ATC API VS SEMP v01.05

Systems Engineering Management Plan (SEMP) for the Advanced Transportation Controller (ATC) Application Programming Interface (API) Validation Suite Project

May 14, 2009

SEMP in support of: USDOT Work Order 14-0801, Tasks 7-8
For approval by: Steve Sill, ITS Standards Program Manager
RITA ITS JPO
For use by: Siva Narla, Chief Engineer and ITS Standards Manager
Institute of Transportation Engineers
George Chen and Douglas Tarico, Co-Chairs
ATC API Working Group
Ralph W. Boaz, Project Manager and Systems Engineer
ATC API Validation Suite Project
Members of the ATC API Working Group
Consulting Team for the ATC API Validation Suite Project
Prepared by: Ralph W. Boaz

© Copyright 2009 AASHTO/ITE/NEMA. All rights reserved.
## 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>
</tr>
<tr>
<td>04/01/09</td>
<td>SEMP v01.02-v01.04. Changes per Noblis/USDOT review.</td>
</tr>
<tr>
<td>05/14/09</td>
<td>SEMP v01.05. Changes in support of PMP 01.05.</td>
</tr>
</tbody>
</table>
NOTICE

Joint NEMA, AASHTO and ITE Copyright and
Advanced Transportation Controller (ATC)
Application Programming Interface (API) Working Group

These materials are delivered “AS IS” without any warranties as to their use or performance.

AASHTO/ITE/NEMA AND THEIR SUPPLIERS DO NOT WARRANT THE PERFORMANCE OR RESULTS YOU MAY OBTAIN BY USING THESE MATERIALS. AASHTO/ITE/NEMA AND THEIR SUPPLIERS MAKE NO WARRANTIES, EXPRESSED OR IMPLIED, AS TO NON-INFRINGEMENT OF THIRD PARTY RIGHTS, MERCHANTABILITY, OR FITNESS FOR ANY PARTICULAR PURPOSE. IN NO EVENT WILL AASHTO, ITE, NEMA, OR THEIR SUPPLIERS BE LIABLE TO YOU OR ANY THIRD PARTY FOR ANY CLAIM OR FOR ANY CONSEQUENTIAL, INCIDENTAL, OR SPECIAL DAMAGES, INCLUDING ANY LOST PROFITS OR LOST SAVINGS ARISING FROM YOUR REPRODUCTION OR USE OF THESE MATERIALS, EVEN IF AN AASHTO, ITE, OR NEMA REPRESENTATIVE HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. Some states or jurisdictions do not allow the exclusion or limitation of incidental, consequential, or special damages, or exclusion of implied warranties, so the above limitations may not apply to you.

Use of these materials does not constitute an endorsement or affiliation by or between AASHTO, ITE, or NEMA and you, your company, or your products and services.

If you are not willing to accept the foregoing restrictions, you should immediately return these materials.

ATC is a trademark of NEMA/AASHTO/ITE.
CONTENTS

1 PURPOSE OF THIS SYSTEMS ENGINEERING MANAGEMENT PLAN ........................................ 5
2 PROJECT SCOPE .................................................................................................................. 5
3 SYSTEMS ENGINEERING PROCESS .................................................................................. 6
   3.1 Concept of Operations .................................................................................................. 6
   3.2 Requirements ............................................................................................................. 7
   3.3 Design ....................................................................................................................... 7
   3.4 Systems Analysis and Control .................................................................................... 8
4 REFERENCED DOCUMENTS ............................................................................................... 13
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) Validation Suite (VS) project under the United States Department of Transportation (USDOT) Work Order 14-0801, Tasks 7-8. The organization of this SEMP is derived to the Systems Engineering Plan described in the International Council on Systems Engineering (INCOSE) Systems Engineering Handbook, Version 3.1, Appendix G (see Section 4). The overall management of the project including the objectives, tasks, schedule, and deliverables are defined in the associated ATC API VS 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 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 SEMP minimally will be revisited after the completion of each major task as defined in the PMP.

2 PROJECT SCOPE

The ATC API VS 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 ATC API Standard (see Section 4) defines a software interface which resides on the "Engine Board" as specified in the ATC Controller Standard (see Section 4). This interface allows application programs to be written so that they may run on any ATC controller unit regardless of the manufacturer. It also defines a software environment that allows multiple application programs to be interoperable on a single controller unit by sharing the fixed resources of the controller.

The key objectives of the ATC API VS Project are:

1) Use IEEE Std 829-1998 approach to develop a Test Plan, Test Design Specifications (TDSs), Test Case Specifications (TCSs) and Test Procedure Specifications (TPSs) for validating implementations of the API Standard.

2) Develop an API VS (software program or set of software programs) to use in conjunction with the Test Plan to validate implementations of the API Standard. Use a Systems Engineering Process to
establish needs, requirements, and design contents for the API VS and ensure completeness and correctness.

3 SYSTEMS ENGINEERING PROCESS

The Systems Engineering Process (SEP) 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 SEP in this project is used in two fashions. First, the development of the API VS software will be guided by the process. Secondly, the software developed will be used to perform the verification and validation of implementations of the API Standard V1.

3.1 Concept of Operations

The API WG will be responsible for identifying and formalizing the user needs for the API VS as part of Task 26 Develop Concept of Operations (ConOps) (see PMP Section 4). The ATC API VS will be built through an SEP starting with a Concept of Operations (ConOps). Since this is a testing system, the ConOps development will be performed in conjunction with the development of a Test Plan. The Test
Plan for the API VS is an important input to the ConOps as it defines the testing environment in which the software must operate, how the testing is organized, the types of testing to be performed and the features to be tested. The development of the Test Plan and subsequent TDSs and TCSs help to identify the user needs that will be captured in the ConOps. In support of the ConOps development, there will be a face-to-face meeting of the API WG and a needs analysis performed. The ConOps will be developed according to IEEE Std 1362-1998 and 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).

3.2 Requirements

In Task 44 Develop Software Requirements Specification (SRS), the API WG will define the requirements for the API VS based on the user needs established in the ConOps. The requirements will be formalized and captured in an SRS. A draft of the requirements will be prepared by the consultant team and reviewed and updated in a face-to-face meeting of the API WG. A second product of the API WG at this stage of development will be TDSs and TCSs that can be used separately as test documentation for users of the API VS. The IEEE Std 829-1998 approach will be used in the production of these documents. It is anticipated that the process of creating the TDSs and TCSs will reveal other requirements for the API VS including the specifics for the user interface. Any maintenance and support requirements identified through the Systems Engineering Process (SEP) will also be included.

Each API VS requirement in the SRS 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 API VS requirements will be evaluated using the following criteria:

a) Is it a “good” requirement? Some of the attributes of “good” requirements are –
   i) Necessary – Must be useful (traceable to needs)
   ii) Unambiguous – Susceptible to only one interpretation
   iii) Concise – Stated in declarative language ("shall statements")
   iv) Consistent – Does not contradict itself, nor any other stated requirement
   v) Complete – The requirement is stated completely in one place. (Related requirements may be grouped for context.)
   vi) Attainable – Realistic to achieve within available resources and time
   vii) Testable – Must be able to determine that the requirement has been met through one of four possible methods (inspection, analysis, demonstration, or test)

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

In Task 57 Develop Software Design Description (SDD), the SRS will be manifest in software design by the API contractor. The SDD will be based on the format of IEEE Std 1016-1998 (see Section 4). The SDD will contain a traceability of the design elements to the requirements of the SRS. Design constraints to be maintained in the standard are as follows:

a) The API VS must operate on an ATC controller unit under the hardware limitations defined in the ATC Controller Standard.
b) The API VS 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 VS should be consistent with each other.

d) If API VS 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 VS functions should use consistent naming conventions, argument styles and return values.

The software design will be reviewed by the API WG for the following:

a) Does it meet the design constraints?

b) 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 API 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 VS project is a software development and testing 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.
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 VS project identified below.

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

The project schedule allows a significant number of reviews of API 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. This risk applies to the Test Plan, TDSs, TCSs, SRS and SDD for the API VS.

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

The project scope will be set by the API WG working group through the Test Plan, TDSs and TCSs. In this respect, the API WG controls the amount of work that is to be included in the project. The risk is that the API WG establishes a level of test documentation that beyond the WG’s ability to generate them according to the project schedule.

**Risk Area #3 SRS and test documentation have larger than expected software development impact.**

The API Validation Software will be developed by a paid contractor according to the test documentation and SRS. The contractor will create an SDD for the API Validation Software, implement and test the software, and capture proper operation in Test Procedure Specifications (TPSS).

**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 VS.
- **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 VS 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 2. Summary of Risk Analysis and Prioritization.**

<table>
<thead>
<tr>
<th>Risk Area</th>
<th>Risk Type</th>
<th>Magnitude</th>
<th>Likelihood</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Area #1 Stated schedule of drafts is not sufficient to achieve consensus.</td>
<td>Technical, Schedule, Cost</td>
<td>Medium</td>
<td>Medium</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
</tr>
<tr>
<td>Risk Area #2 API WG sets scope beyond its ability to meet project deadlines.</td>
<td>Schedule</td>
<td>Medium</td>
<td>Medium</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
</tr>
<tr>
<td>Risk Area #3 SRS and test documentation have a larger than expected software development impact.</td>
<td>Technical, Schedule, Cost</td>
<td>High</td>
<td>Medium</td>
<td>1st</td>
</tr>
<tr>
<td>Risk Area #4 API WG resources are unavailable.</td>
<td>Technical, Schedule</td>
<td>Medium</td>
<td>Medium</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

**Risk Area #1 Stated schedule of drafts is not sufficient to achieve consensus.**
If an event occurs in this risk area, it may reflect on the quality of the work products, 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 Medium because of the SRS and test documents being handled by the API WG at the same time. It is considered a second level priority.

**Risk Area #2 API WG sets 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. There are also more opportunities for "scope creep" considering the test documentation in addition to the SRS. It is considered a second level priority.

**Risk Area #3 SRS and test documentation have larger than expected software development impact.**

If an event occurs in this risk area, the affects will have implications on the API VS (technical impact), schedule and cost. If the quality of the design content is not maintained, this risk would fall into Risk Area #1. The magnitude is High because it is difficult to make implementation judgments at this stage of the project and if implementation issues are discovered late it would have a rippling effects back through the design and requirements. This would all require additional effort for the API WG and the possibility of additional work by the paid consulting team. The likelihood is Medium because of the multiple opportunities for this to occur with SRS, SDD, implementation, and all of the test documentation. The likelihood is not considered High because the API WG and the consultant team have control over this area and should be able to remedy the situation. It is considered a first 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 second 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 achieve consensus.**

This risk area will be mitigated utilizing the QRP. The QRP 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 sets 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 SRS and test documentation have larger than expected software development impact.**
This risk area will be mitigated by including the contractor in the development of the SRS.

**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 API VS project is defined for the SRS, the SDD, the management documents and formal comments.

### 3.4.3.1 Configuration Management of the API VS Project

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 SRS, SDD, Test Plan and the software developed under this SEMP will 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 optionally be used to signify that the only change to a document draft from the preceding one is editorial in nature. 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 and software developed under this SEMP will start with a major revision number of 01.

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 for the PMP and SEMP are as described in the previous section. Only the Project Manager shall modify the PMP. Only the Systems Engineer will modify the SEMP.

3.4.3.3 Comment Database Configuration Management

Although there are no formal comment periods where work product is distributed to the SDO memberships except at the end of the project, it is anticipated that a comment database will be maintained in a similar fashion as those used in standard development. The purpose will be to: 1) capture issues addressed by the API WG so that time is not wasted revisiting old issues and 2) to maintain comments that are 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 API WG, adjudicated as to their relevancy, and changes made to the documentation or software as appropriate.

3.4.4 Verification and Validation Plan

IEEE 1028-1997 will be used in formal reviews of work products. Verification and validation (V&V) of the software developed in this project will be through the circulation of test software through select members of the API WG demonstrating the satisfaction of the requirements of the SRS. This verification will be performed in groups or at intervals as determined prudent by the API WG and the contractor (see Tasks 69, 71, and 73 of the PMP, Section 4). The contractor shall demonstrate that the software developed performs according 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) The contractor will include traceability to the requirements of the SRS in the SDD.

c) During the course of the implementation and testing, the Project Manager or a designee of the API WG shall maintain a table of the requirements that have been demonstrated by the contractor to be satisfied by the API VS.

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.


"Project Management Plan (PMP) for the Advanced Transportation Controller (ATC) Application Programming Interface (API) Validation Suite Project v01.01," 8 January 2009. Available from the Institute of Transportation Engineers.


§