deployment Plan, June 2010, Available at: *http://www.kimley-horn.com/Projects/TennesseeITSArchitecture/documents/memphis/Memphis%20Regional%20ITS%20Deployment%20Plan.pdf*, last accessed August 28, 2011.

Many regions require project sponsors to identify the portion of the regional ITS architecture their project will implement as part of the TIP application. Done properly (i.e., with more depth than just "checking a box"), this requires project sponsors to consider the regional context for their projects. It also provides information in the application that the MPO or DOT can review to verify conformance with the regional ITS architecture and any operations plans for the region. This is particularly important for regionally significant projects that may also be prioritized by defined project selection criteria.

In the Northern Region of the Virginia DOT, the Virginia DOT has provided operations project applicants with a Project Proposal Template. Excerpts from this template are shown below. The template is part of the 2009 Virginia DOT's *Northern Virginia Operations Planning Guide: Leveraging ITS Architecture and Systems Engineering.*[25] The template asks applicants to summarize and check off the ITS strategic plan's goals and objectives that this project will meet. The applicants are also asked to specify the operations needs that the project will address and "provide information related to the component of the Northern Virginia ITS Architecture that are associated with this project."[26] The stakeholders, ITS architecture elements or subsystems, and ITS market packages associated with the proposed project are also requested as part of the operations project proposal template. This template facilitates a direct connection between the programming of ITS/operations projects and the regional ITS architecture and strategic plan.

Appendix A: Project Proposal Template

1 PROJECT OVERVIEW

PROVIDE PROJECT OVERVIEW TEXT HERE INCLUDING PROJECT PURPOSE, LIMITS AND EXPECTED OUTCOMES

2 GOALS AND OBJECTIVES

PROVIDE SUMMARY TEXT OF STRATEGIC PLAN GOALS AND OBJECTIVES MET BY THIS PROJECT

VDOT's vision for the region and also for the Project Corridor is to:

Make Roadway Travel Safe, Efficient, and Reliable.

To meet this vision, VDOT NRO plans to achieve through this project by: (example below)

- Serving the public by providing them with the information they need to make good travel decisions;
- Monitoring real-time traffic conditions and the condition of its infrastructure;
- Proactively and rapidly identifying problems, including traffic congestion, crashes, and other mobility and safety needs;
- Taking rapid and effective action to address current and developing problems, appropriately applying a range of methods including physical improvements and advanced technologies;
- Sharing information, coordinating responses, and planning jointly with its partner agencies.

Goals and objectives met by this project include:

FOR EASE OF USE, PLACE AN "X" IN THE CELLS TO THE LEFT OF THE GOALS AND OBJECTIVES THAT WILL BE ADDRESSED BY THIS PROJECT

[25] Virginia Department of Transportation, Northern Virginia Operations, *Operations Planning Guide: Leveraging ITS Architecture and Systems Engineering*, June 2009. Available at: *http://www.vdot-itsarch.com/docs/PlanningandProgramDeliveryGuideV1%282009-11-17%29.pdf*, last accessed August 28, 2011.

[26] Ibid.

	GOALS AND OBJECTIVES [Mark the goals and objectives that apply to this project with an "X"]	EXPECTED BENEFITS
	Goal #1: Reduce Congestion	• Reduction in travel times • Reduction in delay (vehicle hours) • Reduction in incident duration • Improved travel time reliability
	1.1 Reduce travel times and delays for all modes along identified major corridors	
	1.2 Improve travel time reliability on major corridors	
	1.3 Actively manage travel demand on NRO facilities	
	1.4 Reduce delays due to work zones and planned special events	
	1.5 Reduce incident clearance times	
	Goal #2: Improve Safety	• Reduction in incidents
	2.1 Reduce vehicular crashes	
	2.2 Reduce pedestrian and bicyclist crashes	

6 PROJECT ARCHITECTURE

PROVIDE INFORMATION RELATED TO THE COMPONENTS OF THE NORTHERN VIRGNIA ITS ARCHITECTURE THAT ARE ASSOCIATED WITH THIS PROJECT. The Project Architecture provides a framework that identifies the institutional agreement and technical integration necessary to interface the ITS project with other ITS projects and systems. It addresses the application of the proposed system with a focus on integration and operation of the system(s). The NRO Regional ITS Architecture (www.vdot-itsarch.com/Default.htm) should be used as the basis for generating the project architecture. The section should summarize key stakeholders (e.g. VOT NRO, Private Sector ISPs, MATOC, Video Clearinghouses), elements (e.g. VDOT NRO MPSTOC – TOC CCTV Cameras, VDOT NRO MPSTOC – TOC Detection, VDOT NRO MPSTOC – TOC DMS, and VDOT NRO MPSTOC – TOC, etc.), and ITS Market Packages description and interconnect diagram impacted by the proposed project.

Figure 20: Excerpt from Project Proposal Template in the 2009 Virginia DOT's *Northern Virginia Operations Planning Guide: Leveraging ITS Architecture and Systems Engineering.*

What is Systems Engineering and Why is it Important?

Systems engineering is an organized approach to developing and implementing a system. The approach can be applied to any system development. Whether you are deploying a few CCTV cameras, upgrading your traffic signal system, or implementing a sophisticated transportation management system, systems engineering can be used. The International Council on Systems Engineering (INCOSE) defines systems engineering like this:

"Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem."[27]

Although there are many ways to represent the systems engineering process, the winged "V" (or "Vee") model shown in Figure 21 has been broadly adopted in the transportation industry.

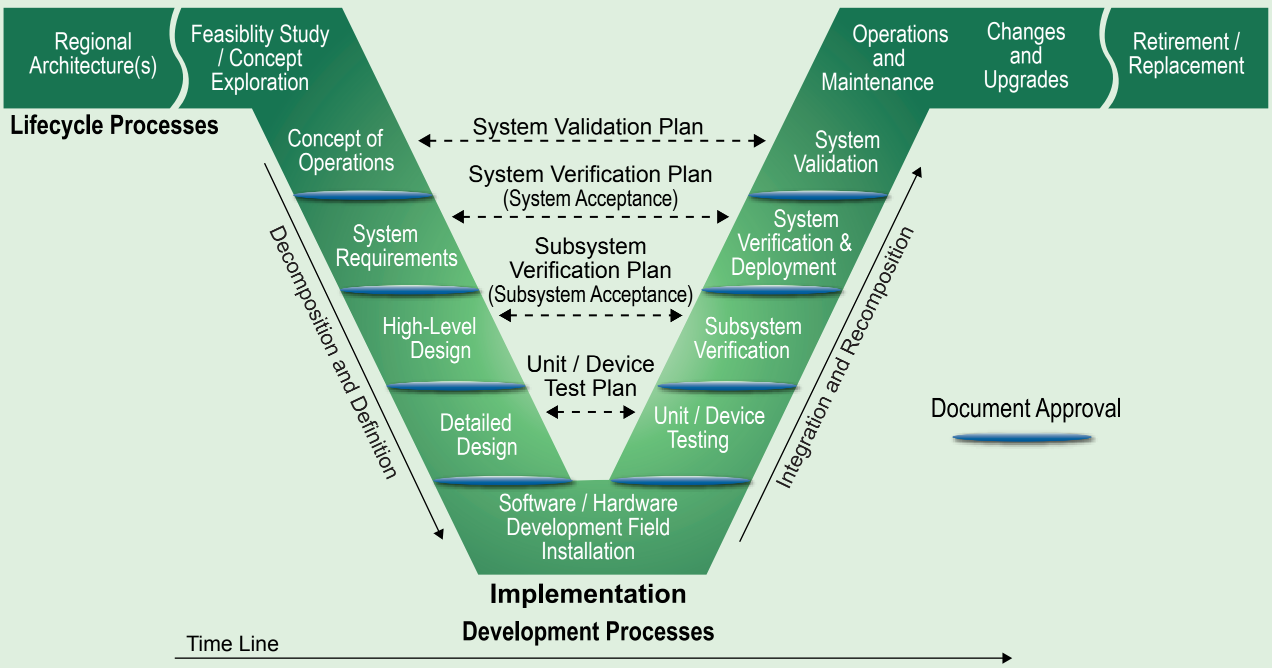


Figure 21: The Systems Engineering "V" Model.

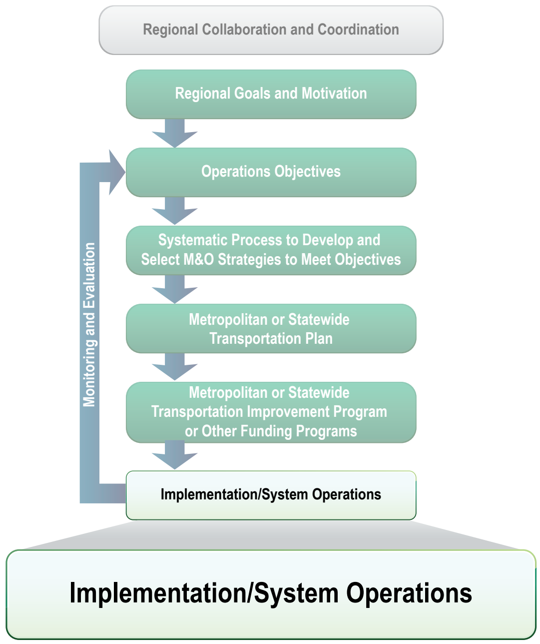
Following the "V" process from left to right, the left wing shows the regional ITS architecture, feasibility studies, and concept exploration that support initial identification and scoping of an ITS project. As you move down the left side of the "V", system definition progresses from a general user view of the system to a detailed specification of the system design. A series of documented baselines are established including a concept of operations that defines the user needs, a set of system requirements, and high-level and detailed design. The hardware and software are procured or built at the bottom of the "V", and the components of the system are integrated and verified on the right side. Ultimately, the completed system is validated to measure how well it meets the user's needs. The right wing includes the operations and maintenance, changes and upgrades, and ultimate retirement of the system.

A systems engineering analysis is required for all ITS projects using Federal funds per Title 23 CFR 940.11. Visit *http://ops.fhwa.dot.gov/int_its_deployment/sys_eng.htm* for additional information and resources including the Systems Engineering Handbook (*http://ops.fhwa.dot.gov/publications/seitsguide/index.htm*) and Systems Engineering Guidebook (*http://www.fhwa.dot.gov/cadiv/segb/*).

[27] International Council on Systems Engineering, "What is Systems Engineering?" Web Site, June 2004. Available at: http://www.incose.org/practice/whatissystemseng.aspx, last accessed December 20, 2011.

3.7. Implementation and System Operations

A regional ITS architecture is an important tool in assisting agencies with project development and system operations. The architecture supports the early steps of the systems engineering process used to guide the lifecycle of ITS-based operations projects. Developing the project's concept of operations, system requirements, and system design are all early elements of the systems engineering that can be supported by the use of the regional ITS architecture. Additionally, the relationships, roles and responsibilities, and institutional agreements specified in the architecture can help in ongoing system operations.



Use the architecture to kick-start project development

The portion of the architecture selected during project definition can support project development once funds are committed and the project is initiated. As shown in Figure 22, many components of the regional ITS architecture provide an initial input to support systems engineering.

Regional ITS architecture content such as the stakeholders, their roles and responsibilities (included in the operational concept), and the list of agreements supports the project concept of operations. The functional requirements are high-level requirements that can support system requirements development, and the interfaces and ITS standards support project design. In addition to assisting project implementers in the preliminary engineering stage, planners may also benefit from participating in the conceptual development of projects and strategies prior to the start of the formal project development. These components can inform creation of project documents, including requests for proposals, and architectural details can inform the project's scope of work.

ADDRESSES CORE QUESTION:

How can we define an M&O project or program in terms of functional requirements, operations concepts, supporting ITS standards, etc.?

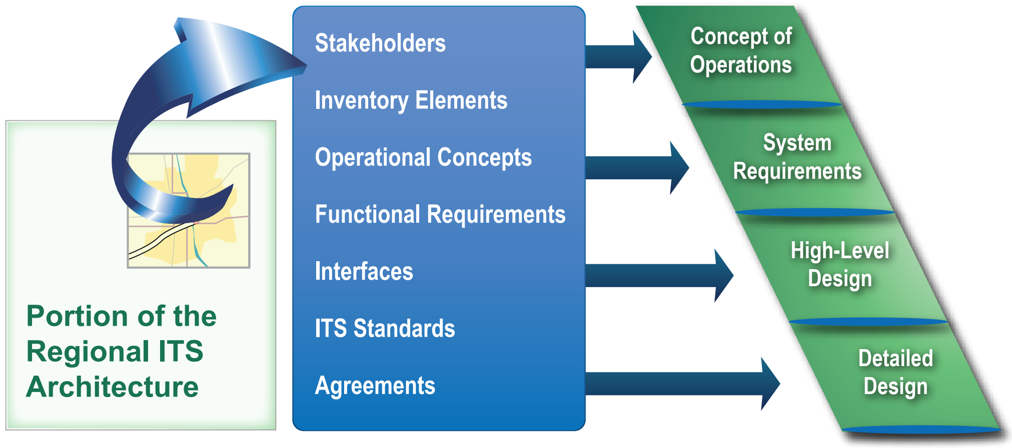


Figure 22: Using the Regional ITS Architecture to Support Project Development.

For example, stakeholders contemplating an Active Traffic Management project would find several relevant service packages: Variable Speed Limits, Dynamic Lane Management and Shoulder Use, and Dynamic Roadway Warning, which includes support for queue warnings.[28] Other more basic service packages including Traffic Metering and Traffic Information Dissemination would also be relevant and associated with the project. Other service packages, like Speed Enforcement, might also be considered but excluded from the first phase of the project. For a simple project, it would be easy to compile the relevant parts of the architecture by hand, but for a significant project like this ATM project, the stakeholders should use Turbo Architecture[29] to quickly assemble the pieces of the regional ITS architecture that apply to the initial ATM project into an ATM project architecture.

In addition to the relevant service packages, the related inventory (the State DOT freeway management center and associated field elements), stakeholders, functional requirements, interfaces, standards, and agreements are extracted and included in the project architecture. Numerous decisions are made along the way as functional requirements are omitted that are associated with border crossings (not applicable), environmental monitoring (future phase), and dynamic truck restrictions (only in the vicinity of the port). After some discussion, the stakeholders elect to also include requirements associated with hard shoulder running. Similar decisions are made when including interfaces in the project architecture as architecture flows associated with variable speed limits, lane management, roadway (including queue) warning, and shoulder management are all included. As a result of this process, the stakeholders develop a project architecture that defines the functional scope of the project and includes a set of high-level requirements, interfaces, and associated ITS standards. The stakeholders can use their project architecture to support project development, including development of a concept of operations and requirements for a statement of work and RFP.

Leverage agency roles and responsibilities and interagency agreements needed to operate the implemented system

The regional ITS architecture contains information on the current and future roles and responsibilities of ITS stakeholders that support the operation of regional ITS systems. These roles and responsibilities are typically identified in collaborative working sessions during architecture development or updates. These sessions also often identify agency agreements that would be required for implementation and operation of the defined systems. Agencies developing multijurisdictional projects or programs similar to those defined in the architecture can use this information to move faster and avoid duplicating effort. Of course, the exact roles, responsibilities, and agreements will need to be adjusted based on the exact specifications of the implemented system.

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28 This discussion reflects Version 7.0 changes to the National ITS Architecture. Consult the National ITS Architecture web site (*www.iteris.com/itsarch/*) for the current set of service packages related to Active Traffic Management.

29 Additional information about Turbo Architecture is available in Appendix A.

3.8. Monitoring and Evaluation

Ongoing monitoring and evaluation is crucial for the successful application of M&O strategies to accomplish specific operations objectives. It also provides important accountability among transportation professionals and with the public and elected leaders. The evaluation of M&O strategies following implementation enables practitioners to baseline overall system performance and estimate the value of their transportation operations investments.

The regional ITS architecture can play an important role in monitoring the operational performance of the transportation system, evaluating M&O strategies, and identifying data sources to support regional planning. There are two primary aspects of operational performance that should be monitored: the performance outcomes from the perspective of the user (how well is the system performing the task of providing mobility to the community) and the performance of the ITS and human operators (how well ITS/operations services are performing the functions they were designed to deliver). Both aspects require collection and monitoring of operational data, and both can be supported by the regional ITS architecture.

Support planning for transportation system performance monitoring

The regional ITS architecture identifies the types of data collected by different agencies using different systems. For example, traffic signal systems collect traffic volume data; transit operators collect bus, light rail transit (LRT), and heavy rail arrival times and passenger occupancies; and third-party providers collect and report speeds and congestion levels on freeways and arterials.

A region's mobility objectives may be established in terms of total travel distance and time on the network; the amount of delay in the network, perhaps during different times of the day and days of the week; travel times by different modes; and travel statistics for vehicles, passengers, and freight. Because collecting data using surveys is expensive and only reports performance as a snapshot in time, there is substantial advantage if the data can be collected, collated, analyzed, and reported automatically and continuously.

The regional ITS architecture can clearly show which performance measures can be quantified using data available from the various ITS systems and subsystems in the region. Processes and procedures for using the data can then be defined. This may require modifying the architecture or updating service packages and associated interfaces to include additional data collection and reporting capabilities.

REAL-TIME SYSTEM MANAGEMENT INFORMATION PROGRAM: SAFETEA-LU SECTION 1201

The information about the types of system performance data collected across the region in the regional ITS architecture can support the establishment of a real-time system management information program to collect and provides timely, accurate traffic and travel condition information to the public and share this data with other public agencies.

For more information: www.ops.fhwa.gov/1201/.

The focal point in the architecture for performance data collection is the Archived Data Management Subsystem (ADMS). Planners and operators can identify the relevant areas in their regional ITS architectures by reviewing the inventory to identify systems associated with ADMS. These are the data collection points in the regional ITS architecture. Depending on how the architecture is organized, these data sources may be identified by reviewing interfaces to data collection points or the three related Archived Data service packages.

Additional potential data sources that could support operations objectives can also be identified by inspecting the Archived Data service packages using the Turbo Architecture software.[30] Untapped potential data sources can then be incorporated into the architecture in the next regional ITS architecture update.

Example

In Rochester, New York, the ITS architecture's data warehousing element provides guidance to planners and system managers on data that can be used to evaluate the performance of projects. For example, archived vehicle counts and speed information provide the ability to quantify the operational impacts of infrastructure and ITS projects after they are deployed.

Consolidate system performance measures across agencies within a region

When transportation performance is measured, it is typically done for a single jurisdiction or mode. For example, a State DOT may record information about highway congestion, while city public works departments may collect delay data on the adjacent arterial roads. In parallel, transit operators may record information about the on-time performance of buses on routes that may include arterials and highways. Far less frequently are agencies across a region able to get a multi-jurisdictional, multimodal view of the operating performance of the regional transportation system. For example, rarely is the measurement of a freeway incident management system broad enough that it consolidates the measurements of performance on the arterials and transit systems to document the impacts of incidents and the benefits of the incident management system in a comprehensive fashion.

The regional ITS architecture exists to prevent data stovepiping and encourage regional solutions to broad problems such as incident management in a corridor. Examining the ITS architecture will identify data that is available or that could be collected by each system in the corridor. The ITS architecture can be used to identify opportunities to consolidate data for more comprehensive measurement of parameters that are currently measured and reported for only some agencies or for some components of the transportation system.

[30] Additional information about Turbo Architecture is available in Appendix A.

In Albuquerque, New Mexico, a new initiative has been identified to create a regional data archive system that will span all of the stakeholders and systems in the region. Though still in the early concept development stage, the goal is to use the defined regional ITS architecture linkages to consolidate all collected data in a regional data warehouse that will compliment current travel data collection activities. The data can then be analyzed to provide comprehensive system performance measures as well as support project development and the CMP.

Support planning for improved measurement of operating agencies' performance

The two previous opportunities relate to measurement of the operational performance of the transportation system. This opportunity concerns measurement of the efficiency of an agency in performing its operations activities.

Operating agencies measure the performance of their operations staff using key indicators of effectiveness and efficiency. For example, a freeway service patrol may measure parameters such as "time to respond to requests for assistance" and "time to clear incidents after arriving at the scene." An automatic incident-detection system will be evaluated by the percentage of incidents detected, the number of false alarms, and the delay between incident occurrence and detection.

These performance measures are typically agency-specific and often do not cross agency boundaries. Like broader transportation system performance measures, performance monitoring of operations components can also be planned at a regional level using the regional ITS architecture. The architecture itself can be used to identify opportunities for monitoring operations performance and overall transportation system performance.

A regional approach to performance monitoring allows complementary elements operated by different agencies to be assessed in context rather than in isolation, enabling better identification of operations components whose performance could be improved. For example, management of an incident may involve reporting through 911, deployment of an freeway service patrol (FSP) vehicle, deployment of DOT crews to clear debris and perform repairs, and deployment of specialty towing and salvage services. The ITS architecture provides an opportunity to plan ways to automate this process and the data collection and monitoring of each facet of the incident response and its impact on the performance of the transportation system.

4 Creating a Planning-Supportive Architecture

If the regional ITS architecture is to be used to support planning for operations, it must be relevant and easy to use. It must assist transportation planners in understanding and solving the tough integration choices facing States and metropolitan areas.

In order to be relevant, the architecture must be clearly connected with the transportation planning process. Section 4.1 describes an approach for connecting the architecture with transportation planning and provides examples of regions that have made this connection in a tangible way.

The regional ITS architecture has a reputation for requiring a steep learning curve with specialized terminology and expansive lists of items that are difficult to sort through. Section 4.2 presents techniques that regions have used to make the architecture more approachable and user-friendly for all users, with particular focus on the planning community.

Finally, there is a gap between the needs of transportation planners to support effective planning for integration and the information that is required to be included in a regional ITS architecture. Regions can fill the gap with an ITS/operations plan as described in Section 4.3.

Regions can follow the advice in Sections 4.1-4.3 and create an architecture that is connected with the planning process, is user friendly, and is augmented with an ITS/operations plan. This will lead to an architecture that can be used effectively, but one more factor should be considered to optimize architecture use— the timing of the architecture updates. To achieve the most benefit, the architecture update should be scheduled specifically to support the transportation planning process as described in Section 4.4.

The techniques described in this chapter can be viewed from two perspectives: 1) They capitalize on the strengths of the architecture and make sure the integration it describes is available to planners when they need it, in a readily consumable format, and 2) They also seek to address the challenges that have encumbered the use of the architecture in some regions. Many of the techniques described here were also mentioned in Chapter 3 as various opportunities for architecture use were highlighted. This section collects together the most successful ideas that we have encountered, and a few additional ideas that appear to have merit, but have yet to be implemented.

4.1. Making the Architecture Connections to Planning Explicit

In Section 2.4, we identified the connections between the planning for operations approach and the regional ITS architecture development process. These connections enable the opportunities for using the architecture to support planning for operations that are discussed in Chapter 3. The connections are important because they

WHY MAKE THE CONNECTION?

A documented connection between architecture and planning links the objectives identified in the planning process (what the region needs to accomplish) with the existing and planned ITS components in the region. The connection is a basis for many of the opportunities identified in Chapter 3. The result is better planning, an improved architecture, and ultimately a better surface transportation system that employs ITS specifically to meet the region's objectives.

establish the relationship between the objectives identified in the planning process and the existing and planned ITS components in the region. In this section, we take a closer look at how the connections should be documented to make the architecture more useful to planners.

The potential connections identified in Section 2.4 are summarized in Table 3 along with a summary of how to make each connection “explicit”. By explicit, we mean that planning outputs and architecture outputs are linked in a table, preferably supported by a database or equivalent application that allows the connection to be managed. You need to document the connection and then maintain the connection using tools so that you can quickly and easily identify disconnects and understand the implications of changes to the planning outputs, architecture outputs, or both.

The number of documented connections should be kept to a minimum since each documented connection creates overhead in the architecture maintenance effort. Fortunately, the architecture components are all linked to each other, so one or two links to the architecture will support access to all architecture components. Although the best approach will vary for each region, we will focus here on two connections that are highlighted in the table.

Table 3: Planning to Architecture Connections.

Planning for Operations Component	Related Architecture Component	Making the Connection Explicit	
Goals and Objectives	--	Link architecture to objectives	
Performance Measures	--	Link performance measures to objectives	
Operations Needs	Needs	Link needs if lists maintained	
Strategies	Services	Link strategies with service packages.	1.
Programs and Projects	Projects and the related subset of the regional ITS architecture: interfaces, functional requirements, etc.	Link programs/projects in the STIP/TIP to regional ITS architecture projects.	2.

Figure 23 shows the two key connection points in the context of the planning and architecture processes. As shown, connection 1 is used to link the architecture with the metropolitan/statewide transportation plan as it connects strategies from the planning process with services in the architecture process. This connection would be established and then maintained for each update of the MTP/LRSTP and major update to the architecture. Connection 2 would link the architecture with the projects identified in the STIP/TIP. Since project definitions and the STIP/TIP are updated more frequently than the MTP/LRSTP and strategies, the second connection would be subject to more frequent maintenance. Both connections may be facilitated by the ITS/operations plan(s) for your region, as described in Section 4.2. These two maintained connections would support the broader set of connections described in Section 2.4 and the opportunities described in Chapter 3. For example, connection 1 can also be used to link objectives to projects since the regional ITS architecture typically already includes a linkage between service packages and projects; objectives are connected to service packages, which are in turn connected to projects. As a planner, these connections will help you establish the relationship between programmed projects and the operations objectives.

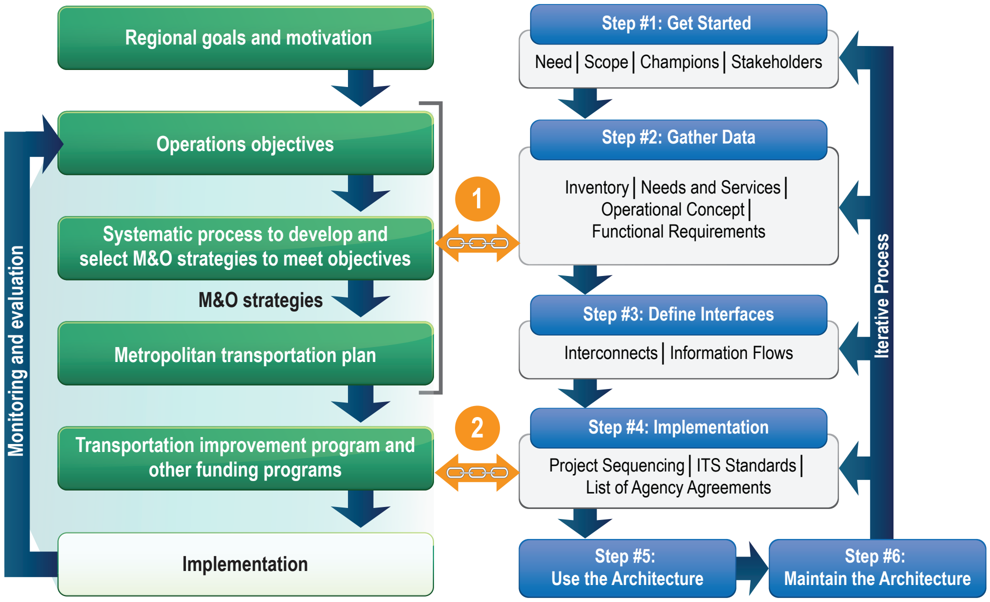

Figure 23: Key Connections in the Context of the Planning and Architecture Processes.

1. Documenting a Connection to Needs and Services.

First and foremost, the regional ITS architecture must reflect the goals and objectives of the region. This may seem like a statement of the obvious to readers of this primer since we have made this point several times; in Section 2.4 as we presented the connections between planning for operations and architecture and again in Chapter 3 when we described the opportunities to use the architecture to support development of regional goals and objectives. Although it may seem obvious, you may be surprised to find that your regional ITS architecture does not include such a connection. Relatively few regional ITS architectures have documented this connection to date.

If the objectives-driven performance-based approach to planning for operations is used, then there will be clear linkages between goals, objectives, and strategies. Needs are also defined as part of the planning for operations approach, but the needs are frequently documented in narrative form rather than as a discrete list of items that can easily be linked to the regional ITS architecture. In the regional ITS architecture, needs and services are also typically linked. If all of these linkages are in place, then a single connection between objectives or strategies from planning for operations and needs or services from the architecture is all that must be established to ground the regional ITS architecture in the regional goals and objectives and also establish the key connection between strategies and services. Figure 24 shows a few of the alternative connections. In the figure, only two sample rows are shown for each potential connection although there will typically be a few hundred rows in a complete, defined connection between a transportation plan and a regional ITS architecture.

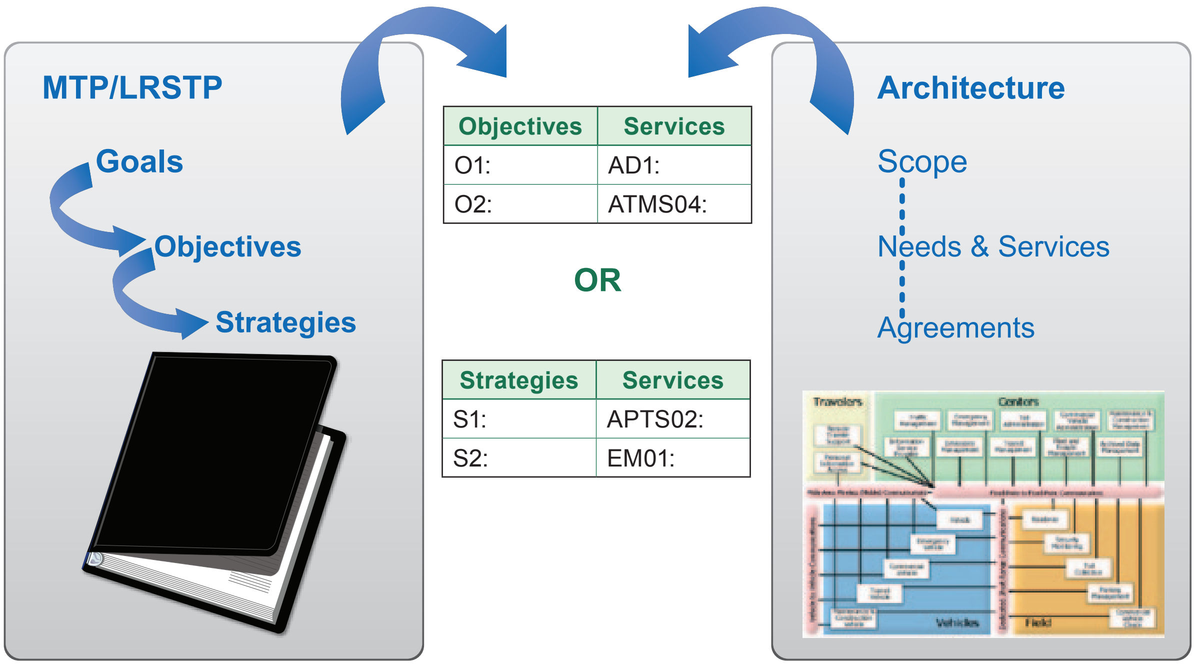

Figure 24: Connecting Objectives and Strategies with Needs and Services.

To establish an explicit connection:

- **Determine the best connection point in the MTP/LRSTP.** If your region has adopted the objectives-driven performance-based approach, then objectives and/or strategies are likely to be the best connection point(s). If this approach has not yet been adopted, then goals or policies or another plan component may be the most effective connection point, depending on how the MTP/LRSTP is structured in your region. Generally, you want to connect with the most detailed, discrete list of items included in the MTP/LRSTP that are traceable back to the regional goals.
- **Similarly, identify the optimal connection point in the architecture.** This connection point will also vary but most frequently will be either needs or services. Needs are an ideal connection point if they are a focus in your regional ITS architecture since they will be a basis for the services that are included in the architecture. If a good list of needs is not included in the architecture, then ITS Services are normally the best connection point as they are almost always well documented in the regional ITS architecture.
- **Establish and document the connection.** This means you need a table that links the selected planning component and architecture component. You can build this table of connections using the Turbo Architecture "Planning Tab"[31] or alternatively, in another database application or tool. Note that you could also create a table in a word processor or publishing application, but such a table would be more difficult to maintain.

[31] Additional information about Turbo Architecture is available in Appendix A.

- **Use the table to identify inconsistencies and needed changes.** If you build the table in Turbo Architecture or another database application, then you can easily run queries or reports to identify disconnects (e.g., services not supported by objectives and objectives that have no supporting services) and more easily keep the table up to date as both the planning and architecture components evolve over time.
- **Publish the table so that it is easy to follow the connections.** Ideally, a user will be able to traverse the established connections. For example, the user should be able to move from a particular objective to the service(s) that support that objective. Similarly, a user should be able to navigate from a particular service to the objective(s) that the service supports. This structure adds organization to the regional ITS architecture "toolbox" of services since it effectively organizes the architecture by the goals and objectives that are important to the region. This capability lends itself to a web-based presentation, but it can also be achieved with a well-organized set of documentation that includes services sorted by goal and/or objective.

At the national level, the objectives categories identified in *Advancing Metropolitan Planning for Operations The Building Blocks of a Model Transportation Plan Incorporating Operations: A Desk Reference* are linked to the National ITS Architecture. If you have not yet built a connection between architecture and objectives, then these connections will provide a head start. Visit the "Planning View" on the National ITS Architecture web site for more information.[32]

The Minnesota Statewide ITS Architecture links high-level polices from the Statewide Transportation Plan to ITS Development Objectives and ITS Project Concepts that are defined as part of the architecture. An excerpt from the table that is included in Volume 1 of the statewide architecture is shown in Chapter 3 (see Figure 15).

2. Establishing a Connection Using Projects.

The most common use of a regional ITS architecture is during programming when projects are scoped, project applications are prepared by project sponsors, and the applications are evaluated by the MPO and/or the State DOT. Specific connections between the programs/projects in the MTP/LRSTP and the STIP/TIP and the projects defined in the regional ITS architecture project sequence will facilitate this use. An ITS/operations plan can align the regional ITS architecture project sequence with the planned and programmed projects or the connection can be documented as part of the regional ITS architecture. In either case, a traceable project-oriented link is created that connects the architecture with the project scoping and programming process.

Figure 25 shows three different approaches that are commonly used to make a connection between projects and the regional ITS architecture. The approach should allow the specific components of the architecture— the services, operational concept, functional requirements, interfaces, associated ITS standards, and agreements— to be identified for a specific project. All three of the approaches shown in the figure allow the user to identify these architecture components due to the links in the regional ITS architecture, but there are differences in the difficulty the user will have in

[32] Planning View is planned for inclusion in Version 7.0 of the National ITS Architecture.

identifying the components and the precision of the fit between the components that are identified and the real scope of the project. Here is a quick discussion and comparison of the three approaches:

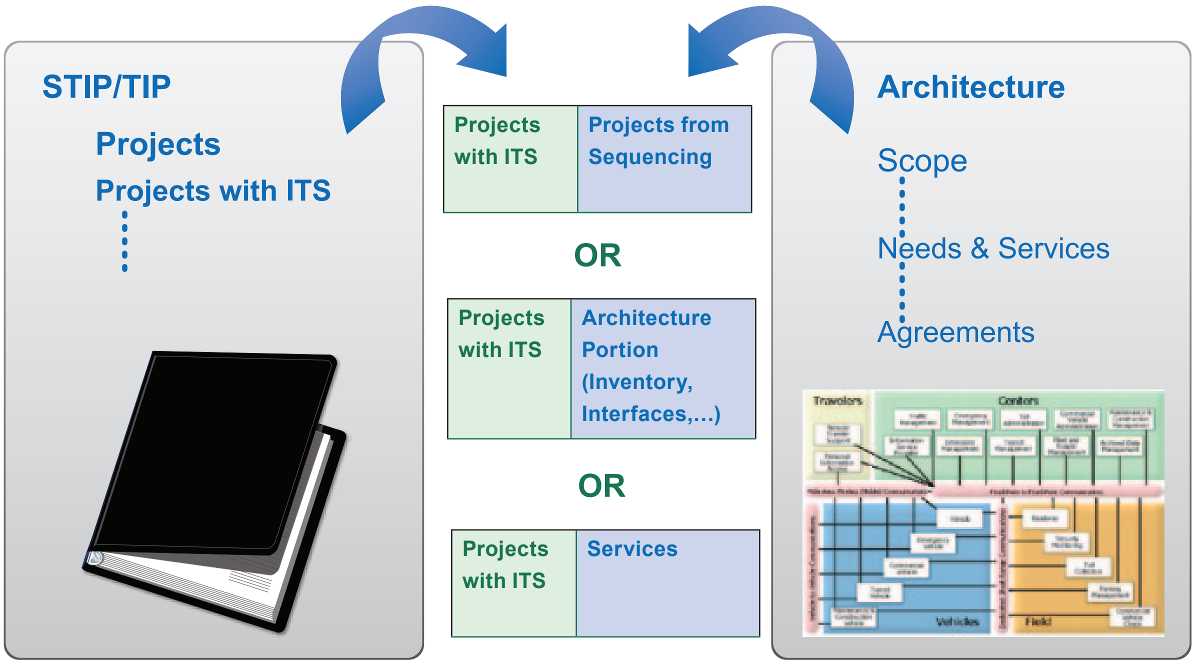

Figure 25: Connecting the STIP/TIP Projects with the Architecture.

1. **Link to the projects in project sequencing.** This approach makes it easy on the user since the user only has to find their project in the sequence. Assuming that each of the projects in the sequence also include a definition in terms of the regional ITS architecture, this approach will also yield an accurate initial scope for the project in architecture terms. Some regions specifically reference the projects listed in the STIP/TIP in the project sequencing documentation included in the regional ITS architecture. The challenge here is that not all regional ITS architectures define the projects in the project sequence in terms of their scope within the regional ITS architecture. For these regions, the user must directly access the regional ITS architecture to understand how their project fits in the region, effectively using approach 2.
2. **Link directly to the components of the regional ITS architecture that support the project.** This approach requires the user to manually identify the subset of the regional ITS architecture related to the project. This activity is much easier if Turbo Architecture is used, but most regional ITS architecture users do not have Turbo installed and don't know how to use it. The benefit of this technique is that the user is required to look at the regional ITS architecture and make specific choices about how their project fits (e.g., should the interface to maintenance be included now or deferred to a future project). In approach 1, these choices are made as part of the regional ITS architecture (or ITS/operations plan) update.
3. **Link to the service (or services) that correspond to the ITS project.** In this approach, the user combs through the service packages that are included in the regional ITS architecture. See Figure 28 in Section 4.3 for an example table that links STIP/TIP projects with regional ITS architecture service packages. Like approach 1, this is a fairly easy exercise for the user, who looks through a list to

find the service that is the closest fit for his or her project. Assuming that the regional ITS architecture documentation includes a complete definition of each service, the user can use the service to access the relevant regional ITS architecture components for the project. The challenge is that the service will often not be a perfect fit for the project, requiring the user to tailor the list of regional ITS architecture components to match the anticipated scope of the project. As in approach 2, this tailoring effectively requires a project ITS architecture to be developed, although in this case, the service package provides a head start. This tailoring can be done by hand for a simple project; users will find that using Turbo Architecture greatly facilitates the work involved in tailoring more complex projects.

The specific nature of projects can pose a challenge when they are defined in terms of the regional ITS architecture. For example, a regional ITS architecture may include only a few general inventory elements to represent the traffic signal systems that are implemented by local agencies in a metropolitan area. These same general elements may be included in many different projects, representing implementations in different locations and by different agencies. The Turbo Architecture software allows more specific architecture elements to be defined for a specific agency and a specific subset of the traffic network. These "element instances" may be used to more specifically define the scope of a particular project without adding too much detail to the regional ITS architecture. Element instances allow you to bridge the gap between the higher level regional ITS architecture and specific projects.

Some regions have taken the next step and are beginning to use a geographic information system (GIS) to extend the architecture to add location specificity for projects while maintaining the linkage to the overarching regional ITS architecture framework. For example, the Mid-Region Council of Governments in Albuquerque, NM is developing a central ITS infrastructure "geodatabase" in GIS (Figure 26). Facilitated by the ITS subcommittee, this system will establish a common framework for near-term ITS infrastructure mapping and deployment summaries and will promote infrastructure consistency and coordination among all stakeholders. The geodatabase will utilize the state of the art in GIS applications and will reside on the internet at a central web site and will be accessed via the internet "cloud." It will provide a centralized location for viewing, mapping, and summarizing regional ITS deployment information for all stakeholders. The links to the regional ITS architecture provide the framework necessary for this level of integration.

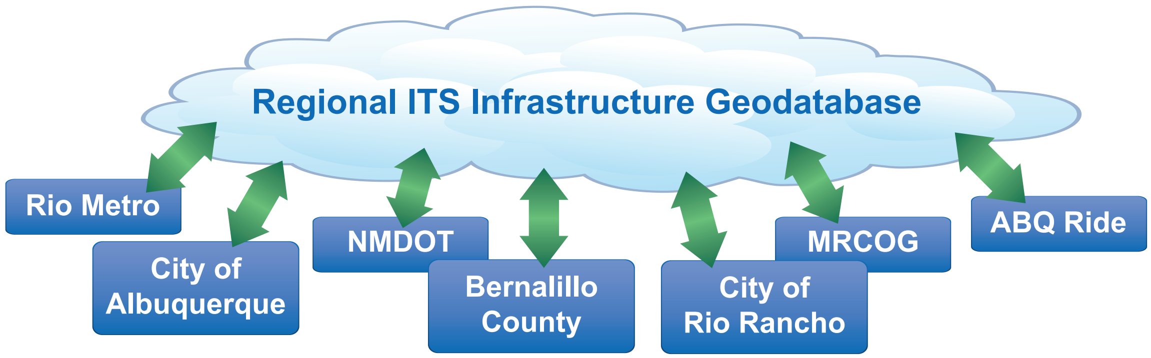

Figure 26: MRCOG Regional ITS Infrastructure Geodatabase.[33]

[33] Image courtesy of the Mid-Region Council of Governments.

4.2. Keeping it Planner-Friendly

There are a number of techniques that can be used to make a regional ITS architecture easier to use for transportation planners. Fortunately, the techniques that are used to make the architecture "planner friendly" also improve the user experience for all users as the techniques address the common challenges identified in Table 4. Each of the techniques is explored further in the remainder of this chapter.

Table 4: Techniques for Making the Architecture Planner-Friendly.

Challenge	Technique
The regional ITS architecture is a specialized topic area with its own terminology and concepts.	User Aids • Provide links to resources like the Regional ITS Architecture Guidance Document and other resources. • Include a glossary of terms. • Provide contact information for those with questions • Include training with your next regional ITS architecture update.
The sheer amount of information in the architecture can be daunting— hundreds or even thousands of functional requirements and interfaces. Users can get lost and never find the information they were seeking.	User-Friendly Organization • Provide a roadmap. • Segment the regional ITS architecture documentation into "views" for different types of users. • Include navigation queues. • Provide summary level information with the opportunity to "drill down" into the detail.
The content can be difficult for planners to pick up and use.	Planner-Friendly Content • Provide summary level graphics suitable for executive summary/presentations. • Provide a planning view, including links to the MTP/LRSTP.

User Aids

Using the regional ITS architecture can be a challenge due to its specialized terminology and concepts that are unfamiliar to most planners. Very few regional ITS architecture users consider themselves to be architecture experts; most need some background information to support their use of the regional ITS architecture. Users access the regional ITS architecture infrequently, so even users that were involved in the regional ITS architecture development may need a quick refresher on the terminology or background on regional ITS architecture concepts. Consider the following techniques for providing assistance to potential architecture users, including planners and non-planners alike.

- **Provide links to resources.** Every regional ITS architecture should include a list of resources like this primer and the Regional ITS Architecture Guidance Document as well as other resources specific to your region. If your regional ITS architecture includes additional background information, then consider packaging this information so that it can be easily referenced.

- **Include a glossary of terms.** The regional ITS architecture documentation will only communicate effectively if the users understand the terminology that is used. An acronym list and a glossary should be included in the documentation. It also helps to provide the definitions in context where possible. For on-line regional ITS architecture documentation, JavaScript can be used to provide definitions in a popup window so that a user can hover over an unfamiliar term and view a definition without leaving the current web page, as shown.
- **Provide contact information for those with questions.** Most regions have at least one or two individuals who can answer user questions about the regional ITS architecture. Provide contact information for those individuals as the last line of support for users.
- **Include training with your next regional ITS architecture update.** Many regions that hire a consultant to support a regional ITS architecture update also include training as part of the update. Training that is specific to your regional ITS architecture and regional planning and project development processes can be very helpful. Consider cost-effective ways to make the training available online. For example, webinars can be recorded and archived for future use.

User-Friendly Organization

Most regional ITS architecture documents are several hundred pages in length. Regional ITS architecture web sites include hundreds or even thousands of pages. All users of the regional ITS architecture must be able to find what they need in the broad set of documentation. Fortunately, there are several techniques that have proven effective in assisting the user in finding the information they seek.

- **Provide a roadmap.** The architecture documentation should include a guide or roadmap to the architecture, preferably directed toward different types of users and anticipated uses of the architecture. For example, the roadmap might direct planners to linkages with the MTP/LRSTP, guide operations staff to documentation that presents the architecture by agency or system element, and point engineers/project development staff toward project-oriented views of the architecture. Not only should the roadmap be featured prominently at the beginning of the architecture documentation, it should also be one of the first pieces of narrative that is outlined. Thinking about the roadmap early in the process will result in documentation that is better organized and more user-oriented. In your first draft of the roadmap, as you try to explain the user-friendly organization, you may find that it is not as friendly as it should be or does not fulfill all of the anticipated uses, suggesting overall changes that should be made in the architecture documentation.
- **Segment the regional ITS architecture documentation into "views" for different types of users.** This technique goes hand-in-hand with the roadmap. Most users are interested in a narrow subset of the architecture that is related to a particular stakeholder organization, inventory element, or service. Planners may be interested in a narrow subset most relevant to them and they may also be interested in top-level views that cover the breadth of the architecture in a user-friendly, approachable manner. Views are provided to facilitate use by different types of users. For example, the Minnesota Statewide ITS Architecture is segmented by service package bundle, grouping traveler information, traffic management, transit, commercial vehicle operations, public safety, and maintenance oriented portions of the architecture into separate volumes.

- **Provide summary level information with the opportunity to "drill down" into the detail.** It is good practice to provide summary level information and make the details available to the users that wish to delve into it. Most regional ITS architecture documents are structured so that the architecture is described at a relatively high-level in the body of the document and large tables of functional requirements and interfaces are relegated to appendices. In regional ITS architecture web pages, top-level pages provide a summary of each aspect of the architecture— stakeholders, inventory, services, etc.— with links to pages that provide more detail in each area.
- **Provide Navigation Queues.** With any complex web site or document, the user will benefit from navigation queues that help the user keep track of where they are in the material. This is particularly true of regional ITS architecture web sites where pages of service packages, projects, and inventory can all look very similar to the uninitiated. Web site navigation queues include highlighted menu entries and navigation breadcrumbs— the hyperlinks at the top of many web pages that show the path from the home page to the current web page (e.g., Home > Roadmap > Find My Project). For documents, including the current chapter information in each page header will suffice.

Planner Friendly Content

- **Provide summary level graphics suitable for executive summaries/presentations.** Many regions have recognized that the regional ITS architecture benefits from "executive summary" level descriptions and graphics that present the integration opportunities identified in the architecture in an accessible way. These graphics can be used in the architecture documentation and included in higher level documents such as the MTP/LRSTP that will be read by many who are unfamiliar with ITS architecture.
- **Provide a planning view, including links to the MTP/LRSTP.** An architecture view that is oriented towards planners would include access to: 1) the architecture organized by the objectives/strategies in the metropolitan/statewide Transportation Plan, 2) the architecture organized by project to facilitate use in evaluating project applications, and 3) the portion of the regional ITS architecture that supports data collection, performance monitoring, and any other interfaces that are of central interest to the planners in the region.

4.3. Adding the Planning Context – ITS/Operations Plans

The regional ITS architecture is focused on defining the integration opportunities for the transportation systems in the region. While it includes a few strategic elements like the project sequencing, the regional ITS architecture typically does not define the strategic vision for operations and the overall approach for how the integrated regional transportation system will be implemented geographically, over time. This missing strategic element is important to the planning process, which seeks to identify and prioritize projects for implementation in specific locations and in specific fiscal years.

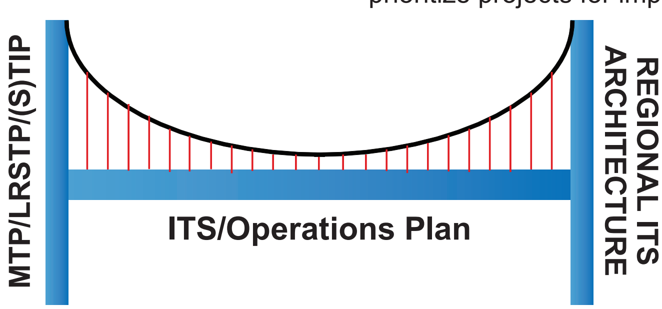

Figure 27: An ITS/Operations Plan Can Connect the Regional ITS Architecture with the Region's Transportation Plan and Program.

Recognizing the gap between what is required to be included in a regional ITS architecture and the strategic planning needs for ITS, many regions have developed an ITS strategic plan (sometimes called an ITS deployment plan) as a companion to the regional ITS architecture. Although the name of the plan varies from region to region, all of these plans articulate the strategy for how ITS will be deployed over time in the region. These plans include the detailed strategies that directly support the STP/MTP. They provide a bridge between the integration-oriented architecture and the planning-oriented MTP, LRSTP, and STIP/TIP.

More recently, regions have also developed operations-focused planning documents including transportation systems management and operations (TSM&O) plans that fill a similar strategic planning need but from an operations perspective. These plans help to tie the management and operation of the transportation system to the enabling technology. Rather than try to specify whether a region should create an ITS strategic plan, a TSM&O plan, or some combination of the two, we use the general term "ITS/operations plan" to refer to the range of plans that can fill this role. The focus here is on the information that could be included in an ITS/operations plan to bridge the gap between the architecture and the planning process. At the end of this chapter, the unique role of a regional concept of transportation operations (RCTO) is discussed along with its relationship to the regional ITS architecture and the metropolitan or statewide transportation planning process.

The elements of an ITS/operations plan that add a planning context to a regional ITS architecture are shown in Figure 28 and discussed in the following paragraphs.

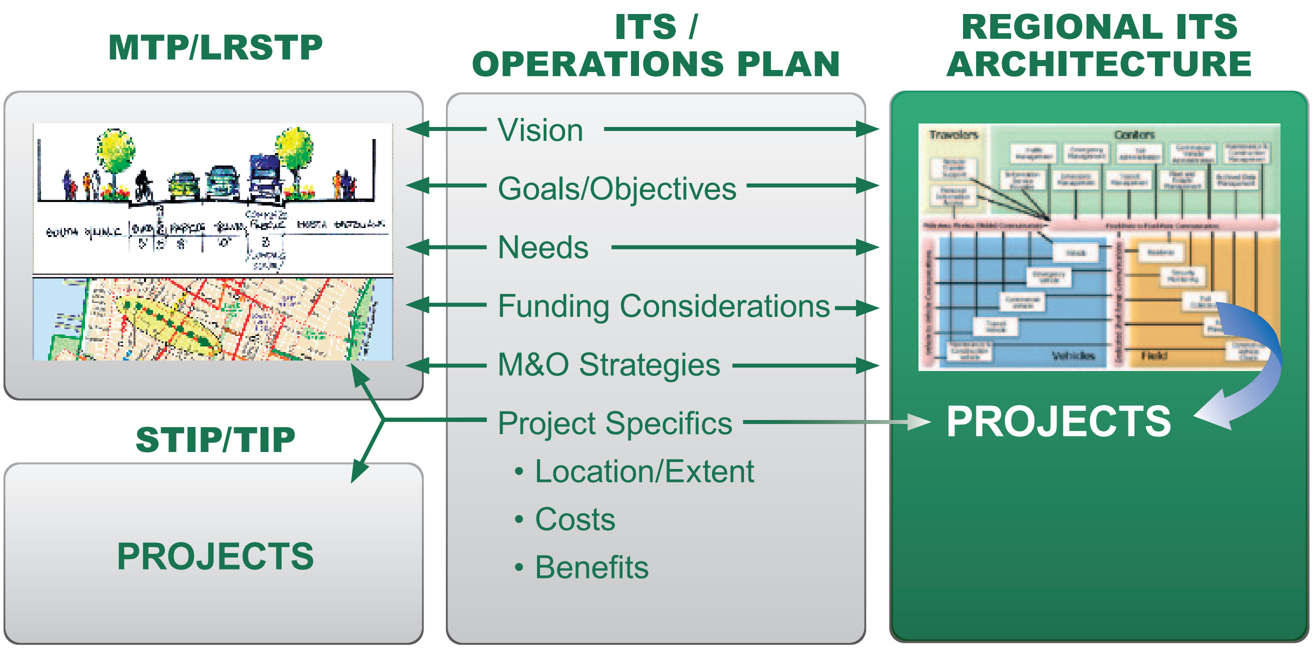

Figure 28: Adding Planning Context with an ITS/Operations Plan.

ITS/Operations Vision: The ITS/operations plan provides a detailed vision for transportation operations in the region, expanding on the broader transportation vision that is articulated in the transportation plan.

Goals and Operations Objectives: In Section 4.1 we established a connection between the goals and objectives in the MTP/LRSTP and the architecture. The goals and objectives may also be documented and expanded in the ITS/operations plan. Specific operations objectives may be defined in more detail in the ITS/operations plan. The specific operations objectives can then be included in the MTP/LRSTP.

Funding Considerations: The regional ITS architecture is not fiscally constrained, but the transportation plans and transportation improvement programs are. The ITS/operations plan considers funding sources and funding requirements for ITS/operations deployments so that the strategy is consistent with anticipated funding.

Operations Needs: The operational needs for the region are frequently defined in the ITS/operations plan and used as a basis for the services that are identified in the regional ITS architecture. The operations needs defined in the ITS/operations plan are also included in the MTP/LRSTP.

Management and Operations Strategies: A range of management and operations strategies suitable for inclusion in the MTP/LRSTP may be defined in detail in the ITS/operations plan. These strategies can also be linked directly to the ITS services in the regional ITS architecture as described in Section 4.1. The strategies are supported by detailed definitions for the prioritized and time-sequenced set of projects that are also defined in the plan.

Detailed Project Definitions: Projects are defined in terms of the regional ITS architecture by collecting together the inventory elements, functional requirements, interfaces and other related components that are included in the project. The regional ITS architecture identifies the integration opportunities, related ITS standards, and other information relevant to the project, but it does not provide sufficient information to estimate costs or benefits, which require more specificity on where and how the project will be implemented. The ITS/operations plan provides the detailed project definitions, locating each project geographically, and estimating the project costs and benefits.

FHWA is currently developing guidance to conducting benefit-cost analysis of operational strategies. In addition, an accompanying decision support tool called Tool for Operations Benefit-Cost Analysis (TOPS BC) is also being developed. When completed, the tool will be placed on the U.S. DOT Planning for Operations web site at *http://www.plan4operations.dot.gov/*. Until then, or for additional information, readers may contact the FHWA Office of Operations at 717-221-4422 or email *jim.hunt@dot.gov*.

Interoperability is a laudable goal, but you have to have the equipment in the right place. If the equipment is not on your most heavily used corridor with the most delay, you can be very interoperable, but it isn't going to do much for you. Eventually, it all needs to go on a map.

Richard Perrin, Genesee Transportation Council

Project Location/Extent: Before you can estimate project benefits or costs, you must locate the project on a map. Individual project locations and the net coverage provided by the planned deployments is key information that is included in an ITS/operations plan. For example, the Southeast Michigan Council of Governments and Michigan DOT developed a Regional ITS Deployment Plan that includes a series of maps like the one shown in Figure 29 that locates the existing ITS infrastructure and planned ITS projects for each county in the region.

Project Costs/Benefits: Ultimately, project prioritization is based on the anticipated project costs compared with the contribution the project will make to the operations objectives. The regional ITS architecture is typically silent on project costs and benefits, but this information can be included in the ITS/operations plan. For example, the MDOT/SEMCOG ITS Deployment Plan includes a cost/benefits analysis using the ITS Deployment Analysis System (IDAS) software tool for each identified project.

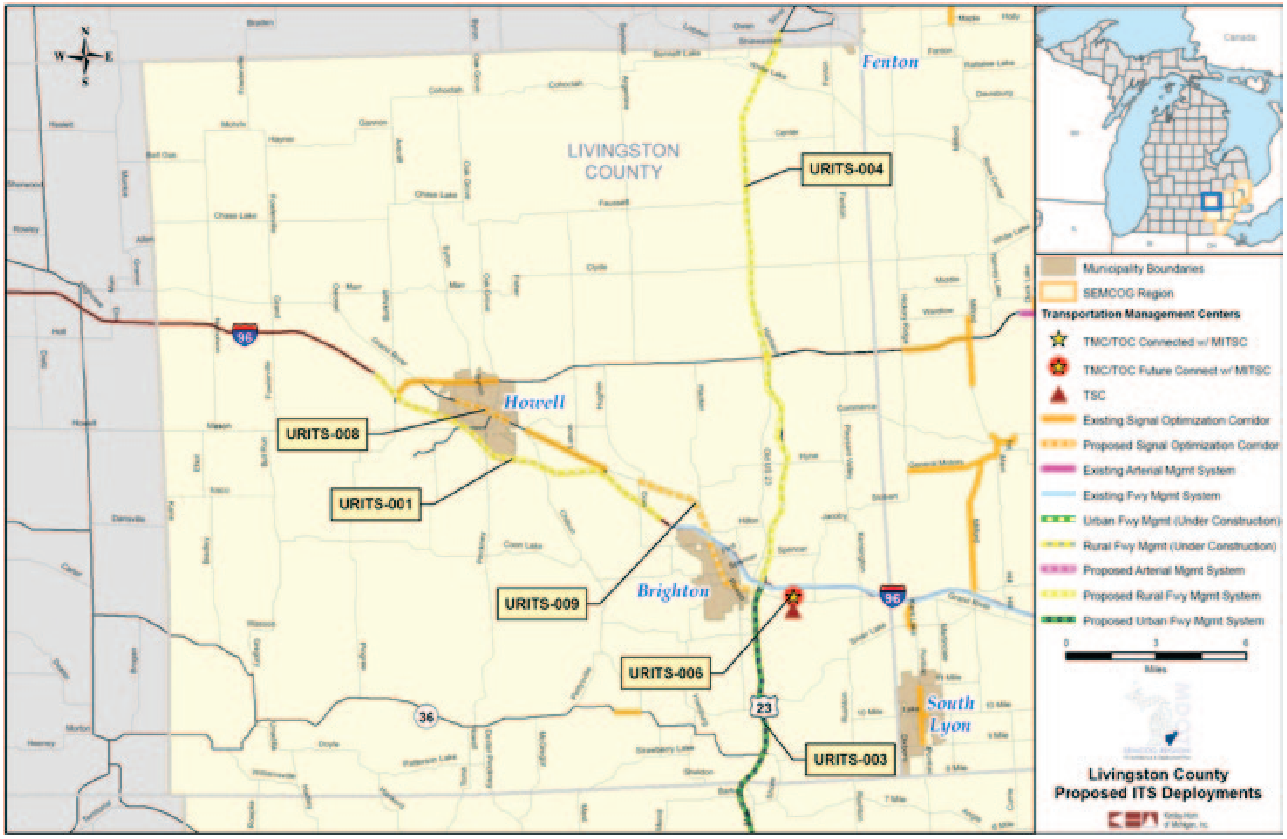

Figure 29: MDOT/SEMCOG ITS Deployment Plan - Livingston County Proposed ITS Deployments.[34]

The Northern Virginia regional ITS architecture includes an online ITS Solutions Decision Support System that provides detailed cost/benefits analysis for ITS projects on their architecture web site as shown in Figure 30.[35]

In addition to these items, an ITS/operations plan should also include: 1) the relationship to other plans, and 2) an explanation of how and when the ITS/operations plan will be updated. The connection to other plans should describe the relationship between the ITS/operations plan, the MTP/LRSTP, STIP/TIP, and the regional ITS architecture, documenting relationships like the ones described in this chapter. The update plan for the ITS/operations plan should be consistent with the plan for updating the architecture and MTP/LRSTP. See Section 4.4 for more information.

Regional Concept for Transportation Operations (RCTO)

A regional concept for transportation operations (RCTO) is a specific type of strategic operations plan that is growing in popularity across the U.S. as planners and operators in a region look for a way to guide their work together in advancing management and operations. The RCTO can also provide a planning context to the regional ITS architecture. The architecture can be used to help implement the M&O strategies or services identified during the development of the RCTO.

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[34] Michigan Department of Transportation and Southeast Michigan Council of Governments, Regional ITS Deployment Plan, November 2008. Available at: *http://www.mi.gov/documents/mdot/SEMCOG_Region_ITS_Deployment_Plan_271573_7.pdf*, last access December 20, 2011.

[35] Virginia Department of Transportation, Northern Region Operations ITS Decision Support Tool. Available at: *http://www.vdot-itsdst.com/*, last accessed December 20, 2011.

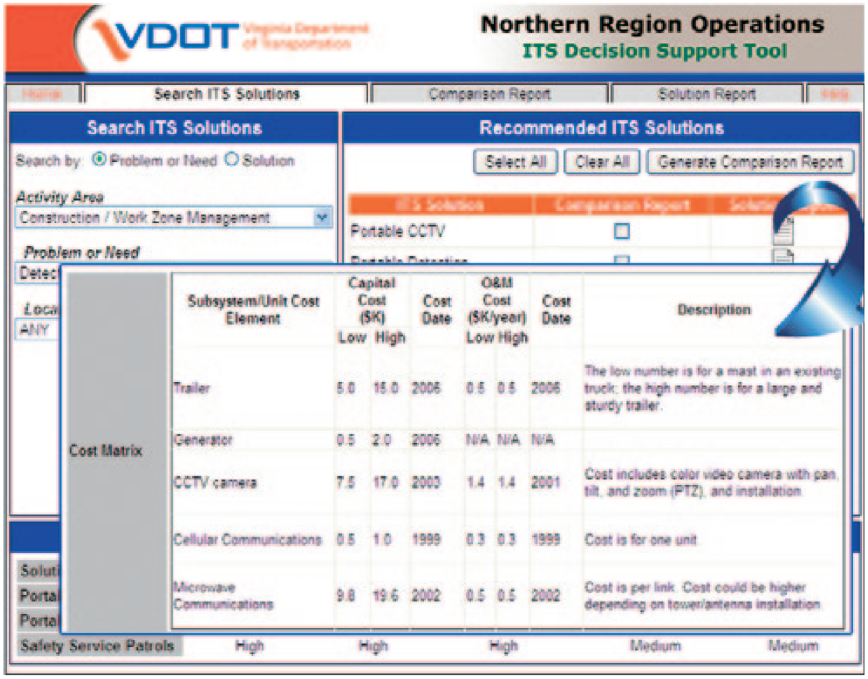


Figure 30: VDOT ITS Decision Support Tool - Cost and Benefit Data[36]

An RCTO is a management tool used by planners and operations practitioners to define a strategic direction for improving regional transportation management and operations in a collaborative manner. The use of an RCTO is growing in regions of different sizes across the U.S. An RCTO focuses on operations objectives and strategies within one or more management and operations functions of regional significance such as traveler information, road weather management, or traffic incident management.

By implementing an RCTO, partners put into action within 3 to 5 years operations strategies that they will sustain over the long term. Central to an RCTO, the operations objective defines the desired outcome, the "what," in specific and measurable terms. The motivation supports the operations objective by grounding the collaborative action in regional needs, agency goals, or operational concerns. The other four elements—approach, relationships and procedures, resource arrangements, and physical improvements—work in concert to define "how" the partners will attain the operations objective.

The regional ITS architecture is an important tool to support the implementation of the RCTO, especially the physical improvements or technology that must be put in place to achieve the operations objectives of the RCTO. There are several ways to combine the use of the RCTO and the regional ITS architecture to support planning for operations. One of those pathways is depicted in Figure 31 using an example from the fictitious region of Kesla Valley. The example shows how an RCTO focused on traffic incident management can support planning for operations and in turn, be supported by a regional ITS architecture.

The Kesla Valley RCTO for Traffic Incident Management was developed to help achieve the regional operations objective of cutting delay by five percent over 10 years. This objective was created and agreed upon as part of the update to the region's metropolitan transportation plan. Incidents were determined to be a significant contributor to delay and congestion on the Kesla Valley freeways and arterials. In response, the MPO planners teamed up with the operations management staff from the State DOT, the county, three cities, and public safety agencies to create and

36 Virginia Department of Transportation, Northern Region Operations ITS Decision Support Tool. Available at http://www.vdot-itsdst.com/, last accessed December 20, 2011.

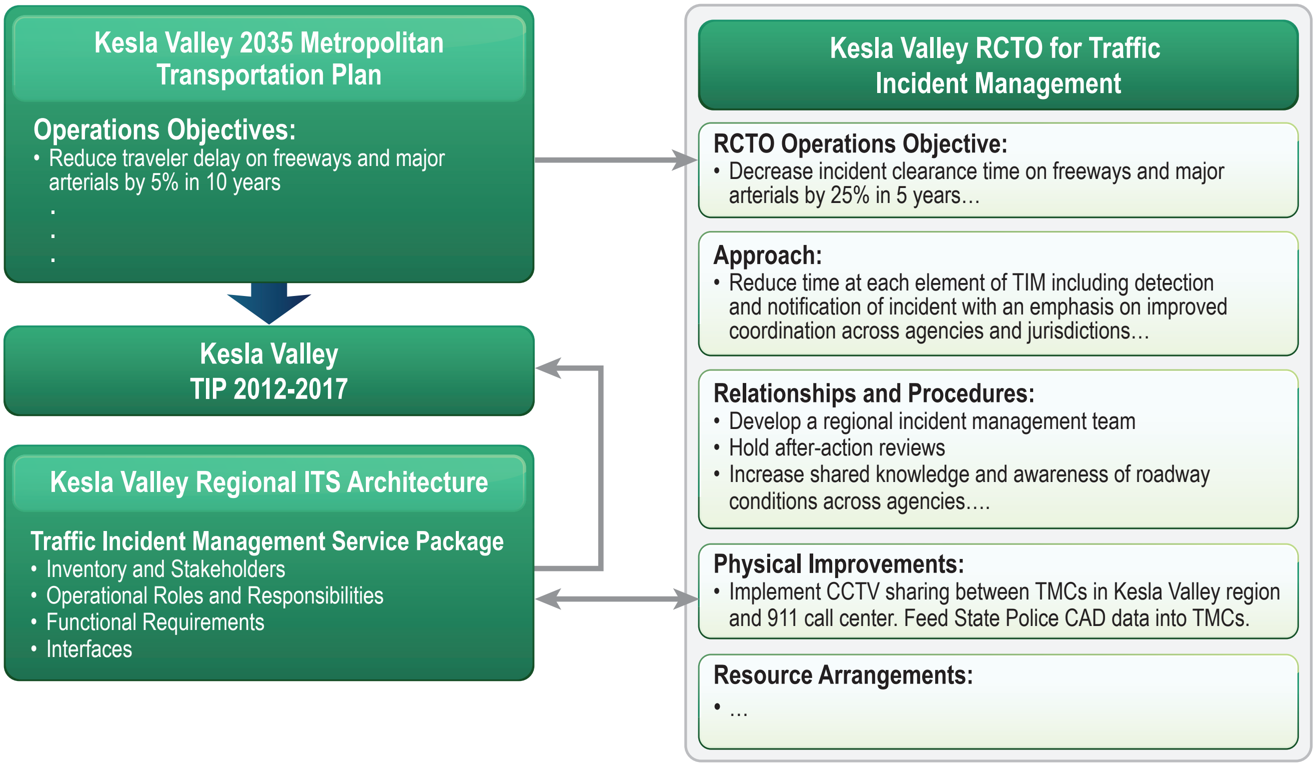


Figure 31: Connecting an RCTO, a Plan, and an Architecture.

implement an RCTO. They formed specific, measurable operations objectives to improve traffic incident management and then devised an overall approach to achieve the RCTO objectives. They defined the necessary relationships and procedures, resource arrangements, and physical improvements.

The RCTO participants identified several physical improvements that required deploying, integrating, and using ITS across several agencies in the region and so they turned to their regional ITS architecture to define the projects that would need to be implemented and how the technology and data flows could be integrated into the regional context. A new service package, Traffic Incident Management System, was added to the Kesla Valley Regional ITS Architecture and the collaborating participants walked through a detailed operational concept for the desired functionality, the interconnects, and the information flows. The partners used the ITS standards already defined in the architecture to ensure that their projects would be compatible with new and existing technology deployments. The RCTO participants used this information to develop three projects to be submitted for approval and funding in the Kesla Valley TIP 2012 – 2017.

Once the projects are implemented, the Kesla Valley architecture will be updated to reflect these new systems that can be built on in the future. The participants also examined the architecture to see where data may be available to track incident clearance time related to the RCTO's operations objective.

In general, a regional ITS architecture enables the regionally coordinated implementation of an RCTO, specifically the ITS that supports the RCTO's approach, but there are many other connections that can be explored by regions looking to get the most out of their investments.

4.4. Scheduling Updates to Optimize Use

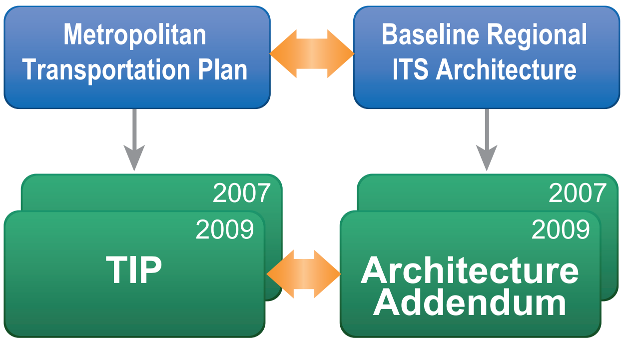


Figure 32: Architecture Updates to Support Planning.

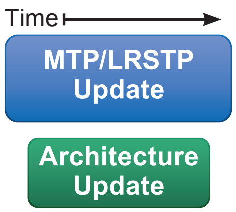
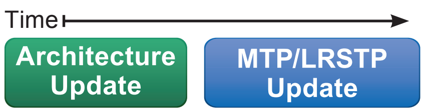
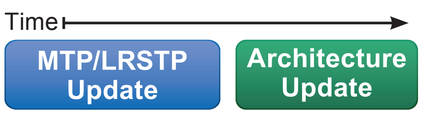
Although FHWA Rule 940 and the accompanying FTA policy do not require a specific update cycle for the regional ITS architecture, it is good practice to align the architecture update schedule with the schedule for the MTP/LRSTP and STIP/TIP updates. One good approach is shown in Figure 32. In this approach, a baseline update is performed to support each MTP/LRSTP update, and a minor project-focused update of the architecture is done to support the STIP/TIP. The remainder of this chapter explores these updates in more detail.

Baseline Architecture Update to Support the MTP/LRSTP

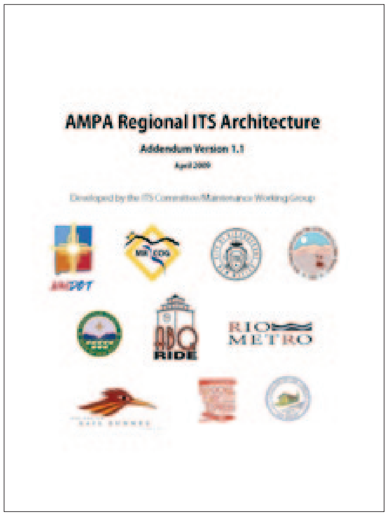
The regional ITS architecture should be updated as needed to support each update of the MTP/LRSTP. This regular update cycle keeps the architecture up-to-date and consistent with the transportation plan. Note that the baseline architecture update is not necessarily a "major" update. The update might require only minor changes if there has not been significant change in goals and objectives, stakeholder participation, or the scope of what is covered by the National ITS Architecture and regional ITS architectures since the last update. The question is whether the regional ITS architecture should be updated, before, at the same time as, or after the related transportation plan.

Table 5 briefly compares the three options. If the architecture is updated before the MTP/LRSTP, then the plan can leverage information included in the updated architecture, but the architecture may not be consistent with the current plan since it was developed in advance. If the plan is updated before the architecture, there is exactly the opposite dynamic. The architecture will be consistent with the plan, but the plan will not be able to incorporate any information from an up-to-date architecture. This "chicken and egg" situation leads us to consider another option, which updates the architecture in parallel with the MTP/LRSTP update. This can be a viable approach because the typical architecture update requires 6 to 9 months of calendar time, which can be nested in the longer MTP/LRSTP update schedule. The question is whether or not the benefits of the parallel update justify the additional stress, potential schedule conflicts, and overlapping resource needs associated with the parallel development. The answer is dependent to some extent on the region. For example, the parallel development approach requires planning staff availability to support the parallel efforts.

Table 5: Architecture and Transportation Plan Update Scheduling Options.

Option	Pros	Cons
1. Architecture Updated In Parallel with MTP/LRSTP  	**Best of Both Worlds: Architecture Consistent with Plan and Plan Leverages Architecture** Opportunity to base architecture on current regional goals and objectives (See Section 3.2). Opportunity to incorporate archived data services/flows to support performance measures (See Section 3.8). Opportunity to leverage overlapping activities like M&O strategy selection for the MTP/LRSTP with service selection in the architecture. (See Section 3.4). Opportunity to reflect integration strategies, projects, and other outputs back into the MTP/LRSTP.	Resource and schedule demands of parallel activities. Scheduling the parallel activities to take advantage of the connections can be a challenge.
2. Architecture Updated Before MTP/LRSTP  	**Plan Leverages Architecture** Opportunity to review architecture services as an input to selection of M&O strategies. (See Section 3.4). Opportunity to reflect integration strategies, projects, and other architecture outputs back into the MTP/LRSTP.	Architecture not based on the current plan.
3. Architecture Update After MTP/LRSTP  	**Architecture Consistent with Plan** Opportunity to base architecture on current regional goals and objectives (See Section 3.2). Opportunity to incorporate archived data services/flows to support performance measures (See Section 3.8). Opportunity to review M&O strategies as an input to selection of architecture services. (See Section 3.4).	Plan developed without input from a current architecture.

Minor Architecture Update to Support the STIP/TIP



The most volatile part of the regional ITS architecture is the project sequencing, which changes frequently as current projects are implemented and new projects are identified. Establishing a good connection between the region's projects and the architecture as described in Section 4.1 can facilitate the architecture maintenance that is required. Minor project-oriented updates of the architecture should be implemented more frequently to align the architecture with programming activities. This update will be project-focused, ensuring that the list of projects identified by the architecture is consistent with the current set of projects programmed in the STIP/TIP.

The Mid-Region Council of Governments (MRCOG) and New Mexico DOT have adopted the practice of releasing an "architecture addendum" with each TIP that focuses on updating the project sequencing and documenting the linkage between the regional ITS architecture and projects programmed in the TIP. These modest, focused updates are performed in-house, without consultant support. Figure 33 is an excerpt from the addendum document that shows the connection between TIP projects and market packages in the Albuquerque Metropolitan Planning Area (AMPA) regional ITS architecture. An additional column in the table, not shown here, provides expanded descriptions of each of the associated market packages.

Category I. Traffic Management, Incident Management, Maintenance Operations Projects, and Studies					BLACK text = Completed or Projects in 2010-2015 TIP BLUE text = Projects programmed in 2012-17 TIP		
MTP/TIP Project Database Information					ITS Regional Architecture Information and TIP Project Descriptions		
Seq.	**MPO ID**	**TIP Yr**	**Project Name in TIP**	**Lead Agency**	**Proj Type**	**Recommended MPs in Regional Architecture**	**Agency-Proposed Project Market Packages (MPs) – Use This Column for Project MPs**
1		all	NMRoads.COM	NMDOT ITS	ITS-TSM	ATIS01,2	ATIS01,2
2	48.7	10	I-25 Safety Project	NMDOT ITS	ITS-TSM		ATMS01, ATMS06
3	103.0	11-17	Albuquerque T M S	Abq DMD	ITS-TSM	ATMS01, 03	AMTS01, 3, 6, AD1, APTS9*
4	464.0	10-12	Unser Blvd Connection (Middle)	Abq DMD	Capacity	ATMS01, 3, APTS9*	ATMS01, 3, APTS9*
5	585.1	11	Wyoming Blvd Widening Ph I	Abq DMD	Capacity	ATMS03	AD1, ATMS01, 3
6	585.3	11	Wyoming Blvd Widening Ph II	Abq DMD	Capacity	ATMS01,3	AD1, ATMS01, 3
7	587.0	11-17	Great Streets	Abq DMD	misc		ATMS01, 3, 6, AD1, APTS9*
8	616.0	10	Coors Corridor Study	Abq DMD	misc		All MPs

Figure 33: Excerpt from AMPA Regional ITS Architecture Addendum.[37]

[37] Mid-Region Council of Governments, *AMPA Regional ITS Architecture, Addendum Version 1.1*, April 2009. Available at: http://nmrailrunner.com/PDF/TIP/AMPA%20Regional%20ITS%20Architecture%20Addendum%20v%2011fw.pdf, last accessed December 19, 2011.

5 Your Action Plan for More Productive Architecture Use

This chapter provides recommendations for how you can advance the use of your region's regional ITS architecture in planning for operations.

Figure 34 shows the three key leverage points that can be used to improve capability and efficiency in any area, including the use of an ITS architecture in transportation planning. The three aspects that are shown are the major determinants of cost, schedule, and quality: the people involved, the technologies/tools that they use, and the processes and practices that are established. Your action plan should consider all three aspects so that your region can adopt a balanced approach that improves the skills of the people involved, arms those people with high quality tools (e.g., an improved, planning-supportive architecture), and adopts documented processes that help to ensure the capability improvements are sustainable in the long run. The following sections provide recommendations that employ all three leverage points: people, process, and tools.

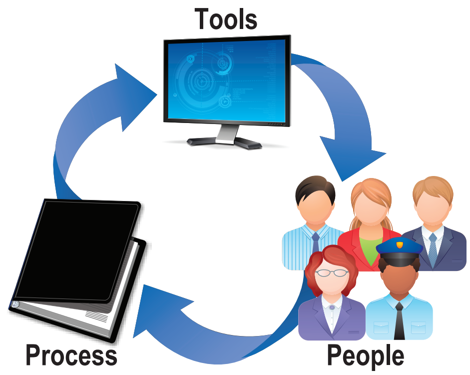


Figure 34: Three Leverage Points for Capability Improvement.

5.1. Establish Support

Regional ITS architecture use will only gain traction if it has support from decisionmakers. The executive summary and Chapter 1 from this primer can be used to help make the case with MPO and State DOT decisionmakers that drive the transportation planning processes. In general, the case is best made by identifying the tangible benefits of regional ITS architecture use as described in Section 1.1. Regulatory requirements for architecture use in planning also provide motivation. See Appendix B for relevant requirements in 23 CFR 450 and 23 CFR 940. Once decisionmaker support has been established, it may be helpful to develop a regional policy regarding improved architecture use in planning for operations. This will help ensure continuity even as decisionmakers are replaced. Additionally, it is important to establish a collaborative forum to coordinate and lead the effort that includes stakeholders with a vested interest in planning for operations and the regional ITS architecture. This may be an ad hoc committee or a new item of business within an existing policy or technical committee.

*While this chapter is focused on measuring and improving capability in the specific area of architecture use in planning for operations, other resources are available for transportation agencies seeking broader process improvement guidance. For example, the **AASHTO Systems Operations and Management Guidance** at www.aashtosomguidance.org/ includes a set of evaluation tools and process improvement guidance covering all facets of transportation system operations and management. **The Capability Maturity Model Integrated (CMMI)** provides strong process improvement guidance for all aspects of project development and acquisition at www.sei.cmu.edu/cmmi/.*

5.2. Self-Assessment

Once you have decisionmaker support, the next step is to perform an unbiased assessment of the region's capability to productively use the regional ITS architecture in planning. Figure 35 shows a basic capability maturity model that can be used to assess your region's capability in this area. The incremental capabilities reflect a natural progression from basic architecture updates to documented, productive use of the regional ITS architecture in planning. This model can also be used to plan and measure your region's improvements over time.

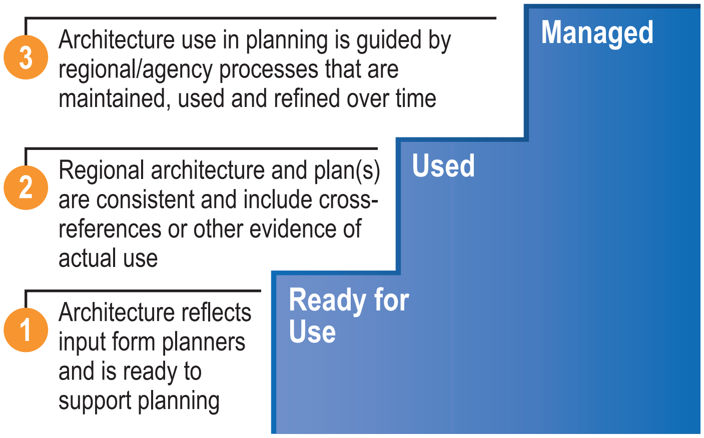


Figure 35: Architecture Use for Planning Capability Levels

As shown, a region's ability to use a regional ITS architecture in planning begins with the architecture itself. Does the architecture reflect input from planners, and does it include components that are ready for use in planning? Architecture use will not be productive until these criteria are met. Refer to Chapter 4 for a broad range of architecture improvements that are oriented towards making the architecture ready for use in transportation planning. At the next capability level, the quality architecture is actually used in planning, as evidenced by consistency and interconnection of the architecture and related plan(s). The third level, "managed" architecture use and maintenance, is governed by regional or agency processes so that architecture use is better supported and more resilient to agency personnel changes.

Table 6 includes self-assessment questions you can ask to measure your region's architecture use in planning. The assessment tool presented in Table 6 should be regarded as a starting point for assessing the degree to which the architecture is used. It is not a comprehensive tool covering all aspects of architecture use, but it will help clarify certain areas and identify opportunities for future improvement.

Table 6: Self-Assessment for Use of Regional ITS Architecture in Planning for Operations.

		Not Achieved	Partially Achieved	Mostly Achieved	Fully Achieved
1. Architecture Supports Planning (Ready for Use)					
A01	The architecture (and ITS strategic plan) includes a detailed description of how the architecture is incorporated and used in the metropolitan or statewide planning process.				
A02	Planners from the MPO and/or State DOT were involved in developing/maintaining the architecture (and ITS strategic plan).				
A03	The architecture (and ITS strategic plan) makes an explicit connection to operations objectives or operations goals in the metropolitan or statewide transportation plan.				

		Not Achieved	Partially Achieved	Mostly Achieved	Fully Achieved
A04	The architecture (and ITS strategic plan) is used to identify an up-to-date sequence of ITS projects.				
A05	The architecture (and ITS strategic plan) includes projects that directly support or implement M&O strategies in the plan.				
A06	The region has developed an ITS strategic plan or similar document that provides a planning context for the architecture. It includes:				
A06a	Vision, goals, objectives				
A06b	Strategies for ITS deployment				
A06c	Funding considerations				
A06d	Detailed project definitions and cost estimates				
A06e	Benefits analysis				
A07	The architecture includes inventory elements that support data collection and performance monitoring that support planning.				
2. Demonstrated Use of the Architecture					
U01	The architecture was updated to support the last update of the related metropolitan/statewide transportation plan.				
U02	The metropolitan/statewide plan identifies M&O strategies that are defined in the architecture (or ITS strategic plan).				
U03	The projects identified in the architecture (or ITS strategic plan) are integrated into the STIP/TIP.				
U04	The metropolitan/statewide transportation plan contains language that refers to the ITS architecture and how it is linked to the plan.				

		Not Achieved	Partially Achieved	Mostly Achieved	Fully Achieved
3. Managed Use of the Architecture					
M01	A regional stakeholder organization or committee has been identified to monitor and manage architecture use and maintenance.				
M02	A documented policy is in place that supports use of the architecture in the planning process.				
M03	Procedures that define the process that is used to develop the metropolitan/statewide transportation plan cover architecture use.				
M04	The STIP/TIP application process for ITS projects includes identification of the relevant portion of the regional ITS architecture.				
M05	The transportation project prioritization process takes into consideration how proposed projects support the regional ITS architecture.				

5.3. Take Action

Once you assess where your region stands in the above capability model, it is time to take small, incremental steps toward increased capability. It will take time to progress all the way up the highest capability level, but major benefits can be gained through making a few basic improvements. Below is a sorted list of actions that correspond to achieving greater capability in applying the architecture to planning for operations.

Organize for Use

- Hold one or more meetings that bring together the regional ITS architecture developers with transportation planners in your region to discuss the function of the regional ITS architecture and its potential for use. Ask planners to identify any issues or challenges in planning for operations that may be better addressed by use of the architecture. For example, the need for data to support system monitoring and performance measurement could be addressed by defining data warehouse capabilities in the regional ITS architecture that would support data reporting and archiving.
- Determine if a regional planning for operations collaborative group exists in your region. If so, meet with the leaders and ask if the regional ITS architecture can be included within the scope of the group. If a group does not exist, form a multi-agency collaborative group that spans those involved with integrating operations into the region's planning process as well as regional ITS architecture developers/participants.
- If you do not already have one, identify an architecture champion or champions for the region.

Build Professional Capacity

- Take advantage of training courses and workshops in regional ITS architecture use and maintenance and Turbo Architecture available through U.S. DOT including the National Highway Institute and the Consortium for ITS Training and Education. Visit *http://www.its.dot.gov/arch* or contact your FHWA Division Office for more information.
- If your regional ITS architecture is not ready for use, plan an update to incorporate some of the improvements described in Chapter 4. If desired, a "Quick-Start" workshop can be conducted for your region that assesses your current architecture, develops a "Concept of Use" that defines how your region will use the architecture in planning and project development, and develops an action plan for your architecture update. Contact your FHWA Division Office for more information.

Align Regional ITS Architecture with Operations in Transportation Planning Process

- Align the regional ITS architecture with the region's goals and operations objectives. This is a step that will be implemented over time as needs and services in the architecture are updated to reflect the region's desired operations outcomes.
- Seek out information on operational needs from the region's transportation planning documents. The congestion management process, if one exists, could be a good source of information on transportation performance issues related to congestion. Integrate those needs into the needs identified in the regional ITS architecture.
- Identify M&O strategies in the region's plan(s) and work toward including service packages in the architecture that support the plan's strategies.
- Update the sequenced list of projects in the regional ITS architecture to reflect the latest STIP/TIP.

Use Regional ITS Architecture to Support Planning for Operations

- Search the architecture for sources of data that could support monitoring system performance and any operations objectives in the region's transportation plan. Involving the region's planners, contact the agencies responsible for the data and discuss possibilities for use of data in operations planning.
- Work with operations project/program implementing agencies to define and develop ITS-based projects with the contextual information provided in the architecture.
- Update the STIP/TIP project application process to require project applications to identify how the project fits with the regional ITS architecture.

A Turbo Architecture

This primer has noted several opportunities for improving the linkage between the regional ITS architecture and planning for operations through the use of the Turbo Architecture software. Examples included:

- Connecting objectives and strategies from the region's plan(s) with services in the regional ITS architecture
- Identifying potential data sources in the region
- Defining projects in the STIP/TIP in terms of the regional ITS architecture

Turbo Architecture is a powerful tool for creating, maintaining, and using regional and project ITS Architectures. Turbo Architecture supports many of the requirements defined in FHWA's 23 CFR 940 Rule and the equivalent FTA Policy. This Rule/Policy requires ITS projects funded through the Highway Trust Fund to conform to the National ITS Architecture and applicable standards. Turbo Architecture uses the National ITS Architecture as a template that can be customized and tailored for your region or project. For example, Turbo allows you to define the interface between specific traffic and transit operations centers in your state or metropolitan area based on the general interface defined in the National ITS Architecture.

The Turbo Architecture user interface is built around a series of tabs that guide you through the process of defining an architecture. For example, the Planning Tab shown in Figure 37 is used to establish the linkages between the architecture and the planning process that are described in this primer.

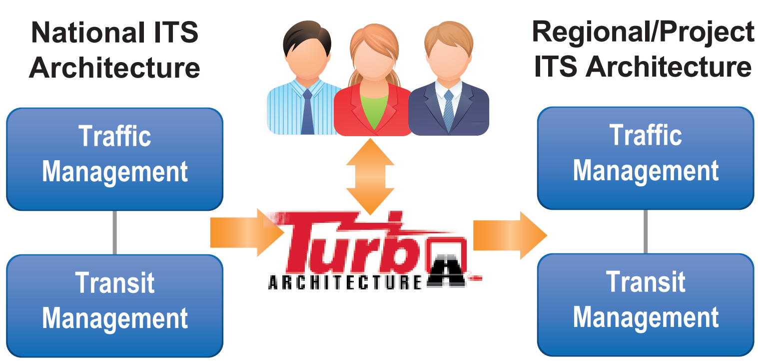


Figure 36: Turbo Architecture Uses the National ITS Architecture

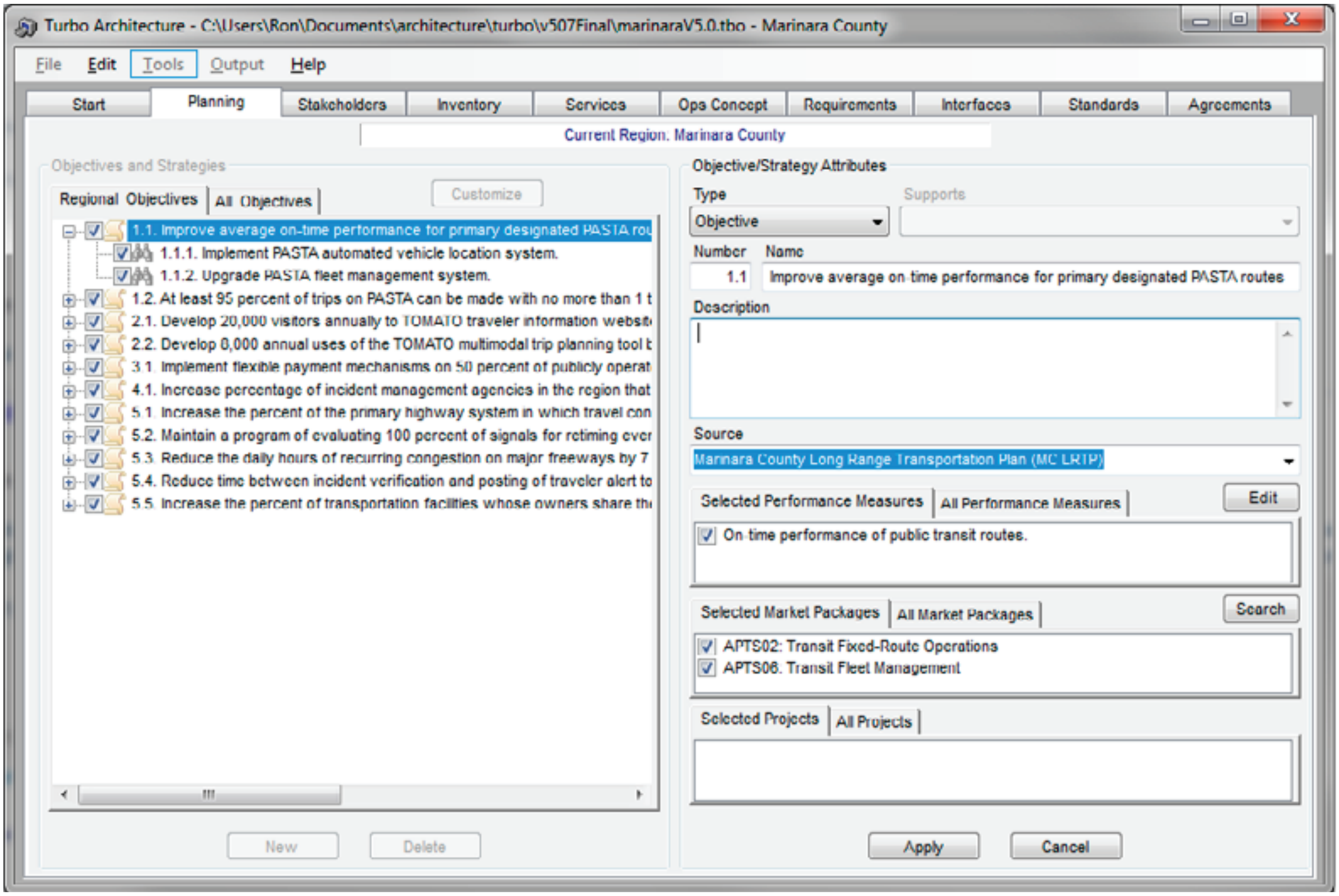


Figure 37: Turbo Architecture Tabbed Interface - The Planning Tab,

As you define an architecture in Turbo, you progress from left to right across each of the tabs to identify the objectives and strategies, involved stakeholders, inventory of existing and planned systems, services, roles and responsibilities, functional requirements, interfaces, standards, and agreements that apply to the architecture. Turbo also helps you establish the connections between each of these components. For example, you define the stakeholders that own and operate each part of the inventory and the ITS services that support each transportation objective. The same basic process can be used whether you are defining the overall architecture for a state or metropolitan area or a specific architecture for a particular project. In either case, you will have defined all of the key components of an ITS architecture by the time you reach the right-most tab in the Turbo interface.

Turbo Architecture can also be used to quickly access and create a variety of outputs for an architecture. Many outputs are available for display, print, or publication as web pages, diagrams, Microsoft Word documents, and Microsoft Excel worksheets. Turbo is a Windows-compatible application that uses a standard Microsoft Access database to store the architecture content, providing another option for integration with other applications.

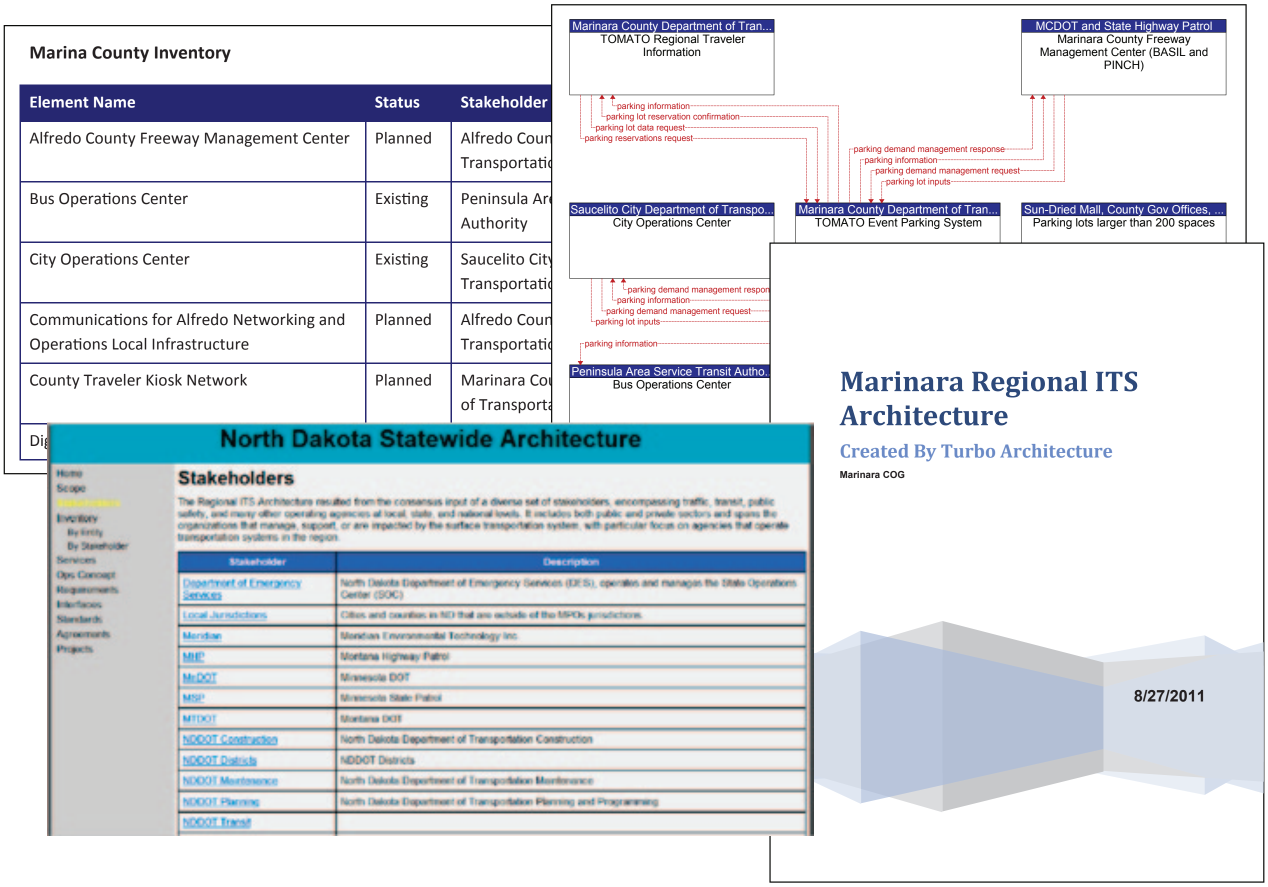


Figure 38: Turbo Architecture Provides Many Output Options.

More on the Planning Tab

Turbo Architecture Version 5.0 was expanded to include a Planning Tab that provides an explicit connection between the regional ITS architecture and the transportation planning process. By using the new Planning Tab, you can better align the architecture with the region's transportation planning process. In turn, the Planning Tab can provide improved traceability between plan objectives, performance measures, M&O strategies, and ITS. The tab is configurable to provide links to any output of the planning process— goals, policies, objectives, strategies, or any other output from your regional planning process can be included on the Planning Tab. By default, the Planning Tab specifically supports the objectives and M&O strategies associated with the objectives-driven, performance-based approach to planning for operations. Figure 39 shows a close-up on the right-side of the Planning Tab as a user enters an operations objective.

Every M&O objective can be entered into the tab along with a reference to the source transportation plan. The defined objectives may then be associated with service packages like Transit Fixed-Route Operations and Transit Fleet Management.

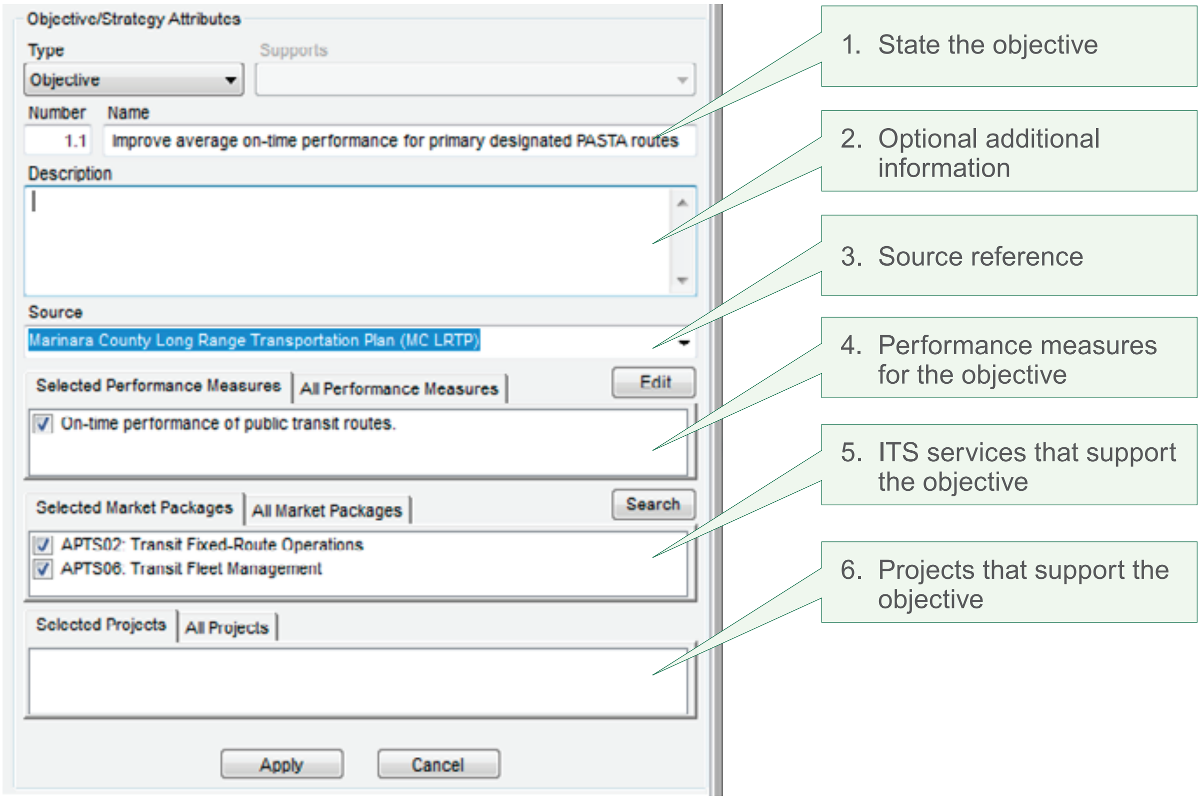


Figure 39: A Closer Look at the Right Side of the Planning Tab.

Creating these linkages provides a cross-check that can aid both the objectives-driven, performance-based approach and the regional ITS architecture. Reports identifying potential disconnects may reveal objectives that are not associated with service packages and service packages that are not associated with objectives, suggesting that either the service package is not needed to support operational objectives or that an operations objective is missing from the list.

Performance measures developed through the objectives-driven, performance based approach can also be associated with the regional ITS architecture. The Planning Tab allows performance measures to be defined and associated with operations objectives, M&O strategies, and service packages. Linking performance measures to the architecture in this way allows the performance measures to be consistently defined across the region and associated with relevant service packages in a systematic way. This enables differences in performance measures to be reconciled to establish a uniform system for performance monitoring and evaluation.

Using the Planning Tab, specific objectives and/or strategies can also be linked to individual programs and projects, providing an explicit connection between projects and the earlier steps in the objectives-driven, performance-based approach.

For More Information

The Windows-compatible Turbo Architecture software is sponsored by U.S. DOT and is available for free download. The software includes a user manual, a quick-start guide, and other documentation to help you get started with the tool. Visit the Turbo Architecture Support Page (*http://www.iteris.com/itsarch/html/turbo/turbomain.htm*) for more information.

B Regulatory Requirements

SAFETEA-LU Requirements

1.1. Management & Operations and Architecture in the Planning Process[38]

On August 10, 2005, the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) was signed into law and became the most recent reauthorization of the Nation's surface transportation program. Along with identifying Federal funding for a range of transportation programs and other transportation-related regulations, SAFETEA-LU updated requirements for metropolitan transportation planning. A final planning rule (23 CFR Part 450) was issued on February 14, 2007. Beginning July 1, 2007, all newly adopted metropolitan transportation plans must comply with Federal regulations identified in SAFETEA-LU and the associated planning rule.

According to the planning rule, "Promote efficient system management and operation" is one of the eight planning factors that must be addressed in metropolitan transportation plans. A second factor, "Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight" is directly supported by regional ITS architecture use in planning. Below is an excerpt from the Statewide Transportation Planning; Metropolitan Transportation Planning; Final Rule, February 14, 2007, Federal Register. (**Bold added to highlight points related to operations.** ***Bold italics added to highlight points related to ITS architecture.***)

§ 450.306 Scope of the metropolitan transportation planning process.

(a) The metropolitan transportation planning process shall be continuous, cooperative, and comprehensive, and provide for consideration and implementation of projects, strategies, and services that will address the following factors:

(1) Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency;

(2) Increase the safety of the transportation system for motorized and non-motorized users;

(3) Increase the security of the transportation system for motorized and non-motorized users;

(4) Increase accessibility and mobility of people and freight;

(5) Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development patterns;

(6) ***Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight;***

(7) **Promote efficient system management and operation;** and

(8) Emphasize the preservation of the existing transportation system.

[38] The section is taken from U.S. DOT, Advancing Metropolitan Planning for Operations: An Objectives-Driven, Performance-Based Approach – A Guidebook, 2010, FHWA-HOP-10-026. Available at: http://www.ops.fhwa.dot.gov/publications/fhwahop10026/index.htm.

(b) Consideration of the planning factors in paragraph (a) of this section shall be reflected, as appropriate, in the metropolitan transportation planning process. The degree of consideration and analysis of the factors should be based on the scale and complexity of many issues, including transportation system development, land use, employment, economic development, human and natural environment, and housing and community development.

(c) The failure to consider any factor specified in paragraph (a) of this section shall not be reviewable by any court under title 23 U.S.C., 49 U.S.C. Chapter 53, subchapter II of title 5, U.S.C. Chapter 5, or title 5 U.S.C. Chapter 7 in any matter affecting a metropolitan transportation plan, TIP, a project or strategy, or the certification of a metropolitan transportation planning process.

(d) The metropolitan transportation planning process shall be carried out in coordination with the statewide transportation planning process required by 23 U.S.C. 135 and 49 U.S.C. 5304.

(e) In carrying out the metropolitan transportation planning process, MPOs, States, and public transportation operators may apply asset management principles and techniques in establishing planning goals, defining TIP priorities, and assessing transportation investment decisions, including transportation system safety, operations, preservation, and maintenance, as well as strategies and policies to support homeland security and to safeguard the personal security of all motorized and non-motorized users.

(f) ***The metropolitan transportation planning process shall (to the maximum extent practicable) be consistent with the development of applicable regional intelligent transportation systems (ITS) architectures, as defined in 23 CFR part 940.***

The Final Rule also strengthens expectations for including management and operations strategies in the transportation planning process. The Rule states that metropolitan transportation plans shall include both long-range and short-range strategies/actions, including operational and management strategies that improve the performance of existing transportation facilities to relieve congestion and maximize the safety and mobility of people and goods.

Selected excerpts are presented below (**bold added to highlight points related to operations**):

§ 450.322 Development and content of the metropolitan transportation plan.

(a) The metropolitan transportation planning process shall include the development of a transportation plan addressing no less than a 20-year planning horizon as of the effective date. In nonattainment and maintenance areas, the effective date of the transportation plan shall be the date of a conformity determination issued by the FHWA and the FTA. In attainment areas, the effective date of the transportation plan shall be its date of adoption by the MPO.

(b) The transportation plan shall include both **long-range and short-range**

strategies/actions that lead to the development of an ***integrated multimodal*** transportation system to facilitate the safe and efficient movement of people and goods in addressing current and future transportation demand.

...

(f) **The metropolitan transportation plan shall, at a minimum, include**:

(1) The projected transportation demand of persons and goods in the metropolitan planning area over the period of the transportation plan;

(2) Existing and proposed transportation facilities (including major roadways, transit, multimodal and intermodal facilities, pedestrian walkways and bicycle facilities, and intermodal connectors) that should function as an integrated metropolitan transportation system, giving emphasis to those facilities that serve important national and regional transportation functions over the period of the transportation plan. In addition, the locally preferred alternative selected from an Alternatives Analysis under the FTA's Capital Investment Grant program (49 U.S.C. 5309 and 49 CFR part 611) needs to be adopted as part of the metropolitan transportation plan as a condition for funding under 49 U.S.C. 5309;

(3) **Operational and management strategies to improve the performance of existing transportation facilities to relieve vehicular congestion and maximize the safety and mobility of people and goods**;

(4) Consideration of the results of the congestion management process in [Transportation Management Areas] TMAs that meet the requirements of this subpart, including the identification of [single-occupancy vehicle] SOV projects that result from a congestion management process in TMAs that are nonattainment for ozone or carbon monoxide;

2.1. Transportation Systems Management and Operations[39]

The SAFETEA-LU Technical Corrections Act of 2008 amended Section 101(a) of Title 23 U.S.C. to include a definition of transportation systems management and operations (TSM&O). TSM&O is also referred to as "management and operations" or "M&O."

Below is an excerpt from the SAFETEA-LU Technical Corrections Act of 2008:

(h) Transportation Systems Management and Operations Defined– Section 101(a) of title 23, United States Code, is amended by adding at the end the following:

(39) TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS—

(A) IN GENERAL– The term 'transportation systems management and operations' means an integrated program to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal, cross-jurisdictional

[39] This section is taken from U.S. DOT, Advancing Metropolitan Planning for Operations: An Objectives-Driven, Performance-Based Approach – A Guidebook, 2010, FHWA-HOP-10-026. Available at: *http://www.ops.fhwa.dot.gov/publications/fhwahop10026/index.htm*.

systems, services, and projects designed to preserve capacity and improve security, safety, and reliability of the transportation system.

(B) INCLUSIONS- The term 'transportation systems management and operations' includes–

(i) regional operations collaboration and coordination activities between transportation and public safety agencies; and

(ii) improvements to the transportation system, such as traffic detection and surveillance, arterial management, freeway management, demand management, work zone management, emergency management, electronic toll collection, automated enforcement, traffic incident management, roadway weather management, traveler information services, commercial vehicle operations, traffic control, freight management, and coordination of highway, rail, transit, bicycle, and pedestrian operations.

3.1. Congestion Management Process[40]

SAFETEA-LU also made a significant change regarding congestion management. Title III Section 3005 and Title VI Section 6001 updated the requirement for addressing congestion in Transportation Management Areas, mandating the incorporation of a "congestion management process" (CMP) within the metropolitan planning process.

The law requires a CMP in TMAs – urban areas with a population greater than 200,000 – as opposed to a congestion management system (CMS). The change in name (and acronym) is intended to be a substantive change in perspective and practice intended to encourage targeted areas to address congestion management through a process that provides for effective M&O and an enhanced linkage to both the planning process and the environmental review process that is based on cooperatively developed travel demand reduction and operational management strategies and capacity increases. This new focus retains the traditional role of the MPO in long-range transportation planning, but empowers the MPO and its partners in planning for the ongoing operations and management of the transportation system.

Below is language from the Statewide Transportation Planning; Metropolitan Transportation Planning; Final Rule, February 14, 2007, Federal Register (**bold added to highlight points related to operations**. ***Bold italics used to highlight areas related to architecture***.):

Sec. 450.320 Congestion management process in transportation management areas.

(a) The transportation planning process in a TMA shall **address congestion management through a process that provides for safe and effective *integrated***

[40] This section is taken from U.S. DOT, Advancing Metropolitan Planning for Operations: An Objectives-Driven, Performance-Based Approach – A Guidebook, 2010, FHWA-HOP-10-026.
Available at: *http://www.ops.fhwa.dot.gov/publications/fhwahop10026/index.htm*.

management and operation of the multimodal transportation system, based on a cooperatively developed and implemented metropolitan- wide strategy, of new and existing transportation facilities eligible for funding under title 23 U.S.C. and title 49 U.S.C. Chapter 53 **through the use of travel demand reduction and operational management strategies**.

(b) The development of a congestion management process **should result in multimodal system performance measures and strategies** that can be reflected in the metropolitan transportation plan and the TIP. The level of system performance deemed acceptable by State and local transportation officials may vary by type of transportation facility, geographic location (metropolitan area or subarea), and/ or time of day. In addition, **consideration should be given to strategies that manage demand, reduce single occupant vehicle (SOV) travel, and improve transportation system management and operations**. Where the addition of general purpose lanes is determined to be an appropriate congestion management strategy, explicit **consideration is to be given to the incorporation of appropriate features into the SOV project to facilitate future demand management strategies and operational improvements** that will maintain the functional integrity and safety of those lanes.

(c) The congestion management process shall be developed, established, and implemented as part of the metropolitan transportation planning process that includes **coordination with transportation system management and operations activities**. The congestion management process shall include:

(1) Methods to monitor and evaluate the performance of the multimodal transportation system, identify the causes of recurring and nonrecurring congestion, identify and evaluate alternative strategies, provide information supporting the implementation of actions, and evaluate the effectiveness of implemented actions;

(2) Definition of **congestion management objectives and appropriate performance measures** to assess the extent of congestion and support the evaluation of the effectiveness of congestion reduction and mobility enhancement strategies for the movement of people and goods. Since levels of acceptable system performance may vary among local communities, **performance measures should be tailored to the specific needs of the area and established cooperatively by the State(s), affected MPO(s), and local officials in consultation with the operators of major modes of transportation in the coverage area**;

(3) Establishment of a coordinated program for **data collection and system performance monitoring** to define the extent and duration of congestion, to contribute in determining the causes of congestion, and evaluate the efficiency and effectiveness of implemented actions. To the extent possible, this data collection program should be coordinated with existing data sources (***including archived operational/ITS data***) and coordinated with operations managers in the metropolitan area;

(4) Identification and **evaluation of the anticipated performance and expected benefits of appropriate congestion management strategies** that will contribute to the more effective use and improved safety of existing and future transportation systems based on the established performance measures. The following categories of strategies, or combinations of strategies, are some examples of what should be appropriately considered for each area:

(i) Demand management measures, including growth management and congestion pricing;

(ii) Traffic operational improvements;

(iii) Public transportation improvements;

(iv) ***ITS technologies as related to the regional ITS architecture***; and

(v) Where necessary, additional system capacity;

(5) Identification of an implementation schedule, implementation responsibilities, and possible funding sources for each strategy (or combination of strategies) proposed for implementation; and

(6) Implementation of a process for periodic **assessment of the effectiveness of implemented strategies, in terms of the area's established performance measures**. The results of this evaluation shall be provided to decisionmakers and the public to provide guidance on selection of effective strategies for future implementation.

(d) In a TMA designated as nonattainment area for ozone or carbon monoxide pursuant to the Clean Air Act, Federal funds may not be programmed for any project that will result in a significant increase in the carrying capacity for SOVs (i.e., a new general purpose highway on a new location or adding general purpose lanes, with the exception of safety improvements or the elimination of bottlenecks), unless the project is addressed through a congestion management process meeting the requirements of this section.

(e) **In TMAs designated as nonattainment for ozone or carbon monoxide, the congestion management process shall provide an appropriate analysis of reasonable (including multimodal) travel demand reduction and operational management strategies for the corridor in which a project that will result in a significant increase in capacity for SOVs** (as described in paragraph (d) of this section) **is proposed** to be advanced with Federal funds. If the analysis demonstrates that travel demand reduction and operational management strategies cannot fully satisfy the need for additional capacity in the corridor and additional SOV capacity is warranted, then the congestion management process shall identify all reasonable strategies to manage the SOV facility safely and effectively (or to facilitate its management in the future). Other travel demand reduction and operational management strategies appropriate for the corridor, but not appropriate for incorporation into the SOV facility itself, shall also be identified through the congestion management process. All identified reasonable travel demand reduction and operational management strategies shall be incorporated into the SOV project or committed to by the State and MPO for implementation.

(f) State laws, rules, or regulations pertaining to congestion management systems or programs may constitute the congestion management process, if the FHWA and the FTA find that the State laws, rules, or regulations are consistent with, and fulfill the intent of, the purposes of 23 U.S.C. 134 and 49 U.S.C. 5303.

23 CFR Rule 940 is the FHWA rule related to ITS architecture and standards which governs the regional ITS architecture development.

4.1. ITS Architecture and Standards

In January 2001, FHWA published 23 CFR 940 (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 officially adopted 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 Rule/Policy continues under the current Federal transportation act. While most of the requirements in Rule 940 relate to regional ITS architecture development (940.9) and use in project development as part of the systems engineering process (940.11), there are several parts of the rule that are relevant to architecture use in planning. ***Planning-related quotes are highlighted with bold italics***.

§ 940.5 Policy

ITS projects shall conform to the National ITS Architecture and standards in accordance with the requirements contained in this part. Conformance with the National ITS Architecture is interpreted to mean the use of the National ITS Architecture to develop a regional ITS architecture, and the subsequent adherence of all ITS projects to that regional ITS architecture. ***Development of the regional ITS architecture should be consistent with the transportation planning process for Statewide and Metropolitan Transportation Planning***.

§ 940.9 Regional ITS architecture.

(a) A regional ITS architecture shall be developed to guide the development of ITS projects and programs and ***be consistent with ITS strategies and projects contained in applicable transportation plans***. The National ITS Architecture shall be used as a resource in the development of the regional ITS architecture. The regional ITS architecture shall be on a scale commensurate with the scope of ITS investment in the region. Provision should be made to include participation from the following agencies, as appropriate, in the development of the regional ITS architecture: Highway agencies; public safety agencies (e.g., police, fire, emergency/medical); transit operators; Federal lands agencies; State motor carrier agencies; and other operating agencies necessary to fully address regional ITS integration.

§ 940.11 Project implementation.

(a) All ITS projects funded with highway trust funds shall be based on a systems engineering analysis.

(b) The analysis should be on a scale commensurate with the project scope.

(c) The systems engineering analysis shall include, at a minimum:

(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;

(3) Requirements definitions;

(4) Analysis of alternative system configurations and technology options to meet requirements;

(5) Procurement options;

(6) Identification of applicable ITS standards and testing procedures; and

(7) Procedures and resources necessary for operations and management of the system.

(d) Upon completion of the regional ITS architecture required in §§ 940.9(b) or 940.9(c), the final design of all ITS projects funded with highway trust funds shall accommodate the interface requirements and information exchanges as specified in the regional ITS architecture. If the final design of the ITS project is inconsistent with the regional ITS architecture, then the regional ITS architecture shall be updated as provided in the process defined in § 940.9(f) to reflect the changes.

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