December 13th, 2007

ITS Implementation Plan Usage Guide

Deliverable A3-b

Final

Central Coast ITS Implementation Plan

Association of Monterey Bay Area Governments

TRANSCORE

CENTRAL COAST ITS IMPLEMENTATION PLAN

Architecture Implementation Plan (Usage Guide)

Deliverable A3-b

Final

Prepared for:

Association of Monterey Bay Area Governments
&
CCITS Coordinating Group

Prepared by:

TransCore

626 Wilshire Blvd.
Suite 818
Los Angeles, California 90017

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TABLE OF CONTENTS **PAGE #**

LIST OF EXHIBITS PAGE

1. INTRODUCTION

This document presents the CCITS Architecture Implementation Plan/Usage Guide. While this document does discuss Turbo Architecture and some of its functionality, it only provides an overview of each major function and is not meant as a tutorial on how to use Turbo (for that, please see the appropriate documentation discussed in Section 6).

This document should be used to show how CCITS members can update (via Turbo) and use their ITS Architectures to facilitate the documentation and implementation of ITS projects under their purview.

2. ITS ARCHITECTURE BASICS

This section presents an overview of the National ITS Architecture and presents a basic "How To" guide for Turbo Architecture (Turbo), the FHWA's software to implement the National ITS Architecture.

2.1 The National ITS Architecture

In its most basic form, an architecture is a set of rules that facilitates the building of systems and that allows these systems to communicate and inter-operate after being built. An ITS architect is to an ITS system, as a building architect is to a building. A building architect could not build a structure without a set of plans. Neither could an ITS architect build a complex ITS environment without a set of plans. These plans are the ITS system architecture. (It is important to distinguish between an architecture built for planning and implementation guidance and an architecture used to design and build actual working systems/projects.)

Since 1992, the U.S. DOT has been engaged in the development of the National ITS Architecture – a framework and common vocabulary for planning, defining, and integrating ITS systems among modes of travel and geographic areas. The toolset that comprise the National ITS Architecture provide a common information source in the following manner:

- **Framework** to identify system components and interconnections
- **Vocabulary** to better communicate with colleagues
- **Guidance** to help develop ITS architectures (e.g., Regional, County, etc.) and to help identify integration opportunities during project definition

The National ITS Architecture's main objectives are to describe what functions/processes are needed, decide where these functions should be located, and identify who needs to be involved and/or is responsible. Basically, the Architecture consists of a series of reports and diagrams/exhibits that show the relationships within/between components, subsystems, and agencies.

The major components of the Architecture will be described briefly in the appropriate Turbo Architecture "How To" sections that follow.

2.2 Turbo Architecture

Turbo Architecture is a Microsoft Access-based tool developed for the USDOT to assist Agencies with building and maintaining their ITS architectures. As of this writing, it is at version 3.1 and implements version 5.1 of the National ITS Architecture.

Turbo provides the data management tools (input, reporting, updating, etc.) needed to create and maintain your ITS architecture(s). In general, there is a data form (implemented via data tabs in Turbo) for each of the types of data discussed in the subsequent sections.

It is assumed that the reader/user has a basic knowledge of using Microsoft Windows applications and has already installed Turbo Architecture on their PC. The following sections step through the Turbo data screens and describe their usage in creating and/or maintaining their ITS architecture.

You will also get a better understanding of the tool and more comfortable with it as you continue to use Turbo to update your architecture(s).

2.2.1 Before you Start

A certain amount of legwork is required prior to building or updating an ITS architecture. If you are going to be updating the architecture, the first step is to ensure that the Architecture Maintenance Plan has been followed and that the requisite documentation has been prepared. If this is not the case, you would be wise to stop here and make sure those steps are followed.

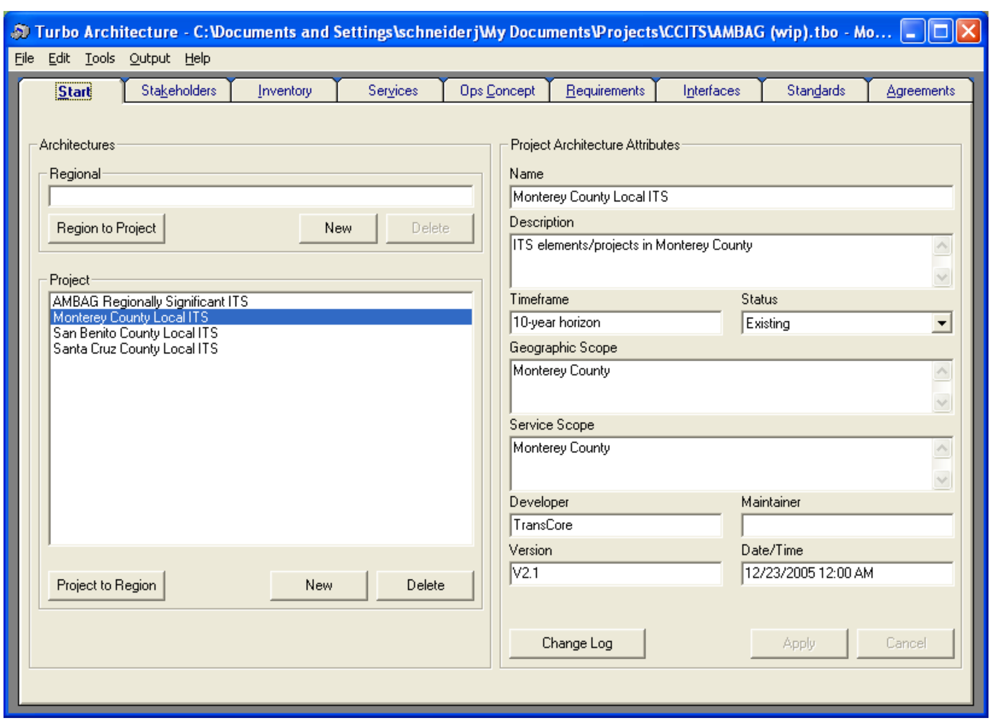
If you are updating the architecture to a new version of the National ITS Architecture (as of this writing it is at V5.1 and is implemented by Turbo Architecture V3.1) you should familiarize yourself with the services, data flows, etc. in your architecture so you will be able to asses the impact of the changes being implemented.

Also, you should always ensure that you have a back-up copy of the original Turbo database file(s) in case something goes amiss and you need to revert back to it. If the changes to be made are substantive, you might also consider making backups of the database at key points along the updating process.

2.2.2 Common Interface/Usage

There are generally two (2) types of user input forms used throughout Turbo: general data input forms and Excel-like grids. General data forms, such as the form used on the Start tab (see Exhibit 2.1) is a data entry form with a combination of fields to input or edit data, make data selections, etc. These forms are usually laid out such that there is a list of items (usually to select from) on the left of the form and the data descriptions/details are to the right.

Exhibit 2.1 – The Start Tab



The forms with Excel-like grids can work in some ways like Excel in that you can resize columns and reorder data, but they do not perform any calculations nor are they used for actual text data entry. They are primarily used for tailoring the architecture by selecting items (data flows, standards, etc.) to include in the architecture. These forms are generally structured with a pick-list in the upper left of the tab, a series of buttons to the immediate right, and the grid occupying the majority of the form below (See Exhibit).

2.2.3 Menus

Along with the standard MS Windows File, Edit, Tools, and Help menus, Turbo Architecture has an additional menu for generating reports and diagrams: the Output menu. Some of the options of the Tools and Output menus are described below.

Tools

The Tools menu can be used to create or edit custom (user defined) Status and Architecture Flow values. For each, a context specific data screen will be presented to allow for data entry and manipulation applicable to that data type. Status is a global data element, so customizations made here will be available throughout Turbo. The customized architecture flow value(s) will only be used in when working with architecture flows.

Output

The Output menu is used to define report filters and/or to select specific inventory elements to be included in the Turbo reports and/or diagrams. This menu is also how you launch the Turbo reports and diagrams screens, which will be discussed in Section 2.2.14.

2.2.4 The "Status" Attribute

Before starting the overview of Turbo Architecture, a brief overview of the "Status" attribute that is used throughout Turbo is in order. The Status attribute is used to define the current implementation stage of the data being described. Turbo has pre-defined status values of Existing and Planned. In several places an additional status of "Not Planned" is also pre-defined. The meanings of these statuses are pretty much self-evident. For the CCITS architectures, we have added an additional status of Programmed for those projects that have already been added in the appropriate planning process(es) – on the way from Planned to Existing.

In some parts of Turbo, it is possible that multiple statuses may apply to the same item. For instance, a signal system may be "Existing", but there are plans to integrate it into a Regional traffic control system. In cases like this, the status of the signal system should still be set to "Existing" for Inventory and in the applicable Market Package, Operational Concepts, Interconnects, etc. assignments/definitions, however the additional integration features should be set to "Planned" or "Programmed".

2.2.5 The Start Tab

The Start tab (**Error! Reference source not found.**) is used to create project and regional architectures, to select an existing architecture to be the active architecture (for maintenance or reporting), and also to maintain the architecture descriptions/definitions in the Turbo database.

The left-hand side of the tab is generally used for selection and the right-hand side for data manipulation.

In addition to its data management aspects, this tab is also used to select which ITS architecture you want to use, report, build, or maintain. This is done by clicking your mouse on the desired ITS architecture (from the list on the left) and proceeding to your desired functions. Selecting the architecture is a vital step in the maintenance of the MPO architecture – failing to do so may cause your changes to be implemented in the wrong ITS architecture.

Major Data Fields:

Field	Description
Name (required)	Name of the ITS Project of Regional Architecture.
Description	Description of the architecture.
Timeframe	The time horizon for the architecture (e.g., 10 year).
Status (required)	The deployment status of the architecture (Not Planned is not a valid selection; only project architectures are defined for the CCITS).
Geographic Scope	Where the architecture will be deployed (e.g., the geographic area).
Service Scope	The scope of services to be covered.
Version & Date/Time	Fields to keep track of changes made to the architecture.

Major Operations:

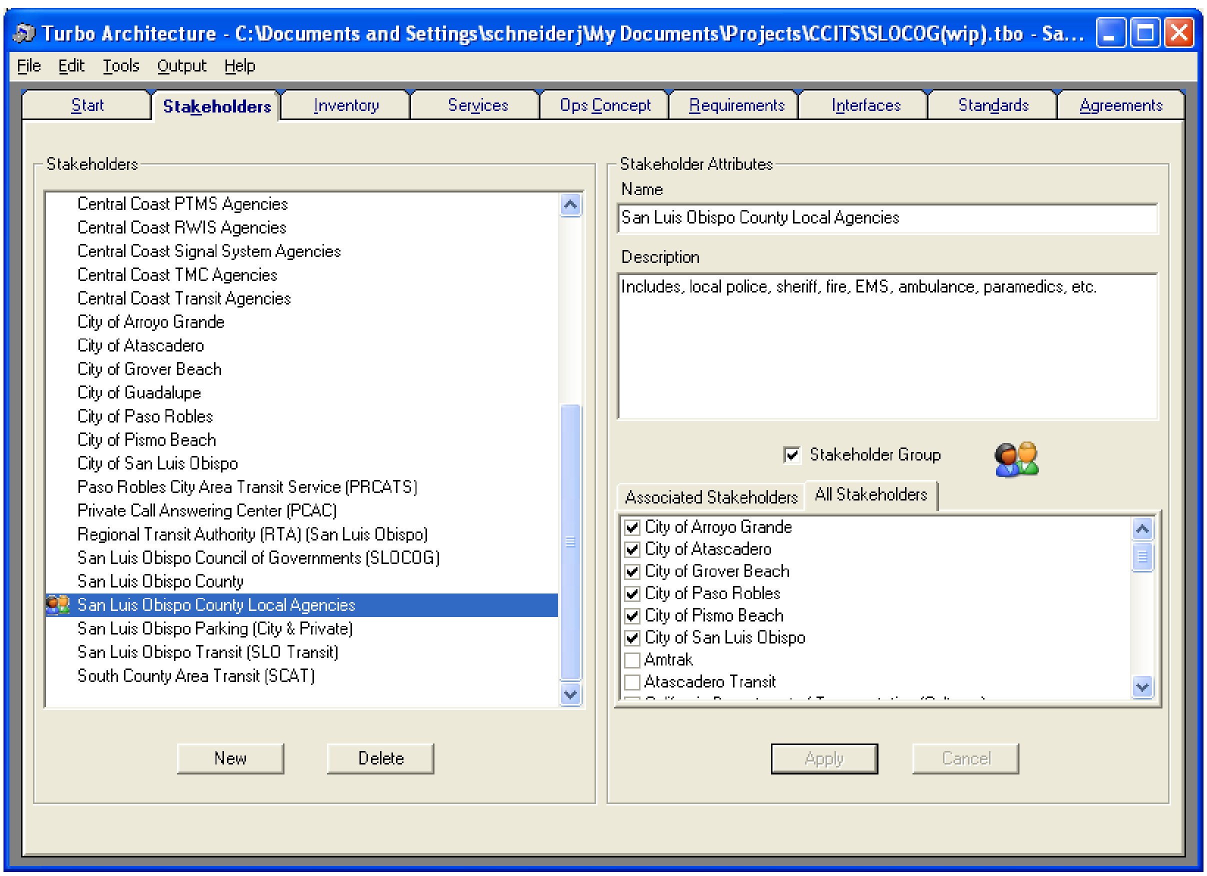
Button	Function
New	Used to create a new regional or project architecture in the open database. There can be multiple project architectures but only one regional architecture per Turbo database. Pressing the New button (either one) will create an empty form for data entry and you must enter the required fields before hitting the Apply button.
Project to Region	Used to merge/promote a project architecture into the regional architecture. Note that not all data is moved.
Region to Project	Used to demote a regional architecture into a project architecture. Note that not all data is moved.
Apply	Saves the changes to the Turbo database.
Cancel	Ignore the changes and revert to the original data.
Delete	Used to delete the selected architecture and cannot be undone once deleted (you will be prompted to verify the delete).
Change Log	Allows you to keep a history of changes made to the architecture (log/history viewable by report only).

2.2.6 The Stakeholders Tab

The Stakeholders tab is where you can maintain the slate of stakeholders for the overall ITS architecture. Stakeholders are available to all ITS architectures in the database. You can also define a stakeholder group, which is a way of simplifying the architecture by having a single pseudo-stakeholder represent many individual stakeholders. For example, all of the municipal emergency service providers (e.g., police, fire, ambulance, etc.) in each CCITS County have been grouped into a "Local County Agencies" stakeholder, rather than enumerating each one individually.

Stakeholder groups can greatly simplify the architecture by consolidating repetitive and/or redundant ITS inventory, interconnections, information flows, etc. Stakeholder groups can be identified in the list by a special icon to the left of the stakeholder name (see the example in Exhibit 2.1).

Exhibit 2.2– The Stakeholders Tab



Major Data Fields:

Field	Description
Name (required)	Name of the stakeholder.
Description	Description of the stakeholder.
Stakeholder Group	Checkbox to indicate that the specified stakeholder is a Group Stakeholder.
Stakeholders (tabs)	Indicates which real stakeholders are members of the group (grayed out if the Stakeholder Group checkbox is not selected).

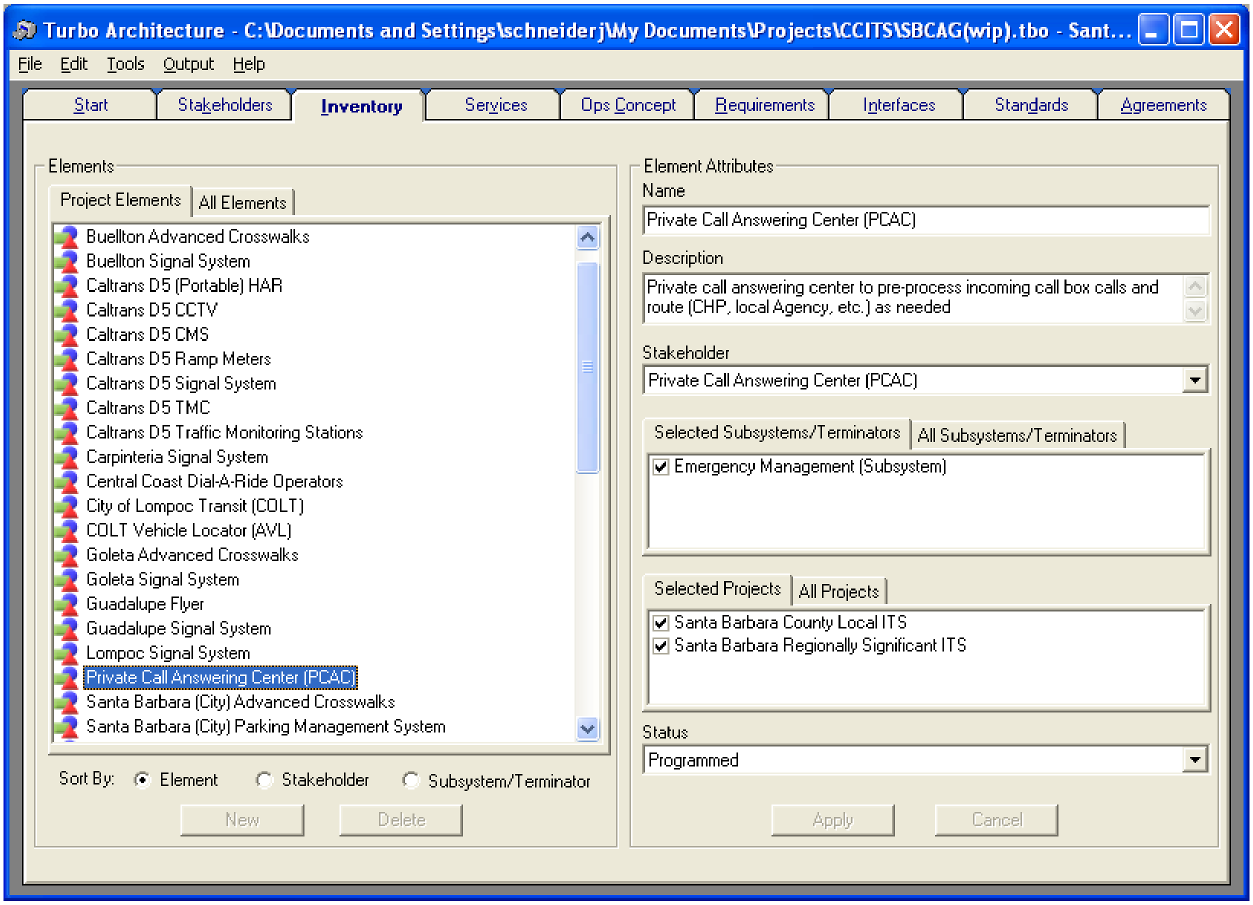
Major Operations:

Button	Function
New	Used to create a stakeholder.
Delete	Used to delete the selected stakeholder (note that this does not delete the stakeholder's associated ITS inventory, if any).
Apply	Saves the changes to the Turbo database.
Cancel	Ignore the changes and revert to the original data.

2.2.7 The Inventory Tab

The ITS inventory is a core step in building and maintaining an ITS architecture and this tab is where it is managed in Turbo (Exhibit 2.3). The left-hand side of the form is the list of ITS elements in the architecture (if any have been created for it). There is an additional tab on this form to select whether to view only the inventory in the active architecture (selected on the Start tab described above) or all items in the database, regardless of which particular architecture(s) the element is in. (An inventory element may be in multiple ITS architectures in the same Turbo database.) You may only add or delete ITS elements when the "All Elements" tab is active, but you can change its data properties in either mode.

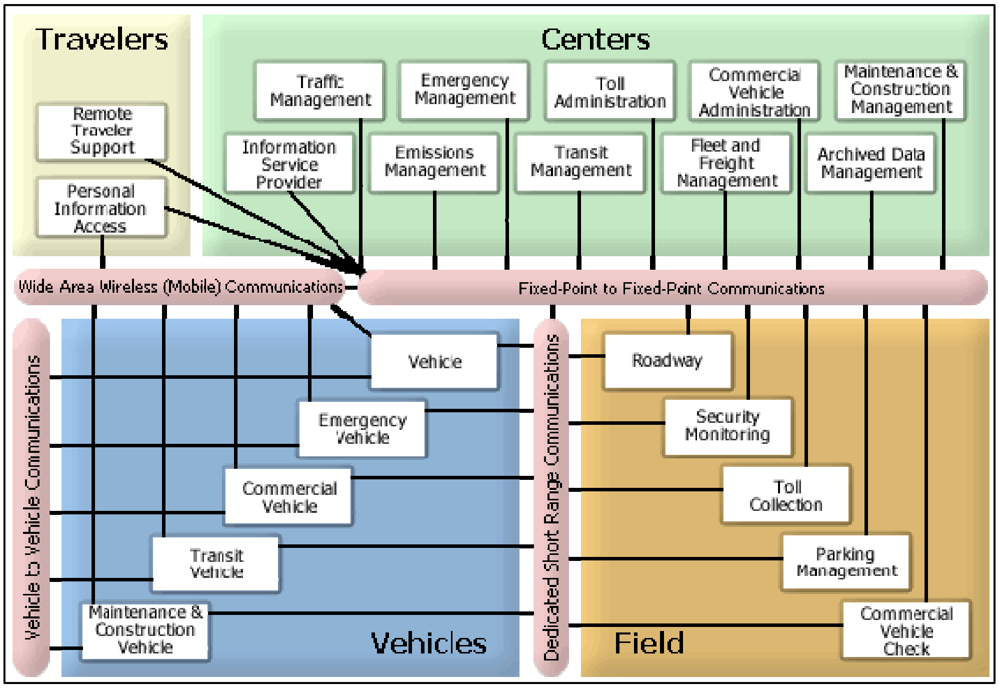
Exhibit 2.3 – The Inventory Tab



This screen is where you define the various items that are or will be part of your ITS system. In general, we advise you to use the following naming convention for ITS elements: start each element with the stakeholder/owner name or its abbreviation followed by a descriptive name. This will group related elements in subsequent tasks and reports. We also advise trying to avoid using “brick and mortar” items (e.g., buildings) unless there is an ITS system associated with it, such as a TMC.

Every ITS element must have at least one subsystem or terminator associated with it. Subsystems are defined by the National ITS Architecture and correspond to physical implementations of ITS functionality. They are grouped into four categories, based upon where they are (to be) deployed: Centers, Field, Vehicles, and Travelers (Exhibit 2.4). For example, depending upon its functionality, a TMC might be associated with the Traffic Management and Emergency Management subsystems (both from the Field group), or a smart card system to be used for transit and parking might be associated with the Transit Management, Transit Vehicle, and Parking Management subsystems.

Exhibit 2.4 – National ITS Architecture Subsystems



Selection of subsystems is an important step as these assignments will be the foundation for developing subsequent parts of the architecture. Associating too many subsystems will lead to additional filtering work later, while adding too few will limit your available choices and may require returning here to associate the "missing" subsystem(s).

At a minimum, you must provide the element name and assign at least one subsystem in order to be able to save data on this tab, but you should be as complete as possible when defining data here (or on any of the Turbo forms).

Major Data Fields:

Field	Description
Name (required)	Name of the ITS element.
Description	Description of the ITS element.
Stakeholder	Primary "owner" of the ITS element (pick-list from the Stakeholders tab).
Subsystems (required)	Checkbox list of applicable subsystems. Note that you can right-click in this area to expand the list and get descriptions of each of the subsystems (right-click again to collapse the section back to normal size).
Projects	Checkbox list of available ITS architectures in the database.
Status	Status of the ITS element (default values are Existing and Planned, but additional status values, such as Programmed, can be created).

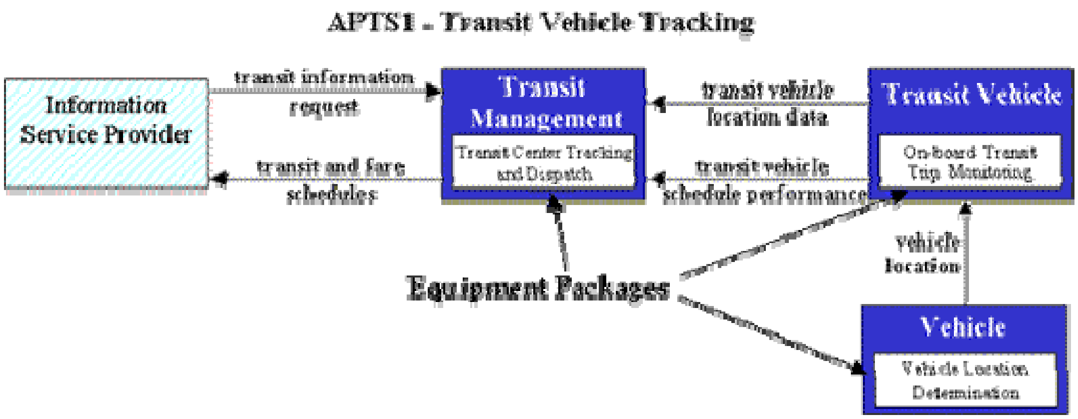
Major Operations:

Button/Control	Function
Elements tab	Selects whether to show all ITS elements in the database or only those for the selected ITS architecture.
Sort by	Sort the ITS inventory by various criteria.
New	Used to create a new ITS element in the database (only available from the "All Elements" tab).
Delete	Used to delete an ITS element from the database (only available from the "All Elements" tab).
Apply	Saves the changes to the Turbo database.
Cancel	Ignore the changes and revert to the original data.

2.2.8 The Services Tab

The Services tab is where you associate the ITS inventory elements to National ITS Architecture Market Packages. Market Packages (MPs) are pre-defined transportation service technology "bundles" that can be deployed (built or bought) to improve some aspect of traveling. Each MP consists of one or more "equipment packages" that work together to deliver a specific transportation service and the data flows between them. Exhibit 2.5 shows the APTS1 – Transit Vehicle Tracking MP. It is comprised of three (3) equipment packages from three (3) different subsystems (Information System Provider is external to this MP).

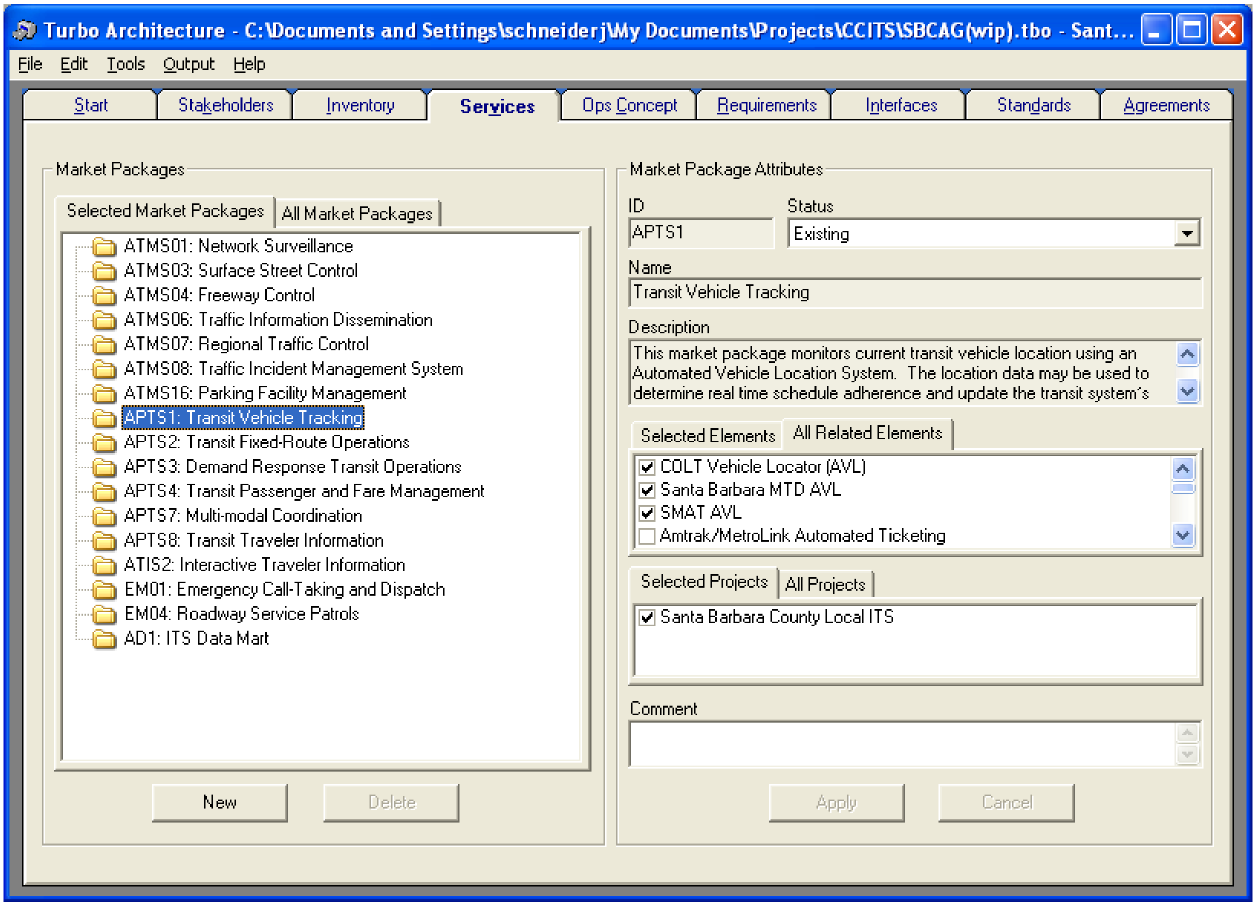
Exhibit 2.5 – The Transit Vehicle Tracking Market Package



To associate MPs with ITS elements, select the desired MP from the list on the left of the form (information about the selected MP will be shown in grayed-out fields on the right-hand side of the form) and check (select) the inventory elements that should be associated with it (i.e., which elements will provide those services). You need to also indicate the applicable architecture(s) that this MP is (or will be) in based upon which architectures the inventory elements are in (or will be).

Lastly, the MP's status should be assigned. The default selections are Existing, Planned, Not-Planned. In general, you do not need to define Not-Planned MPs. If any part of the MP is already implemented, then the MP should have a status of Existing. Exhibit 2.6 is an example of the Services tab.

Exhibit 2.6 – The Services Tab (Market Packages)



Major Data Fields:

Field	Description
Status	Status of the ITS element (default values are Existing and Planned, but additional status values, such as Programmed, can be used).
Selected Elements	Checkbox list of ITS inventory that can be associated with the MP.
Projects	Checkbox list of available ITS architectures in the database.
Comment	Additional information can be added here (e.g., timeframe, status, etc.).

Major Operations:

Button/Control	Function
Market Packages tab	Selects whether to show all MPs or only those selected in the active ITS architecture.
New	Used to create a new ITS element in the database (only available from the “All Elements” tab).
Delete	Used to delete an ITS element from the database (only available from the “All Elements” tab).
Apply	Saves the changes to the Turbo database.
Cancel	Ignore the changes and revert to the original data.

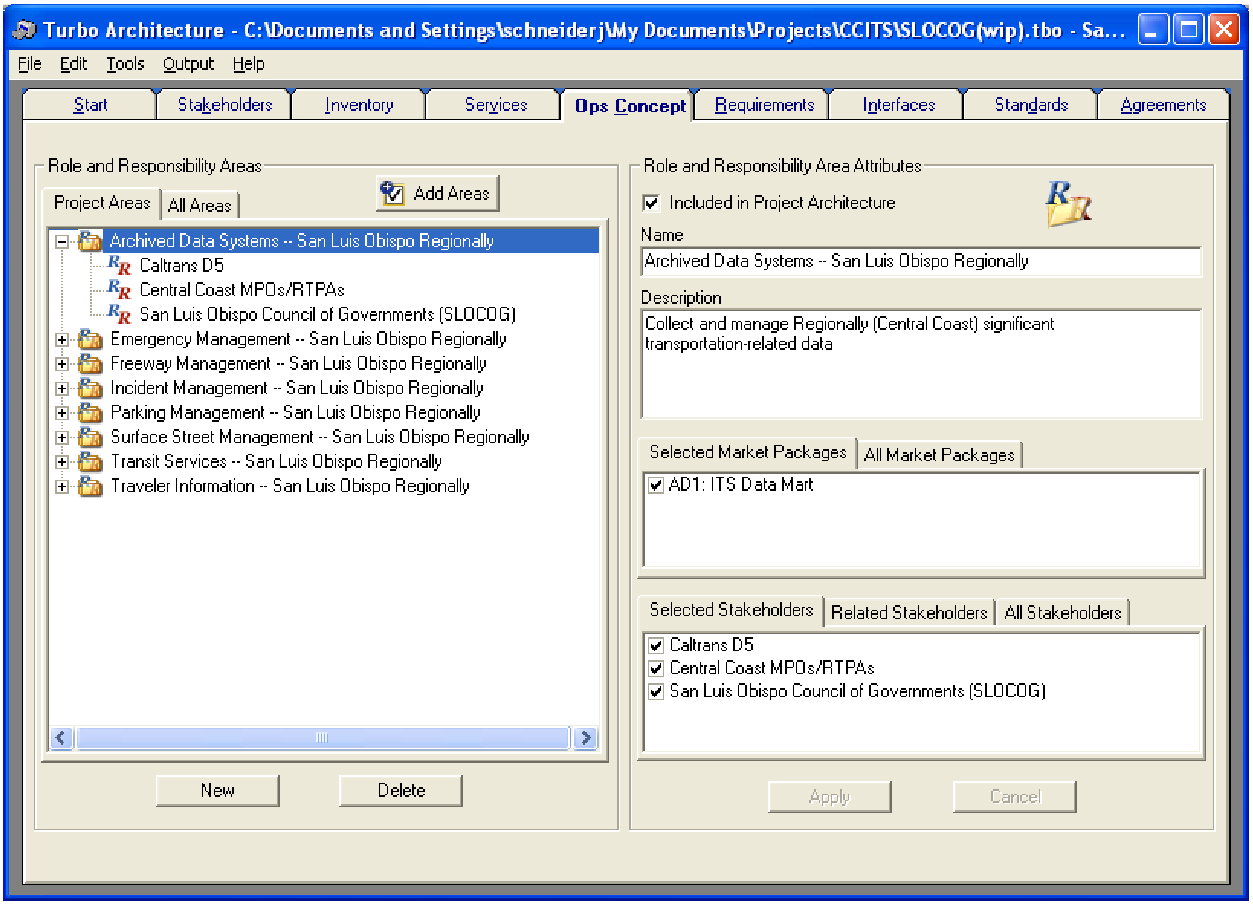
2.2.9 The Ops Concept Tab

The Operational Concepts tab is where the various stakeholder’s ITS-related roles and responsibilities (R&Rs) are defined. In general, these are descriptions of the high-level tasks and activities that the stakeholder is or will be performing with respect to the implementation and operation of the transportation services described in the ITS architecture.

Turbo will build an initial set of R&R Areas for you based upon the MP selections for the active architecture. You may perform this function at any time by pressing the Add Areas button and Turbo will create the R&R Areas (or recreate them if any were deleted) and automatically pre-select potential MP associations. You will need to review these selections and deselect those MPs that are not applicable or select additional MPs (very unlikely). You can also create R&R Areas from scratch by hitting the New button then adding the appropriate MP associations. Whether you create the R&R Areas manually or automatically, you should also add descriptive text for the R&R area.

The final step of the R&R Area definition is associating the stakeholders who will be performing these tasks with the R&R Areas. The R&R Areas in the left-hand pane (see Exhibit 2.7) are shown in a tree structure. Areas with associated stakeholders are denoted with a plus sign (+) next to the Area’s name. These items can be expanded (by clicking on the plus sign) to show the associated stakeholder(s). R&R Areas without any associated stakeholder(s) have no notation beside the name.

Exhibit 2.7 – The Ops Concept Tab – R&R Area Definition



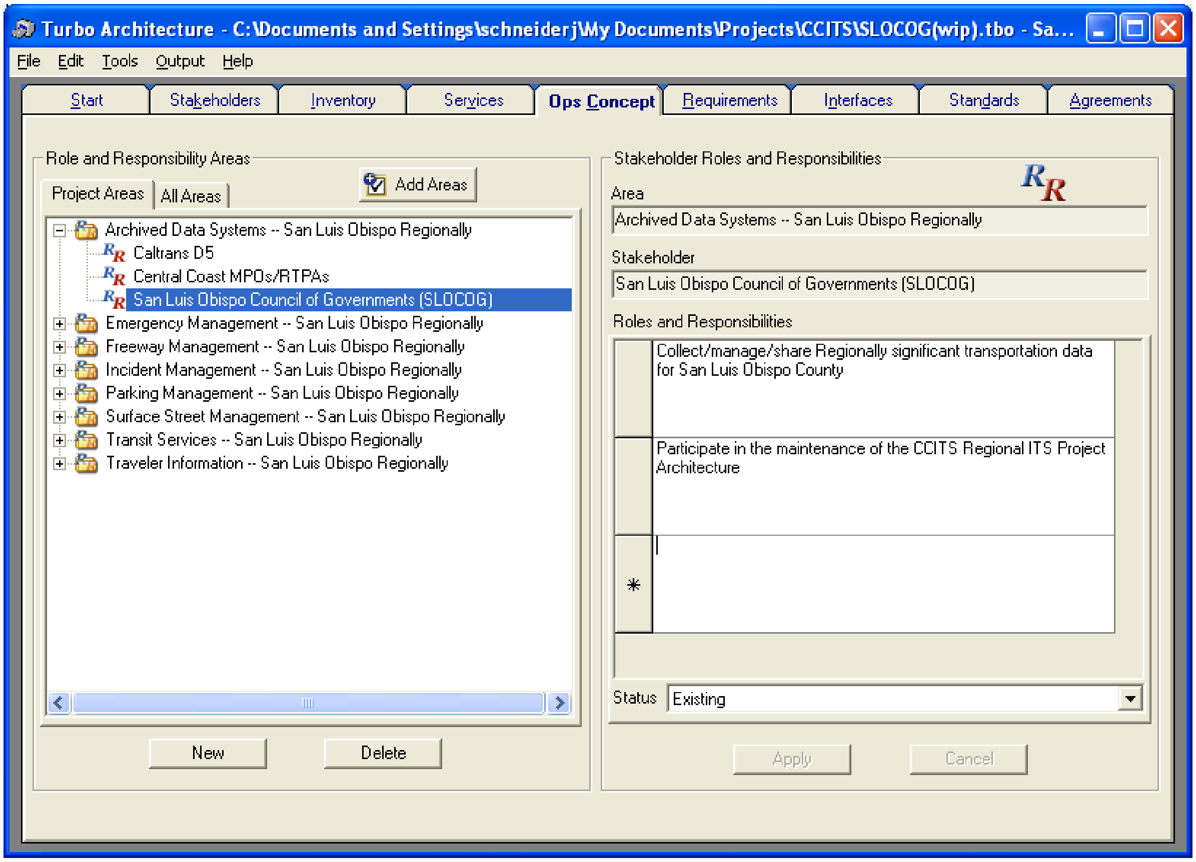
To define the actual activities for a stakeholder, expand the appropriate R&R Area and select the desired stakeholder (you must apply any existing changes before you can proceed with this step). This will change the data fields available on the tab (Exhibit 2.8) and you can now enter the high-level duties that the stakeholder is or will perform.

Enter one task description per row of the R&R table (on the right-hand side). You will want the task descriptions to be concise but still to get the point across – remember you are not the only person needing to understand the task activities.

The status for each activity also needs to be set (Existing, Planned or Programmed). Please note that a task may have a status that is different than either the inventory element or MP that is supporting the task. For example (continuing with the earlier signal system "status" example), there may be a responsibility related to signal synchronization that is "Planned" while a related signals operation and maintenance task in the same R&R Area has a status of "Existing".

Unfortunately, there is no way of easily copying activities between stakeholders or architectures. So, if you need to copy tasks, you will need to use Windows' copy and past functionality as you navigate between the stakeholders and/or R&R Areas.

Exhibit 2.8 – The Ops Concept Tab – Roles & Responsibilities



Major Data Fields:

Field	Description
Include in Architecture checkbox (Overview view)	Check box to include the selected R&R area in the active architecture.
Name (Overview view)	Name of the R&R area.
Description (Overview view)	Description of the R&R Area.
Market Packages tab (Overview view)	Select the applicable MPs for the R&R area (these will be pre-selected if the Add Areas button was used to create the R&R Areas); you can view only MPs selected for this R&R Area or all MPs selected in the active architecture.
Stakeholders tab (Overview view)	Select the Stakeholders that will be performing the tasks; you can view only stakeholders assigned to the R&R Area, stakeholders that could have a role in the R&R Area (based on MP/ITS element associations), or all stakeholders.

Field	Description
Role & Responsibility (R&R tab)	Actual description of the various R&Rs for the R&R Area.
Status (R&R tab)	Status of the active R&R (NOT for the R&R Area).

Major Operations:

Button/Control	Function
Areas tab	Selects whether to show all R&R Areas or only those defined in the active ITS architecture.
Add Areas button	Button to automatically add R&R Areas for selection.
New	Used to create a new R&R Area in the database.
Delete	Used to delete an R&R Area from the database.
Apply	Saves the changes to the Turbo database.
Cancel	Ignore the changes and revert to the original data.

2.2.10 The (Functional) Requirements Tab

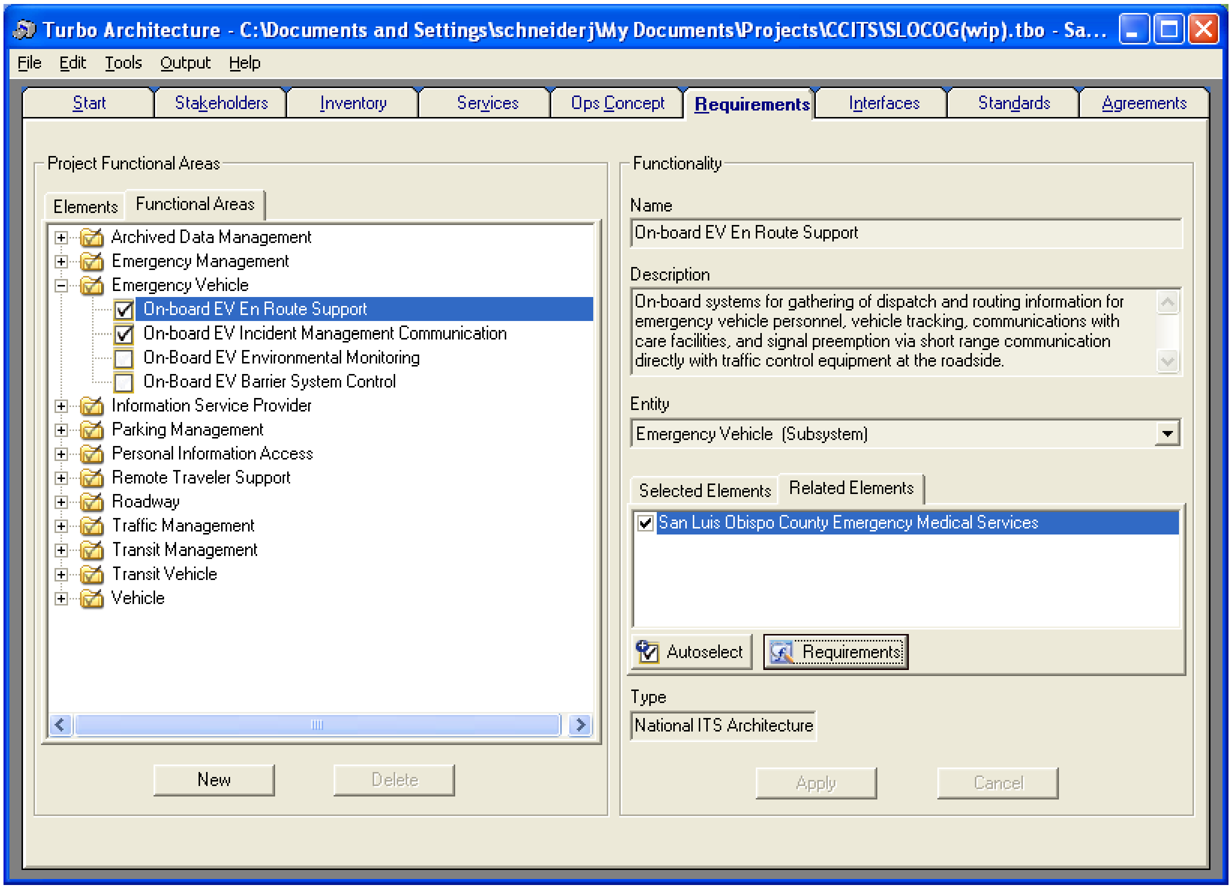
While the Operational Concepts describe how stakeholders will use the ITS elements, the functional requirements (FRs) describe what (functions) the individual ITS elements are to perform. The requirements should be described at a level to provide enough detail to understand what the system will do, and certainly not detailed enough to be used to build a system. The National ITS Architecture has defined a large set of functional requirements based upon MP Equipment Package functionality that you can select from or tailor, as needed.

The Functional Requirements tab operates similarly to the Ops Concept tab in that you must first define and select the desired functional areas and then provide/select the actual requirements in a second step. You cannot change the name, description, or Entity data for pre-defined functional areas since they are taken from the National ITS Architecture. If you create a new functional area, you will need to define these items.

There are two (2) ways to select the actual functional areas (using the Functional Area sub-tabs): by element or by functional area and each has its own merits. The Element sub-tab will present the list of ITS elements in the active architecture on the left-hand side and the applicable/related functional areas on the right-hand of the form. If you only need to add or modify one (or a few) individual element(s), then you should probably use the Elements view.

If you want to compare or modify the requirements for a related group of elements, then the Functional Area view will probably work best. In this view (see Exhibit 2.9), functional areas are presented in a tree on the left-hand side and applicable/related ITS elements are on the right-hand of the form. Either way, select the appropriate element and functional area and press the Requirements button to add or review the actual functional requirements.

Exhibit 2.9 – The Requirements Tab: Functional Areas



Major Data Fields:

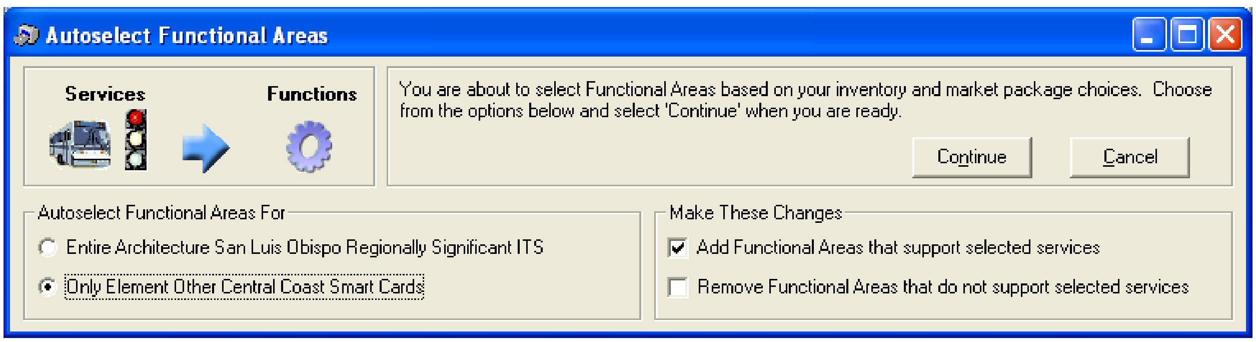
Field	Description
Name	Name of the Functional Area (only available via the Functional Areas view).
Description (Functional Areas view)	Description of the R&R Area.
Entity (Functional Areas view)	Picklist of National ITS Architecture subsystems.
Elements	List of inventory elements associated with the Functional Area.

Major Operations:

Button	Function
Autoselect button	Button to automatically add Functional Areas.
New (Functional Areas view)	Used to create a new Functional Area in the database.
Requirements button	Used to manage (create, delete, edit) FRs for selected Functional Area and Element (only active if an inventory element is selected).
Delete	Used to delete an R&R Area from the database (only active for user-created Functional Areas).
Apply	Saves the changes to the Turbo database.
Cancel	Ignore the changes and revert to the original data.

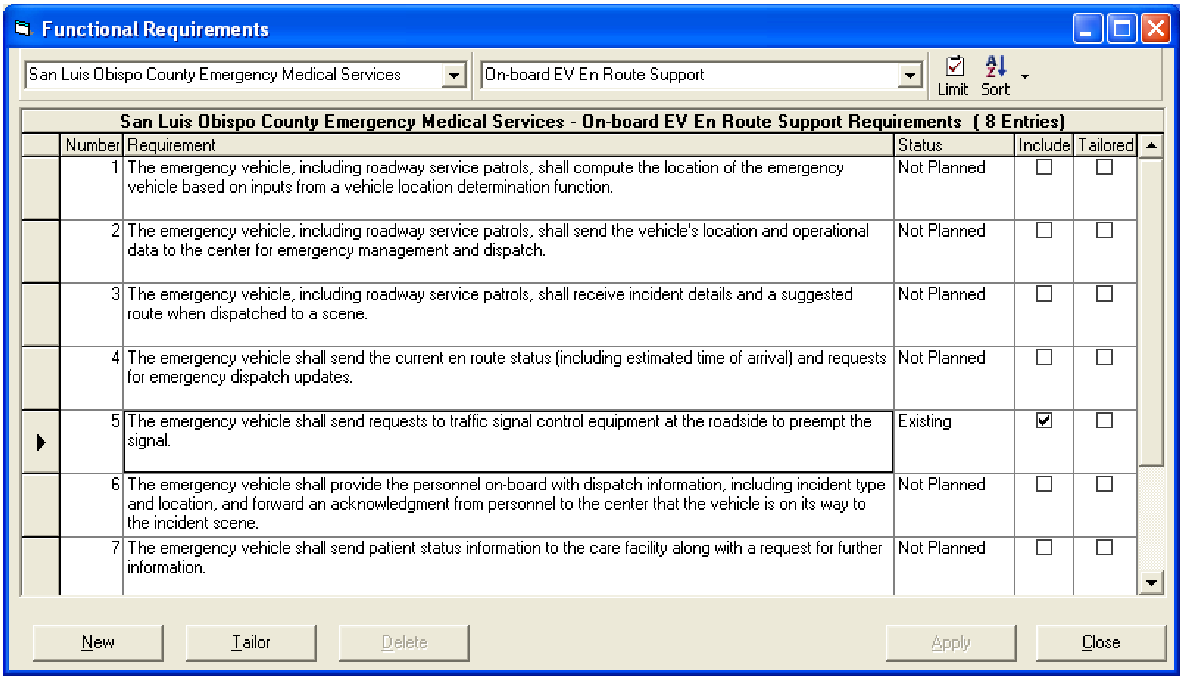
There is actually a third way to select functional areas. You can have Turbo select the functional areas automatically (but not the requirements, themselves). This can be done for a specific element or the entire active architecture (Exhibit 2.10). This tool can create the functional areas for the entire active project or a specific element. It will present the list of proposed changes and let you approve or reject them (en masse, not individually) prior to adding them to the architecture.

Exhibit 2.10 – Functional Requirements: Functional Areas Autoselection



As stated earlier, the initial actual functional requirements are taken from the National ITS Architecture. You may select the applicable ones from them, tailor (customize) them as needed, or create new ones altogether. When the Requirements button is pressed, a new form (Exhibit 2.11) will be presented with a list of potentially applicable (and pre-defined) FRs for the selected element and functional area. (If no functional area is selected/active, all applicable functional requirements for the element will be presented.)

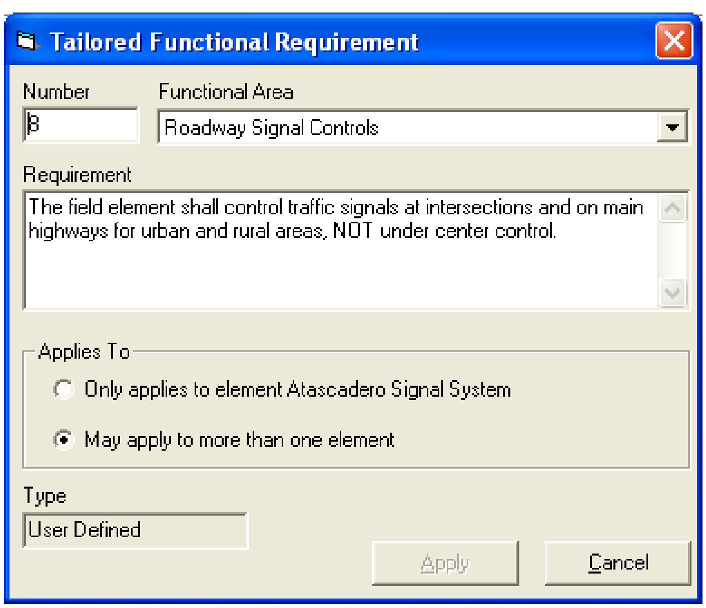
Exhibit 2.11 – Functional Requirements



Number	Requirement	Status	Include	Tailored
1	The emergency vehicle, including roadway service patrols, shall compute the location of the emergency vehicle based on inputs from a vehicle location determination function.	Not Planned	☐	☐
2	The emergency vehicle, including roadway service patrols, shall send the vehicle's location and operational data to the center for emergency management and dispatch.	Not Planned	☐	☐
3	The emergency vehicle, including roadway service patrols, shall receive incident details and a suggested route when dispatched to a scene.	Not Planned	☐	☐
4	The emergency vehicle shall send the current en route status (including estimated time of arrival) and requests for emergency dispatch updates.	Not Planned	☐	☐
5	The emergency vehicle shall send requests to traffic signal control equipment at the roadside to preempt the signal.	Existing	☑	☐
6	The emergency vehicle shall provide the personnel on-board with dispatch information, including incident type and location, and forward an acknowledgment from personnel to the center that the vehicle is on its way to the incident scene.	Not Planned	☐	☐
7	The emergency vehicle shall send patient status information to the care facility along with a request for further information.	Not Planned	☐	☐

This process is fairly straightforward. Review the list of functional requirements and include those that apply to the element. If a requirement is close to the desired functionality, but needs minor changes, you can tailor it by selecting the requirement and hitting the Tailor button. This will raise a new form (Exhibit 2.12) where you can make the needed changes. While there is an option to have this change apply only to the selected element, it is usually best to have the new requirement available to all elements. You may apply the changes or revert back to the original version.

Exhibit 2.12 – Functional Requirements: Tailored Requirements



If you find that you need a completely new requirement, hit the New button and the same form will appear, however there will not be any data for you to modify. Before you hit the New button, you must make sure that you are in the correct functional area or your new requirement may not be saved in the correct place.

Major Data Fields:

Field	Description
Requirement	Text of the Functional Requirement (only editable when creating or tailoring a FR).
Status	Status of the FR in the active architecture (changing the status of the FR from Not Planned automatically includes it).
Include	Checkbox to indicate if the FR is to be included in the active architecture.
Functional Area	Used to select the Functional Area for the FR.
Applies To (Tailoring Form)	Used to indicate the scope of the new/custom FR (generally let it apply to more than one element).

Major Operations:

Button	Function
New (Requirements Form)	Used to create a new Functional Requirement (starts the Tailoring Form).
Tailor (Requirements Form)	Used to modify an existing National ITS Architecture Functional Requirement (a new version of the requirement is created).
Delete	Used to delete an R&R Area from the database (only active for user-created Functional Areas).
Apply	Saves the changes to the Turbo database.
Cancel	Ignore the changes and revert to the original data.

2.2.11 The Interfaces Tab

The Interfaces tab presents a slightly different user interface than the previous tabs. This interface is more Excel-like in that a data grid is presented from which elements (or data flows) are selected for inclusion in the active architecture. In addition, there is a row of buttons that (mostly) affect what and how data is displayed. Since the interfaces and flows are so inter-related, they are presented on the same tab. In fact, when Turbo is used to generate the interfaces, the data flows are built at the same time.

<u>Interfaces</u>

Interfaces describe what ITS elements are or are going to be connected to which other ITS elements. Usually, these connections are in the same active architecture, but it does not need to be that way (i.e., just as in real implementations, the interconnections can cross architecture boundaries). Interconnections are independent of what data is being shared or which direction the data is flowing – basically, they define who's talking to whom (or what's connected to what).

There is not an explicit implementation status for interconnections. Although the standard Turbo report does include one, the only way to manipulate the implementation status of interfaces is by setting the associated data flows (explained more in the Flows section).

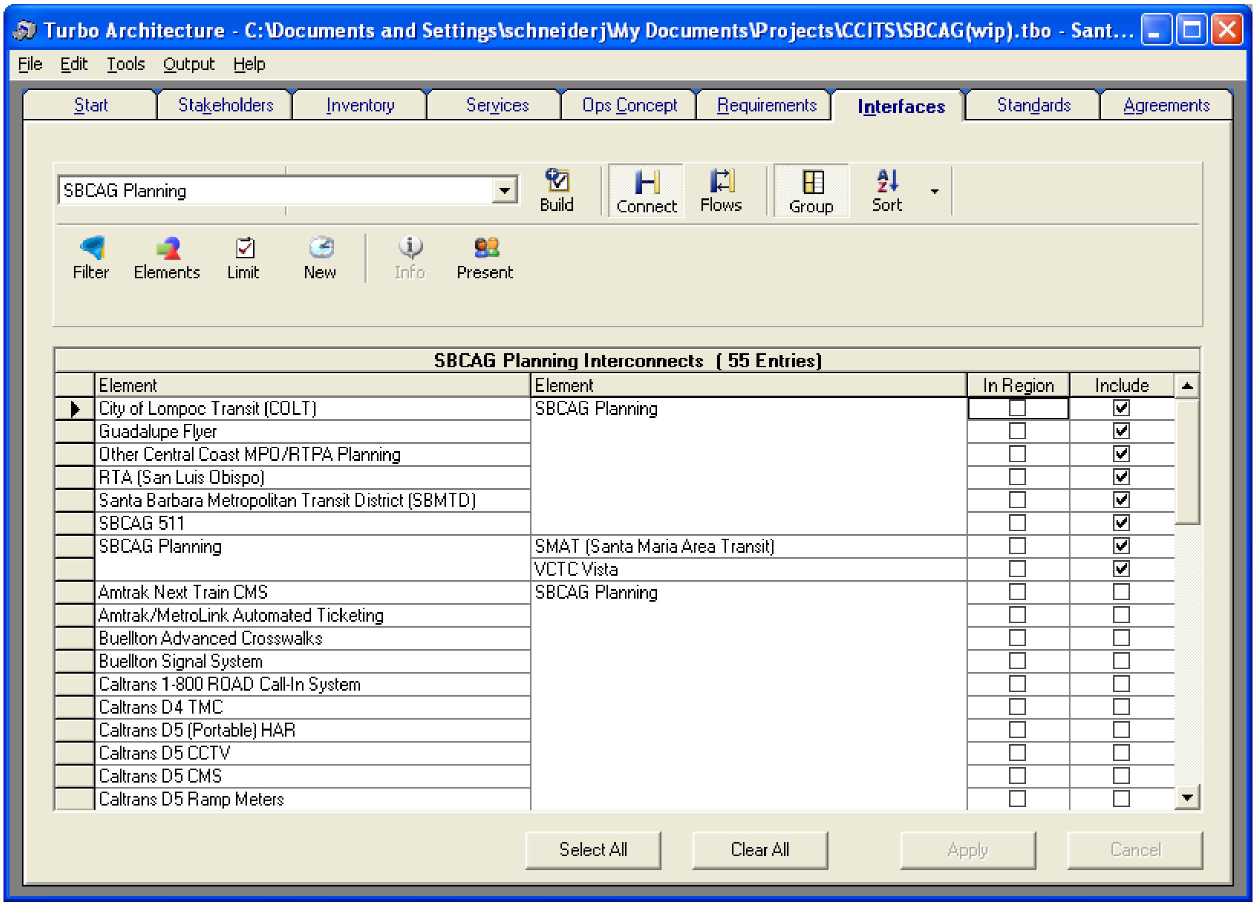
The Interconnects interface is pretty straightforward (Exhibit 2.13). It presents a source and destination ITS element with each row representing a potential interconnection and you can include (check the Include column) or exclude each potential interconnection (unchecked). Because interconnects are directionless, Turbo only displays the potential interconnection once (even though logically it could "go" either way), so you may need to check both Element columns to find the desired interconnection pairing.

In general, the potential interconnections are based upon subsystem assignments made to the inventory elements earlier in the development process. So, if a potential interconnection is missing, you may need to go back and ensure that the inventory is properly defined. (Note that if you change the definition of a particular ITS inventory, you may need to change other related aspects of the architecture, such as the functional requirements, etc.).

Turbo will build a set of interconnects (and data flows) for the active architecture by using the Build button (the interconnects and data flows for each architecture in the Turbo database need to be built individually). In fact, you must use Turbo's build function in order to work with an element in the Interfaces tab. In general, if you are adding new elements to the active architecture (or changing an element's subsystem associations), you will need to "rebuild" the architecture prior to proceeding. If you are merely updating data for existing elements (e.g., new flows, etc.) then you probably do not need to perform a rebuild unless the interconnects and/or flows you are looking for are not present. Please note that rebuilding an architecture may in fact remove some interconnections/flows that were excluded previously.

The "In Region" column indicates if the interconnection is defined in the regional Turbo database (not the MPO's regionally significant ITS project architecture). Since there are not regional Turbo architectures, this field does not apply to the CCITS as of this writing.

Exhibit 2.13 – The Interfaces Tab: Interconnects



Data Flows

The data flows are the real meat of the ITS architecture. The flows are taken from the National ITS Architecture (custom flows can be created, if needed) and show what data is actually being shared between ITS systems – the actual and planned integration of systems. If the interconnects describe who's talking to whom, the flows describe what's being said and by whom.

The major differences between the interconnection and flow screens are the addition of two columns: Flow Name and Status; otherwise, the operation of the Flows form (see Exhibit 2.14) is basically the same as the Connections. Each row represents a potential data flow between elements that are interconnected and each data flow is either included in the active architecture and given a status of Existing or Planned (or Programmed, if that status is being used) or not included (unchecked or a status of Not Planned).

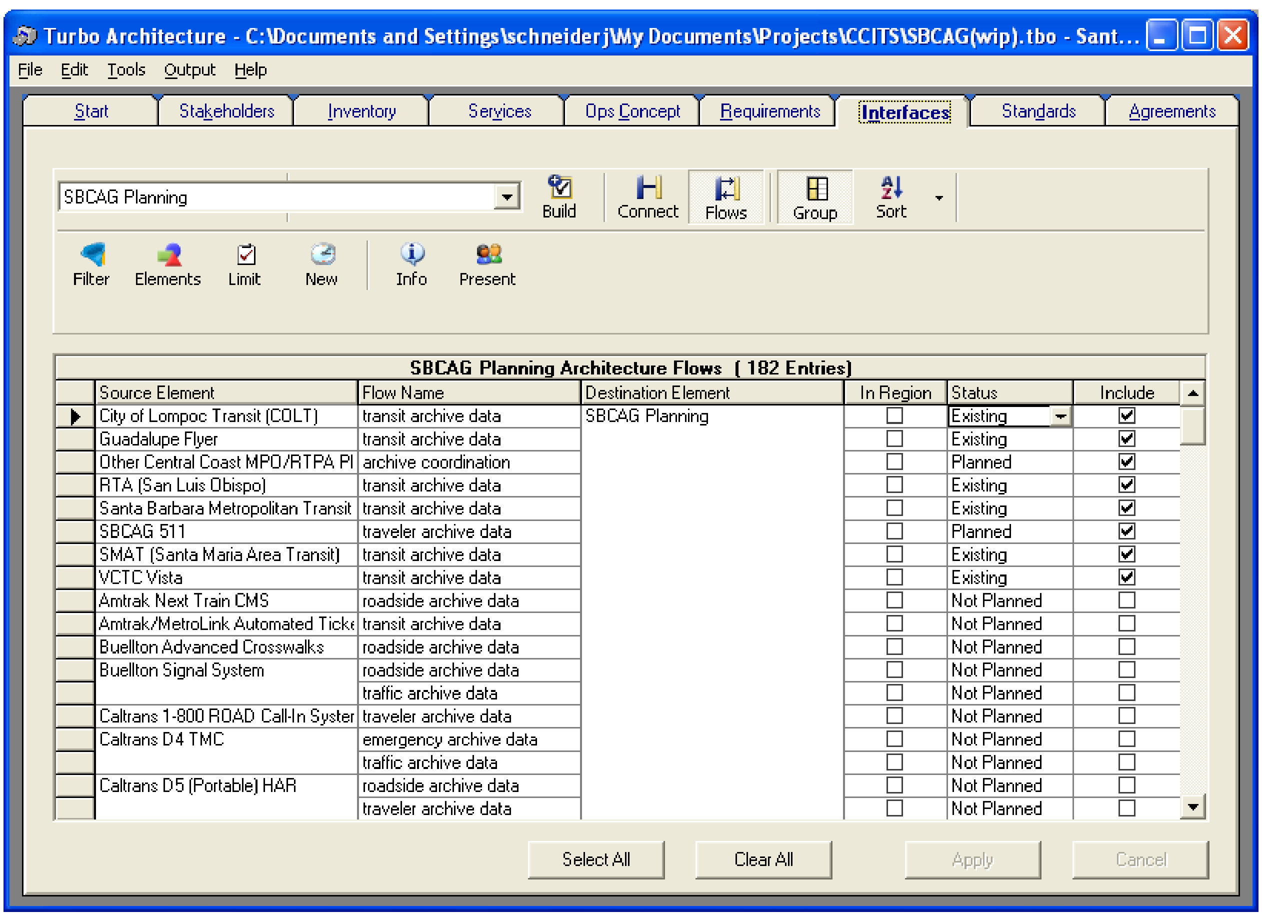
As opposed to interconnections, data flows do have a direction associated with them, so you may need to have seemingly duplicated data flows between elements if the same data flows exist between both systems. For example, if two TMCs both (plan to) share CCTV images and control, then "traffic images" and "video surveillance control" data flows (amongst others, potentially) will need to be defined between the TMC in both directions. However, if only one of the TMCs will allow shared CCTV control, then both directions will have the traffic images data flow and only one will have the "video surveillance control" data flow defined.

Note that you can indirectly define an interconnection between elements by including a data flow between them (even if they were not linked via the Connect view). Conversely, you can indirectly remove an interconnection by eliminating all defined data flows between the elements.

It is possible that different flows between the same elements may have different statuses. This can occur under several circumstances, but most commonly when existing systems have plans to expand functionality or to be integrated into a larger system. (As an aside, the status of an interconnection is based upon the status of its data flows. In most cases, if there is an Existing data flow between elements, then the interconnect status between the elements is normally assumed to be Existing.)

Please remember that you may need to perform a rebuild of the active architecture, depending upon what has been updated. This may become evident when required data flows are not found.

Exhibit 2.14 – The Interfaces Tab: Architecture (Data) Flows



Source Element	Flow Name	Destination Element	In Region	Status	Include
City of Lompoc Transit (COLT)	transit archive data	SBCAG Planning	☐	Existing	☑
Guadalupe Flyer	transit archive data		☐	Existing	☑
Other Central Coast MPO/RTPA Pl	archive coordination		☐	Planned	☑
RTA (San Luis Obispo)	transit archive data		☐	Existing	☑
Santa Barbara Metropolitan Transit	transit archive data		☐	Existing	☑
SBCAG 511	traveler archive data		☐	Planned	☑
SMAT (Santa Maria Area Transit)	transit archive data		☐	Existing	☑
VCTC Vista	transit archive data		☐	Existing	☑
Amtrak Next Train CMS	roadside archive data		☐	Not Planned	☐
Amtrak/MetroLink Automated Ticke	transit archive data		☐	Not Planned	☐
Buellton Advanced Crosswalks	roadside archive data		☐	Not Planned	☐
Buellton Signal System	roadside archive data		☐	Not Planned	☐
	traffic archive data		☐	Not Planned	☐
Caltrans 1-800 ROAD Call-In Syster	traveler archive data		☐	Not Planned	☐
Caltrans D4 TMC	emergency archive data		☐	Not Planned	☐
	traffic archive data		☐	Not Planned	☐
Caltrans D5 (Portable) HAR	roadside archive data		☐	Not Planned	☐
	traveler archive data		☐	Not Planned	☐

Major Data Fields:

Field	Description
Include	Checkbox to indicate if the Connection or Data Flow is to be included in the active architecture.
Status (Flows view)	Status of the data flow: Existing, Planned, or for some databases, Programmed; setting a flow to Not Planned unchecks Include (i.e., excludes the Data Flow) and setting the status to any other status checks Include.

Major Operations:

There are basically two (2) types of buttons across the top of the Interfaces form (for both Interconnects and Flows): action and switches. Action buttons perform a task (sort data, start another form, etc.) and switches turn functions on or off.

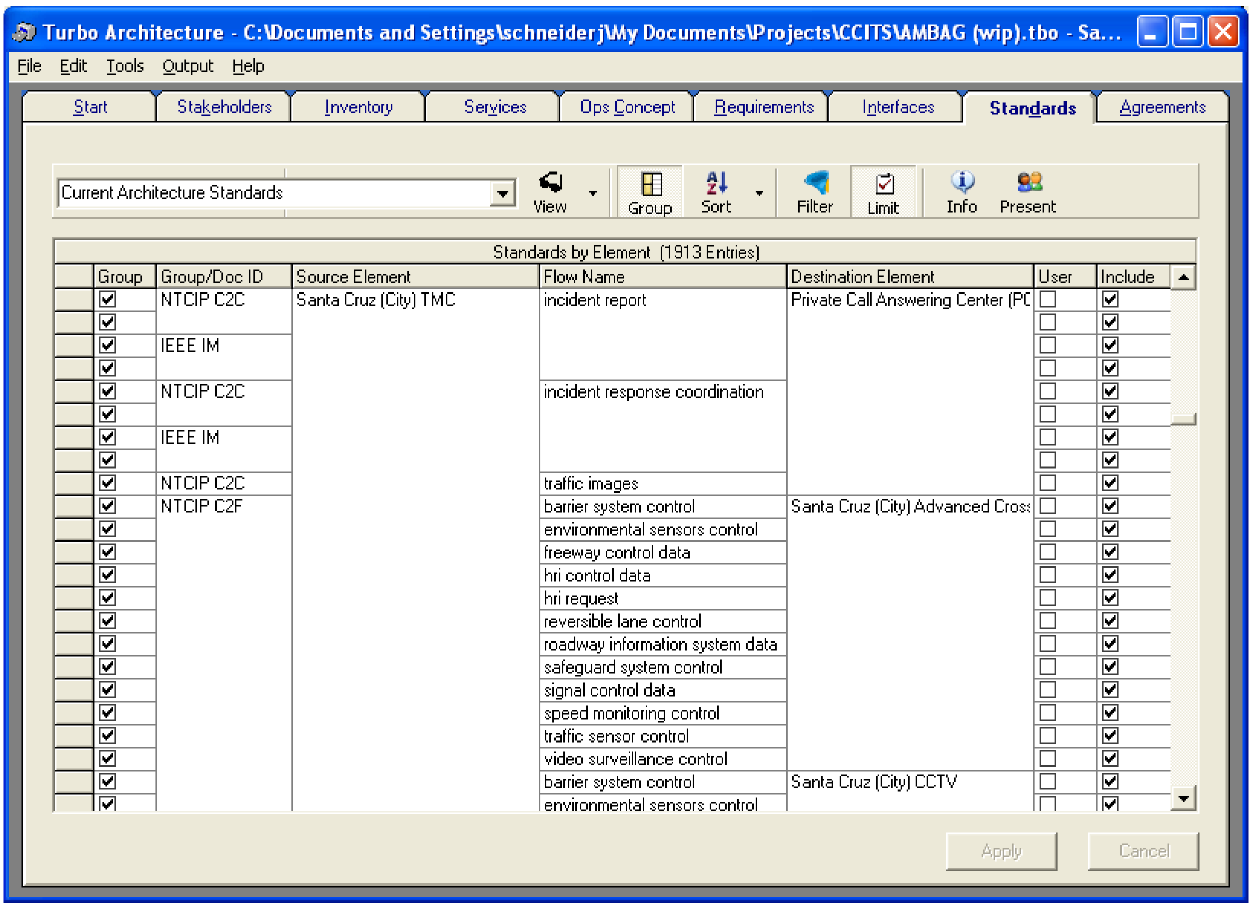
Control/Button	Function
Element List	Drop-down list of all elements in the active architecture that controls what interconnects/flows to present: All elements or only the selected element.
Build	Action button that starts the build process. A new screen is presented that will allow you to generate a cross-reference report and actually perform the build. When the build is complete you can review and accept or reject the just built flows (en masse, not individually). A rebuild may also delete interconnects/flows that were previously excluded.
Connect/Flows buttons	Toggle buttons to indicate whether to show interconnections or data flows in the data grid.
Group	Toggle button to change the data grid to only show the element name of consecutive rows once (improved readability).
Sort	Action button to reorder the data grid using pre-defined or user-defined sorts.
Elements	Toggle and action button that is used to select which elements in the Turbo database to include in the display. You can (and will probably want to) select only those elements in the active architecture, all architectures, or any subset. Pushing the button applies the selection. Right-clicking on the button starts the element selection form.
Limit	Toggle button to limit the data grid to only those items included in the active architecture.
New	Toggle button to limit the data grid to only those items added in the last build.
Info (Flows view)	Provides additional information regarding the specified data flow.
Select All	Switch to select (check) all of the rows in the displayed table.
Clear All	Switch to unselect (uncheck) all of the rows in the displayed table.
Apply	Saves the changes to the Turbo database.
Cancel	Ignore the changes and revert to the original data.

2.2.12 The Standards Tab

The Standards tab is used to indicate which ITS-related standards are (to be) implemented. There are numerous potential standards managed by several different standards development organizations (SDOs). More information on ITS standards can be obtained on the web at http://www.standards.its.dot.gov/default.asp.

The Standards tab (Exhibit 2.15) operates very much like the Interfaces tab with many of the same buttons and functions. The standards can be presented in several ways: by ITS standard, subsystem, or element. The element and subsystem presentations display the standards by data included flows between elements.

Exhibit 2.15 – The Standards Tab



Major Data Fields:

Field	Description
Include	Checkbox to indicate if the Connection or Data Flow is to be included in the active architecture.

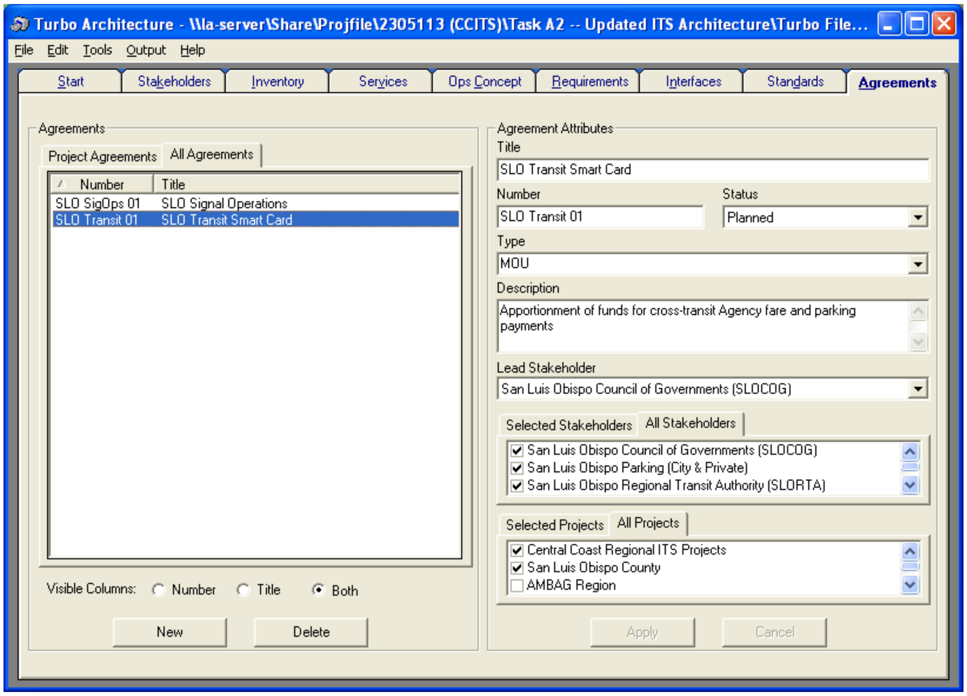
Major Operations:

Control/Button	Function
Standards List	Drop-down list of all ITS standards that controls what standards to present: all or only the selected standard.
View	Action button to indicate which standards view to display.
Group	Toggle button to change the data grid to only show the standard and element names of consecutive rows once (improved readability).
Sort	Action button to reorder the data grid using pre-defined or user-defined sorts.
Limit	Toggle button to limit the data grid to only those items included in the active architecture.
Info	Provides additional information regarding the specified standard.
Apply	Saves the changes to the Turbo database.
Cancel	Ignore the changes and revert to the original data.

2.2.13 The Agreements Tab

The Agreements tab (Exhibit 2.16) is used to document and mange various (existing and potential) Agency agreements. There should be a correlation between R&Rs (described earlier in the operational concepts) and Agency agreements. This tab functions very similarly to the Inventory tab: Agency agreements on the left-hand pane and the associated data are to the right. The display of the agreements can be restricted to the active architecture or the entire Turbo database.

Exhibit 2.16 – The Agreements Tab



Major Data Fields:

Field	Description
Title (required)	Title of the agreement.
Number	An agreement number (should be unique).
Status	Status of the agreement (default values are Existing and Planned, but additional status values, such as Programmed, can be created).
Type	User definable and selectable list of agreement types (e.g., MOU, Handshake, etc.) Either pick a type from the list or enter a new agreement type.
Description	Description of the agreement.
Lead Stakeholder	Primary "owner" of the agreement (pick-list from the Stakeholders tab).
Stakeholders	Checkbox list of applicable stakeholders/participants.
Projects	Checkbox list of applicable ITS architectures in the database.

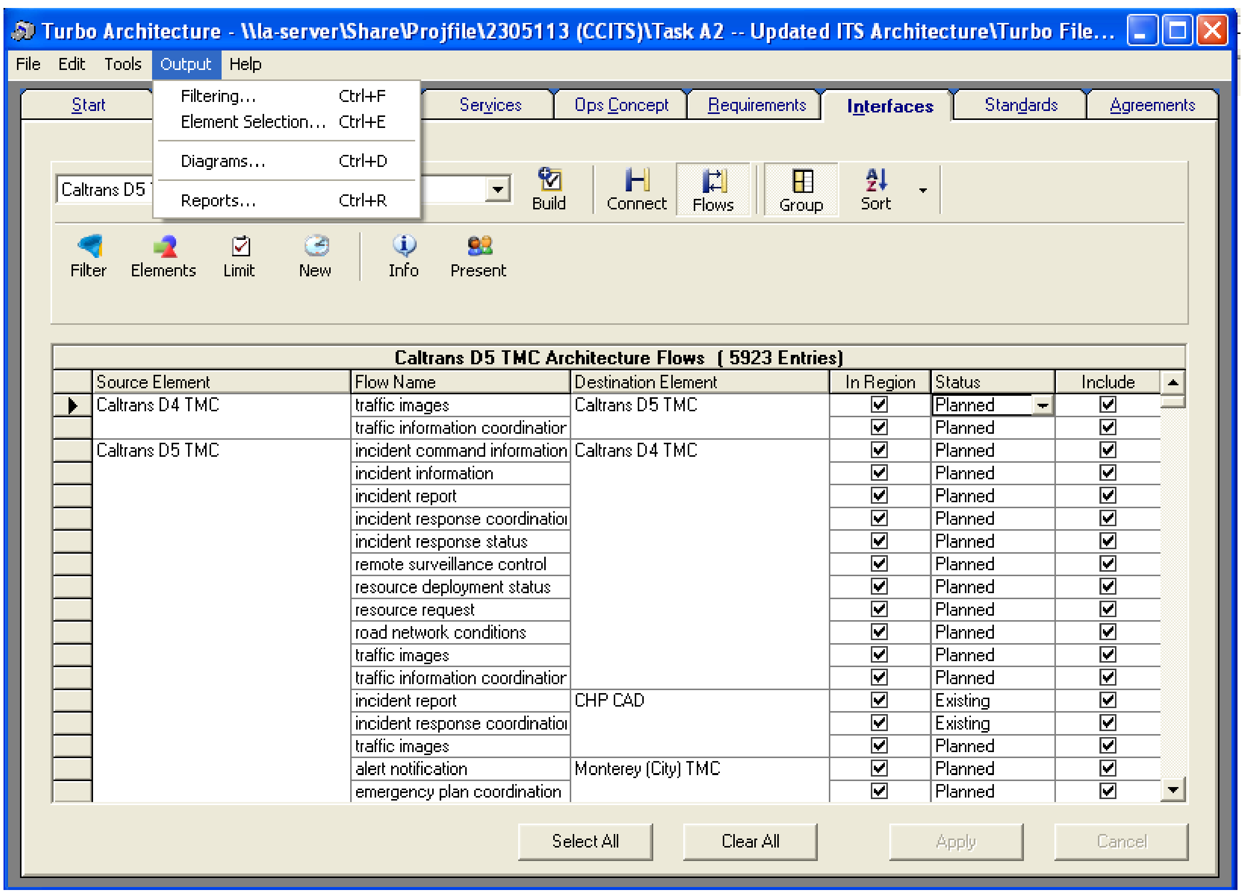
Major Operations:

Button	Function
Agreements sub-tab	Selects whether to show all agreements in the database or only those for the selected ITS architecture.
New	Used to create a new agreements in the database.
Delete	Used to delete an all agreements from the database.
Apply	Saves the changes to the Turbo database.
Cancel	Ignore the changes and revert to the original data.

2.2.14 Running Reports

Turbo Architecture comes with a variety of pre-built reports and diagrams. Generally there is at least one report or diagram for each Turbo tab. The reports can be accessed via the Turbo Menu via the Output menu item (Exhibit 2.17). In general, the data to be used in the reports and diagrams are for the active architecture only and not the entire Turbo database.

Exhibit 2.17 – The Reports Menu



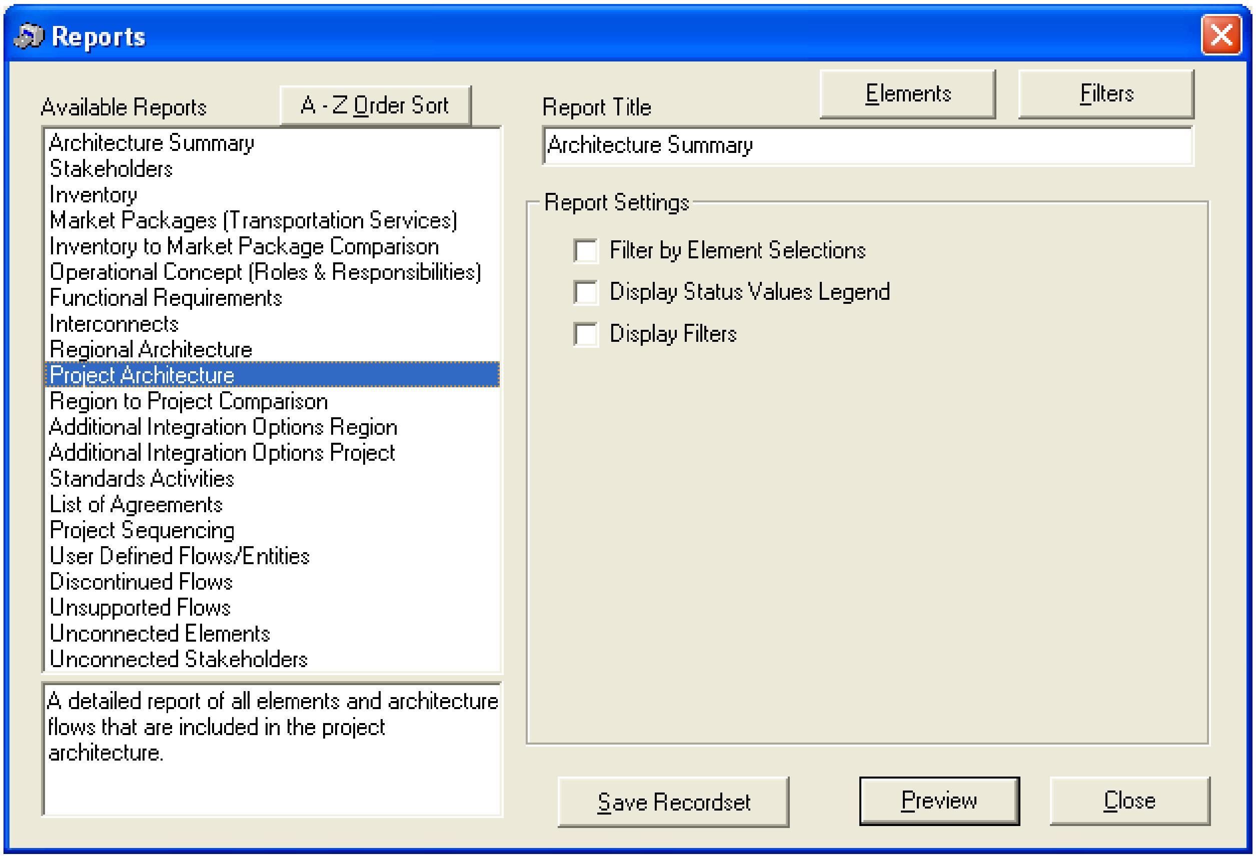
The following is a summary of some of the more important or useful reports and diagrams:

Report/Diagram	Description
Subsystem Diagram	Generates a Physical Diagram (a.k.a. Sausage Diagram) that shows the selected subsystems and communications for the active architecture.
Interconnect Diagram*	Diagram showing how the selected systems are interconnected.
Flow Diagram*	Diagram showing how the selected systems are interconnected and the related data flows.
Architecture Summary	Report showing all of the ITS inventory for all architectures in the Turbo database.
Stakeholders	Report showing all stakeholders in the Turbo database.
Inventory*	Report listing the ITS inventory in the active architecture.
Market Packages	Report showing the selected Market Packages and associated inventory elements for the active architecture.
Operational Concepts	Report showing the stakeholder roles and responsibilities defined in the active architecture.
Functional Requirements	Report showing the functional requirements defined for the ITS (selected) elements in the active architecture.
Interconnects*	Report showing how the (selected) elements in the active architecture are interconnected (note that his report only lists each interconnection once, so, for example, the connection between TAMC Planning and AMBAG Planning will only appear under AMBAG Planning).
Project Architecture*	Report showing data flows between the (selected) elements in the active architecture.
Standards*	Report showing the applicable ITS-related standards for the active architecture.
Agency Agreements	Report showing the Agency agreements that have been entered into Turbo.

* You can limit these reports and diagrams to any or all of the elements in the active architecture by filtering or explicit element selection

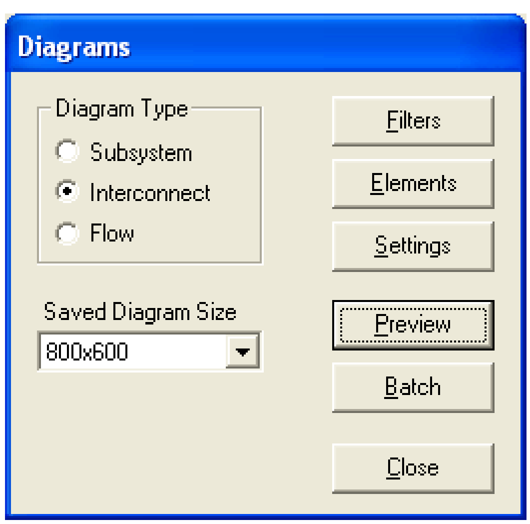
To run a report, select the desired report in the left-hand window (Exhibit 2.18), select the desired options and filters using the checkboxes and top buttons and then hit the Preview button. This will generate the report in a new window. From there, you can examine the output and print or save it, if desired.

Exhibit 2.18 – Report Selection



Similarly, to run a diagram (Exhibit 2.19), select the diagram from Diagram Type and set the desired filters and options (unfortunately, you cannot filter the Subsystem diagram). Press the preview button to generate the diagram. The Batch button allows you to submit a large number of the same type of diagram at one time, but this can take a long time and use a lot of system resources.

Exhibit 2.19 – Diagram Selection



Most of the architecture reports presented in the CCITS project were custom MS Access reports. If you are proficient with MS Access (or other data reporting tools), you can export the data used to generate the Turbo reports (in CSV format) using the Save Recordset button and then import the file into your tool of choice. This functionality may be of particular use when working with a complex interconnection or flow diagram that is difficult to read and a tabular presentation could make the information more accessible.

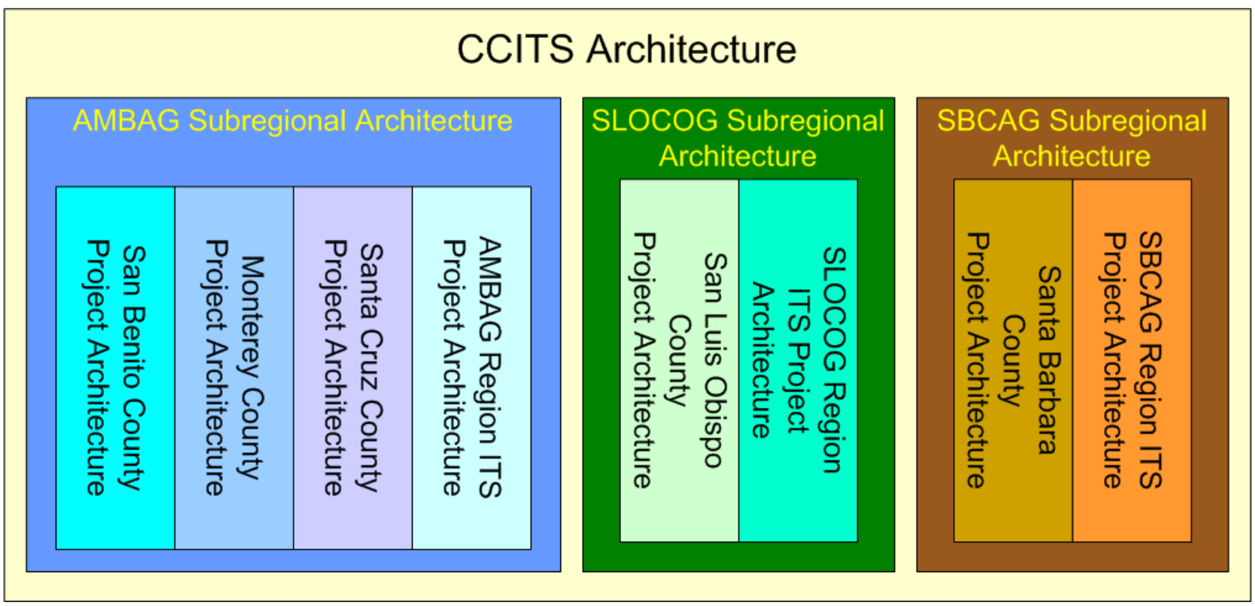
3. CCITS ARCHITECTURES

This section describes the structure of the CCITS Architecture database and how to obtain the correct database prior to performing updates.

3.1 CCITS Architecture Databases

Turbo allows two (2) types of architectures: regional and project. The CCITS Turbo databases have been segmented into separate Turbo databases for each CCITS MPO. (Originally, there was a single CCITS Turbo database with seven (7) project architectures, one for each County, AMBAG and Regionally significant projects.) Currently, in each MPO Turbo database there is a project database that is representative of local ITS for each constituent County of the MPO (i.e., ITS that is [to be] implemented in the County and is generally local to Agencies in the County) and a separate project architecture for ITS that is of significance to the entire MPO and/or beyond the MPO boundaries. The combination of the individual County architectures and the MPO-significant architecture form the regional architecture for the MPO. (Note that these individual project architectures could be "merged" together to create an actual Turbo regional ITS architecture, but that would create additional complexities, especially when updating the architectures.) Exhibit 3.1 depicts the CCITS Turbo database structure graphically.

Exhibit 3.1 – CCITS Turbo Database Structure



3.2 ITS Architecture Maintenance Plans

An ITS Architecture Maintenance Plan has been developed for each CCITS County/MPO (with AMBAG covering its tri-County area). These plans are available from the project website (http://www.iteris.com/ccits-admin/html/deliverables.html) and describe the roles and responsibilities needed to keep each of the ITS architectures up-to-date. The plans also contain advice on what project-related data to collect prior to starting the update process and how to document that data.

ITS architecture maintenance is a complex and collaborative process that is subject to change as ITS evolves in the Central Coast region. As changes occur, portions of the architecture, if not the whole architecture will need to be updated accordingly. These changes should be initiated by the stakeholders as the need arises, and as resources allow. The following list includes events that may require change to a regional ITS architecture:

- Changes in regional needs
- Addition of new stakeholders
- Changes in stakeholder status
- Changes in stakeholder or element names
- Changes in scope of services considered
- Changes in other architectures that overlap or have an impact (e.g., statewide, neighboring regions, neighboring counties, etc.)
- Changes in project status (e.g., definition, implementation, expansion, etc.)
- Changes due to project addition/deletion
- Changes in project priority
- New ITS updates release at national/state level
- Regularly scheduled update (e.g. monthly, quarterly, annually, etc.)
- Coordination with transportation planning updates [e.g., Metropolitan Transportation Plans (MTP), Metropolitan Transportation Improvement Program (MTIP), Regional Transportation Plans (RTPs), etc.]

3.3 How to get the appropriate ITS Architecture

Each MPO is responsible for managing its own ITS architecture and Turbo database. This includes version control procedures and distribution of the Turbo database and related files (paper and electronic). Refer to the Architecture Maintenance Plan for your MPO to obtain the needed reference information and contacts.

3.4 Relationship with other ITS Architectures

One of the goals of an ITS architecture is to document existing and potential interfaces between ITS systems (i.e., ITS integration). This is of particular importance when defining links with systems outside of the local project area and thus defined in another ITS architecture. In general, only projects that are of Regional significance should rise to this level. For example, a local Agency’s signal system will probably not require this consideration. However, a transit Smart Card might, if there are plans to allow usage of the Smart Card with adjacent transit Agencies or with Agencies outside of the MPO area.

In general, most ITS elements in a County architecture will not interface with systems beyond the owning/operating Agency or, in some cases the Regionally significant ITS (i.e., not beyond the MPO architecture). ITS that has a scope involving multiple Agencies throughout the MPO or that (may) integrate with systems outside of the MPO will need to have those Agencies or systems represented in the ITS architecture. These items will also need to be coordinated with updates to the corresponding ITS architectures when they are updated.

The Architecture Maintenance Plan for each CCITS architecture contains a list of potentially impacted ITS architectures that need to be to be considered (for coordination) when updating the particular architecture(s). This information can be found in Chapter 7 of each project architecture maintenance plan.

In order to advance the integration of ITS in the Central Coast, it is recommended that AMBAG and Caltrans promote and facilitate the coordination and standardization of the various CCITS ITS architectures henceforth.

4. ITS PROJECT IMPLEMENTATION

If the data in the architecture is not used, then its development and maintenance is merely a bureaucratic exercise. The key to getting value from the ITS architecture is to integrate it into the (local and) Regional ITS planning and deployment processes.

4.1 Interrelationship of ITS Planning and the ITS Architecture

In the recent past, ITS projects were often funded through various R&D and/or demonstration projects without competing against "traditional" transportation projects that had gone through the planning process(es). With the relatively new FHWA and FTA rules, this is no longer possible for projects that receive federal funds. Therefore, planned projects identified in the ITS architecture (and in the forthcoming updated ITS Implementation Plan) will need to go through the defined transportation planning processes.

Now that your ITS architecture is built, you can make it part of your Region's various planning processes. Section 4 of the ITS Architecture Maintenance Plan discusses when the MPO's architecture should be updated so it can be better linked with planning events, such as the preparation of the Regional Transportation Plan or Regional Transportation Improvement Plan.

But why update the architecture at these points? Because the ITS architecture can be used as a resource in the preparation of these documents and also because the process of updating these documents involves identifying new ITS-related projects that need to be added to the ITS architecture. Also, the ITS Architecture offers a way to help examine the linkages between projects/systems and provide insight into project sequencing.

4.2 Moving from Project Concept to Operating System

The Central Coast ITS Strategic Deployment Plan (2000) laid out a set of recommended ITS projects for the Region and for each of the Counties. The CCITS Implementation Plan will update this slate of projects.

The various Agencies throughout the Region will generate additional project concepts over time that will need to be added into the mix. These projects will need to be added to the Regional SDP and evaluated vs. the other projects already in the SDP. This can be accomplished by using a Project Description Form (the SDP project form) similar to the ones used by the SDP, thus allowing an evaluation with data similar in format. The SDP project form should be completed by the proposing Agency and in the same level of detail as those in the SDP. Several areas of the SDP project form relate to the National ITS Architecture, so adding the project to the appropriate ITS architecture(s) will assist with its completion.

The project concept needs to then get added into the transportation planning process. (Section 4.1 addressed the linkages between the ITS Architecture and the various planning processes.) This is where the project will get evaluated against other project competing for limited funding. Additional paperwork may be required, depending upon which planning process is being performed and what funding sources are being requested. The project sponsor will need to determine what is required by the particular funding program(s) being considered and to meet the funding requirements (e.g. timelines, data requirements, etc.).

For example, if Federal funds are being requested, a Systems Engineering Review Form (SERF) will probably be required. (Section 5.2 has an overview of how to use the ITS architecture when developing a Systems Engineering Analysis, which has some similarities to the SERF.)

Most, if not all, funding sources now require projects follow a Systems Engineering (SE) approach when developing ITS projects. SE entails a full life-cycle view of the project, so you will need to consider details like ongoing Operations and Maintenance (O&M) and project termination in your analyses. In addition, since all CCITS projects are in the State of California, the projects will also need to follow Caltrans' ITS project guidelines (e.g., Local Assistance Program Guidelines, etc.).

4.2.1 Funding Programs

There are several potential funding opportunities for ITS projects and each will have their own requirements, in terms of background/paperwork as well as types of projects available for funding. Caltrans' Division of Local Assistance has a variety of documents to help with the policies and programs. Here are some of the available funding opportunities:

- Federal Programs and Grants
    - Surface Transportation Program (STP) – funds transportation projects from capital improvements to planning (e.g., traffic signal systems, planning studies, etc.)
    - Congestion Mitigation and Air Quality (CMAQ) – funds transpiration projects targeted at improving congestion and/or air quality (e.g., transit improvements, HOV lanes, etc.)
    - Transportation Enhancement Activities (TEA) – funds projects that are over and above "normal" transportation projects; TEA has been incorporated into the STIP (see below), so this is now a two (2) step application process and is managed at the State level
    - Urbanized Area Formula Program – funds mostly transit projects (planning, capitol investments, security, etc.) and applies to incorporated areas with populations of at least 50,000
    - State Planning and Research Program – funds transit planning in small urban areas (under 50,000 population) and multi-regional transit planning projects
    - Transportation, Community and System Preservation Program – funds for the planning, development, and implementation of strategies that improve the efficiency of the transportation system and reduce the impacts of transportation on the environment or reduce the need for costly future infrastructure (Congressional appropriation)
- State
    - State Transportation Improvement Program (STIP) – (mostly funded with Federal monies) funds transportation projects from capital improvements to planning and ridesharing
    - SHOPP – funds a variety of transportation projects on State highways (available to Caltrans only)

  - Hazard Elimination Safety – funds safety improvement projects on public roads
  - SB-821 Bicycle and Pedestrian Facilities Program – Calls for projects are usually made in June and allocations made in July
- Local (varies by locality)
  - Many Counties have funds set aside via local fees and taxes that are available for transpiration-related projects (e.g., ½ cent gas taxes [Santa Barbara County Measure D], bed taxes, developer fees, etc.)

4.2.2 Procurement Options

Once the project is approved and funded, there are several methods of procurement available. Sole sourcing might be used if only a single contractor can provide the technical solution or when compatibility with existing equipment or systems is needed. While it is probably the easiest method, due to the potential for abuse and overcharging, this technique is not usually looked upon favorably.

Competitive procurements (e.g., invitation to bid, request for proposal, etc.) allow Agencies to select the best from a variety or technical approaches and/or costs. The Agency can assign weighting to different parts of the proposal requirements based upon the type of project. For example, for a project that involves commodity-like items (e.g., signal controllers), price may be the most important factor, but more complex projects (e.g., a Regional smart card system) the technical approach may be paramount.

While this approach is probably the best for most system procurements, it does require effort by the Agency. Up front, the requirements and legal matters (proposal language, contract, etc.) need to be developed along with the evaluation methodology. Then the Agency must perform the evaluation and select the winning offer.

Other procurement options include a two-step process for engineering/construction, design/build, and system manager. Exhibit 4-1 summarizes each of the aforementioned procurement approaches.

Exhibit 4-1 – Procurement Options

Procurement Method	Description/Usage
Sole Source	Purchase direct from vendor without competition. Use when singular source for technology or with compatibility issues.
Invitation for Bid (IFB)	Requesting pricing from multiple vendors for specific product(s). Generally award to lowest price or best value.
Request for Proposal (RFP)	Allow Agency to select the best solution (technical, cost, schedule) to the stated problem(s). Award to vendor that scores highest in evaluation.
Request for Qualifications (RFQ)	Used to select a vender that is best qualified to address a problem without considering cost. Negotiate cost following selecting the most qualified vendor.

Procurement Method	Description/Usage
Two-step/Turn-key	Typically used on civil engineering projects. First an engineer develops contract documents (PS&E) for a specific project phase, which is then advertised. Vendor with the lowest cost/best value response is awarded the contract and is responsible for providing an operations system.
Design/Build	A single vendor is contracted to be responsible for all work needed to deliver the project following an Agency review of the vendor-submitted conceptual plans. The vendor is then responsible for all design work and any and all procurement and subcontracting until the system is on-line and turned over to the contracting Agency. Not often used for transportation projects in the US.
System Manager	The system manager approach is similar to design/build, except the Agency's normal procurement processes are used and the Agency is more involved in the process.

As mentioned earlier, the SE process requires you to address O&M in your project. The O&M analysis involves addressing the proactive and reactive activities concerned with operating a system, such as system checks, equipment repair and replacement, upgrades, etc. and their associated direct and indirect costs (e.g., staffing, training, workarounds or rental of temporary equipment, etc.). Consider this scenario: you get funding to design and build a TMC, but since there was no plan for the O&M, it sits idle because there is no staff to operate it. The costs (hard and soft) for these activities need to be factored into the budget and planned for in the procurement process.

5. USAGE EXAMPLES

This section presents two (2) scenarios showing how the ITS Architecture can be used to help support Agency ITS Project-related activities.

5.1 Scenario 1: Add a new ITS project to the Architecture

The first step to adding a new ITS project into the appropriate ITS architecture is to gather and review the required information. The particular information needed is discussed in the Architecture Maintenance Plan for your MPO. (The architecture mark-up described in Section 2.3 of the Maintenance Plan should already have been completed.)

This scenario assumes that the correct Turbo database has already been obtained (and a back-up copy created) and that any needed coordination (between Caltrans, other local Agencies, MPOs, etc.) has been completed and incorporated into the preparatory documentation.

A summary of the information you will need to update the architecture is described below:

- The name of the system/project, its owner, and implementation status
- An understanding of what the system is to do and who will operate it
- What other Agencies and systems will it interact with

Once the information is gathered and understood, the following steps will update the ITS architecture with the new project/system:

- Select the appropriate project architecture on the Start tab (based upon the system's scope and location/ownership) and update the log information (version, maintainer, etc.)
- If needed, add the stakeholder using the Stakeholder tab
- Move to the Inventory tab
  - Click on the All Elements sub-tab and then hit the New button
  - Enter the project name and description
  - Select the appropriate stakeholder from the picklist
  - Check the appropriate subsystems from the list of Subsystem/Terminators (remember, you expand the list to see explanations of the subsystems) – generally 1 to 3 subsystems will fully cover a project
  - Select the appropriate project architectures for this system based upon its scope. For example, if it is a local project (e.g., a signal system, advanced crosswalk, etc.), then it belongs with the County project architecture; if it spans the MPO or will interface with systems outside the MPO (e.g., a smart card, etc.), then it should be part of the MPO's Regionally Significant architecture; if it has aspects of both (e.g., a TMC, etc.), then make it part of both.
  - Select the status of the project (if you are adding the element as part of your planning process, the status is probably Programmed, otherwise it is probably Planned)
  - Apply your changes once you are satisfied with your entries

- Move to the **Services tab**
    - Review the list of Market Packages already defined for the MPO. Select the new project from the All Related Elements sub-tab
    - Add the MP to additional architecture projects if the scope of this project necessitates that change (e.g., adding a Regional fare control system might extend APTS4 [Transit Passenger and Fare Management] to the regionally significant architecture, if it were not already in it)
    - If all of the needed MPs are not yet selected, click on the All Market Packages sub-tab and repeat the previous steps as required (as well as adding the correct MP status)
    - Apply your changes for each MP change/addition
- Move to the **Ops Concepts** tab
    - Review the R&R areas already defined for the selected architecture
    - If there are any R&R areas missing you will need to add them
        - Hit the New button
        - Enter the Name (chose a name similar in structure to the existing Areas) and Description
        - Select the applicable MPs (note that the list will be limited by MP selected on the Services tab)
        - Select the applicable stakeholders (who will be performing the tasks to be defined)
        - Accept entries when complete
    - If the needed R&R Area(s) are already included, add the applicable stakeholders (who will be performing the tasks to be defined) to each Area, as needed
    - Enter the actual Responsibilities for each affected R&R Area (note that you may need to add R&Rs for other stakeholders, depending upon the scope and functionality of the project being added)
        - Expand the R&R Area by double-clicking on it or clicking on the + symbol next to the Area name
            - Select the desired stakeholder and enter the responsibilities in the grid (one per row) and its status. You may want to use or copy existing R&Rs as examples.
            - Repeat as needed for each R&R Area & stakeholder
        - Apply your changes for each R&R Area
- Move to the **Requirements tab**
    - Generally, you will want to use the Elements view for adding or modifying a single project/system. The new element should be in the list, but with no FRs. Select the new project/system and click the Specify Functionality checkbox.
    - Check the checkbox of each of the applicable Functional Areas

    - For each checked Functional Area, select it and hit the Requirements button. This will start the Requirements form where you can
    - Select applicable pre-defined requirements as-is by clicking on the applicable Include box(es) and setting the Status field for each requirement. (Alternately, if you set the Status field, the Include field is automatically selected.)
    - If an existing requirement is close, but minor changes are needed, double-click on Requirement field (or select the field and hit the Tailor button). This will start another form where you can modify an existing requirement as needed (be sure to allow the change to apply to more than one element). Apply the change and Close the forms.
    - If a new requirement needs to be written, hit the New button, select the correct Functional Area on the new form and enter the requirement text (be sure to allow the change to apply to more than one element). Apply the change and Close the forms.
- Move to the **Interfaces tab** (Interconnects and Data Flows)
    - You will need to rebuild the active architecture in order to get the interconnections and flows defined. Hit the Build button and run and review the offered Inventory/MP report, if desired, or answer no and initiate the build process (you shouldn't need to change any of the Build the settings at this point). The build may take a while, depending upon your computer and the amount of changes made.
    - When the build process is complete, you will be shown a form with the proposed flows (added flows and possibly some flows to be removed from the architecture). Review the entries to make sure that the new element's flows look reasonable (you will revisit them in a while). If it appears to be good, then accept the changes. If not, reject the changes, change the subsystem and MP assignments for the new element(s), and perform another Build.
    - Once the Build is approved, put the Interfaces form into the Connect view and select the new element from the picklist (upper left corner).
    - Include the desired system interconnections (check the Include box for each applicable system interconnection row) and Apply the changes
    - Switch the form into the Flows view (the new element should still be selected)
    - Select the applicable data flows (and its Status) between the systems just interconnected (remember that the flows need to be defined to and from both systems)
    - Apply the changes when completed
- Move to the **Standards tab**
    - Put the form into the Standards by Element view (click on the arrow on View button)
    - Sort by Source Element by clicking on the column heading
    - Review the standards for each of the defined data flows (detailed information on each can be obtained by hitting the Info button) and include/exclude as applicable

- Sort by Destination Element and repeat the previous step
- Move to the **Agreements tab**, if this new project will require an Agency agreement
  - Select the All Agreements sub-tab
  - Select any existing agreements that need to be modified and amend as needed
  - If new agreements are needed, hit the New button and enter
    - Agreement name and description
    - Agreement number (must be unique)
    - Agreement status and type from the pulldown lists
    - Select the lead stakeholder and other stakeholders involved in the agreement
    - Select the applicable architecture(s) based upon the scope of the project/system
  - Accept the changes
- Go back through each of the tabs to review your changes and make sure that the new project is fully described. If you are not satisfied make additional changes until you are satisfied with it.
- If you want to print any diagrams or reports, open the **Output menu** and select and run the diagrams and reports desired (one at a time)
- Close Turbo (**File|Exit menu**) and save your work.

5.2 Scenario 2: Using the Architecture to Help Prepare a Systems Engineering Analysis

Systems Engineering Analysis (SEA) is a method of designing projects that considers all phases of the project's life cycle, including initial planning, design, acquisition/development, deployment, O&M, and eventually retirement. An SEA is an important part of developing and deploying ITS projects and is a key component needed to help satisfy Federal funding requirements.

An ITS architecture can support the development of an SEA document by providing some of the initial content. A typical SEA document consists of the following sections:

1. **ITS Project Description**

   ITS architecture support: The Description field for the ITS element can be used as a starting point.

2. **Identification of Regional ITS Architecture Being Implemented**

   ITS architecture support: The ITS element's subsystems, MP associations and interconnections can be used as the main content for this section. Alternately the Physical ("Sausage") Architecture diagram might also be useful, unfortunately, the Turbo diagram can not be filtered, so additional text would be required to explain which parts of the diagram apply.

3. **Participating Agencies and Their Roles and Responsibilities**

   ITS architecture support: The applicable stakeholders' Op Concepts can be used to satisfy this section.

4. **Requirements Definitions**

   ITS architecture support: The FRs and the data flows for the ITS element can be used for this section.

5. **Alternative Analysis of Configuration and Technology Options**

   ITS architecture support: None.

6. **Procurement Options**

   ITS architecture support: None.

7. **Applicable ITS Standards and Testing Procedures**

   ITS architecture support: The ITS Architecture's Standards report will directly feed the first part of this section.

8. **Resources Needed for System O&M**

   ITS architecture support: None directly, but the R&Rs relating to O&M can be used as a starting point for this section.

To extract ITS element-specific reports from Turbo, hit the Elements button on the Report Selection screen. You will then get a form where you will be able to limit your report to a single element or a specific subset of elements. Note that not all reports allow this feature. In those cases, you will need to either manually copy/transcribe the desired information or export the data into another tool, such as MS Access, and generate a custom report.

6. ITS RESOURCES

If you have questions regarding ITS in general and/or your ITS architecture, your MPO representative (the person that gave you a copy of your ITS architecture) should probably be your first point of contact after you have tried the on-line resources (if you are from a local Agency). Another option might be to contact a peer at another nearby Agency.

If you still need additional assistance or just want to get more in-depth information, there are a variety of informational and assistance resources available to you, for both Turbo and ITS in general.

6.1 Websites

There are a number of websites dedicated to ITS and the National ITS Architecture. Many local Agencies also have good information about their ITS as well as additional ITS-related links. Some of the more noteworthy websites include:

- ITS America's website (http://www.itsa.org/) contains a plethora of ITS information and links
- The National ITS Architecture (http://itsarch.iteris.com/itsarch/)
- ITS Standards (http://www.standards.its.dot.gov/default.asp)
- FHWA Joint Programs Office website (http://www.its.dot.gov/index.htm) has ITS deployment-related information, including ITS costs and benefits database
- California Statewide ITS Architecture (http://www.kimley-horn.com/CAArchitecture/)
- USDOT's Lessons Learned database (http://www.itslessons.its.dot.gov/) is a searchable knowledge-base of Agency experiences with evaluating and deploying various ITS
- Caltrans' Statewide ITS architecture (http://www.kimley-horn.com/CAArchitecture/)
- Caltrans' Division of Local Assistance has a variety of resources to help with ITS project funding and documentation (http://www.dot.ca.gov/hq/LocalPrograms/index.htm)
- Caltrans transportation planning grant website (http://www.dot.ca.gov/hq/tpp/grants.htm)
- PATH (http://www.calccit.org/itsdecision/) can be used to find information about ITS Services and Technologies and their performance and is operated by a consortia that includes Caltrans
- ITS and architecture training/education is available through CITE (Consortium for ITS Training and Education) (http://www.citeconsortium.org/)
- The National Highway Institute also offers ITS and ITS architecture courses (http://www.nhi.fhwa.dot.gov/category.asp?category_id=8)

6.2 Turbo Help

Turbo Architecture help is available several ways. For quick-and-dirty help on Turbo in general or for a specific tab or function, you can hit the F1 key (or go through the Help menu item) and you will be shown a summary of the functions and options for each of the Turbo tabs. This is a standard Windows help system, so there is a table of contents and limited keyword searching. This will probably be sufficient for most issues.

If you find you need more in-depth information, the Turbo Architecture User Manual (Turbo Architecture User's Manual V3.1.pdf) can be found on the Turbo installation CD. This document should have been copied to your local PC during the installation process and should be found in: C:\Program Files\National Architecture\Turbo Documents\, if you installed Turbo in the default directory. Please note that the file name will change with the version of Turbo Architecture installed.)

There is limited Turbo training available through several sources. Training information is available on-line at: http://itsarch.iteris.com/itsarch/html/training/training.htm and the NHI link, above. Additional Turbo assistance is also available via an email form at: http://itsarch.iteris.com/itsarch/html/menu/feedback.htm.

Lastly, other Central Coast Agencies might have also run into the same issue(s) and it might be useful to discuss them with other Central Coast Agencies or Caltrans. This will also help facilitate coordination between the various CCITS Agencies.

6.3 Caltrans

Caltrans has developed the Statewide ITS architecture for California (see link above). It can be used in a variety of ways, including as a resource for additional information and examples relating to usage and application of Turbo and the National ITS Architecture. The site also includes ITS glossaries, links to other sites, etc.

Some specific assistance from Caltrans can be found in the Appendices. Appendix A presents "Chapter 12 – Other Federal Programs" from Caltrans' Local Assistance Program Guidelines, which discusses various Federal funding programs and eligibility requirements. Appendix B is a supplement to the Local Assistance Program Guidelines (Appendix A). Appendix B updates "Section 12.6 – Intelligent Transportation Systems" of the Local Assistance Program Guidelines (Appendix A) as it provides an overview of Federal funding and oversight of ITS projects.

In addition, Caltrans District 5, in San Luis Obispo, may be able to provide information regarding ITS in the Region, funding opportunities, etc. More importantly, the District 5 office can assist with Regional project coordination and related questions.

6.4 FHWA

The USDOT/FHWA has a plethora of information and resources regarding ITS and the National ITS Architecture (some of the links are provided above). As of this writing, Frank Cechini is the FHWA representative for the Central Coast. He will be able to address questions about the National ITS Architecture, applicability of particular aspects of the ITS architecture related to local projects, documentation, funding, etc. (For specific Turbo questions please refer to section 6.2).

For more detailed information, please refer to the Regional ITS Architecture Guidance Document, specifically "Section 7 – Using a Regional ITS Architecture". Within this guidance document, informative materials and discussion which can be understood by a lay person are presented which help to better describe the use of the regional ITS architecture within both the transportation planning process as well as ITS project deployment.

The FHWA also maintains an ITS Help line that can be accessed via telephone (866-367-7487) or email (itshelp@volpe.dot.gov). The help line was established to assist the general transportation community to seek resources, websites, and documents that relate to Operations and ITS

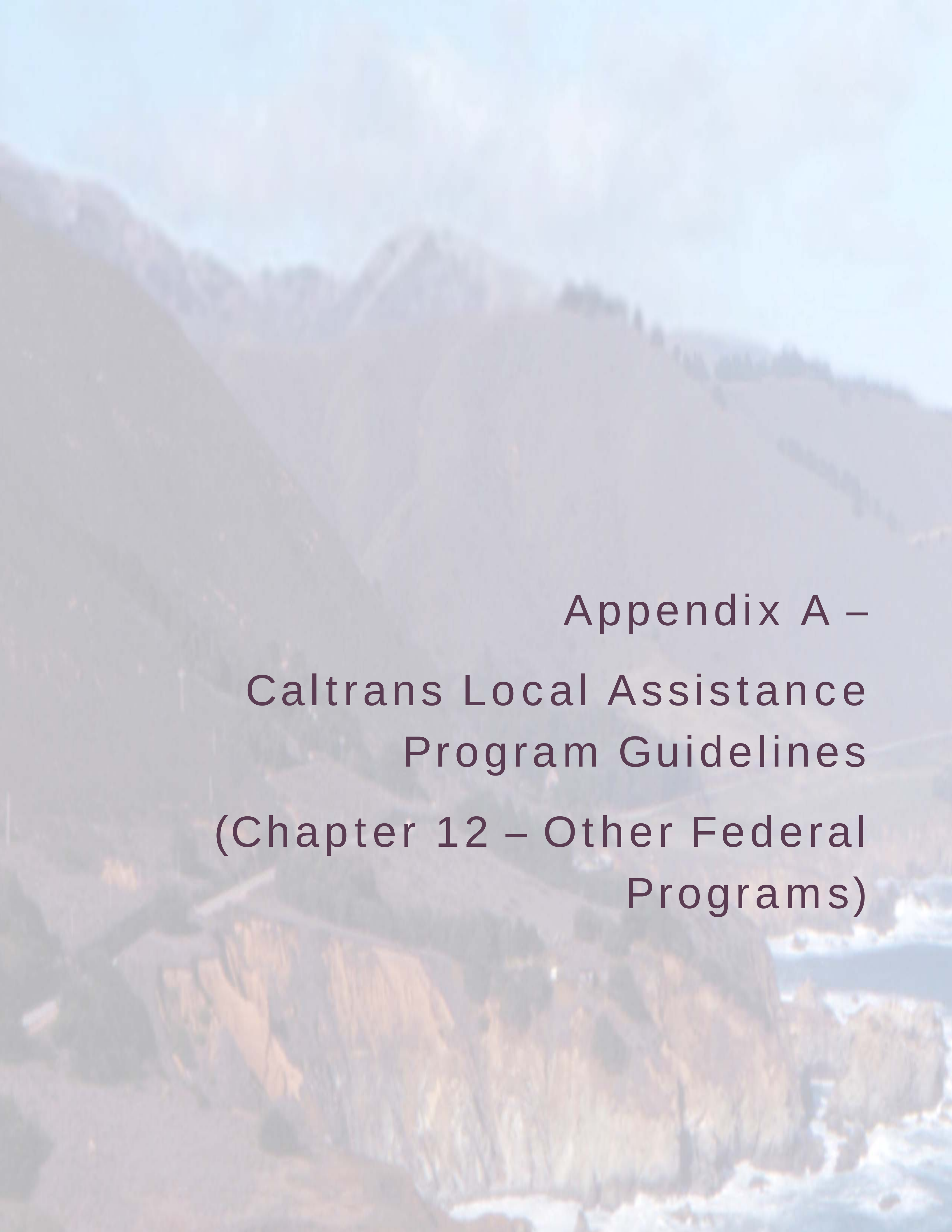
6.5 CCITS Implementation Plan

For further information, please refer to the CCITS Implementation Plan. Within "Section 4 – Central Coast Regional ITS Architecture", information is presented regarding how the National ITS Architecture was "tailored" to the Central Coast, ITS Architecture conformance in the Central Coast, as well as is presented, as well as an overview of the Central Coast's Architecture Maintenance Plans. Within "Section 5 – ITS Deployment Considerations", information is presented regarding "mainstreaming" ITS into the planning process, Federal funding and ITS projects, as well as how both the Systems Engineering Review Form (SERF) and the Systems Engineering Management Plan (SEMP) relate to ITS projects.

Appendix A –

Caltrans Local Assistance Program Guidelines

(Chapter 12 – Other Federal Programs)



Appendix A –

Caltrans Local Assistance Program Guidelines

(Chapter 12 – Other Federal Programs)

CHAPTER 12 OTHER FEDERAL PROGRAMS

CONTENTS

EXHIBITS

CHAPTER 12 OTHER FEDERAL PROGRAMS

12.1 DEMONSTRATION PROJECTS

INTRODUCTION

A Demonstration project is a project that has been specifically established and funded through federal law. Demonstration projects are generally provided as part of the annual transportation appropriation acts or the six-year transportation authorization acts. Both acts provide general project description and fund amount.

Demonstration projects are not restricted to any specific project type. Interchange improvements, grade crossing improvements, safety projects, bridges, and park and ride projects are all examples of projects funded with Demonstration funds. Over the life of the Demonstration Program in California, there have been approximately 250 Demonstration projects set forth by legislation including the Transportation Authorization Act of 1982, the Surface Transportation and Uniform Relocation Act of 1987 (STURA), the Intermodal Surface Transportation Act of 1991 (ISTEA), the Transportation Equity Act for the Twenty-First Century (TEA-21), and Annual Appropriation Acts. These projects account for approximately $1.54 billion in federal funds in California.

INITIATION OF DEMONSTRATION PROJECTS

Demonstration projects are initiated by Congress at the request of constituents within a given congressperson's district. The agency, special interest group or individual that requests the project through a Congressperson is known as the project sponsor. Once a project has been earmarked, the project sponsor should notify and provide the District Local Assistance Engineer (DLAE) with a copy of the application that was sent to their Congressperson. A copy is then forwarded to the Caltrans Demonstration Program Coordinator in the HQ Division of Local Assistance.

Caltrans management has adopted a position of neutrality toward initiation of Demonstration projects. Caltrans' current policy is to cooperate with local interests seeking to establish meaningful Demonstration projects both on the State Highway System (SHS) and on the local system. Caltrans will support the local agencies during the planning process for cost-effective projects.

ELIGIBILITY

Demonstration funds are allocated to specific projects by law. The proposed project must therefore, match the legislated project description and fund amount. It is therefore, the responsibility of the project sponsor to assure the accuracy of the project description and fund amount. These funds can only be used for the project to which they were assigned by law. Any changes to the legislated project description or funding must be approved by Congressional action.

If the legislated project description has a typographical or technical error, the local agency or district should forward the correct information to the Demonstration Program Coordinator through the DLAE. The Demonstration Program Coordinator will then coordinate with the FHWA (Federal Highway Administration) Division Office to make the appropriate changes.

All funds dedicated to a specific Demonstration project may be used on any project with a scope consistent with the original legislated description. The funds may be used for one project or several separate projects adding up to the available funding limit. If the project sponsor wishes to modify the legislated project description, the sponsor must coordinate with the appropriate Congressperson to pursue Congressional action. A copy of any formal request to change the project legislation should be transmitted to the DLAE and the Demonstration Program Coordinator.

FUNDING

The yearly allocations for Demonstration projects are only available after passage of the respective annual acts. The yearly allocations are subject to the annual limits set by Congress in the appropriations act. This means that even though a certain amount of funds are allocated, the appropriations act sets limits on how much can actually be spent.

Local agencies may request "Advanced Construction" authorization for a Demonstration project. This authorizes them to begin the work, using their own funds in advance to pay for the work before federal funds become available. The local agency must recognize that federal reimbursement in this case is not guaranteed. In addition, Advanced Construction may not be used for right-of-way acquisition except in the case of hardship or protection. The DLAE, Area Engineer, and Demonstration Program Coordinator will approve advanced construction on a project-by-project basis.

Obligational Authority (OA) is the federal limitation placed on the amount of allocated federal funds, which a state can obligate within a fiscal year. The Demonstration Program has its own special OA, which cannot be used for any other program. This special OA does not expire if not used by the end of the fiscal year, but is available until expended or rescinded by legislation. However, it is subject to annual limits set by Congress in each annual appropriations act. The Demonstration Program Coordinator can be contacted for specific OA information.

TEA-21 High Priority Projects

One hundred and fifty-six projects are identified in TEA-21 and are known as High Priority Projects (HPP). Like all Demonstration projects, the funds allocated under TEA-21 are available until expended or rescinded by legislation. TEA-21 allocates funds incrementally on a yearly basis over the life of the Act. These allocations, which total $877.3 million over 6 years were made available as follows:

Year:	1998	1999	2000	2001	2002	2003
Allocation:	11%	15%	18%	18%	19%	19%
Accumulative Allocation:	11%	26%	44%	62%	81%	100%
OA Limit:	89.1%	88.3%	87.1%	87.9%	90.4%	103.1%

The federal share for TEA-21 HPP projects is 80%. The local agency is responsible for the 20% nonfederal match and any additional funds necessary to fully fund the project. The appropriation code for TEA-21 HPP projects is Q920.

Revenue Aligned Budget Authority (RABA) funds are also provided for the TEA-21 HPP projects. RABA funds reflect revised receipt estimates to the Federal Highway Trust Fund and can be zero, positive or negative. RABA funds, which were provided for FY 2000 and 2001 totalled approximately 2.6% of the six-year HPP allocation. RABA funds come with its own OA at 100% and uses appropriation code Q920.

The total OA limit for TEA-21 projects including RABA, is approximately 93.8%. This means that local agencies can calculate the approximate amount of federal funds available to their project by multiplying the total funds by 93.8%. Contact the Demonstration Program Coordinator for the exact amount of funds available for each project.

Since the special OA for this program is less than 100% of the allocations, in order to fully utilize the allocations, regular OA available from other federal-aid highway programs may be used to make up the short fall. This may require approval from the Metropolitan Planning Organization (MPO), or the Regional Transportation Planning Agency (RTPA), the Department, and the Federal Highway Administration (FHWA). Upon approval, the project sponsor should notify the DLAE in writing. After the information is received from the DLAE, the Demonstration Program Coordinator will then request that FHWA transfer the shortfall amount in appropriation code Q920 funds to the Q930 account. Upon transfer of funds, the Q930 funds are available for obligation.

For non-TEA-21 project information, please contact the DLAE or the Demonstration Program Coordinator.

PLANNING AND PROGRAMMING THE FUNDS

The local agencies are responsible for submitting their projects to the MPO/RTPA for inclusion in the Federal Approved State Transportation Improvement Program (FSTIP). The FHWA will not obligate federal funds for the project unless the project is included in the FSTIP.

The process for obtaining federal authorization to proceed and placing the project under agreement is the same as for other federal-aid projects. Caltrans and local agency staff are advised to work closely with their FHWA representatives to ensure agreement as to the degree of FHWA involvement. See Chapter 3 "Project Authorization" in the *Local Assistance Procedures Manual* (LAPM).

Federal Fund Requests

Most Demonstration projects are processed (as outlined in Chapter 3, "Project Authorization" in the *Local Assistance Procedures Manual* [*LAPM*]) through the Division of Local Assistance (DLA). Project Managers handling Demonstration projects where the Department is the lead agency must also work with the DLA to obligate Demonstration funds for their project.

The local agency must request federal funds from the DLAE. The DLAE will assure that the project for which the local agency is requesting funds fits the legislated project description. The DLAE then completes the E-76 and forwards it to the Implementation Engineer in Caltrans HQ DLA. When the DLAE fills out the E-76, the Public Law Section, and Legislated Project Number should be noted in the "State Remarks" section. The Demo ID field must also be populated. The Implementation Engineer approves the E-76 and forwards it to FHWA.

For Demonstration projects on the SHS, if a local agency has stepped forward with a contribution of its Federal-aid Demonstration funds, a "Local Assistance Contribution Authorization Agreement" (Contribution Agreement) needs to be processed. If a local agency will be doing any work, contributing its own funds, or requesting the state to perform the work for them, a Cooperative Agreement will need to be processed. The Contribution Agreement can be combined with the Cooperative Agreement.

Demonstration funds for projects on the SHS require a CTC vote. When Caltrans is the administering agency of a local sponsored Demonstration project from TEA-21 and post 1998 Appropriation Acts, Demonstration funds are set up for subvention reimbursement through Local Program Accounting. This allows Caltrans to be directly reimbursed by FHWA rather than having the funds pass through the local agency.

MATCHING FUND POLICY

Because of many factors impacting each project, matching fund programming must be considered on a project-by-project basis.

State funds used to match federal Demonstration project allocations, may be provided through the State Transportation Improvement Program (STIP). For local agency demonstration projects that Caltrans considers beneficial to the SHS, Caltrans may support it by seeking state-matching funds through the STIP development process.

CONSTRUCTION AND INVOICING

For construction and invoicing procedures follow the standard procedure for federal-aid projects as covered in Chapters 5,"Accounting/Invoices," Chapter 15, "Advertise and Award Project," Chapter 16, "Administer Construction Contracts," Chapter 17, "Project Completion," of the *LAPM.*

12.2 PUBLIC LANDS HIGHWAYS PROGRAM

INTRODUCTION

Section 204 of Title 23, United States Code (U.S.C.) establishes a Federal Lands Highways Program (FLHP), which consists of projects on Public Lands Highways, park roads, parkways, Indian Reservation roads and refuge roads. Caltrans involvement is limited to the Public Lands Highways (PLH) element of the FLHP.

To put this in perspective, the following is a breakdown of the elements in the FLHP:

Federal Lands Highways Program:

- Park Road & Parkways
- Indian Reservation Roads
- Public Lands Highways
  a) Discretionary
  b) Forest Highways
- Refuge Roads

The term PLH is not limited to highways on the federal-aid system. The term also includes: forest roads under the jurisdiction of and maintained by a public authority and open to public travel, any highway through unappropriated or unreserved public lands, nontaxable Indian lands, and other federal reservations under the jurisdiction of and maintained by a public which is open to public travel. Projects need not be bordered on both sides by federal lands to qualify for funding from the PLH program.

PLANNING

All PLH projects must be listed in the approved Federal Statewide Transportation Improvement Programs (FSTIP). Local agencies are urged to coordinate with their transportation planning agency and obtain their concurrence prior to project proposal submittal.

ADMINISTRATION

The administration of projects in the PLH Program is a cooperative effort between Caltrans and various federal agencies including the FHWA, United States Department of Agriculture (USDA) Forest Service, Bureau of Land Management (BLM), etc. Within Caltrans, the PLH Program Coordinator of the HQ DLA is responsible for coordinating and tracking the local element for PLH projects, and the Caltrans Districts are responsible for the state element. The state must concur in project selection and planning of PLH projects. After a project is selected and programmed, the Federal Lands Division of FHWA normally administers all phases of work.

FUNDING LEVELS

Under TEA-21, $196 million was authorized nationwide for the 1998 FY and $246 million annually nationwide thereafter for the PLH Program. Of this amount, 66 percent is allocated to the Forest Highways portion of the PLH, and the remaining 34 percent are allocated to the Discretionary portion of the PLH. After administrative and engineering costs are deducted, California's average allocation for construction under the Forest Highways portion of the PLH is approximately $19 million per year. Typically, one to four projects per year are programmed in California with PLH Discretionary funds

The federal share of the costs for any project eligible under this program is 100%. All FLHP funds are subject to obligation limitations under TEA-21 Section 1102(f). However, 100% OA is provided with the allocation of funds for the selected projects. Authorized funds (contract authority), which exceed the obligation limitation for fiscal years 1998-2003 is to be distributed to states as STIP funds. These STIP funds lose their identity as FLHP funds and are no longer available for obligation by Federal Land Management Agencies.

Under the RABA provisions in TEA-21, this available funding may also increase or decrease each year depending on the estimated receipts for the Highway Trust Fund. However, for fiscal years 2000 and 2001, Congress modified the TEA-21 provisions in the appropriations acts for those years and the RABA increases were not available for the PLH Program.

PROJECT ELIGIBILITY

PLH funds are available for planning, research, engineering and construction of any kind of eligible transportation project that is within, adjacent to, or provides access to public lands. The program emphasis is on reconstruction of substandard sections of road, which have a high percentage of use by traffic accessing Forest Service or BLM lands, to the appropriate standards. In addition to highway improvement and construction projects, other eligible project types include:

- Transportation planning for tourism and recreational travel including the National Forest Scenic Byways Program, BLM Back Country Byways Program, National Trail System Program, and other similar federal programs that benefit recreational development.
- Adjacent vehicular parking areas.
- Interpretive signing.
- Acquisition of necessary scenic easements and scenic or historic sites.
- Provision for pedestrians and bicycles.
- Construction and reconstruction of roadside rest areas including sanitary and water facilities.
- Other appropriate public road facilities such as visitor centers.

In accordance with 23 USC Sec 204(i), PLH funds are also available for administrative expenses and transportation planning costs of Federal Land Management Agencies.

SELECTION PROCESS FOR FOREST HIGHWAY FUNDS

Overall the USDA Forest Service Director of Engineering and the Caltrans Deputy Director of Project Delivery establish program direction for Forest Highway funds. Projects meeting the program direction are developed by the local agency in cooperation with the USDA Forest Service Engineer and the DLAE.

Local agencies must submit applications to the USDA Forest Service Engineer no later than October 30 for programming consideration for the following year. The USDA Forest Service Regional Transportation Engineer in conformance with FHWA eligibility requirements forwards the applications for review.

The Caltrans Chief, Office of Project Development Procedures and Quality Improvement FHWA Program Coordinator, and local agencies arrange a tour of candidate project sites, usually conducted each June. This tour facilitates discussion of project details among involved representatives. Following the tour, the representatives review and consider impacts of the candidate projects on the existing priority list. The list is reviewed and updated through the joint efforts of the USDA Forest Service, Caltrans, and the FHWA. Following Caltrans' concurrence with the list, this list is forwarded to FHWA for approval and implementation.

For project development, the FHWA uses procedures included in the Nationwide Action Plan written for Federal Highway projects. These procedures require that a Social, Economic, and Environmental (SEE) study team be established to provide guidance in the pertinent areas during project development process. The SEE team may include the DLAE and other members having decision authority in the project development process.

SELECTION PROCESS FOR DISCRETIONARY FUNDS

With the significant Congressional designation of PLH Discretionary funding in the annual appropriations act in the past few years, FHWA will not solicit candidate projects for funding until after passage of the annual appropriation act. FHWA will know the extent of the Congressional designating of funds and solicit applications for these designated projects and candidate projects for any discretionary funding that remains afterward.

The FHWA Division Office will solicit from Caltrans, who is the only agency that can submit candidates from California for this program under the provisions of 23 USC 202(b). Caltrans will coordinate with the local and federal agencies to develop viable candidate projects before submitting the candidate projects to the FHWA Division Office. After the FHWA Division Office has reviewed the submission and ensured that the submission is complete and all requirements are met, the application is forwarded to FHWA HQ, Office of Program Administration.

The solicitation memorandum is also posted on the FHWA web site at: www.fhwa.dot.gov/discretionary. The solicitation memorandum shows funding information, describes FHWA criteria for the selection of projects, format and content of required application and specifies the timetable for the solicitation process for a particular year.

12.3 SCENIC BYWAYS

INTRODUCTION

Section 1219 of TEA-21, enacted in 1998, continues the National Scenic Byways (NSB) Program, which was originally created by Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991. The NSB grant program provides funding each year for projects on National Scenic Byways, All-American Roads, or state designated scenic byways.

The program also recognizes highways that are outstanding examples of scenic, historic, recreational, cultural, archeological, and/or natural qualities, by designating them as either National Scenic Byways or All-American Roads. To be considered for national designation, a road must be either a state designated scenic highway or Federal Land Management scenic byway. The US Secretary of Transportation makes national designations.

ADMINISTRATION

The administration of projects in the NSB Program is a cooperative effort between Caltrans, federal agencies, FHWA, USDA Forest Service, local transportation agencies, and byway organizations. Within Caltrans, the Division of Landscape rather than the DLA, is responsible for coordinating and tracking the local element for scenic byway projects. The appropriate Caltrans district is responsible for coordinating and tracking the state element for scenic byway projects.

FUNDING LEVELS

Discretionary funds totaling $148 million nationwide are authorized for the NSB Program. Previously under ISTEA, federal funding for this program affected the state's minimum allocation. Under TEA-21 this is no longer the case.

FHWA will fund up to 80 percent of the project cost. There must be a minimum 20 percent in matching funds available for the project when the grant application is submitted. This matching requirement can be satisfied in whole or in part with state, local government, private sector, or Federal Land Management Agency funds. Additionally, third party in-kind donations can be credited toward the matching share of the project cost. Third party in-kind donations can include services, property, materials, and equipment.

PROJECT IMPLEMENTATION

Once Scenic Byway grant projects are selected, they must be listed in FSTIP. Project sponsors are urged to coordinate with their local or regional transportation agency and obtain their concurrence prior to submittal of grant applications. Projects become eligible for reimbursement through the FHWA authorization and obligation process. Expenses incurred prior to authorization are not eligible for reimbursement (see Chapter 3, "Project Authorization," in the *LAPM*).

PROJECT ELIGIBILITY

National Scenic Byways, All-American Roads and Designated State Scenic Highways are eligible for funding. Federal Land Management Agency Byways (i.e., Forest Service Scenic Byways) are not eligible for funding until they receive state or national designation. Categories for funding projects under this program include:

1. Activity related to the planning, design, or development of a State Scenic Highway Program.

2. Development and implementation of a corridor management plan to maintain the scenic, historical, recreational, cultural, natural, and archeological characteristics of a byway corridor.

3. Safety improvements to a State Scenic Byway, National Scenic Byway, or All-American Road to the extent the improvements are necessary to accommodate increased traffic as a result of designation.

4. Construction along a scenic byway of a facility for pedestrians and bicyclists, rest area, turnout, overlook, or interpretive facility.

5. An improvement to a scenic byway that will enhance access to an area for the purpose of recreation, including water-related recreation.

6. Protection of scenic, historical, recreational, cultural, natural, and archeological resources in an area adjacent to a scenic byway.

7. Development and provision of tourist information to the public, including interpretive information about a scenic byway.

8. Development and implementation of a scenic byway-marketing program.

In addition, project sponsors must provide assurances for the 20 percent matching funds requirement and the ability to implement the proposal.

SELECTION PROCESS

Caltrans districts, federal and local agencies, and scenic byway groups must complete grant applications for each project by the using the electronic form on the National Scenic Byways web site at: http://www.byways.org/. Applicants should coordinate proposals with the State Scenic Highway Coordinator to develop viable grant projects. The State Scenic Highway Coordinator shall ensure that all projects meet eligibility requirements and assign priority numbers to each project according to the FHWA funding criteria, quality of proposals, and level of local support. Applications are due to the State Scenic Highway Coordinator one month prior to the submission deadline to the FHWA Division Office (usually occurring in July/August).

In accordance with TEA-21, priority for funding will be given to:

- Eligible projects that are associated with highways designated as NSB or All-American Road and that are consistent with the corridor management plans for the byway.
- Projects along a State-designated scenic highway that are consistent with the corridor protection program for the highway or are intended to make the highway eligible or designation as a NSB or All-American Road.
- Eligible projects associated with the development of a State Scenic Highway Program

These three priorities are treated equally, they are not considered to be listed in priority order.

FHWA will select projects and give preference to project types in the following order:

- Development of state programs, development and implementation of corridor management plans and marketing plans, and interpretative information.
- Development of interpretive facilities, turnouts and overlooks, and scenic byway resource protection.
- Construction of rest areas, pedestrian and bicycle facilities.
- Improvements to a highway for safety, passing lanes, highway shoulders, or to enhance access to recreational facilities.

FHWA will consider the timely use of scenic byways funds as to how successful a state has been in meeting its project work plan. States showing greater progress toward the completion of prior approved projects are better positioned to initiate new projects and will increase their chances to receive additional scenic byway grant funds.

Because the annual request for funding far exceeds the available scenic byway funds, commitment of other funding sources to complement the requested funding is an important factor.

12.4 DISCRETIONARY BRIDGE PROGRAM

The Surface Transportation Assistance Act of 1978 established the Highway Bridge Replacement and Rehabilitation Program (HBRRP) to help the states improve the condition of the nation's bridges. The program is divided into two distinct categories: (1) Apportioned funds distributed according to relative state's needs (normally referred to as the HBRRP), and (2) Discretionary funds set-aside for use by the Secretary of Transportation to replace or rehabilitate deficient, high-cost highway bridges on federal-aid highways.

Appropriations for the Discretionary Bridge Program (DBP) fit into this second category and are described in Section 144(g) of 23 U.S.C. The program has been continued with each highway or transportation act since 1978. TEA-21 continued the program through 2003.

The annual appropriations nationwide are about $100 million. DBP funds are not allocated to a state that has in a preceding year transferred HBRRP funds to other fund categories such as Surface Transportation Program (STP). In California, these transfers are used to fund the seismic retrofit of bridges not eligible under the HBRRP, the Bridge Barrier Railing Replacement Program, and the painting of bridges not on the HBRRP Eligible Bridge List.

When California is eligible to compete for Bridge Discretionary Funds, FHWA circulates an application package that collects information to determine rating factors to prioritize candidate projects. The rating factor formula is described in 23 CFR 650 Subpart (G).

Eligible projects under the DBP must meet the same requirements of the HBRRP and must cost more than $10 million. Preliminary Engineering is not eligible for reimbursement using DBP funds.

Per FHWA requirements, only states' transportation departments may make application for funds. Caltrans reviews currently programmed state and local projects to determine which projects would be ready to advertise in the FY the funds will be available. Based on this review, Caltrans develops the applications and submits the packages to FHWA for consideration.

The federal share of the costs for projects funded under the DBP is 80%. OA is provided at 100%. All DBP funds may be obligated in the year allocated.

For local assistance, the DLAEs and the HBRR Program Coordinator will provide the coordination.

12.5 DEFENSE ACCESS ROADS (DAR)

INTRODUCTION

Defense Access Roads (DAR) program provides a means by which the federal government may pay its fair share of costs for:

- Highway improvement needed for adequate service to defense and defense-related installations.
- New transportation facilities to replace those, which must be closed to permit expansion of existing or establishment of a new defense installation.
- Repair of damage to roadways caused by major military maneuvers.
- Repair of damages due to the activities of contractors engaged in the construction of missile sites
- Missile-route to ensure their continued ability to support the missile-erector (TE) vehicle.

Definitions

Access Roads: An existing or proposed public highway, which is needed to provide essential highway transportation services to a defense installation. (This definition may include public highways through military installations only when right-of-way for such roads is dedicated to public use and the roads are maintained by a local agency.

Certification: The statement to the Secretary of Transportation by Secretary of Defense (or such other official as the President may designate) that certain roads are important to the national defense.

Defense Installation: A military reservation or installation, or defense-related industry, or source of raw materials.

Major Strategic Highway Network Connectors: These are highways, which provide access between major military installations, and part of the STRAHNET.

Maneuver Area Road: A public road in an area delineated by official orders for field maneuvers or exercises of military forces.

Military Traffic Management Command (MTMC): The military transportation agency with responsibilities assigned by the Secretary of Defense for maintaining liaison between FHWA and other agencies for the integration of defense needs into the nation's highway program.

National Highway System (NHS): It is approximately 160,000 miles of roadway important to the nation's economy, defense, and mobility. It includes all of the Interstate System, selected principal arterials, Strategic Highway Network (STRAHNET), major STRAHNET connectors and intermodal connectors. Congress approved the NHS in 1995. Since that time federal-aid funds have been specifically provided for it annually including the TEA-21 period. Federal-aid projects on the NHS must meet AASHTO design standards.

Replacement Road: A public road constructed to replace one closed by establishment of a new, or the expansion of an old defense installation.

Strategic Highway Network (STRAHNET): This is a network of highways, which are important to the United States' strategic defense policy and which provide access, continuity and emergency capabilities for defense purposes.

Transporter-erector route: A public road specifically designated for use by the TE vehicle for access to missile sites.

FEDERAL POLICY

a) Federal government expects states and local agencies to assume the same responsibility for developing and maintaining adequate highways to permanent defense installations as they do for highways serving private industrial establishments or any other permanent traffic generators.

   It is expected that highway improvements in the vicinity of defense installations will receive due consideration and treatment as states and local agencies develop their programs of improvements.

   FHWA will provide assistance as requested by MTMC, to ascertain states' program plans for improvements to roads serving as access to defense installations.

   Roads which serve permanent defense installations and which qualify under established criteria as federal-aid routes should be included in the appropriate federal-aid system.

b) It is recognized that problems may arise in connection with the establishment, expansion, or operation of defense installations, which create an unanticipated impact upon the long-range requirements for the development of highways in the vicinity.

   These problems can be resolved equitably only by federal assistance from other than normal federal-aid highway programs for part or all of the cost of improvements necessary for the functioning of the installation.

ELIGIBILITY

Local agencies that think their highways would be eligible for DAR funds should contact the base commander of the defense installation that will impact their highways. Sometimes base commanders will contact the local agency when they are planning modifications of their facilities. If after meeting with the local agency the base commander believes that access highway deficiencies are of such character as to justify relief through an improvement, the base commander will report the deficiencies to MTMC.

MTMC has the responsibility for determining the eligibility of proposed improvements for financing with DAR funds. MTMC will request the FHWA, California Division Office, to make an evaluation report of the access road needs of the installation. The evaluation report will include comments and recommendations by the base commander and the local agency. See Exhibit 12-A, "DAR Evaluation Report" in this chapter for information that is included in the report.

The evaluation report will be furnished to MTMC for its use in making the determination of eligibility and certification of importance to the national defense. The criteria upon which MTMC will base its determination of eligibility are included in Exhibit 12-B, "MTMC Eligibility Criteria" in this chapter.

If MTMC determines a project to be eligible for financing either in whole or in part with defense access road funds. MTMC will certify the project as important to the national defense and will authorize DAR funds for the project. The certification will indicate to FHWA the eligible project scope, funding amounts and appropriation code.

DESIGN STANDARDS

a) Access roads to permanent defense installations and replacement roads shall be designed to conform to the same standards as the agency having jurisdiction is currently using for other comparable highways under similar conditions in the area, and in accordance with Chapter 11, "Design Standards" of the *LAPM*. Should local agencies desire higher standards than they are currently using for other comparable highways under similar conditions in the area, the local agencies shall finance the increases in cost.

b) Access roads to temporary military establishments or for service to workers temporarily engaged in construction of defense installations should be designed to the minimum standards necessary to provide services for a limited period without intolerable congestion and hazard. As a guide, widening to more than two lanes generally will not be undertaken to accommodate anticipated one-way, or traffic of less than 1,200 vehicles per hour. The resurfacing or strengthening of existing pavements will be held to a minimum type having structural integrity to carry traffic for the short period of anticipated use.

PROJECT ADMINISTRATION

a) Determination of the agency best able to accomplish the location, design, and construction of the DAR projects will be made by the FHWA California Division Office after consultation with Caltrans and/or local agency within whose jurisdiction the highway lies. When an agency other than Caltrans or the local agency (sometimes another federal agency has jurisdiction over the project area) is selected to administer the project, the FHWA Division Office will be responsible for any necessary coordination between this agency and the other parties during the life of the project.

b) DAR projects under the supervision of a local agency, whether "on" or "off" the federal-aid system, shall be administered in accordance with the procedures in the *LAPM*, as modified specifically, unless approval of other procedures has been obtained from Washington Headquarters Federal Lands Highway Office. DAR funds must be included in the FSTIP and project phases authorized by Caltrans prior to beginning work for which reimbursement will be sought, see Chapter 3 "Project Authorization," of the *LAPM*.

c) The FHWA Division Office shall have a firm commitment from Caltrans or local agency within whose jurisdiction the access road lies, that they will accept responsibility for the maintenance of the completed facility before authorization of acquisition of right-of-way or construction of the project.

d) When DAR funds are available for a pro-rata portion of the total project cost, the remaining portion of the project may be funded as a federal-aid project if on a federal-aid route. DAR funds shall not be substituted for matching share of the federal-aid portion of a project.

MANEUVER AREA ROADS

a) Claims by a local agency for costs incurred to restore to their former condition, roads damaged by maneuvers involving a military force at least equal in strength to a ground division or air wing will be paid from funds appropriated for the maneuver and transferred to FHWA by the Department of Defense (DOD) agency. DAR funds may be used to reimburse the local agency pending transfer of funds by the DOD agency.

b) Cost incurred by the local agency while conducting a pre-or post-condition survey may be included in the claim to DOD for direct settlement or in the damage repair project as appropriate.

STRATEGIC HIGHWAY NETWORK (STRAHNET)

The STRAHNET system of public highways provides access, continuity, and emergency transportation of personnel and equipment in times of peace and war. The 61,000-mile system designated by the FHWA in partnership with the DOD, comprises about 45,000 miles of interstate and defense highways and 15,600 other public highways.

The STRAHNET is complimented by another 1,700 miles of connectors (additional highway routes) that link more than 200 military installations and ports to the network. While installations may have multiple access/egress routes, the STRAHNET connector is generally the most direct and highest functional class roadway.

As the designated agent for public highway matters, the DOD's MTMC is the proponent for STRAHNET and STRAHNET Connectors. The MTMC identifies STRAHNET and STRAHNET Connectors in coordination with the FHWA, the states' transportation departments, the military services and installations, and the ports.

The ISTEA of 1991 and the National Highway System Designation Act of 1995, provided for inclusion of STRAHNET and STRAHNET Connectors in the 160,955-mile NHS. Federal oversight will ensure optimum maintenance levels for the NHS, thus assuring that the roads can support an emergency deployment.

In addition, the MTMC is also concerned about the traffic safety issues associated with the STRAHNET and STRAHNET Connectors. It is imperative that the number of fatalities, injuries and personal property accidents affecting military personnel are reduced. Therefore, the local agencies, states and FHWA should be cognizant of the need to identify traffic safety issues on this system and program, and appropriate corrective measures.

For official STRAHNET and Update Procedures website:
http:// www.fhwa.dot.gov/hep10/nhs

12.6 INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

INTRODUCTION

This guideline focuses on federal-aid Intelligent Transportation Systems (ITS) project procedures to assure compliance with the federal ITS regulations, per Code of Federal Regulations, Chapter 23, Section 940 (23 CFR 940) entitled "Intelligent Transportation System Architecture and Standards." In addition, these procedures establish the roles and responsibilities for all parties who are involved in the federal-aid ITS process. However, there is a need for the basic understanding of ITS and ITS regulations in order to understand the ITS project procedures. Therefore, this guideline is set up with basics on ITS, a summary of the ITS regulations, followed by the federal-aid ITS procedures.

The target audience for this guideline is primarily federal, state and local agency project management personnel. Some of these managers may have little or no expertise in ITS, therefore, every effort was made to simplify the definitions and language in this guideline. Hopefully, this simplification will not cause any misunderstanding. A point to make is that one should not be expected to understand everything there is to know about systems, telecommunications, electronics, etc., in order to manage ITS projects.

For most public transportation managers, ITS represents a relatively new field that will require a certain amount of training to comprehend terminology and assure compliance with ITS regulations. Periodic training may also be necessary in order to keep up with technological changes in ITS.

Designing and developing ITS projects also represent a paradigm shift in the engineering mindset, compared to traditional highway projects. For example, ITS projects may not have a clear break between the preliminary engineering phase and construction phase. Furthermore, some ITS projects may not include a construction phase and may not be suitable for "low-bid" construction contracts. The iterative nature of Systems Engineering for ITS projects also implies a greater risk and uncertainties to successful completion of an ITS project. There are also other factors that appeared to be more critical to ITS projects than the traditional highway projects. Such factors are verification, validation, compatibility, reliability, usability, supportability, and maintainability.

WHAT ARE ITS?

Intelligent Transportation Systems are the electronics, communications, or information technology (IT) processing, applied to transportation operations that result in improved transportation efficiency and safety. In simple terms, it is primarily any electronic transportation system that communicates to the traveler to provide transportation safety and efficiency. The traveler as well as the system planner or operator is provided with better travel information and improved services. A more precise definition of ITS can be found in the "Definitions" section of this guideline. ITS follows a logical process of data collection, processing, and acting on the processed information.

Examples of ITS components are traffic signals, surveillance cameras, changeable message signs, ramp meters, weigh-in-motion devices, roadway service patrols, and transportation management centers. Examples of ITS are: centralized control from traffic or transit management centers of many of these components, traveler information broadcast systems, traffic signal priority for emergency or transit vehicles, ITS data archive management, and vehicle safety warning systems.

An ITS project is any project that in whole or in part, funds the deployment of ITS component and/or systems that provide or significantly contribute to one or more ITS user services as defined in the National ITS Architecture (NA). An example of a relatively small ITS project would be the installation of traffic signal hardware (traffic controller, detectors, etc) at an intersection. An example of a relatively large ITS project is the installation of a network of traffic signals that is controlled from a traffic management center.

A traditional highway project, which has an ITS element, such as a traffic signal or a ramp meter, meets the definition of an ITS project. However, it is our intent to apply ITS regulations only to the ITS portion of a project. The amount of Systems Engineering applied to an ITS project should also be commensurate with its complexity. ITS projects are unlike traditional highway projects in a number of ways. Some of the differences are as follows:

- Traditional highway projects involve mostly civil engineering, whereas ITS projects involve significant amounts of electronic engineering as well as other engineering disciplines.

- Due to the complexity of electronics in ITS projects, user and functional requirements need to be defined and testing plans formalized before detailed design begins.
- Highway projects are usually in segments affecting only a corridor, whereas ITS projects can ultimately have regional impacts.
- A completed highway project is normally owned, operated and maintained by one public agency, whereas a completed ITS project could be owned, operated and maintained by more than one public agency.
  - Procurement procedures for ITS projects are not as clear-cut as traditional highway improvements. In addition to construction contracts that are based on competitive bidding, consideration should be given to engineering and design services contracts on the basis of qualifications-based selection, followed by competitive negotiations.

NATIONAL ITS ARCHITECTURE (NA)

The National ITS Architecture (NA) provides a nationwide common framework and template for planning and designing ITS projects for interoperability. It can save the planner and designer a significant amount of study and research time when it is used for planning and designing ITS projects. It helps to identify the ITS subsystems or components that are needed in a region.

The key components of the NA are:

- User Services
- Logical Architecture
- Physical Architecture
- Market Packages
- Equipment Packages
- ITS Standards

Successful ITS integration and interoperability require two different fundamental activities: *Technical,* and *Institutional Integration*. *Technical Integration* of electronic systems enable information to be received, processed, stored and accessed by various parts of the system. It requires interconnectivity, compatibility and standardization. *Institutional Integration* requires coordination between various agencies and jurisdictions to achieve seamless operations and interoperability. In order to achieve effective *Institutional Integration* of systems, the stakeholder agencies and jurisdictions must agree on the benefits of an ITS, and the value of being part of an integrated system. They must agree on roles, responsibilities, and shared operational strategies. They must also agree on standards, technologies, and operational procedures in order to ensure interoperability. The transportation agencies must also coordinate with other ITS users, such as emergency services and law enforcement agencies where transportation is not a key part of their business.

Successful dealing with both the technical and institutional issues requires a high-level conceptual view of the future system and careful comprehensive planning. The framework for this system is referred to as the architecture. Architecture defines the key functions, system components, the organizations involved, and the type of information shared between organizations and various parts of the system. Architecture, therefore, is fundamental to the success of system implementation, integration and interoperability. The NA is therefore, developed to assure this success.

The NA is now available and maintained by the U.S. Department of Transportation (USDOT) at the Internet web site http://itsarch.iteris.com/itsarch The most current version of the NA is also available on CD-ROM from FHWA. The Internet and CD versions include useful traceability features, which will guide the developer or designer to the appropriate or applicable elements of the NA, such as relating the functions with the correct market packages and standards. It will continue to evolve as new applications and as new needs will occur over time.

The graphical view below provides an interconnected presentation of the logical architecture, physical architecture, implementation, and standard-oriented components of the NA. These will be further described in the following text.

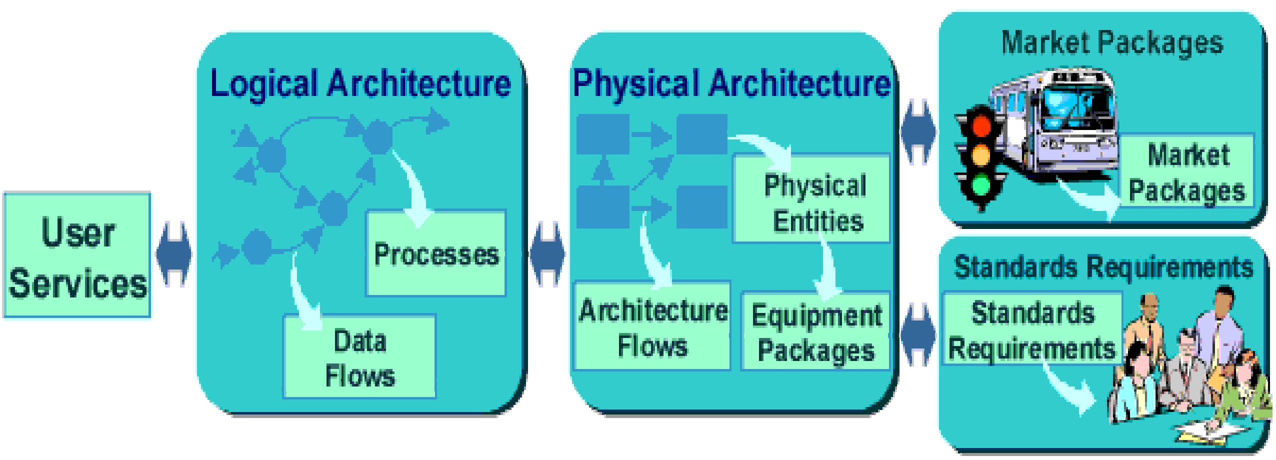


Figure 12-1 National ITS Architecture Relationships

DETAILS OF KEY COMPONENTS OF THE NATIONAL ITS ARCHITECTURE

A. USER SERVICES AND USER SERVICE REQUIREMENTS

User services provide improvements in transportation safety and efficiency. After a thorough study by the NA task force, the following user services have been identified as ITS activities. New or updated user services may be added to the NA over time.

The ITS Users Services (33 to date) are as follow:

- Pre-trip travel information
- Route guidance
- Traveler services information
- Incident management
- Emissions testing and mitigation
- Public transportation management
- Personalized public transit
- Electronic payment services
- Automated roadside safety inspection
- Commercial vehicle administrative processes
- Freight mobility
- Emergency vehicle management
- Lateral collision avoidance
- Safety readiness
- Automated vehicle operation
- Maintenance and construction operations
- En route driver information
- Ride matching and reservation
- Traffic control
- Travel demand management
- Highway-rail crossings
- En-route transit information
- Public travel security
- Commercial vehicle electronic clearances
- On board safety and security monitoring
- Hazardous material security and incident response
- Emergency notification and personal security
- Disaster response and Evacuation
- Longitudinal collision avoidance
- Vision enhancement for crash avoidance
- Intersection collision avoidance
- Pre-crash restraint deployment
- Archived data function

Benefits from the user services include: improving safety, increasing highway capacity, reducing traffic congestion, reducing travel time for travelers and goods movement, improving the economy, reducing driving stress, reducing fuel consumption and emissions, and smoother traffic flows.

A number of functions are required to accomplish each user service. To reflect this, each of the user services is broken down into successively more detailed functional statements, called User Service Requirements**.** Examples of the "traffic control" user service functions are traffic flow optimization, traffic surveillance, control function, and provide information. These functions are found under each user service heading in the NA.

B. LOGICAL ARCHITECTURE

This component represents the unseen or software part of the system that depicts the functional processes and information flows of ITS. It is depicted in the form of data flow diagrams (often called "Bubble" diagrams) as shown on the next page. It guides the development of functional requirements for new systems and improvements. It is the conceptualized computer equivalent of how the human brain observes something, analyzes and acts on it, but in a more formalized format. An interesting observation here is that a human can act on fragmentary information known as "intuition" or "gut feeling," whereas ITS needs very specific supporting information before it can act on it.

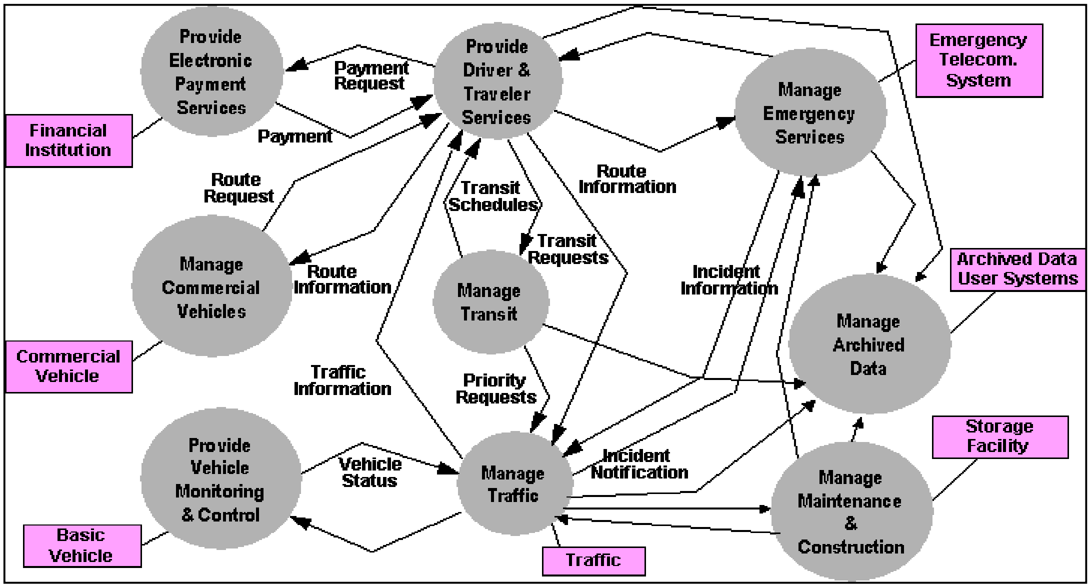


Figure 12-2 Example of Logical Architecture

The lines drawn between the functions and between the functions and the terminators represent the data flows. In order to understand this "Bubble "diagram, one must visualize a scenario. For example, the "Provide Vehicle Monitoring & Control" function will notify the "Manage Traffic" function of an accident. The "Manage Traffic" function will respond by notifying: the "Provide Driver & Traveler Services" function with alert or detour information, the "Manage Maintenance & Construction" function for traffic control devices, and the "Manage Emergency Services" function for emergency services that are needed.

C. PHYSICAL ARCHITECTURE

This component is a physical (hardware/software) representation of how the system should provide the required functions. The Physical Architecture takes the processes identified in the logical architecture and assigns them to physical entities known as subsystems in the NA. For example, the Physical Architecture includes types of communication modes for transfer of information and data to transportation entities, information providers, emergency service providers, and tow and recovery providers. The Physical Architecture also determines who should communicate with whom and mode of communication. This varies on a regional level based on the unique needs and characteristics of the region.

The diagram next page illustrates the Physical Architecture of the NA and also represents the entire physical ITS universe. It shows 4 types of subsystems: travelers, centers, vehicles and field. It also shows 4 modes of communications between the subsystems: fixed-point to fixed-point, wireless, vehicle-to-vehicle and dedicated short range. This Subsystem or Interconnect Diagram is often referred to as the "Sausage" diagram.

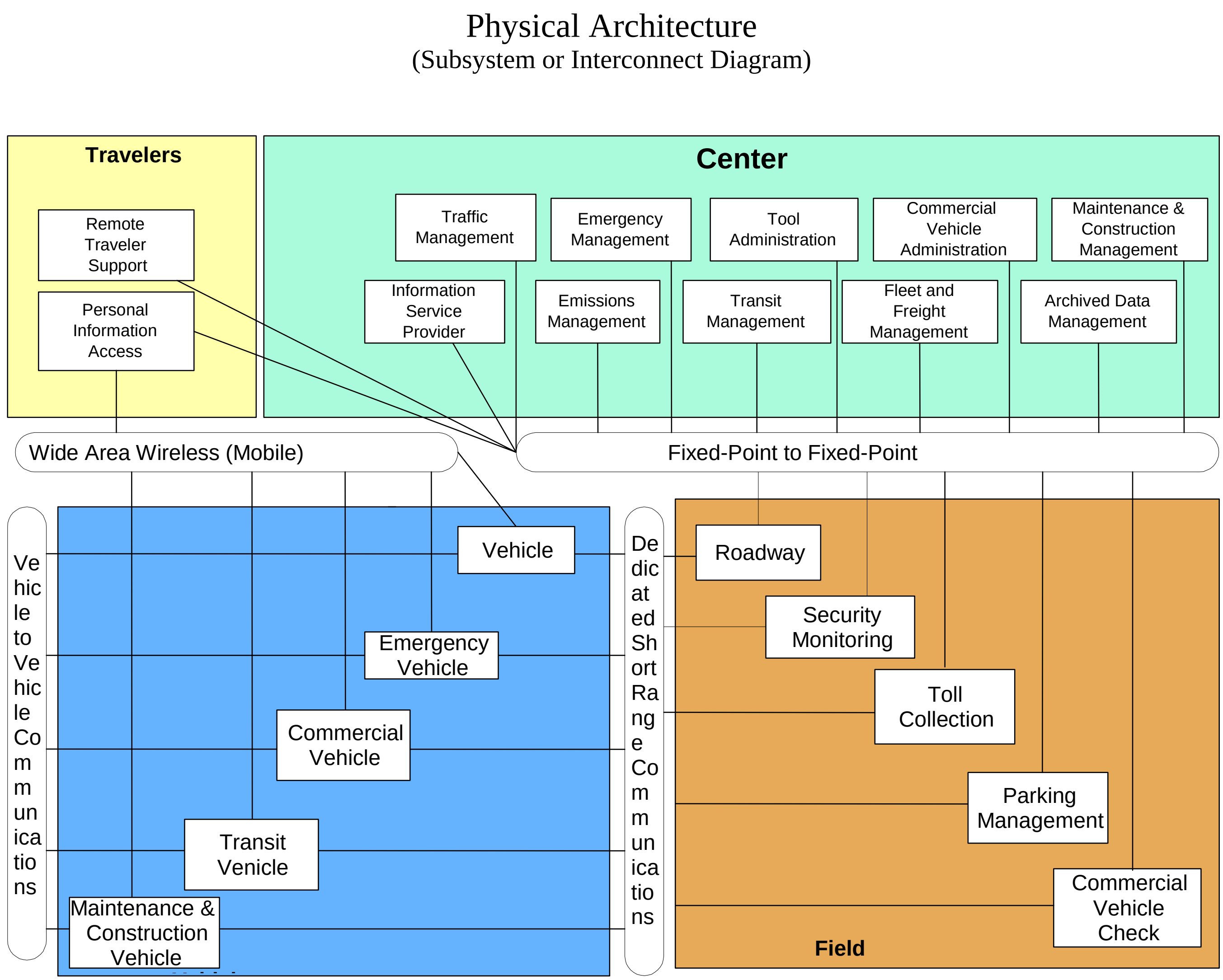


FIGURE 12-3 PHYSICAL ARCHITECTURE

D. MARKET PACKAGES

A Market Package is a service-oriented perspective of applications that are tailored to fit real world transportation problems and needs. In other words, they identify the pieces of the Physical Architecture that are required to implement a particular transportation service. When a Market Package is set up, it can perform one or more of the user services.

The Market packages are listed below and grouped to show how they relate to eight major types of activities:

1. Traffic Management:	Network Surveillance Probe Surveillance Surface Street Control Freeway Control HOV Lane Management Traffic Information Dissemination Regional Traffic Control Traffic Incident Management System Traffic Forecast and Demand Management Electronic Toll Collection Emissions Monitoring and Management Virtual TMC and Smart Probe Data Standard Railroad Grade Crossing Advanced Railroad Grade Crossing Railroad Operations Coordination Parking Facility Management Regional Parking Management Reversible Lane Management Speed Monitoring Drawbridge Management Roadway Closure Management
2. Public Transportation:	Transit Vehicle Tracking Transit Fixed-Route Operations Demand Response Transit Operations Transit Passenger and Fare Management Transit Security Transit Maintenance Multi-Modal Coordination Transit Traveler Information
3. Traveler Information:	Broadcast Traveler Information Interactive Traveler Information Autonomous Route Guidance Dynamic Route Guidance Information Service Provider Based Route Guidance Integrated Transportation Management/Route Guidance Yellow Pages and Reservation Dynamic Ridesharing In-Vehicle Signing
4. Vehicle Safety:	Vehicle Safety Monitoring Driver Safety Monitoring Longitudinal Safety Warning Lateral Safety Warning Intersection Safety Warning Pre-crash Restraint Deployment Driver Visibility Improvement Advanced Vehicle Longitudinal Control Advanced Vehicle Lateral Control Intersection Collision Avoidance Automated Highway System

5. Commercial Vehicles:	Fleet Administration Freight Administration Electronic Clearance Commercial Vehicle Administrative Processes International Border Electronic Clearance Weigh-In-Motion Roadside CVO Safety Onboard CVO Safety CVO Fleet Maintenance HAZMAT Management Roadside HAZMAT Security Detection and Mitigation CV Diver Security Authentication Freight Assignment Tracking
6. Emergency Management:	Emergency Response Call-Taking Emergency Routing MAYDAY Support Roadway Service Patrols Transportation Infrastructure Protection Wide-Area Alert Early Warning System Disaster Response and Recovery Evacuation and Reentry Management Disaster Traveler Information
7. Archived Data Management:	ITS Data Mart ITS Data Warehouse ITS Virtual Data Warehouse
8. Maintenance and Construction Management	Maintenance and Construction Vehicle and Equipment Tracking Maintenance and Construction Vehicle Maintenance Road Weather Information Processing and Distribution Roadway Automated Treatment Winter Treatment Roadway Maintenance and Construction Work Zone Management Work Zone Safety Monitoring Maintenance and Construction Activity Coordination

A description of each Market Package can be found using the NA at the website http://itsarch.iteris.com/itsarch or on the CD-ROM, which is available at the FHWA.

E. EQUIPMENT PACKAGES

Equipment Packages are the building blocks of the Physical Architecture. They grouped similar data processes together into an “implementable” Market Package. The grouping takes into account the user services, and the need to accommodate various levels of functionality.

A description of each Equipment Package can be found using the NA at the website http://itsarch.iteris.com/itsarch or on a CD-ROM, which is available at the FHWA.

F. STANDARDS

Standards identify and specify the way information will be exchanged between logical components of transportation systems. The ITS standards are being developed by Standards Development Organizations (**SDO**s). These standards are developed in order to assure interoperability, interconnectivity, compatibility, interchangeability and expandability. The standards are sets of rules on how messages are coded and transmitted between electronic equipment in order to communicate in the same language or format. They are somewhat like human languages that has an alphabet, vocabulary, and grammar rules that are used by everyone who speaks a particular language.

The standards will facilitate deployment of interoperable systems without impeding innovation as technology advances and new approaches evolve.

The following is a list of **SDO**s:

- **AASHTO** (American Association of State Highway and Transportation Officials)
- **ANSI** (American National Standards Institute)
- **ASTM** (American Society for Testing and Materials
- **IEEE** (Institute of Electrical and Electronics Engineers)
- **ITE** (Institute of Transportation Engineers)
- **NEMA** (National Electrical Manufacturers Association)
- **SAE** (Society of Automotive Engineers)

REGIONAL ITS ARCHITECTURE (RA)

According to 23 CFR 940, federally funded ITS projects should conform to the NA. The federal definition of conformance with the NA is the development of a Regional ITS Architecture (RA). The RA is a regional level framework and template for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects. It defines the pieces of the system, how they are linked to each other, and what information is exchanged between them.

The RA is a tailored version of the NA to meet regional needs. It specifically describes the region, identifies user services to be provided, ownership of ITS subsystems, all of the stakeholders, the users in the region, and their roles and responsibilities. See Exhibit 12-C "ITS Architecture Matrix" in this chapter for a visual comparison of the difference between the NA and the RA.

A region is defined as an area no less than the boundaries of a metropolitan planning area. It can be the entire state. The regions are allowed until April 8, 2005, to have RA developed. Their architecture must be consistent and should be an integral part of the regional or metropolitan transportation planning process.

Although, the regulations did not specify who is responsible for creating and maintaining the RA, it would be logical for the MPO or RTPA to assume the responsibility. Most of California's MPOs have taken on that responsibility. In at least one rural area, the Caltrans district has accepted the RA responsibility for that region. Caltrans is currently developing the Statewide ITS Architecture to assure consistency on a statewide level. For the time being, FHWA will only rely on the RAs developed by the MPOs and RTPAs for conformity within the regions.

Development of a Regional ITS Architecture depends on addressing the following eight items:

1. Description of the region.
2. Identification of the participating agencies and stakeholders.
3. Preparation of an operational concept that identifies roles and responsibilities of stakeholders.
4. Definition of high-level system functional requirements.
5. Determination of interface requirements and information exchanges with planned and existing systems and subsystems.
6. Definition of sequence of projects required for implementation.
7. Development of list of agency agreements required for operations.
8. Identification of ITS Standards supporting regional and national interoperability.

FEDERAL LAWS AND REGULATIONS

The federal laws and regulations, shown below, apply to all ITS projects. It is important to note that even though the federal regulations allows until April 8, 2005, for the development of a RA**,** other parts of the regulations such as ITS Standards and Systems Engineering are effective as of April 8, 2001.

Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA*)*

- Created the ITS Program.
- Provided funding for ITS research.
- Provided for the development of the NA.

Transportation Equity Act of the 21st Century (TEA-21) of 1998

- Established the requirement for conformity with NA.
- Provided $101 million to $122 million per year nationwide for the ITS Deployment Program. These program funds are limited to earmark by Congress in TEA-21 and the annual Appropriation Acts during the life of TEA-21 (6 years).
- Clarified ITS project eligibility for funds from the National Highway System (NHS) Program, the Surface Transportation Program (STP), and the Congestion Mitigation and Air Quality (CMAQ) Program.

23 CFR 940, Intelligent Transportation System Architecture and Standards

Applicability - The National ITS Architecture regulations, per 23 CFR 940, applies to all ITS projects that are funded in whole or in part with Federal-aid Highway Funds as of April 8, 2001.

- Required that all ITS projects funded from the Highway Trust Fund should be in conformity with the NA and applicable standards.
- Conformity with the NA is defined as:

  a) Developing RA by April 8, 2005, for those regions currently implementing ITS projects, or
  b) Developing RA within four years of final design of their first ITS project for those regions which have not had an ITS project yet,
  c) Using the NA as a resource in developing the RA,
  d) Developing RA that contains the 8 items described in the section above on *Regional ITS Architecture,*
  e) Subsequent adherence of ITS projects to the RA, and
  f) Prior to development of RA, a major ITS project must have a Project Level ITS Architecture (PA) developed that is coordinated with the development of RA.

- The agencies and other stakeholders participating in the development of RA shall develop and implement procedures and responsibilities for maintaining the RA, as needs evolve in the region.
- Requires that all ITS projects be developed and designed using a Systems Engineering Analysis, and
- Requires that all ITS projects use ITS Standards and interoperability tests that were officially adopted by the USDOT.

Exceptions:

The FHWA may, however, authorize exceptions to the National ITS Architecture and ITS Standards for:

- Certain research projects outlined in 23 CFR 940.7, and

- The upgrade or expansion of an ITS system in existence on the date of the enactment of TEA-21; if it would not adversely affect the goals or purposes of ITS under TEA-21, is carried out before the end of the useful life of such system, and is cost-effective as compared to alternatives that would meet the conformity requirements of this rule.

FEDERAL-AID ITS PROGRAMS

There is actually only one funded ITS program, known as the ITS Deployment Program. ITS projects which are not part of the ITS Deployment Program can however, be funded from other normal federal-aid programs. To distinguish regular ITS projects from ITS Deployment projects in this guideline, a regular ITS project is any ITS project that is not funded by the ITS Deployment Program.

A. REGULAR FEDERAL-AID ITS PROJECTS

Even though there are no specific programs or budget for regular federal-aid ITS projects, such projects are eligible for federal-aid funds from the NHS Program, STP Program and CMAQ Program. Some ITS Projects such as Traffic Signal Projects can be funded from the Hazard Elimination Safety (HES) Program. The funding pro-rata depends on each program respectively. Furthermore, TEA-21 clarified the eligibility of operation and management of ITS for NHS, STP and CMAQ funds. These projects follow normal federal-aid regulations and procedures for project development with the exception of some extra steps for compliance with Systems Engineering requirements as shown in the Project Procedures section in this subchapter.

B. ITS DEPLOYMENT PROGRAM

This program is limited to Congressional earmarks. Congress selects projects for this program via applications from the state or local agency sponsors. The successful state or local transportation agency sponsors and their projects are then listed and identified in either an Authorization Act or an annual Transportation Appropriation Bill. ITS Deployment Projects must be for integration purposes. Integration is defined as combining or interconnecting two or more ITS systems for a sharing of information and interoperability between systems, subsystems or jurisdictions.

The requirements for projects in this program are subject to changes by Congress or FHWA each year. For the most current requirements, the local agency must rely on the latest annual *FHWA ITS Deployment Program Guideline*. The FHWA guidelines are normally issued every January and are available on the FHWA Discretionary Program website at: http://www.fhwa.dot.gov/discretionary/proginfo.htm

Even after the Authorization Act or Appropriations Bill is passed, local agency sponsors with successful earmarks must submit a project description for review and approval by FHWA prior to authorization to proceed with project. FHWA reviews the project description for integration, eligibility, funding match, ITS architecture, standards, reporting requirements, etc.

Upon FHWA approval of the project description, the project follows the normal federal-aid procedures for clearances, obligation, authorization and construction. This program however, has a couple more requirements during and after construction. They are the quarterly status reporting and project evaluation.

FEDERAL APPROVED STATE TRANSPORTATION IMPROVEMENT PROGRAM (FSTIP)

All ITS projects must be listed on the FSTIP prior to obligation of funds. However, many ITS projects are not required to be listed individually, since they are classed as air quality exempt. Such projects may be lumped together in the FSTIP. If a traditional highway project contains an ITS element, the requirement for FSTIP listing would be dependent on the overall project. Earmarked ITS Deployment Projects must however, be individually listed in the FSTIP regardless of air quality status.

The FHWA has requested that the regional or metropolitan transportation planning agencies (e.g., MPOs, RTPAs), set up a system that would require Caltrans and the local agencies to "flag" major ITS projects in their FTIP submittal. This could be a symbol designation within the current FTIP format, a separate page listing, or any other means. This will be useful in allowing the regional planning agency responsible for maintaining the RA, to perform a preliminary screening of the project for inclusion within the RA. At the same time, it assures that the local agency is aware that it must consider integration when developing and designing an ITS project. It will also facilitate early education and technical assistance from FHWA and/or Caltrans for project sponsors in the application of the Systems Engineering process and avoid unnecessary delays to project delivery.

PRELIMINARY ENGINEERING (PE)

Preliminary Engineering (PE) activities for ITS projects may include traditional roadway design, environmental process, and ITS system (software and hardware) design using a formal Systems Engineering process.

Both the Field Review form and PE checklist include ITS requirements to be addressed when applicable. See Chapters 3, " Project Authorization" and Chapter 7, "Field Review," of the *LAPM*.

For major ITS projects, a 2-phased PE obligation and authorization process will be followed. Phase 1 work will include all activities of the Systems Engineering process leading up to software/hardware component detailed design (see Systems Engineering Methodology diagram on page 31 in this chapter). Phase 2 work, which continues Systems Engineering, includes software specification, coding, computer hardware component purchase and installation, component (software/hardware) integration, system implementation, and testing. A separate construction obligation and authorization will be needed for traditional roadway improvements and equipment installations that accompany system implementation.

Time will be allowed in the 2-phased PE obligation and authorization process for adequate FHWA oversight and approval of Systems Engineering activities. After Phase 1 is obligated and authorized, the Field Review form, which includes the Systems Engineering Review Form (SERF), is filled out by the local agency and submitted for review by FHWA. The completed Field Review package should be submitted as soon as possible to FHWA for SERF review comments in order to assure adequate guidance for preparing an acceptable Systems Engineering Management Plan (SEMP), thus avoiding unnecessary project delays.

Phase 2 will be obligated and authorized after environmental clearance and SEMP is completed and approved by FHWA. Based on 23 CFR 940, all ITS projects shall undergo Systems Engineering Analysis. The SEMP provides for management of the Systems Engineering Analysis. See the Systems Engineering section and Exhibit 12-E in this chapter for additional details.

Since software development in ITS projects involve a certain amount of iterative development and uncertainty, such projects are not suitable for low-bid type contracts. Therefore, flexibility is allowed for non-construction ITS projects or Phase 2 software/hardware component developments, to be procured by consultant services contracts. See Procurement Section of this guideline for the definition of non-construction.

If an ITS project includes minor amounts of construction, say 5% to 10% of project, compared to the nonconstruction portion, flexibility is allowed to have the entire project deployed in the PE phase.

If the construction portion is significant, and a significant amount of software development is involved, care should be taken to coordinate closely the completion of the software and electronic equipment portion with the construction portion to avoid any contract delays. This will be typically performed by different procurement methods, software by consultant services and construction by low-bid contract.

Many ITS projects are relatively complex requiring the need for most local agencies to obtain consultants for engineering and design services to develop and design an ITS project. For these types of services, the Consultant Selection procedures (qualifications-based) in Chapter 10 of the *LAPM* must be followed. These ITS consultant contracts could involve traditional planning, research, design, system integration, traffic management, software development, operations, maintenance and project evaluation services.

The special skills of a system integrator and/or a system manager may also be needed to assure successful development and deployment of ITS projects. The system integrator's role is to establish solid requirements, assure successful integration of ITS components, subsystems and systems, and possibly perform the subsystem and system testing. The system manager will work on behalf of and in coordination with the local agency to complete the overall implementation of the ITS projects.

By the nature of this activity, consultant contracts for ITS system integrators and system managers normally extend through the PE, construction, and testing phases. For complex ITS projects, it is strongly advised that such services be obtained in order to assure a successful project.

Per Federal Laws and Regulations section in this guideline, the FHWA may authorize exceptions to ITS Standards for the upgrade, or expansion of existing ITS systems under certain conditions. Therefore, for minor ITS projects, the local agencies are delegated the authority to make the exception determination based on 23 CFR 940.7 and document the determination. For major ITS projects, the FHWA will make the exception determination based on 23 CFR 940.7.

ITS projects that include a state contribution of funds (STIP funds) have relatively short PE and construction deadlines. These state-mandated deadlines are too short to account for the services of a systems integrator or systems manager. Therefore, the local agencies must be aware of the need to request time extensions in advance of the deadline in order to be reimbursed for these services, or classify the construction phase of the consultant's activities as construction engineering. See Chapter 23. 2.1, "Timely Use of Funds" of the *LAPG* for information on STIP deadlines and time extension.

ENVIRONMENTAL

The environmental process and environmental clearances for ITS projects are processed under normal federal-aid regulations and procedures. For environmental guidance, see Chapter 6 " Environmental Procedures" of the *LAPM*. Generally, the only ground disturbance that normally occurs on ITS projects is the excavation of long narrow trenches on existing public roads for fiber optics. Existing utility poles are often used for mounting surveillance equipment. Occasionally, ITS projects involve the construction of transportation management centers or information kiosks. These types of projects create relatively small "footprints." Such projects are not likely to cause any negative environmental impacts, except in rare cases where they might encounter an archaeological site, a historic site or an endangered species habitat.

With few exceptions, most ITS projects can be classed as either Programmatic Categorical Exclusion (PCE) or Categorical Exclusion (CE). CE approvals remain with FHWA, whereas the PCE approvals are delegated to Caltrans. CE projects are normally projects that do not have any significant impacts. The following are examples of ITS projects which are normally CE:

- Traffic operations improvement projects, which include: *installation of ramp metering, deployment or construction of a transportation management center and interconnect of traffic signals along a corridor.*
- Construction of bus transfer facilities (an open area consisting of passenger shelters, boarding areas, kiosks) when located in a commercial area or other high activity center in which there is adequate street capacity for projected bus traffic. *Traveler information kiosks are in this category.*

PCE projects are normally CE projects that do not have any unusual circumstances or require any special studies. Normally, projects that do not involve any ground disturbance fit the PCE category. For example, ITS projects consisting only of electronic equipment installation in an office and /or software development activities fit the PCE category. See Exhibit 6-D, Chapter 6, "Environmental Procedures" of the *LAPM* for more specific rules on meeting the PCE criteria.

RIGHT-OF-WAY

Generally, the amount of right-of-way needed for ITS projects are minor, since the right-of-way is primarily used for the placement of fiber optics under existing city streets or county roads. The only right-of-way that maybe needed is easements for fiber optics. Occasionally, an ITS project may involve utility relocations or the purchase of right-of-way for construction of a traffic management center, information kiosk, etc. For guidance on right-of-way procedures, see Chapter 13, "Right-of Way" of the *LAPM*.

SYSTEMS ENGINEERING

Systems Engineering is required for all federal-aid ITS projects per 23 CFR 940, regardless of size or complexity. However, the amount of Systems Engineering should be commensurate with the project scope and complexity.

Systems Engineering is a way of thinking about developing and completing a project. It is a process, not a checklist. The figure below shows the Systems Engineering process. The process covers the entire life cycle of a project, from planning (concept of operations, stakeholder and user needs identification) to design, operations and maintenance. The process transforms user needs into system requirements and then into a system design. As a result Systems Engineering ensures a successful and long-lasting system by (1) reducing long-term system costs, (2) reducing risk, (3) satisfying user's needs, and (4) improving system quality.

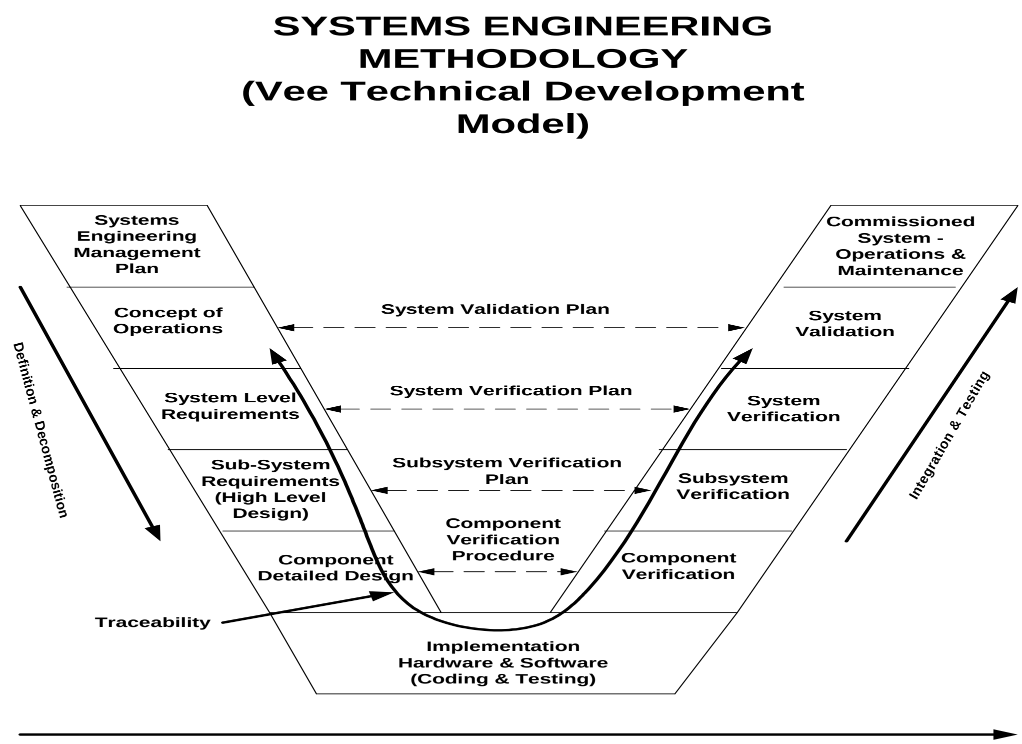


Figure 12-4 Systems Engineering Methodology

Systems Engineering is an iterative process of technical management, system design, acquisition, product realization, and technical evaluation. Similarities exist between the Systems Engineering process as used for ITS project and the structured Caltrans Project Study Report (PSR) process. Systems Engineering transforms user needs and/or operational requirements into system scope and design, whereas the PSR process transforms highway needs into project scope and design.

Systems Engineering spans the entire life cycle from systems analysis, requirements definition and conceptual design at the outset of a development through integration, testing, and operational support, to ultimately planning for replacement, and eventual retirement and disposal at the end of a program. In accordance with the 23 CFR 940, the Systems Engineering process will address at a minimum for all ITS projects the following:

- Identification of portions of the RA being implemented or if a RA does not exist, the applicable portions of the National ITS Architecture.
- Identification of participating agencies and their roles and responsibilities.
- Requirements definitions.
- Analysis of alternative system configurations and technology options to meet requirements.
- Procurement options.
- Identification of applicable ITS standards and testing procedures.
- Procedures and resources necessary for operation and management of the system

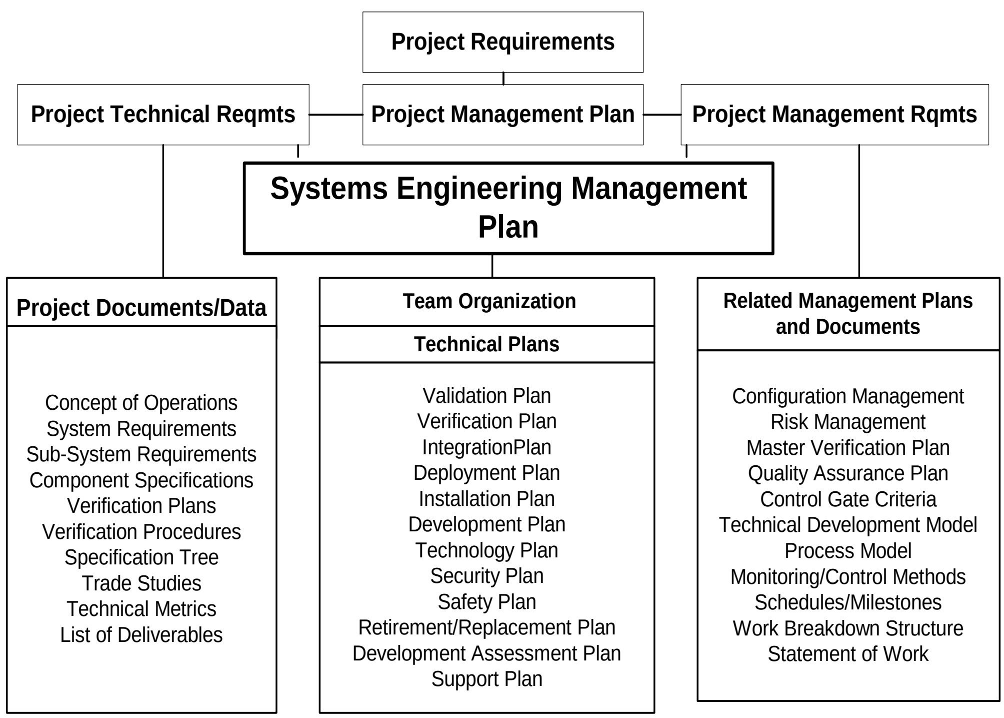


Figure 12-5 Relationship of Systems Engineering Management Plan with Project Requirements

The SEMP is the primary, top-level technical management document that defines and describes the Systems Engineering Management, the tailored Systems Engineering process, and how the technical disciplines will be integrated for the life of a transportation project. SEMP establishes the technical program organization, direction, and control mechanisms for the project to meet its cost, schedule, and performance objectives. It is the foundation for all engineering activities during the entire project.

The SEMP applies to all team personnel and all technical activities conducted in the fulfillment of the project. It applies to all processes and products that are deemed necessary for accomplishing the project, whether or not they are required under contract.

A SEMP should be developed for every project that includes software/hardware integration. It should be tailored to project size, complexity, and cover all development phases. The SEMP is not necessarily a long document but for some projects, it could be a page long, for others it could be hundreds of pages long. The plan needs to be specific to the needs of the project.

The SEMP, therefore, is a living document and as a result, additions, deletions, and modifications will occur as it is utilized. It will be updated as the development work proceeds, and Systems Engineering process products are produced. All updates must be reviewed and approved by the local transportation agency project manager.

For details on SEMP submittal, review, and approval, please refer to the "Procedures" section in this chapter as well as Exhibit 12-E " Systems Engineering Management Plan (SEMP) Guidelines."

PROCUREMENT (CONTRACTING)

The federal-aid procurement regulations as set forth in 23 CFR 172, 635, 655, and 49 CFR 18, define the requirements that state and local agencies must adhere to when procuring projects with federal-aid highway funds. These procurement regulations identify possible contracting options available for designing and constructing projects including such contracts as "engineering and design related services," "construction," and "non-engineering/non-architectural." Procurement regulations require the use of competitive contract award procedures for any federal-aid highway project and award as follows:

- Construction contracts on the basis of competitive bidding,
- Engineering and Design services contracts on the basis of qualifications-based selection, and
- Non-engineering/non-architectural contracts use state approved procurement procedures in accordance with 49 CFR 18.

Construction Versus NonConstruction

Understanding the definition of "construction" is necessary for determining the most cost-effective method of procurement. Provided next page are examples of construction and non-construction:

Improvements that typically meet the definition of Construction:

- Physical installation of field hardware and devices for freeway management and traffic signal control systems including changeable message signs, ramp meters, new traffic signals, new controller cabinets, lane use control signs and vehicle detectors.
- Erection of towers to support wireless communication, direct-bury conduit and hardware interconnect between signals and field devices or systems.
- Installation of field hardware and devices to provide detection and verification capabilities.

Improvements that individually may not meet the definition of construction (Non-Construction):

- Procurement of portable message signs, electronic devices and communication interfaces within traffic signal controllers and cabinets, computer hardware, and software development.
- Communication devices, which are wireless or require only limited installation (e.g. on existing poles or towers)

Miscellaneous Contract Conditions

ITS deployment contracts should include documentation and training. Documentation and training are necessary to assure successful operation and maintenance of any electronic system. Documentation is in the form of logistical support manuals, which will provide the new ITS operators/owners with information necessary for operation and maintenance of the system including sources for technical support and replacement parts.

It is also advisable to consider maintainability and supportability of the system in the contract for such items as: the supply support network (i.e., spares, repair parts, operating inventories), test and support equipment, transportation and handling equipment, computer resources (i.e., software), personnel and training, facilities and technical data. Other considerations are repair policies and contract warranty provisions.

CONSTRUCTION

As noted in the PE Section in this guideline, ITS projects, which involve software development, are not suitable for low-bid construction contracts. Therefore, all ITS projects should be carefully examined to determine the appropriate contracting method(s), or contracting combinations to use in accordance with the federal procurement regulations. For guidance see the Preliminary Engineering and Procurement sections in this guideline.

RECORD KEEPING

The U.S. DOT and the Comptroller General of the United States have the right to access to all documents pertaining to federal-aid projects. Nonfederal partners must maintain sufficient documentation to substantiate the costs. Such items as: direct labor, fringe benefits, material costs, consultant costs, public involvement costs, subcontract costs, and travel costs should be included in that documentation. These project records must be kept on file for a minimum of three (3) years beyond the date the final voucher is paid for each project.

PROCEDURES

A. MAJOR ITS PROJECTS - PROCEDURES

Major federal-aid ITS projects shall follow the regular federal-aid procedures outlined in the *LAPM*, except for the addition of a 2-phased PE obligation and authorization procedure to assure conformity with the NA regulations. Application and control of the Systems Engineering process is a key reason for the 2-phased PE process as shown below.

Transportation Planning:

1. The local agency submits project to the regional planning agency for inclusion in the Federal Approved State Transportation Improvement Program (FSTIP).

   The FHWA requests that regional or metropolitan planning agencies (e.g., MPOs, RTPAs) obtain from the local agencies an indication (flag) of major ITS projects along with the FTIP submittal. This could be a symbol designation within the current FTIP format, a separate page listing, or any other means. This will be useful for allowing the agency responsible for maintaining the RA to perform a preliminary screening of the project for inclusion with the RA. At the same time, it assures that the local agency is aware that it must consider integration when developing and designing an ITS project. This will also facilitate early education and technical assistance from FHWA and/or Caltrans to project sponsors in application of the Systems Engineering process and avoid unnecessary delay to project delivery.

   In California, the owner of the RA is in general a regional planning organization, which could be a Metropolitan Planning Organization (MPO), a Regional Transportation Planning Agency (RTPA), a Local Transportation Commission (LTC), a county, and a Caltrans District Office or Caltrans HQ.

2. The regional planning organization reviews the project for consistency with the transportation planning process before submitting the FTIP to Caltrans HQ.

3. Caltrans HQ incorporates the FTIP in the FSTIP, and submits the FSTIP to the FHWA Division for review and approval.

4. The FHWA Division reviews and approves the FSTIP.

Project Development:

5. The local agency verifies that the project is listed in the FSTIP, and then submits a Phase 1 Preliminary Engineering (PE) request package to the DLAE.

- 6. When the PE package is satisfactory, the DLAE forwards the package, and submits E-76 for Phase 1 PE to DLA Implementation.

7. When the PE package is satisfactory, DLA Implementation executes the E-76, and submits it to the FHWA for obligation.

- 8. The DLAE verifies from the E-76 system that FHWA has obligated the funds before issuing authorization to proceed with Phase 1 PE.

- 9. Soon after Phase 1 PE begins, the local agency submits the completed Field Review form to the DLAE.

The completed Field Review form includes an ITS Systems Engineering Review Form (SERF). In the SERF, the local agency must provide as much as possible information for each of the following ITS requirements, and include a commitment to address them in detail during system design.

a) Identification of portions of the RA being implemented.

b) Identification of participating agencies roles and responsibilities.

c) Requirements definitions.

d) Analysis of alternative system configurations and technology options to meet requirements.

e) Procurement options.

f) Identification of applicable ITS standards and testing procedures.

g) Procedures and resources necessary for operations and management of the system.

- 10. The DLAE forwards the field review package to DLA Implementation with a copy to the DLA ITS Coordinator.

11. The DLA ITS Coordinator forwards the package to FHWA.

12. FHWA reviews the SERF for FHWA oversight determination, comments on the SERF, and sends the information back to the DLA ITS Coordinator.

FHWA oversight can consist of approval of the Systems Engineering Management Plan (SEMP); products from each step of the Systems Engineering process, or portions thereof, or merely participate in scheduled process technical review points. FHWA is also available to provide the local agencies with additional ITS technical assistance and guidance as needed.

13. The DLA ITS Coordinator relays the information to the DLAE, who relays it to the local agency.

14. Upon receipt of the Field Review package, the DLA Implementation Engineer prepares a Program Supplement, with ITS covenants added. After approval by Caltrans Local Program Accounting, the Program Supplement is transmitted directly to the local agency for signature.

15. The local agency signs the Program Supplement and returns it to DLA Implementation.

16. Prior to component detailed design, the local agency submits the completed SEMP as well as the Systems Engineering process products(s) mentioned in Step #12 above, through the DLAE and DLA ITS Coordinator for FHWA's review and approval.

17. FHWA notifies the DLA ITS Coordinator that they approved the SEMP and specified process product(s).

18. The DLA ITS Coordinator relays the approval to the local agency through the DLAE with a copy to the DLA Implementation Engineer.

19. Upon receiving final SEMP and process product(s) approval, the local agency may proceed with a request for Phase 2 PE (component detailed design).

20. The DLAE checks for environmental clearance before preparing and submitting an E-76 for Phase 2 PE to the DLA Implementation Engineer.

21. The DLA Implementation Engineer reviews for completeness and accuracy before transmitting the E-76 to FHWA.

22. The DLAE verifies FHWA obligation of funds on the E-76 before issuing the Authorization to Proceed with Phase 2 PE.

23. The local agency proceeds with component detailed design.

<u>Construction:</u>

24. If the ITS project includes activities defined as construction; the local agency must submit a PS&E package requesting construction authorization. The request includes the necessary federal-aid paperwork and clearances.

- 25. Beyond this point, normal federal-aid procedures apply for completing the project. Use Final Inspection Form 17 C to finalize the project.

B. MINOR ITS PROJECTS - PROCEDURES

The procedures for minor ITS projects will follow the traditional 1-Phased federal-aid PE procedures. ITS documentation remains a requirement. However, no SERF review and SEMP review and approval by FHWA are required.

DEFINITIONS

***Architecture* -** A framework within which a system can be built. Architecture functionally defines the pieces of the system and the information that is exchanged between them.

***Architecture Baseline* -** The clear identification of the architecture products that will be maintained, including specific format and version information. Changes to the architecture baseline must follow an approved change management process typically documented in a maintenance plan. The architecture baseline will change over time as the architecture is revised.

***Architecture Flow* -** Information that is exchanged or interfaced between subsystems and between subsystems and terminators in the physical architecture view of the NA. The terms "information flow" and "architecture flow" can be used interchangeably.

***Architecture Interconnect* -** Communication paths that carry information between subsystems and terminators in the physical architecture view of the NA. Four different types of communication links are identified: wireline, wide area wireless, dedicated short-range communications and vehicle-to-vehicle communications.

***Configuration Management* -** A process developed to control change in complex information technology based systems.

***Center Subsystems* -** Subsystems that provide management, administrative and support functions for the transportation system. One of four general subsystems defined in the NA.

***Concept of Operations* -** It is the stakeholders' vision of how the system will operate in actual practice (standard operating procedure). The concept of operation is a document that defines, in sequence, how the subsystems and institutions will operate with each other for each incident or situation. It identifies and defines the roles and responsibilities of the systems and subsystems of each agency, and the physical environment. It is very useful as a starting point for the development of RA, PIA or an ITS project. The concept of operations is normally drawn up as a flow diagram.

***Data Dictionary Entry (DDE)* -** Contains definitions and description of every data flow included in the logical architecture view of the NA as well as identification of lower level data elements that make up the data flow.

***Data Flows* -** They represent data flowing between processes or between processes and a terminator. A data flow is shown as an arrow on a data flow diagram and is defined in a data dictionary entry. Data flows are aggregated together to form high-level architecture flows in the physical architecture view of the NA. See Data Flow diagram.

***Data Flow Diagram* -** The diagrams in the logical architecture view of the NA that show the functions that are required for ITS and the data that moves between these functions.

***Data Store* -** Represents data depositories that are required to support data aggregation or archival functions in the logical architecture. A data store represents "data at rest" in a data flow diagram.

Dedicated Short Range Communications (DSRC)- A wireless communications channel used for close-proximity communications between vehicles and the immediate infrastructure. It supports location-specific communications for ITS services such as toll collection, transit vehicle management, driver information, and automated commercial vehicle operations. One of four types of interconnects defined in the NA.

Deployment - An act of placing strategically.

Element - The basic building block of an ITS architecture. The name used by stakeholders to describe a system or piece of a system.

Equipment Packages - They are electronic equipment that has already been developed by manufacturers, which are ready for interconnection. A number of them need to be grouped and interconnected before the system can perform one or more user services. Such group is known as market package.

Federal Highway Administration (FHWA)- An agency of the United States Department of Transportation that funds and regulates federal funded highway projects.

Federal Transit Administration (FTA) - An agency of the United States Department of Transportation the funds and regulates federal funded transit projects.

Functional Requirements - What a system must do to address the needs or provide the services that have been identified for the region. In a regional ITS architecture, the functional requirements focus on the high-level requirements for providing desired service to the user.

Information Flow - Information that is exchanged between subsystems and terminators in the physical architecture view of the National ITS Architecture. The terms "information flow" and "architecture flow" are used interchangeably.

Infrastructure - The underlying foundation or basic framework of a system or an organization.

Institutional Integration- Represents the process of combining existing and emerging institutional constraints and arrangements.

Integrate - To incorporate into a larger system. Includes combining, interconnecting, or interfacing different systems and jurisdictions.

Intelligent Transportation System (ITS)- Electronics, communications, or information processing used singly or in combination to improve the efficiency or safety of a surface transportation system.

Interchangeability - The capability to exchange devices of the same type from any vendor without changing the software.

Interconnect - See architecture interconnect. Also applies to traffic signal interconnect.

Interface - The place at which independent systems meet and act on or communicate with each other. The means by which interaction or communication is effected. In the RA, an interface is described by the architecture interconnect.

Interoperability **-** The capability to operate devices from different manufacturers or different device types (e.g., signal controllers and dynamic message signs on the same communication channel).

ITS Architecture **-** Defines how systems functionally operate and the interconnection of information exchanges that must take place between these systems to accomplish transportation services.

ITS Project **-** Any project that in whole or in part funds the acquisition of technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS user services as defined in the National ITS Architecture.

ITS Strategic Plan - A guide for long-term implementation of ITS in the state, metropolitan area or region. It normally includes identifying regional transportation needs and then defining ITS elements to be implemented over time, aimed at meeting those needs. RA is typically a core component of an ITS strategic plan.

Legacy System **-** Existing transportation systems, communication systems or institutional systems.

Life cycle **-** Denotes the strategic cycle or sequencing of a specific process.

Logical Architecture **-** This is primarily the software part of the system. It defines the thought or logic processes that perform ITS functions and the information or data flows that are shared between these processes.

Maintenance Plan **-** A description of configuration control and update guidelines for regional and/or project ITS architectures. The primary purpose of the maintenance plan is to maintain an architecture baseline.

Major ITS Project **-** An ITS project that implements part of a regional ITS initiative that is multi-jurisdictional, multi-modal, or otherwise affects regional integration of ITS systems.

Market Packages **-** They are groups of electronic equipment that are already manufactured and ready to be interconnected to perform one or more user services.

National ITS Architecture (NA)- A common established national framework for ITS interconnectivity and interoperability. It comprises the logical architecture and physical architecture that satisfy a defined set of user services. Maintained by the U.S. Department of Transportation (USDOT), under contract at: http://itsarch.iteris.com/itsarch.

National Program Plan **-** A plan jointly prepared by the USDOT and ITS America with substantial involvement from the broader ITS community. The purpose of the plan was to guide the development and deployment of ITS. It defined the first 28 user services that were the basis for the National ITS Architecture development effort. This plan is updated periodically.

Operational Concept **-** Describes how the system will work by identifying in sequence the roles and responsibilities of participating agencies and stakeholders for a given scenario(s).

***Physical Architecture* -** This is primarily the hardware part of the system. The part of the NA that provides a physical representation of the important ITS interfaces and major system components. The principal elements of the physical architecture are the subsystems, terminators and the communication interface between them.

***Process* -** A function or activity identified in the logical architecture view of the NA that is required to support the ITS user services.

***Process Specification (PSpec)*-** The textual definition of the most detailed process identified in the logical architecture view of the NA. The PSpec includes an overview, a set of functional requirements, a complete set of inputs and outputs, and a list of user service requirements that are satisfied by the PSpec.

***Project ITS Architecture (PIA)*-** A framework that identifies the institutional agreement and technical integration necessary to define an ITS project and its interface with other ITS projects and systems.

***Project Sequencing* -** The order in which projects are deployed. An efficient sequencing can allow projects to incrementally build on each other.

***Protocol Communications* -** A set of rules for how messages are coded and transmitted between electronic devices. The equipment at each end of a data transmission must use the same protocol to successfully communicate. It is like human language that has an alphabet, vocabulary, and grammar rules used by everyone who speaks that language.

***Region* -** The geographical area that identifies the boundaries of the RA based on the needs of the participating agencies and stakeholders. In metropolitan areas, a region should be no less than the boundaries of the metropolitan planning area.

***Regional ITS Architecture (RA)* -** A regional or state level framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects. It defines what pieces of the system are linked to others and what information is exchanged between them.

***Requirements Definitions* -** A total set of considerations that govern what is to be accomplished, how well and under what conditions.

***Roadside Subsystems* -** One of four general classes of subsystems defined in the NA. This class is distributed along the transportation network, which performs surveillance, information provision, and control functions. Located on roadway facilities, parking facilities, toll systems, and commercial vehicle check systems that are at or near the roadside.

***Rural Areas* -** For the purposes of this guideline, they are areas not under any MPO jurisdiction.

***Sausage Diagram* -** A top-level diagram, which depicts all subsystems in the NA and the basic communication, interconnects between the subsystems. It can be used as a template for the physical architecture portion of a RA.

***Service Boundaries* -** The geographic boundary of a specific service or agency that provides a service. An example is the service area of a transit agency. The transit agency provides services within a defined boundary.

***Stakeholders* -** Anyone with a vested interest or "stake" in the regional ITS architecture. This includes public agencies, private organizations, special interest groups and traveling public.

***Standards* -** Established and documented technical specifications sponsored by a Standards Development Organization (SDO) to be used consistently by industries or government for interoperability, compatibility, interconnect ability, interchangeability and expandability. Already developed ITS standards can be found in the NA web site by selecting an Architecture Flow.

***Subsystem* -** The principal structural elements of the physical architecture view of the NA. Subsystems are grouped in four classes: centers, roadside, vehicles and travelers.

***System Inventory* -** The collection of all ITS related elements in a RA.

***Systems Engineering Analysis* -** Is a structured process for arriving at a final design of a system. The final design is selected from a number of alternatives that would accomplish the same objectives and considers the total life-cycle of the project including not only the technical merits of potential solutions but also the costs and relative value of alternatives.

***Terminator* -** Terminators define the boundary of architecture. They represent people, systems, and general environment that interface with ITS. Since they are in essence, "external", the interfaces are defined but no functional requirements are allocated to them. Both the logical and physical architectures have exactly the same terminators.

***Traveler Subsystems* -** Equipment used by travelers to access ITS services pre-trip and en route. This includes services owned and operated by the traveler as well as services that are owned by transportation and information providers. One of four general subsystem classes defined in the NA.

***Turbo Architecture* -** An automated software tool used to input and manage system inventory, market packages, interconnects and architecture flows with regards to RA. The Turbo Architecture is an excellent software tool for developing RA, PIA, development and design of an ITS project. However, the Turbo Architecture must be purchased since it is not a public domain.

***User Services* -** They are services that ITS provide the user from the user's perspective. User Services form the basis for the National ITS Architecture development effort. Currently, 33 user services are defined in the NA.

***User Service Requirements* -** Specific statements specifying what must be done to support the ITS user services. The user services requirements were developed specifically to serve as a baseline to drive NA development. The user service requirements are not requirements to system/architecture implementers, but rather are directions to the NA development team.

***Vehicle Subsystems* -** They are subsystems located in vehicles, which include driver information and safety systems. One of four general subsystem classes defined in the NA.

Vehicle-to-Vehicle Communications **-** Dedicated wireless system handling high data rate, low probability of error, line-of-sight communications between vehicles. Advanced vehicle services may use this link in the future to support advanced collision avoidance implementations, road condition information sharing, and active coordination to advanced control systems. One of four types of architecture interconnects defined in the NA.

Wide-Area Wireless communications **-** A communications link that provides communications via a wireless device between the user and an infrastructure based system. These links support a range of services including real time traveler information and various forms of fleet communications. One of four types of architecture interconnects defined in the NA.

Wireline Communications **-** A communications link serving fixed locations. It uses a variety of public or private communications networks that may physically include wireless (e.g. microwave) as well as wireline infrastructure. One of four types of architecture interconnects defined in the NA.

ACRONYMS

AASHTO - American Association of State Highway and Transportation Officials

ADMS - Archived Data Management Subsystem

ADUS - Archived Data User Service

AFD - Architecture Flow Diagram

AID - Architecture Interconnect Diagram

AHS - Automated Highway System

AMPS - Advanced Mobile Phone System

ANSI- American National Standards Institute

APTS - Advanced Public Transportation System

ASTM - American Society for Testing and Materials

AVCS - Advanced Vehicle Control Systems

AVI - Automated Vehicle Identification

AVL - Automated Vehicle Location

AVO - Automated Vehicle Operation

BNF - Backus-Naur Form

BRT - Bus Rapid Transit

CASE - Computer Aided Systems Engineering

CCTV - Closed Circuit TV

CD - Compact Disk

CDMA - Code Division Multiple Access

CDPD- Cellular Digital Packet Data

CD-ROM - CD Read-only Memory

CMA - Congestion Management Agency

CMS - Changeable Message Sign

CORBA - Common Object Request Broker Architecture

COTR - Contracting Officer Technical Representative

COTS – Commercial of-the-Shelf products

CSP - Communication Service Provide**r**

CV - Commercial Vehicle

CVAS - Commercial Vehicle Administration Subsystem

CVCS - Commercial Vehicle Check Subsystem

CVISN - Commercial Vehicle Information Systems and Networks

CVO - Commercial Vehicle Operations

CVS - Commercial Vehicle Subsystem

CWD - Corridor Wide Display System

DAB - Digital Audio Broadcast

DD - Data Dictionary

DDE - Data Dictionary Element

DEN - Data Exchange Network Display System

DFD - Data Flow Diagram

DGPS- Differential Global Positioning System

DLA- Division of Local Assistance

DLAE - District Local Assistance Engineer

DMS - Dynamic Message Sign

DMV - Department of Motor Vehicle

DOT - Department of Transportation

DR&I - Caltrans Headquarters Division of Research & Innovation

DSRC - Dedicated Short Range Communications

DTA - Dynamic Traffic Assignment

911 - Emergency 9-1-1

ECPA - Electronic Communications Privacy Act

EDI - Electronic Data Interchange

EDP - Early Deployment Plan

EM - Emergency Management Subsystem

EMC- Emergency Management Center

EMMS - Emissions Management Subsystem

ESMR - Enhanced Specialized Mobile Radio

ETA - Expected Time of Arrival

ETTM - Electronic Toll and Traffic Management

ETS - Emergency Telephone Services

FARS - Fatal Accident Reporting System

FCC - Federal Communications Commission

FHWA- Federal Highway Administration

FIPS - Federal Information Processing Standard

FMC - Freeway Management Center

FMCSA - Federal Motor Carrier Safety Administration

FMS - Fleet Management Subsystem

FOT - Field Operational Test

FPR - Final Program Review

FSTIP - Federal State Transportation Improvement Program

FTA - Federal Transit Administration

GIS - Geographic Information System

GPS - Global Positioning System

GUI - Graphical User Interface

HAR - Highway Advisory Radio

HAZMAT - Hazardous Material

HOV - High Occupancy Vehicle

HRI - Highway Rail Intersection

HSR - High Speed Rail

HUD - Head Up Display

IDL - Interface Definition Language

IEEE - Institute of Electrical and Electronics Engineers, Inc.

IEN - Information Exchange Network

IP- Internet Protocol

IPR - Interim Program Review

ISO - International Standards Organization

ISP - Information Service Provider

ISTEA - Intermodal Surface Transportation Efficiency Act

ITE - Institute of Transportation Engineers

ITI - Intelligent Transportation Infrastructure

ITS - Intelligent Transportation Systems*

ITS America - Intelligent Transportation Society of America

IVIS - In Vehicle Information System

LAN - Local Area Network

LCD - Liquid Crystal Display

LED - Light Emitting Diode

LEO - Low-Earth Orbit Satellite System

LRMS - Location Reference Messaging Standard

LRT- Light Rail Transit

MAN- Metropolitan Area Network

MDI- Model Deployment Initiative

MMDI- Metropolitan MDI

MMI - Man-Machine Interface

MOE - Measure of Effectiveness

MPO - Metropolitan Planning Organization

MPH - Miles per Hour

NA- National ITS Architecture

NAR- National Architecture Review

NAV- Navigation

NEMA - National Electrical Manufacturers Association

NHPN - National Highway Planning Network

NHTSA - National Highway Traffic Safety Administration

NII - National Information Infrastructure

NPRM - Notice of Proposed Rulemaking

NTCIP- National Transportation Communications for ITS Protocol

OEM- Original Equipment Manufacturer

OSI - Open Systems Interconnection

OTP - Operational Test Plan

PC - Personal Computer

PCS - Personal Communications System

PD - Police Department

PDA - Personal Digital Assistant

PE- Preliminary Engineering

PIA- Project ITS Architecture

PIAS - Personal Information Access Subsystem

PMS - Parking Management System

PS - Planning Subsystem

PSA - Precursor System Architecture

PS&E - Plans, Specifications and Estimate

PSPEC - Process Specification

PSTN- Public Switched Telephone Network

PTS- Positive Train Separation

R & D- Research and Development

RDS- Radio Data Systems

RDSTMC - RDS incorporating a Traffic Message Channel

RFP - Request for Proposal

RA - Regional ITS Architecture

RS - Roadway Subsystem

RTA- Regional Transit Authority

RTPA- Regional Transportation Planning Agency

RTS- Remote Traveler Support Subsystem

SAE- Society of Automotive Engineers

SC- Single Click

SDO- Standards Development Organization

SEMP- System Engineering Management Plan

SERF-System Engineering Review Form

SMR - Specialized Mobile Radio

SNMP - Simple Network Management Protocol

SONET - Synchronous Optical Network

SOV - Single Occupancy Vehicle

SOW- Statement of Work

STMF- Simple Transportation Management Framework

STMP- Simple Transportation Management Protocol

SQL- Standard Query Language

SSR- Standard Speed Rail, also Spread Spectrum Radio

TAS - Toll Administration Subsystem

TCIP - Transit Communications Interface Profiles

TCS- Toll Collection Subsystem

TDM - Travel Demand Management

TDMA - Time Division Multiple Access

TM - Transportation Management

TMC- Transportation Management Center

TMDD - Traffic Management Data Dictionary

TMS - Traffic Management Subsystem

TOC - Traffic Operations Center

TRB - Transportation Research Board

TRMC - Transit Management Center

TRMS - Transit Management Subsystem

TRT- Technical Review Team

TRVS - Transit Vehicle Subsystem

USDOT- United States Department of Transportation

USR - User Service Requirement

VMS - Variable Message Sign

VRC - Vehicle/Roadside Communications

VS - Vehicle Subsystem

WAN - Wide Area Network

WIM- Weigh-in-Motion

WWW- World Wide Web

REFERENCES

- 1991 Intermodal Surface Transportation Efficiency Act (ISTEA)
- 1998 Transportation Equity Act of the 21st Century (TEA-21), Section 5206(e)
- Title 23 USC 103(b)(6), Eligibility for NHS Program
- Title 23 USC 133(b), Eligibility for STP Program
- Title 23 CFR 655, Traffic Surveillance and Control
- Title 23 CFR 940, National ITS Architecture
- Title 49 CFR 18, Common Rule
- FHWA Memorandum dated March 22, 2002, Guidance on Federal-aid Eligibility of Operating Costs for Transportation Management Systems
- 2002 Project Approval and Oversight Letter of Agreement (Stewardship Agreement) between the Federal Highway Administration and the California Department of Transportation
- January, 2002 Using the National ITS Architecture for Deployment, NHI training course
- *LAPM*, Chapter 2, Roles and Responsibilities
- *LAPM*, Chapter 3, Project Authorizations
- *LAPM*, Chapter 6, Environmental Procedures
- *LAPM*, Chapter 7, Field Review
- *LAPM* Chapter 10, Consultant Selection Procedures
- *LAPM*, Chapter 11, Design Standards

- *LAPM*, Chapter 12, Plans, Specifications & Estimate
- *LAPM*, Chapter 15, Advertise and Award Project
- *LAPM*, Chapter 16, Administer Construction Contracts
- *LAPM*, Chapter 17, Project Completion
- *LAPM*, Chapter 13, Right-of-Way
- June 2000 Intelligent Transportation Systems Procurement, NHI training course

Exhibit 12-A

DEFENSE ACCESS ROADS EVALUATION REPORT

a. The narrative report should include as appropriate, but not be restricted to information on:

(1) volume and character of present and future traffic anticipated on the recommended project, as well as a peak-hour turning movement diagram for any major intersection involved,

(2) the percentage of installation traffic compared to total traffic,

(3) personnel strength,

(4) number of shifts worked or to be worked,

(5) a recommended project if warranted or, if no project is warranted, the report should so indicate,

(6) a description of the recommended improvement including a sketch map showing location,

(7) a realistic cost estimate updated to the year of anticipated construction,

(8) a statement to indicate whether similar designs are being used under similar conditions on regular federal-aid, state or local projects in the area. Highway engineering economic analysis should be used as appropriate in evaluating alternatives and justification of the recommended improvements,

(9) discussion of state and/or local plans for improvements in the area including:

(a) priority that the state or local agency has placed on a proposed improvement,

(b) appropriate comments relative to the priority rating furnished by the state or local highway agency,

(c) extent of state or local commitment for participation in need improvements,

(d) an estimate of the date when the work could be accomplished, providing funds were available, and

(e) an estimate of the time (in months) that may be required to accomplish each of the following phases of the recommended project: preliminary engineering, environmental clearance, final design, right-of-way acquisition, and construction including advertisement and award, and

(10) need for control of access to protect the project from obsolescence, especially where a four-lane facility is proposed or will be required at a later date. A determination should be based primarily on the economic justification and desirability of this type of design.

b. Three copies of the narrative report and sketch map are to be submitted to MTMC. If the decision has been made that the project is to be handled by a Federal Lands Highway Division, two additional copies of the report should be furnished to the Federal Lands Highway Division.

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Exhibit 12-B

MILITARY TRAFFIC MANAGEMENT COMMAND ELIGIBILITY CRITERIA

1. Defense Access Roads

a. Military Installations. The Department of Defense has the responsibility for determining the eligibility of proposed improvements for financing with defense access road funds. Generally, projects meeting the following requirements will be considered appropriate for such financing.

(1) Access roads providing new connections between either old or new military installations and main highways may be considered eligible for 100 percent financing with defense access road funds, providing that in urban areas where a new entrance is established and access to a main thoroughfare is via existing city streets, the 100 percent defense access financing extends outward from the reservation only so far as the traffic generated by the installation is greater than other traffic.

(2) Urgently needed improvements of existing highways that are neither a part of nor qualified for inclusion in the federal-aid urban system, but upon which traffic is suddenly doubled (or more than doubled) by reason of the establishment or expansion of a permanent military installation may be considered eligible for financing in whole or in part with defense access road funds. One hundred percent defense access road financing will be considered only on the lightly traveled portion of these highways which are a part of the federal-aid rural system, or which are of insufficient importance to qualify for such designation. The more heavily traveled federal-aid rural highways (upon which traffic is suddenly doubled or more than doubled), generally regarded as being self-supporting from their earnings of road-user revenues, are eligible for only partial defense access road financing.

(3) Urgent improvements needed to avoid intolerable congestion or critical structural failure of any highway serving a temporary surge of defense-generated traffic (such as that which results from the establishment and operation of a temporary military installation, or from large-scale construction activity) may be considered eligible for financing to the extent necessary to provide the minimum essential facility to accommodate the temporary surge of traffic. A temporary surge of traffic is defined as one of several months duration, at least, but very short in duration as compared to the total life of a normal highway improvement.

(4) Alteration of a public road in the immediate vicinity of a military installation to accommodate regular and frequent movements of special military vehicles such as tank transporters or heavy ammunition carriers may be financed with defense access road funds, provided it is impractical or uneconomical to acquire right-of-way and develop such roads for exclusive military use. However, highway funds from other sources should finance any improvement that may be needed to bring the highway to a stage satisfactory for accommodation of all traffic except the special military vehicles.

(5) Access roads serving State National Guard facilities which are federally owned are eligible under paragraphs 1a (2) and (4). Roads serving federally owned National Guard facilities, which are of appreciable non-military local benefit, are eligible for only partial defense access road financing. Roads serving state-owned National Guard facilities are ineligible.

(6) No highway located within the boundaries of a military reservation is eligible for financing from defense access road funds. This prohibition does not apply to a highway through a military reservation on public rights-of-way open to free use of the public with no military restrictions or to a highway located along and partly within the installation boundaries but not subject to closure by military authorities.

(7) Projects on the NHS are not generally considered eligible for financing with defense access road funds.

(8) Traffic signal installations when justified may be financed as part of a new construction project.

b. Defense Industries. Criteria governing eligibility of access roads for military installations also apply to any defense industry as defined in current joint Army-Navy-Air Force regulations.

2. Replacement Roads (Military). Highways constructed to replace those closed by establishment of new military installations or the expansion of old ones are considered eligible for financing with defense access road funds to the extent of 100 percent of the cost of constructing the replacement road to current standards for current traffic.

EXHIBIT 12-C

ITS ARCHITECTURE MATRIX

National ITS Architecture	Regional ITS Architecture
User Services & User Services Requirements	Description of the Region Identification of participating agencies and other stakeholders An Operational Concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the RIA Any agreements for ITS operation, interoperability, use of ITS Standards and operation of ITS projects in the RIA
Logical Architecture	System functional requirements
Physical Architecture	Interface requirements and information exchanges with planned and existing systems and subsystems The sequence of projects required for implementation
ITS Standards	Identification of ITS Standards supporting regional and national interoperability
Equipment Packages Market Packages	ITS inventory
	Develop and implement procedures and responsibilities for maintaining the RIA as needs evolve in the region

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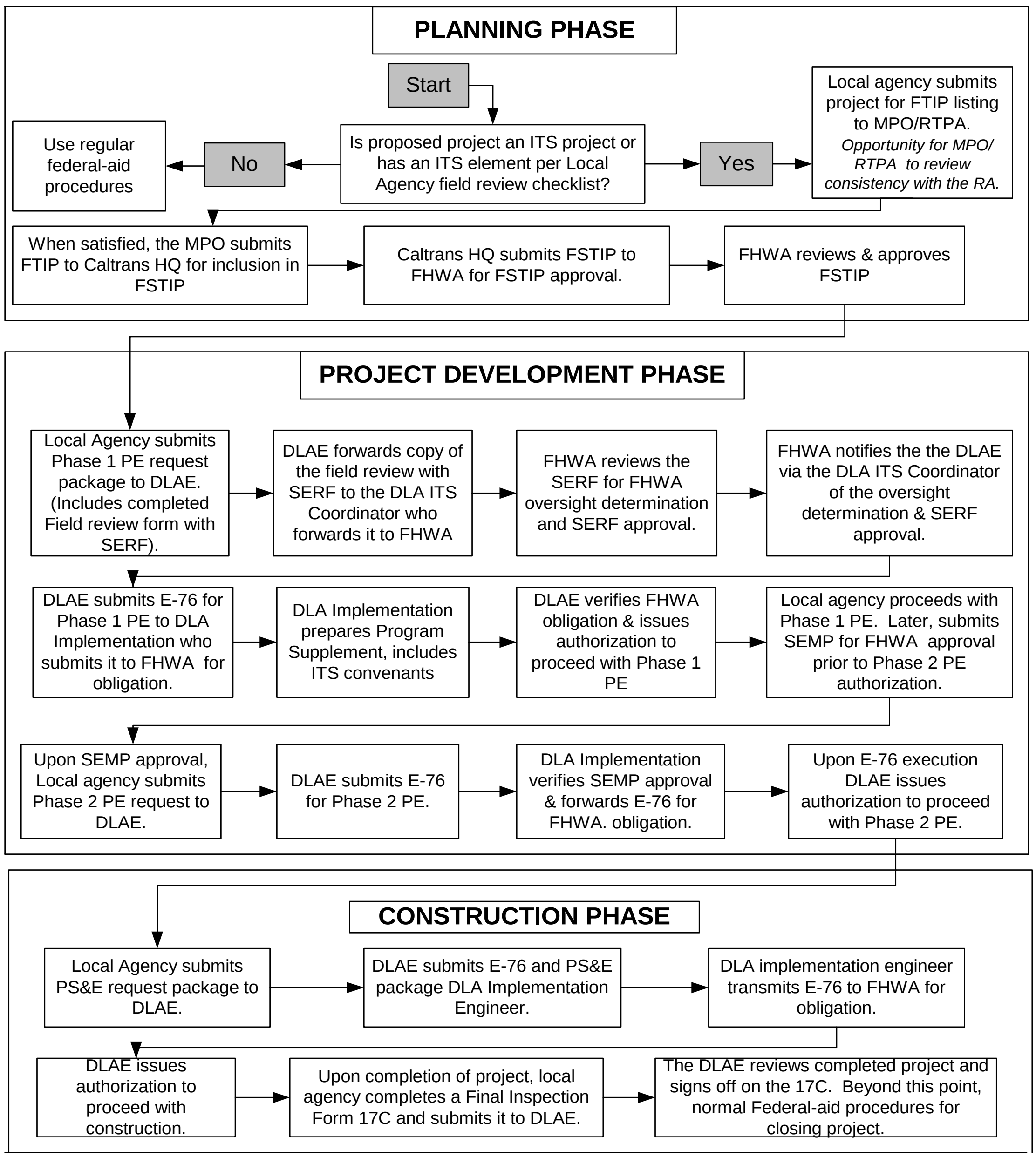
Exhibit 12-D1

MAJOR ITS PROJECTS

(Non-Exempt Projects)



Note:

- This flow chart process does not apply to the earmarked ITS Deployment Projects (QT80 projects).
- This 2-phased PE procedure requires FHWA review of the SERF and approval of the SEMP.
- Full FHWA oversight for PE phases on all major ITS projects.
- Non-exempt for E-76 purposes.
- For simplicity, the right-of-way phase is not shown in this chart. If right-of-way is involved, refer to Chapter 13,"Right-of-Way," of the *LAPM* for information and procedures.

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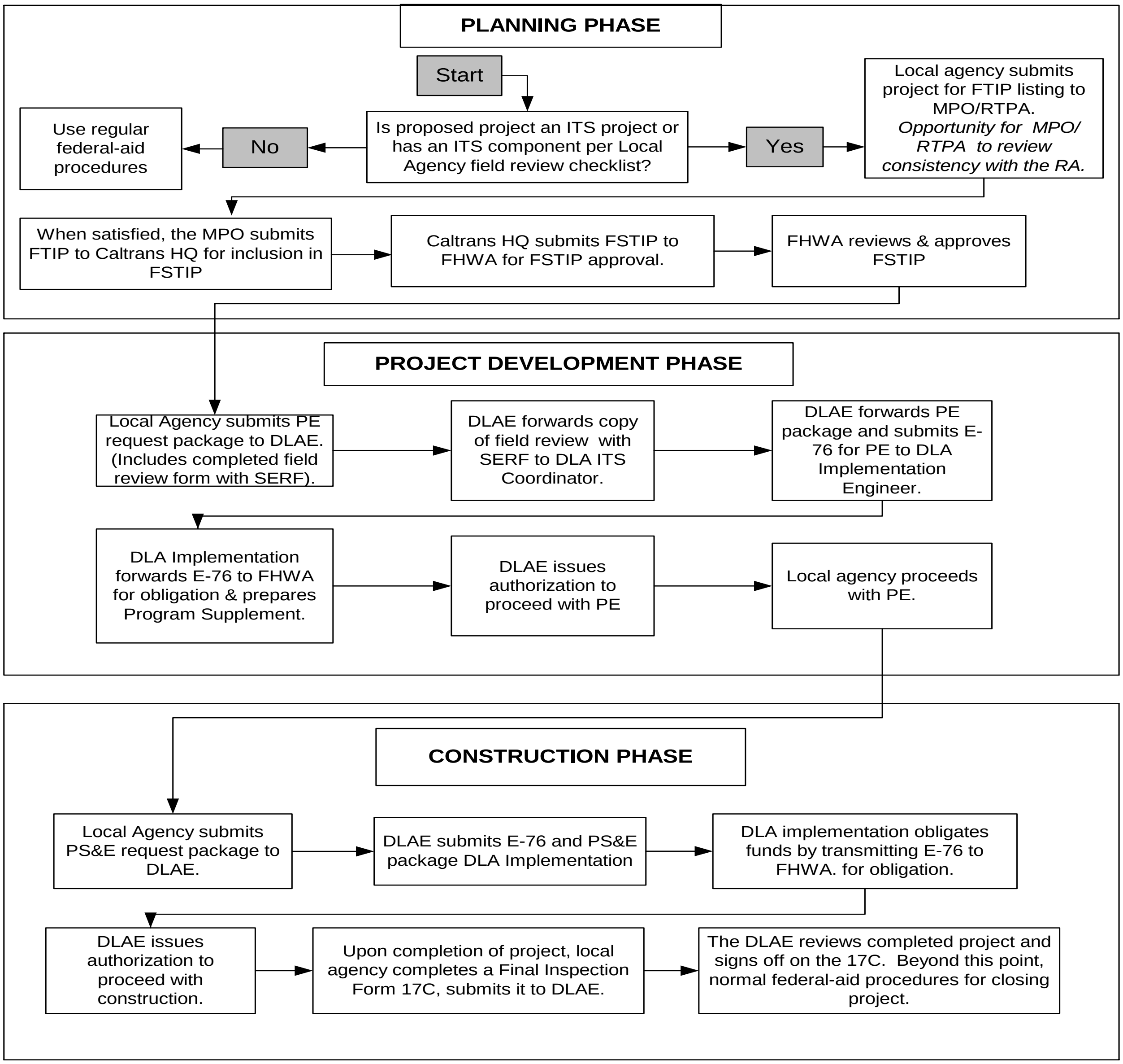
Exhibit 12-D2
MINOR ITS PROJECTS
(Exempt Projects)



Note:
- This flow chart process does not apply to the earmarked ITS Deployment Projects (QT80 projects).
- Miinor ITS projects will follow the above traditional single phased PE procedures.
- No FHWA oversight for procedure shown on this flowchart (SERF review and SEMP approval not required).
- Exempt for E-76.
- For simplicity, the right-of-way phase is not shown in this chart. If right-of-way is involved, refer to Chapter 13, "Right-of-Way," of the *LAPM* for information and procedures.

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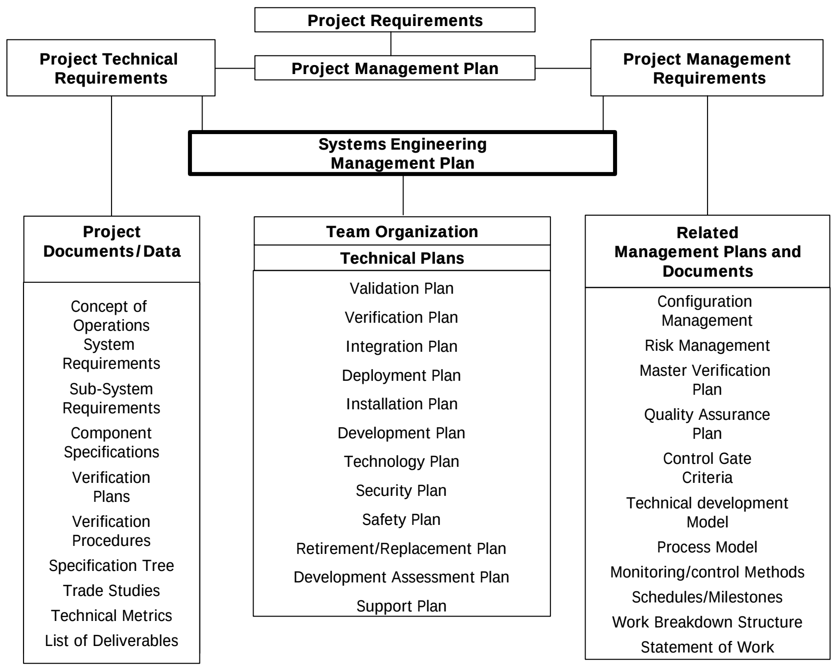
Exhibit 12-E
Systems Engineering Management Plan (SEMP) Guidelines

INTRODUCTION

The Systems Engineering Management Plan (SEMP) is the primary, top-level technical management document that defines and describes the systems engineering management, the tailored systems engineering process, and how the technical disciplines will be integrated for the life of a transportation project. This document establishes the technical program organization, direction, and control mechanisms for the project to meet its cost, schedule, and performance objectives. The SEMP is the foundation for all engineering activities during the entire project.



The SEMP applies to all team personnel and all technical activities conducted in the fulfillment of the project. It applies to all processes and products that are deemed necessary for accomplishing the project, whether or not they are required under contract.

A SEMP should be developed for every project that includes software development or software/hardware integration. The SEMP should be tailored to project size and complexity, yet cover all development phases. The SEMP is not necessarily a long document. For some projects, it could be few pages long and for others it could be hundreds of pages long. The plan needs to be specific to the needs of the particular project.

The SEMP is a living document and as a result additions, deletions, and modifications will occur as it is utilized. It will be updated as the development work proceeds and systems engineering process products are produced. All updates must be reviewed and approved by the Transportation Agency project manager.

The SEMP will be prepared in two stages. The first stage is a framework (or scope) for the SEMP established by the Transportation Agency. The second stage is the completion of the SEMP by the Developer (system manager and/or integrator) before software detailed design and software/hardware integration begin.

The Transportation Agency, in conjunction with any directed systems engineering management working group(s), establishes a framework for the SEMP by stating project goals and organizational management and establishing requirements for what should be in it. This takes the form of a *Draft Scope* (typically the first section of the SEMP) and can be useful for project management decisions and contract RFP scope developments.

The Developer will provide complete SEMP content in the second stage. This content will be addressed as a part of the contract proposal and finalized in technical documents that are approved before software component detailed design begins. With the Developer's input, the SEMP becomes the control document for work to be performed for the life of the project.

In the sections that follow, an example format and description of the SEMP is presented.

Format and Description of SEMP:

Title Page

The title page should follow the Transportation Agency procedures or style guide as applicable. It shall contain the following information (not in order):

- SYSTEMS ENGINEERING MANAGEMENT PLAN FOR THE *Name of Project*, AND *Transportation Agency*
- Contract Number
- Date the document was formally approved
- The organization responsible for 'preparing' the document
- Internal Document Control Number, if available
- Revision version

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Table of Contents

Page Number

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1. SCOPE

Transportation Agency - *"What is the project goal and what is expected from the Developer?"*

Developer - *"What is proposed and how will it be delivered?"*

The *Scope* shall identify the specific project and its purpose, to include complexities and challenges that will be addressed by the technical development effort. It will specify the systems engineering process (see Fig. 1 next page) to be used for the system's design, development, test, and evaluation. Overall organizational structure and technical, direction and control for the project should be summarized. This includes management work groups and multi-disciplinary technical teams that are critical to reaching successful system deployment.

The *Scope* will summarize all associated planning, technical, and management activities described in the SEMP sections that follow. This information will be provided from two perspectives, the Transportation Agency in the form of a *Draft Scope*, and the Developer as a part of the contract proposal and completed in the final SEMP delivered for approval.

From the perspective of the Transportation Agency, the *Draft Scope* will state project goals and organizational management and summarize the minimum requirements expected of the Developer. Drawing upon the details presented in the following Sections of this SEMP guidance, these agency expectations can be documented. This will be useful for project management decisions and contract RFP scope developments.

The Developer completes the *Scope* content in stages, as a part of the contract proposal and as technical documents are finalized and approved before the Component Detailed Design phase begins (see Figure 1). The Developer will provide the necessary details in the other sections of this SEMP guidance. The content of the *Scope* has similarity to an Executive Summary.

The VEE life-cycle technical development model should be specified by the Transportation Agency in the *Draft Scope* to represent the overlying systems engineering process for analysis. See Figure 1. Other models may be used to supplement the analysis.

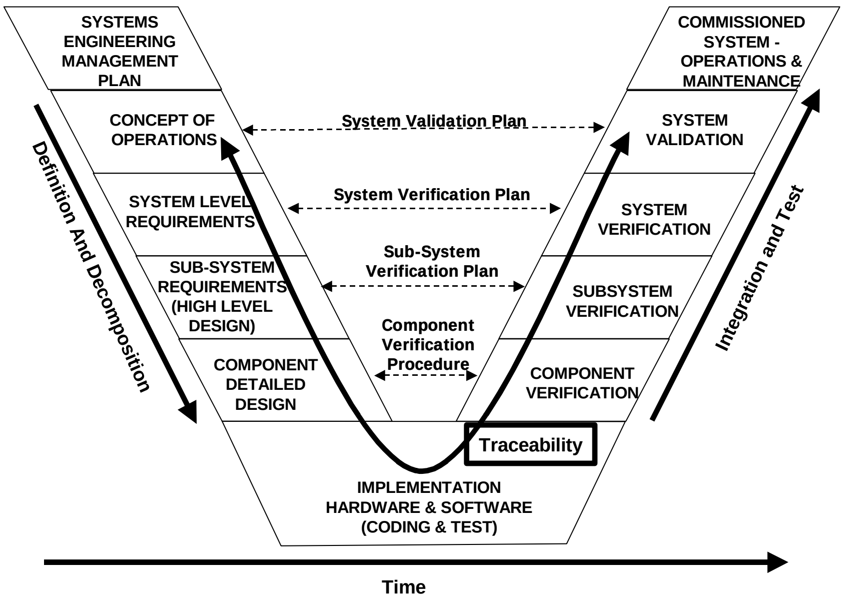

Figure 1. VEE Systems Engineering Technical Model

The level of detail at each of the phases of the analysis should be on a scale commensurate with the project scope. The details of this tailoring will be summarized in the *Scope* by the Developer and described in full in SEMP Section 3 entitled *Systems Engineering Process*.

The Transportation Agency shall state in the *Scope* that the Federal Regulation 23 CFR 940, *Intelligent Transportation Systems (ITS) Architecture and Standards*, *Final Rule* will be satisfied. 23 CFR 940 states, “All ITS projects funded with highway trust funds shall be based on a systems engineering analysis.” The project implementation requirements specified in 23 CFR 940.11 are as follows:

- Identification of portions of the Regional ITS Architecture being implemented or if a Regional ITS Architecture does not exist, the applicable portions of the National ITS Architecture,
- Identification of participating agencies and their roles and responsibilities,
- Requirements definitions,
- Analysis of alternative system configurations and technology options to meet requirements,
- Procurement options,
- Identification of applicable ITS standards and testing procedures, and
- Procedures and resources necessary for operation and management of the system.

The relationships of these seven bullets from 23 CFR 940 to the recommended VEE technical model phases are depicted in Figure 2. In the process phases leading up to Component Detailed Design, these seven regulatory requirements will be addressed. The Developer shall acknowledge in the *Scope*, as a part of the contract proposal that these will be addressed in the systems engineering analysis and any associated process tailoring detailed in Section 3, *Systems Engineering Process*.

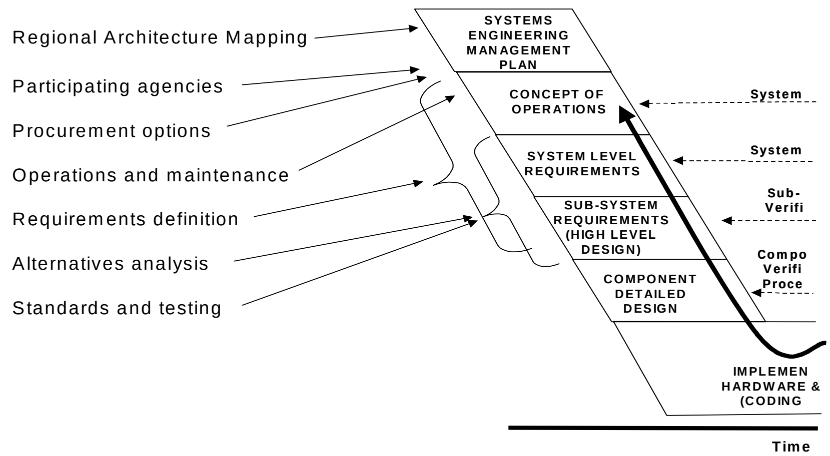

Figure 2. Relationship between 23 CFR 940.11 and the VEE

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2. TECHNICAL PLANNING AND CONTROL

"What needs to be documented, and how will the development be managed?"

Technical Planning and Control contains the core systems engineering planning information that the Developer will convey within a contract proposal and provide during the system design development. *Technical Planning and Control* identifies overall organizational structure and responsibilities for systems engineering activities during the total system life cycle. The section will detail the technical direction and control of contracted, and subcontracted engineering tasks. It applies to all technical activities conducted, and to all processes and products that are deemed necessary for accomplishing the project.

Technical Planning and Control defines the project's interaction with all internal and external organizations involved in performing technical work (i.e., teammates, subcontractors, and vendors). Multi-disciplinary teams that are critical to reaching successful system deployment will be formed. Multi-disciplinary teams will be discussed in detail in Section 4, *Integration of the Systems Engineering Effort.*

The Transportation Agency should specify in the *Draft Scope* the planning activities important to the success of the project. A final decision will be made through consultation with the Developer at time of contract proposal approval. The planning activities important to most system developments consist of the following:

- Major decision deliverables – produce the requirements databases, specifications, and baselines.
- Process inputs - identify source material for the deliverables noted above, which includes the SOW and the specification from the RFP, and previously developed specifications for similar systems.

- Technical objectives – include success criteria defining when the design is done. May be a source document for deliverables noted above. Could be part of a Concept of Operations.
- Contract Work Breakdown Structure (WBS) - defines the tasks in the Systems Engineering Master Schedule and the milestones of the Systems Engineering Detailed Schedule. The Detailed Schedule may or may not be an expectation at the contract proposal phase.
- Training – planned for agency staff to operate the system and for contract staff on the basis of the requirements of the RFP/SOW, with associated scheduling.
- Standards and procedures – identify within the Developer company those that are applicable, such as workmanship, quality assurance, engineering policies and procedures, and time charging practices, etc.
- Resource allocation – identifies resource requirements (capital equipment, software, personnel, agency-furnished equipment and information, and time-phased needs), procedures for resource control, and reallocation procedures (workarounds).
- Constraints - identify source, e.g., RFP, system concept, technology availability, availability of required resources, funding, facilities, etc.
- Work authorization – describes process for handling requests for work (e.g., task orders), or changes to existing tasking; especially important with subcontractors.
- Test and Evaluation – acknowledge that a Testability Plan be prepared. See description of Testability Plan below.

As part of *Technical Planning and Control*, (1) technical documents, and (2) related project management plans applicable to the project, are identified. The Transportation Agency will give initial indication in the *Draft Scope* of those technical documents they desire to see developed, and specify project management plan requirements that relate to this development that they already have in place. A final decision will be made through consultation with the Developer at time of contract proposal approval. The Developer will describe the associated technical management aspects for this development in the final SEMP.

The technical documents include both schedules and plans. Each schedule and plan is designed to interact with other project plans to provide complete coverage of the engineering effort and ensure continuity of management control. Typical technical documents (schedules and plans) include:

- Systems Engineering Master Schedule – top-level process control and progress measurement tool to ensure completion of identified accomplishments.
- Systems Engineering Detailed Schedule – reflects the detailed work efforts required to support critical events and tasks. May be required by the RFP.
  - Software Development Plan – describes organizational structure of the effort, facilities and engineering environment, management techniques to maintain control over development activities.
- Hardware Development Plan – describes organizational structure of the effort, procedures, facilities and engineering environment, management techniques to maintain control over development activities.

- Interface Control Plan – identifies and defines physical, electronic, content characteristics of all system internal and external interfaces, and communications links. Includes interfaces with people as well as hardware and software.
- System Installation Plan – describes in detail planned step-by-step activities on site-by-site basis for the release, both physical installation as well as electronic updating, also organizational structure.
- System Integration Plan – identifies organizational structure, optimal sequence for incremental delivery, assembly, and activation of the various components into operational system. Addresses factors to minimize assembly difficulties and cost/schedule impact.
- Testability Plan – basic tool to establish and execute a test program. Emphasizes: integration with other design requirements, consistency with end product requirements, identifies guides, analysis models, and procedures, planning for review and use of data submissions, how/when tasks to be done and how results are to be used, physical and personnel resources and overall testing schedule.
- Technical Review Plan – lists technical reviews to be conducted and describes associated tasks for each contract phase, methods to solve problems during reviews, information needed as prerequisite, and schedule. A listing of life cycle phase technical reviews can be found in EIA/IS 632, Annex E.
- Technology Plan – describes evolution to identify, assess, and applies emerging technology, activities and criteria for transitioning from development and demonstration, addresses selection criteria for alternative technologies.

The above list is not meant to be exhaustive. Other test plans will be called for in transportation projects, such as Verification Plans, Validation Plans, and Test Plans for which much of the information in the Testability Plan would be included. Other technical plans that may be appropriate include: Quality Assurance Plan, Maintenance Plan, and Human Factors Plan. For smaller, less complex projects, several of these plans could be combined and some may not be necessary at all.

In addition to the technical plans, certain project management plans will be prescribed for the development. Project management plans include at a minimum

Configuration Management Plan – describes Developer approach and methods to manage configuration of system products and processes. Describes change control procedures and baseline management.

- Data Management Plan – describe how and which data will be controlled, method of documentation, and responsibilities. Describes control systems in place, company procedures, and recent practices on similar programs.
- Risk Management Plan – addresses risk identification, assessment, mitigation, and monitoring activities associated with development, test and evaluation requirements. Also addresses roles and responsibilities of all organizations.

For small, less complex projects, the configuration and data management plans could be combined. Other management plans that may be appropriate include: System Safety Plan, System Security Plan, and Resource Management Plan

A complete list of enabling content that the Developer should consider for these plans, which are applicable, follows:

- Statement of Work
- Work Breakdown Structure
- Activity Breakdown Structure
- Computerized Resource Tracking (Resources Loaded Network)
- Glossary of terms
- Schedule
- Technical milestones
- Project team organization
- Project control method
- Process models
- Management plans (configuration management, interface, risk, training, etc)
- List all deliverables
- Technical metrics
- Systems Engineering life cycle model
- Gate and exit criteria (decision points)
- Technical plans (integration, installation, etc.)
- System description
- Specification tree
- Trade studies

A final decision by the Transportation Agency project manager on selected documentation will occur with contract proposal approval. Plans, as they are completed during development, must be reviewed and approved by the Transportation Agency project manager.

3. SYSTEMS ENGINEERING PROCESS

How will the development be done?"

Systems Engineering Process will convey how the Developer executes the development of the system. The VEE life-cycle technical development model will be specified by the Transportation Agency in the *Draft Scope* to represent the overlying systems engineering process for analysis. See Figure 1. Other models may be used to supplement the analysis, e.g., the Spiral risk-mitigation model.

Systems Engineering Process will describe all tailoring of the systems engineering process requirements. Tailoring is the modification of any process requirements – managerial or technical. The details of this tailoring will be summarized in the *Scope* by the Developer and described in full in this Section. To further describe these tailoring activities, they are categorized as:

- System Requirements Analysis
- Sub-System (Functional) Analysis
- Design Synthesis
- System Analysis

System Requirements Analysis

Describes approach and methods for analyzing and defining the concept of operation and top-level system requirements. These evolve iteratively. The concept of operations approval results from peer reviews, working groups, scenario studies, simulation, and/or demonstrations, as necessary. Requirements are analyzed for development, deployment, verification, operations, support, and training.

Sub-System (Functional) Analysis

Describes approach and methods to allocate requirements to lower-level functions; defines functional interfaces; and defines the functional architecture. This is not practical during a proposal effort for each and every system requirement. This can be managed through the use of risk analysis, with high-risk requirements in terms of likelihood and severity being defined in some detail, while low-risk requirements are included in an overall general scope of analysis. For items defined in detail, the SEMP should include consideration of type of analysis, tools, schedule and budget constraints, and the completion criterion. From the systems engineering perspective, address the "illities".

Design Synthesis

Describe approach and methods to transform the functional architecture into a physical architecture; to define alternative system concepts; to define physical interfaces, and to select preferred product and process solutions. Also describe how requirements are transformed into detailed system design specifications.

System Analysis

Describe approach and methods to undertake trade-off studies, system/cost effectiveness analysis, and risk analysis. The results of these analyses should provide: (1) rigorous basis for technical decision-making, (2) quantifiable basis for decision-making ensuring that cost, schedule, and performance are addressed, and (3) support for risk strategy development and management.

Developers (systems managers and integrators) are accustomed to these processes and should be able to scale the tailoring for small, less complex, projects. Each process of the VEE technical model should be addressed, though, whether categorized as above or in another format.

As a part of the tailoring discussion, the Developer should explain the established relationship of the requirements from 23 CFR 940 with the tailored processes of the VEE technical model. The project implementation requirements specified in 23 CFR 940.11 are as follows: (See also Figure 2)

- Identification of portions of the Regional ITS Architecture being implemented or if a Regional ITS Architecture does not exist, the applicable portions of the National ITS Architecture,
- Identification of participating agencies and their roles and responsibilities,
- Requirements definitions,
- Analysis of alternative system configurations and technology options to meet requirements,
- Identification of applicable ITS standards and testing procedures, and
- Procedures and resources necessary for operation and management of the system.

4. Transitioning Critical Technologies

"How do I avoid obsolescence?"

This section describes key technologies, the approach for transitioning those technologies into the project system development, and their associated risk. This includes the activities and criteria for assessing and transitioning critical technologies from their development and demonstration programs into the project system development.

Transitioning critical technologies should be done as a part of the risk management. It is called separately here for special emphasis. Identify what technologies are critical and follow the steps outlined for risk management. This will establish which alternative and when an alternative is incorporated into the project to meet performance and functional requirements. As a separate section of the SEMP, reference to the work that will be done to address critical technologies will be incorporated here as a part of the proposal submittal.

The ability to evolve the technologies employed in a system hinges on several factors: knowledge of the technologies, knowledge of technology status (e.g., mature, leading edge, bleeding edge, etc.), and use of an open architecture strategy in the system design. A system design based upon an open architecture is necessary to be able to easily take advantage of newer and better technologies.

The result of this activity is to establish and maintain a viable technological baseline during project development.

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5. Integration of the Systems Engineering Effort

"How will the process activities be brought together to assure an operational system?"

This section describes the planned integration activities leading to final project implementation. In illustration, this Section concentrates on what is needed to climb the right side of the VEE methodology (See Figure 1).

Integration is planned for and supported from the early concept phase of the systems engineering process with the formation of multi-disciplinary teams, described below. Application of the schedules and integration technical plans described in *2. Technical Planning and Control* will be described here.

An integrated team approach is critical to successful integration of products and other inputs (e.g., test plans) into a coordinated systems engineering effort that meets cost, schedule, and performance objectives. The steps toward ultimate system implementation include:

- Multi-disciplinary team organization
- Technology verifications
- Development test and evaluation
- Implementation of software designs for system end items
- Operations & maintenance sustainability and user training development

Multi-disciplinary team organization

Teamwork is the key! Multi-disciplinary teams are an integrated set of cross-functional teams (an overall team comprised of many smaller teams) given the appropriate resources and charged with the responsibility to define, develop, produce, and support a product and/or service. A basic principle is to get all disciplines involved at the beginning of the development process to ensure that requirements are completely stated and understood for the full life cycle. By using multi-disciplinary teams, the systems engineers still lead the requirements development process, but now more (all) disciplines participate in it. This includes the software designers and software/hardware component integrators if contracted separately by the Transportation Agency.

The Developer will describe how their organizational structure will support team formation, the composition of functional and subsystem teams, and the products each subsystem and higher-level team will support (e.g., teams organized to support a specific product in the Work Breakdown Structure). This team approach will address assessment and review of progress, traceability of technical changes, integration of data, configuration management, and risk management. Depending on the complexity of the project, this can mean a hierarchy of teams to address product development, product integration, and umbrella system integration and program issues.

The multi-disciplinary teams are partnerships between the agency stakeholders, the Developer and any sub-contractors or other contractors, and key areas of experts. They should be end-item oriented. In other words team members must focus on the overall project performance as well as the performance of their particular team.

For small, less complex projects, the entire staff constitutes a single team. In such cases, tailor this section to reflect that there is only one team for the project. The Developer's organizational structure should be able to bring together representatives from all relevant disciplines to one or more teams for the duration of their need.

Technology verifications

Technology solutions are verified using design analysis, design simulation, inspection, demonstration, and/or test. Required performance of all critical characteristics is verified by demonstration and test. Design analysis and simulation are used to complement, not replace demonstration and test.

Development test and evaluation

After completion of the total system, a formal system verification review is held by the agency stakeholders. The purpose of this review is to demonstrate that the total system has been verified to be compliant with the requirements in the configuration baselines. System verification testing is conducted following completion of integration testing.

Operations & maintenance sustainability and user training development

Consideration should be given to ongoing support to an existing system, preplanned system improvement, evolutionary development, or to support the developed system after it has been fielded. Describe how system faults will be addressed, user requests for support, and the level of support and resources to be provided.

6. Applicable Documents

This section will identify all the applicable and referenced documents that are required for the specific project. Referenced documents are those standards, specifications, and technical documents that are external to the project statement of work.

List by title, version number, and issue date. The order of precedence and availability of the documents should be stated. For example:

- *EIA Standard 632, Processes for Engineering a System, Version 1.0, April 28, 1998.*
- *In the event of conflict between this document and the contents of the project SOW, SOW shall be considered a superseding requirement. The document is available for purchase on the Internet at http://www.global.ihs.com.*

This will include the list of documents from the Request for Proposal. Identify any contractual and noncontractual provisions. This includes any international or American national standards, and government and industry directive documents applicable to the conduct of the tasks within the SEMP.

When the rest of the SEMP has been completed, go back to this section and cross off the documents that are not referenced in your SEMP, and add any documents referenced in your SEMP that weren't already on the list.

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7. Notes

(Background Information, Acronyms, abbreviations, glossary)

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Exhibit 12-F
ITS WEBSITES

AASHTO:	http://www.aashto.org
ANSI:	http://www.ansi.org
ASTM:	http://www.astm.org/
CALTRANS:	http://www.dot.ca.gov/
CVISN:	http://www.jhuapl.edu/cvisn/index.html
FHWA:	http://www.fhwa.dot.gov
FRA:	http://www.fra.dot.gov/
FTA:	http://www.fta.dot.gov/index.html
IEEE:	http://www.ieee.org/index.html
ITE:	http://www.ite.org
ITS Conformity Rule	http://www.its.dot.gov/aconform/aconform.htm
ITS Integration Program	http://www.fhwa.dot.gov/discretionary/
ITS Standards:	http://www.its-standards.net
ITS Standards Training:	http://www.its-standards.net/train.htm
ITS Training Site:	http://www.pcb.its.dot.gov/
McTrans:	http://www-mctrans.ce.ufl.edu
NTCIP:	http://www.ntcip.org
National ITS Architecture:	http://www.iteris.com/itsarch
SAE:	http://www.sae.org/servlets/index
EDL:	http://www.its.dot.gov/welcome.htm
JPO:	http://www.its.dot.gov/home.htm
NHI:	http://nhi.fhwa.dot.gov/index.html

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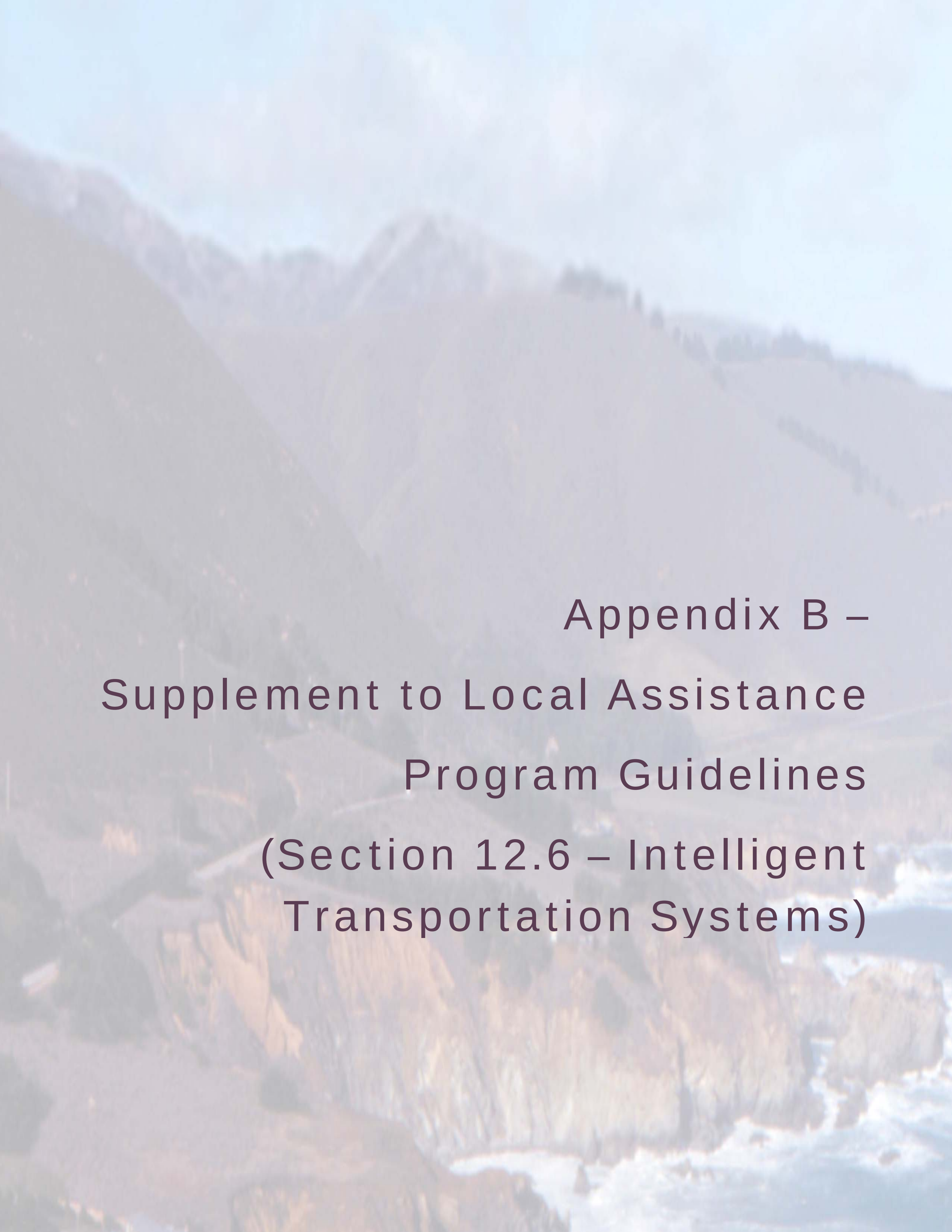

Appendix B –

Supplement to Local Assistance Program Guidelines

(Section 12.6 – Intelligent Transportation Systems)

Supplement to Local Assistance Program Guidelines - Chapter 12, Other Federal Programs Section 12.6 Intelligent Transportation Systems

OVERVIEW OF FEDERAL FUNDING AND OVERSIGHT OF ITS PROJECTS

Resources:

- The Caltrans Local Assistance process for ITS projects is described in the following document (1.3MB). Please note that Systems Engineering requirements are discussed beginning on page 12-31.
  http://www.dot.ca.gov/hq/LocalPrograms/lam/prog_g/g12othr.pdf

- A "Systems Engineering Guidebook for ITS" was first published in February 2005 by Caltrans and FHWA, updated as version 2.0 in January 2007. It is a valuable reference tool. The SE Guidebook is available as an interactive version on the web and can be accessed by clicking on the following link: http://www.fhwa.dot.gov/cadiv/segb.

- Systems Engineering Training Course - The S.E. Guidebook is being used in conjunction with an updated version of the UC Berkeley Tech Transfer course "Systems Engineering Fundamentals (TE-21)". If you are interested in taking this 2-day course, schedule and registration information can be found at http://www.techtransfer.berkeley.edu/training.

Background

Federal regulation 23 CFR 940 provides policies and procedures pertaining to conformance with the National ITS Architecture and Standards. Section 940.11 (Project Implementation) states that "all ITS projects be based on a systems engineering analysis." Section 940.13 (Project Administration) states that "Prior to authorization of highway trust funds for construction or implementation of ITS projects, compliance with Paragraph 940.11 shall be demonstrated."

Caltrans Local Assistance implemented new procedures to address the ITS program by local agencies in California in 2004. Local Assistance manuals and guidance were updated to include new procedures for identification, review, funding, and implementation of ITS projects by local agencies. Highlights of changes within the new procedures are the following:

- ITS projects are defined as two types – minor and major. Minor ITS projects involve the design and installation of ITS field devices expanding and/or upgrading existing systems, which add no new capabilities or interfaces. Minor ITS projects are more often referred to as *ITS Infrastructure Expansion* projects. Major ITS projects include multi-jurisdictional or multi-modal system implementations. These projects involve software development and/or software/hardware integration. Major ITS projects are more often referred to as *ITS System* developments.

  Experience in implementing the 2004 Local Assistance guidance has resulted in an additional type of ITS project that needs clarification. ITS projects that are "exempt" are not covered under the Local Assistance ITS Guidelines and the process discussion within this document does not apply. *Exempt* ITS projects are the following:

  - Routine maintenance and operation of existing systems.
  - Signal re-timing projects that do not implement any new hardware or software
  - Studies, analyses, or plans that do not implement any new hardware or software
  - Installation of traffic signals at isolated intersections

The first three bullets highlight the fact that NO new hardware or software is being implemented to provide a transportation service. The last bullet takes into account that there is no current integration potential nor likely opportunity for integration in the future because of the isolation of the location.

- Planning TIP Listing of ITS Projects – delineates operational improvements from the rest of the capital program. This gives FHWA ITS Engineers opportunity to make pre-authorization outreach visits to project sponsors to assess degree of education, technical assistance, and oversight that will be needed before the project reaches its funding year. This can reduces risk of project failure.

- Preliminary Engineering (PE) Approval Steps – An additional Preliminary Engineering funding step has been added for ITS system developments. In addition to the traditional PE step to allow initial project development, FHWA gives funding authority to perform design and deployment of hardware/software systems at completion of system definition phase.

- Systems Engineering Review Form (SERF) – this fill-in form provides responses to the seven requirements for systems engineering analysis within 23 CFR 940(11). It documents conformance with 23 CFR 940 for ITS infrastructure expansion/upgrade of existing systems. For those new system developments, the SERF does not document conformance - it simply highlights expectations in application of the systems engineering process by the project sponsor and/or their contractor in later phases of the project development.

- Systems Engineering Management Plan (SEMP) – completed in early phases of system development to serve as part of the Project Management Plan, the SEMP identifies the "best professional practices" to manage and undertake the technical tasks. For new systems (new functionality), conformance to 23 CFR 940 is supported within the completed System Engineering Management Plan, submitted to FHWA for approval at completion of system definition and before actual design and implementation begins. This approval releases remaining PE funds to complete the system implementation. Any infrastructure within the field (on the street) needed to complement the hardware/software system development will undergo the traditional PE and Construction approval processes.

Initial Action for all ITS projects

Either before or soon after initial Preliminary Engineering funding is authorized, the sponsor agency submits the completed Field Review Form package to the Caltrans District Local Assistance Engineer. The completed Field Review package includes an ITS Systems Engineering Review Form (SERF). In the SERF, the sponsor agency must provide as much information as possible for each of the following ITS requirements,

1. Identification of portions of the RA being implemented.
2. Identification of participating agencies roles and responsibilities.
3. Requirements definitions.
4. Analysis of alternative system configurations and technology options to meet requirements.
5. Procurement options.
6. Identification of applicable ITS standards and testing procedures.
7. Procedures and resources necessary for operations and management of the system.

The determination of Major and Minor ITS projects is delegated to the local agency. If a Minor ITS project (ITS Infrastructure) the SERF documents conformance with 23 CFR 940. No further ITS review or approval actions are necessary in this case. If a Major ITS Project (ITS system development), the SERF is submitted to FHWA for review and determination of level of federal oversight of the systems engineering process to be undertaken.

FHWA Oversight for "Major" ITS Projects - How It Works

The following information defines the FHWA oversight of the Systems Engineering process while the project is being executed, as is required by Caltrans Local Assistance Procedures. Please note that ***this S.E. oversight is limited to the ITS portions of the project only***. General oversight for all other aspects of the federal-aid process will continue to be handled by the field operations engineers in the FHWA California Division Office.

This section describes how the ITS oversight process works, in general. Although it is not a "requirement," FHWA strongly encourage the use of the Caltrans/FHWA "*Systems Engineering Guidebook for ITS"* as a reference for organizing the ITS project tasks and defining work products. The terminology used in this discussion is defined fully in that Guidebook.

The FHWA oversight process is built upon the common SE practice of using "control gates" as a project-management tool. It assumes that implementation of the ITS project (or the ITS elements of a larger construction project) will follow a pre-determined sequence of steps, with each step (or "milestone") being judged by the project manager to be satisfactorily completed before substantive work begins on the next step.

FHWA will exercise its oversight responsibilities primarily via review of the document(s) produced at each of the milestones in the SE process (e.g. Concept of Operations, Acceptance Tests, etc.). They will do this in a manner that avoids unnecessary delays to the project. The action at each step will take ONE of the following forms: a.) Review and approval, b.) Review and comment, or c.) Information only. These terms are explained below. This determination of level of oversight will be made at time of SERF review, which occurs before SE process tasks have begun.

- Review and Approval - FHWA shall receive the final version of the milestone document for review and approval. They will respond within one week -- whenever given at least two weeks advanced notice of the document's arrival. Otherwise, turnaround time will be two to three weeks. If they do not respond within the applicable time period the document is automatically deemed approved.

- Review and Comment - FHWA shall participate in the normal review process that the agency uses at the "final draft" stage of developing the milestone document. They will abide by the same schedule that is given to all other reviewers. If they do not provide comments within the given schedule, project work may proceed without them. Their comments will be treated as suggestions that will be given the same consideration as comments from other stakeholders.

- Information Only - Upon completion of the milestone, the project manager shall email the associated document to FHWA. No "approval" by FHWA will be needed. Upon emailing the document, the project may begin the next task immediately.

Regardless of the level of oversight determined for each SE process milestone deliverable, the completed Systems Engineering Management Plan (SEMP) must always be submitted to FHWA for review and approval at completion of the system definition tasks. This approval will authorize Caltrans Local Assistance to obligate preliminary engineering funding for system design and implementation. Specific SEMP development and documentation guidance can be found in the Caltrans/FHWA "*Systems Engineering Guidebook for ITS"*.

To expedite FHWA review process, they recommend that these documents be sent via email to FHWA simultaneously with distribution to Caltrans and/or other stakeholders involved in the project development. Paper copies are ***not*** required, unless the materials cannot be sent electronically.