ATC API V2 SEMP v01.02

Systems Engineering Management Plan (SEMP) for the Advanced Transportation Controller (ATC) Application Programming Interface (API) Standard Version 2 Project

July 20, 2009

SEMP in support of: USDOT Work Order 14-0801, Tasks 1-6

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## CHANGE HISTORY

<table>
<thead>
<tr>
<th>DATE</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/02/09</td>
<td>Initial Draft Systems Engineering Management Plan (SEMP) v01.00.</td>
</tr>
<tr>
<td>01/08/09</td>
<td>SEMP v01.01 following API Telecon 01/08/09.</td>
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<tr>
<td>07/20/09</td>
<td>PMP v01.02 Update per Noblis/USDOT review and comment.</td>
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Application Programming Interface (API) Working Group

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1 PURPOSE OF THIS SYSTEMS ENGINEERING MANAGEMENT PLAN

This document establishes a Systems Engineering Management Plan (SEMP) for the Advanced Transportation Controller (ATC) Application Programming Interface (API) Standard Version 2 (V2) project under the United States Department of Transportation (USDOT) Work Order 14-0801, Tasks 1-6. 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 3.1 (see Section 4). The overall management of the project including the objectives, tasks, schedule, and deliverables are defined in the associated ATC API Standard V2 Project Management Plan (PMP) (see Section 4). This SEMP establishes the a common understanding of how the systems engineering portion of the project will be organized, structured, conducted and controlled to meet the project goals for:

a) The USDOT Joint Program Office (JPO) who is sponsoring the work;

b) The Standard Development Organizations (SDOs) overseeing the development; and

c) The consultants, manufacturers, and public transportation professionals from both the public and the private sectors who participate in the committees and working groups which will develop the work products specified in the project.

Portions of this SEMP may be updated during the course of the project if the management team or the USDOT JPO determines that modification would significantly facilitate the system engineering functions including, but not limited to, changes in associated portions of the PMP, changes in the risk prioritization and analysis, or the identification of new risk areas. The SEM minimally will be revisited after the completion of each major task as defined in the PMP.

2 PROJECT SCOPE

The ATC API Standard V2 Project is sponsored by the USDOT JPO as part of an Intelligent Transportation Systems (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 API Working Group (WG), a technical subcommittee of the ATC JC. There is also a paid consultant team to support the API WG and SDO staff.

The key objectives of the ATC API Standard V2 Project are:

1) Establish the needs, requirements and design content of an ATC Configuration Manager for the ATC API Standard V2. The function of this capability is to provide a uniform interface for ATC controller units to set/manage/view system wide parameters (analogous to the Control Panel Utility of Windows Operating Systems). This may include Time, Ethernet Ports, Device Driver Information, Operating System Version Information, API Library Information, and Host EEPROM information as described in the ATC Standard 5.2b, Section B.3.3 (see Section 4). It should be noted that the design content for this activity covers both a user interface and associated functions in a fashion consistent with the existing content ATC API Standard V1.

2) Use a Systems Engineering Process to ensure the completeness and correctness of the ATC API Standard V2 and associated documents. The standard must be traceable and logically consistent.
3 SYSTEMS ENGINEERING PROCESS

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 development. Figure 1 illustrates the systems engineering process VEE model promoted by the USDOT. System development moves from the left side of the VEE model to the right side as a project moves through each stage of development. Although not shown, it is typical for some level of iteration between stages taking place as a project moves from one stage to the next. Before a project moves to the next stage, appropriate levels of verification take place to make sure that the current stage properly addresses the needs/requirements/design/product of the previous stage. The stages in the right side of the VEE model also verify and validate the stages in the left side. For a complete description of the systems engineering process, see the Systems Engineering Guidebook for ITS and “INCOSE Systems Engineering Handbook Version 3.1” (see Section 4).

The objectives of this project concern the development of a standard. While the quality of this effort will impact products based on the standard, the project does not directly involve any software development, hardware fabrication, or subsequent testing, verification and validation thereof. The sections of the VEE model that pertain to this SEMP are indicated by the oval in Figure 1.

![Figure 1. The Systems Engineering Process VEE Model.](image)

3.1 Concept of Operations

The purpose of this project is to add new capability to the API Standard V1 creating the API Standard V2. It is anticipated that the outline of API Standard V2 will be the same as the previous version as shown in Figure 2. It is an adaptation of IEEE 830-1998 and has similar content to IEEE 1362-1998. Sections 1 and 2 of the API Standard V2 will be updated to include the user needs and associated supporting information of the ATC Configuration Manager. These sections serve as the Concept of Operations (ConOps) content of the standard.
The API WG will be responsible for identifying and formalizing the user needs for the Configuration Manager in a face-to-face meeting. The results of this needs analysis will be used to develop the ConOps content in conformance with the Risk Management Plan, Configuration Management Plan, and Verification and Validation Plan (see Sections 3.4). It has been determined that the API WG has the depth and breadth to adequately perform this activity (see Section 3.4.1). Updates to the traceability matrix found in the Appendix will be deferred until the design content is completed.

### 3.2 Requirements

In Task 41 Develop Requirements Content, the API WG will define the requirements for the API Configuration Manager based on the user needs established in the ConOps content. The requirements will be formalized and captured in Section 3 of the API Standard V2. The API WG and the consultant team will parse each user need extracting and formalizing requirements. Each requirement will be uniquely numbered to support traceability throughout the document. There will be at least one requirement for each user need and a single requirement may help satisfy multiple needs. It should be noted that user interface portions of the standard may utilize diagrams and pictures to effectively capture requirements. The new API requirements will be evaluated using the following criteria:

a) Is it a “well-formed” requirement? Some of the attributes of well-formed requirements are –
i. Necessary
ii. Clear (unambiguous)
iii. Complete
iv. Measurable (quantifiable)
v. Consistent (with each other)
vi. Achievable (feasible)
vii. Testable
viii. Technology independent

b) Is the requirement mapped to one or more user needs? This will also address whether the requirement is in fact needed.
c) Does the requirement satisfy the intent and all key items of the need?

3.3 Design

The functional interface of the ATC Configuration Manager and any associated data structures will be defined in Task 52 Develop Design Content and added to Section 4 of the API Standard V2. During this task the traceability matrix found in the Appendix will be updated showing the relationship of the user needs, requirements and design content. Design constraints to be maintained in the standard are as follows:

a) The API must operate on an ATC controller unit under the hardware limitations defined in the ATC Controller Standard.
b) The API function calls must be specified using the C programming language as described by “ISO/IEC 9899:1999,” commonly referred to as the C99 Standard (see Section 4).
c) The operational look and feel of user interfaces developed for the API should be consistent with each other.
d) If API functions have a similar operation to existing Linux functions, they should have a similar name and argument style to those functions to the extent possible without causing compilation issues.
e) The API functions should use consistent naming conventions, argument styles and return values.

Each functional interface developed will be reviewed by the API WG for the following:

a) Is functional interface or data structure necessary, clear, complete and consistent? Where:
   i) "Necessary" means that there are no additional functions or arguments that are not in support of a requirement.
   ii) "Clear" means the function names and arguments are descriptive and their meaning is apparent to the user;
   iii) "Complete" means that the function interface performs all of the operations required; and
   iv) "Consistent" means that the naming conventions, argument lists and descriptive terminology used in the new additions to the API functional interface are similar to those already in use in the ATC API Standard V1.
b) Does it meet the design constraints specified in the draft API Standard V2?
c) Does each requirement have a design feature or set of features that completely satisfies the requirement?

3.4 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 risk management plan, a configuration management plan, and a verification and validation plan.
3.4.1 Project Team Organization

The API Working Group will carry out the technical effort of the project. The API WG is supported by: 1) the ATC JC providing oversight and review; 2) SDO staff to provide coordination and administrative support; 3) paid consultants and contractors to perform project management, systems engineering and document editing; and 4) a Quick Response Group (QRG) made up of a subset of the WG that can respond to technical matters on short notice (typically 2 days) but still be representative of the group as a whole.

The API Standard V2 project is a software interface specification activity. The majority of the API WG is made up of current or former software developers from both private and public sectors. The project team is shown in Figure 3. The members of the QRG have not yet been determined for this project. Table 1 identifies the management team for the project.

![Figure 3. API Standard V2 Project Team Organization.](image)

### Table 1. Project Management Team.

<table>
<thead>
<tr>
<th>Management Resource</th>
<th>Management Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siva Narla</td>
<td>Administrator/Coordinator, ITE Staff</td>
</tr>
<tr>
<td>George Chen</td>
<td>API WG, Co-Chair</td>
</tr>
<tr>
<td>Douglas Tarico</td>
<td>API WG, Co-Chair</td>
</tr>
<tr>
<td>Ralph Boaz</td>
<td>Project Manager</td>
</tr>
</tbody>
</table>

3.4.2 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. The Risk Management Plan is made up of the following subsections: Risk Identification, Risk Analysis and Prioritization; Risk Mitigation; and Risk Monitoring.
3.4.2.1 Risk Identification

The risks associated with the API Standard V2 project identified below.

**Risk Area #1 Stated schedule of drafts is not sufficient to reach consensus**

The project schedule allows a significant number of reviews by the working group of interim WG drafts and work products. The risk that is identified is that key people do not agree on details potentially causing the need for additional drafts to be created.

**Risk Area #2 API WG expands scope beyond its ability to meet project deadlines.**

The project scope is intentionally narrow and the PMP has been developed with this assumption. The temptation will be to do more work than has been planned for and exceed the API WGs ability to meet the project milestones.

**Risk Area #3 Identified User Needs / Requirements have larger than expected design impact.**

The project scope is intentionally narrow and the PMP has been developed with this assumption. The risk is that once the user needs and requirements are formalized there will be a larger design effort than anticipated.

**Risk Area #4 API WG resources are unavailable.**

The API WG is executing a second project at the same time it is executing this one. While there are paid contractors to assist the WG, the risk is that the volunteer effort of the committee may be diluted and that the quality of the standard may be affected.

3.4.2.2 Risk Analysis and Prioritization

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

The types of risks that may affect the project are categorized as follows:

a) Technical. Risks affecting the completeness or correctness of the ATC API Standard V2.

b) Schedule. Risks that cause schedule slippage of the project.

c) Cost. Risks that cause cost to exceed budget of the project.

The magnitude of a risk is categorized as follows:

a) Large
   i. Technical. Results in errors that do not allow deployments to use parts of the API Standard V2 as developed.
   ii. Schedule. Results in schedule slippage of over 2 months.
   iii. Cost. Results in cost overrun of more than 5%.

b) Medium
   i. Technical. Results in errors that require additional work for the contractor team or API WG to resolve.
   ii. Schedule. Results in schedule slippage of 1-2 months.
   iii. Cost. Results in cost overruns of less than 5%.

c) Small
   i. Technical. Results in minor errors that can be corrected through the normal standards maintenance process.
ii. Schedule. Results in schedule slippage of 1-3 weeks.
iii. Cost. Results in cost expenditures that don’t match budget plan, but do not exceed the overall budget.

The likelihood of a risk occurring is categorized as:
  a) High (greater than 30%).
  b) Medium (less than 30%).
  c) Low (less than 10%).

Given these dimensions, the risk areas for the project are analyzed and prioritized as shown in Table 2. Priority is assigned with the highest priority assigned as "1st."

<table>
<thead>
<tr>
<th>Risk Area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk Area #1 Stated schedule of drafts is not sufficient to reach consensus.</strong></td>
</tr>
<tr>
<td><strong>Risk Area #2 API WG expands scope beyond its ability to meet project deadlines.</strong></td>
</tr>
<tr>
<td><strong>Risk Area #3 Identified User Needs/Requirements have larger than expected design impact.</strong></td>
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<tr>
<td><strong>Risk Area #4 API WG resources are unavailable.</strong></td>
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</table>

<table>
<thead>
<tr>
<th>Risk Area</th>
<th>Risk Type</th>
<th>Magnitude</th>
<th>Likelihood</th>
<th>Priority</th>
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</thead>
<tbody>
<tr>
<td>Risk Area #1</td>
<td>Technical, Schedule, Cost</td>
<td>Medium</td>
<td>Low</td>
<td>2nd</td>
</tr>
<tr>
<td>Risk Area #2</td>
<td>Schedule</td>
<td>Medium</td>
<td>Medium</td>
<td>1st</td>
</tr>
<tr>
<td>Risk Area #3</td>
<td>Technical, Schedule, Cost</td>
<td>Medium</td>
<td>Low</td>
<td>2nd</td>
</tr>
<tr>
<td>Risk Area #4</td>
<td>Technical, Schedule</td>
<td>Medium</td>
<td>Medium</td>
<td>1st</td>
</tr>
</tbody>
</table>

**Risk Area #1 Stated schedule of drafts is not sufficient to reach consensus.**

If an event occurs in this risk area, it may reflect on the quality of the standard, the schedule may have to be extended, and cost may exceed the original budget as paid consultants are asked to do additional work. The magnitude is Medium because it would be difficult to have any additional draft take less than one month. The likelihood is Low because of the narrow scope of the project and the many opportunities for review of draft documents already built into the project schedule. It is considered a second level priority.

**Risk Area #2 API WG expands scope beyond its ability to meet project deadlines.**

If an event occurs in this risk area, the affect will be on schedule. The magnitude is Medium because, if the scope is expanded, it will have rippling effects through the project. The likelihood is Medium because, historically, this has been an issue for the API WG. It is considered a first level priority.

**Risk Area #3 Identified User Needs / Requirements have larger than expected design impact.**

If an event occurs in this risk area, the affect will be on schedule and cost assuming that the level of quality of the design content is maintained. If the quality of the design content is not maintained, this risk would fall into Risk Area #1. The magnitude is Medium because of the effort required for the API WG to finish the design content and the possibility of additional work by the paid consulting team. The likelihood is Low because the scope of the project is narrow at the outset. It is considered a second level priority.

**Risk Area #4 API WG resources are unavailable.**

If an event occurs in this risk area, it would affect the quality of the standard (technical) and project schedule. As stated previously, there are two projects for the API WG being executed concurrently. The magnitude is Medium because of the extra effort and expanded schedule to get the work completed.
should there be contention for resources between the projects. The likelihood is Medium because the issue could run the course of the project. It is considered a first level priority.

3.4.2.3 Risk Mitigation

A mitigation strategy for each risk is proposed.

*Risk Area #1 Stated schedule of drafts is not sufficient to reach consensus.*

This risk area will be mitigated utilizing the QRG. The QRG has been established to hold review documents and hold teleconferences in a matter of 2-3 days and still be considered representative of the WG.

*Risk Area #2 API WG expands scope beyond its ability to meet project deadlines.*

This risk area will be mitigated by the project leadership team reviewing the results of the API Meetings and Teleconferences at their monthly meetings (see PMP, Section 6).

*Risk Area #3 Identified User Needs / Requirements have larger than expected design impact.*

This risk area will be mitigated by dividing and assigning portions of the design effort to different individuals or subgroups of the API WG as is practical.

*Risk Area #4 API WG resources are unavailable.*

This risk area will be mitigated through the monthly meetings of the project management team. It should be noted that the same management team is in place for the concurrent API WG projects. Should a resource (API WG member) become unavailable or under perform, the team may replace the resource using another member of the API WG. The QRG may also be used to mitigate lapses in the activity of a resource or other subgroup.

3.4.2.4 Risk Monitoring

Risk monitoring will be performed by the project management team in their monthly meetings. Each risk area addressed in this SEMP 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 API WG 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 this SEMP.

3.4.3 Configuration Management Plan

The configuration management for the ATC API Standard V2 project is defined for the standard document itself, the management documents and formal comments.

3.4.3.1 Configuration Management of the ATC API Standard V2

The standards under the oversight of the ATC JC use version numbering to uniquely identify draft documents that are circulated for review, comment, acceptance and approval within the WGs, ATC JC, and the SDOs. The API standards use the form "XX.YY(z)" where: "XX" is the two digit major revision
number, "YY" is the two digit minor revision number, and "z" is an optional lower case letter that may be used to signify that the only change to a document draft from the preceding one is editorial in nature. Whenever a document is to be circulated the author increments 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.

The first published API Standard, ATC API Standard V1, had an official version number of 02.06b. The ATC API Standard V2 will maintain the major version number of 02. The minor version number will be incremented as appropriate.

In addition to the numbering scheme described above, configuration management is maintained by the API WG with respect to a document's "status" within the development process. The status precedes the title of the document and includes the words as follows:

a) "Working Group" when a document is intended for distribution within the API WG only;
b) "User Comment" when a document is intended for distribution within the SDOs for the solicitation of comments from the SDO members; and
c) "Recommended" when the document has achieved acceptance or approval as a final product of the ATC JC.

The title of the document then takes on the form "A Working Group Draft...", "A User Comment Draft...", "A Recommended Document...", etc.

For the API WG to give a document any status other than that of "Working Group" requires the API WG to "propose" the status to the ATC JC and gain acceptance and/or approval as is the practice of the ATC JC. Consequently, there are also "Proposed User Comment" documents and "Proposed Recommended" documents to track documents during adjudication by the ATC JC.

The associated document number and status is to be maintained for the life of the project.

3.4.3.2 PMP and SEMP Configuration Management

Configuration management and version numbering are similar for the PMP and SEMP as that of the ATC API Standard V2 except that only the Project Manager shall modify the PMP and only the Systems Engineer will modify the SEMP.

3.4.3.3 Comment Database Configuration Management

The ATC API Standard V2 development incorporates the circulation of the standard through two formal reviews by the SDOs where comments are solicited from the SDO members. Formal comments are sent to the Administrator/Coordinator recorded and then forwarded to the Project Manager for inclusion in a comment database for the project. During the development process, the formal comments will be reviewed by the API WG, adjudicated as to their relevancy, and changes made to the draft API Standard V2 accordingly.
3.4.4 Verification and Validation Plan

IEEE 1028-1997 will be used in formal reviews of the work products. Verification and validation (V&V) of ATC API Standard V2 will be performed by select members of the API WG at each stage of the development. Specifically, the requirements will be verified to the user needs, and the design content will be verified to the requirements. In the effort to make this development complete and correct, the following steps will be taken:

a) The systems engineer will insure that in technical discussions of the WG that the systems engineering principles are being observed.

b) During the development of the design content (see Task 52 of the project schedule in PMP, Section 4), the contracting team will update the traceability matrix in the Appendix to show traceability of the new user needs, requirements and design content.

c) At least two people from the API WG will be asked to specifically review the traceability in the development of the User Comment Draft (UCD) of API Standard V2 (see Task 63 of the project schedule in PMP, Section 4).

In addition to the V&V steps above, the consensus process of the ATC JC (see the PMP, Section 2) incorporated in the project schedule (see the PMP, Section 4) solicits the SDO members for their review and comments of drafts of the standard (see Tasks 73 and 91).
4 REFERENCED DOCUMENTS

The references used in the preparation of this PMP are listed below.

"ATC API Standard v02.06a, Application Programming Interface (API) Standard for the Advanced Transportation Controller (ATC)," ATC JC, 31 May 2007. Available from the Institute of Transportation Engineers.

“ATC Controller Standard Revision v5.2b,” ATC JC, 26 June 2006. Available from the Institute of Transportation Engineers.


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