System Engineering Management Plan (SEMP) for the Intelligent Transportation System (ITS) Cabinet Version 2 Project – USDOT Work Order 14-0701, Tasks 7-12

November 4, 2009

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American Association of State Highway and Transportation Officials (AASHTO)
444 North Capitol St., NW, Suite 249
Washington, DC 20001

Institute of Transportation Engineers (ITE)
1099 14th St. NW, Suite 300 West
Washington, DC 20005

National Electrical Manufacturers Association (NEMA)
1300 North 17th Street, Suite 1752
Rosslyn, VA 22209-3806

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Revision History

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<th>Filename</th>
<th>Version</th>
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<td>ITS Cabinet SEMP- draft v1.doc</td>
<td>0.00.1</td>
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</tr>
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<td>ITS Cabinet SEMP-00-02.doc</td>
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<td>7/11/08</td>
<td>Incorporate comments from Working Group</td>
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<tr>
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<td>Initial final version incorporating comments from Noblis</td>
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<td>11/04/09</td>
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1 Purpose of Document
This document is a description of the system engineering plan that will be used for the development of the ITS Cabinet Version 2. The Systems Engineering Management Plan (SEMP) is the top-level plan for managing the systems engineering effort. The SEMP defines how the systems engineering portion of the project will be organized, structured and conducted and how the total engineering process will be controlled to provide a product that fulfills customer requirements. The SEMP will be used in technical management of the project. The SEMP outline included in INCOSE SE Handbook, Version 2a, Appendix C was used as a guide for the development of this SEMP. The format and content of the SEMP has been tailored to fit the project.

2 Project Scope
The following project scope description is copied from the Program Management Plan (see Section 4 Referenced Documents).

The ITS Cabinet Version 2 Project is sponsored by the United States Department of Transportation (USDOT) Joint Program Office (JPO) as part of an ITS Standards Development Program. The project is to be performed under the direction of the Advanced Transportation Controller (ATC) Joint Committee (JC). The ATC JC is made up of representatives from three SDOs: the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE) and the National Electrical Manufacturers Association (NEMA). The development effort will be carried out by the ITS Cabinet Working Group (WG), a technical subcommittee of the ATC JC, and a paid consultant team including a Project Manager, Systems Engineer, and Technical Expert/Technical Writer to support the WG.

The Advanced Transportation Controller (ATC) family of standards are intended to provide open architecture hardware and software platforms that can support a wide variety of ITS applications including traffic management, safety, security and other applications. There are currently four ATC Standards: the ATC/2070 Standard, the ITS Cabinet Standard, the ATC Controller Standard, and the ATC Application Programming Interface (API) Standard. These standards are used by agencies who specify and purchase ATC equipment, manufacturers who build ATC equipment, software developers who write application software for ATC equipment, and consultants who integrate ATC equipment into systems.

The key objectives of the ITS Cabinet V2 Project are:

1. Develop an ITS Cabinet V2 Standard assessing issues and integrating lessons learned from current deployments of the ITS Cabinet Standard into a Concept of Operation (ConOps), requirements and design. User needs to be considered include, but are not limited to: low-power features, items referred to as "B-List" items by the ITS Cabinet WG, and mercury relay replacement. These items along with all others solicited will be introduced into the Systems Engineering Process (see objective #2) to examine their relevancy.
2. Use a Systems Engineering Process to ensure the completeness and correctness of ITS Cabinet V2 documents. The standard must be traceable and logically consistent.
3. Develop a detailed conformance statement that addresses backwards compatibility and provides clear and unambiguous instruction on how to extend the standard.

3 Systems Engineering Process

3.1 Systems Engineering Process Overview

A systems engineering process is a structured way of thinking about and defining a system. The systems engineering process is an iterative approach to technical management, acquisition and supply, system design, product realization, and technical evaluation at each level of the system, beginning at the top (the system level) and propagating those processes through a series of steps which eventually lead to a preferred system solution. Figure 1 shows a representation of the systems engineering process called the VEE diagram. This general process has been customized for use in the development of the ITS Cabinet V2 Standard. The focus of this development effort will be the process steps from the left side of the VEE that are indicated by the oval in Figure 1.

![Figure 1: Systems Engineering Process](image)

Due to the nature of this development effort, there is no software coding or hardware fabrication involved in the final outputs. Nor is there testing per se. The effort will focus on concept of operations (defined by user needs), system requirements (primarily functional requirements), and design (both aspects of high level and detailed design). The following sections focus on the process for performing the system engineering steps that are a part of this project.

3.2 Concept of Operations

The purpose of a Concept of Operations is to clearly convey a high-level view of the “system” to be developed that each stakeholder can understand. This portion of the development effort identifies the user needs that must be addressed by the standard. The current ITS Cabinet
ITS Cabinet V2 SEMP

The new concept of operations section will contain subsections per the above outline except for Referenced Document, System Overview, and Operational Scenarios. The primary source of user needs update will be a User Needs Workshop which is planned early in the development effort. The focus of the workshop will be to gather needs (and associated requirements or design inputs) from the following groups:

- Public Sector deployers of existing cabinet standards and specifications including ITS Cabinet V1, NEMA TS 2, NEMA TS 1, and Caltrans TEES.
- Manufacturers who build ITS field equipment.
- Software developers who create application programs that operate on ITS field equipment.
- Systems integrators who create systems with ITS field equipment.

The workshop will identify Advanced Cabinet needs using some combination of presentations by the contractor team and by stakeholder representatives. The precise format of the workshop will be determined based upon discussions with the ITS Cabinet Working Group. The workshop may be a face to face meeting, or a web conference, depending on discussion with the Working Group.

Following the workshop, a set of user needs covering the Advanced Cabinet will be created and will be entered into a database that will be used to provide traceability of needs to requirements to design (discussed in Section 3.5.6).

3.3 System Requirements

This portion of the development process identifies the system requirements which the Advanced Cabinet must satisfy. The current version of the ITS Cabinet Standard is a design specification that is hierarchically organized in the following way:

- General ITS Cabinet Requirements
- Requirements on Auxiliary Cabinet Units
- Requirements on Detector Sensor Units, Elements and Isolators
- Cabinet System Requirements

The current standard does not include a set of requirements traced to this design.
The plan for ITS Cabinet development is to create a set of requirements that fully cover the complete scope of an Advanced Cabinet (as identified by the working group). Each requirement will be uniquely numbered to support traceability throughout the project. Requirements collection will begin at the User Needs Workshop described above, augmented by additional written inputs from deployers. The full set of requirements will be entered into a requirements traceability tool in order to perform requirements traceability as discussed in Section 3.5.6.

The process of requirements development will identify that these requirements are complete and correct. This will make use of the Needs to Requirements Traceability Matrix (NRTM), which is discussed in more detail in Section 3.5.5. For each requirement the following criteria will be reviewed:

1. Is it a “good” requirement? Some of the attributes of “good” requirements are:
   - Necessary (see bullet 2)
   - Clear (unambiguous)
   - Complete (see bullet 3)
   - Measurable (quantifiable)
   - Consistent (with each other)
   - Achievable (feasible)
   - Testable
   - Technology independent

2. Is the requirement mapped to one or more user needs? This will also address whether the requirement is in fact needed.

3. Does the requirement satisfy the intent and all key items of the need?

### 3.4 Design

The exact scope of the design effort for this project will be reviewed and determined at the conclusion of the requirements development effort. The needs and requirements aspects of the project are addressing the complete scope of an Advanced Cabinet.

**Backwards Compatibility and Extensions to the Standard**

One of the objectives of the project is to “develop a detailed conformance statement that addresses backwards compatibility and provides clear and unambiguous instruction on how to extend the standard.” The contractor team will work with the Working Group to define what backwards compatibility means for the ITS Cabinet V2 Standard and the types of cabinets to which it will apply (ITS Cabinet V1, NEMA TS2 Type 1, etc.). Regarding extensions, the contractor team will also work with the Working Group to define to what extent extensions will be allowed to the standard.

### 3.5 Systems Analysis and Control

This portion of the SEMP describes the team organization and the plans that will be put in place to control the development process.

#### 3.5.1 Team Organization

The ITS Cabinet Version 2 effort will be carried out by the team identified in Figure 3.
The development of the Cabinet Specification involves a Development Team to perform the development work and an SDO organizational structure to review and approve the effort.

The development team is headed by Siva Narla of ITE. Reporting to him are four contractors who will perform various aspects of the development effort. The contractors include:

- **Ralph Boaz, Project Manager.** His responsibility is to provide overall technical management of the project. He will be the primary interface between the contractor team and the SDO committee/working group.
- **James Kinnard, Technical Expert.** His responsibility is to create the detailed Concept of Operations, Requirements Specification, and Design Specification. He will incorporate committee/working group needs and requirements in the standard and create a revised design for Version 2.
- **Bruce Eisenhart, System Engineer.** His responsibility is to ensure that the System Engineering Process is adhered to during the development of the Standard, and ensure the completeness and correctness of ITS Cabinet V2 documents.
- **Michelle Birdsall, Technical Editor.** Her responsibility is to review the User Comment Draft (UCD) and Ballot Draft to ensure that proper format and a consistency of presentation of information within the standard.

This team will be responsible for creation of all the project deliverables (described in detail in the Project Management Plan), which will include all of the baseline outputs described in 3.5.3.1.

The project is to be performed under the direction of the Advanced Transportation Controller (ATC) Joint Committee (JC). The ATC JC is made up of representatives from three SDOs: the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE) and the National Electrical Manufacturers Association (NEMA). The joint committee members are shown in Table 1. The development effort will be overseen by the ITS Cabinet Working Group (WG), a technical subcommittee of the ATC JC. The responsibility of the Joint Committee will be to review the documentation developed by the
ITS Cabinet V2 SEMP

contractor team, along with the comments (and resolutions to those comments) coming from the ITS Cabinet Working Group. The Joint Committee will ultimately approve sending the User Comment Draft of the standard out for user comments, and sending the Ballot draft of the standard out for balloting. The responsibility of the ITS Cabinet Working Group (whose members are shown in Table 2) will be to review each deliverable at the technical level, provide comments to the contractor team, and to work with the team to resolve the comments. As part of this review the Working Group will perform a review of the completeness and correctness of the standard as described in Section 3.5.4. In summary, the ATC JC provides policy and direction, while the ATC WG provides assistance and review and comment (Vetting) at the technical detail level of the standard. The WG is expected to work closely with the project team at the technical level. The JC members may also participate in the technical level with the WG, but JC decisions and directions should avoid resolution of detailed technical issues and defer them to the WG.

Table 1: ATC Joint Committee Members

<table>
<thead>
<tr>
<th>ATC Joint Committee Member</th>
<th>Company/Agency</th>
<th>SDO Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seymour, Edward J.</td>
<td>Texas Transportation Institute</td>
<td>ITE</td>
</tr>
<tr>
<td>Mao, Andrew</td>
<td>Houston Transtar</td>
<td>ITE</td>
</tr>
<tr>
<td>Rausch, Bob</td>
<td>Transcore</td>
<td>ITE</td>
</tr>
<tr>
<td>Talas, Mohamad</td>
<td>City of New York</td>
<td>ITE</td>
</tr>
<tr>
<td>Tarico, Douglas</td>
<td>Siemens ITS</td>
<td>ITE</td>
</tr>
<tr>
<td>Thai, John</td>
<td>City of Anaheim</td>
<td>ITE</td>
</tr>
<tr>
<td>Holstein, Dave</td>
<td>Ohio DOT</td>
<td>AASHTO</td>
</tr>
<tr>
<td>Kosik, Al</td>
<td>TXDOT</td>
<td>AASHTO</td>
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<tr>
<td>Ramos, Guillermo</td>
<td>NYSDOT</td>
<td>AASHTO</td>
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<tr>
<td>Montgomery, Ken</td>
<td>Georgia DOT</td>
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</tr>
<tr>
<td>McRae, Jeff</td>
<td>CALTRANS</td>
<td>AASHTO</td>
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<tr>
<td>Duncan, Gary</td>
<td>Econolite</td>
<td>NEMA</td>
</tr>
<tr>
<td>Evans, Scott</td>
<td>Eberle Design Inc</td>
<td>NEMA</td>
</tr>
<tr>
<td>Miller, Dave (Committee Chair)</td>
<td>Siemens ITS</td>
<td>NEMA</td>
</tr>
<tr>
<td>O’Leary, Tim</td>
<td>Quixote</td>
<td>NEMA</td>
</tr>
<tr>
<td>Gardner, Craig</td>
<td>Intelight</td>
<td>NEMA</td>
</tr>
<tr>
<td>Deetlefs, Kleinjanz</td>
<td>McCain</td>
<td>NEMA</td>
</tr>
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Table 2: ITS Cabinet Working Group Members

<table>
<thead>
<tr>
<th>Working Group Member</th>
<th>Company/Agency</th>
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<tr>
<td>Rausch, Bob (Private Sector Co-Chair)</td>
<td>Transcore</td>
</tr>
<tr>
<td>Evans, Scott</td>
<td>Eberle Design Inc.</td>
</tr>
<tr>
<td>Gardner, Craig</td>
<td>Intelight</td>
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<tr>
<td>Roozitalab, Reza</td>
<td>McCain</td>
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<tr>
<td>Fiebrich, Tim</td>
<td>Siemens ITS</td>
</tr>
<tr>
<td>Ragsdale, Peter</td>
<td>Quixote</td>
</tr>
<tr>
<td>Johnson, Ron (Public Sector Co-Chair)</td>
<td>Harris County, TX</td>
</tr>
<tr>
<td>Montgomery, Ken</td>
<td>Georgia DOT</td>
</tr>
<tr>
<td>Welborn, Robert</td>
<td>City of Houston</td>
</tr>
</tbody>
</table>
3.5.2 Risk Management Plan
Risk management is the identification and control of risks associated with the development effort. The goal of risk management is to identify potential problems before they occur, plan for their occurrence, and monitor the system development so that early actions can be taken.

Risk management includes the following general steps:

- Risk Identification
- Risk analysis and prioritization
- Risk Mitigation
- Risk Monitoring

The specific risks associated with the ITS Cabinet V2 Project development and plan for dealing with these risks are defined below.

3.5.2.1 Risk Identification

The risks associated with the development of ITS Cabinet V2 Project standard are affected by the nature of the development. The following five risk areas have been identified and will be analyzed in the following section.

Risk area #1: Don’t get correct or complete inputs on Needs and Requirements at the Needs Assessment Workshop
This development effort will be identifying a set of needs and requirements for the Advanced Cabinet. The development process, as described in the Project Management Plan identifies a Needs Assessment Workshop, occurring early in the development process, as the primary venue for obtaining needs/requirements from the working group.

The assumption in the project development cycle is that complete and correct inputs will be obtained from all sources, enabling the development team to proceed with concept of operations and then requirements. What if this assumption is not correct-e.g. key stakeholders do not attend the workshop to provide inputs, or those in attendance provide incomplete inputs. This is a risk area that will need to be evaluated and monitored.

Risk area #2- New needs (or requirements) come in late in the process
What happens if new needs (or more likely new requirements) are identified after the “final” needs or requirements have been developed (which is scheduled to occur on 3/03/09 for the needs and on 6/8/09 for requirements)? This could happen because new players come to the table during the development process.
Risk area #3 – Stated schedule of drafts is not sufficient to come to agreement within the Working Group

The schedule has been developed to create a first draft, second draft, and final for each of the key outputs (needs, requirements, and design). To maintain this schedule will require numerous working group reviews. The risk that is identified is that key people will not give the material an adequate review, resulting in a lack of consensus.

Risk area #4 – The number and frequency of meetings and teleconferences will not be supported by the working group.

The project schedule calls for numerous reviews in meeting and teleconferences as part of the development process. There is a risk the Working Group participation will not maintain a consistent high level through all of the reviews.

Risk area #5 – The needs and requirements identified in the first part of the project identify a design that is significantly different from the current standard.

The project is developing a complete set of needs/requirements for an Advanced Cabinet, but the funding available does not support the development from scratch of a design covering all the requirements.

3.5.2.2 Risk Analysis and Prioritization

For the risk areas identified, these risks need to be categorized in terms of the type of risk, magnitude of the risk, and likelihood of the risk occurring.

Risks that may affect the project will fall into three general categories:

- Technical (risks affecting the completeness or correctness of the resulting standard)
- Schedule (risks that cause schedule slippage)
- Cost (risks that cause cost to exceed budget)

The magnitude of risk can be characterized as:

- Large (having significant impact in any category)
  - Technical- resulting in errors that do not allow deployments to use parts of the standard as developed
  - Schedule- resulting in schedule slippage of over 2 months
  - Cost- resulting in cost overrun of more than 5%
- Medium (having major impact in any category)
  - Technical- resulting in errors that require additional committee work to resolve
  - Schedule- resulting in schedule slippage of 1-2 months
  - Cost- resulting in cost overruns of less than 5%
- Small (having minor impact in any category)
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- Technical- resulting in minor errors in the standard that can be corrected through the normal standards maintenance process
- Schedule- resulting in schedule slippage of 1-3 weeks
- Cost- resulting in cost expenditures that don’t match budget plan, but do not exceed the overall budget.

The likelihood of risk occurring can be characterized as:

- High (greater than 30%)
- Medium (less than 30 %)
- Low (less than 10 %)

Given these three dimensions, the risk areas for the project can be analyzed and prioritized. This is summarized in Table 3.

**Table 3: Summary of Risk Analysis and Prioritization**

<table>
<thead>
<tr>
<th>Risk Area</th>
<th>Category</th>
<th>Magnitude</th>
<th>Likelihood</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk area #1: Don’t get correct or complete inputs at the Needs Assessment Workshop</td>
<td>Technical</td>
<td>Medium</td>
<td>Medium</td>
<td>1</td>
</tr>
<tr>
<td>Risk area #2- New needs (or requirements) come in late in the process</td>
<td>Technical, Schedule, and Cost</td>
<td>Medium</td>
<td>Medium</td>
<td>1</td>
</tr>
<tr>
<td>Risk area #3- Stated schedule of drafts is not sufficient to come to agreement within the Working Group</td>
<td>Technical, Schedule, and Cost</td>
<td>Medium</td>
<td>Medium</td>
<td>1</td>
</tr>
<tr>
<td>Risk area #4 – The number and frequency of meetings and teleconferences will not be supported by the working group.</td>
<td>Schedule</td>
<td>Medium</td>
<td>Low</td>
<td>2</td>
</tr>
<tr>
<td>Risk area #5 – The needs and requirements identified in the first part of the project identify a design that is significantly different from the current standard.</td>
<td>Technical</td>
<td>Medium</td>
<td>Medium</td>
<td>1</td>
</tr>
</tbody>
</table>

**Risk area #1: Don’t get correct or complete inputs at the Needs Assessment Workshop** represents a primarily technical risk that needs or requirements will not be captured early enough in the development process. The magnitude of the impact is judged to be medium since missed needs or requirements could result in errors in the standard that would require working group rework at a later date. The likelihood is judged to be medium since some key participants in the process (deployers) will not be funded to attend the needs assessment workshop, and may not choose to attend. From a prioritization standpoint this is judged to be the highest priority risk and one that will be closely monitored.
**Risk area #2- New needs (or requirements) come in late in the process** represents a primarily technical risk, but does have cost and schedule components if the new requirements require additional iteration through of parts of the process. The magnitude of this risk is also judged to be medium, due to potential to impact schedule or cost. The likelihood is considered medium as well, because although some people may have built a few of the items in the standard there will be new items that have never been built and it is not until several manufacturers actually try to build it that issues will be uncovered including interchangeability problems.

From a prioritization standpoint this is judged to be the high priority risk and one that will be closely monitored.

**Risk area #3- Stated schedule of drafts is not sufficient to come to agreement within the Working Group** is risk that has technical, cost and schedule components. The magnitude of the risk is judged to be medium due to the schedule and cost implications. The likelihood is also judged to be medium since past history of this working group has shown that agreement over the details may be challenging.

**Risk area #4 – The number and frequency of meetings and teleconferences will not be supported by the working group.** This is primarily a schedule risk, but it could have technical implications. The magnitude is judged to be medium, because if the working group does not attend the reviews the contractor team will not get timely feedback. The likelihood is judged to be low because the contractor team feels the steps taken as part of the mitigation will work to make the likelihood small.

**Risk Area 5 - The needs and requirements identified in the first part of the project identify a design that is significantly different from the current standard.** This is primarily a technical risk, but it is caused by the original scope of work that envisioned design would cover only the low power cabinet and possibly a few additional features. The magnitude is judged to be medium because of the uncertainty in how the requirements portion will end up. The likelihood is judged to be medium due to the same uncertainty of results from the requirements phase.

### 3.5.2.3 Risk Mitigation

For each risk identified a mitigation strategy should be developed. For the five risk areas identified here are the risk mitigation strategies:

**Risk area #1: Don’t get correct or complete inputs at the Needs Assessment Workshop**

The working group chairs and the contractor team will coordinate with key deployment and standards representatives to clearly identify the information needed and will follow-up prior to the workshop to ensure they understand and are able to provide the information. At the workshop the contractor team will provide an overview of the system engineering process being used and provide examples of needs, requirements, and design to help guide the attendees. If the contractor team feels that incomplete information (or conflicting information) is obtained, or that any key stakeholders did not attend the workshop, the working group chairs and/or contractor team will contact and engage the affected stakeholders during or directly following the workshop.

**Risk area #2- New needs (or requirements) come in late in the process**
The mitigation strategy for risk area 1 will reduce the likelihood of this risk area occurring (by uncovering the complete set of requirements and needs). 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. Automation of the needs to requirements trace will assist in integrating new needs/requirements as they arise.

**Risk area #3 - Stated schedule of drafts is not sufficient to come to agreement within the Working Group**

The four primary mitigations to this risk area are

1. Invite the full set of affected stakeholders to each technical review so that if one reviewer does not get a full review, there will be others who do.
2. Hold many of the technical reviews via webcast or similar so physical presence isn’t required. This will increase attendance at the reviews, particularly by those parties who are not directly funded to attend meetings.
3. Hold real technical walkthroughs that cover the changes page by page - allowing detailed comments to be made and recorded on the spot.
4. Identify a Quick Response Group as a subgroup of the working group who can provide quick review of key issues to help keep the effort on track.

**Risk area #4 – The number and frequency of meetings and teleconferences will not be supported by the working group**

The mitigation to this risk starts with the publishing (and maintaining throughout the project) of a detailed schedule that clearly defines all the review dates. Additionally, the contractor team will work with the working group chair and the SDO representatives to define the review/meeting dates early enough that conflicts are minimized.

**Risk area #5 – The needs and requirements identified in the first part of the project identify a design that is significantly different from the current standard.**

1. The primary mitigation to this risk is in the design of the project. The PMP has been set up to review the scope of the design effort at the conclusion of the requirements effort. This will allow the Working Group to prioritize the aspects of the Advanced Cabinet that will push forward to design.
2. Document any remaining disconnects as part of the RTM (see Section 3.5.6).

The first mitigation will seek to minimize the disconnects, while the second will document those remaining.

**3.5.2.4 Risk Monitoring**

Risk monitoring defines when and how the risks will be monitored. The plan for monitoring is to review the risk areas at monthly project teleconferences. In addition this plan will be updated at key transition points of the project (such as conclusion of ConOps and Requirements phases) in order to review the basic risk areas and add or delete areas as appropriate. We will also be tracking the parties providing input to ensure that we have obtained input from all known interested parties.
3.5.3 Configuration Management Plan

Configuration management is defined as: “A management process for establishing and maintaining consistency of a product’s performance, functional, and physical attributes with its requirements, design and operational information throughout its life” (ANSI/EIA 649-1998). This plan for configuration management of the ITS Cabinet V2 Project development effort identifies an initial set of outputs that will form the baseline and discusses the planned process for managing the configuration of the baseline outputs.

3.5.3.1 Baseline Outputs

The following products of the development effort form the initial definition of the baseline that will come under configuration management:

- Advanced Cabinet ConOps, Advanced Cabinet Standard Requirements Specification (SRS) and ITS Cabinet V2 Standard (which includes the ConOps, SRS and design content): This represents the various document outputs that will occur during the development process.

- Traceability files. These are the file that defines the traceability of needs to requirements and requirements to design. A database tool will be used to support the traceability effort, but at this time that tool has not been selected. A Microsoft Excel version of the Needs to Requirement Traceability Matrix (NRTM) and Requirements Traceability Matrix (RTM) will be delivered as separate files and the information will be included in tables in the ITS Cabinet V2 Standard.

- Comment Database. This will be a Microsoft Access database that contains comments received against this version of the standard.

- Configuration Status Report. This document will identify the baseline versions of each output as well as document the tool versions (e.g. the version of Microsoft Access) used to create or contain each of the outputs. The Configuration Status Report will show the title, document number, creator, and version (where applicable) for all project documents.


All of the documentation created on the project will employ a document numbering scheme that contains document name, version (if applicable), and date of document creation.

3.5.3.2 Change Control Procedures and Baseline Management

Baseline Creation of Comments Database and Comments Traceability

A comments database will be maintained to track comments and resolution status, as well as to define the resolution itself and impact on the ITS Cabinet V2 Standard (specifically, tracing to any ConOps, Requirements, and Design requiring a change).

Key fields from the Comments Tracking and Resolution table are shown below.

- CommentId – Unique ID assigned to the comment.
• Commenter – Person or organization providing comment. Contact information about the commentor- including their organization and e-mail address will be maintained in a separate table to provide a way to contact the commenter in case clarification is needed.
• DateOfComment – Date Comment received by SDO.
• StandardVersionDate – Version and date of the standard to which comment applies.
• PageParagraph – Page and paragraph comment applies to.
• Comment – The comment.
• Keyword – Type of standards item impacted by comment: ConOps, Requirement, Design.
• ProposedResolution – Description of change to the standard to address the comment.
• ApprovalStatus – Description of status of comment resolution.
• ApprovalDate – Date upon which approval to make change took place. (The ITS Cabinet Working Group is the group that grants approval.)

Managing Updates to the ITS Cabinet V2 Standard
The following describes the process for addressing comments and managing updates to the ITS Cabinet V2 Standard:

• ITE or subcommittee chairs receives comment(s)
• Comment is forwarded to developers.
• Comments Database is updated to log comment (including adding a comment ID).
• Developer proposes resolution and identifies what standards items that will be changed.
• Comments and Resolution Authority (ITS Cabinet Working Group) provides approval of resolution. (Note that some comments will be presented to the ITS Cabinet Working Group for approval at meetings, while others will be circulated electronically and discussed and approved via teleconference)
• ITS Cabinet V2 Standard is updated.
• Once all comments have been disposed the ITS Cabinet V2 is ready for general public release.

When all comments are resolved the comments database will be added to the version of the ITS Cabinet for which the standard applies (see next section).

Comments will be a rolling database to track all comments throughout the life of the ITS Cabinet V2 Standard effort.

3.5.3.3 CM Plan for Systems and Related Documentation
This subsection includes the configuration management plan for the system and related documentation, and programmatic documents such as meeting minutes and schedules. The baseline outputs that will be put under configuration management are defined in Section 3.5.3.1. The system documents (minus comments database) will be packaged into a zip formatted file, for which the date remains stable. The comments database will be added as a separate entry.

• At each step in the development process the draft (and eventually final) baseline documentation will be sent directly via email to the working group participants. Until
completion of the effort the contractor team will maintain the “golden” copy of each deliverable.

3.5.4 Verification and Validation Plan:
Verification and validation of whether the information content of the ITS Cabinet V2 Standard is complete and correct will rely on two reviews of the pertinent information:
1. The contractor team will perform a check for completeness and correctness of the needs and requirements. This check will be presented to stakeholders as part of the technical reviews.
2. Detailed review of the deliverables, including the trace matrices, by the working group members will provide an independent check for completeness and correctness.

The contractor team will provide a presentation to the Working Group at the first meeting following delivery of the Needs to Requirements Traceability Matrix (NRTM) (discussed in section 3.5.5) to explain the issues of completeness and correctness. This will occur at the Technical Walkthrough of the Draft SRS (see Section 3.5.5 for a definition of when this occurs). The contractor team will have done its initial check for completeness and correctness prior to this delivery. The contractor team will solicit an independent review from the Working Group at and immediately following the walkthrough. These reviews by the working group will continue at subsequent milestones. Once a design specification is created the review for completeness and correctness will consider not only the NRTM, but the Requirements Traceability Matrix (RTM).

The Requirements-Design Specification traceability table will verify that requirements trace to a specific design specification. This table, called the Requirements Traceability Matrix (RTM) will be created in a traceability tool. The tool has not yet been chosen and will depend upon the complexity of the trace required. The tool may be as simple as an Access Database, or as complex as the Rational RequisitePro traceability tool used by ITE on the TMDD project. (Note: the Requirements Traceability Matrix (RTM) will be included as a table in the ITS Cabinet V2 Standard). The verification and validation of this mapping will follow a similar two step process as given above:
1. The contractor team will create the RTM and perform the initial check that all requirements are satisfied by design specifications.
2. Stakeholders will review and comment on the mapping of requirements to design elements to ensure that all the requirements are completely covered by the design.
In this way, the RTM will be used to verify and validate that the design specification solution satisfies one or more system requirements.

3.5.5 Technical Reviews
Technical reviews provide a structured and organized approach to reviewing project products to determine if they are complete, correct, and accurate. Technical reviews are used to identify defects (in needs, requirements or design) and identify alternative solutions. They are also used to clarify outputs (needs, requirements, or data concepts) and create a common understanding among the reviewers of the material. These reviews represent the “control gates” that must be passed before the project can proceed to the next step in the development process. Section 4 of the PMP identifies planned technical reviews for the project. Generally, the WG is empowered
by the JC to perform the technical work and detailed technical reviews. The JC reviews are at a summary level and are used to gain acceptance and/or approval to move the project to the next stage of development.

The following provides a discussion of the process that is anticipated for conducting the technical walkthroughs.

The plan for each walkthrough is to go through the portion of the standard being reviewed (e.g. concept of operations) page by page, discussing the changes and soliciting comments on the proposed changes. Each technical review will have a draft review output made available two weeks prior to the meeting for review by the ITS Cabinet Working Group and other interested parties. Comments received prior to the walkthroughs and comments received at the walkthroughs will be entered into the comment database. As a part of each walkthrough the changes to the comment database (new comments and resolutions to old comments) will be reviewed with the walkthrough attendees.

### 3.5.6 Requirements Traceability

One of the key control and validation activities of the development will be tracing requirements. This tracing will occur in two directions - backwards to the user needs defined in the concept of operations and forward to the specification of design.

To perform this traceability we will use a database tool. At present the choice of tool has not been made. This choice will depend upon the complexity of needs and requirements identified.

Two types of traceability will be managed throughout the development process: 1) Concept of Operations to Requirements traceability, called a Needs to Requirements traceability, and 2) Requirements to Design traceability, called a Requirements Traceability.

Each of the following will be given a unique ID to support traceability:
- ConOps User Need
- Requirement
- Design Specification

**Baseline Creation of Traceability Matrices**

The initial Needs to Requirements Traceability Matrix (NRTM) will be developed for the first deliverable of the requirements (Task 8.2.1).

**Table 4. NRTM Fields**

<table>
<thead>
<tr>
<th>ConOpsId</th>
<th>ConOpsDocSection</th>
<th>UserNeedTitle</th>
<th>ReqID</th>
<th>ReqDocSection</th>
<th>ReqTitle</th>
<th>ProjectUse</th>
<th>AdditionalProjectRequirements/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID defined in tool*</td>
<td>Corresponding section in ConOps document</td>
<td>User need</td>
<td>ID defined in tool*</td>
<td>Corresponding section in Req Doc</td>
<td>Title of Section in Req Doc</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* This will be maintained in the database but not presented in the final outputs.

The Project Use section is suggested to define if the requirement is mandatory or optional. The Additional Project Requirements /Comments column provides a place to put additional information relative to the specific requirement.
Key fields for the RTM are shown below:

Table 5 Requirements Table Fields

<table>
<thead>
<tr>
<th>ReqId</th>
<th>RequirementsDocSection</th>
<th>Requirement Title</th>
<th>Design Spec ID</th>
<th>Design Spec Section</th>
<th>Design Spec Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID defined in tool.*</td>
<td>Corresponding section in Requirements document</td>
<td>Title of Requirement Section</td>
<td>ID defined in tool.*</td>
<td>Corresponding section in Design Spec</td>
<td>Title of Design Spec Section</td>
</tr>
</tbody>
</table>

* This will be maintained in the database but not presented in the final outputs.

Throughout the project these tables will be updated at each step in the process.

4 Referenced Documents

The following documents (or contents thereof) are referenced in this system engineering management plan:

INCOSE-TP-2003-016-02, Version 2a, SYSTEMS ENGINEERING HANDBOOK, 1 June 2004


Project Management Plan (PMP) for the Intelligent Transportation System (ITS) Cabinet Version 2 Project – USDOT Work Order 14-0701

