# Florida Department of Transportation Systems Engineering and Intelligent Transportation Systems (ITS) Architecture Procedure

**750-040-003-c**
**February 7, 2020**

Transportation Systems Management & Operations

Florida Department of Transportation
Traffic Engineering and Operations Office
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## DEFINITIONS

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| Concept of Operations | For a specific project, the document in which the project stakeholders detail their shared understanding of the system to be developed and how it will be operated and maintained. A user-oriented document that describes a system's operational characteristics from the end user's viewpoint. A Concept of Operations (ConOps) document is a project level detail of the portion of the Operational Concept (OpsCon) in the Regional Intelligent Transportation System Architecture (RITSA). |
| Intelligent Transportation Systems | Intelligent transportation systems (ITS) include the electronics, communications, or information processing used singly or in combination to improve the efficiency or safety of a surface transportation system. |
| ITS Architecture | A structure of interrelated stakeholder systems that work together, sometimes across stakeholder boundaries, to deliver transportation services. An ITS architecture defines how stakeholder systems functionally operate and the interconnection of information exchanges that must take place between these stakeholder systems to achieve transportation services. |
| ITS Project | Any project that, in whole or in part, funds the acquisition of technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS Service Packages as defined in the National ITS Architecture (NITSA). |
| Maintenance of Architectures | Regular, periodic updates to ensure the statewide or regional ITS architecture conforms to the NITSA and identifies current stakeholders and projects planned or completed within the region. Exception maintenance documents changes that occur between periodic updates. |
| National ITS Reference Architecture | The National ITS Reference Architecture, also known as the "*Architecture Reference for Cooperative and Intelligent Transportation*" or simply "ARC-IT", provides a common framework for planning, defining, and integrating intelligent transportation systems. ARC-IT is a reference architecture providing a common basis for planners and engineers with |

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| | differing concerns to conceive, design and implement systems using a common language as a basis for delivering ITS, but does not mandate any particular implementation. The National ITS Reference Architecture is maintained by the United States Department of Transportation (USDOT). www.arc-it.net |
| Open Standards | Standards are intended to assure interoperability between system elements. An open standard gives users free and unlimited rights to use the standard (even though users may pay the standards development organization (SDO) for copyrighted copies of the open standard documentation). Open standards may also have various properties of how they were designed (e.g., the systems engineering process used to develop the standard). Open standards are developed by a committee that is open to broad membership by representatives of any public and/or private organization.<br><br>Open standards committees develop standards following the bylaws of one or more SDO. Examples of SDOs that develop open ITS standards in the United States are the Institute of Transportation Engineers (ITE), National Electrical Manufacturers Association (NEMA), American Association of State Highway and Transportation Officials (AASHTO), Institute of Electrical and Electronics Engineers, Society of Automotive Engineers, and American Public Transportation Association. Internationally open standards are developed by standards committees of the International Organization for Standardization.<br><br>An example of open ITS standards is the National Transportation Communications for Intelligent Transportation System Protocol suite of standards, which are cooperatively developed and updated by AASHTO, ITE, and NEMA with support from the Federal Highway Administration (FHWA). |
| Operational Concept | A component of a regional architecture that identifies the roles and responsibilities of participating agencies and stakeholders in the existing and planned systems. The operational concept (or OpsCon) defines the institutional and technical vision for the region and describes how ITS will work at a very high level, frequently using operational scenarios as a basis. |
| Project Architecture | Also referred to as High-Level Design, project architecture is the transitional step between what the system does (the requirements) and how the system will be implemented to meet the system requirements. The project architecture identifies internal and external interfaces along with the |

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| | needed standards for the system. It is a more detailed level architecture, used for decomposition of requirements in the analysis process than the portion of the regional architecture the project intends to fulfill. Allocating these functions to the physical elements of the system forms the complete project architecture. The project architecture also defines the integration activities to be performed. A project architecture is verified to be consistent with the regional architecture, but because some inconsistencies occur as system details are developed, these differences are documented and reflected in the regional architecture. |
| Project Manager | The Project Manager (PM) is the individual responsible for the execution and completion of an ITS Project. Throughout this procedure, the term PM refers to the Florida Department of Transportation (FDOT) PM or the local agency's PM, depending on project ownership. The term does not refer to a consultant PM or FDOT Local Programs PM. |
| Region | A geographical area that identifies the boundaries of the RITSA, which is defined by and based on the needs of the participating agencies and other stakeholders. In metropolitan areas, a region should be no less than the boundaries of the metropolitan planning area. |
| Regional ITS Architecture | A regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects. |
| Requirements Validation | Supports backward traceability of requirements development to ensure correctness, consistency, completeness, and accuracy in translating needs from the owner/stakeholder perspective into requirements. Requirements Validation answers the question, are the right requirements for the system being developed? |
| Stakeholders | A public agency or authority, private organization, or the traveling public with a vested interest or a "stake" in one or more transportation elements within a RITSA. |
| Standards | Documented technical specifications sponsored by an SDO to be used consistently as rules, guidelines, or definitions of characteristics for the interchange of data. A broad array of ITS standards that specifically define the interfaces identified in the NITSA are currently in place or under development.<br><br>The USDOT recommends judicious use of the available standards. A broad array of ITS standards are currently under development that will specifically define the interfaces identified in ARC-IT. For current information on ITS |

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| | Standards from the USDOT, go to https://standards.its.dot.gov/. |
| Systems Engineering | Systems engineering is defined by the International Council on Systems Engineering (INCOSE) as 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, and then proceeding with design synthesis and system validation while considering the complete problem. Systems engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs. |
| System Validation | The process of assessing the performance of the delivered system against the stakeholder's needs and expectations as identified in the System Validation Plan. Validation results may identify new needs and requirements for system refinement or evolution. System Validation answers the question, was the right system built? |
| System Verification | The process of ensuring that the system components meet the system requirements (and/or that the built system components meet the design specifications) from the development team's perspective. Verification may entail testing, observation, demonstration, and/or analysis as identified in the system verification plan. Final system verification supports project acceptance. |
| Traceability | Traceability is the process for directly correlating that all:<br>• System needs from the ConOps are fulfilled by system requirements.<br>• System requirements are fulfilled by system design specifications.<br>• System components fulfill system design specifications.<br>• System components are fulfilled by system modules.<br>• The final system fulfills system modules. |

## LIST OF ACRONYMS

AASHTO ................ American Association of State Highway and Transportation Officials
APL ..................................................................................... Approved Product List
CFR ........................................................................... Code of Federal Regulations
CO .......................................................................................................... Central Office
ConOps ............................................................................... Concept of Operations
COTS ..................................................................................... Commercial Off-The-Shelf
FDOT ........................................................................ Florida Department of Transportation
FHWA ............................................................................ Federal Highway Administration
INCOSE ...................................................... International Council on Systems Engineering
IPL ............................................................................................ Innovative Product List
ITE .................................................................................. Institute of Transportation Engineers
ITS ........................................................................... Intelligent Transportation System
LRTP ....................................................................... Long-Range Transportation Plan
MPO ....................................................................... Metropolitan Planning Organization
NEMA ........................................................ National Electrical Manufacturers Association
NITSA .......................................................................................... National ITS Architecture
OpsCon ........................................................................................ Operational Concept
PITSA ............................................................................................ Project ITS Architecture
PM ............................................................................................................ Project Manager
PSEMP ................................................ Project Systems Engineering Management Plan
RFP ......................................................................................... Request for Proposal
RITSA ....................................... Regional Intelligent Transportation Systems Architecture
RTVM ........................................................ Requirements Traceability Verification Matrix
SDO ................................................................. Standard Development Organization
SE ..................................................................................................... Systems Engineering
SITSA .................................................................................... Statewide ITS Architecture
TIP ............................................................................ Transportation Improvement Program
TPO .................................................................. Transportation Planning Organization
TSM&O ....................................... Transportation Systems Management and Operations
USDOT ....................................................... United States Department of Transportation

Approved:

Effective: February 7, 2020
Review: July 17, 2019
Office: Traffic Engineering & Operations
Topic Number: 750-040-003-c

Kevin J Thibault, Secretary

# SYSTEMS ENGINEERING AND INTELLIGENT TRANSPORTATION SYSTEMS (ITS) ARCHITECTURE PROCEDURE

## PURPOSE

The purpose of this procedure is to ensure Florida Department of Transportation (FDOT) compliance with federal regulations in the Code of Federal Regulations (CFR) Title 23, Part 940, and CFR Title 23, Section 450.306(g).

## AUTHORITY

***Section 334.048(3), Florida Statutes (FS)***
***Section 20.23(3)(a), FS***

## SCOPE

This procedure concerns all entities associated with federally-funded intelligent transportation systems (ITS) projects including local agencies, metropolitan planning organizations (MPO), and all applicable units of FDOT.

## REFERENCES

1. *23 CFR, Part 940 Intelligent Transportation System Architecture and Standards*, http://www.gpo.gov/fdsys/pkg/CFR-2008-title23-vol1/pdf/CFR-2008-title23-vol1-part940.pdf
2. *International Council on Systems Engineering (INCOSE) Systems Engineering Handbook* v. 3.2.2, INCOSE-TP-2003-002-03.2.2. October 2011. INCOSE at 7670 Opportunity Rd, Suite 220, San Diego, CA 92111-2222.
3. *Systems Engineering for Intelligent Transportation Systems – An Introduction for Transportation Professionals*. January 2007. Federal Highway Administration, http://ops.fhwa.dot.gov/publications/seitsguide/seguide.pdf

4. *Regional ITS Architecture Guidance: Developing, Using, and Maintaining an ITS Architecture for Your Region*. Version 2.0. July 2006. Federal Highway Administration, https://ops.fhwa.dot.gov/publications/regitsarchguide/raguide.pdf
5. *Stewardship and Oversight Agreement*, Procedure Topic No. 700-000-005,
   - https://fdotwp1.dot.state.fl.us/ProceduresInformationManagementSystemInternet/?viewBy=0&procType=pr#
   - https://www.fhwa.dot.gov/federalaid/stewardship/agreements/fl.pdf

# SECTION 1 - SYSTEMS ENGINEERING AND INTELLIGENT TRANSPORTATION SYSTEMS ARCHITECTURE INTRODUCTION

## 1.1 SYSTEMS ENGINEERING PROCESS

Systems engineering (SE) outlines the project management methodology for conducting projects over their entire life cycle. Studies have shown that the likelihood of a project's success increases with the implementation of an appropriate SE management process. Using SE for ITS projects will increase the likelihood that the following objectives are met:

- Deployments result in systems meeting the original needs.
- Projects stay within budget and remain on schedule.

SE achieves these related objectives by detecting defects early when they are less costly to repair. SE does this by using *verification* and *validation*, as outlined below.

- *Verification* reviews can be of two kinds:
    1. Checking traceability from one stage of decomposition/recomposition to the next.
    2. Testing the system components against their specifications, or the system against its requirements.
- In-process *validation* reviews allow stakeholders and subject matter experts to ensure the right requirements are developed for the system.
- Post-implementation *validation* assesses project results against the Concept of Operations (ConOps) document to identify necessary refinements/evolution of the system and feedback to Regional ITS Architecture (RITSA).

**Figure 1** identifies the typical full SE process structure depicted using a Vee diagram. Use of the SE process will be required for federally funded high-risk ITS projects as defined in Sections 2.1 and 2.2. For state-funded high-risk projects, the District Transportation Systems Management and Operations (TSM&O) Program Engineer may require the use of the SE process.

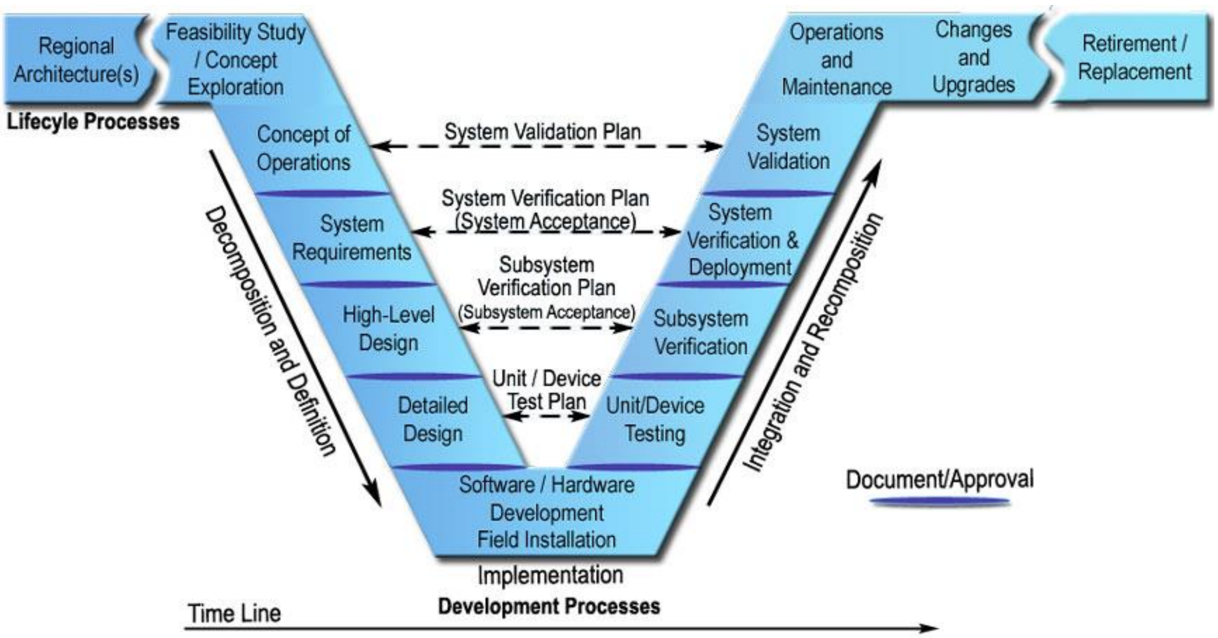


**Figure 1: Typical Systems Engineering Process Depicted as a Vee Diagram**

Using a system engineering approach is critical to successful ITS project development. The Vee model shown in Figure 1 is the typical systems engineering process for most FDOT ITS projects. For larger and more complex ITS projects involving new technologies and/or software development, a spiral model may be considered. A spiral model can be envisioned as a series of Vee models. A spiral model allows complex projects to be implemented incrementally rather than all at once, potentially reducing costs and risks. Additional capabilities are added to the system through successive iterations of the Vee model.

## 1.2 SYSTEMS ENGINEERING ANALYSIS

All federally-funded ITS projects must adhere to the respective RITSA (23 CFR, Part 940.5). To provide consistency in the RITSA process, FHWA requires a system engineering analysis be applied to all federally-funded ITS projects, regardless of size or budget. The analysis, however, should be on a scale commensurate with the project scope. If it is determined, during the development of a regional ITS architecture, that a specific planned project offers no real integration opportunities for the region, then the impact of this rule on that specific project is minimal. To allow for the greatest flexibility at the state and local level, FHWA identified a minimum number of elements for inclusion in the systems engineering analysis (23 CFR, Part 940.11). Prior to authorization of highway trust funds for construction or implementation of ITS projects, compliance with Part 940.11 must be demonstrated.

Per 23 CFR, Part 940.11, agencies are required to use an SE analysis for federally funded ITS projects. The SE analysis must be on a scale commensurate with the project scope and at a minimum, include the following seven items:

1. Identification of portions of the RITSA being implemented.
2. Identification of participating agencies roles and responsibilities which draws from the RITSA Operational Concept (OpsCon) and Agreements.
3. Identification of requirements definitions (draws from RITSA system functional requirements, interface requirements, and architecture flows).
4. Analysis of alternative system configurations and technology options to meet requirements.
5. Identification of procurement options.
6. Identification of applicable ITS standards and testing procedures (draws from RITSA identification of standards).
7. Identification of procedures and resources necessary for operations and management of the system (draws from RITSA OpsCon and Agreements).

An SE analysis is narrower than the SE process in that it does not fully address all steps in the SE process depicted in **Figure 1**. For example, SE analysis item 2 is typically included in the ConOps step on the left side of the Vee diagram, but a complete ConOps contains more than this information. Specifically, it describes the who, what, why, where, and how of the project/system, including stakeholder needs and constraints.

The SE analysis will be used for federally funded low-risk and high-risk ITS projects as defined in Sections 2.1 and 2.2. For state-funded low-risk and high-risk projects, the District TSM&O Program Engineer may require that the SE analysis is conducted.

## 1.3 REGIONAL INTELLIGENT TRANSPORTATION SYSTEMS ARCHITECTURE

A RITSA must be developed and maintained to guide the development of ITS projects and programs, funded in whole or in part by the Highway Trust Fund, and must be consistent with ITS strategies and projects contained in applicable transportation plans.

The National ITS Architecture (NITSA) shall be used as a resource in the development of the regional ITS architecture. The regional ITS architecture must be on a scale commensurate with the scope of ITS investment in the region.

Provisions 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.

The RITSA defines the technical and institutional environment in which each project will be built and is an important part of the planning and implementation of ITS in the region. The RITSA allows system implementers to plan for the long term and implement sizable projects (which may involve multiple modes and stakeholders) over time based on resource and funding availability. The RITSA has several benefits, including:

- Encouraging the use of open standards.
- Recommending design with the future in mind so systems do not have to be significantly reworked or replaced later to meet long-term visions.
- Ensuring all stakeholders are accounted for when developing projects.
- Enhancing collaboration and avoiding duplicative efforts.
- Identifying and addressing opportunities for interoperability

It is important to maintain consistency among the NITSA, statewide ITS architecture (SITSA), and Florida's RITSAs. The level of generalization decreases, and specificity increases when moving from the NITSA to the SITSA, RITSAs, and Project ITS Architectures while the consistency needs to be maintained among different ITS architectures, as identified in **Figure 2**.

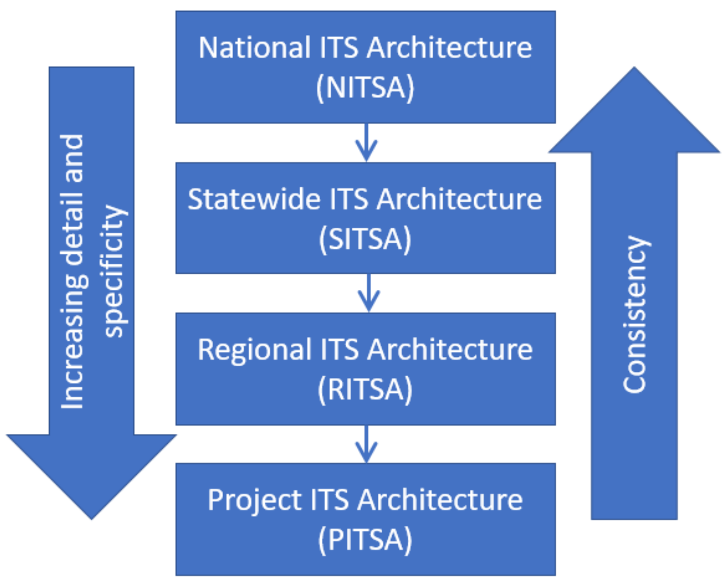


**Figure 2: Relationship Among Different ITS Architectures**

## 1.4 TAILORING THE SYSTEMS ENGINEERING PROCESS

This section provides an approach to tailoring the SE process commensurate with the project scope and risk. Tailoring the SE process establishes an acceptable amount of SE process overhead committed to activities not otherwise directly related to the creation of the system. Tailoring scales the rigorous application of the SE process to an appropriate level based on the perceived project risk. For example, tighter assessment and control is recommended in the development stage of a system.

**Figure 3** is a graphical representation of the need to scale the formal SE process commensurate with complexity, schedule, and cost risks.

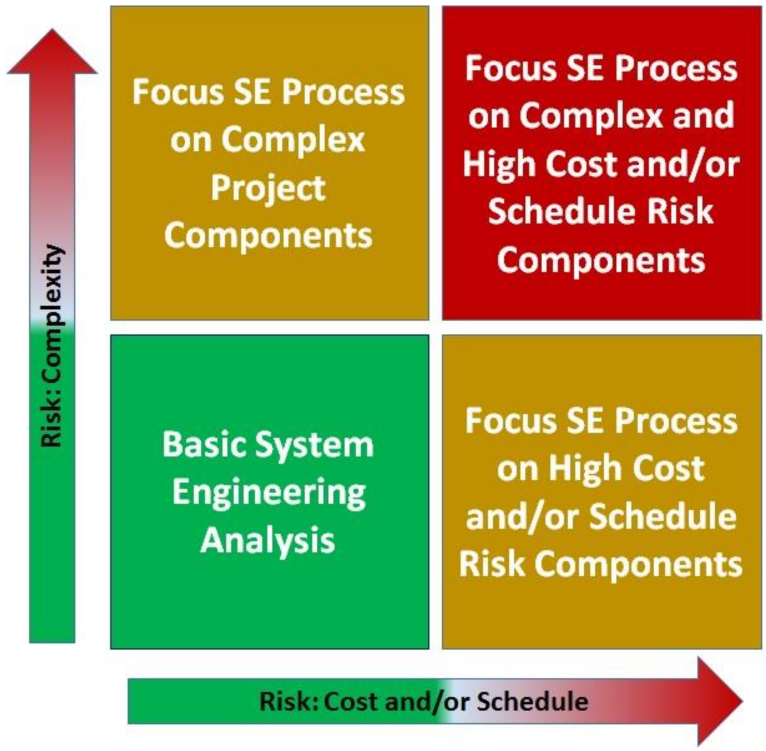


**Figure 3: Balancing the Overhead Cost of the SE Process Against Project Risk**

The intent is to balance the application of a rigorous SE against the cost of implementing the SE process. On all projects, there is an appropriate amount of SE that manages risk at a practical SE overhead cost. SE tailoring is a process applied throughout the life cycle of the project, depending on the risks and the current state of the project. SE tailoring should be continually monitored and adjusted as needed. The extent of tailoring should be prescribed in the Project Systems Engineering Management Plan (PSEMP).

## 1.5 TAILORING GUIDE

Project managers (PM) shall use the risk assessment guidelines shown in **Table 1** to tailor the SE processes used in an ITS project. The projects are categorized in this document as low risk or high risk. 23 CFR, Part 940 does not view projects based on funding amounts because projects with small funding could still have high-risk components, hence necessitating the need for the SE process. **Table 1** discusses the seven risk attributes that determine if a project is considered high risk or low risk.

**Table 1: Risk Assessment for ITS Projects**

| | Low-Risk Project Attributes | High-Risk Project Attributes | Risk Factors |
|---|---|---|---|
| **1** | Single jurisdiction and single transportation mode (highway, transit, or rail). | Multi-jurisdictional or multi-modal. | With multiple agencies, departments, and disciplines, disagreements can arise about roles, responsibilities, cost sharing, data sharing, schedules, changing priorities, etc. Detailed written agreements are crucial.<br><br>Technical agreement on how information will be shared across stakeholder boundaries is essential, especially when stakeholder schedules for deploying their elements of the solution may not be in sync. |
| **2** | No software creation; uses commercial off-the-shelf (COTS) or proven software that has been confirmed to meet the needs of the project such as SunGuide® or agency's ATMS software. | Custom software development required, or modifications are required to SunGuide or the agency's ATMS software. | Custom software requires additional development, testing, training, documentation, maintenance, and product update procedures – all unique to one installation. This is very expensive, so hidden shortcuts are often taken to keep costs low. Additionally, integration with existing software can be challenging, especially because documentation is often not complete and is out-of-date, introduce unintended cybersecurity risks or the existing software was never intended to support an interface to the new system. |
| **3** | Proven technologies including: COTS hardware and communications technologies and equipment on FDOT's Approved Products List (APL) or Innovative Product List (IPL). | Hardware or communications technology that is "cutting edge" or not in common use, may include equipment newly listed on the IPL or that requires development of a Technical Special Provision. | New technologies are not "proven" until they have been installed and operated in a substantial number of different environments. New environments often uncover unanticipated problems. New technologies or new businesses can sometimes fail completely. Multiple proven technologies combined in the same project would be high risk if there are new interfaces between them. |

| | Low-Risk Project Attributes | High-Risk Project Attributes | Risk Factors |
|---|---|---|---|
| **4** | No new interfaces; for example, all needed interfaces are shown in the RITSA as complete but just adding more equipment. | New interfaces to other systems required either in the RITSA shown as planned, or not in the RITSA, potentially requiring a modification to the RITSA. | New interfaces require documentation for the "other" system to be complete and up-to-date. If not, building a new interface can become difficult or impossible. Duplication of existing interfaces reduces the risk. "Open Standard" interfaces are usually well documented and, if also mature (e.g., used before), then is considered low risk. |
| **5** | Confirmed that system requirements are fully detailed in writing and meet the project needs; for example, in SE documents, configuration manuals, or manufacturer operation and maintenance documents. | System requirements not detailed or not fully documented, requiring further development during the SE process. | System requirements are critical for stakeholders, consultants, and/or contractor agreement on what it means for a system to work correctly. The requirements must describe, in detail, all functions the system must perform, the performance expected, plus the operating environment. Good requirements can be a few pages for a small system and hundreds of pages for a complex system. When existing systems are upgraded with new capabilities, existing requirements must be reviewed and revised as needed to correctly describe the new system. |
| **6** | Operating procedures fully detailed in writing, for example, in existing operations and maintenance guides and contracts. | Operating procedures not detailed or not fully documented and need to be developed or updated. | For existing systems, standard operating procedures may need to be updated. |
| **7** | None of the technologies used are near end-of-service life expectancy. | Some technologies included are near end-of-service life expectancy. | Computer technology changes rapidly. Local area networks using internet standards have had a long life, but in contrast, some mobile phones that use proprietary communication protocols have quickly become obsolete. Similarly, the useful life of ITS technology (hardware, software, and communications) is short. Whether a project is a new system or expanding an existing one, examine carefully all the technology elements to |

| Low-Risk Project Attributes | High-Risk Project Attributes | Risk Factors |
|---|---|---|
| | | assess the remaining cost-effective service life expectancy and keep vulnerabilities at a manageable level. |

If the agency performing the risk assessment does not know or is unfamiliar with any of the risk attributes, it shall make a conservative assessment and consider the project as a high-risk project. While all federally-funded ITS projects require a systems engineering analysis, low-risk projects with a completed *Project Risk Assessment and Regulatory Compliance Checklist* (Form 750-040-05) may follow the process prescribed in traditional road-building projects or use the SE process (preferred), and high-risk projects shall use the SE process. Examples of low-risk and high-risk projects can be found in **Table 2**.

**Table 2: Examples of Low-Risk and High-Risk ITS Projects**

| Project Type | Example |
|---|---|
| **Low-Risk ITS Projects** | Expansion/upgrade to existing ITS (e.g., closed-circuit television cameras and dynamic message signs) where requirements and agency agreements already exist. |
| **High-Risk ITS Projects** | New systems, multi-jurisdictional, multi-modal, software development, and adaptive signal systems. |

## 1.6 SYSTEMS ENGINEERING CHECKLISTS AND SUPPORTING DOCUMENTS

All federally funded ITS projects, shall, at a minimum, produce the *Project Risk Assessment and Regulatory Compliance Checklist* (FDOT Form 750-040-05). All state-funded ITS projects shall produce the *Project Risk Assessment and Regulatory Compliance Checklist* (FDOT Form 750-040-05) if required by the District TSM&O Program Engineer. The *Project Risk Assessment and Regulatory Compliance Checklist* (FDOT Form 750-040-05) is used to (a) assess if the project is low risk or high risk and (b) address all regulatory SE items in 23 CFR, Part 940.11.

Federally funded high-risk projects shall produce the *Systems Engineering Project Checklist* (FDOT Form 750-040-06) and include the following minimum SE supporting documentation:

1. PSEMP
2. ConOps
3. Analysis of Alternative System Configurations and Technology Options
4. High-Level System Requirements
5. Requirements Traceability Verification Matrix (RTVM)
6. List of ITS Standards
7. System Verification Plan

8. System Validation Plan
9. Operations and Management Plan

State-funded high-risk projects shall produce the *Systems Engineering Project Checklist* (FDOT Form 750-040-06) and supporting documentation listed above (items 1-9) if required by the District TSM&O Program Engineer. For federally-funded high-risk projects, the *Systems Engineering Project Checklist* (FDOT Form 750-040-06) is also required.

The *Project Risk Assessment and Regulatory Compliance Checklist* (FDOT Form 750-040-05) is required for low-risk projects.

Deadlines for submitting the *Project Risk Assessment and Regulatory Compliance* Checklist (FDOT Form 750-040-05) and the *Systems Engineering Project Checklist* (FDOT Form 750-040-06) are indicated in the respective forms.

SE documentation requirements are summarized in **Table 3**.

a

**Table 3: SE Documentation Requirements Based on Project Risk and Funding Source**

| Project Type | Required SE Documentation |
|---|---|
| **Low Risk, Federal Funds, in ITS and/or Non-ITS Portions of the Project** | • *Project Risk Assessment and Regulatory Compliance Checklist (FDOT Form 750-040-05)* |
| **Low Risk, Non-Federal Funds** | • *Project Risk Assessment and Regulatory Compliance Checklist (FDOT Form 750-040-05), if required by the FDOT District TSM&O Program Engineer* |
| **High Risk, Federal Funds in ITS and/or Non-ITS Portions of the Project** | • *Project Risk Assessment and Regulatory Compliance Checklist (FDOT Form 750-040-05)*<br>• *Systems Engineering Project Checklist (FDOT Form 750-040-06) (and required supporting documents)* |
| **High Risk, Non-Federal Funds** | • *Project Risk Assessment and Regulatory Compliance Checklist (FDOT Form 750-040-05), if required by the FDOT District TSM&O Program Engineer*<br>• *Systems Engineering Project Checklist (FDOT Form 750-040-06) (and required supporting documents) , if required by the FDOT District TSM&O Program Engineer* |

SE documents created for previous ITS projects may be reused if applicable to the current ITS project. When using previously created SE documents, verify they are up to date and validated by current project stakeholders, and that the project described in the SE documents remains in conformance with the current RITSA.

All SE documents produced as part of the SE process shall use the document templates (if the template exists) located at: https://www.fdot.gov/traffic/ITS/Projects-Deploy/SEMP.shtm .

SE documents can be tailored based on the project risk.

# SECTION 2 – MAINTAINING THE INTELLIGENT TRANSPORTATION SYSTEMS ARCHITECTURE

In Florida, the SITSA is made up of seven RITSAs that have boundaries coinciding with the FDOT District boundaries (Districts 4 and 6 were combined), including Florida's Turnpike Enterprise. Additionally, a statewide layer was added to include statewide services that are common to all Districts and/or managed by the FDOT Central Office. These eight components make up the SITSA. The most recent version of the SITSA and RITSAs can be obtained via the FDOT Traffic Engineering and Operations Office website located at:
https://www.fdot.gov/traffic/ITS/Projects-Arch/SITSA.shtm

For each RITSA, the baseline documentation to maintain includes (a) a hyperlinked website of the architecture, (b) customized service packages, and (c) an architecture summary document. If an update is found during annual reviews, the following components in a RITSA shall be updated, as needed:

- A description of the region.
- A list of stakeholders with existing or planned ITS elements in the region (or that communicate with or are serviced by ITS elements in the region).
- Operational concepts for each stakeholder for all planned and existing ITS elements.
- A list of stakeholder ITS elements (inventory).
- A list of customized service packages.
- Interfaces between stakeholder elements (information flows).
- A list of agreements (existing or new) required for operation.
- System functional requirements for each stakeholder ITS element (existing and planned).
- Applicable ITS standards for the information flows (where available).
- List of planned and existing ITS projects in the region.
- Project sequencing required for implementation of planned systems

To maintain their effectiveness for planning and deploying ITS, the SITSA and RITSAs, like most other long-range transportation plans (LRTP), must be updated. Controlled ITS architecture baseline updates will ensure that architectures continue to accurately reflect the region's existing ITS capabilities and future plans. The following list includes many of the events that will cause changes to a RITSA:

- Changes in statewide or regional needs.
- Changes in the SITSA.
- New stakeholders.
- Changes in the scope of services considered (including those that might be due to a NITSA update including new or revised ITS service packages).
- Changes in stakeholder or element names.
- Changes in architectures of adjacent regions that may affect the RITSA.
- Changes due to ITS project definition or implementation.

- Changes due to ITS project completion/addition/deletion.
- Changes in ITS project priority.
- Changes to the NITSA.
- Issuance of new federal rules or policies.

Per 23 CFR, Part 940.11, the final design of all ITS projects funded with highway trust funds is required to accommodate the interface requirements and information exchanges as specified in the RITSA. If the final design of the ITS project is inconsistent with the RITSA, then the RITSA must be updated.

## 2.1 MAINTENANCE PLAN

The District TSM&O Program Engineer(s) and the Central Office (CO) TSM&O Program are both responsible for maintaining the RITSAs. FDOT will seek and incorporate MPO/TPO and local agency input when maintaining and updating the RITSAs. The CO TSM&O Program is responsible for maintaining the SITSA. Both periodic maintenance and exception maintenance (for changes to the RITSAs that are needed quickly) shall be used to update the architectures. The process for periodic updates includes (for the SITSA and for each RITSA) the following: (a) a kickoff meeting with key stakeholders, (b) key stakeholder interviews, (c) a stakeholder workshop for presentation of the draft architecture, and (d) a stakeholder review/comments period before the architecture is finalized and approved.

The need for exception maintenance (interim) shall be evaluated as needed. Exception maintenance of the SITSA and RITSAs shall be conducted based upon individual change requests using a process depicted in **Figure 4** and defined in this section.

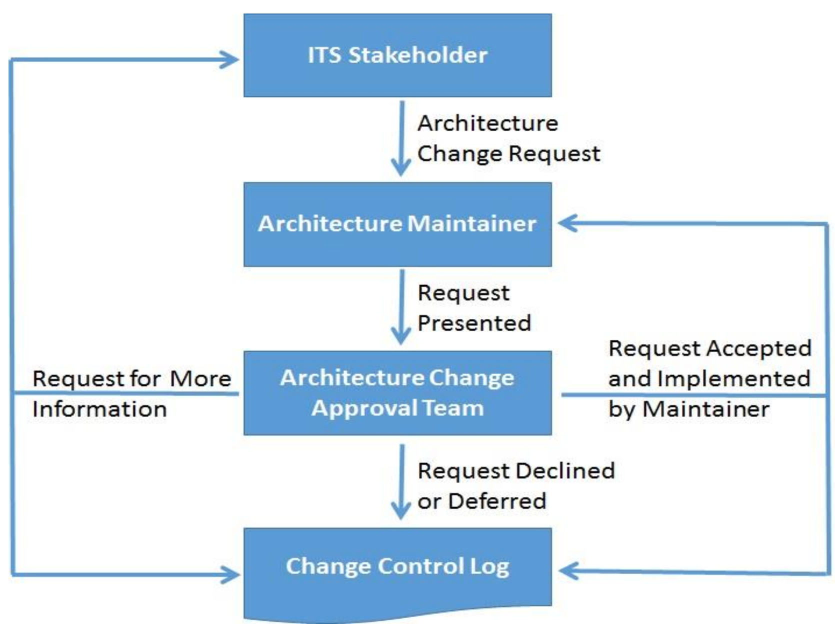


**Figure 4: Process Utilized for Exception Maintenance of the SITSA and RITSAs**

All updates to the SITSA and RITSAs (except for technical corrections) shall be reviewed by relevant stakeholders (including members from the areas of traffic, transit, public safety, and maintenance), and final baseline versions shall be approved by the District TSM&O Program Engineer(s) and the CO TSM&O Program. The FDOT and FHWA will review the RITSAs annually to ensure major changes are captured in each RITSA.

Change requests to the architecture may be submitted by various statewide and regional stakeholders. Stakeholders should inform their District TSM&O Program Engineer and CO TSM&O Program of a change in the status of any ITS-related project (including new projects with an ITS component). To properly maintain the architecture, the District TSM&O Program Engineer and CO TSM&O Program must be informed not only when projects are planned, but also when projects are completed or when changes are made during design or construction that impact the architecture. The change requests should be submitted using the *ITS Architecture Change Request Form* (FDOT Form 750-040-04) and include supporting documentation.

The District TSM&O Program Engineer(s) and the CO TSM&O Program shall evaluate the need for the change and analyze its impact on other system components. If a change request impacts other stakeholders, the District TSM&O Program Engineer(s) and the CO TSM&O Program shall ensure that the impacted stakeholders have been contacted and their agreement with the modification is confirmed. If any issue involves several stakeholders or requires extensive discussion and agreement, a stakeholder meeting/workshop to discuss the modification may be held. Prior to acting (rejecting, deferring, or accepting the change), additional information or further clarification may be requested. If the change is rejected or deferred, the requestor shall be given a justification for the decision. If the change is accepted, the requestor shall be notified, and the change prioritized with other requests and scheduled for implementation either in the next major update or annual periodic maintenance.

Once a draft update is available, the District TSM&O Program Engineer(s) and the CO TSM&O Program shall ask the requestor and other relevant stakeholders to review and provide comments to finalize the architecture update. Once finalized, a new architecture baseline will be established, and all stakeholders notified of the change and the new baseline architecture. In addition, the CO ITS Section shall track all change requests and record their disposition in a change control log.

## 2.2 INTELLIGENT TRANSPORTATION SYSTEMS ARCHITECTURE CHECKLIST AND CHANGE REQUESTS

For requesting changes to the RITSA or SITSA, the requestor shall submit the *ITS Architecture Change Request Form* (FDOT Form 750-040-04).

## SECTION 3 – AGENCY ROLES FOR SYSTEMS ENGINEERING AND INTELLIGENT TRANSPORTATION SYSTEMS ARCHITECTURE

The role of agencies in ensuring this procedure is applied uniformly and consistently throughout the state is discussed in this section.

## 3.1 PROJECT-SPECIFIC ROLES

### 3.1.1 Stand-Alone ITS Projects

This subsection discusses the agency roles and responsibilities prior to and during project deployment.

<u>Project Planning Phase</u>
Agency managers (FDOT districts or local agencies) shall conduct an initial project risk assessment early in the project planning cycle. The initial project risk assessment will use the *Project Risk Assessment and Regulatory Compliance Checklist* (FDOT Form 750-040-05) to determine the level of risk associated with the project. The results of the initial project risk assessment will provide input into the project prioritization process. If the project is selected for implementation through the project prioritization process, the project will be recommended for inclusion in FDOT's *Five-Year Work Program*. Depending on the risk assessment results, the project budget shall be adjusted, as needed, to ensure adequate funding for SE activities through preliminary design, final design, implementation, and verification. For high risk projects, the SE process may require additional funds and time to complete the project. Typically, 15 percent of the total project cost should be budgeted for completing SE on high risk projects, but the actual amount may be less depending on the project risks and the SE activities selected to manage specific risks. The process to utilize during ITS project planning for conformity to this procedure is depicted in **Figure 5**.


**Figure 5: Steps Involved in ITS Project Planning**

Project Advertisement

Agency managers, while producing the project scope documents for the procurement package, shall repeat the risk assessment as the scope is more clearly defined at this stage (or it may have changed since the project planning phase). Also, agency managers shall ensure that the SE analysis requirements are included in the procurement scope and that the SE process requirements are also included, as needed, based on project risk. In addition to making sure that the project scope includes SE activities for consultants and contractors, it is important to ensure that stakeholders have project budgets to allocate staff or consultant time for their participation in in-process validation activities and in-process verification reviews. The ITS project advertisement process is summarized in in **Figure 6**.

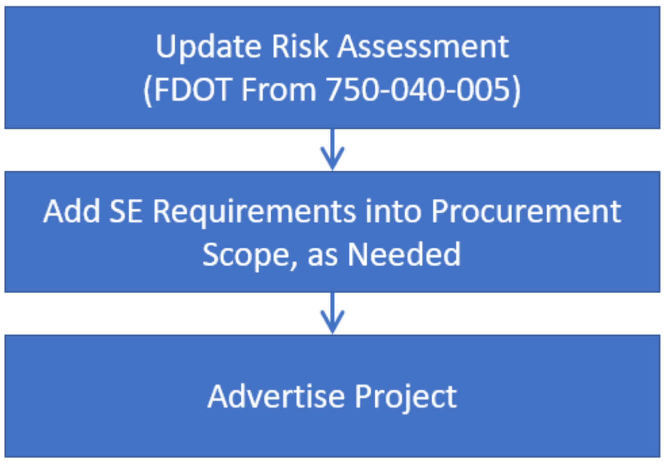


**Figure 6: Steps Involved in ITS Project Advertisement**

Project Deployment

To ensure that the SE process is followed properly throughout the project deployment, it is essential for stakeholders to understand their roles and responsibilities (and that they each have the budget to participate in their respective roles, including validation and verification activities). The agency can choose from different contracting methods and, typically, the agency will have access to a system engineer to verify the work performed by the systems installers and integrators. In the conventional Request for Proposal (RFP) projects, Construction Engineering and Inspection and/or agency personnel have an important role in verification that the systems were built, integrated, and operating as intended; however, in the systems manager contracting process, the systems engineer performs the systems verification role.

The example in **Figure 7** helps to explain typical activities that the agency, systems engineer, and systems integrator will perform throughout the project as they follow the SE process. This example does not include a comprehensive set of activities.

SE Vee Diagram Stages

### Decomposition Stage

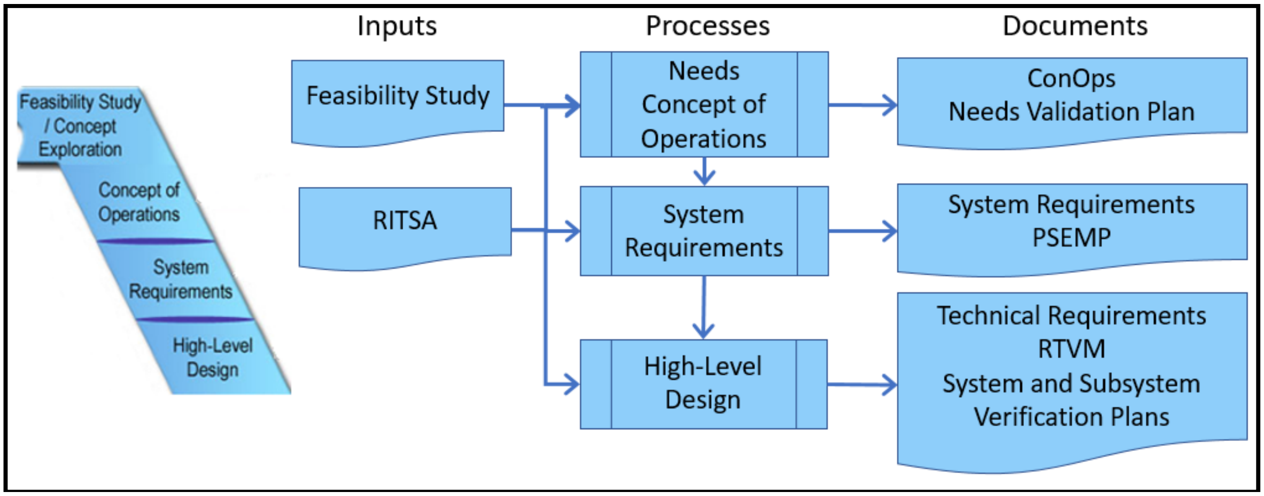


**Figure 7: Decomposition Phase**

In the decomposition stage, the agency documents the project needs, drawing from the RITSA, along with the project vision, constraints, system validation plan, agreements, and resource needs. The agency uses its systems engineer to help develop the vision, operational scenarios, requirements, validation and verification plans, interface needs, and high-level design. The systems integrator must be aware of the documents produced but does not have any official role in producing them.

### Implementation Stage

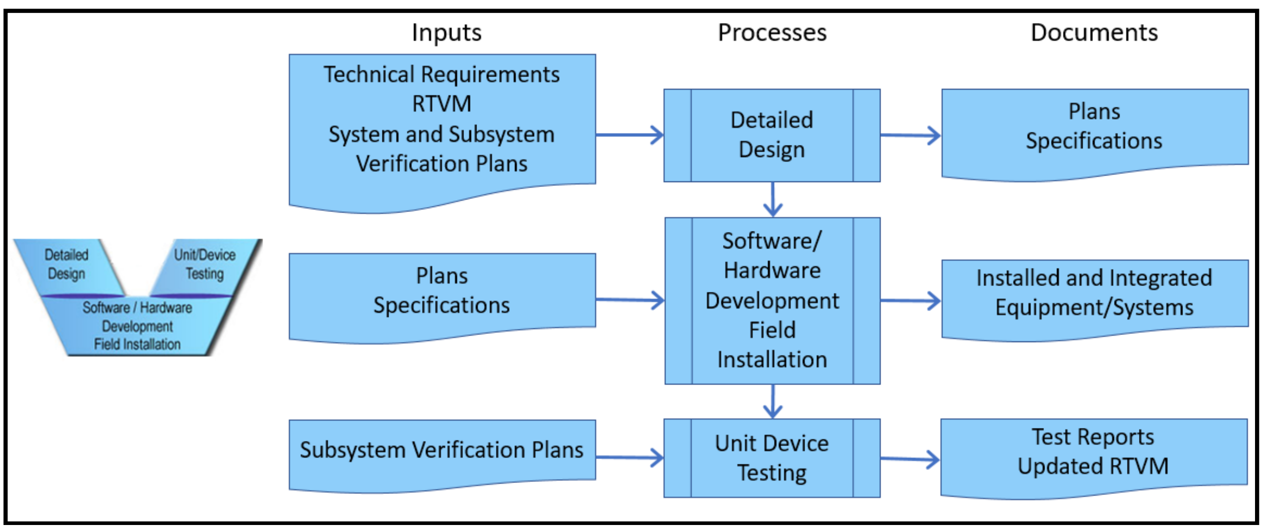


**Figure 8: Implementation Phase**

The agency in the implementation stage, shown in **Figure 8**, typically conducts technical reviews, configuration management activities, product reviews, and participates in development of an RFP. The systems engineer assists the agency's PM with systems integrator evaluation, product evaluation, detailed design, risk management, and technical plans review. The systems integrator develops the technical plans, conducts configuration management, and performs activities described in the scope, including unit tests as part of the development activities.

**Recomposition Phase**

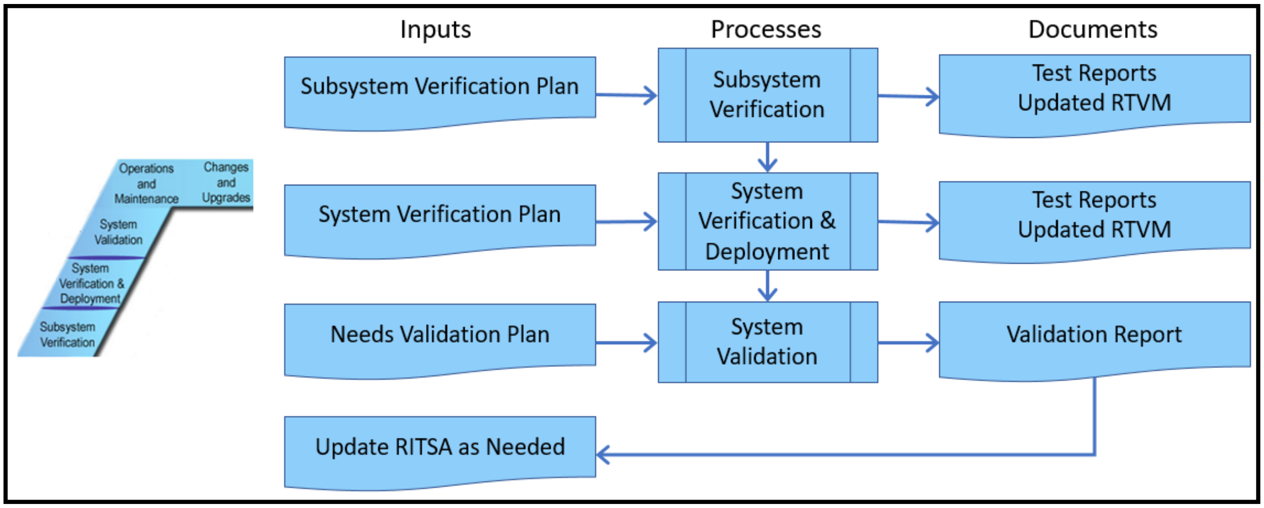


**Figure 9: Recomposition Phase**

During the recomposition stage, shown in **Figure 9**, the agency reviews, participates in, and approves the integration plan, training documentation, and test plans/procedures. The systems engineer supports, participates in, and monitors integration, training, test procedures, tests, and risk management. The systems integrator performs, documents, and implements integration tests, and resolves defects. Additionally, he/she confirms that system requirements are met, performs configuration management, and conducts risk management. The system evaluator conducts validation studies and reports results to the project stakeholders. As the last step, the RITSA is updated, as a minimum to change the status of the project from planned to existing. Also, the RITSA should be updated to capture any changes caused by the project related to operational concepts, stakeholders, operating agreements, etc.

<u>Central Office TSM&O Program</u>

For all federally funded projects (and state-funded projects, if required by the District TSM&O Program Engineer), a copy of the completed *Project Risk Assessment and Regulatory Compliance Checklist* (FDOT Form 750-040-05) shall be provided to the CO TSM&O Program for its record. For federally funded high-risk projects (and state-funded high-risk projects, if required by the District TSM&O Program Engineer), a copy of the completed *Systems Engineering Project Checklist* (FDOT Form 750-040-06) and supporting documentation shall also be provided to the CO TSM&O Program. The CO TSM&O Program shall ensure that the district's comments and questions are addressed for use of SE and ITS architecture in projects.

District TSM&O Program Engineers and PMs (FDOT or Local Agencies)
The District TSM&O Program Engineers and PMs shall ensure that (a) federally funded projects initiated at the district or local agency level are compliant with the RITSA, and (b) the SE process is used, if justified, employing the risk-assessment tools discussed in this procedure.

The District TSM&O Program Engineers and PMs shall ensure that state-funded projects initiated at the district or local agency level use the SE process by employing the same risk-assessment tools, and if required by the District TSM&O Program Engineers, for local agency projects.

The District TSM&O Program Engineers and PMs shall ensure projects that are underway, if modified during any stage of the project development, undergo the RITSA compliance and SE checks. As needed, PMs shall submit RITSA or SITSA change requests triggered by ITS projects to the CO TSM&O Program and District TSM&O Program Engineer(s) for their reviews and approvals.

PMs shall submit the *Project Risk Assessment and Regulatory Compliance Checklis*t (FDOT Form 750-040-05) for all federally funded projects and maintain this documentation in their project records. PMs shall submit the *Project Risk Assessment and Regulatory Compliance Checklis*t (FDOT Form 750-040-05) for state-funded projects, if required by the District TSM&O Program Engineers and maintain this documentation in their project records. For federally funded high-risk projects, PMs shall submit the *Systems Engineering Project Checklist* (FDOT Form 750-040-06), compile all minimum required documents specified in **Section 2.2**, and provide all documentation to the FHWA Florida Division (for full FHWA oversight projects), the District TSM&O Program Engineer, and the CO TSM&O Program. For state-funded high-risk projects, PMs shall submit the *Systems Engineering Project Checklist* (FDOT Form 750-040-06), compile all minimum required documents specified in **Section 2.2**, and provide all documentation to the District TSM&O Program Engineer and the CO TSM&O Program. For federally funded local agency projects with FDOT-delegated oversight, PMs shall submit the above documentation to the District's Local Programs Administrators for their reviews and approvals.

District's Local Programs Administrators
For local agency projects with FDOT-delegated oversight, the District's Local Programs Administrators shall coordinate the review of the SE documentation submitted for FDOT review and approval with the District TSM&O Program Engineers. This is to ensure that (a) federally funded projects initiated at the local agency are compliant with the RITSA, and (b) the SE process is used, if justified, employing the risk-assessment tools discussed in this procedure.

FHWA Florida Division
The FHWA Florida Division uses the Stewardship and Oversight Agreement, Section V, to delegate some local project oversight to FDOT for well-qualified local agencies. The FDOT, in turn, delegates some responsibilities to local agencies through the Local Agency Program. The FHWA, in cooperation with the CO TSM&O Program, performs annual assessments as prescribed in the agreement.

### 3.1.2 Roadway Projects with Intelligent Transportation Systems Components

The SE process is typically discussed with ITS deployment projects in mind. However, projects, such as roadway construction or maintenance projects with ITS components (for example, ITS devices such as adaptive or interconnected traffic signal systems, closed-circuit television cameras, or dynamic message signs), shall have, at a minimum, a SE analysis and use the SE process for the ITS components, if required, based on risk assessment (see Section 1.5) and as described in 23 CFR, Part 940.11.

District TSM&O Program Engineers and PMs (FDOT or Local Agencies)
For such projects, PMs shall recognize requirements in 23 CFR, Part 940.11 apply to federally funded projects containing ITS components. PMs shall work with the District TSM&O Program Engineers to ensure (a) the SE analysis is conducted for the ITS portion of the project, (b) the SE process is used for the same ITS portion, if justified, based on risk assessment (or if required by the District TSM&O Program Engineer, and (c) the ITS elements of the project are consistent with, and adhere to the RITSA on these projects.

District Local Programs Administrators
For federally funded local agency projects with FDOT-delegated oversight, the district's Local Programs Administrators shall coordinate the documentation review with the District TSM&O Program Engineers.

## 3.2 NON-PROJECT SPECIFIC ROLES

CO TSM&O Program
The CO TSM&O Program, in collaboration with the District TSM&O Program Engineers for their architecture region, should conduct periodic updates and exception maintenance of the RITSAs in accordance with 23 CFR, Part 940 (including final approval of all updates). The CO TSM&O Program should conduct periodic and exception maintenance of the SITSA in accordance with 23 CFR, Part 940.9 (including final approval of all updates). The CO TSM&O Program shall track all architecture (RITSAs or SITSA) change requests submitted by ITS stakeholders.

The CO TSM&O Program shall track the NITSA to identify changes that should be addressed in the SITSA and RITSAs. Any needed updates to the SITSA and RITSAs shall be addressed as periodic or exception maintenance, depending on the scope and impact of the NITSA change.

The CO TSM&O Program may also propose changes to the NITSA using the contact form and process available through the NITSA website:

https://www.its.dot.gov/research_archives/arch/

The CO TSM&O Program shall ensure that the ITS and TSM&O strategic plans and the SITSA and RITSAs are in agreement with each other and shall work with the District

TSM&O Program Engineers, MPOs, and transportation planning organizations (TPO) to ensure that the ITS and TSM&O strategic plans are consistent with the LRTPs.

The CO TSM&O Program shall offer guidance and training in SE and ITS architecture as requested by the District TSM&O Program Engineers. The CO TSM&O Program shall, as needed, coordinate with the districts and discuss ways to better assist the districts in promoting SE and ITS architecture within the districts and local agencies.

<u>District TSM&O Program Engineers</u>

The District TSM&O Program Engineers for their architecture region, in collaboration with the CO TSM&O Program, should conduct periodic updates and exception maintenance of the RITSAs in accordance with 23 CFR, Part 940.9 (including final approval of all updates).

The District TSM&O Program Engineers shall work with the district's Planning Office, MPOs, TPOs, and local agencies in their region on using the RITSA (located at [https://www.fdot.gov/traffic/ITS/Projects-Arch/SITSA.shtm](https://www.fdot.gov/traffic/ITS/Projects-Arch/SITSA.shtm)).

The District TSM&O Program Engineers shall work with the CO TSM&O Program and FHWA Florida Division for training materials or guidance on specific deployment scenarios.

The District TSM&O Program Engineers shall work with MPOs and TPOs as the MPOs and TPOs conduct high-level screening of all ITS projects in the LRTPs, Statewide Transportation Improvement Program, and Transportation Improvement Programs (TIP) for compatibility with the ITS architecture. The District TSM&O Program Engineers, in coordination with the MPOs and TPOs, shall determine whether the ITS architecture requirements are being met in their region.

<u>FHWA Florida Division</u>

The FHWA Florida Division, in coordination with the CO TSM&O Program, plans to perform annual RITSA reviews and, when requested, offer guidance and training to local agencies and districts regarding SE and ITS architecture.

<u>Local Agencies</u>

Local agencies shall work with the District TSM&O Program Engineers to ensure that the local systems are consistent with the RITSA and that they have a working knowledge of SE and ITS architecture. If guidance is needed, the local agencies shall coordinate with their District TSM&O Program Engineers.

As necessary, local agencies shall forward requested RITSA updates to the District TSM&O Program Engineers and CO TSM&O Program using the *ITS Architecture Change Request Form* (FDOT Form 750-040-04). Local agencies are also encouraged to participate in architecture stakeholder workshops to ensure their requested updates are included in periodic (every five years) RITSA updates.

<u>MPOs and TPOs</u>

The MPOs are responsible for ensuring that the RITSA is consistent with their LRTP and TIP, in accordance with 23 CFR, Part 450.306(g). 23 CFR, Part 450.306(g) 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.*"

## TRAINING

Training on this procedure is required.

## FORMS

The following forms are available in the FDOT's Forms library:

FDOT Form 750-040-06 Systems Engineering Project Checklist
FDOT Form 750-040-05 Project Risk Assessment and Regulatory Compliance Checklist
FDOT Form 750-040-04 ITS Architecture Change Request Form