

2015 Design Training Expo

Systems Engineering Process

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Celebrating 100 Years of Innovation, Mobility and Economic Development

Contents

- Federal regulations for ITS projects
- Overview of systems engineering (SE)
- Application of SE process to projects
- FDOT policy/procedural requirements for use of SE
- Roles and responsibilities of stakeholders
- Future steps



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Federal Regulations (FHWA)

23 CFR 940.11 “Project Implementation” requires:

- 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.

ITS project (per 23 CFR 940.3) means any project that **in whole or in part** funds the acquisition of technologies (or systems of technologies) that provide or significantly contribute to the provision of one or more ITS user services as defined in the National ITS Architecture.



Federal Regulations (FHWA) (Cont.)

23 CFR 940.11 “Project Implementation” requires:

- c) Any major ITS project funded with highway trust funds that advances to final design shall have a project level ITS architecture that is coordinated with the development of the regional ITS architecture.
- d) The project level ITS architecture shall be based on the results of the systems engineering analysis.

Major ITS project (per 23 CFR 940.3) means any ITS project that implements **part of** a regional ITS initiative that is multi-jurisdictional, multi-modal, or otherwise affects regional integration of ITS.



Federal Regulations (FHWA) (Cont.)

23 CFR 940.13 “Project Administration” requires:

- e) Prior to authorization of highway trust funds for construction or implementation of ITS projects, compliance with §940.11 shall be demonstrated.
- f) Compliance will be monitored under federal-aid oversight procedures.
 - Each FHWA Division Office works with state and local partners to establish these procedures.



23 CFR 940.11(c) Defines Seven Minimum “systems engineering analysis” Items

1. Regional ITS architecture
2. Stakeholders’ roles and responsibilities
3. Requirements
4. Alternative system configurations and technology
5. Procurement
6. ITS standards and testing
7. Operations and management of the system



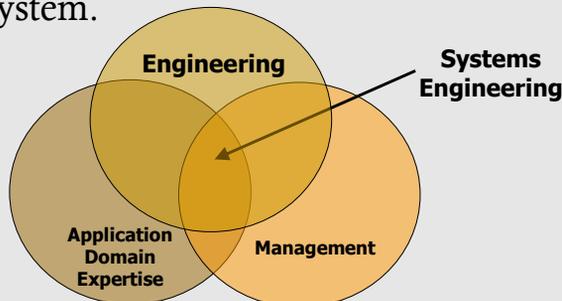
23 CFR 940.11(e) Defines Five “project level ITS architecture” Items

1. Project scope
2. Operational concept
3. Functional requirements
4. Interface requirements and information exchanges
5. ITS standards



What is Systems Engineering (SE)?

An *inter-disciplinary approach* and means to enable the realization of successful systems... A *structured process* for arriving at a final design of a system.



System means a combination of interacting elements organized to achieve one or more stated purposes.



What are the SE Principles?

- Start with your eye on the finish line
- Involve stakeholders
- Define the problem before implementing the solution
- Delay technology choices
- Divide and conquer
- Connect the dots – traceability

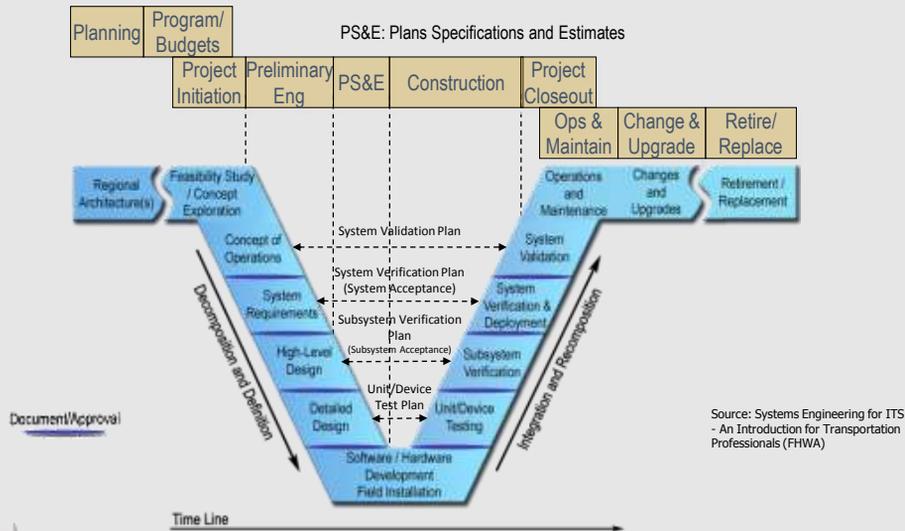


What are the Benefits of Using SE?

- Reduced risk of schedule and cost overruns
- Users' needs met
- Improved stakeholder participation
- More adaptable and resilient systems
- Verified functionality and fewer defects
- Higher level of reuse from one project to the next
- Better documentation



Traditional Road Project Process and the SE “V”



Using the Regional ITS Architecture



• Key activities:

- Identify relevant regional ITS architecture(s)
- Identify portions of regional ITS architecture that the project will implement*
- Identify stakeholders' roles and responsibilities*
- Identify functional requirements*
- Identify interfaces requirements and information exchanges*
- Identify ITS standards*
- Verify project is consistent with regional ITS architecture
- Identify any necessary changes to regional ITS architecture

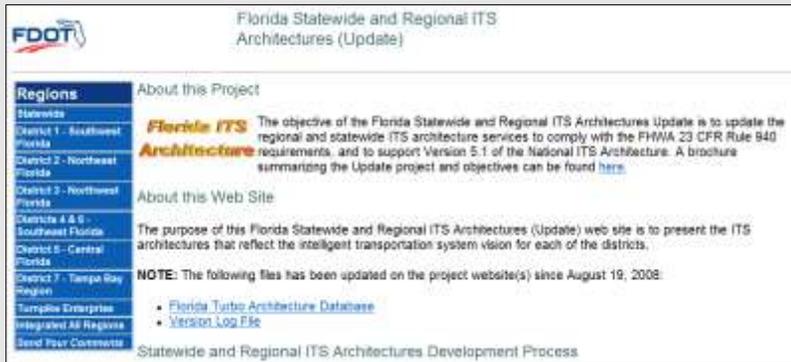
*Denotes FHWA requirement



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Where are the Regional ITS Architectures?

<http://www.consystec.com/florida/default.htm>



FDOT Florida Statewide and Regional ITS Architectures (Update)

Regions

- Statewide
- District 1 - Southwest Florida
- District 2 - Northwest Florida
- District 3 - Northwest Florida
- Districts 4 & 5 - Southeast Florida
- District 6 - Central Florida
- District 7 - Tampa Bay Region
- Turnpike Enterprise
- Integrated All Regions
- Send Your Comments

About this Project

Florida ITS Architecture The objective of the Florida Statewide and Regional ITS Architectures Update is to update the regional and statewide ITS architecture services to comply with the FHWA 23 CFR Rule 940 requirements, and to support Version 5.1 of the National ITS Architecture. A brochure summarizing the Update project and objectives can be found [here](#).

About this Web Site

The purpose of this Florida Statewide and Regional ITS Architectures (Update) web site is to present the ITS architectures that reflect the intelligent transportation system vision for each of the districts.

NOTE: The following files has been updated on the project website(s) since August 19, 2008:

- Florida Turbo Architecture Database
- Version Log File

Statewide and Regional ITS Architectures Development Process



Is My Project in the Regional ITS Architecture?



FDOT FDOT District 1 Regional ITS Architecture (Final)

State Home FDOT D1 Home Stakeholders Inventory Services Architectures Projects Resources Feedback

Projects by Stakeholder

PROJECTS BY STAKEHOLDER

[Printable Version](#)

The following are a list of ITS projects that have been identified for the region. This list was created from an analysis of the existing Transp (TIP) for the region and from discussions with the stakeholders. Projects are listed by stakeholder (agency).



Concept of Operations



- The ConOps defines:
 - Who: Stakeholder roles and responsibilities
 - What: Stakeholder needs, system elements, and high-level capabilities
 - Where: Geographic and physical extent
 - When: Sequence of activities performed
 - How: Development, operations, and maintenance of the system



Concept of Operations (Cont.)



- Key activities:
 - Identify stakeholders
 - Define core group responsible for creating ConOps
 - Develop initial ConOps, review with broader stakeholder group, and iterate
 - Define stakeholder needs
 - Create a System Validation Plan



System Requirements



- Key activities:
 - Elicit, analyze, document, validate, and manage Requirements
 - Create a System Verification Plan that assures testing, demonstration, inspection, and analysis in relation to each requirement
 - Create a System Acceptance Plan that describes the functionality the system must display prior to customer acceptance

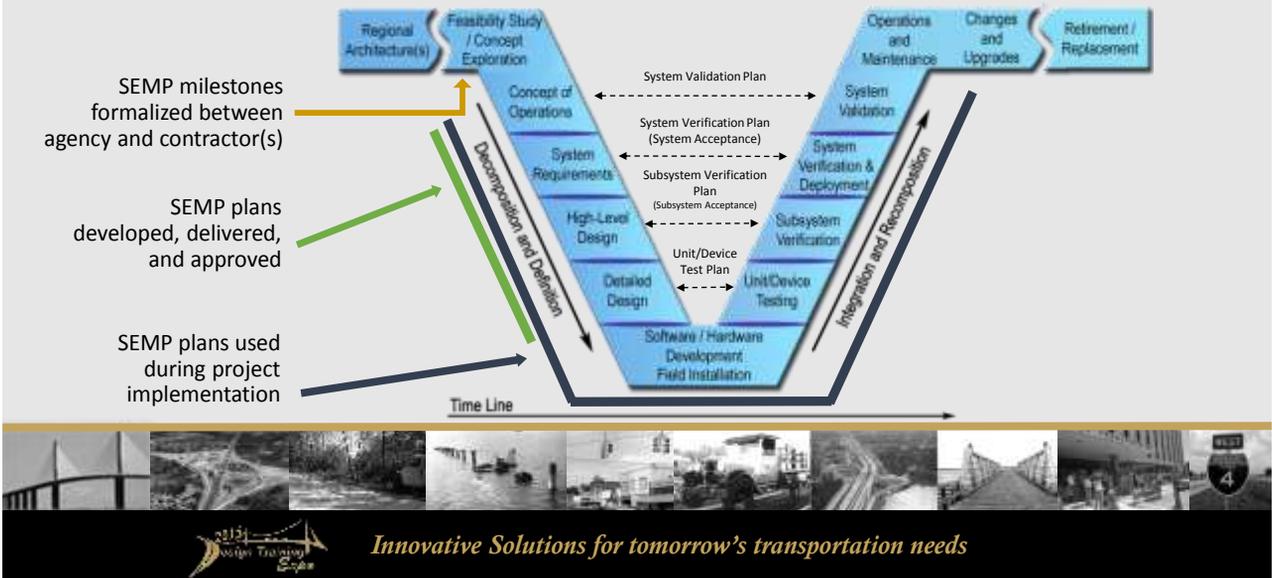


How is SE Applied to a Project?

- Project Systems Engineering Management Plan (PSEMP):
 - Documents how the technical development will be managed and what needs to be documented
 - Details how the SE process will be tailored and development will be conducted
 - Explains how the process activities will be brought together

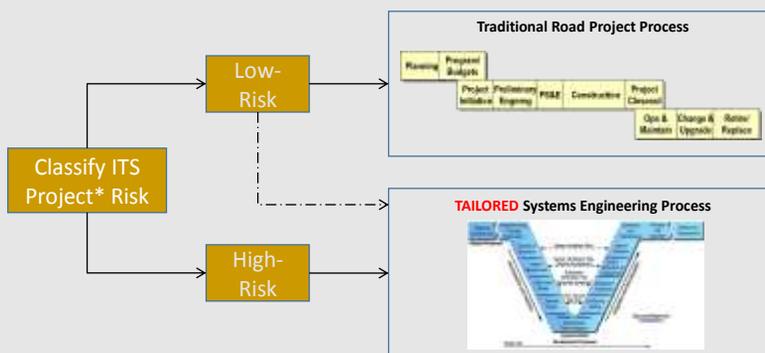


How is SE Applied to a Project? (Cont.)



FDOT Policy/Procedure for SE

Systems Engineering and ITS Architecture Procedure (FDOT ID# 750-040-003-c) requires:



* Project funded with highway trust funds and project risk evaluated for ITS component(s) ONLY



FDOT Policy/Procedure for SE (Cont.)

Required for all ITS projects funded with highway trust funds to classify risk and address SE analysis items



Project Risk Assessment and Regulatory Compliance Checklist
 Submit completed form electronically to the FHWA Florida Division ITS Engineer, FDOT District Engineer and FDOT Central Office ITS Coordinator (tywendarch@fdot.state.fl.us), as required

PROJECT RISK ASSESSMENT AND REGULATORY COMPLIANCE CHECKLIST
 (To Be Completed By Project Manager and Required for all Federally Funded ITS Projects)

SECTION 1 – Project Information:

1.1 Submittal date: _____ 1.2 Agency: _____
 1.3 Agency Project Manager's name, phone and e-mail: _____
 1.4 Project title, description and location: _____

1.5 Nature of work:
 Software development ITS implementation Traditional construction with ITS
 Operations Maintenance (Equipment replacement) Other
 If Other, explain: _____

1.6 Questions:
(Indicate Yes or No for each question. If you are unsure about a question, no response, if an "Yes" are selected, this is a probability indicator of a Low-Risk project. If there is even one "No" selected, the project is high-risk. Use Table 1: Risk Assessment for Intelligent Transportation System (ITS) Projects within the procedure for additional details regarding risk levels.)

	Yes	No
a. Will the project depend on only your agency to implement and operate?	<input type="checkbox"/>	<input type="checkbox"/>
b. Will the project use only software proven elsewhere, with no new software writing or no software at all?	<input type="checkbox"/>	<input type="checkbox"/>



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Seven Project Risk Attributes

	Low-Risk Attributes
1	Single jurisdiction and single transportation mode (highway, transit, or rail)
2	No software creation; uses COTS or proven software
3	Proven COTS hardware and communications technology
4	No new interfaces
5	System requirements fully detailed in writing
6	Operating procedures fully detailed in writing
7	None of the technologies used are near end-of-service life

COTS: Commercial off-the-shelf



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Seven Project Risk Attributes (Cont.)

	High-Risk Attributes
1	Multi-jurisdictional or multi-modal
2	Custom software development required
3	Hardware or communications technology "cutting edge" or not in common use
4	New interfaces to other systems required
5	System requirements not detailed or not fully documented
6	Operating procedures not detailed or not fully documented
7	Some technologies included near end-of-service life



FDOT Policy/Procedure for SE (Cont.)

Required for all ITS projects funded with highway trust funds classified as high-risk



Systems Engineering Project Checklist
Submit completed checklist electronically to the FHWA Florida Division (ES_Enginesr@fdot.state.fl.us), FDOT District ITS Engineer, and FDOT Central Office ITS Coordinator (gsandarc@dot.state.fl.us), as required.

SYSTEMS ENGINEERING PROJECT CHECKLIST
(To Be Completed by Project Manager and Required for Federally Funded High-Risk ITS Projects)

SECTION 1 – Project Information

1.1 Submittal date: _____ 1.2 Agency: _____
1.3 Agency Project Manager's name, phone and e-mail: _____

1.4 Project title, description and location: _____

1.5 Is there a project plan with task breakdown?
 No Yes
If "Yes" was selected, please provide document. If "No" was selected, please specify reason: _____

SECTION 2 – Systems Engineering Management Plan

2.1 Is there a Project Systems Engineering Management Plan (P-SEMP)?
 Yes
Please provide required document (as specified in FDOT procedure 750.040.003).

SECTION 3 – Architecture Assessment

3.1 Portions of architecture(s) implemented by project:
 Statewide District 1 District 2 District 3 Districts 4 & 6 District 5
 District 7 Florida's Turnpike Enterprise None

3.2 Is the project included in the architecture?
 No Yes
If "Yes" was selected, please provide the corresponding service package diagram and as needed, include revisions to diagram. If "No" was selected, please specify reason: _____

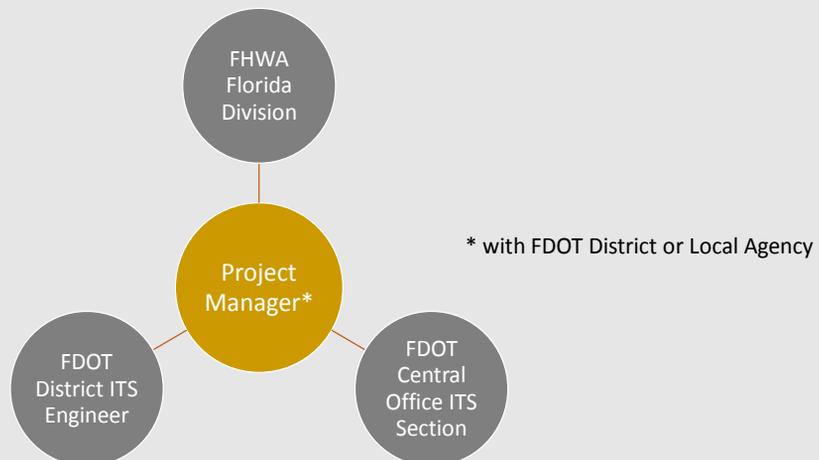


Eleven Items of the Systems Engineering Project Checklist

- | | |
|--|--------------------------------------|
| 1. Project information | 7. High level and detailed design |
| 2. Systems engineering management plan | 8. Implementation |
| 3. Architecture assessment | 9. Integration and verification |
| 4. Alternative analysis | 10. System validation and acceptance |
| 5. Concept of operations | 11. Operations and maintenance |
| 6. Requirements definitions | |



Stakeholders Identified in FDOT Policy/Procedure for SE



Roles and Responsibilities for ITS Projects Funded with Highway Trust Funds and FHWA Oversight

Role	Action
Project Manager (PM)	<ul style="list-style-type: none"> <input type="checkbox"/> Complete Project Risk Assessment and Regulatory Compliance Checklist <input type="checkbox"/> Complete Systems Engineering Project Checklist¹ <input type="checkbox"/> Include tailored Systems Engineering Documents¹ <input type="checkbox"/> Coordinate extent of oversight with District ITS Engineer and FHWA Florida Division <input type="checkbox"/> Submit all documentation to FHWA Florida Division and Central Office ITS Section

¹for projects classified as high-risk



Roles and Responsibilities for ITS Projects Funded with Highway Trust Funds and FHWA Oversight (Cont.)

Role	Action
District ITS Engineer	<input type="checkbox"/> Provide assistance to PM for ensuring compliance with FDOT policy/procedure
FHWA Florida Division	<input type="checkbox"/> Review and approve documentation (for FHWA oversight projects ONLY)
Central Office ITS Section	<input type="checkbox"/> Provide clarification on FDOT policy/procedure for use on projects



Project Example



- A new state road is proposed for construction in Florida. The project will also include deployment of six CCTV cameras. It will be partially funded with highway trust funds and cameras will require new interfaces to other systems. The project manager is from the Construction Office.
- What would you do as a project manager?



Project Example (Cont.)



- Does the project meet the federal definition of an ITS project? **Yes**
- Is it funded with highway trust funds? **Yes**
- Does 23 CFR 940 apply? **Yes**
- Is it a high- or low-risk project? **High-risk**
- Why is it a high-risk project? **New interfaces**
- Who is responsible for developing the SE documentation? **Project manager**
- Which SE documentation needs to be developed?



Future Steps

- Outreach and coordination of document updates through multiple FDOT offices

Document Title	Document Owner
Project Management Handbook	Production Support Office
Local Agency Program Manual	Production Support Office
Plans Preparation Manual	Roadway Design Office
Construction Project Administration Manual	Construction Office



Resources

Statewide and Regional ITS Architectures:

http://www.dot.state.fl.us/trafficoperations/ITS/Projects_Arch/SITSA.shtm

Systems Engineering and ITS Architecture Procedure (750-040-003-c)*:

<http://www.dot.state.fl.us/proceduraldocuments/procedures.shtm>

* Not yet posted

Project Risk Assessment and Regulatory Compliance Checklist, and Systems Engineering Project Checklist*:

<http://www.dot.state.fl.us/proceduraldocuments/forms.shtm>

Systems Engineering for ITS – An Introduction for Transportation Professionals (FHWA):

<http://ops.fhwa.dot.gov/publications/seitsguide/seguide.pdf>



Contacts

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QUESTIONS AND ANSWERS

