

## How to Manage an Incident: Response Plans

A package is thrown from a car on the I-210 corridor in LA County. It lands near the Gold Line transit tracks. It could be a bomb or worse. The authorities shut down the I-210 and the Gold Line transit service, bringing transportation to a standstill at 9:00 on a Monday morning. Can this type of situation occur? It did, on Monday, December 7, 2016. Regrettably, the Connected Corridors program had not yet been launched, and there was no way for a fully coordinated traffic management response plan to be put in place to safely route travelers around the scene and reduce the chaos that resulted on city streets.

Understanding how the I-210 stakeholders can most effectively respond to serious traffic incidents is what the Connected Corridors program is all about. Over two years ago, the stakeholders began focusing on designing corridor-wide response plans for incidents such as these. What should a response plan do? What ITS infrastructure is needed to implement the response plans? How do we decide—in real time—which response plan to use? What approval mechanisms are needed and how do we know when to end a response plan?

Step one in the definition of response plans was the identification of approximately 300 preliminary alternate routes within the corridor. This list went through several iterations to refine the number of options and match them with available ITS element resources. The list is now at approximately 60 alternate routes for both the east

and west directions. The 2015 Call for Projects funding approved by Metro and Caltrans SHOPP project funds are being used to purchase and install the traffic signals, traffic sensors, and the necessary changeable message signs needed to guide travelers along the designated alternate routes.

A response plan is not limited to just a traffic reroute. Signal and metering light timing changes, equipment and personnel requests, and communication plans could also be deployed as a part of a response plan. Stakeholders are currently defining all of these response plan components and when and where they will be used. Rules are being developed in the form of: “If an event occurs at location X, do Y and notify Z.” These rules will be processed by a rules engine, which will evaluate many rules and determine the best response plans.

The rules engine must support a complex set of conditions to account for the complexity of incidents, considering factors such as time of day, day of the week, expected duration, location of the incident, and possible issues with alternate routes such as an active school zone. A response plan can also be scaled depending on the severity and length of the incident. For example, if two lanes of the freeway are expected to be closed for one hour, that would warrant a different response plan than if the two lanes were expected to be closed for ten hours or if the closure were to occur at 3am versus 3pm.

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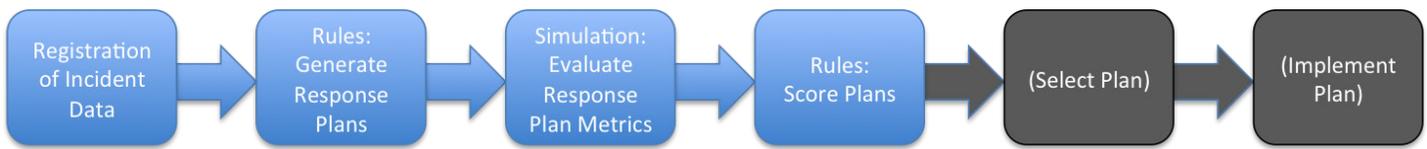
The beginning stages of identifying possible alternate routes to be used in the response plans

## ● Response Plans, continued from page 1

So how will a response plan get deployed? First, an incident must be identified and characterized with information such as its location, severity, and anticipated clearance time. Most of the time this will likely be done by Caltrans TMC operators, as they monitor the corridor 24/7. This information will then be passed to the Decision Support System (DSS) which will use the rules engine to suggest one or more response plans. Simulation models will then be used by the DSS to rank the possible response plans based on how much improvement each is likely to provide. Depending on the situation, the top response plan could then be automatically implemented or reviewed

by transportation management staff who could either implement, modify, or reject the response plan. This process will take approximately 10 minutes from start to finish.

The team continues to make steady progress on development of the DSS, the rules engine, the corridor simulation models, the rules themselves, and the exact processes to be used in deploying a response plan. Stakeholders, motivated by the I-210 incident mentioned at the beginning of the article, continue to work together to complete the development of the response plans and the installation of the ITS elements needed to implement them.



Real-time role of the rules engine

## Q & A with Brian Simi

*In this fifth installment of the Question and Answer series, we spoke with Brian Simi to discuss his new role at Caltrans District 7.*

***Tell us a little bit about your current role at Caltrans District 7.***

I am currently the Acting System Management Principal in the District 7 Traffic Operations Division. I oversee five offices which includes three Corridor Management Traffic Engineering offices, the District Traffic Management office, and the System Performance office. My role is to assist the district with the organizational transition to better focus on corridor management. Leveraging work previously completed by consultants, I will be working with staff to determine the new organizational structure and roles and responsibilities that will accompany each new office and branch. My goal is to implement the vision of our Deputy District Director of Operations, Ali Zaghari, of taking a holistic approach to looking at the corridor to avoid artificial boundaries and traditional stovepipe mentality and working with our local partners to provide improved mobility and safety for our customers.

***You were at Caltrans Headquarters prior to coming to District 7. Can you tell us a little bit about what HQ is doing to support the districts and the implementation of Connected Corridors?***

I spent about two years as the Transportation Systems Winter 2016

Performance Manager prior to my temporary assignment here in District 7. One of the focuses from HQ is to encourage and support the implementation of TSM&O (Transportation Systems Management and Operations) strategies. Our Division Chief, Tom Hallenbeck, is committed to the success of Connected Corridors in District 7 and throughout the State. He is championing the revision of the TSM&O Directors policy that will codify the role of TSM&O and TSM&O strategies such as ICM. Several offices in HQ support the CC effort in a number of ways. Nick Compin's Office of Strategic Development is leading the charge by focusing on TSM&O policy and championing it through executive management. They also provide the District with needed assistance, including consultant support for developing the framework for Connected Corridors or Integrated Corridor Management in the 25 priority corridors identified in the State. As system technology is the cornerstone of the CC implementation, the Office of Technology, led by Stan Slavin, is partnering with the Caltrans IT department to keep management and technical staff engaged on issues that arise. Our IT partners also play a key role in communication with external control agencies, helping to reduce deployment schedule risks.

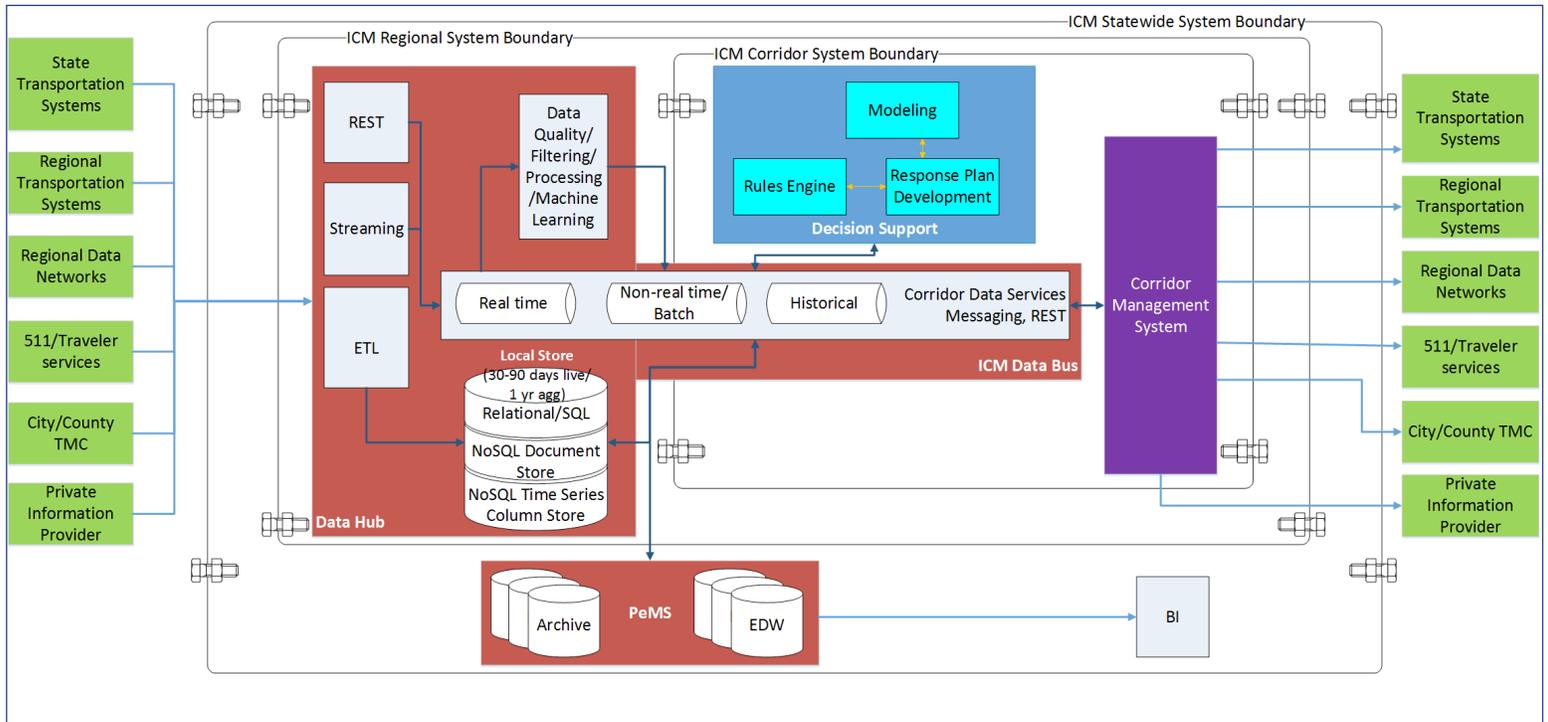
○ **Continued on page 6**

# High-Level Design of the Proposed ICM Architecture

Over the last several months, the Connected Corridors development team, along with Caltrans, has been refining the high-level design for the ICM Core System. This system comprises the majority of the IT infrastructure for the I-210 Pilot, including the data hub, decision support system, and corridor management system. The ICM Core System architecture provides a system design with the following attributes:

- Cloud-based design for flexibility, on-demand

- scalability, redundancy, and lower deployment and operational costs
- Multiple database technologies for optimized performance
- Separate data management, decision support, and control functions for configurability
- State, regional, and local layer design with flexibility for future scaling to other corridors



**Figure 3: ICM Core System High-Level Design**

**Field elements:** The green elements in Figure 3 represent the various corridor field data sources and field element controls, including various state, regional, and local transportation systems, regional transportation data networks, and private information providers. On the left side of the diagram, these elements represent the various data sources for information input and processing by the ICM system. On the right side, these represent the various control interfaces to execute response plan elements selected by operators of the ICM system.

**Data Hub:** Represented in red in Figure 3, the data hub is a key component of the system, with multiple input channels (REST, Streaming, and ETL--Extract, Transform, & Load) based on the type and characterization of the data being received; high-speed, high-volume computing platforms; and multiple data

storage technologies optimized for the type and usage of the data being stored. The primary functions of the data hub are:

- Receive field data from local and regional providers
- Process, analyze, and verify quality of received data
- Data messaging and communications within the system
- Data storage
- Data security

**Decision Support:** The decision support system, portrayed in blue in Figure 3, provides:

- Corridor traffic state determination
- Corridor traffic state prediction
- Response plan development and evaluation

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## ● System Architecture, continued from page 3

**Corridor Management:** The corridor management system, portrayed in purple, is expected to be a commercial, off-the-shelf component that provides the following:

- Primary user interface
- Corridor and asset state visualization, control, and management
- Response plan lifecycle management including:
  - Initiation
  - Development
  - Evaluation
  - Selection
  - Modification
  - Approval
  - Execution
  - Monitoring
  - Close
  - Post-incident/event analysis
- ICM System management
  - Rules configuration and management
  - Response plan configuration and management

- System monitoring
- Security
- System configuration

The design of this system is based on experience the Connected Corridors development team has had developing the modeling components of the decision support system. The modeling system is a similar decoupled design based on single-purpose services connected by messaging technology. It is fully based in an Amazon cloud environment, using multiple database technologies optimized for the type of data being processed. The modeling system is currently running a continuous freeway estimation for the I-210 corridor in a test environment. Data hub construction (red) will begin in early 2017, and market research is currently being conducted for a proof of concept of the corridor management component (purple). For more information on the architecture, please contact Program Manager Joe Butler at [joebutler@path.berkeley.edu](mailto:joebutler@path.berkeley.edu).

## Other Noteworthy News

- The I-210 Pilot software design envisions that the functionality in the purple box (Corridor Management System) in Figure 3 on page 3 will be provided by a COTS (Commercial Off The Shelf) software interfaced with the Data Hub (red box). PATH will be soliciting proposals from vendors who would like to participate in a proof of concept where they will install their software for review and use during the Pilot. The results of the Pilot will be used to update and refine requirements for a procurement process leading to the purchase of a system to perform the Corridor Management System functions in the production system.
- The Project Charter Amendment #1 has been finalized and will be circulated for signatures later this month. Thanks to all who provided input and continue to be an important part of the Pilot.
- Over the summer, SCAG released the 2016 Regional Transportation Plan/Sustainable Communities Strategies (RTP/SCS) and featured the Connected Corridors I-210 Pilot as a case study. You can access the final report at <http://scagrtpscs.net/> and find the case study in Chapter 5 on page 88.
- The Advanced Transportation and Congestion Management Technologies Deployment (ATC-MTD) grant recipients were announced in October. Our application made it to the top 20 (the “highly recommended” category), but did not make it to the final eight that were recommended for funding. Although the Pilot was not awarded funding in this round, we will apply again in future years.
- On February 16 and 17, 2017, PATH will celebrate their 30th anniversary with a 2-day symposium. Speakers will include past and present PATH Directors, Caltrans officials, and corporate partners. All stakeholders are invited to attend. For more information or to register, please visit <http://path.berkeley.edu/path-30-symposium-and-celebration>
- Malcolm Dougherty, Director of Caltrans, has been appointed as Vice Chair of the TRB Executive Committee and will assume the role of Chair starting January 12, at the conclusion of the TRB Annual Meeting.

# Institutional Requirements: Where We've Been and Where We're Going

by Lisa Hammon



When I first heard the term “Institutional Requirements,” I must admit I wasn’t sure how I was going to write a whole section on it for the I-210 Pilot System Requirements document. In my background, “institutional”

meant governmental, academic, or something along those lines, but in the context of the I-210 Pilot, the term is much broader and includes people, organizations, agencies, committees, etc. Thus I had to expand my thinking of “institutional” and ensure that the institutional components are incorporated throughout the I-210 Pilot documents, job descriptions and duties, etc.

By way of background, the “people” part of the Connected Corridors I-210 Pilot has been an important part of the project from the beginning, including:

- Engaging stakeholders
- Securing project champions at each agency
- Reaching out to numerous local and regional agencies to educate them about the Pilot
- Working with consulting firms on the Caltrans District 7 reorganization effort to ensure that the right people, positions, and training are put in place for corridor management
- Setting up regular and specific meetings with the partner agencies; etc.

In the beginning, however, we did not use the overarching “institutional” descriptor.

When we began to develop the Institutional Requirements for the System Requirements document, we held many meetings with specific groups to understand their needs, including: Public Information Officers, first responders (CHP, fire departments, local police and sheriffs, etc.), traffic operations personnel and other groups from Caltrans District 7; Caltrans Headquarters staff; individual cities and LA County; and staff from the various transit agencies. Each meeting usually had multiple representatives from various departments. For example, there were over thirteen attendees in Pasadena at their city meeting. Based upon the comments we received, there are now over 300 specific Institutional Requirements and eleven categories of generic Institutional Requirements, including Corridor Strategic Planning, Organizational Composition and Structure (including roles and responsibilities for individuals in

each organization), Management Structure and Processes, Interagency Trust and Communication, etc. The generic requirements contain the more holistic descriptions of the requirements and will be used as templates for other ICM efforts.

The next part of the process was to prepare Job Descriptions and Duties/Tasks for the seventeen positions identified in the “Specific Requirements for the I-210 Pilot” that will be needed to run and maintain the ICM system. The document is a subset of the System Requirements that only includes the job descriptions and a table of the duties and tasks for each job in different categories such as Institutional Support, Corridor Monitoring, Real-Time Incident/Event Monitoring, etc. It was prepared so that the stakeholders can see exactly what personnel are needed to plan and implement the I-210 Pilot. They include the Corridor Manager, Corridor Technical Manager, Corridor Data Analyst, Software Engineers, Stakeholders, and Public Information Officers, to name a few. These job descriptions outline the duties/tasks for each position in detail. The specific tasks include setting up meetings and ensuring that the correct people are in attendance; identifying who is responsible for tracking corridor assets for transit, traffic control devices, etc.; reviewing incidents and events and ensuring the appropriate follow-up has taken place; developing a 5-year system upgrade plan; resolving issues with user interfaces and maintaining the interfaces; and many more. For a successful launch of the I-210 Pilot, each position and its related duties/tasks will need to be in place so that nothing falls through the cracks. After this document is reviewed and accepted, these institutional requirement details will feed into the high-level design. Beyond that, the “people” element will continue to be vital to the Pilot, through meetings, agreements between agencies, outreach to existing and new stakeholders, coordination of numerous aspects of the project, and so forth.

The Institutional components of the Pilot are the “glue” that holds the project together, and the Institutional Requirements ensure that all of the partners know the expectations for staff support now and into the future. The I-210 corridor stakeholders have been supportive since the project’s inception. Without them, the project would not exist, and without their ongoing commitment and dedication, the project would be less successful.

## ● Q&A, continued from page 2

### *How do you see Connected Corridors being rolled out throughout the state?*

In accordance with the Caltrans Strategic Management Plan 2015-2020, the Department's goal is to implement three ICMs by 2020, along with five implementation plans by 2018. We are well on our way in meeting these goals. Successes from the I-210 Pilot, along with the work going on in Caltrans District 4 with the I-80 SMART Corridor project, will help build the foundation from which to expand future CC implementation. I think we will gain valuable lessons learned from both deployments, helping guide the next implementation plans. Future plans will include more details on standardization efforts to make the systems more sustainable long term. The focus will continue to be on priority corridors that experience poor trip reliability to maximize resources. No two corridors are exactly the same, so some amount of customization will be required based on the individual needs of the corridor. Additionally, future efforts will likely involve multimodal enhancements to incorporate more transit options.

### *You've been a part of the effort to improve the data quality in the I-210 corridor. How is this going? What must be done to maintain the data quality in the long term?*

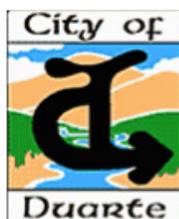
This has been one of the more challenging areas and one that I was involved with long before I came to the District. Reliable and accurate vehicle detection is a concern statewide. We have aging infrastructure, so many systems have gone beyond their expected life, and there have been limited resources available to address it. As a part of the Asset Management effort, there has been more emphasis on this issue statewide and an infusion of \$150 million in SHOPP funding. This will

take some time to trickle down to actual improvements, but in the interim, D7 and the consultant team have tried to tackle problems where they can. We've identified and are working to correct numerous data quality issues, such as detection data from the wrong direction of travel. These things may be missed by the casual observer, but when used to build a system model, they become apparent, and addressing them is paramount. In some cases the fixes are simple, but in cases where there are physical problems in the field, the team has to rely on maintenance crews and contractors to address them. So we have a monitoring team led by Tadeo Lau, who is working directly with the maintenance staff in the field to help identify and hopefully repair those problems. Long term, the district will be repairing communication and detection infrastructure to improve reliability. In addition, the department will be looking to third-party data to help augment existing data sources where feasible.

### *For other Districts to be successful, what do you think is the most important takeaway from the I-210 Pilot at this point in time?*

Communicate, communicate, communicate.

Internally and externally – Communicate a shared vision of integrated traffic management with the customer in mind. The Caltrans and consultant team here has done a great job partnering with the regions from the executive to the staff level. The frequent status and update meetings provide valuable feedback and are critical to the project's success. I know the amount of communication and regular interactions among the stakeholders are crucial for the success of our project and will also be vital for other Districts wanting to implement similar programs.



## **PATH presents AMS Effort to Stakeholders**

On October 25, the Federal Highway Administration (FHWA) sponsored an Analysis, Modeling, and Simulation (AMS) workshop at Caltrans District 7 headquarters in Los Angeles. At the workshop, Connected Corridors staff presented over 30 stakeholders with detailed information on the traffic simulation model developed by PATH and how it will be used in the CC Pilot. James Colyar from FHWA and Vassili Alexiadis from Cambridge Systematics spoke at the workshop and reviewed the team's AMS work. "We have conducted similar workshops across the country and are excited to be a part of this workshop and to see first-hand the progress made by PATH and its partners in developing an AMS capability for the I-210 corridor," said FHWA Transportation Specialist James Colyar. "We have learned from other ICM deployments that AMS helps agencies identify and confirm the operations strategies they are considering will have the intended effects before they invest in them."

The model includes 1,000 lane miles of road, 5,000 traffic detectors, 459 signalized intersections and control plans, 45 freeway ramp meters, and all rail and bus routes in the corridor, making it one of the most comprehensive models of a corridor currently available. Once the Connected Corridors Pilot is deployed, the model will evaluate traffic conditions and recommend appropriate response plans to counteract incident or event congestion. In order for the model and response plans to be useful, the model must have good data (to produce good results) and execute the response plans in real time. The traditional solution has been to run the model on computers with very high processing power. However, the Connected Corridors team will be running the model in the Amazon cloud so that computing power can be scaled as needed. Data quality is also of the utmost importance. The data must be timely, accurate, and cover the majority of the corridor. To ensure good data is provided to the model, Caltrans and the stakeholders have been working for months to fix freeway and arterial sensors and make sure detectors are returning accurate information. The model was also recently showcased as a part of a five-year National Science Foundation (NSF) Engineering Research Center proposal submitted by a group of universities including UC Berkeley. The proposal is still under review.

Stakeholders were very positive about the model and the progress made on collecting high-quality data, as well as the response plans. "There was good interaction with the audience and positive discussions regarding calibration, estimation, prediction, and data quality," says Anthony Patire, one of the workshop's presenters. "Participants liked the 3-D traffic animation video created by Carol Zhang, one of our undergraduate researchers. We are now able to pull some building and land use data from Open Streetmaps into Aimsun for visualization. The video showed this new work through a Santa Anita reroute scenario. The workshop overall really highlighted the amount of effort that continues to go into the development of the I-210 model."

Additionally, the work being done now is positioning the I-210 corridor to be an ideal candidate for future innovation and technologies such as connected and automated vehicles, integration with smart cities and regions, and transportation as a service. The Connected Corridors team will also be sharing the models, data, and algorithms with other Berkeley research initiatives as well as public and private agencies to further the state-of-the-practice in AMS and advance the field of transportation system management and operations in California and around the globe.



**Dr. Francois Dion from PATH presenting at the AMS Workshop**

# Connected Corridors Statewide Rollout

PATH and Caltrans Headquarters staff recently began a comprehensive effort to roll out Connected Corridors statewide, including the discussion of important topics such as funding.

## ***Why are we doing the Connected Corridors Statewide Rollout?***

One of the primary objectives of the Connected Corridors I-210 Pilot is to provide a “how to” template for other Integrated Corridor Management (ICM) projects. The CC statewide rollout program will share information related to Caltrans’ internal processes for managing corridor projects, the I-210 Pilot, and ICM beyond California (both in the U.S. and abroad). The goal is to provide other corridor managers with information – from planning all the way through implementation – on how to do an Integrated Corridor Management project.

Caltrans’ focus is on multimodal, multijurisdictional ways to efficiently manage existing transportation infrastructure and systems on corridors throughout the state, rather than just adding capacity to manage congestion. By providing information to the districts, Caltrans is saving time and other resources by using processes that have been developed for the Connected Corridors I-210 Pilot, the first Caltrans-led ICM effort. The rollout program will take into account all of the components of the I-210 Pilot, including:

- Internal and external funding
- The Systems Engineering process and its impact on ICM projects
- Stakeholder engagement
- Legal agreements, interagency

- responsibilities, and MOUs
- Synergies between Caltrans efforts such as Transportation Systems Management & Operations (TSM&O), the Strategic Management Plan, etc.
- Regional and statewide technical tools (decision support system, data quality, etc.), architecture, and the data hub
- Internal organizational structure and job descriptions/duties; knowledge, skills, and abilities
- Comprehensive training for district and headquarters personnel, as well as consultants and stakeholders
- Outreach and communications
- Essential research

## ***How will the rollout be done?***

For the past four years, PATH has been documenting the progress of the project. The Connected Corridors website (<http://connected-corridors.berkeley.edu/>) was launched over three years ago and contains information not only about the I-210 Pilot, but about ICM in general. For example, the Concept of Operations for the I-210 Pilot, as well as several other ConOps for ICM projects around the U.S., can be found there. Shortly after the Connected Corridors website was developed, PATH launched the ccdocs website (<http://ccd.docs.berkeley.edu/>). Initially, ccdocs was an internal site for stakeholders to learn about the Systems Engineering process and check the progress on specific documents for the I-210 Pilot. Since then, the ccdocs site has been made an “open” site (no longer password-protected) with information available to the general public.

The statewide rollout will follow

the same approach to presenting information as Connected Corridors. It will be provided via a website, first internally through the Caltrans website and eventually expanded for corridor managers in other states or countries to use. Since the next corridor projects will be in California, we will strive to get the templates, documentation, “how to’s,” training, job functions needed, etc. honed within California first.

## ***What is the timing of the CC Statewide Rollout?***

The plan is to have the Connected Corridors statewide rollout project complete no later than the first quarter of 2017, but hopefully sooner. If you have any questions, please call Lisa Hammon at 510.642.5923.

## **About**

**CONNECTED** is a quarterly newsletter with updates and stories about the Connected Corridors program. For more information on the program or the newsletter, please visit our website at [connected-corridors.berkeley.edu](http://connected-corridors.berkeley.edu) or contact one of our team members listed below.

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