Connected Intersections PMP v1.04a

Project Management Plan (PMP) for the Connected Intersections Project

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June 1, 2021

PMP in support of:	USDOT Contract # DTFH61-16-D-00055, TOPR # HOIT190166PR
For approval by:	Steve Sill, ITS Architecture & Standards Program Manager USDOT ITS Joint Program Office
For use by:	Siva Narla, Senior Director, Transportation Technology Institute of Transportation Engineers Connected Intersections Project
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CHANGE HISTORY

Version	DATE	EDIT	NOTE
Draft v1.0	10/18/19		Initial Draft for this Project Management Plan (PMP) v01.00.
Draft v2.0	10/25/19		Editorial changes. Added Stakeholders. Replaced CSI reference in document.
Draft v3.0	01/10/20	Lahiri, Chan	Updated based on comments.
Draft v3.01	01/27/20	Eisenhart, Chan	Added language on the 3 stakeholder groups and specification versus standard.
V1.01	3/11/20	Nicola Tavares	Remove reference to CSI or Connected Signalized Intersection in document. Remove highlight from list of subcontractors. Added contractors.
V1.02	04/06/20	Lahiri, Chan	Updated to Connected Intersections and CI
V1.03	7/22/20	Lahiri, Chan	Updated schedule, risks, and staff
V1.03a	08/11/20	Chan	Updated roles and responsibilities table based on comments.
V1.04	05/14/21	Chan	Updated Task 3 and project managers.
V1.04a	06/01/21	Lahiri	Added Task 4 Phase 1 Add on

CONTENTS

1 INTRODUCTION

1.1 Purpose of the Project Management Plan

This document defines a Project Management Plan (PMP) for the Connected Intersections (CI) Project under the United States Department of Transportation (USDOT) Contract Number DTFH61-16-D-00055, Task Order Proposal Request (TOPR) # HOIT190166PR. This PMP identifies the activities for the Connected Intersections Project and establishes a common understanding for the management of the project for:

a) The USDOT Intelligent Transportation Systems (ITS) Joint Program Office (JPO) who is sponsoring the work;

b) The partner Standard Development Organizations (SDOs) who are representing stakeholders for this project;

c) The sub-consultant team contracted to perform the work; and

d) The infrastructure community, the automotive industry representatives, Travel Information and Service Providers (TISP) and professionals participating in the Connected Intersections Project Committee which will use the deliverable items specified in this PMP.

This PMP is based on the Performance Work Statement (PWS) for the Connected Intersections project provided by the USDOT. The PMP includes plans for scope management; communications; deliverables and milestones; quality management; human resource management; and a Systems Engineering Management Plan (SEMP). Portions of this PMP may be updated during the course of the project if the Project Management Team or the USDOT determines that modification would significantly facilitate the project management functions. The PMP is not intended to be a progress tracking tool or to be modified for minor changes in schedule once the project has started.

1.2 Background of Project

USDOT and ITE and their standards development partners have worked on ITS standards since the inception of the ITS Standards Program over 20 years ago. The USDOT, in conjunction with early deployment agencies, has identified a number of ambiguities and gaps associated with deploying interoperable connected signalized intersections. To reliably deploy connected signalized intersections that interoperate across the country, additional guidance and standardization is necessary. Many current standards that deal with connected signalized intersections do not provide enough guidance to broadcast messages and develop applications that are truly interoperable. A document that addresses the ambiguities and gaps identified by early deployers is essential to ensure that future deployments will be interoperable across the United States. This is especially important for the development of automated transportation systems, as they are expected to be important users of this technology. Utilizing the USDOT sponsored document Cooperative Automated Transportation Coalition's *Clarifications for Consistent Implementations (CCIs) To Ensure National Interoperability Connected Signalized Intersections* as a starting point, it is the ideal time to document the key capabilities and interfaces that the stakeholders (infrastructure community, automotive industry representatives, and TISPs) expect in a connected signalized intersection and develop Software Reference Implementations (RI) of that document. This document should focus on utilizing the existing guidance developed to more rapidly develop and publish the document, utilizing the systems engineering (SE) process and ensuring the document supports future evolutionary updates. The following work statement will identify the steps necessary for developing a non-proprietary, industry-based consensus Connected Intersection document.

2   SCOPE MANAGEMENT PLAN

2.1   Purpose of the Scope Management Plan

This Scope Management Plan establishes the scope management approach and processes as they pertain to scope description, verification and control measures. It establishes the processes which ensure that the Connected Intersections Project includes all of the tasks required to complete the work identified while excluding all work that is unnecessary. Each of the major project tasks are listed below with the objectives, approach and deliverables identified. Tasks specifically identified in the PWS are identified in brackets with the PWS task number (i.e. [PWS Task #]). Specific deliverables identified in the PWS are identified in brackets as "[PWS Deliverable]".

2.2   Scope Statement

2.2.1   Project Scope Description

The subsections below describe the project activities listed in the Gantt Charts in Section 4.3 Project Schedule. The development of the deliverable documents is carried out using a cyclical draft-review-update process with a Connected Intersections Project Committee of qualified reviewers that is not a part of the sub-consultant team.

2.2.1.1   Task 1 Project Management [PWS Task 1]

The purpose of this task is to establish the management processes for the Connected Intersections Project. ITE will participate in a "kick off" meeting with the USDOT and its representatives ("the Government") to ensure that all parties have a clear understanding of the requirements of this PWS and what the USDOT's expectations are. The kick-off meeting will take place within 45 working days of the Authorization to Proceed (ATP) unless otherwise agreed to by the Government. The project management activities include the development of a Project Management Plan (PMP) and Systems Engineering Management Plan (SEMP). The following stipulations apply:
- The approved version of the PMP, SEMP and project schedule only with pre-approval from the Contracting Officer's Representative (COR) and any modified version will be delivered to the COR within 10 working days after receiving COR approval.
- Once the draft PMP, SEMP and project schedule are ready for review, a meeting with the USDOT and its representatives will be scheduled to review each document and ensure that all parties are in agreement on the overall approach to project execution.
- The revised version of each contract deliverable (including the detailed project schedule) will be under document configuration control with version numbers assigned to each document. All documents submitted to and approved by the USDOT will be assigned a unique version number.
- An authorization to proceed (ATP) is pursuant to USDOT's approval of a revised PMP and schedule.

2.2.1.1.1   Task 1.1 Monthly Progress Reporting [PWS Task 1.1]

Objectives
- Establish and execute the process of monthly project reviews.

Approach
- Prepare and deliver monthly progress reports for the Connected Intersections Project as defined in the PWS, Exhibit 4.

Deliverables
- Monthly Progress Reports [PWS Deliverable]

2.2.1.1.2   Task 1.2 Project Management Plan (PMP) [PWS Task 1.2]

Objectives
- Develop a PMP that describes the overall approach to managing the Connected Intersections Project and coordinating the work performed by the Project Development Team.

Approach
- The PMP is based on a PMP template found in Attachment A of the PWS.
- The PMP contains a Communications Plan that describes how ITE will coordinate their efforts with the USDOT, particularly the Contracting Officer's Representative (COR) and the Contracting Officer (CO).
- The PMP includes a Human Resources Management Plan that describes the overall structure of the Project Development Team including how to leverage key experience and capabilities, explain the roles and responsibilities of all key individuals, and describe the reporting relationships among the team. The Human Resources Management Plan will contain team resumes, representing domain experts and a qualified technical editor. The Human Resources Management Plan, including team members, is subject to USDOT approval as part of the overall approval of the PMP.
- The PMP includes a Quality Management Plan to ensure that the documents submitted as deliverables will:
  - contain suitable material for the target audience;
  - be organized in presentation;
  - contain proper word use and English diction;
  - contain detailed illustrations;
  - be comprehensive, complete and correct; and
  - be edited for grammatical and editorial errors.

  The Quality Management section is subject to USDOT approval as part of the overall approval of the PMP.
- The PMP includes the Risk Management Plan that identifies risks that might affect the project and the characteristics of the risk. Types of risks considered include risks potentially impacting: technical, project schedule, scope, and costs. A Risk Management Log will be maintained on an on-going basis during the entire period of performance to track risks, mitigation plans and status. Each risk will have a unique number, probability of occurrence and impact of occurrence rating.
- The PMP includes a detailed project schedule in Microsoft Project 2010 format that contains all of the planned tasks and milestones for the project. The project schedule will address all project management activities. The project schedule will reflect a work breakdown structure (WBS) comprised of at least three levels. An updated project schedule reflecting actual work performed for the previous month will be included with every monthly report (see Section 2.2.1.1.1). The monthly updated project schedule will reflect both the baselined task start and end dates and the actual start and end dates for each task. The project schedule will be provided as both a Microsoft Project Document (MPP) and a Portable Document Format (PDF).
- The PMP will be delivered 30 days after ATP.
- The approved version of the PMP and project schedule will only be revised with pre-approval from the COR. Any modified version of the project schedule will be delivered to the within 10 working days after receiving COR approval.
- Once the draft PMP and project schedule are ready for review, ITE will schedule a meeting with USDOT and its representatives, AASHTO, NEMA and subcontracted SMEs to review each document and ensure that all parties are in agreement on the overall approach to project execution.
- ITE will put the revised version of each contract deliverable (including the project schedule) under document configuration control, with version numbers assigned to each document. All documents submitted to, and approved by, USDOT will be assigned a unique version number.

- ATP to Task 2 is pursuant to USDOT's approval of the revised PMP and schedule.

Deliverables
- Project Management Plan and Project Schedule [PWS Deliverable]

2.2.1.1.3   Task 1.3 Systems Engineering Management Plan (SEMP) [PWS Task 1.3]

Objectives
- Develop a SEMP that focuses on the technical plan and systems engineering processes to be used for the Connected Intersections project. IEEE Std. 1220-2005 will be used for guidance in producing the SEMP.

Approach
- IEEE Std. 1220-2005 will be used for guidance in producing the SEMP.
- The activities in the SEMP are included in the overall project schedule provided in the PMP as a Microsoft Project Document.
- All SEMP activities included in the overall project schedule provided in the PMP are based on the remaining tasks below.
- The SEMP will also include the following sections: a Configuration Management Plan, Verification and Validation Plan, and a Risk Management Plan.
- The SEMP sections will be included as sections of the PMP.

Deliverables
- Systems Engineering Management Plan [PWS Deliverable]

2.2.1.2   Task 2 Develop Connected Intersection Standard [PWS Task 2]

The purpose of this task is to develop a Connected Intersection document that builds on the guidance provided in the *Cooperative Automated Transportation Clarifications for Consistent Implementations (CCIs) to Ensure National Interoperability Connected Signalized Intersections*.

2.2.1.2.1   Task 2.1 Develop Connected Intersection Standard ConOps [PWS Task 2.1]

Objectives
- Develop a Connected Intersections Concept of Operations (ConOps) following the guidance of NTCIP 8002 Annex B-1 and IEEE Std. 1362-1998.

Approach
- **Task 2.1.1: Establish Connected Intersections Project Committee.** A Connected Intersections Project Committee (the "Committee") will be established and will include members with experience relevant to the development or deployment of connected signalized intersections and the development and deployment of on-board units (OBUs) and automated vehicles (AV). This includes the infrastructure community and their vendors that have participated in connected intersection deployments such as the Connected Vehicle (CV) Pilot projects and the Signal Phase and Timing (SPaT) Challenge. As the connected intersection document will likely touch on CV and AV messaging capabilities, the Project Management Team will ensure that appropriate Subject Matter Experts (SMEs) from SAE have the opportunity to participate in all of the Committee activities and document reviews. The composition of this committee will reflect balanced representation across stakeholder groups (infrastructure community, automotive industry representatives, and TISPs). The Project Management Team will document the Committee membership in the connected intersections Project Committee Roster.
- **Task 2.1.2: Deliver Draft Connected Intersection ConOps.**

- o A review of the *Cooperative Automated Transportation Clarifications for Consistent Implementations (CCIs) to Ensure National Interoperability Connected Signalized Intersections* will be performed to identify existing use cases and user needs. Key stakeholders and SMEs will be interviewed as part of the research process to gain an understanding and develop additional use cases (scenarios) and user needs. A stakeholder list will be developed and approved by USDOT prior to conducting the interviews.
  - o Establish task forces consisting of volunteering members of the committee, SMEs and other interested parties. Each volunteer may sign up for a maximum of three task forces. Each task force will address a particular topic such as Traffic Controller Issues, Security, Positioning, SPaT/MAP Messages and Testing/Conformity. Task forces will assess and identify issues for their respective topics through research and interviews. Task force progress will be reported to the committee on a monthly basis.
  - o Develop a Draft Concept of Operations (ConOps) for the Connected Intersection document. IEEE Std. 1362-1998 is the document that will be used for guidance in this area. An example outline for the ConOps can be found in Appendix B of the PWS. As part of the effort to develop the ConOps, the sub-consultant team will develop the user needs for the Connected Intersection document. These user needs will be derived from the work performed by the task forces. The needs developed will meet the test of being "well-written" as defined in Appendix A of the PWS.
  - o The ConOps will describe expected technical, environmental, and institutional constraints for the system of interest. The ConOps will provide system concepts (including a high-level discussion of technical and non-technical requirements), operational scenarios, and the rationale for key concept decisions. A context diagram will be included as part of the ConOps that shows the environment the Connected Intersection will work in and any possible options in the high-level architecture.
  - o A Draft Connected Intersection ConOps will be delivered to the Committee and USDOT to be reviewed and used during a technical walkthrough.
- **Task 2.1.3: Walkthrough on Draft ConOps.**
  - o In consultation with the Task Order Contracting Officer's Representative (TOCOR), a list of knowledgeable SMEs will be prepared comprised of stakeholders (USDOT, infrastructure community (including center-to-field experts, Transit, Commercial Vehicle Operations (CVO)), automotive industry representatives (including CV and AV) and travel information and service providers) and contractors involved with RSU research, telecommunications and relevant other Standards Development Organizations and/or working groups. The USDOT will approve the list prior to the walkthrough being organized. Those on the list will be invited to attend a face-to-face technical walkthrough of the draft ConOps.
  - o The SMEs will provide comments on the ConOps from a functional, technical, management and implementation perspective. Also, in consultation with the TOCOR, a time and facility will be arranged where the walkthrough will take place. ITE will be responsible for sending invitations, distributing advance material including the draft ConOps, registrations, travel reimbursement, note taking, and coordination of the walkthrough.
  - o A ConOps Walkthrough Plan based on IEEE Std. 1028-1997 will be prepared. The walkthrough plan will be implemented once approved by USDOT. As part of this task, a ConOps Walkthrough Comment Resolution Report will be prepared and delivered which details each walkthrough comment and the Project Development Team's recommended resolution.

Deliverables
- Connected Intersections Project Committee Roster [PWS Deliverable]
- Draft Connected Intersection Concept of Operations [PWS Deliverable]
- ConOps Walkthrough Plan [PWS Deliverable]

- Connected Intersection Concept of Operations
- ConOps Walkthrough Comment Resolution Report [PWS Deliverable]

2.2.1.2.2   Task 2.2 Develop Connected Intersection Standard System Requirements Specification (SRS) [PWS Task 2.2]

Objectives
- Develop a Connected Intersection System Requirements Specification (SRS) following the guidance of NTCIP 8002 Annex B-1 and IEEE Std. 830-1998. The draft SRS will have full traceability between user needs and requirements.

Approach
- **Task 2.2.1: Develop Draft Connected Intersection SRS**
    - o A Software Requirements Specification (SRS) will be developed based on the ConOps and following the guidance of IEEE Std. 830-1998. The SRS will contain a Protocol Requirements List (PRL) that is conformant to NTCIP 8002 Annex B1. The requirements documented in the SRS will meet the test of being "well-formed" requirements. See Appendix A of the PWS for the definition of a "well-formed" requirement. The requirements for the interface will consist of the following.
        - – Functional requirements
        - – Performance requirements
        - – Security requirements*
        - – Reliability requirements
        * Note: The security requirements may be required to be conformant to connected vehicle security requirements.
    - o Relevant requirements identified in the *Cooperative Automated Transportation Clarifications for Consistent Implementations (CCIs) To Ensure National Interoperability Connected Signalized Intersections* will exist within this draft and have the proper traceability to user needs.
    - o A draft Connected Intersection SRS will be delivered to the Committee and USDOT to be used during a technical walkthrough of the draft SRS.
- **Task 2.2.2: Walkthrough on Draft SRS**
    - o In consultation with the Task Order Contracting Officer's Representative (TOCOR), a list of knowledgeable SMEs will be prepared comprised of stakeholders (USDOT, infrastructure community (including center-to-field experts, Transit, Commercial Vehicle Operations (CVO)), automotive industry representatives (including CV and AV) and travel information and service providers) and contractors involved with RSU research, telecommunications and relevant other Standards Development Organizations and/or working groups. The USDOT will approve the list prior to the walkthrough being organized. Those on the list will be invited to attend a face-to-face technical walkthrough of the draft SRS.
    - o The SMEs will provide comments on the SRS from a functional, technical, management and implementation perspective. Also, in consultation with the TOCOR, a time and facility will be arranged where the walkthrough will take place. ITE will be responsible for sending invitations, distributing advance material including the draft SRS, registrations, travel reimbursement, note taking, and coordination of the walkthrough.
    - o An SRS Walkthrough Plan based on IEEE Std. 1028-1997 will be prepared. The walkthrough plan will be implemented once approved by USDOT. As part of this task, an SRS Walkthrough Comment Resolution Report will be prepared and delivered which details each walkthrough comment and the Project Development Team's recommended resolution.

Deliverables
- Draft Connected Intersection Systems Requirements Specification [PWS Deliverable]
- SRS Walkthrough Plan [PWS Deliverable]
- SRS Walkthrough Comment Resolution Report [PWS Deliverable]

2.2.1.2.3 Task 2.3 Develop Connected Intersection System Design Description (SDD) [PWS Task 2.3]

Objectives
- Develop a Connected Intersection System Design Description (SDD) following the guidance of NTCIP 8002 Annex B-1 and IEEE Std. 1362-1998. The draft SDD will have full traceability between user needs, requirements and design elements.

Approach
- **Task 2.3.1: Develop Draft Connected Intersection SDD**
  - o A System Design Descriptions (SDD) document will be developed based on the ConOps and SRS. IEEE Std. 1016-1998 is the document that will be used for guidance in this area. The sub-consultant team will document the design solution for each requirement developed in the previous tasks. The SDD will specify the content, constraints on formats, timing, and other factors needed. The sub-consultant team will include a Requirements Traceability Matrix (RTM) in the SDD. The RTM will be conformant with NTCIP 8002 Annex B1.
  - o Verification and validation checks will be conducted as per the SEMP. In addition, the latest version of the Test Procedure Generator (TPG) will be used to perform an NTCIP 8002 Annex B1 format conformance check and to verify traceability between the requirements and the design content prior to releasing the draft document for review for the SDD Walkthrough.
  - o A draft Connected Intersection SDD will be delivered with the rest of the document (ConOps and SRS) to the Committee and USDOT to be used during the walkthrough of the draft SDD.
- **Task 2.3.2: Walkthrough on Connected Intersection SDD**
  - o In consultation with the Task Order Contracting Officer's Representative (TOCOR), a list of knowledgeable SMEs will be prepared comprised of stakeholders (USDOT, infrastructure community (including center-to-field experts, Transit, Commercial Vehicle Operations (CVO)), automotive industry representatives (including CV and AV) and travel information and service providers) and contractors involved with RSU research, telecommunications and relevant other Standards Development Organizations and/or working groups. The USDOT will approve the list prior to the walkthrough being organized. Those on the list will be invited to attend a face-to-face technical walkthrough of the draft SDD.
  - o The SMEs will provide comments on the SDD from a functional, technical, management and implementation perspective. Also, in consultation with the TOCOR, a time and facility will be arranged where the walkthrough will take place. ITE will be responsible for sending invitations, distributing advance material including the draft SDD, registrations, travel reimbursement, note taking, and coordination of the walkthrough.
  - o An SDD Walkthrough Plan based on IEEE Std. 1028-1997 will be prepared. The walkthrough plan will be implemented once approved by USDOT. As part of this task, an SDD Walkthrough Comment Resolution Report will be prepared and delivered which details each walkthrough comment and the Project Development Team's recommended resolution.

Deliverables
- Draft Connected Intersection System Design Document [PWS Deliverable]
- SDD Walkthrough Plan [PWS Deliverable]

- SDD Walkthrough Comment Resolution Report [PWS Deliverable]

2.2.1.2.4   Task 2.4 Publish Connected Intersection Document [PWS Task 2.4]

Objectives
- Publish a fully balloted and approved Connected Intersection document that meets the systems engineering documentation guidance in NTCIP 8002 Annex B-1 and IEEE Std. 1362-1998. The goal is to publish a standard but given the range of stakeholders that need to be accommodated, this may not be practical within the timeframe allotted. In that case a specification will be created that goes through internal reviews, but not SDO reviews.

Approach
- **Task 2.4.1: Develop Recommended Connected Intersection Document.** A user comment draft Connected Intersection document will be developed based on the ConOps, SRS, and SDD developed in the previous tasks. The Project Development Team will circulate a draft to the Committee and interested stakeholders for comments. The Project Management Team will collect all comments received and the sub-consultant team will prepare a response sheet for all comments. The Project Management Team will conduct Committee meetings to finalize agreements on the resolution of the comments, and the sub-consultant team will prepare responses to all comments received from the Committee and the USDOT. The document will be updated and the Committee will determine if the document is to be submitted to the relevant SDOs as a proposed Specification or as a proposed Standard. The document will then be submitted to the SDOs for further review and balloting.
- **Task 2.4.2: Publish Approved Connected Intersection Document.** The Project Development Team will review ballot comments, revise the ballot document per the comments and publish the document once all SDOs involved have approved it. As part of the publication process, the MIB and ASN.1 will be generated as applicable and delivered with the final Connected Intersection Document.

Deliverables
- Recommended Connected Intersection Document [PWS Deliverable]
- Connected Intersection Document MIB and/or ASN.1 [PWS Deliverable]
- Connected Intersection Document [PWS Deliverable]

2.2.1.3   Task 3 Develop Connected Intersection Standard Validation [PWS Task 3]

Objectives
- Validate the Connected Intersection Specification/ Standard.

Approach
- This approach is made up of 4 subtasks to address all of the tasks identified in the PWS:
    - **Task 3.1 ATP CI Validation Phase.** This task is written approval by the Government (COR) to start work on Task 3.
    - **Task 3.2 Collection of Data from Validation Sites.** This task involves the collection and analysis of field data from the validation sites, specifically SAE J2735 SPaT and MAP messages and RTCMcorrections messages if available. This task also includes hours to enhance the existing application software and toolset for to the user community, allowing the user community to self-assess and analyze its own implementation. This work is based on existing tools that are already under development on other projects. Written feedback from validation sites on ambiguities and gaps in the System Design Details (SDD) document of the CI Implementation Guide is also being collected.
    - **Task 3.3 Develop Connected Intersections Validation Report.** A report that compiles and summarizes the findings from the validation sites will be provided. These findings

include a summary of the field data collection and field data analysis performed by the subject matter experts, and the ambiguities, gaps and comments provided by the validation sites. The validation report will be a separate document from the CI Implementation Guide.

- o **Task 3.4 Deliver Connected Intersections Validation Report.** The report will be delivered to USDOT.

Deliverables
- Connected Intersections Validation Report [PWS Deliverable]

2.2.1.4 Task 4 Update to Connected Intersections Guide [PWS Task 4]
Objectives
- Develop additional guidance for inclusion in an updated CI Implementation Guide that improves the usability of the initial published guidance document.

Approach
- This approach is made up of 4 subtasks to address all of the tasks identified in the PWS:
    - o **Task 4.1 Develop Additional Guidance.** A new draft CI Implementation Guide with additional guidance will be written to improve to the usability of the initial published guidance document. The additional guidance will cover the following.
        - How to fulfill the SPaT message requirements in the CI Implementation Guide using the existing TSCBM objects. Most current implementations of a connected intersection use the TSCBM. As the TSCBM was a solution developed as a stopgap, the CI Committee has decided to endorse NTCIP 1202 v03A moving forward, but recognize that most existing implementations use TSCBM.
        - For specific security requirements, provide guidance on how an attack tree could be constructed, an example attack tree, and example design choices to mitigate the threat. Specific examples of cybersecurity documentation, such as a security threat tree, may be included.
        - From the point in time a traffic signal controller makes a change in signal state for an intersection, identifying the causes and expected delay (latency) for a) the representative SPaT messages to be received by OBUs and b) the observable change in signal indications by drivers.
    - o **Task 4.2 Review and Comment on Additional Guidance.** The draft CI Implementation Guide will be circulated among the CI Committee and comments will be solicited.
    - o **Task 4.3 Convene CI Committee and Adjudicate Comments.** The CI Committee will convene to finalize agreements on the resolution of the comments.
    - o **Task 4.4 Update CI Implementation Guide Based on Comments.** The CI Implementation Guide will be updated to address the comments by the CI Committee and USDOT.
    - o **Task 4.5 Deliver Updated CI Implementation Guide.** The amended CI Implementation Guide will be submitted to the CI Committee for ballot.

Deliverables
- Updated CI Implementation Guide [PWS Deliverable]

2.2.2 Project Acceptance Criteria

Overall project acceptance is based on acceptance of the deliverables. Table 1 identifies the acceptance criteria and the accepting entity for each type of deliverable identified in the Section 2.2.1 Project Scope Description.

Table 1. Deliverable Acceptance Criteria and Accepting Entity

Deliverable Type	Acceptance Criteria	Acceptance By
Monthly Progress Reports	• Adherence to Section 4.1. • Meets quality control criteria as described in Section 5.3.	COR
Project Management Plan	• Adherence to Section 2.2.1.1.2. • Meets quality control criteria as described in Section 5.3.	USDOT
Systems Engineering Management Plan	• Adherence to Section 2.2.1.1.3. • Meets quality control criteria as described in Section 5.3.	USDOT
Comment Disposition Reports	• Criteria to be established by the Project Manager. • Meets quality control criteria as described in Section 5.3.	Connected Intersections Project Committee, PM, USDOT
All Deliverable Engineering Documents and Standards	• Meets the objectives of the applicable project task (see Sections 2.2.1.2 and subtasks). • Meets quality control criteria as described in Section 5.3.	Connected Intersections Project Committee, PM, USDOT
Connected Intersection Software	• Not Applicable	Not Applicable

2.2.3   Project Exclusions

No exclusions have been identified.

2.2.4   Project Constraints

The following constraints have been established for the Connected Intersections project:
   a) The project schedule may not extend beyond August 28, 2021.
   b) No capital expenditures are available on the project.
   c) Project travel must be preapproved by ITE.

2.2.5   Project Assumptions

The following assumptions are being made for the Connected Intersections Project:
   a) Additional web conferences will be used as needed to meet the project goals.
   b) Time has been built in to many of the tasks due to the Committee reviews and process.
   c) Throughout the project, there may be various versions of the project schedule produced to take advantage of economies discovered or to account for anomalies unforeseen. As long as there is no change in scope, this PMP does not need to be modified.

2.3   Scope Verification

It is the responsibility of the Project Manager to verify interim project deliverables against the original scope as defined in the scope description (see Section 2.2.1). If there is a proposed change of scope (see Section 2.4), ITS JPO must formally accept the change prior to its incorporation into the project.

2.4   Scope Control

The Project Manager and the Project Development Team will work together to control the scope of the project. The Project Development Team will leverage the project scope description (see Section 2.2.1) and the project schedule (see Section 4.3) as a statement of work for each task. The Project Development Team and subject matter experts will ensure that they perform only the work described in the project scope

description and generate the deliverables identified. The Project Manager will oversee the Subcontracted Subject Matter Experts ("sub-consultant team") and the progression of the project to ensure that this scope control process is followed.

A change in scope is defined by a change in the overall budget, a change that extends the overall schedule, or a change in the work to be performed. Any member of the Project Management Team, the sub-consultant team, the Committee, or the ITS JPO may propose a change in scope. The proposed change is assessed by the Project Management Team and sub-consultant team. If the Project Management Team and sub-consultant team determine that a change in scope is warranted, formal approval from ITS JPO is required. This PMP is to be updated in the case of an approved change in scope.

3   COMMUNICATIONS PLAN

3.1   Purpose of the Communications Plan

This Communications Management Plan sets the communications framework for the administration of the Connected Intersections Project. It identifies the key stakeholders, their roles, and contact information.

3.2   Stakeholder Points of Contact

ITS JPO Contracting Officer's Representative (COR)

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 (202) 624-5497
gmurthy@aashto.org

3.3   Project Team and Committee Communications

Communications within the sub-consultant team is on an ad hoc basis. Meetings of the Connected Intersections Project Committee will typically use web conferencing. Throughout the project, the Committee will provide technical guidance and document reviews. The Project Manager will work to ensure that Committee meetings and web conferences are carried out according to the project needs.

3.4   Communications with ITS JPO

Communications between the Project Development Team and ITS JPO will formally take place once monthly and as deliverables occur as described in Section 4. It is anticipated that ITS JPO will have one or more technical staff participating in the Committee meetings and web conferences where they will have extemporaneous and informal communication with the Project Development Team. Official communications between ITS JPO and the Project Development Team should be made through the Project Administrator/Coordinator and the COR (see Section 3.2).

4   DELIVERABLES AND MILESTONES

4.1   Monthly Progress Reports

ITE will provide monthly progress reports as follows:
   a) Monthly Status Reports – ITE will submit monthly progress reports no later than 30 days after the end of the month being reported on in the format specified by the COR. The progress report will describe work completed during the period, anticipated work, problems encountered and and/or anticipated as well as financial status including at least hours expended and other costs.
   b) Project Schedule – ITE will submit, to the Government, an initial project schedule in Microsoft Project Document (MPP) format within sixty (60) days after the effective date of the contract and updates showing the percent complete of major deliverables every thirty (30) days thereafter. The schedule will include at a minimum, the major deliverables and milestones and adhere to the Microsoft Project template structure provided by the COR. Any changes to due dates after the initial project schedule baseline must be approved by the Government. ITE will support the identification of schedule dependencies related to the project and in accordance with the Government defined process.
   c) Risk Register – ITE will document risks that might affect the project and the characteristics of the risk defined by the ITS JPO. The COR will provide a Microsoft Excel-based Risk Register template for ITE to populate and update as necessary. Each risk will have a unique number, probability of occurrence and impact of occurrence rating. The risk log will be updated monthly and submitted with monthly progress reports.

ITS JPO templates are available at http://www.its.dot.gov/project_mang/index.htm

The Project Manager will provide a monthly summary of the sub-consultant team progress reports to the Project Administrator/Coordinator and an updated project schedule per the requirements for the Project Administrator/Coordinator's monthly reporting.

4.2 Deliverable Summary

Documents and software deliverables are to be sent electronically to the COR. Table 2 identifies the deliverables based on the project tasks identified on the Gantt Chart in Figure 1 and Figure 2. The delivery dates have not been established due to adjustments in the project schedules as stated in Section 4.3.

Table 2. Deliverables by Project and Task

Proj Task	Deliverable Item	Delivery Date
1.1	Monthly Progress Reporting	30 days after the end of the month
1.2	Project Management Plan	30 days after ATP
1.3	System Engineering Management Plan	30 days after ATP
2.1.2	Connected Intersections Project Committee Roster	Per Schedule
2.1.4	Draft Connected Intersection ConOps	Per Schedule
2.1.6	ConOps Walkthrough Plan	Per Schedule
2.1.14	Final Connected Intersection ConOps *(not included in PWS)*	Per Schedule
2.1.16	ConOps Comment Resolution Report	Per Schedule
2.2.2	Draft Connected Intersection Systems Requirements Specification	Per Schedule
2.2.4	SRS Walkthrough Plan	Per Schedule
2.2.8	SRS Comment Resolution Report	Per Schedule
2.3.2	Draft Connected Intersection SDD	Per Schedule
2.3.4	SDD Walkthrough Plan	Per Schedule
2.3.8	SDD Comment Resolution Report	Per Schedule
2.4.1.5	Recommended Connected Intersection Document	Per Schedule
2.4.2.4	Connected Intersection Standard MIB and/or ASN.1	Per Schedule
2.4.2.3	Final Connected Intersection Document	Per Schedule
3.4	Connected Intersection Validation Report	Per Schedule
4.5	Deliver Updated CI Implementation Guide	Per Schedule

4.3 Project Schedule

The Gantt Charts in in Figure 1 and Figure 2 provide the schedule for the Connected Intersections Project. Deliverables are identified by a diamond shape (◆). Web conferences are identified by a diamond shape within a circle (◈). Face-to-face meetings are identified by solid circle (●). It must be emphasized that these projects are not "leveled" based on personnel or priority as funding levels have not been solidified. This means that the dates of projects do not reflect the makeup of the sub-consultant team, their skills and their availability. Once funding levels and priorities are established the project schedules will be adjusted.

ID	Proj Task	Task Name	Baseline2 Start	Baseline2 Finish	Baseline2 Duration	Actual Start	Actual Finish	Actual Duration	2019
1	Proj Task	Connected Intersections (CI)	Tue 10/8/19	Fri 9/17/21	463.85 days	Tue 10/8/19	NA	419.98 days	
2		Project Authorization to Proceed	Tue 10/8/19	Tue 10/8/19	1 day	Tue 10/8/19	Tue 10/8/19	1 day	
3	1	Project Management [PWS Task 1]	Tue 10/8/19	Thu 4/22/21	361 days	Tue 10/8/19	Thu 4/22/21	362 days	
4	1.1	Monthly Progress Reporting [PWS Task 1.1]	Tue 10/8/19	Thu 4/22/21	361 days	Tue 10/8/19	Thu 4/22/21	362 days	
5	1.1.1	Monthly Progress Report Preparation	Tue 10/8/19	Thu 4/22/21	360 days	Tue 10/8/19	Thu 4/22/21	360 days	
6	1.1.2	Deliver Monthly Progress Report [PWS Deliverable]	Tue 10/8/19	Thu 4/22/21	360 days	Tue 10/8/19	Thu 4/22/21	360 days	
7	1.2	Project Management Plan (PMP) [PWS Task 1.2]	Fri 10/18/19	Wed 2/12/20	65 days	Fri 10/18/19	Wed 2/12/20	65 days	
8	1.2.1	Develop Draft PMP	Fri 10/18/19	Mon 10/28/19	7 days	Fri 10/18/19	Mon 10/28/19	7 days	
9	1.2.2	Deliver Draft PMP	Mon 10/28/19	Mon 10/28/19	1 day	Mon 10/28/19	Mon 10/28/19	1 day	
10	1.2.3	USDOT Review and Comment on PMP	Tue 10/29/19	Tue 10/29/19	1 day	Tue 10/29/19	Tue 10/29/19	1 day	
11	1.2.4	PMP Review Meeting with USDOT	Thu 11/21/19	Thu 11/21/19	1 day	Thu 11/21/19	Thu 11/21/19	1 day	11/21
12	1.2.5	Update Draft PMP Per USDOT Review	Fri 11/22/19	Tue 1/28/20	30 days	Fri 11/22/19	Tue 1/28/20	30 days	
13	1.2.6	Deliver PMP [PWS Deliverable]	Tue 1/28/20	Tue 1/28/20	1 day	Tue 1/28/20	Tue 1/28/20	1 day	
14	1.2.7	ATP for CI Development	Wed 2/12/20	Wed 2/12/20	1 day	Wed 2/12/20	Wed 2/12/20	1 day	
15	1.3	Systems Engineering Management Plan (SEMP) [PWS Task 1.3]	Mon 11/25/19	Tue 1/28/20	29 days	Mon 11/25/19	Tue 1/28/20	29 days	
16	1.3.1	Develop Draft SEMP	Mon 11/25/19	Wed 12/4/19	6 days	Mon 11/25/19	Wed 12/4/19	6 days	
17	1.3.2	Deliver Draft SEMP	Fri 12/6/19	Fri 12/6/19	1 day	Fri 12/6/19	Fri 12/6/19	1 day	
18	1.3.3	USDOT Review and Comment on SEMP	Fri 12/6/19	Wed 12/18/19	9 days	Fri 12/6/19	Wed 12/18/19	9 days	
19	1.3.4	SEMP Review Meeting with USDOT	Wed 12/18/19	Wed 12/18/19	1 day	Wed 12/18/19	Wed 12/18/19	1 day	12/18
20	1.3.5	Update Draft SEMP Per USDOT Review	Wed 12/18/19	Mon 1/6/20	4 days	Wed 12/18/19	Mon 1/6/20	4 days	
21	1.3.6	Deliver SEMP [PWS Deliverable]	Tue 1/28/20	Tue 1/28/20	1 day	Tue 1/28/20	Tue 1/28/20	1 day	
22	2	Develop CI Standard [PWS Task 2]	Thu 12/12/19	Fri 9/17/21	420.85 days	Thu 12/12/19	NA	391.46 days	
23	2.1	Develop CI Standard Concept of Operations (ConOps) [PWS Task 2.1]	Thu 12/12/19	Thu 10/1/20	185.85 days	Thu 12/12/19	Fri 10/30/20	206 days	
24	2.1.1	Establish CI Project Committee [PWS Task 2.1.1]	Thu 12/12/19	Tue 3/3/20	37 days	Thu 12/12/19	Tue 3/3/20	37 days	
25	2.1.2	Deliver CI Project Committee Roster [PWS Deliverable 2.1.1]	Fri 3/13/20	Fri 3/13/20	1 day	Fri 3/13/20	Fri 3/13/20	1 day	3/13
26	2.1.2.a	Create CI Task Forces	Fri 5/29/20	Fri 6/26/20	21 days	Fri 5/29/20	Fri 7/17/20	35 days	
27	2.1.3	Develop Draft CI ConOps [PWS Task 2.1.2]	Thu 4/30/20	Fri 7/24/20	19 days	Thu 4/30/20	Wed 8/19/20	30.35 days	
28	2.1.4	Deliver Draft CI ConOps [PWS Deliverable 2.1.2]	Fri 7/24/20	Fri 7/24/20	0 days	Wed 8/19/20	Wed 8/19/20	1 day	
29	2.1.5	Develop ConOps Walkthrough Plan	Tue 7/21/20	Fri 7/24/20	3 days	Wed 7/29/20	Fri 7/31/20	3 days	
30	2.1.6	Deliver ConOps Walkthrough Plan [PWS Deliverable 2.1.3]	Fri 7/24/20	Fri 7/24/20	0 days	Mon 8/3/20	Mon 8/3/20	0 days	8/3
31	2.1.7	Review and Comment on Draft ConOps	Fri 7/24/20	Fri 8/14/20	10 days	Wed 8/19/20	Fri 8/28/20	7 days	
32	2.1.8	Convene Technical Walkthrough of Draft ConOps and Adjudicate Comments [PWS Task 2.1.3]	Fri 8/14/20	Fri 8/28/20	10 days	Mon 8/31/20	Wed 9/2/20	3 days	8/31
33	2.1.9	Revise Draft ConOps per Technical Walkthrough and Comments	Fri 8/28/20	Mon 9/14/20	10 days	Thu 9/3/20	Tue 9/15/20	8 days	
34	2.1.10	Deliver Second Draft ConOps	Mon 9/14/20	Mon 9/21/20	5 days	Tue 9/15/20	Tue 9/15/20	0 days	9/15

Figure 1. Connected Intersections Project Schedule (Part 1 of 3)

ID	Proj Task	Task Name	Baseline2 Start	Baseline2 Finish	Baseline2 Duration	Actual Start	Actual Finish	Actual Duration	2019
35	2.1.11	Committee Review and Comment on Second Draft ConOps	Mon 9/21/20	Tue 9/22/20	1 day	Tue 9/15/20	Tue 9/29/20	10 days	
36	2.1.12	Convene Committee Web Conference to Adjudicate Comments on Second Draft ConOps	Tue 9/22/20	Tue 9/22/20	0 days	Mon 9/21/20	Mon 9/21/20	1 day	
37	2.1.13	Revise Second Draft ConOps per Comment Resolution	Tue 9/22/20	Tue 9/29/20	5 days	Wed 9/30/20	Fri 10/30/20	22 days	
38	2.1.14	Deliver CI ConOps	Tue 9/29/20	Tue 9/29/20	0 days	Fri 10/30/20	Fri 10/30/20	0 days	10/30
39	2.1.15	Prepare ConOps Comment Resolution Report	Tue 9/29/20	Thu 10/1/20	2 days	Thu 9/3/20	Tue 10/27/20	37 days	
40	2.1.16	Deliver ConOps Comment Resolution Report [PWS Deliverable 2.1.3]	Thu 10/1/20	Thu 10/1/20	0 days	Tue 10/27/20	Tue 10/27/20	1 day	
41	2.2	**Develop CI Standard Systems Requirements Specification (SRS) [PWS Task 2.2]**	**Tue 9/29/20**	**Mon 1/4/21**	**58 days**	**Thu 9/3/20**	**Tue 1/26/21**	**91 days**	
42	2.2.1	Develop Draft SRS [PWS Task 2.2.1]	Tue 9/29/20	Thu 11/12/20	30 days	Thu 9/3/20	Mon 11/23/20	30.5 days	
43	2.2.2	Deliver Draft SRS [PWS Deliverable 2.2.1]	Thu 11/12/20	Thu 11/12/20	0 days	Mon 11/23/20	Mon 11/23/20	1 day	
44	2.2.3	Develop SRS Walkthrough Plan	Fri 11/6/20	Thu 11/12/20	3 days	Mon 11/2/20	Fri 11/6/20	5 days	
45	2.2.4	Deliver SRS Walkthrough Plan [PWS Deliverable 2.2.2]	Thu 11/12/20	Thu 11/12/20	0 days	Fri 11/6/20	Fri 11/6/20	1 day	
46	2.2.5	Review and Comment on Draft SRS	Thu 11/12/20	Mon 11/30/20	10 days	Mon 11/23/20	Fri 12/4/20	7 days	
47	2.2.6	Convene Technical Walkthrough of Draft SRS and Adjudicate Comments [PWS Task 2.2.2]	Mon 11/30/20	Thu 12/3/20	3 days	Mon 12/7/20	Thu 12/10/20	4 days	12/7
48	2.2.7	Revise Draft SRS per Technical Walkthrough and Comments	Thu 12/3/20	Mon 1/4/21	15 days	Fri 12/11/20	Mon 1/25/21	25 days	
49	2.2.8	Deliver SRS Comment Resolution Report [PWS Deliverable 2.2.2]	Mon 1/4/21	Mon 1/4/21	0 days	Tue 1/26/21	Tue 1/26/21	0 days	1/26
50	2.3	**Develop CI Standard Systems Design Description (SDD) [PWS Task 2.3]**	**Mon 1/4/21**	**Tue 4/6/21**	**64 days**	**Mon 12/28/20**	**Mon 4/19/21**	**75 days**	
51	2.3.1	Develop Draft SDD [PWS Task 2.3.1]	Mon 1/4/21	Wed 2/17/21	30 days	Mon 12/28/20	Fri 2/26/21	39 days	
52	2.3.2	Deliver Draft SDD to Committee [PWS Deliverable 2.3.1]	Wed 2/17/21	Wed 2/17/21	0 days	Fri 2/26/21	Fri 2/26/21	1 day	
53	2.3.3	Develop SDD Walkthrough Plan	Thu 2/11/21	Wed 2/17/21	3 days	Thu 2/18/21	Fri 2/19/21	2 days	
54	2.3.4	Deliver SDD Walkthrough Plan [PWS Deliverable 2.3.2]	Wed 2/17/21	Wed 2/17/21	0 days	Fri 2/19/21	Fri 2/19/21	1 day	
55	2.3.5	Committee Review and Comment on Draft SDD	Wed 2/17/21	Wed 3/3/21	10 days	Fri 2/26/21	Fri 3/5/21	5 days	
56	2.3.6	Convene Technical Walkthrough of Draft SDD and Adjudicate Comments [PWS Task 2.3.2]	Wed 3/3/21	Tue 3/9/21	4 days	Mon 3/8/21	Thu 3/11/21	4 days	
57	2.3.7	Revise Draft SDD per Technical Walkthrough and Comments	Tue 3/9/21	Tue 4/6/21	20 days	Fri 3/12/21	Mon 4/19/21	27 days	
58	2.3.8	Deliver SDD Comment Resolution Report [PWS Deliverable 2.3.2]	Tue 4/6/21	Tue 4/6/21	0 days	Mon 4/19/21	Mon 4/19/21	1 day	
59	2.4	**Publish CI Standard [PWS Task 2.4]**	**Wed 6/30/21**	**Fri 9/17/21**	**55 days**	**NA**	**NA**	**0 days**	
60	2.4.1	**Develop Recommended CI Standard Document [PWS Task 2.4.1]**	**Wed 6/30/21**	**Fri 9/10/21**	**50 days**	**NA**	**NA**	**0 days**	
61	2.4.1.1	Develop Draft Recommended CI Document	Wed 6/30/21	Fri 8/6/21	26 days	NA	NA	0 days	
62	2.4.1.2	Review and Comment on Draft Recommended CI Document	Mon 8/9/21	Fri 8/20/21	9 days	NA	NA	0 days	
63	2.4.1.3	Convene CI Committee Web Conference and Adjudicate Comments	Mon 8/23/21	Fri 9/3/21	9 days	NA	NA	0 days	9/14

Figure 2. Connected Intersections Project Schedule (Part 2 of 3)

ID	Proj Task	Task Name	Baseline2 Start	Baseline2 Finish	Baseline2 Duration	Actual Start	Actual Finish	Actual Duration	2019
64	2.4.1.4	Update Draft Recommended CI Document Based on Comments	Mon 8/30/21	Fri 9/10/21	8 days	NA	NA	0 days	
65	2.4.1.5	Deliver Recommended CI Document [PWS Deliverable 2.4.1]	Fri 9/10/21	Fri 9/10/21	0 days	NA	NA	0 days	10/13
66	**2.4.2**	**Publish Approved CI Standard [PWS 2.4.2]**	**Sun 9/5/21**	**Fri 9/17/21**	**8 days**	**NA**	**NA**	**0 days**	
67	2.4.2.1	Develop Publish Ready Approved CI Document	Sun 9/5/21	Fri 9/17/21	8 days	NA	NA	0 days	
68	2.4.2.2	Prepare Compilable CI MIB and/or ASN.1	Fri 9/17/21	Fri 9/17/21	0 days	NA	NA	0 days	11/2
69	2.4.2.3	Deliver Final CI Document [PWS Deliverable 2.4.2]	Fri 9/17/21	Fri 9/17/21	0 days	NA	NA	0 days	11/2
70	2.4.2.4	Deliver Final CI MIB and/or ASN.1 [PWS Deliverable 2.4.2]	Fri 9/17/21	Fri 9/17/21	0 days	NA	NA	0 days	11/2
71	3	**Develop Connected Intersection Standard Validation [PWS Task 3]**	**Mon 4/19/21**	**Fri 9/17/21**	**106 days**	**Thu 4/29/21**	**NA**	**1.23 days**	
72	3.1	ATP CI Validation	Mon 4/19/21	Mon 4/19/21	0 days	Wed 5/19/21	Wed 5/19/21	1 day	
73	3.2	Collection of Data from Validation Sites	Thu 4/29/21	Fri 7/30/21	62 days	Thu 4/29/21	NA	0 days	
74	3.3	Develop Connected Intersections Validation Report	Mon 7/19/21	Tue 11/30/21	44 days	NA	NA	0 days	
75	3.4	Deliver Connected Intersections Validation Report [PWS Deliverable 3.4]	Tue 11/30/21	Tue 11/30/21	0 days	NA	NA	0 days	8/13
76	4	**Update to Connected Intersections Guide [PWS Task 4]**	**Mon 6/21/21**	**Mon 1/31/22**	**153 days**	**NA**	**NA**	**0 days**	
77	4.1	Develop Additional Guidance	Mon 6/21/21	Fri 10/29/21	92 days	NA	NA	0 days	
78	4.2	Review and Comment on Additional Guidance	Mon 11/1/21	Fri 11/19/21	14 days	NA	NA	0 days	
79	4.3	Convene CI Committee and Adjudicate Comments	Mon 11/22/21	Fri 12/10/21	14 days	NA	NA	0 days	
80	4.4	Update CI Implementation Guide Based on Comments	Mon 11/29/21	Fri 1/28/22	42 days	NA	NA	0 days	
81	4.5	Deliver Updated CI Implementation Guide [PWS Deliverable 4.5]	Mon 1/31/22	Mon 1/31/22	0 days	NA	NA	0 days	

Figure 3. Connected Intersections Project Schedule (Part 3 of 3)

5 QUALITY MANAGEMENT PLAN

5.1 Purpose of the Quality Management Plan

This Quality Management Plan describes how quality will be managed throughout the life of the project. It includes processes and practices for ensuring quality planning, quality control and quality assurance.

5.2 Quality Planning

In order to be successful, this PMP has integrated a quality system into the project tasks, project schedule, project deliverables and Project Development Team. The project relies heavily on the Committee to perform the role of a quality review team. The Committee is made up of subject matter experts including those from public agencies, manufacturers, software providers, consulting firms, and automotive equipment providers. The Committee include operational users which provide quality input from the infrastructure community, the automotive industry representatives and the TISP perspective. The Committee will also include one or more technical staff from ITS JPO. This allows the ITS JPO to have quality input early in the development of project deliverables. It is the responsibility of the Committee Co-Chairs and the Project Manager to ensure that the Committee is made up of individuals appropriate for the quality aspects of the project. The Project Manager and sub-consultant team have been selected for their experience with the connected intersections and the systems engineering process.

There are two types of "quality" addressed by this plan: "product quality" and "process quality." Product quality focuses on the project deliverables. Product quality will be insured by the Committee as described in the previous paragraph. Process quality focuses on how the project deliverables will be produced. The project scope description establishes multiple cycles of Committee review, comment and comment resolution periods all directed at the aspect of quality.

5.3 Quality Control

This section describes the process for monitoring and recording the results of executing the quality activities. It applies to the project's products as opposed to its processes.

The Committee review of all project deliverables will be performed according to the project schedule. Additional reviews may be required to meet project objectives. Reviewers will verify that deliverable documents:
   a) contain suitable material for the target audience;
   b) are organized in presentation;
   c) contain proper word use and English diction;
   d) contain detailed illustrations;
   e) are comprehensive, complete and technically correct; and
   f) are edited for grammatical and editorial errors.

Project deliverables will be judged on a "suitable for purpose" basis. The Project Development Team may identify more items or make suggestions for changes to a document than are needed to meet the project goals. In some cases, gaining consensus on technical matters within a Committee can be time consuming. If any undertaking by a Committee may jeopardize the project schedule, the Project Manager or Project Coordinator/Administrator may make decisions and recommendations to move the project forward.

5.4 Quality Assurance

A Quality Checklist will be established and maintained by the Project Manager to assist in identifying specific items to be reviewed by the Committee. A Project Issue Log will be established and maintained by

the Project Manager to capture any issue regarding the project that should be addressed by the Project Management Team including items that pertain to quality. Items for the Quality Checklist and Project Issue Log may be proposed by any member of the Project Development Team. It is up to the Project Management Team to determine if these items should be included on these lists and if any action should be taken. The Project Management Team will discuss any quality items on a bi-weekly basis.

6 HUMAN RESOURCES MANAGEMENT PLAN

6.1 Purpose of the Human Resources Management Plan

This Human Resources Management Plan is a tool which aides in the management of the human resources throughout the Connected Intersections Project. It contains the roles, responsibilities and reporting on the project.

6.2 Roles, Responsibilities and Reporting

Table 3 identifies the members of the Connected Intersections Project Development Team, their roles within the project, their project responsibilities and their reporting responsibilities.

Table 3. Connected Intersections Project Development Team and Reporting

Name	Project Role	Responsibilities	Reporting
Narla, Siva ITE (202) 464-6219 snarla@ite.org	Project Administrator/ Coordinator	• Part of the Project Management Team. • Official administration and coordination of the project from a contracts perspective. • Monitors project expenditures in labor, travel expenses and capital expenses. • Official project communications channel to the COR. • Coordinates and supports the Connected Intersections Committee.	• Provides monthly progress reports to the COR per Section 4.1 including an updated Microsoft Project Schedule.
Tavares, Nicola ITE (202) 464-6208 ntavares@ite.org	Deputy Project Administrator/ Coordinator	• Part of the Project Management Team. • Official administration and coordination of the project from a contracts perspective. • Monitors project expenditures in labor, travel expenses and capital expenses. • Official project communications channel to the COR. • Supports the Connected Intersections Committee.	• Provides monthly progress reports to the COR per Section 4.1 including an updated Microsoft Project Schedule.
Roy Goudy Nissan Motor Co, Ltd (248) 488-4007 goudyr1@ntcna.nissan-usa.com	Connected Intersections Committee Co-Chair	• Part of the Project Management Team. • Provides leadership of the Connected Intersections Project Committee. • Presides over Connected Intersections Project Committee teleconferences and meetings. • Focuses the effort of the Connected Intersections Project Committee to review documents and provide feedback to the sub-consultant team in a timely fashion. • Builds consensus with the Connected Intersections Project Committee members.	•
John Thai, P.E. City of Anaheim (714) 765-5202 jthai@anaheim.net	Connected Intersections Committee Co-Chair	• Part of the Project Management Team. • Provides leadership of the Connected Intersections Project Committee. • Presides over Connected Intersections Project Committee teleconferences and meetings. • Focuses the effort of the Connected Intersections Project Committee to review documents and provide feedback to the sub-consultant team in a timely fashion. • Builds consensus with the Connected Intersections Project Committee members.	•
Tatiana Richey ITE (202) 785-0060 ntavares@ite.org	Contracts Manager	• Part of the Project Management Team. • Official administration and coordination of the project from a contracts perspective. • Prepares project policies and procedures to fulfil contract requirements.	• Provides monthly progress reports to the COR per Section 4.1 including an updated Microsoft Project Schedule.

Name	Project Role	Responsibilities	Reporting
Shen, Kezhen NEMA (703) 841-3228 Kezhen.Shen@nema.org	Project Manager	• Part of the Project Management Team. • Works with the ITE program manager to maintain project reporting required by the USDOT. • Serves as quality reviewer. • Supports the Connected Intersections Task Force.	• Provides monthly progress reports to the Project Administrator/Coordinator per Section 4.1.
Gummada Murthy, Ph.D., P.E. AASHTO (202) 624-8913 gmurthy@aashto.org	Project Manager	• Part of the Project Management Team • Works with the ITE program manager to maintain project reporting required by the USDOT. • Supports the Connected Intersections Task Force.	• Provides monthly progress reports to the Project Administrator/Coordinator per Section 4.1
Md Shah Imran, Ph.D., P.E. Atkins Global (678) 247-2523 mdshah.imran@atkinsglobal.com	SME	• Part of the Sub-Consultant Team. • Provide feedback on technical deliverables as appropriate. For example, ConOps, SysReq and SDD documents. • Participates in technical reviews (e.g., walkthroughs) of the technical deliverables.	•
Ralph Boaz Pillar Consulting (858) 352-6281 rboaz@pillarinc.com	SME	• Part of the Sub-Consultant Team. • Provide feedback on technical deliverables as appropriate. For example, ConOps, SysReq and SDD documents. • Participates in technical reviews (e.g., walkthroughs) of the technical deliverables.	•
Jay Parikh CAMP jparikh@campllc.org	SME	• Part of the Sub-Consultant Team. • Provide feedback on technical deliverables as appropriate. For example, ConOps, SysReq and SDD documents. • Participates in technical reviews (e.g., walkthroughs) of the technical deliverables.	•
Manny Insignares ConSysTec (917) 971-6962 manny.insignares@consystec.com	SME	• Part of the Sub-Consultant Team. • Provide feedback on technical deliverables as appropriate. For example, ConOps, SysReq and SDD documents. • Participates in technical reviews (e.g., walkthroughs) of the technical deliverables.	•
Patrick Chan, P.E ConSysTec (917) 497-6718 Patrick.chan@consystec.com	SME	• Part of the Sub-Consultant Team. • Provide feedback on technical deliverables as appropriate. For example, ConOps, SysReq and SDD documents. • Participates in technical reviews (e.g., walkthroughs) of the technical deliverables. • Maintains the PMP and MS Project schedule. • Prepares and maintains the SEMP.	• Provides weekly progress reports to the Project Managers per Section 4.1 including an updated Microsoft Project Schedule.

Name	Project Role	Responsibilities	Reporting
AJ Lahiri ConSysTec New York, NY (646) 874-9289 ajl@consystec.com	Consultant	• Part of the Sub-Consultant Team. • Prepare updated project schedule reflecting actual work performed for the previous month will be included with every monthly report • Prepares and maintains the PMP and MS Project schedule.	•
Wolfgang Buckel Siemens Industry, Inc. wolfgang.buckel@siemens.com	SME	• Part of the Sub-Consultant Team. • Provide feedback on technical deliverables as appropriate. For example, ConOps, SysReq and SDD documents. • Participates in technical reviews (e.g., walkthroughs) of the technical deliverables.	•
Steve Sprouffske Kapsch TrafficCom USA, Inc. steve.sprouffske@kapsch.net	SME	• Part of the Sub-Consultant Team. • Provide feedback on technical deliverables as appropriate. For example, ConOps, SysReq and SDD documents. • Participates in technical reviews (e.g., walkthroughs) of the technical deliverables.	•
Lee Mixon Mixon Hill Lee.Mixon@mixonhill.com	SME	• Part of the Sub-Consultant Team. • Provide feedback on technical deliverables as appropriate. For example, ConOps, SysReq and SDD documents. • Participates in technical reviews (e.g., walkthroughs) of the technical deliverables.	•
Michaela Vanderveen mvandervn@gmail.com	SME	• Part of the Sub-Consultant Team. • Provide feedback on technical deliverables as appropriate. For example, ConOps, SysReq and SDD documents. • Participates in technical reviews (e.g., walkthroughs) of the technical deliverables.	•

7 SYSTEMS ENGINEERING MANAGEMENT PLAN

7.1 Purpose of the Systems Engineering Management Plan

This Systems Engineering Management Plan (SEMP) establishes a common understanding of how the systems engineering portions of the project will be organized, structured, conducted and controlled to meet the project goals for:

a) The USDOT Intelligent Transportation Systems (ITS) Joint Program Office (JPO) who is sponsoring the work;

b) The partner Standard Development Organizations (SDOs) who are representing stakeholders for this project;

c) The sub-consultant team contracted to perform the work; and

d) The infrastructure community, the automotive industry representatives, Travel Information and Service Providers (TISP) and professionals participating in the Connected Intersections Project Committee which will use the deliverable items specified in this SEMP.

The organization of this SEMP is derived from the Systems Engineering Plan described in the International Council on Systems Engineering (INCOSE) Systems Engineering Handbook, Version 3.2 and IEEE Std 1220-2005, IEEE Standard for Application and Management of the Systems Engineering Process.

7.2 Systems Engineering Process Application

7.2.1 Systems Engineering Process Planning

The central activity of the Connected Intersections Project is the development of standard (or specification) to allow infrastructure community, the automotive industry representatives, and TISPs to reliably deploy and develop connected signalized intersection applications that are truly interoperable. A systems engineering process (SEP) is being applied to the project incorporating layers of review and modification of the deliverable documents to minimize development risk. Sections 2.2.1 and 4.3 provide the details of the tasks and schedule. The primary objectives of this project are to: a) establish and maintain a cohesive project management plan; b) deliver an approved Connected Intersection guidance document; and c) provide stakeholder input based on actual product development.

7.2.2 Process Inputs

Inputs to this systems engineering process are as follows:

- *Clarifications for Consistent Implementations (CCIs) To Ensure National Interoperability Connected Signalized Intersections*
- *SAE J2735_201903, Dedicated Short Range Communications (DSRC) Message Set Dictionary*
- *MAP/SPaT Planning and Implementation Considerations*
- *Industry experience from CV Pilot Programs and the Signal Phase and Timing (SPaT) Challenge*

7.2.3 Technical Objectives

The technical objectives for the Connected Intersections Project are identified in the project scope description found in Section 2.2.1 of this document.

7.2.4   Training

The Project Development Team requires no additional training. Most members of the team are at a senior level technically and considered subject matter experts with the deployment of connected vehicle applications at signalized intersections.

7.2.5   Standards and Procedures

Table 4 identifies the standards or procedures used in the production of the project deliverables. (Note: this table uses the Task numbers identified in Section 2.2).   If there are multiple drafts of a deliverable item, only the first version of the deliverable is listed. All the other versions of the deliverable will use the same standard or procedure.

Table 4. Deliverable Items and Associated Standards or Procedures

Proj Task	Deliverable Item	Standard or Procedure
1.1	Monthly Progress Report	As described in Section 4.1.
1.2	Project Management Plan including System Engineering Management Plan	As described in Section 2.2.1.1.2 of this PMP.
2.1.1	Connected Intersection Committee Roster	None
2.1.2	Draft Connected Intersection ConOps	IEEE 1362-1998
2.1.3	ConOps Walkthrough Plan	IEEE 1028-1997
2.1.3	ConOps Walkthrough Comment Resolution Report	None
2.2.1	Draft Connected Intersection System Requirements Specification	IEEE 830-1998
2.2.2	SRS Walkthrough Plan	IEEE 1028-1997
2.2.2	SRS Walkthrough Comment Resolution Report	None
2.3.1	Draft Connected Intersection System Design Description	IEEE 1016-1998
2.3.2	SDD Walkthrough Plan	IEEE 1028-2008
2.3.2	SDD Walkthrough Comment Resolution Report	None
2.4.2	Final Connected Intersection MIB and/or ASN.1 (if necessary)	Not Applicable
2.4.2	Final Connected Intersection Document	NTCIP 8002 Annex B1
3	Connected Intersection Validation Report	None
4	Updated CI Implementation Guide	NTCIP 8002 Annex B1

7.2.6   Systems Engineer Role

The Systems Engineer (SE) role has a broader influence in the Connected Intersections Project than that of traditional SE roles. Responsibilities include:

-
- Support task forces in research and interview process and identifying user needs.
- Collecting user needs from task forces.
- Preparing and maintaining the SEMP.
- Developing the ConOps and SRS documents.
- Assisting with systems engineering portions of design documents.

- Leading walkthroughs of documents at various stages of the project.
- Providing the overall project rigor required to verify that complete and correct project products are being developed.
- Ensuring traceability throughout project documents as appropriate.

General resource levels for the Systems Engineer are shown in Table 5. Resource levels are categorized as follows:
a) Primary – The task is primarily an SE function.
b) Secondary – The SE plays a secondary role in the task.
c) Advisory – The SE plays a small or advisory role in the task.
d) N/A – The task does not apply to the SE.

Table 5. Resource Levels for the Systems Engineer

Proj Task	Project Task	Resource Level
1.2.6	Project Management Plan	Secondary
1.3.6	System Engineering Management Plan	Primary
2.1.2	Review CCIs	Secondary
2.1.2	Develop questionnaires and perform stakeholder interviews	Primary
2.1.2	Develop Draft Concept of Operations	Primary
2.1.3	Walkthrough on Draft Concept of Operations	Primary
2.1.3	ConOps Walkthrough Comment Resolution Report	Primary
2.1.3	Final Concept of Operations	Primary
2.2.1	Develop Draft System Requirements Specification	Primary
2.2.2	Walkthrough on Draft Systems Requirements Specification	Primary
2.2.2	SRS Walkthrough Comment Resolution Report	Primary
2.3.1	Draft System Design Descriptions	Primary
2.3.2	Walkthrough on Draft System Design Descriptions	Primary
2.3.2	SDD Walkthrough Comment Resolution Report	Primary
2.4.1	Develop Recommended Connected Intersection Document	Primary
2.4.2	Publish the Connected Intersection Document	Secondary
3	Develop Connected Intersection Standard Validation	Primary
4	Update to Connected Intersections Guide	Primary

7.2.7   Work Authorization

Specific work authorization is required at the following points in the Connected Intersections Project:

- Task 1.2 Authorization to Proceed is required from USDOT before advancing to Task 2 Develop Connected Intersection Standard.
- Task 3.1. Receive Authorization to Proceed is required from USDOT before work on Task 3 may begin.

7.3   Systems Analysis and Control

This section describes how the systems engineering portions of the project shall be performed and controlled. Included are the project team organization, a configuration management plan, a verification and validation plan and a risk management plan,

7.3.1   Configuration Management Plan

It is intended that each deliverable document and will be maintained under an electronic configuration management system which includes issue tracking.

7.3.1.1   Configuration Management of the Connected Intersections Products

The products delivered under this project shall use version numbering to uniquely identify draft documents that are circulated for review, comment, acceptance and approval within the project development team, the Connected Intersections Project Committee, and the SDOs. The systems engineering documents ConOps, SRS, SDD, and the software developed under this SEMP will use the form "XX.YY" where: "XX" is the two digit major revision number, and "YY" is the two digit minor revision number. Whenever a document or software is to be circulated, the author will increment the minor revision number or letter whichever is appropriate prior to circulation. The author may increment the version of a document multiple times for his or her own configuration management purposes. This is permitted. If a document is being edited by multiple people simultaneously, one person will be designated by the project manager as editor-in-chief (EIC). In this case, the EIC will gather the document changes, paragraphs, sections, etc. from the other authors and be responsible for sending out the draft document with a new version number. All documents developed under this SEMP will start with a major revision number of 01.

The Project Manager and Connected Intersections Project Committee Co-Chairs will act as a configuration management board. They will determine when Project Products are suitable for coming under configuration management. Table 7 lists the project products which are the baseline items to come under configuration management.

Table 7. Project Products for Baseline Configuration Management

Proj Task	Configuration Management Baseline Item
1.2.6, 1.3.6	Project Management Plan including System Engineering Management Plan
2.1.2	Stakeholder List and Questionnaire
2.1.2	Draft Connected Intersection ConOps
2.1.3	ConOps Walkthrough Plan
2.1.3	Connected Intersection ConOps Walkthrough Workbook
2.1.3	ConOps Walkthrough Comment Resolution Report
2.2.1	Draft Connected Intersection Systems Requirements Specification
2.2.2	SRS Walkthrough Plan
2.2.2	Connected Intersection SRS Walkthrough Workbook
2.2.2	SRS Walkthrough Comment Resolution Report
2.3.1	Draft Connected Intersection SDD
2.3.2	SDD Walkthrough Plan
2.3.2	Connected Intersection SDD Walkthrough Workbook
2.3.2	SDD Comment Resolution Report
2.4.1	Recommended Connected Intersection Document
2.4.2	Connected Intersection Standard MIB and/or ASN.1
2.4.1	Final Connected Intersection Document
3.3	Connected Intersections Validation Report
4.5	Updated CI Implementation Guide

7.3.1.2   Comment Database Configuration Management

A comment database will be maintained throughout the entire project. The purpose will be to: a) capture comments both external and internal to the Committee that are to be addressed and b) to maintain comments that are to be deferred for a future time if they are not addressed during this development. During the development process, the formal comments will be reviewed by the Committee, adjudicated as to their relevancy, and changes made to the documentation as appropriate. This comment database is separate from the Project Issue Log discussed in Section 5.4.

7.3.2   Verification and Validation Plan

Verification and validation (V&V) of whether the information content of the Connected Intersection document is complete and correct will rely on reviews of the pertinent information, summarized in the list below, and detailed in the subsequent Technical Review subsections:

a) The sub-consultant team and the Committee will perform at least two technical reviews of the ConOps, requirements content and design content.

b) The sub-consultant team will perform a check for completeness and correctness of the user needs and requirements wording. The user needs and requirements are documented in the ConOps and the Requirements Specifications. The wording of each User Need will be evaluated as expressing a major capability, being solution free, and capturing intent and rationale. The wording of each Requirement statement will be checked for identifying a necessary attribute, capability, characteristic, or quality of the system in order for the system to have value and utility. This wording check will be presented to the Committee and other stakeholders as part of respective Walkthroughs.

c) The sub-consultant team and the Committee will perform a check for logical completeness by performing a requirements traceability and consistency check. Requirements traceability is documented in the PRL and the RTM. This requirements traceability check will be presented to the Committee and other stakeholders as part of the SRS Walkthrough efforts.

d) The sub-consultant team and the Committee will perform a Design Content Consistency Check of the new Requirements content to the prior and/or revised system design details. This check will be presented to the Committee and other stakeholders as part of the SDD Walkthrough.

e) The sub-consultant team will compile the MIB or ASN.1, if appropriate, prior to the proposed User Comment Draft (UCD) to check the MIB for completeness and correctness. The MIB check will be performed again prior to the proposed Recommended Specification or proposed Recommended Standard (pRS). Note this may be a specification rather than a standard based on schedule constraints, as determined by the Committee.

f) The UCD version, distributed to all interested parties with an invitation to submit proposed revisions (formerly known as "user comments", is a customer-based V&V activity.

g) The pRS version, distributed to the Committee for review, comment and acceptance, is a V&V activity.

7.3.3   Walkthrough Reviews

Walkthroughs, sometimes referred to as "technical reviews," or "technical walkthroughs," provide a structured and organized approach to reviewing project products to determine if they are complete, correct, and accurate. Walkthroughs are used to identify defects (in needs, requirements or design) and identify alternative solutions at specified points in development (such as ConOps, SRS, and SDD). Walkthroughs are also used to clarify outputs (needs, requirements, or data concepts) and create a common understanding among the reviewers of the material. Walkthroughs represent the "control gates" that must be passed before the project can proceed to the next step in the development process. Walkthroughs generally focus on technical "correct-ness" and logical consistency; however, in conjunction with the SRS Walkthrough, requirements traceability (as reflected in PRL) is evaluated; and, in conjunction with the SDD walkthrough, requirements traceability (as reflected in the RTM) is evaluated. TPG software may be employed at either or both of these stages, timing permitting, to augment the

requirements traceability and logical consistency checks performed by participants. Regardless of timing, TPG software will be used to evaluate requirements traceability either prior to or during, the User Comment Draft stage. The committee may schedule additional, subsequent reviews with task forces to provide support by web conference.

At least two weeks prior to each scheduled Walkthrough, the sub-consultant team will develop a draft review output to be used in the conduct of the Walkthrough. This output is likely to include a draft Walkthrough workbook to guide Walkthrough participants in their review for logical consistency, quality of User Need and/or Functional Requirements, and (for SRS and SDD Walkthroughs) requirements traceability. The sub-consultant team (assisted by the Committee and stakeholders) will perform a logical consistency check, including a requirements traceability check if appropriate, at appropriate points prior to or following Walkthroughs, using TPG software when appropriate.

The Walkthrough workbook will be used to manage revisions identified during the walkthrough. Officially submitted or external comments received prior to or following the Walkthroughs will be entered into the proposed revision database. Editorial proposed revisions, such as grammar and spelling, do not have to be disposed of during the Walkthrough or entered in the proposed revision database and can be addressed directly by the sub-consultant team. However, as a part of each Walkthrough, any entry in the proposed revision database that may impact the Walkthrough will be brought to the attention of Walkthrough participants for consideration. Any changes to the proposed revision database (new comments and resolutions to old comments) resulting from the Walkthrough will be entered in the proposed revision database, for subsequent consideration. Informal comments, such as those that may arise during a Walkthrough, may not be entered in the proposed revision database; rather, the draft resulting from the Walkthrough serves to capture proposed revisions.

Beyond addressing the comments received, the format of and procedures used for each Walkthrough and subsequent review will vary by subtask and depending on whether the review is of the first draft of ConOps or later walkthroughs. For example, the ConOps Walkthrough may only consist of a page by page review of the user needs for correctness and logical consistency; while the SRS Walkthrough should consist of a review for correctness and logical consistency, as well as requirements traceability. The SDD Walkthrough will review content from the design document as part of its logical consistency and traceability check, which may result in revision of the ConOps. Or, at later stages, only content that has changed since the ConOps Walkthrough may be subjected to logical consistency and requirements traceability checks. Regardless, IEEE 1028-2008's Section 7 will be used as a reference to design and conduct the Walkthrough, and the format and procedures to be used for that walkthrough shall be included in the draft review output prior to the Walkthrough.

7.3.4 Requirements Traceability and Logic Check

One of the key controls and validation activities of the development is tracing requirements. This tracing will occur in two directions - backward to the User Needs defined in the ConOps, and forward to the specification of design details.

Two types of traceability will be managed throughout the development process:

a) User Needs to Requirements traceability, called a Needs to Requirements Traceability; and
b) Requirements to Design traceability, called a Requirements Traceability.

7.3.4.1 User Needs to Requirements Traceability and Logic Check

The Committee and stakeholders will review and comment on the check of needs and requirements performed by the sub-consultant team to ensure that all user needs are defined and that the requirements

stated satisfy a particular user need. The User Needs to Requirements traceability is documented in the PRL. The PRL forms the basis for this check and its review by the stakeholders.

The sub-consultant team anticipates holding at least one Walkthrough in Washington, D.C. to enable the participation of all SDO staff and the ITS JPO support staff.

The PRL lists all the user needs in the ConOps and is used to verify that all the User Needs have been satisfied by at least one Requirement. The PRL will be created after the completion of the ConOps, and then will be updated at each remaining step of the development process. The logical association of the User Needs and their supporting Requirements will be tested. Illogical associations will be eliminated, or statement wording will be revised.

The goals and technical approach of the logical consistency check is to ensure that the organizational list of the concepts (the UNs and Requirements) make a logical framework that makes sense to both IOOs and OEMs. While software (such as TPG) may be used for Requirements Traceability purposes, it is anticipated that logical consistency checks are the responsibility of the sub-consultant team, the Committee, and stakeholders, as part of the ConOps and SRS Walkthroughs. The concepts should flow from broad to narrow, or in some other easily recognized framework. The technical approach can include listing in a table (e.g., the PRL), organizing, diagramming, charting, or using other graphical techniques to build and visualize a framework. Walkthrough workbooks are anticipated for both the ConOps and SRS Walkthroughs to guide review of technical correct-ness and traceability.

7.3.4.2   Requirements to Design Traceability and Logic Check

During the SDD Walkthrough, the sub-consultant team, the Committee, and stakeholders will review and comment on the mapping of requirements to design elements to ensure that all requirements are satisfied by the design elements. The Requirements to Design traceability will be documented in the RTM. The RTM forms the basis for this check and its review by stakeholders. In this way, the RTM will be used to verify and validate that a dialog satisfies one or more information exchange requirements. A Walkthrough workbook is also anticipated prior to the SDD Walkthrough to guide review.

The RTM will map from requirements to design details. Each requirement will map to one and only design detail. The RTM will be created after the completion of the requirements content, then will be updated at each remaining step of the development process.

In addition, while software (such as TPG) may be used for Requirements Traceability purposes, it is anticipated that logical consistency checks remain the responsibility of the sub-consultant team, the Committee, and stakeholders, as part of the SDD Walkthrough. The sub-consultant team will provide periodic reminders to the Committee and stakeholders, so that this responsibility is not overlooked.

Upon completion of the RTM, the sub-consultant team will perform a traceability check of the Connected Intersection document for any orphan design details that may have been overlooked as part of the preceding Walkthroughs, e.g., any dialogs, data objects, or block objects that have not been mapped to a requirement. Those orphan design details will be reviewed with the Committee to determine if any user need and requirement can be identified that the design details can be mapped to. If no user need and requirement can be identified for an orphan design detail, that design detail will be deprecated for the Connected Intersection document.

When the project reaches Task 2.4, each Systems Engineering (SE) element will have been considered during at least one walkthrough, and during at least one walkthrough, participants will have considered a "logical consistency check" signified by a question for each SE element in a walkthrough workbook. For each SE element, participants are asked a question of the form: "Is the [systems engineering element]

logically consistent with [the related systems engineering element(s)]?" The logical consistency check is, by its nature:

    a) Subjective - requiring a moment of critical thinking by each walkthrough participant, regarding each Systems Engineering element (user need, requirement, SDD, or test case); and
    b) Incremental - conducted as part of each walkthrough.

To restate, it is anticipated that, logical consistency for each SE element is evaluated:

    a) when new SE elements are developed, or when existing SE elements are revised, by the Systems Engineer;
    b) during at least one walkthrough, as SE elements are developed and traced (when walkthrough participants consider the question "is this SE element logically consistent?"); and finally,
    c) at this stage, logical consistency is evaluated for SE elements, to ensure that SE elements are "clear, concise and properly constructed ensuring proper communication is translated into the document, and reflected in the design" is verified.

7.3.5   Risk Management Plan

This section identifies potential problems in the project before they occur, plans for their occurrence, and monitors the system development so that early actions can be taken. A Risk Log has been established as shown in Table 6. Using this log risks can be identified, analyzed, prioritized, and mitigated. Note: The Risk Log will be initiated with risk items once funding levels and priorities are established for the Connected Intersections Project.

Risk monitoring will be performed by the project manager on a bi-weekly basis. Each risk area addressed in this PMP will be reviewed along with any new risk area that is identified during the execution of the project. At any time during the project any member of the Committee or interested parties may alert the management team of the occurrence of a risk item or identify new risk areas. New risk areas identified will be added to a Risk Log Table maintained by the project manager.

Table 6. Risk Log

ID#	Project Work Stream	Status	Risk Category	Description	Impacts	Owner	Mitigation (update where applicable)	(P)	(I)	P*I	Priority
01		N	c	Insufficient Participation from Different Stakeholder Groups			See below.	2	2	4	
02		N	c	Incorrect or Incomplete Inputs on User Needs and Requirements			See below.	2	2	4	
03		N	a, b, c	Late User Needs (or Requirements) come in late in the process			See below.	1	2	2	
04		N	c	Rulemaking from Regulatory Agencies may impact User Needs and Requirements			See below.	2	2	4	
05		N	a, b, c	Insufficient Time to Develop a Complete Standard			See below.	3	3	9	

LEGEND:
ID# – Unique identifier for each identified risk item.
Project Work Stream – Specific contract/task order activity and/or deliverable to which the risk item applies.
Status – N: New
       R: Retired
       IDPMP: Identified in PMP or SEMP
Risk Category –
    a) Schedule – Risks that cause schedule slippage of the project;
    b) Cost – Risks that cause cost to exceed budget of the project; and
    c) Technical – Risks affecting the completeness or correctness of the product.
Description – Concise description of the risk item.
Impacts – Impacts on the task or program if the identified risk occurs.
Owner – Individual or entity with authority to resolve risk.
Risk Response Plan – Description of the planned response should an identified risk occur. This column can be a reference to a specific plan document.
Date Assessed – Most recent date the risk and/or risk response plan was updated.
(P) – See Table 5 below.
(I) – See Table 5 below.
P*I – Risk probability (P) multiplied by impact of risk (I).
Priority - Identifies priority based on the P*I.

Table 7. Values Assigned for Probability of Risk and Impact of Risk

Probability of Occurrence (P)	Impact of Risk (I)
3 = High Certain or very likely to occur	**3 = High** Major impact on cost, schedule, or scope
2 = Medium 50/50 chance of occurring	**2 = Medium** Significant impact on cost, schedule or scope
1 = Low Possible, but unlikely to occur	**1 = Low** Insignificant impact on cost, schedule, or scope

Risk Item Details

01) Insufficient Participation from Different Stakeholder Groups

02) Incorrect or Incomplete Inputs on User Needs and Requirements

03) Late User Needs (or Requirements) come in late in the process

04) Rulemaking from Regulatory Agencies may impact User Needs and Requirements

05) Insufficient Time to Develop a Complete Standard

Risk Area #1: Insufficient Participation from Different Stakeholder Groups

The risk is that this project needs inputs from different stakeholders and insufficient participation or inputs are collected from different stakeholder groups. This project involves the development of a document that represents a clear understanding between three different sets of stakeholders, the infrastructure community providing data about the traffic signal operations at a signalized intersection, the automotive industry representatives, who must interpret the data provided so a driver and/or vehicle can safety traverse the signalized intersection, and travel information and service providers (TISPs), who must access the information, and format the information for use by travelers.

The assumption in the project development cycle is that complete and correct inputs will be obtained from all sources, enabling the sub-consultant team to proceed with the development of the ConOps and other technical deliverables that may flow from the ConOps. The inputs from the different stakeholder groups will result in different user needs for the Connected Intersections project. What if this assumption is not correct – i.e., there is insufficient representation from the different stakeholder groups being interviewed to provide their inputs, or those who are the subject of targeted interviews provide incomplete inputs. This is a risk area that will need to be carefully evaluated and monitored by the Project Management Team.

Mitigation:
The three primary mitigations to this risk area are:
a) Include several example operational scenarios in the ConOps to allow the sets of stakeholders to gain a clear understanding of the traffic signal operations, how those operations are represented, and how the same operations should be interpreted. Through these operational scenarios, stakeholders may also identify user needs that have not already been identified.
b) The SDOs representing other stakeholder groups, such as SAE International representing the automotive industry, and IEEE, representing the communications/networking industry, will provide liaisons that can identify additional stakeholders to provide inputs.
c) The draft ConOps may be distributed concurrently to solicit broader feedback from other affected stakeholders beyond the sub-consultant team and the Connected Intersections Project Committee.

Risk Area #2: Incorrect or Incomplete Inputs on User Needs and Requirements

The risk is that the sub-consultant team does not get correct or complete inputs on User Needs and Requirements from the User Needs targeted user interviews. This development effort will be identifying a set of needs and requirements for the Connected Intersections project. The inputs by each task force are the primary source of information from which User Needs are identified. Requirements are later derived from the User Needs.

The assumption in the project development cycle is that complete and correct inputs will be obtained from all sources, enabling the sub-consultant team to proceed with the development of the ConOps and requirements. What if this assumption is not correct – i.e., the key stakeholders are not able to be interviewed to provide their inputs, or those who are the subject of targeted interviews provide incomplete inputs. This is a risk area that will need to be carefully evaluated and monitored by the Project Management Team.

Mitigation:
The four primary mitigations to this risk area are:
   a) Include several example operational scenarios in the ConOps to allow both set of stakeholder groups to gain a clear understanding of the traffic signal operations, how those operations are represented, and how the same operations should be interpreted. Through these operational scenarios, stakeholders may also identify user needs that have not already been identified.
   b) The Connected Intersections Project Committee Co-Chairs and the task forces will coordinate with key stakeholders to clearly identify the information needed and will follow up prior to the User Needs targeted stakeholder interviews to ensure they understand and are able to provide the information. If incomplete information is obtained, the Connected Intersections Project Committee Co-Chairs or the appropriate task force will contact and engage the interviewees for a follow-up interview.
   c) The draft ConOps may be distributed concurrently to solicit broader feedback from other affected stakeholders beyond the sub-consultant team and the Connected Intersections Project Committee.
   d) The appropriate task force team will review the *Clarifications for Consistent Implementations (CCIs) To Ensure National Interoperability Connected Signalized Intersections* document to confirm that the user needs and requirements are consistent with the functionality defined in the document. The SMEs on the sub-consultant team and the Connected Intersections Project Committee members should have the knowledge to "fill in" the incomplete areas based upon their technical knowledge of the document and the subject matter.

Risk Area #3: Late User Needs (or Requirements) come in late in the process

The risk is that User Needs or Requirements come in late in the process; that is, new User Needs (or more likely new Requirements) are identified after the "final" needs or requirements have been developed. This could happen as new stakeholders become involved during the development process, or as each step through the process uncovers new or changed needs or requirements.

Mitigation:
This risk will be mitigated if the mitigation strategies for Risk Area #2 are successful by uncovering a fairly complete set of needs and requirements. The schedule does recognize that some changes in needs/ requirements will occur and has built in effort (from a cost standpoint) to deal with these. If this risk becomes more severe during the design phase (or later under the final development), part of the risk mitigation strategy for this risk will be to explicitly address needs and requirements impacts as part of the design

discussion and to engage the Connected Intersections Project Committee in discussion at each meeting about the importance of the suggested changes.

The Project Management Team may activate a rapid response team, if necessary, to address any late user needs or requirements that may be received.

Risk Area #4: Rulemaking from Regulatory Agencies may impact User Needs and Requirements

The risk is that regulatory agencies, such as the Federal Communications Commission (FCC) or USDOT may issue rulemaking that impacts the user needs and requirements for this project. For example, while the Connected Intersections project may strive to communications agnostic, regulations that dictate the availability and the usage of a communications technologies will impact primarily the requirements for the Connected Intersections project, and possibly how the user needs are expressed.

Mitigation:
The two primary mitigations to this risk area are:
   a) The sub-consultant team will carefully write the user needs and requirements in a communications agnostic manner so not to dictate or restrict the communications technologies that can be used to fulfill requirements and satisfy user needs.
   b) The Project Management Team will closely track proposed rulemakings from the applicable regulatory agencies, such as the FCC or USDOT. If a new rulemaking has a potential impact on the Connected Intersections project, the Project Management Team will immediately inform USDOT so the impacts on the Connected Intersection document can be quickly understood, and a decision can be made on any potential changes to the scope or performance of the tasks. Based on those decisions, the Connected Intersections Project Committee will be informed, and the Connected Intersections Project Committee will provide guidance to the sub-consultant team on any changes that may need to be made to the current user needs and requirements for the Connected Intersections Project.

Risk Area #5: Insufficient Time to Develop a Complete Standard

The risk is that there is insufficient time to finish the development of a fully complete standard going through all the steps of the standards development process of the participating SDOs within the period of performance (2 years) of the Connected Intersections project. The development of a standard for an SDO involves multiple well-defined steps that must be completed prior to balloting and approval by the SDO. NTCIP, for example, has a defined process that involves the development of a document under the auspices of a working group appointed by the NTCIP Joint Committee, the incremental development of drafts with allotted periods for review of drafts, approval of drafts by the working group, and approval by the Joint Committee, then balloting and approval by the 3 SDOs that comprise the NTCIP based on each SDO's individual balloting processes. This standards development process requires a fixed amount time to complete at a minimum. The amount of time to complete the standards development process for the Connected Intersections project is further exacerbated in that SDOs for other stakeholder groups are involved in this project (e.g., SAE International) and those SDOs may require approval of the project products in accordance to their individual SDO standards development processes.

When considering the different steps involved with the standards development process, the steps involved, the number of required reviews, the minimum period required for reviews, and the minimum required times for balloting by SDOs, there will likely be insufficient time available for actual development of a Connected Intersection standard within the 2 year period of performance.

Mitigation:
The primary mitigation to this risk area is to:

a) While completing the steps for a standards development process, focus on the development of a Connected Intersection specification. The industry, as represented by the stakeholder groups involved with the project, needs guidance for a connected signalized intersection in a timely manner. The development of a guidance document or a specification does not require as rigorous review as those necessary for a proposed standard. By focusing on the development of a specification, guidance can be provided to the stakeholder groups within the period of performance and in a timely manner. The project will follow the steps for a standards development process, so, if the development of a standard can be completed within the period of performance, that would be the goal for the efforts. The decision on if the Connected Intersection document is released as a proposed Recommended Specification or as a proposed Recommended Standard will be determined by the Committee.

APPENDIX A – REFERENCES

USDOT ITS Joint Program Office, *Performance Work Statement for Institute of Transportation Engineers (ITE) Connected Signalized Intersection, Contract DTFH6116D00055, Task Order Proposal Request No. HOIT190166PR*. USDOT ITS Joint Program Office, 2019.

Cooperative Automated Transportation Coalition (CAT), *Clarifications for Consistent Implementations (CCIs) To Ensure National Interoperability Connected Signalized Intersections.*

IEEE, *IEEE Std 830-1998, IEEE Recommended Practice for Software Requirements Specifications,* 1998.

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IEEE, *IEEE Std 1028-1997, IEEE Standard for Software Reviews,* 1997.

IEEE, *IEEE Std 1220-2005, IEEE Standard for Application and Management of the Systems Engineering Process,* 2005.

IEEE, *IEEE Std 1362-1998, IEEE Guide for Information Technology - System Definition - Concept of Operations Document,* 2005.

National Transportation Communications for ITS Protocol (NTCIP) Website
https://www.ntcip.org

APPENDIX B – GLOSSARY, ACRONYMS AND ABBREVIATIONS

Term	Definition
AASHTO	American Association of State Highway and Transportation Officials
ATP	Authorization to Proceed
AV	Automated Vehicles
CCI	Clarifications for Consistent Implementations
CO	Contracting Officer
ConOps	Concept of Operations
COR	Contract Officer's Representative
CI	Connected Intersection
CV	Connected Vehicles
CVO	Commercial Vehicle Operations
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
N/A	Not Applicable
NEMA	National Electrical Manufacturers Association
NTCIP	National Transportation Communications for ITS Protocol
OBU	On Board Unit
OSS	Open Source Software
PMP	Project Management Plan
PRL	Protocol Requirements List
pRS	Proposed Recommended Standard
PWS	Performance Work Statement
RI	Reference Implementations
RSU	RoadSide Unit
RTCM	Radio Technical Commission for Maritime Services
RTM	Requirements Traceability Matrix
SDD	System Design Description
SDO	Standards Development Organization
SE	Systems Engineering
SEMP	Systems Engineering Management Plan
SEMS	Systems Engineering Master Schedule
SEP	Systems Engineering Process
SME	Subject Matter Expert

Term	Definition
SPaT	Signal Phase and Timing
SRS	System Requirements Specification
TBD	To Be Determined
TISP	Travel Information and Service Provider
TOCOR	Task Order Contracting Officer's Representative
TPG	Test Procedure Generator
TSCBM	Traffic Signal Controller Broadcast Message
USDOT	United States Department of Transportation
WBS	Work Breakdown Structure

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