CALTRANS – DIVISION OF TRAFFIC OPERATIONS

EXAMPLE - TECHNICAL AGREEMENT PROPOSAL – PROJECT SELECTION THROUGH AMS

CONNECTED CORRIDORS

I-210 PILOT IMPLEMENTATION – PROJECT MANAGEMENT, OUTREACH, SYSTEM ENGINEERING, AND AMS (ANALYSIS, MODELING, AND SIMULATION)

Proposed By:

PARTNERS FOR ADVANCED TRANSPORTATION TECHNOLOGY

HOW TO USE THIS DOCUMENT

Over the last 30 years, the California Department of Transportation (Caltrans) has partnered with California PATH (Partners for Advanced Transportation Technology) on numerous transportation and technology projects.

This latest effort, Connected Corridors, is an integral component of Caltrans' plan to shift its focus from capacity building to transportation system management and operations (TSMO). Connected Corridors seeks to utilize new information and communications technologies to bring together vehicles, infrastructure, and people. Known traffic management strategies, such as ramp metering and signal synchronization will be combined with innovative practices including better integrated intermodal operations, real-time decision support systems, and dynamic traffic-responsive route guidance.

The Connected Corridors program is starting with a Pilot located on the I-210 corridor in Los Angeles County. The I-210 Pilot is focused on improving corridor level transportation system operations and management, specifically during incidents and events. Since 2013, Caltrans and PATH have actively engaged local stakeholders including LA Metro, LA County, and the cities of Pasadena, Arcadia, Duarte, and Monrovia.

In addition to implementing transportation management for the I-210 corridor, another crucial goal for the I-210 Pilot is creating document templates and software tools for other corridors and districts to use. To achieve this goal, the Connected Corridors team has invested a significant amount of time into documenting our process and making this information available to Caltrans Districts and other interested parties.

We have created this ICM Proposal Example as an example for other Districts and parties to review the tasks that we have found critical from the start of the Pilot through implementation. The ICM Technical Agreement found in this example is an excerpt from a proposal prepared by PATH for the Connected Corridors Program. This ICM Proposal Example has been broken into two parts for easier use. Part 1 includes Tracks A through D which covers project management, outreach, systems engineering, and AMS (analysis, modeling, and simulation). The amount of AMS the I-210 Pilot team did was more detailed than may be required for your project. Please note this as a potential difference for your project. Part 2 includes two additional tracks, Tracks E and F, which cover integration and deployment and operational support.

When beginning a TSMO project, we recommend you consider the following steps:

- **Needs Assessment** – Complete an inventory of the corridor or project area. What assets does the corridor have? Who are the key stakeholders? What are the key systems and transportation components? What is the corridor missing? What are the issues most impacting the transportation system? The I-210 Pilot team considered multiple corridors before settling on the I-210 corridor. In addition to strong stakeholder relationships in the region, LA Metro was in the process of extending one of their light rail lines through the area. Frequent incidents causing congestion, supportive stakeholders, and multiple adjacent arterials made the I-210 corridor standout to the project team.
- **Project Management** – Strong project management is required to work with the numerous vendors and stakeholders involved. Project Champions are also critical to support the mission of the project and share their excitement with the team. Management of an ICM implementation is a full time job. It includes both standard project management activities and leadership. The Project Manager is the person who is ultimately responsible for maintaining and growing the vision, nurturing the enthusiasm of the project champions, coordinating the funding, ensuring the right resources are available, managing stakeholder relationships, and doing whatever needs to be done to ensure the project is delivered. The challenge here

is to find a person who understands their role with Caltrans, who understands that while Caltrans may be funding and leading the effort, they are new to this type of cooperative leadership, are often unable to assign a full time project manager on their side, and are currently experiencing a large number of retirements. These realities require that the PM be willing to engage in forthright conversations that are not always comfortable. This is also true with the vendors and consultants who are an integral and required part of the success of the project. Thus, the selected PM should be a person/organization willing to take risks to ensure the success of the project, provide a long-term commitment, and in cooperation with Caltrans, truly assume the leadership mantle.

- **Project Planning/Concept of Operations** – Prepare the Systems Engineering Management Plan and a high-level Concept of Operations with input from stakeholders to serve as the foundation for the project. Start building a stakeholder team and develop a project vision with clear objectives that all stakeholders can support. Develop a Project Charter early in the planning process and ensure stakeholders buy-in to the project's vision and level of effort required of them. The Concept of Operations should include the information learned from the needs assessment, as well as the project's vision and objectives. Funding may still be unknown, so project specifics may be somewhat lacking. The more stakeholders you can involve at this point, the better. The I-210 Pilot's Project Charter was signed by eleven agencies, with the primary purpose of getting them involved for the development of the Pilot. Ultimately, the MOU will be signed by only the stakeholders that have equipment connected to the ICM system, about seven agencies for the I-210 Pilot.
- **Apply for Funding** – Use the high-level concept of operations and your stakeholder team to apply for local, regional, state and/or federal funding. Caltrans supported the I-210 Pilot with SHOPP funding, in addition to applying for regional and federal grants. Caltrans was awarded funding from LA Metro, a key project stakeholder, for the arterial improvements. The management of this local funding by Caltrans was precedent setting and showed Caltrans commitment to the stakeholders and the I-210 Pilot's success.
- **AMS** – Analysis, Modeling, and Simulation is needed to ensure the success of the project. Early on, AMS uses the initial corridor inventory to determine what new ITS elements are needed and on which routes these elements will be installed. Later on, AMS helps with the development of response plans and assessing the benefits after launch. A significant amount of time continues to be spent on improving and refining the I-210 corridor model. The model is being used to develop response plans, signal timing changes and other possible improvements. Once deployed, the model will continue to play a vital role in the recommendation of new response plans and in justifying further corridor improvements.
- **System Definition** – Refine the Concept of Operations document and develop the System Requirements, and High-level system architecture. Obtain stakeholder input at every step and begin to pursue a Memorandum of Understanding for system integration and operations. Caltrans and PATH held numerous meetings with stakeholders to develop the system requirements including specific job skills and tasks that were determined necessary to operate and maintain the system. Many of these job skills were new to Caltrans. Having the system requirements early in the process gives everyone time to allocate the necessary resources, including staffing to meet those requirements. The MOU process often requires educating additional stakeholders about the project and refining everyone's agreed upon roles and responsibilities. Project leaders need to find the balance between starting the process early, but having enough of the details of the system and operations to execute a meaningful MOU.
- **System Design and Development** – Understand the components of your system implementation. Utilize the documentation and software available from the I-210 Pilot. The I-210 Pilot software systems were developed specifically to be reused in new corridors. The decision to use the Cloud, build standardized TMDD based center to center communications software, develop a reusable data hub and decision

support system, and to prequalify Kapsch, Parsons, and Telegra as suitable vendors was made so that future TSMO projects could be implemented faster and more efficiently.

- **System Integration** – Test the system components as they are developed. As systems are acquired and tested, integrate them to prepare for launch. Revise requirements and design documents as needed. Extensive testing was completed for every new or upgraded system within the I-210 Pilot architecture to ensure a successful launch. Successfully integrating the stakeholders' systems to better respond to incidents as a unified team is the core purpose of the I-210 Pilot.
- **Deployment** – Begin operating the system in the live environment. Continue to work with the stakeholder team to identify issues and resolve problems quickly. Evaluate the systems performance and modify as necessary. We are preparing to launch the I-210 Pilot and plan to devote ongoing resources to continual improvement of the system.

The above summary is a very condensed version of the Systems Engineering process and the steps the Connected Corridors team considers to be very important. The Connected Corridors website (https://connected-corridors.berkeley.edu/) contains a wealth of information related to the Systems Engineering process and all of the SE documents we've generated thus far for the I-210 Pilot. We encourage other districts and agencies to review our process and use it as a guide.

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WORK PLAN

The Connected Corridors project's work plan is divided up into six tracks. Each track corresponds to a major theme of the Connected Corridors program and is comprised of a collection of work packages. The work packages are the basic project units that will result in major deliverables.

The first four project tracks have been included in Part 1 of this proposal example. The remaining two tracks are in Part 2.

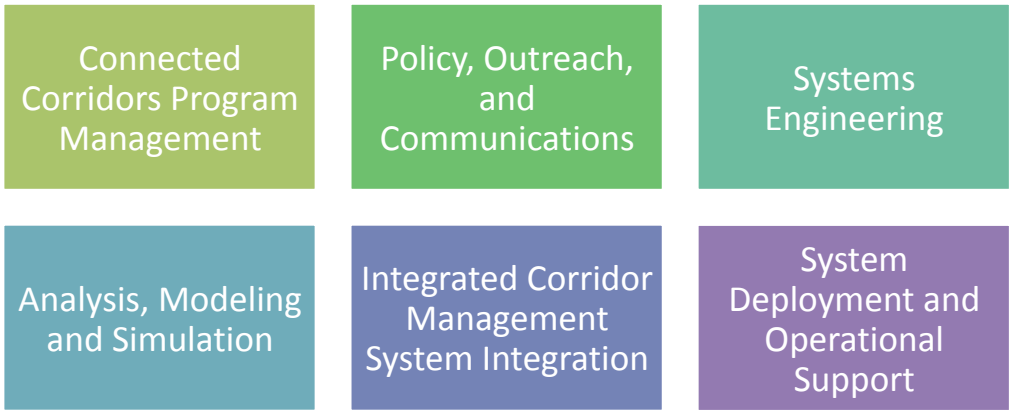

Figure 1 - The Six Tracks of the Connected Corridors Project

The project tracks this example document includes are:

A. Connected Corridors Program Management: Planning, coordination and reporting activities that will take place as part of the project and support the Connected Corridors Program including additional program-level tasks through which the project team will support Caltrans' Division of Traffic Operations
B. Policy, Outreach, and Communications: – Ensuring the coordination and cooperation among the many project stakeholders. Coordinating and monitoring stakeholder meetings, communications, information exchanges, etc. The establishment and maintenance of inter-agency agreements and understandings. The management of web sites and other information management and communication functions. The coordination of fund requests.
C. System Engineering: The development and maintenance of system engineering documents including Requirements, High Level Design, Technical Design, Validation and System Operations.
D. Analysis, Modeling and Simulation: Ongoing analysis of the 210 Corridor in order to determine the best interventions to be used to improve traffic during an incident. This includes the collection of data, the building and running of traffic models and the analysis of intervention results

TRACK A - CONNECTED CORRIDORS PROGRAM MANAGEMENT

Track A encompasses project activities that will support the development of the Connected Corridors program as a statewide effort focused on the deployment of Integrated Corridor Management. It includes two work packages:

A1. Project Management: This work package includes planning, coordination, and reporting activities that will take place as part of the project.
A2. Assistance to Caltrans' Division of Traffic Operations: This work package includes additional program-level tasks focused on supporting Caltrans' Division of Traffic Operations.

PROJECT MANAGEMENT

As a large, multi-track project, the Connected Corridors Pilot will require a substantial amount of planning, coordination among project sub-teams, guidance of outside stakeholders and frequent reporting to Caltrans. Additionally, because of the high public visibility, the project will require communication and coordination with media outlets.

This work package is comprised of the following two tasks:

1) Project planning and coordination
2) Project reporting

PROJECT PLANNING AND COORDINATION

This task will include both the day to day management of the Connected Corridors Program, as well as the long term planning and strategic leadership needed to ensure enduring success. Specific activities include:

1. Strategic Leadership –
    - Long Term Decision Making: All decisions should be made with an eye toward the effects two to three years in the future. Proper relationships will be developed with stakeholders, vendors, and other partners so that their support and capabilities are available when needed.
    - Risk Management- The identification of long term risks and the development of mitigation plans.
2. Budget Management - On a project of this size it is important to pay close attention to the budget, budget projections and the proper classification of expenditures.
3. Human Resource Management - The project cannot succeed without hiring the proper personnel. It can take many months to find, hire, and train employees. These employees must also be managed so that they stay with the program and employee turnover is held to a manageable level.

Deliverables:

1. **Strategic plans and long term schedules**
2. **Up to date and accurate budgets and budget predications**
3. **An organization chart matching the needs of the program**

PROJECT REPORTING

This task will include the development of written monthly progress and budget reports that will be provided to Caltrans, the setting up of regular meetings between the project's leadership and the Connected Corridor's stakeholders, and the preparation of additional updates deemed necessary by Caltrans management.

Deliverables:

The various reports the team will submit to Caltrans will (1) enable the team to effectively monitor progress and respond appropriately to change and (2) enable Caltrans to effectively ensure that the project is proceeding in a manner consistent with its strategic objectives.

ASSISTANCE TO CALTRANS DIVISION OF OPERATIONS

Given the scope of the Connected Corridors program, there are technical and policy questions that underlie its implementation, as well as many stakeholders that need to be consulted, or in some cases brought on board with the vision of Connected Corridors. Additionally, as the Connected Corridors Pilot results are fanned out to other sites in California, site visits and educational interactions will be needed.

This work package is comprised of the following two tasks described in further details below: (1) Support of Caltrans internal requests and (2) Support with requests related to future Connected Corridor's sites.

SUPPORT OF CALTRANS' INTERNAL REQUESTS

In this task, key investigators on the project team will be available as needed to work with Caltrans to develop reports, provide briefings or make presentations. For example, Caltrans may require a study of other ICM sites or ask for advice on purchasing data as part of the ICM statewide effort.

Deliverables:

1. **Ad hoc written briefings and reports, as required by Caltrans;**
2. **Ad hoc meetings with Caltrans officials, teleconferences etc. and**
3. **Ad hoc workshops or briefing meetings held with Caltrans or on behalf of Caltrans.**

SUPPORT WITH CALTRANS' REQUESTS RELATED TO FUTURE CONNECTED CORRIDOR'S SITES

In this task, key investigators on the project team will be available as needed to work with personnel from future Connected Corridor's sites. Experience has shown us that new sites will likely require several site visits and assistance with using our web resources and tools.

Deliverables:

1. *Ad hoc* meetings and presentations with new corridor stakeholders
2. *Ad hoc* information sharing sessions
3. *Ad hoc* tool demonstration sessions

TRACK B - POLICY, OUTREACH AND COMMUNICATIONS

The success of the Connected Corridors program and the I-210 Pilot are highly dependent upon effective, strategic, timely, and clear communications strategies and materials. Track B includes activities that build upon and enhance the outreach and communications that have taken place since the inception of Connected Corridors. It also includes policy research and reporting on specific topics; weighing-in on important programs, projects, research, and/or funding applications; and providing analysis in writing or verbally in response to specific questions. Communication strategies with Caltrans and the project stakeholders will be continually evaluated and addressed.

The Policy, Outreach, and Communications goals include:

- Building awareness of Connected Corridors and the I-210 Pilot
- Providing information in multiple formats to clearly articulate the who, what, where, when, and why of the program
- Promoting Connected Corridors and Caltrans' focus on system operations and corridor management throughout the state
- Engaging all stakeholders and keeping them educated and informed (as well as producing supplemental materials)
- Generating support
- Obtaining positive media coverage
- Providing meaningful and timely research on topics identified by Caltrans and/or the stakeholders
- Keeping abreast of policy, legal, and/or institutional issues that may affect Connected Corridors or the I-210 Pilot

There are five work packages in this Task:

1. Stakeholder Communications and Coordination – This work package aims to keep new and future stakeholders informed about the project through various means.
2. Stakeholder Agreements – This work package will ensure that all of the project stakeholders are in agreement on the project scope, roles and responsibilities, timeline, etc. for the I-210 Pilot.
3. Public/Media Relations – This work task will garner public/media relations support and publications for the I-210 Pilot.
4. Policy Research and Reporting – The purpose of this work task is to provide policy research on activities related to corridors, Integrated Corridor Management, and the I-210 Pilot and to report in writing or verbally on findings.
5. Funding Applications – This work task will provide information, recommendations, and coordination on funding applications, with the ultimate goal of securing additional funding for the project.

STAKEHOLDER COMMUNICATIONS AND COORDINATION

This work package aims to provide information; coordinate communications and meetings; and furnish knowledge to the existing stakeholders, additional stakeholders, Connected Corridors team, and Caltrans regarding Integrated Corridor

Management, Connected Corridors, the I-210 Pilot, and future corridors in the state. The tasks associated with this package include:

- Connected Corridors Website – Keeping the Connected Corridors website updated and relevant
- Connected Corridors Documentation – Keeping the Connected Corridors Documentation website up-to-date and leading to the preparing of the Final Report on the I-210 Pilot
- Stakeholder Communications – Informing, educating, and advising regarding the I-210 Pilot and Connected Corridors

CONNECTED CORRIDORS WEBSITE

The Connected Corridors website is the primary communications medium for Connected Corridors and the I-210 Pilot. It will be continually updated with new information about corridors in the U.S. and abroad, Integrated Corridor Management, webinars, publications, conference presentations, etc. The goal is to have the Connected Corridors website be the "go to" place for information on Integrated Corridor Management and related topics. Additionally, since the Connected Corridors program will contribute significantly to the knowledge base regarding advanced methods to achieve optimal corridor operations and performance, the website will ensure that Caltrans' investments are widely disseminated and documented.

Deliverable:

1. **The first key deliverable in this work package is the ongoing updating and management of the ***Connected Corridors website***, and monthly "Digest" postings (the "Digest" is a compendium of articles, research papers, conference information, newsletters, etc. related to ICM, corridors, and other closely-related topics).

CONNECTED CORRIDORS DOCUMENTATION

The Connected Corridors Documentation website ("CCDocs") contains all of the project information and documentation. It will continually be updated throughout the I-210 Pilot. The information in the CCDocs website will de facto become the project's Final Report and organized to make it useful, replicable, and relevant to Caltrans and other project sponsors.

Deliverable:

1. **The second key deliverable in this work package is the ongoing updating and management of the ***Connected Corridors Documentation*** website ("CCDocs"). CCDocs is the repository for all ongoing information (outreach, technical, research, reporting, etc.) for the I-210 Pilot.

**Since the preparation of this proposal, the Connected Corridors website and CCDocs sites have been merged. The content still covers the areas listed in the deliverables including the technical and reporting elements of the Pilot.

STAKEHOLDER COMMUNICATIONS

Stakeholder communications will inform, coordinate, and monitor the information distribution to the project stakeholders (including current and prospective stakeholders). This task also includes working with yet-to-be-determined committees such as a Technical Advisory Committee and/or a Policy Advisory Committee.

Deliverables:

1. The organization and management of multiple stakeholder communication efforts including monthly update meetings in Los Angeles, and the continued development and distribution of fliers and Fact Sheets to be used at conferences and for general information.
2. Plan and implement weekly conference calls with the project team.
3. Produce the "Connected" stakeholder newsletter and consider other publications for stakeholders and/or other audiences (such as the general public, elected officials, etc.).
4. Schedule meetings with the I-210 Pilot stakeholders including the City staff and City Councils, San Gabriel Valley Council of Governments, South Coast Air Quality Management District, Metro Board, SCAG Board, transit agency field supervisors, etc. Meet with adjacent cities, Phase 2 jurisdictions, and/or future corridor stakeholders as required.
5. As the project develops and matures, plan and organize various committees such as the Technical Advisory Committee and the Policy Advisory Committee.
6. Identify additional project stakeholders and partners, including community and non-profit associations and other government agencies and private companies.

STAKEHOLDER AGREEMENTS

Stakeholder agreements are the "glue" that hold the project together. Starting with more general agreements such as the Project Charter (where all stakeholders agree to the project purpose, goals, objectives, boundaries, coordination, staff support, basic roles and responsibilities, etc.) to more formal legal agreements, such as a Cooperative Agreement (which will define substantial programmatic involvement and coordination) or a Memorandum of Understanding (which will specify mutually agreed-upon expectations and will include more formal, legally-binding language), the agreements are key to keeping the I-210 Pilot moving forward and all stakeholders informed. Specific activities related to this work package include:

- Produce Agreements – Writing, editing, distributing, and executing the project agreements.
- Other Related Tasks – Activities related to the Risk Management Plan and the Risk Register; and implementing training programs and materials.

PRODUCE AGREEMENTS

This task involves researching the type of agreement(s) to recommend to the stakeholders, meeting with the appropriate staff to ensure the documents are ultimately reviewed and executed, and coordinating meetings or workshops to provide information to the stakeholders regarding the agreement(s).

Deliverables:

1. ***Produce agreements*** such as the Project Charter, Memorandum(s) of Understanding, Cooperative Agreements, etc.
2. Meet with stakeholder legal staff on legally-binding documents to receive comments and answer questions early in the process, and to ultimately receive buy-in.
3. Ensure timely review of the Agreements by the stakeholders; coordinate final approval and signature by the appropriate parties; and distribute final, executed documents to the stakeholders.
4. Coordinate workshops and/or meetings to review project agreements and to answer questions; and to discuss specific topics such as scenarios and response plans.

OTHER RELATED TASKS

The other work in this task includes monitoring and following-up on the Risk Management Plan and the Risk Register and preparing training programs and materials for the stakeholders and others (including training materials for the implementation and follow-up on the I-210 Pilot).

Deliverables:

1. Monitor the Risk Management Plan and the activities in the Risk Register including the responsible party, the risk trigger, and risk follow up.
2. Design, develop, and implement training programs and materials.

PUBLIC/MEDIA RELATIONS

The Public/Media Relations component of Task B includes the distribution of information in order to earn and confirm the media, the stakeholders', and the public's understanding of Connected Corridors and the I-210 Pilot. Both the specific audience and the message will be targeted, relevant, and consistent so as to garner continued support and momentum for the project. Specific tasks include:

- Develop a Public/Media Relations Timeline – In coordination with Caltrans and the stakeholders, writing, editing, and producing a public/media relations timeline and associated documents.
- Oversee other Media Coordination, Publications, and Press and Media Events – Researching and coordinating other media and press activities.

DEVELOP A PUBLIC/MEDIA RELATIONS TIMELINE

A short- and long-range public/media relations strategy and timeline (with responsible parties and tasks) will be developed for the I-210 Pilot and for the Connected Corridors program, and appropriate media outlets will be identified.

Deliverable:

1. Investigate and outline a ***public/media relations strategy and timeline*** for the next two years to five years; research the Top 20 media outlets for Connected Corridors and the I-210 Pilot.

OVERSEE OTHER MEDIA COORDINATION, PUBLICATIONS, AND OTHER PRESS/MEDIA EVENTS

In this task, media, public relations, and press/media events will be researched, coordinated with the project sponsors/partners, written, and published.

Deliverables:

1. Research the use of social media for the project and make recommendations regarding launching social media outlets such as Facebook and/or Twitter.
2. Coordinate with Caltrans Headquarters and District Public Relations on press events and printed materials; plan and carry out media events.
3. Continue to follow media updates on the project via newspapers, conference proceedings, etc.
4. Coordinate press releases and/or media advisories on project milestones and highlights such as successful funding applications, research, demos, etc.
5. Review industry and trade publications for article ideas and obtain submittal details; coordinate writing, publishing, and follow-up on articles.
6. Determine the need for a speaker's bureau and members of the team to speak on behalf of Connected Corridors and/or the I-210 Pilot; prepare speaking points and coordinate speaking engagements.

POLICY RESEARCH AND REPORTING

In this task, the staff will contribute information, analysis, and research on policy issues and activities that may affect Connected Corridors, the I-210 Pilot, Caltrans, or the stakeholders. Policy information, analysis, or research will lead to making informed decisions, the identification of different alternatives, and the selection of an alternative that is best for the program. The deliverables in this task will assist the project team in meeting the project's goals.

Deliverables:

1. Monitor the political environment in the I-210 Pilot project area for changes, risks, and factors that may affect Connected Corridors or the Pilot; report to Caltrans and/or the stakeholders; mitigate the risks to the degree possible.
2. Contribute to the Risk Register and monitoring the project risks.
3. Ad hoc written or verbal briefings or reports to Caltrans, stakeholders, or others.
4. Ad hoc workshops, meetings, and teleconferences with Caltrans, stakeholders, or others.

FUNDING APPLICATIONS

Ongoing funding is a key component of the Connected Corridors program and the I-210 Pilot. It is also the #1 Risk for the project (lack of ongoing funding, shortfalls in funding, etc.). Therefore, information on potential local, regional, State, or Federal funding programs is a critical success factor. The work tasks are:

- Identify and Recommend Funding Opportunities – Research and recommend grant and/or other funding opportunities for the I-210 Pilot.
- Grant Writing Coordination – Coordinate the writing, editing, production, and submittal of grants and funding applications.

IDENTIFY AND RECOMMEND FUNDING OPPORTUNITIES

This task involves research into appropriate and available funding sources, gathering information on the grant/funding source, and preparing a strategy for applying for and securing the funding.

Deliverable:

1. Research and recommend ***funding opportunities*** for Connected Corridors and/or the I-210 Pilot.

GRANT WRITING COORDINATION

Ensure that the writing, editing, and production of grant/funding applications is coordinated and timely.

Deliverables:

1. Coordinate grant writing, review, and final production of funding applications.
2. Monitor funding agency progress on selecting projects; answer questions.
3. Announce successful funding applications to the media.

TRACK C - SYSTEMS ENGINEERING

Regardless of whether the Connected Corridors Pilot receives federal funding or not, its implementation will adhere to systems engineering principles. In addition to making the project eligible for federal funds, following a system engineering approach has been demonstrated to reduce risks associated with a project's schedule and costs.

Systems engineering is a set of management tools designed to handle complex, interdisciplinary technical projects. System engineering focuses on defining customer needs and required functionality early in the development cycle of a product, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem at hand. The goal is to integrate all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Both the business and the technical needs of all customers are considered, with the goal of providing a quality product that meets the user needs.

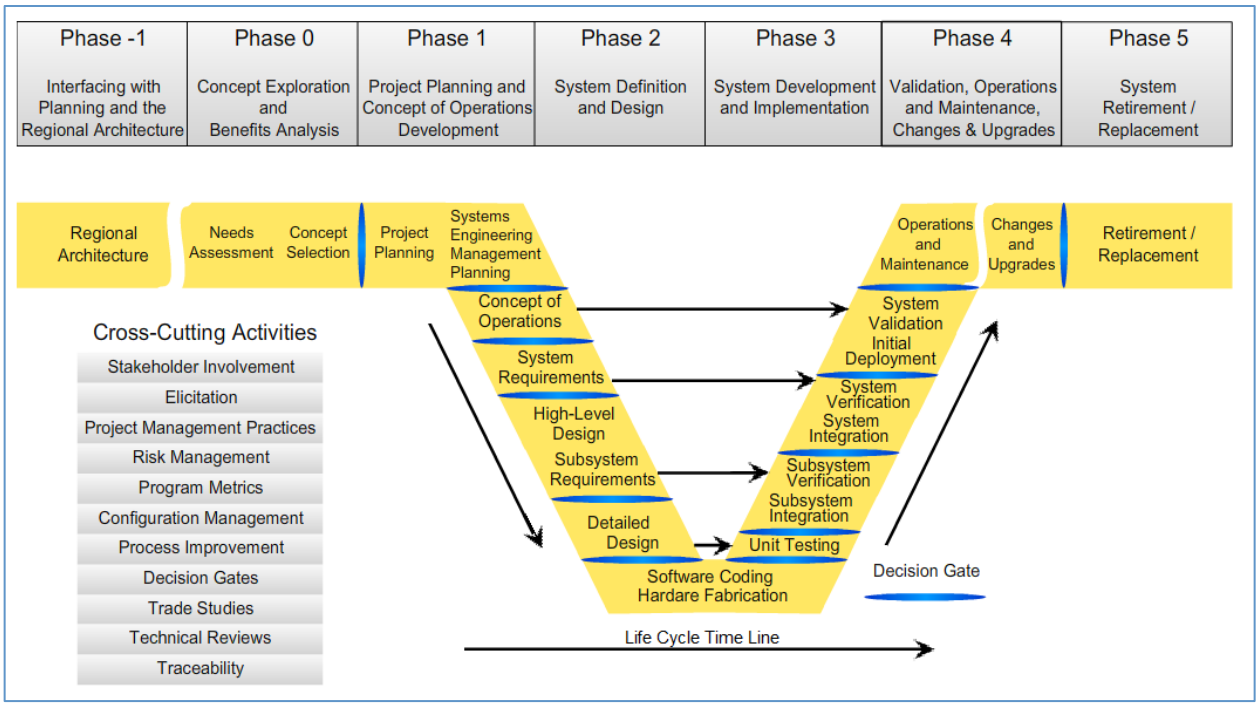

Figure 2 – Vee Diagram from FHWA's System Engineering Guidebook for ITS Projects, Version 3.0

Figure 10 presents the so-called "Vee" diagram from FHWA' Systems Engineering Guidebook for ITS projects. The sequence of processes illustrated in the diagram assumes that an all-inclusive approach is followed and that all elements of the illustrated process are strictly adhered. While adherence to the illustrated process is generally sought, some minor deviations are generally accepted for large, complex projects when such modifications would strengthen project processes and outcomes. The primary rationale behind the system engineering approach is to provide a path promoting successful project outcomes, not a framework that should be blindly applied.

The Connected Corridors Pilot implementation will follow, to the extent practical, the system engineering approach. This effort is to result, at a minimum, in the development of the following key documents:

- A **Project Management Plan** (PMP) documenting how the project will be conducted.
- A **Risk Registry** identifying the potential risks to the project, their potential impact, who are responsible for the individual risks, and potential mitigation strategies.
- A **Systems Engineering Management Plan** (SEMP) that will describe how systems engineering will be used throughout the project, and states the methods and standards to be employed.
- A **Concept of Operations** (ConOps) providing a comprehensive view of the Connected Corridors Pilot operations with a particular focus on the interactions between users, stakeholders and information systems.
- **System Requirements Specifications** listing all of the subsystems and components to be developed or integrated along with their functional and performance specifications.
- **Design Documents** describing how the system is to be built based upon the identified system requirements.
- A **Deployment Plan** outlining how the proposed system is to be deployed along the I-210 corridor.
- **Verification Documents** describing activities to be carried out to ensure that the system being built meets the specified requirements.
- **Validation Documents** describing activities to be carried out to ensure the developed system meets the intended purpose and needs of its stakeholders.
- An **Operations and Maintenance Plan** that focuses on the roles and responsibilities of project stakeholders once the Connected Corridors Pilot is up and running.

A needs assessment was conducted early in the project through various early discussions with potential corridor stakeholders. Following an agreement on the need to develop the ICM system to help address the management of incidents and events, and the subsequent selection of the I-210 corridor for the deployment of the Pilot ICM system, a Project Management Plan was completed in June 2014, and a Concept of Operations in early 2015. Project activities in late 2014 and early 2015 also led to the development of several key elements of a SEMP for the project.

Track C of the project plan lists activities that will be carried out to continue the application of system engineering principles to the project. This track includes the following three work packages:

B1. Maintenance of Existing System Engineering Documents: This work package groups various activities that may be conducted to update, if necessary, the system engineering documents that have already been developed (Project Management Plan, System Engineering Management Plan, and Concept of Operations) to reflect changes introduced by corridor stakeholders to the system to be developed.

B2. Application of System Engineering Principles: This work package groups project activities that will result in the development of design documents describing the system to be developed and plans outlining how the proposed system is to be deployed, validated, verified, and eventually operated. Specific activities associated with this package include development of the following items:
   - System Requirements: Activities leading to the collaborative development, by all corridor stakeholders, of system requirements for the ICM system to be developed.
   - Design Specifications: Activities leading to the design of system components and functionalities based on the identified system requirements.
   - System Deployment Plan: Development of a plan for deploying and activating system components along the I-210 corridor.
   - System Verification and Acceptance Plan: Development of tests and procedures that will be used during the system deployment phase to verify that developed system components meet the identified requirements.
   - System Validation Plan: Development of criteria to verify that the developed system meets its intended purpose and the needs of corridor stakeholders.
   - System Operations and Maintenance Procedures: Development of operational procedures and manuals supporting the post-launch operations of the ICM system.

B3. System Engineering Knowledge Transfer: Activities aiming to provide corridor stakeholders basic knowledge of how system engineering concepts were applied to the development of the ICM system.

MAINTENANCE OF EXISTING SYSTEM ENGINEERING DOCUMENTS

While the system engineering Vee diagram calls for a straightforward process to develop various documents, constraints uncovered or decisions made later in a project can affect earlier system design decisions. When such changes occur, various documents may need to be updated to reflect the changes so that the documents remain a true representation of the project. Activities associated with this track are primarily concerned with ensuring that all documents that have been developed to support the system engineering track remain up to date. This may include periodic revisions to the Project Management Plan (PMP), Risk Registry, Concept of Operations, System Engineering Management Plan (SEMP), and any other already developed relevant documents. In all cases, the proposed revisions to the system engineering documents will be subject to review/approval process by all relevant corridor stakeholders.

Deliverables:

1. Update to the ***Project Management Plan (PMP)***
2. Update to the ***Risk Registry***
3. Update to the ***Concept of Operations (ConOps)***
4. Update to the ***System Engineering Management Plan (SEMP)***

APPLICATION OF SYSTEM ENGINEERING PRINCIPLES

This work package focuses on the collaborative development by corridor stakeholders of documents defining the ICM system to be deployed along the I-210 corridor and indicating how this system is to be verified, validated, and operated. While this team will be responsible for writing the documents, corridor stakeholders will be asked to contribute to the development of the content of various documents. Stakeholders will also be asked to review/approve the documents that will be developed.

Key groups of documents to be developed as part of this work package are described below. They include:

- System requirements
- System design specifications
- System deployment plan
- System verification and validation plans
- System operations and maintenance procedures

SYSTEM REQUIREMENTS

System requirements describe what the system is to do, and how well it is to perform under defined conditions. They do not define how the system is to be built, but rather what must be considered when designing the system. A key input to this process will be the Concept of Operations approved by corridor stakeholders, and more particularly the user needs identified within the document. Various other elements may also influence the process, such as the need to follow specific standards, applicable statutes, regulations, and policies; constraints imposed by required legacy system interfaces, hardware/software platforms, etc. The development of system requirements will also require active participation from all the corridor stakeholders to ensure that all stakeholder needs, requirements and constraints are adequately addressed. Final system requirements will further be subject to formal approval by all corridor stakeholders.

Deliverable:

1. ***Draft System Requirements*** for the I-210 Pilot
2. ***Stakeholder-approved System Requirements*** for the I-210 Pilot

DESIGN SPECIFICATIONS

Design specifications describe how the system is to be built. They take the requirements (what the system will do) and translate them into a hardware, software and organizational designs that can be built. The purpose of these specifications is to:

- Provide a documented description of the design of the system that can be reviewed and approved by the stakeholders
- Provide a description of the system in enough detail that its component parts can be procured and built
- Provide a description of the hardware, software, and organizational system components in sufficient detail for them to be maintained and upgraded

For most projects, two levels of design specification are developed: a high-level design specification and a detailed, design specification. The high-level design specifications support the project architecture, interfaces, and sub-system requirements, while the detailed specifications provide the build-to specification for software, hardware and organization construction.

As part of the development of design specifications, a Component Integration Plan, outlining how the various system components are to be brought together into a coherent system, will be written.

Deliverables:

1. ***Draft Design specifications*** for the I-210 Pilot
2. ***Stakeholder-approved Design Specifications*** for the I-210 Pilot
3. ***Component Integration Plan***

SYSTEM DEPLOYMENT PLAN

Following the development of the system specifications and an integration plan, a plan indicating how the resulting system is to be deployed. This deployment plan will be developed based on a thorough analysis of the steps necessary to achieve the deployment goals of the project. It will both serve to justify the strategy for deployment and to inform deployment participants and system stakeholders of what will happen and what they will be required to do.

Deliverables:

1. ***Draft Deployment Plan*** for the I-210 Pilot
2. ***Stakeholder-approved Deployment Plan*** for the I-210 Pilot

SYSTEM VERIFICATION AND ACCEPTANCE PLAN

Verification is the process that proves that the developed system meets its requirements and matches the design specifications. It seeks to answer whether the system was built right. A critical issue in this process is assuring that all requirements are verified by testing activities. This is best done by first tracing each requirement into a test case and then, into a step in the verification procedure.

Verification plans are best written at the same time system requirements are developed. This allows showing that the system requirements can be verified as written. While general plans indicating how system components may be verified can be drafted early in the system design process, the development of specific verification procedures detailing the steps to be taken to verify each requirement and design element typically occurs at the end of the design effort.

System verification includes system acceptance. System acceptance occurs when the system is installed and ready for operations. It involves verifying that a certain set of system capabilities function successfully before turning the system over to its intended customers. Activities leading to system acceptance by corridor stakeholders will therefore be defined as part of the system verification plan.

Deliverables:

1. ***Draft I-210 Pilot ICM System Verification and Acceptance Plan***

SYSTEM VALIDATION PLAN

The System Validation Plan will define the activities to be conducted to ensure that the developed system meets its intended purpose and the needs of the corridor stakeholders. This is different from system verification activities. Verification activities seek to confirm that a system meets its specified requirements. Validation confirms that the system fulfills its intended use. While the majority of system verifications can be performed before a system is deployed, validation cannot be completed until a system has been launched and is being used by its real customers.

The Validation Plan will lay out the overall expectations for the assessment of the completed system. However, the validation plan will not impose strict step-by-step validation procedures. It will instead let the system users work the system as part of their every day job and define how they will want to determine how the system satisfies their needs. Reporting the results and any corrective actions needed will be part of this effort.

Deliverables:

1. ***Draft I-210 Pilot ICM System Validation Plan***
2. ***Stakeholder-approved ICM System Validation Plan***
3. ***Draft I-210 Pilot ICM Validation Report***
4. ***Stakeholder-approved I-210 Pilot ICM Validation Report***

SYSTEM OPERATIONS AND MAINTENANCE PROCEDURES

An Operations and Maintenance Plan for the I-210 ICM system will be developed as part of the project. This plan will describe how the finished system will be operated and maintained. It will be developed incrementally during system implementation, and subsequently subject to revisions as needed during on-going system operations.

In addition to the Operations and Maintenance plan, operating and maintenance manuals will be developed for the system components to be developed by the university. This will include manuals for the overall system. These documents will describe detailed procedures to be followed, whereas the Operations and Maintenance Plan will describe resource

organization, responsibilities, policies, and general procedures. As an example, a plan may state that the system administrator will ensure that databases are backed up daily, but the operation and maintenance manual will describe how to do the backup.

Deliverables:

1. ***I-210 Pilot ICM System Operations and Maintenance Plan***
2. ***I-210 Pilot ICM System Operations and Maintenance Manual***

SYSTEM ENGINEERING KNOWLEDGE TRANSFER

Over the course of the Connected Corridors Pilot, the project team will collectively accumulate a large body of knowledge related to the application of system engineering principle to support the development, design, implementation and evaluation of ICM systems in complex urban environments. This expertise will not only be developed from the team's own activities on the I-210 Pilot project, but also from information and advice received from other agencies who have ventured into similar projects and from consulting firms who have contributed to the development of ICM systems.

This work package will ensure proper gathering and dissemination of this knowledge to corridor stakeholders. Key activities associated with this package include the organization of information sessions with interested participants from Caltrans and possible other agencies and the development of various presentation material.

Deliverables:

1. ***Ad-hoc briefings***, as required

TRACK D - ANALYSIS MODELING AND SIMULATION

AMS (Analysis, Modeling and Simulation) is an essential component of Corridor Management. It involves collecting data about the corridor, building traffic models, and performing simulations with the resulting models to determine the best responses to incidents and events. Phase 1 of the AMS function was completed during the first ICM contract. Phase 1 involved a study of the corridor to provide an estimate of the savings in travel time expected through adjustments to the ramp metering rates and traffic signal control plans, as well as some degree of traffic rerouting. This study was coarse in nature. It scaled up several example incidents to corridor-wide improvement estimates. The AMS work continues in this proposal, moving from example incidents to corridor-wide simulations, with the aim of improving our cost benefit analysis and providing better data for selecting traffic management strategies.

Track D includes the following work packages:

B1. Data Collection
   - Static and Point in Time Data Collection
   - Dynamic/Real Time Data Collection

B2. Corridor Model Development

- Corridor Model Creation – Development of a model of the corridor incorporating the I-210 freeway, surrounding arterials, and relevant transit services
- Corridor Model Calibration – Calibration of the developed model to allow it to provide accurate results when used with actual corridor data
- Simulation Model Improvements – Identification and documentation of improvements to be made to the model based on experience gained with the utilization of the model

B3. Strategies Development –

- Strategy Creation - Review of corridor assets and political agreements that may be used to determine the best strategies to consider for responding to different types of incidents or events
- Rules Determination – Working with stakeholders to determine special situations that affect the application of strategies. For example, certain routes may not be useable during student arrival and departure time from schools
- Simulation of Strategies – Simulation of the identified strategies under different traffic conditions to assess their effectiveness
- Strategy Recommendations – Based on results from the simulation of strategies, identification of the best strategies that should be recommended for consideration by the DSS system during an incident

B4. Incident Response Evaluation

- Evaluation of strategy use – Review of impacts of given strategies to provide insight and improvements in dealing with future incidents
- Updating of strategies – Identification of improvements to be made to the identified strategies, as well as the Corridor Model, to improve their outcome and overall corridor operations

DATA COLLECTION

Multiple types of data must be collected in order to perform needed evaluations. This data can be categorized into:

- **Static data** (networks, sensors, controllers, etc.), typically used to build analytical and simulation models.
- **Point-in-time data** (measurements made infrequently), typically used to calibrate a model.
- **Dynamic data** (or real time), typically used to tune a model, determine when incidents occur, provide estimations of current state for model predictions and to perform evaluations of model results.

STATIC AND POINT IN TIME DATA COLLECTION

For the collection of static and point-in-time data, the project needs to define and maintain:

1) *The state of the network* – Information characterizing roadways, arterials and transit routes. This include data identifying the number of lanes, HCM operational characteristics, frequency of passage of buses or trains, etc.
2) *Sensor information* – Information characterizing the type, location, cabinet location, frequency of data reporting and data formats
3) *Ramp meter information* – information characterizing the type, location, cabinet location, frequency of data reporting, and data formats.
4) *Ramp meter plan information* – Information detailing the ramp meter plans and when each plan is typically used
5) *Signal information* – Information characterizing the type, location, cabinet location, frequency of data reporting, and data formats
6) *Signal Plan information* - Details of the signal plans and when they are used by default. For adaptive signals, this also include information about the algorithms used to adjust the signal timings to observed traffic demand.

7) *Unavailable Traffic Counts* – Counts of traffic not available from sensors, including through and left hand turns at intersections
8) *CMS/Wayfinder signs* – Information about the type of signs being used, their location, permissible messages, etc.
9) *Travel Time Sensors* – Information about type of sensors used, their location, the frequency of data reporting, and data formats
10) *Transit information* – Information about bus and train routes, transit stops, average ridership, on time performance, passenger counts, etc.
11) Any other types of information that may be identified as necessary to support system operations

Sourcing this data, gathering it, and ensuring that it is placed in the Connected Corridors database is a complex task as the data is controlled by multiple jurisdictions, and stored in various formats. The data must also be kept up to date. While subsequent tasks are concerned with understanding exactly how the data will be transferred to and from the static data elements, this task must ensure that the data are supplied in usable formats, that the availability of the data is appropriate, and that the accuracy and quality of the data acceptable. Depending on collected data, additional data may need to be measured by the project team in the field to address identified gaps. This task will be shared with the following task on System Integration (see Part 2), which will also, in a broader context define data, data formats and missing data needs.

Deliverables:

1. A ***Connected Corridors Corridor Pilot Data Assessment Report*** summarizes the static data needed and its sourcing
2. A ***Connected Corridors Pilot Data Repository*** filled with needed data
3. Arranging for and managing the collection of missing data from corridor stakeholders or hired contractors

In addition to guiding the team's activities in relation to the Pilot, these deliverables will be a valuable resource for other corridor stakeholders.

DYNAMIC/REAL TIME DATA COLLECTION

One of the objectives of the Connected Corridors program will be to bring data "online" as much as possible. In other words, a key legacy of the program should be to shift from the current practice that separates transportation operations from performance evaluation into an integrated approach in which data is collected and analyzed on an ongoing basis.

To accomplish the above goal, the project needs to define and maintain the following information:

1) Items that might modify basic network characteristics, such as planned lane closures
2) Working status of highway loop detectors
3) Highway loop detector count data
4) Working status of arterial loop detectors
5) Arterial loop detector count data
6) Working status of ramp meters
7) Ramp metering plans available
8) Ramp metering plan currently in operation
9) Working status of signals
10) Signal timing plans available
11) Signal timing plan currently selected
12) Real time transit information that is available which is to be determined
13) Working status of CMS signs
14) Current message on CMS signs

15) Travel time data
16) Third party data that may support project activities – This is yet to be determined but may include probe counts and estimated speeds

Sourcing the above data, gathering it, and ensuring that it is placed in the Connected Corridors database **in real time** will be a challenging task. As indicated in the previous work package, we must ensure that the data formats are correct, that there is an appropriate availability of data, and that data accuracy and quality is acceptable. In this case, however, this data must be supplied electronically and cannot be collected by project members in the field. As with static data, this task will be shared with the System Integration task.

Deliverables:

1. A ***Connected Corridors Corridor Pilot Real Time Data Assessment Report*** summarizing the dynamic data required
2. A plan for obtaining real time data feeds

CORRIDOR MODEL DEVELOPMENT

This work package will serve the critical function of creating and calibrating a Corridor model of the I-210 corridor that will be used to:

1) Test out Traffic Management Strategies through simulations runs using static or point in time data
2) Support real time decision making in the decision support system

Before going any further, a note is required on terminology:

1) The set of generic algorithms used to simulate traffic behavior is called a **Simulation Logic**. In this context the Connected Corridors program currently envisions using a macroscopic, data driven simulation model for our efforts. We are also considering using a mesoscopic data driven simulation model for our arterial network. However, this may change as we refine our requirements. Note: We ended up using a microscopic model (Aimsun).
2) The difference between **macroscopic**, **mesoscopic,** and **microscopic** models is in the level of details associated with the modeling. Macroscopic models simulate traffic behavior by processing aggregate flow parameters, such as flow rate, flow density, and speed to estimate travel times along roadway links and queues at the downstream end of a link. Microscopic models model in details the behavior of individual vehicles. Mesoscopic models fall between macroscopic and microscopic models. In **macroscopic-based mesoscopic models**, the consideration of aggregate flow parameters is retained, but links are divided into a series of small cells to refine the spatial representation of traffic behavior. In **microscopic-based mesoscopic models**, the modeling of individual vehicles is retained, but a simplified logic is used to simulate vehicle behavior along a link.
3) A simulation model is comprised of two key elements: **a simulation logic** and a **road network model**. The simulation logic includes the algorithms used to replicate driver or vehicle behavior. The network modeling contains the representation of roads and control devices present within the road network. Since the I-210 network model includes both freeways and arterials, it is referred herein as the **I-210 Corridor Model**.
4) When a base corridor model is slightly modified to test out alternative controls, traffic demands, or geometric layouts, these variations on the base corridor model are referred to as **Scenarios**.
5) Scenarios can include several types of modification to a simulation model. Modifications altering traffic control elements (ramp meters, signal lights, routing signs) referred to as **Traffic Management Strategies.** Modifications

altering the travel demand placed on a network are referred to as **Travel Demand Strategies**, while modifications altering the geometry of the road network are referred to as **Network Geometry Strategies.**

6) The execution of a Simulation Model on a Corridor Model or one of its variants is called **Running a Simulation**, a **Simulation Run,** or simply a **Simulation**.
7) The output of running a simulation is referred to as **Simulation results/output** or **Model results/output**. We will use simulation results in this document.

Confusingly one can say "We are going to use our model as input to our evaluation models and review the model results. We will try to avoid these sentences in this document.

While this task is principally concerned with the creation of a Corridor Model, it is envisioned that as we run simulations we will need to make modifications to the Simulation Logic and the Calibration tools. Although making these modifications is principally the responsibility of the Decision Support System task, the AMS effort will need to provide the specifications for these changes.

The subtasks within this task are:

1. Corridor Model Creation – A corridor model of the highway, arterial and transit corridor must be built and maintained.
2. Corridor Model Calibration – The corridor model must be calibrated so that it provides accurate results.
3. Documentation of Model Improvements - It is likely that areas for improvement in simulation logic and calibration tools will be identified. These improvements will be documented.

COORIDOR MODEL CREATION

The creation of a corridor model requires the following elements to be specified:

1) *Network geometry* – Information characterizing the geometry of roadway elements, such as link length, number of lanes, lane widths, lane assignments, location of intersections and ramps, etc.
2) *Location and type of traffic sensors* – Information about what type of sensors are used (loop, video, etc.), where individual sensors are located along arterials relative to intersections, on the freeway mainline, on freeway on-ramps and off-ramps, and on freeway-to-freeway connectors.
3) *Signal controls* – Information regarding the type of controllers used for the operation of traffic signals and ramp meters, signal timing plans used at individual intersections, ramp metering tables or algorithms used on specific freeway on-ramps and connectors, etc.
4) Information regarding any other devices that need to be coded into the model.

This data must be entered into the database in a format suitable for the simulation model to use it in performing simulation runs. This is a detailed task requiring on-site and satellite view validation.

Deliverable:

1. A ***model*** of the I-210 corridor containing a geographical representation of transportation systems and representations of devices used to control traffic

COORIDOR MODEL CALIBRATION

The corridor models that will be developed as part of this project will require calibration. This will involve the five following steps:

1) Utilizing calibration algorithms based on static and point-in-time data to generate initial values for:
    a. Fundamental Diagrams
    b. Turn percentages (split ratios) at network junctions (intersections, ramps, etc)
    c. Demand profiles at network boundaries
    d. Note: These steps were different for our microsimulation model
2) Running the simulations using the roughly calibrated corridor model, reviewing the results against actual corridor conditions, and using engineering judgment to determine the various coded parameters and algorithms should be adjusted to produce a better fit to observed data
3) Implementing into the model the identified adjustments
4) Rerunning the simulation using the updated calibration data
5) Iterating steps 2, 3, and 4 until the simulation results adequately reflect traffic state on the corridor

Deliverable:

1. A ***calibrated model*** of the I-210 corridor

A calibrated corridor model is an essential tool for testing different traffic management strategies and scenarios in a risk-free environment. Without such a tool, it will not be possible to make credible evaluations of the impacts of proposed changes on corridor operations.

DOCUMENTATION OF IDENTIFIED SIMULATION MODEL IMPROVEMENT NEEDS

There are many tools needed to build, calibrate, and run our corridor model. These include:

1) Gather data
2) Create networks
3) Add sensors
4) Add controllers and their associated plans
5) Specify split ratios, and fundamental diagrams
6) Visualization and results generation tools

It is a certainty that areas for improvement in usability and in basic functionality will be identified. These will be documented and provided to the proper personnel for prioritization in the building of the Decision Support System.

Deliverable:

1. Documents specifying the improvements or missing functionality needed in the simulation model

STRATEGIES DEVELOPMENT

Parallel to the development of the simulation model, work will start on determining a set of transportation management strategies, based on the corridor's existing operational capabilities, that will be used to address typical incidents and events that have been observed to occur on the I-210. The development of strategies will significantly rely on previous work that has been conducted by the research team to characterize current operational conditions within the corridor, such as the location of freeway bottlenecks, available capacity at signalized intersections, roadway segments with a high frequency of incidents, etc. Wherever possible, strategies will be evaluated and fine-tuned through simulation before being vetted by relevant corridor or project stakeholders.

The specific subtasks associated with this task are:

1) Strategy Creation – Creation of multiple candidate strategies to improve traffic during incidents.
2) Rules Determination – Working with stakeholders to determine special situations that affect the application of strategies. For example, certain routes may not be useable during student arrival and departure time from schools.
3) Strategy Simulation – Use of simulation to assess the operational performance and impacts on traffic of the individual strategies created in step 1.
4) Strategy Selection – Selection of the most suitable strategies to help address incidents and events that should later be promoted to corridor stakeholders based on results of the operational evaluations.

STRATEGY CREATION

The first task will consist in outlining a basic operations plan outside of simulation. This exercise will rely on the collective expertise of the project team, identified existing conditions on the pilot corridor, and discussions with corridor stakeholders. It will result in a set of recommended high-level strategies that may include, among other things, adaptive ramp metering, coordinated traffic signal operations, modified transit operations, and active traffic management signage.

It is envisioned that stakeholders will impose constraints on the various strategies (restrictions on whether some roads may be used, when some routes may be used, what types of vehicles may be allowed along a given road, etc.). These constraints, as well as standard practices for interacting with police and fire, will be taken into account during this phase of strategy determination.

Deliverable:

1. A set of recommended strategies for refinement through simulation. These will be documented in the Analysis, Modeling and Simulation Report

RULES DETERMINATION

There are two sets of rules that must be created. The first is when to apply certain strategies. For example: Use a certain reroute strategy when an incident occurs in Pasadena. A different strategy may be used if the incident occurs on the freeway in Arcadia. These are high level rules that affect the choice of strategies that the DSS will simulate in order to determine the optimum incident response actions.

The second type of rule involves small changes to strategies based on time of day, location of incident, temporary constraints, etc. The example provided from SANDAG was that a certain road could not be used during certain hours because it ran by a school.

Both sets of rules will be agreed upon with stakeholders and entered into the rules engine which is part of the Decision Support System

Deliverables:

1. A setoff agreed upon rules
2. Those rules entered into the rules engine

STRATEGIES SIMULATION

This task will consist of evaluating and fine-tuning the strategies identified in the previous subtask using the simulation model developed in earlier tasks. This will involve translating the recommended strategies into simulation scenarios and then running these scenarios through the simulation model. Results will be noted for analysis in the next subtask. At this point, it is planned to use overall delay, either defined on a person or vehicle basis, as the basic comparison metric. Other metrics may be added as per stakeholder request.

Team members will apply their respective expertise to analyze results and incrementally refine individual strategies while also paying special attention to the interrelations between those strategies so that the final plan reflects a truly integrative approach. The recommendation process will involve communicating on an ongoing basis with stakeholders in the Pilot system to ensure that all their views and needs are properly included.

Deliverable:

1. A 'strategies' chapter in the Analysis, Modeling and Simulation report which will include recommendations with regard to each specific traffic management strategy that could be implemented based on stakeholder views and feedback
2. Description of the scenarios used to test the strategies

STRATEGIES SELECTION

This task will consist in determining the strategies that performed best in simulation, and then reviewing these with stakeholders. These strategies will be reviewed in detail to raise the confidence of stakeholders that they will perform well on the ground once implemented (as opposed to within the simulation only).

Considerable stakeholder involvement will be required during this phase as the result is a signed agreement that these strategies can be applied during an incident in their jurisdictions.

Deliverable:

1. A set of strategies, agreed to by stakeholders, for use during an incident on the I-210. These will be documented in the AMS report
2. Letters of agreement from the stakeholders agreeing to the use of these strategies

These are key deliverables for the Connected Corridors program, summarizing a small number of possible integrated traffic management strategies for a range of realistic traffic situations. Being based upon the best available data in the corridor, the document will be a reliable basis for traffic management decisions.

INCIDENT RESPONSE EVALUATION

The focus of this task is to evaluate how well proposed incident response strategies fulfill their intended goal. This will involve reviewing the results of simulation runs and reviewing these results against actual data gathered during an incident. This work will lead the project team to identify recommendations for potential improvements to the strategies and/or the corridor model.

Specific subtasks within this task include:

1) Analysis of strategy application – Review of the results of the application of proposed strategies within the corridor model to provide insight and improvements in dealing with future incidents.
2) Updating of strategies – Identification of improvements to be made to the reviewed strategy and/or Corridor Model to improve results or the realism of evaluations.

EVALUATION OF STRATEGY USE

The goal of Connected Corridors program is to bring performance based management to California transportation corridors. Thus the performance of traffic management strategies will be measured and evaluated after each incident. The evaluation will be conducted in partnership with Caltrans and other corridor stakeholders. The results will be used in the next subtask to provide continuous improvement to the management of traffic in the corridor.

Deliverables: An analysis of incidents where a traffic management strategy was deployed. These will be provided as appendixes to the AMS Report.

This deliverable will ensure that the team communicates effectively with Caltrans and other stakeholders on how the new systems are working in practice. More importantly, it will enable systematic consideration of further developments and hopefully achieve consensus on the way forward.

UPDATING OF STRATEGIES

It is likely that evaluations of actual performance results from strategy implementations will lead to suggestions for improvements in the strategies, the manner in which the strategies are applied, and to the Corridor Model so that it can improve its fidelity in simulating traffic management in the corridor.

Deliverables:

1. Updated strategies (Both the description and the actual scenario used in the simulation model)
2. Where appropriate, changes to the corridor model to reflect new information learned from the analysis of the strategy application