



# Memorandum

Subject: **INFORMATION**: Systems Engineering  
for ITS Projects

Date: JUL 7 2022

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In Reply Refer To:  
HOTM-1

To: Directors of Field Services  
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This memorandum implements section 11304 of the Bipartisan Infrastructure Law (BIL), enacted as the Infrastructure Investment and Jobs Act (Public Law 117-58), which directs the Secretary of Transportation to develop guidance for using existing flexibilities with respect to Systems Engineering Analyses described in 23 CFR part 940.<sup>1</sup> Except for the statutes and regulations cited within, the contents of this memorandum do not have the force and effect of law and are not meant to bind the public in any way. This memorandum is provided for information and does not represent a change in policy.

States are leading the way in developing best practices for implementing systems engineering to support intelligent transportation system (ITS) projects.<sup>2</sup> To implement section 11304 of the BIL and respond to recent questions from some State departments of transportation, FHWA is restating the importance of undertaking systems engineering that reduces risk and improves project outcomes with a level of effort appropriately scaled to the risk posed by the project. We encourage Division Offices to seek out processes tailored to the risks imposed by projects as demonstrated by the examples below. The goal is to avoid unnecessary burden on State and local governments, prevent unintentionally imposing requirements exceeding those outlined in law and regulation, and enhance the necessary engagement and collaboration between division staff and their counterparts in State and local agencies with respect to ITS projects.

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<sup>1</sup> Section 11304 further directs the Secretary to ensure that this guidance (1) clearly identifies criteria for low-risk and exempt intelligent transportation systems projects, with a goal of minimizing unnecessary delay or paperwork burden; (2) is consistently implemented by the Department nationwide; and (3) is disseminated to Federal-aid recipients.

<sup>2</sup> An ITS project is defined in 23 CFR 940.3 as “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.”

Systems engineering provides a needs-focused, requirements-driven engineering process for ensuring that projects involving technologies used for intelligent transportation management meet the needs and the expectations of the agencies undertaking them. It is also used to demonstrate that projects are consistent with any applicable regional ITS architecture to ensure that they maintain interoperability in accordance with the stated needs and objectives of their stakeholder agencies.

Under 23 CFR 940.13, Division Offices (or States that have signed a Stewardship and Oversight Agreement) provide oversight of ITS projects. Oversight of ITS projects includes ensuring that compliance with the requirements in 23 CFR 940.11 is demonstrated. Projects that do not fund the acquisition of technologies that provide or contribute to the provision of ITS user services do not fall within the definition of an ITS project in 23 CFR 940.3 and, therefore, are not subject to these requirements. Examples of such projects include construction of traffic signals that are not expected to be part of a coordinated system of traffic signals, upgrades to existing signals, signal timing and other operational studies, operations and ITS feasibility and planning studies, and routine operations.

While systems engineering comprises a broad spectrum of proven engineering practices that take a variety of forms, 23 CFR 940.11 requires only the provision of a Systems Engineering Analysis that includes the seven attributes outlined in 23 CFR 940.11(c):

- (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.*

The analysis should be proportional to the scope and complexity of the project.

A regional ITS architecture, which is discussed in 23 CFR 940.9, can be described as a database of ITS technologies and systems, the interfaces and data that flow between them, the roles and responsibilities of their operating agencies, the requirements those systems will fulfill, and the goals and objectives that those systems help regional stakeholders to attain. Importantly, the regional ITS architecture is an outgrowth of an operations planning process, as identified in 23 CFR 940.9(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.** [emphasis added]*

The Systems Engineering Analysis, therefore, connects an implementation project to a program of operational improvements that deploy ITS over the horizon of applicable transportation plans. Systems engineering stands on a foundation of operations planning.

Most ITS projects that deploy conventional ITS technologies in support of existing operational activities pose lower risk than projects deploying innovative technologies in support of operational activities new to the agency undertaking them. A low-risk project has the following characteristics:

- Experienced users who understand the application of the technology being implemented.
- Clear and sufficiently detailed documentation of the agency's activities, needs, and requirements that are applicable to the proposed work.
- No new agencies, jurisdictions, or modes that may require additional documentation of their activities and needs beyond what is already identified in existing documentation.
- No new software being developed.
- No new interfaces between systems not previously in use.
- Use of technologies already shown to fulfill documented requirements.
- Use of technology products that are not at the end of their service life such that their use would shorten the project lifecycle.

For low-risk projects, the required attributes of a Systems Engineering Analysis provided in 23 CFR 940.11 can be addressed using existing, reused, or pre-drafted documentation. For these low-risk projects, State and local transportation agencies have demonstrated several different approaches for conducting systems engineering at an appropriate level of detail to minimize risk without unnecessarily developing systems engineering products from scratch, and without the need to hire a systems engineering consultant. These approaches can include:

- 1) Categorical Systems Engineering. For example, Minnesota Department of Transportation (DOT) devised a risk-based approach that provides pre-drafted systems engineering documents for common lower-risk categories of projects. These pre-drafted documents can be used as supporting documentation that provides complete and correct descriptions of needs and requirements for the projects within the category. (See <https://www.dot.state.mn.us/its/systemsengineering.html>). Ohio DOT similarly identified specific types of projects that would be given defined systems engineering treatment. (See the Ohio DOT Traffic Engineering Manual, Part 13 Intelligent Transportation Systems (Section 1300 (ITS), Subsection 1301-3.2)): [http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/TEM/Documents/Part\\_13\\_Complete\\_011714Revision\\_011614\\_bookmarked.pdf](http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/TEM/Documents/Part_13_Complete_011714Revision_011614_bookmarked.pdf)).
- 2) Extensions of existing systems, for which systems engineering documents already exist. For example, California Department of Transportation (Caltrans) assesses risk for projects in this category based on the existence of the elements of a Systems Engineering Analysis already in place that can be used for the project in question.

- (See the Caltrans Local Assistance Program Guidelines, Chapter 13 Intelligent Transportation Systems (ITS) Program (pages 1 – 19): <https://dot.ca.gov/-/media/dot-media/programs/local-assistance/documents/lapg/g13.pdf>).
- 3) Extracting Systems Engineering Analysis elements from current and appropriately updated regional ITS architectures. A well-maintained regional ITS architecture developed in accordance with 23 CFR 940.9 includes roles, objectives, and requirements at the planning level. A project architecture includes these elements extracted from the regional architecture. These elements can be used to support a Systems Engineering Analysis.
  - 4) The use of Model Systems Engineering Documents. A number of State and local agencies successfully employed the Model Systems Engineering Documents for Adaptive Control Signal Technologies developed by FHWA as part of Every Day Counts (Round 1). The success of these applications led to the expansion of the library of Model Systems Engineering Documents to include the following:
    - a) Traffic Signal Systems (incorporates and supersedes Adaptive Control Signal Technologies): <https://ops.fhwa.dot.gov/publications/fhwahop19019/index.htm>
    - b) Dynamic Message Signs: <https://ops.fhwa.dot.gov/publications/fhwahop18080/index.htm>
    - c) Closed-Circuit Television: <https://ops.fhwa.dot.gov/publications/fhwahop18060/index.htm>
    - d) Transportation Sensor and Detection Systems: (forthcoming)

These documents provide pre-drafted needs and requirements from which agencies may extract the relevant portions related to their project. Projects that use more than one of these technologies may combine the needs and requirements extracted from these model documents.

Some ITS projects, such as projects that lack a clear and documented understanding of the requirements they must fulfill, or the needs they must satisfy, demonstrate higher risk. In some cases, these projects may involve technologies approaching obsolescence or technologies not previously tested. In addition, projects that will develop new software or interfaces not previously in use pose greater risk. The degree of agency familiarity with a technology or operational activity also influences risk. For higher-risk projects, implementing agencies should consider the development of new systems engineering documentation as needed to provide the attributes required to support a Systems Engineering Analysis per 23 CFR 940.11.

Many States use a Systems Engineering Review Form (or similar document) to assess the risk of the project as the basis for identifying the systems engineering steps appropriate to mitigate those risks (for example, see the New Jersey DOT TSM Procedures Manual at page 12:

<https://www.state.nj.us/transportation/eng/elec/ITS/pdf/TSMProceduresManual.pdf>). If that review reveals gaps in the required systems engineering documentation, a plan for filling those gaps may be embodied in a Systems Engineering Management Plan (SEMP) or similar document (see Caltrans Local Assistance Program Guide at Chapter 13 page 2: <https://dot.ca.gov/-/media/dot-media/programs/local-assistance/documents/lapg/g13.pdf>).

The SEMP can be the basis for demonstrating compliance with 23 CFR 940.11, as required under 23 CFR 940.13(a).

In cases where agencies identify a need for more detailed systems engineering, we can refer them to reference materials such as those listed in the Systems Engineering Guidebook for Intelligent Transportation Systems (<https://www.fhwa.dot.gov/cadiv/segb/>; in revision) and general systems engineering literature.

In summary, we encourage division staff to engage and collaborate with stakeholders in State and local agencies to tailor processes to address risk without unnecessary burden, support outcomes that advance State capabilities, and avoid unintentionally imposing requirements exceeding those in law and regulation.

Division Administrators are encouraged to engage FHWA program offices and the Resource Center as needed for assistance in tailoring the scope of requirements for systems engineering, to provide needed training and technical assistance for their staff, and to provide training and technical assistance for State and local agencies. Technical assistance is available as part of the Architecture Deployment Support Program and from the Resource Center Operations Team. More information is also available at: [https://ops.fhwa.dot.gov/int\\_its\\_deployment/sys\\_eng.htm](https://ops.fhwa.dot.gov/int_its_deployment/sys_eng.htm).

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