Procedures for Implementing HPDP ITS Systems Engineering Requirement
A Quick Reference Guide

Purpose

Federal law (23 CFR 940, known as "Rule 940") requires public agencies to demonstrate that systems engineering analysis is performed on projects containing intelligent transportation systems (ITS). Systems engineering is an organized approach to developing and implementing successful ITS technologies. It considers both the business and technical needs of all customers with the goal of providing a quality product that meets the user needs while reducing risk and errors in developing complex projects.

MnDOT has developed procedures to ensure Rule 940 is implemented on applicable projects. Rule 940 requires that all ITS systems or components be developed based on a systems engineering process, and the systems engineering analysis should be on a scale commensurate with the project scope.

The purpose of this guide is to provide step-by-step instructions on how to implement the procedures for ITS projects or projects with ITS components to ensure Rule 940 compliance. The procedures are applicable to the following:

- All ITS projects funded (in whole or in part) with the highway trust fund (including National Highway System (NHS) and non-NHS facilities); and
- All State funded ITS projects in which ITS component(s) will be connected/integrated to another ITS component, project or system.

Useful References

- HPDP ITS Systems Engineering Requirement (https://edocs-public.dot.state.mn.us/edocs_public/DMResultSet/download?docId=1598710)
- ITS Implementation – Project Classification and Systems Engineering Requirement Decision Tree (https://www.dot.state.mn.us/its/docs/decisiontree.pdf)
- FHWA ITS Implementation Memo (http://www.dot.state.mn.us/its/docs/fhwaimplementationmemo.pdf)
- MnDOT ITS Systems Engineering Website (http://www.dot.state.mn.us/its/systemsengineering.html)

Stage I: Project Scoping

The primary purpose of project scoping is to identify the resources required to develop and implement a project. During the scoping process, use the HPDP ITS Systems Engineering Requirement and the ITS Implementation – Project Classification and Systems Engineering Requirement Decision Tree to complete the following steps:

Step 1: Identify ITS applications for your project. Refer to the HPDP ITS Systems Engineering Requirement and the Decision Tree for a list of common ITS applications.

Step 2: Request for Internal ITS Design Shared Services. MnDOT Districts shall request assistance from RTMC for ITS project design. The assistance should be requested as early as possible during project scoping. Requests less than twelve (12) months may impact RTMC (or to secure a consultant under contract) to perform work in a timely manner to meet the proposed project letting date. Please refer to the Process Guidance for Internal ITS Design Shared Services (http://ihub/trafficeng/resources.html) and complete the request form.

Step 3: Determine Project Class. Use the project ITS applications along with the HPDP ITS Systems Engineering Requirement and the Decision Tree as a guide to determine the appropriate ITS Class(es) for your project.

Step 4: Identify systems engineering analysis and documentation development required for your project. Use the HPDP ITS Systems Engineering Requirement and the Decision Tree to identify the systems engineering documents that need to be developed for the project.

Step 5: Include cost estimates for systems engineering analysis and documentation during project scoping. Determine and include cost estimates needed for the development of the required systems engineering documents.

Stage II: Project Development and Implementation

Once the project has been programmed into the STIP and during project development and implementation, complete the following steps to ensure compliance with Rule 940 and eligibility for federal and state funding. Please note that this may be an iterative process based on project information available.

Step 1: Review HPDP ITS Systems Engineering Requirement to understand the purpose and requirements, as well as, your roles and responsibility for ITS implementation of your project. Key requirements include:

- Coordination and consistency check with the Minnesota Statewide Regional ITS Architecture
- Systems engineering process, analysis and outputs
- ITS standards for interoperability
- Your roles and responsibilities as a project manager for implementing Rule 940 on ITS projects

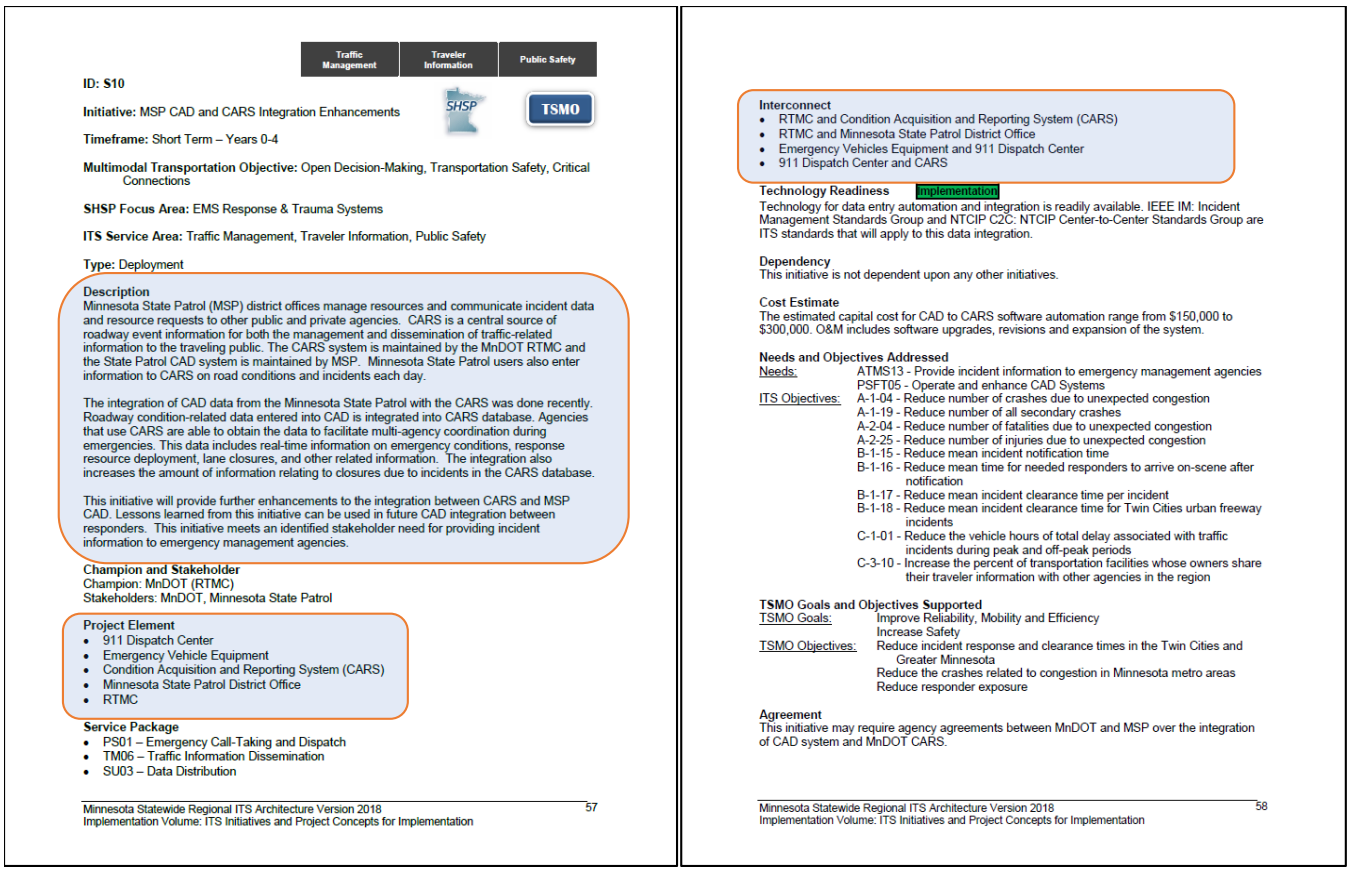
Step 2: Identify ITS applications of your projects. Use the HPDP ITS Systems Engineering Requirement and the Decision Tree as references to identify the ITS applications in your project.

Step 3: Determine the ITS class of your project. Once the ITS applications are identified, use the HPDP ITS Systems Engineering Requirement and the Decision Tree to determine the appropriate class for your project. For Minnesota, ITS projects or projects with an ITS component are divided into five classes:

- Class A-1 and Class A-2: Programmatic ITS Applications
- Class B-1: Freeway Traffic Management Applications
- Class B-2: Arterial Traffic Management Applications
- Class C: Large Scale/Complex ITS Projects

Step 4: Identify and verify your project is consistent with the Minnesota Statewide ITS Architecture.

1) Identify and verify if your project is included in the Minnesota Statewide ITS Architecture (http://www.dot.state.mn.us/its/projects/2016-2020/itsarchitecture.html). See **Implementation Volume** of the Minnesota Statewide Regional ITS Architecture (http://www.dot.state.mn.us/its/projects/2016-2020/itsarchitecture/implementation-volume.pdf) for a complete list of ITS projects.
    - Use Table 2 or Table 3 as a filter to identify a project concept that aligns with your project.
    - Review the project concept identified above. Verify your project is consistent with the project concept in the architecture. A sample of a project concept write-up is illustrated on the next page. Pay particular attention to three areas in your review and verification: description, project element, and interconnect. The three areas are circled in red in the example.



Traffic Management | Traveler Information | Public Safety

ID: S10

Initiative: MSP CAD and CARS Integration Enhancements

Timeframe: Short Term – Years 0-4

Multimodal Transportation Objective: Open Decision-Making, Transportation Safety, Critical Connections

SHSP Focus Area: EMS Response & Trauma Systems

ITS Service Area: Traffic Management, Traveler Information, Public Safety

Type: Deployment

Description
Minnesota State Patrol (MSP) district offices manage resources and communicate incident data and resource requests to other public and private agencies. CARS is a central source of roadway event information for both the management and dissemination of traffic-related information to the traveling public. The CARS system is maintained by the MnDOT RTMC and the State Patrol CAD system is maintained by MSP. Minnesota State Patrol users also enter information to CARS on road conditions and incidents each day.

The integration of CAD data from the Minnesota State Patrol with the CARS was done recently. Roadway condition-related data entered into CAD is integrated into CARS database. Agencies that use CARS are able to obtain the data to facilitate multi-agency coordination during emergencies. This data includes real-time information on emergency conditions, response resource deployment, lane closures, and other related information. The integration also increases the amount of information relating to closures due to incidents in the CARS database.

This initiative will provide further enhancements to the integration between CARS and MSP CAD. Lessons learned from this initiative can be used in future CAD integration between responders. This initiative meets an identified stakeholder need for providing incident information to emergency management agencies.

Champion and Stakeholder
Champion: MnDOT (RTMC)
Stakeholders: MnDOT, Minnesota State Patrol

Project Element
- 911 Dispatch Center
- Emergency Vehicle Equipment
- Condition Acquisition and Reporting System (CARS)
- Minnesota State Patrol District Office
- RTMC

Service Package
- PS01 – Emergency Call-Taking and Dispatch
- TM06 – Traffic Information Dissemination
- SU03 – Data Distribution

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Interconnect
- RTMC and Condition Acquisition and Reporting System (CARS)
- RTMC and Minnesota State Patrol District Office
- Emergency Vehicles Equipment and 911 Dispatch Center
- 911 Dispatch Center and CARS

Technology Readiness Implementation
Technology for data entry automation and integration is readily available. IEEE IM: Incident Management Standards Group and NTCIP C2C: NTCIP Center-to-Center Standards Group are ITS standards that will apply to this data integration.

Dependency
This initiative is not dependent upon any other initiatives.

Cost Estimate
The estimated capital cost for CAD to CARS software automation range from $150,000 to $300,000. O&M includes software upgrades, revisions and expansion of the system.

Needs and Objectives Addressed
Needs: ATMS13 - Provide incident information to emergency management agencies
PSFT05 - Operate and enhance CAD Systems
ITS Objectives: A-1-04 - Reduce number of crashes due to unexpected congestion
A-1-19 - Reduce number of all secondary crashes
A-2-04 - Reduce number of fatalities due to unexpected congestion
A-2-25 - Reduce number of injuries due to unexpected congestion
B-1-15 - Reduce mean incident notification time
B-1-16 - Reduce mean time for needed responders to arrive on-scene after notification
B-1-17 - Reduce mean incident clearance time per incident
B-1-18 - Reduce mean incident clearance time for Twin Cities urban freeway incidents
C-1-01 - Reduce the vehicle hours of total delay associated with traffic incidents during peak and off-peak periods
C-3-10 - Increase the percent of transportation facilities whose owners share their traveler information with other agencies in the region

TSMO Goals and Objectives Supported
TSMO Goals: Improve Reliability, Mobility and Efficiency
Increase Safety
TSMO Objectives: Reduce incident response and clearance times in the Twin Cities and Greater Minnesota
Reduce the crashes related to congestion in Minnesota metro areas
Reduce responder exposure

Agreement
This initiative may require agency agreements between MnDOT and MSP over the integration of CAD system and MnDOT CARS.

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2) If the project is included in the architecture and is consistent with the project concept, proceed with **Step 5**.
3) If the project is included in the architecture, but the current project concept in the architecture is not completely consistent with the proposed project, then a revision or update will be required for inclusion. Contact and submit request via email to Rashmi Brewer (Rashmi.Brewer@state.mn.us) of MnDOT Office of Connected & Automated Vehicles (CAV-X) to update the architecture.
4) If the Minnesota Statewide Regional ITS Architecture does not contain your project, create a project-level architecture and contact Rashmi Brewer (Rashmi.Brewer@state.mn.us) of MnDOT Office of CAV-X for guidance and assistance.

Step 5: Determine systems engineering analysis and documentation needs. Use the Decision Tree to determine the ITS class of your project, then identify and verity the systems engineering documentation needs.

1) If your project belongs to **Class A-1 or A-2 Programmatic ITS Applications:**
   - For **Class A-1 applications**, visit the ITS Implementation for CAV Readiness web page at http://www.dot.state.mn.us/its/projects/2016-2020/cavreadiness.html. Review the concept of operations, functional requirements, and test plan documents that correspond to your project.
   - For **Class A-2 applications**, visit the MnDOT Systems Engineering for ITS and CAV Readiness web page at http://www.dot.state.mn.us/its/projects/2016-2020/seforitscavreadiness.html, or the Systems Engineering for Work Zone Data Initiatives (WZDI) and Warning Systems - Phase 1 web page at

https://www.dot.state.mn.us/its/projects/2016-2020/se-wzdi-phase1.html. Review the concept of operations, functional requirements & test plan document that correspond to your project.

- If your project is consistent with the concept of operations and functional requirements for Standard ITS Applications, proceed with **Step 6**.
- If the project is **not** consistent with the concept of operations and/or functional requirements for Standard ITS Applications, use the standard concept of operations/functional requirements above as a base and develop a project specific concept of operations and/or functional requirements for your project. Contact Rashmi Brewer (Rashmi.Brewer@state.mn.us) of MnDOT Office of CAV-X for guidance and assistance as needed.

2) If your project belongs to **Class B-1 Freeway Traffic Management** or **Class B-2 Arterial Traffic Management**, review the concept of operations document at https://www.dot.state.mn.us/its/projects/2016-2020/cavreadiness/freeway-con-ops.pdf or https://www.dot.state.mn.us/its/projects/2016-2020/cavreadiness/arterial-con-ops.pdf, respectively.
   - If your project is consistent with the concept of operations, proceed with the development of functional requirements and a test plan for the project.
   - If the project is not consistent with the concept of operations, use the standard concept of operations above as a base and develop and tailor a project specific concept of operations for your project. Then, develop functional requirements and a test plan based on the project specific concept of operations. Contact Rashmi Brewer (Rashmi.Brewer@state.mn.us) of MnDOT Office of CAV-X for guidance and assistance as needed.
3) If your project belongs to **Class C Large Scale/Complex ITS Projects**, perform a full systems engineering analysis following the systems engineering process described on pages 3 and 4 of the HPDP ITS Systems Engineering Requirement.
4) If your project consists of **only** applications of **Class A-1/A-2** and **Class B-1**, or **Class A-1/A-2** and **Class B-2**, use the systems engineering documents for both classes as resources to build upon and perform a full systems engineering analysis following the systems engineering process described on pages 3 and 4 of the HPDP ITS Systems Engineering Requirement.
5) If your project consists of any application(s) not listed in Classes A, B-1 and B-2, then the project belongs to Class C, and a full systems engineering analysis should be performed. See 3) above.

Step 6: Complete the ITS Systems Engineering Checklist(s).

1) Use the Decision Tree as a guide to identify the appropriate ITS Systems Engineering Checklist(s) for your project.
2) Project Engineer or District Traffic Project Engineer completes the checklist(s).
3) Send the completed checklist(s) to Rashmi Brewer of MnDOT Office of CAV-X via email at Rashmi.Brewer@state.mn.us for review and electronic approval.
4) Project Manager obtains signatory approval(s). Refer to page 7 of the HPDP ITS Systems Engineering Requirement for a list of approval agencies.
5) Project Manager obtains signature from Project Engineer or District Traffic Project Engineer to certify the compliance with the HPDP ITS Systems Engineering Requirement.
6) Save the approved checklist(s) in the project file, both electronically and paper copy.
7) Submit the approved checklist(s) along with the Federal Authorization Form or Project Memo for approval.
8) For questions regarding the completion of the checklist, contact Rashmi Brewer, P.E., MnDOT Office of CAV-X via e-mail at Rashmi.Brewer@state.mn.us.