LOCAL EVALUATION REPORT

FOR THE

ARDEN CORRIDOR INVESTMENT

Submitted to:

Federal Highway Administration

Submitted by:

City of Sacramento
9/26/2008

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INTRODUCTION

In the Sacramento area, the ITS Partnership serves to guide the planning and implementation of local and regional ITS projects. Larger agencies in the Partnership include Caltrans District 3, City of Sacramento, County of Sacramento, Sacramento Regional Transit District, and the Sacramento Area Council of Governments (SACOG). This Partnership demonstrates the region's commitment to a multi-agency, multi-mode approach. In particular, one of the most significant regional ITS project in Sacramento is **STARNET.** STARNET, the **S**acramento **T**ransportation **Ar**ea **Net**work, is an interagency video and data communications network conceived and adopted as the communications backbone that will serve to provide the connectivity between and among the Partnership's transportation management efforts, and their various ITS field devices. In addition to conceptualizing the data sharing system, the STARNET plan identified several multijurisdictional Priority Corridors within the Sacramento Metropolitan Area of which Arden Way is one of the corridors.

ARDEN WAY CORRIDOR

The Arden Way Corridor is a key link in the City of Sacramento's City-wide ATMS Communications Master Plan. The principal focus of this initial stage of the total corridor investment was the provision of the first dedicated communications linkage between the City of Sacramento's and the County of Sacramento's traffic management systems. As indicated in the STARNET Plan, this linkage is an important milestone for the STARNET Program where it will provide the medium for the integration and information sharing that will be implemented as part of that program. Along with this communication linkage, the implementation of a variety of complementary ITS elements along Arden Way was completed. The City and County of Sacramento are cooperative partners for this Arden Way Corridor. The Arden Way Corridor is illustrated in the location map below.

Corridor Setting

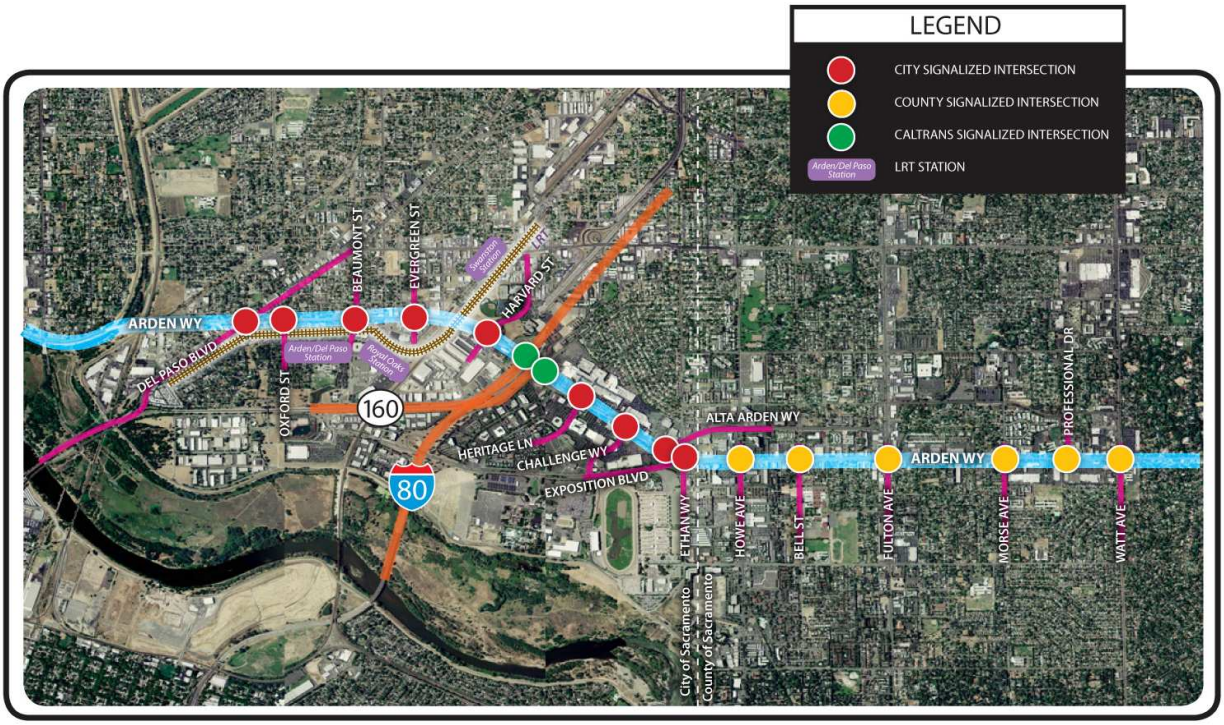
Arden Way is one of the Sacramento urban area's most important cross-town east-west arterial roadways. Located just north of the American River, it is a major east/west traffic arterial that passes from the City into the unincorporated County area. It serves the Interstate 80 Business Route freeway (Business 80) to the west and the unincorporated area of Sacramento County to the east. It was identified as the 3rd highest Priority Corridor in the STARNET master plan report.

The Sacramento Regional Transit District (RT) operates four bus routes in this corridor consisting of about 60 scheduled runs per day that serve over 5,000 passenger boardings per day. There is a transit transfer point along the corridor along with three light rail stations on the west segment of the corridor.

Some of the critical ITS investments that were implemented in the project included the following:

- Fiber optic communications link between the City's hub at Arden Way and Del Paso Avenue and the County's hub on Watt Avenue north of Arden Way;
- Deployment of ITS field devices (CCTV cameras and system detection);
- Deployment of transit signal priority (TSP) including upgrading traffic signal controllers with controllers that have TSP functionality; and

- Development and implementation of new traffic signal coordination plans along the corridor, taking advantage of the new controllers' advanced capabilities and implementation of TSP response and recovery routines.



Source: Base map by Google Maps. Overlay graphics by City of Sacramento Department of Transportation.

PROJECT GOALS

The project served as a way of identifying, evaluating, and implementing multiple ITS functions in an integrated fashion between the different agencies. With the investment of the communications infrastructure and ITS field devices, the City, County and RT are now able to leverage future ITS investments especially STARNET. Specifically, this project realized the following goals:

- Establish a foundation for the connection between several ITS partners as part of interagency efforts for future expanded regional ITS integration.
- Provide successful interagency collaboration and working relationships amongst the ITS partners.
- Support the regional and multi-modal mobility including operational processes between the City and the County and eventually the STARNET stakeholders.
- Provide coordinated signal timing effort between City and County, a test site for other congested corridors.
- Procure and implement transit signal priority functionalities.

Another goal of this project was to provide coordinated signal timing between the two agency systems along the Arden Way corridor. To facilitate such compatible signal timing plans, the ITS investments along this corridor included the first and only direct communications connectivity between the City's and

County's traffic signal management centers. This fiber optic link provides the communication path for video and data sharing and control between them, as well as other agencies.

The City was the lead agency for this project with the County as the other major participant. The City and unincorporated County areas are contiguous within the urban Sacramento area, and specifically on this corridor. Close cooperation and integration of ITS between the two agencies has allowed each one to better manage traffic flows and produce optimal and synchronized traffic patterns for this corridor which ultimately serves to benefit the entire urban area.

PROJECT EVALUATION

This section documents the technical and institutional issues that were encountered over the course of the project and the methods used to resolve those issues. In addition, it briefly documents some of the lessons learned from the process, both technically and institutionally.

Evaluate the institutional issues associated with achieving cooperation among public sector agencies and document how they were overcome.

Cooperation Among Public Sector Agencies

As was described above, the ITS Partnership is the main organization guiding the STARNET Program of which the Arden Corridor is a vital link. The Arden Corridor Investment provides the main trunkline and is the only connection between the City, County, Sacramento Regional Transit, SACOG and Caltrans. These are the effectively the major agencies in the region.

For the Arden Corridor Investment, there were several institutional issues that had to be overcome in order to achieve cooperation among the stakeholder agencies. Those institutional issues fell under the following list of items or stages of the project:

- Video and Data Sharing
- Cost Sharing
- Project Management
- Design
- Construction Inspection
- Traveler Information
- Traffic Signal Coordination
- Transit Signal Priority

Each of these issues was dealt with in different ways and is discussed below.

Video and Data Sharing. The City and the County have a goal of exchanging video and data and this Arden Corridor investment provided the dedicated communications link for that future exchange to

happen. The ultimate institutional and technical arrangements for the video and data sharing will be part of the STARNET Program.

Cost Sharing. There was a cost sharing agreement developed between the City and the County of Sacramento. The agreement included sharing of the costs for design, project management, and construction inspection. The cost sharing started and was maintained at a 50%/50% split between the two agencies through construction. Additionally, the funding allocations were re-evaluated once the actual construction costs, or bids were received. The purpose of the re-evaluation was to ensure that the 50% split of costs was maintained. For example, if the bids showed more funds being spent in the County, and there were funds remaining, additional elements were installed in the City.

Project Management. Given that the project would cover areas in both the City and the County, it was determined early in the process that a lead agency had to be established to handle all of the project management duties. The Cost sharing Agreement designated that the overall project management was to be lead by the City of Sacramento and the associated costs to perform these services were reimbursed 50% by the County to the City.

Design. During the construction stage of the project, there were utility coordination issues within the County. Since the County has had to deal with these issues before, it is their standard practice to provide all the utility contacts on the design plans. However, this is not a standard City practice and thus the utility contacts were not provided on the design plans. This became an issue when utilities had to be contacted in an emergency situation. In the end, the Contractor was able to minimize the emergency situation providing enough time for the County staff to locate the utility agency.

Construction Inspection. The agencies acknowledged early on in the process that in order to properly execute the construction contract, there would need to be a single agency leading the inspection of the construction. Thus, as part of the Cost Sharing Agreement, the City of Sacramento was designated as the agency that would perform construction inspection services, and that the County would reimburse the City for half of the costs to perform these services.

This approach was successful from the perspective of the management of the overall project. However, it did present some issues between the agencies in terms of understanding the specifics of how each agency handles certain aspects of construction. There were cases where decisions by the City's inspector, while made under the best of intentions, were not consistent with the County's inspector's methods. In the end, it was the cooperative nature of the two agencies and their inspectors that served to rectify these issues and serve to complete the construction. The lesson learned was that more upfront collaboration between the agencies and their inspectors would have been beneficial to set up consistent rules for the inspectors to follow.

Traveler Information. The installation of a changeable message sign was originally part of the project. City of Sacramento engineering staff preferred the installation of the sign along the corridor as a means of managing congestion. However, the community, predominantly in the County was opposed to the installation of the sign. Given that the County already had faced issues for a message sign installation on Watt Avenue, it was likely that the same issues spilled over to the Arden Way Corridor.

Traffic Signal Coordination. The City and the County have different central traffic signal systems, traffic controllers and signal timing needs/requirements. Thus, they engaged in a collaborative process of developing new coordinated signal timings across their jurisdictional boundaries. In essence, both agencies developed their optimal timings and at the City/County boundary, they worked together to match the signal timings so there would be a seamless flow of traffic.

Transit Signal Priority. The Sacramento Regional Transit (RT) has several transit routes traversing Arden Way. There were discussions between the City, County and RT on the use of transit signal priority (TSP) along the corridor. The discussions yielded that RT was not immediately ready to utilize TSP along Arden Way. However, in keeping with the project goals, the City and the County deployed the capabilities for TSP operations in the future. This includes the installation of TSP detectors and traffic controllers with TSP capabilities. This provides the capability for transit signal priority on the corridor should RT decide to implement it in the future. Also, certain infrastructure including pull boxes and vaults for the fiber optic trunk line were located close to transit stations in case RT has a need to use the fiber in the future thereby providing easy access to the fiber trunk line.

Provide a brief lessons learned report on the technical and institutional issues encountered in integrating ITS components.

Institutional Issues

For the Arden Corridor Investment, there were several institutional issues that arose during the installation and integration of the ITS components.

Network Topology. The original plan was to install both a copper and a fiber infrastructure. The copper was to be for communications with the traffic controllers and the fiber was to be for the cameras and the trunkline. In the end, the City and the County decided to abandon the plans to install the copper infrastructure opting for fiber for the entire project. During the same timeframe, there was the decision to implement a topology based on the Ethernet and IP standards. This change in direction, especially with the Ethernet/IP topology was viewed as a significant risk that the agencies were willing to take. In the end, this change has set the stage even closer for the implementation of the STARNET Program and the fiber trunkline along Arden Way. However, the County experienced some technical issues with this new direction. This is described in more detail below.

City of Sacramento Network Support. The City of Sacramento has a separate IT Department from the Transportation Department. With the decision to move to an Ethernet/IP-based system, the Sacramento Transportation Department needed the network support from the City IT Department. However, the City IT Department has their own set of requirements that the Transportation Department needs to follow if they want support from City IT staff. This includes the IT's preference for a specific vendor's equipment, even if the equipment does not satisfy the Transportation Department's requirements. The City Transportation Department is working on establishing proper requirements which will satisfy the City IT Department and at the same time allow the Transportation Department to implement their ITS Program.

County of Sacramento Network Support. The County's implementation of the elements including network devices was performed primarily between the Contractor and County Traffic Engineering staff. There was minimal involvement from the IT Department except for some minor help with network setup and configuration. The County IT Department did purchase a network switch for the Traffic Engineering Department as part of the Arden Corridor Project.

Technical Issues

For the Arden Corridor Investment, there were many technical issues that arose during the installation and integration of the ITS components.

Traffic Signal Controller and Central Signal System. The City of Sacramento is still trying to determine which traffic controller type and local software/firmware to permanently deploy. There are eight different traffic controller types in the City, and the ultimate goal is to reduce that number for cost savings and ease of maintenance.

The City evaluated many different traffic controller types for this project that would meet the traffic operational needs. Due to the City's needs for complex intersection operations, there were limited controllers that provided the capabilities off the shelf. In the end, two different types of traffic controllers were installed as part of the Arden Corridor Investment. One controller type was installed where traditional traffic operations and simple transit signal priority and light rail preemption was required. Another controller type was used for more complex intersection and light rail operations.

For the Arden Corridor Investment, the City has been having issues with the central software system and the traffic controllers that have been deployed. Currently, of the two types of traffic controllers installed, only one of the traffic controller types is able to communicate with the central software system in terms of issuing commands. While status information is attainable, issuing commands or making changes to parameters in the traffic controller at times results in the intersection going into flash mode. These issues have persisted although the central system and traffic controller vendor both confirmed that communications between these two systems was already established.

One factor that has contributed to the systems integration issues appears to be that the vendors of the central system and the traffic controllers are not coordinated with their upgrades. The release versions and timing of the release versions are different between the two vendors where the different release versions of the traffic controller firmware and the central system are not compatible. The scenario typically happens in this fashion: The traffic controller vendor releases a new version of the firmware. The central system vendor starts working on integrating this new firmware. Before the integration of the new traffic controller firmware version is completed, the traffic controller vendor releases a new version of the firmware. This results in incompatibility issues and has been a source of delays for the project. A conclusion is that version control and system integration has been lacking by the both vendors.

The County also experienced technical issues with the integration of the traffic signal controllers and the central software system. The issue was traced back to the use of the Ethernet and IP standards for

communications. The traffic signal had issues whereby communicating using Ethernet had a significant risk of placing the traffic signal into flash mode. The issue was compounded by the vendor's lack of support and response to resolve the issue. In the end, the County staff was able to install a software upgrade provided a third party vendor to resolve the problem and implement the new communications topology. The lesson learned from this ordeal was that the County, using their own shadow network, is now able to troubleshoot and resolve issues more efficiently and effectively than the vendors.

CCTV Cameras. From the City's perspective, the use of the existing camera type for the Arden Corridor made the implementation a very smooth process. Since City staff already had the technical knowledge of the camera units and the communications topology, the integration process was completed seamlessly. From the County's perspective, the use of IP-based cameras was similarly a very smooth process. However, for County this smooth process was largely due to the support of the Contractor. The Contactor provided the upfront configuration and network setup and integrated all of the cameras into the system.

Traffic Count Stations. As part of the Arden Corridor Investment, the one unit installed on Arden Way in the City is not functioning and has been deemed non-operational. The City intends to replace this count station with a more robust unit potentially using a different technology. The decision to include the traffic count stations was a late one in the procurement process when there were some remaining funds. It is acknowledged that a more rigorous research, selection and testing process was necessary including more responsibility placed on the contractor to make it the unit functional.

Within the County, there were three units installed. However, based on the design of the units with the traffic controller, only a very small set of data would be able to be gathered from each unit. As it turns out there were some remaining funds that the County decided to use towards the acquisition of software to extract the full suite of information that the units collect.

Traffic Signal Timing. The City and the County had some interactions on the development and implementation of the new traffic signal timings. However, due to the nature of the Arden Corridor where lane transitions occur and traffic volumes vary widely from one end to the other, it was determined that providing the signal coordination at the boundary signals was the best approach to the implementation of the signal timings.

Construction Coordination. In developing the construction drawings and technical specifications, the focus was predominantly on the installation of the physical elements (e.g., CCTVs cameras, traffic signal controllers). As the construction progressed, there was an issue with not having the systems integration effort included with the construction contract. The construction contractor purchased the equipment, installed the equipment, and made sure that the equipment was able to be powered up. However, the contractor did not possess the knowledge to understand if the equipment installed was working properly. Subsequently, the City had to hire a systems integrator to determine which pieces of equipment weren't working properly and/or troubleshoot the equipment to work properly. It was determined in several cases that the responsibility to integrate the field elements was not defined as the clearly in the technical specifications. The lesson learned was that having construction contractor responsible for integrating the ITS elements and having one point of contact would have made the project installation more seamless.

Produce a lessons learned report on the experiences, challenges and approaches used in achieving consistency with the National ITS Architecture and/or implementation of ITS standards.

National ITS Architecture and Standards

The Sacramento Region ITS Partnership is charged with development of a regional architecture to be fully compliant with the National ITS Architecture and ITS Standards. The Partnership completed the Strategic Deployment Plan (SDP) that updated the Regional Architecture and brought it into conformity with the release of National ITS Architecture version 5.0. The Arden Corridor project elements are included as part of the updated Regional ITS Architecture for the Sacramento Region.

The fiber optic communication cable that was installed on this project provides the only direct fiber connection between the City and the County's traffic signal system via their respective field hubs. This fiber connection is simply the medium with no current data and video sharing occurring at this time. It is the intent that the video and data information sharing will be handled via the STARNET system.

Relying on STARNET, the level of information sharing will be high with nearly everything being view-able, and with appropriate levels of sharing of control that will be established by adoption of interjurisdictional policies and procedures. It has always been acknowledged that having this standardized communications link in place will allow for the technical and institutional policies to take place between the City and the County.

It is anticipated that the systems integration including software and hardware will be provided by STARNET to achieve this system-to-system interoperability at the console. The vision is to retain independent and separate systems, but to allow the information exchange with a common software and user interface. This system software and interface would utilize ITS standards.

Traffic Signal Controllers. The traffic signal controllers that have been deployed along Arden Way are compliant with the National Transportation for ITS Protocols (NTCIP), meaning that they utilize NTCIP mandatory data objects for communications with their respective central systems. One note of reference is that there have been cases where the City has chosen to use different communications protocols that may not be consistent with NTCIP protocols. This is a result of the integration issues between the central system software and the traffic signal controllers.

CCTV Cameras. The CCTV cameras installed in the City are not NTCIP compliant. The CCTV cameras installed in the County are IP-based cameras communicating over an Ethernet link to the County's TMC. This provides NTCIP compliance but at the subnetwork profile only. Both agencies' cameras are using proprietary (but publicly available) camera control data. It should be noted that the standards for camera control (NTCIP 1205) is being amended and CCTV camera vendors have yet to fully embrace and offer camera control data based on the original standard.

Traffic Count Stations. The traffic count stations that have been deployed on the Arden Corridor are not NTCIP compliant. Much of this issue has to deal with the traffic count data being typically tied directly to the traffic controller and from there transmitted back to the central system software. These count stations are proprietary in nature from the methods of collecting the data to transferring the data to a central system software for data management. However, as indicated above, the City is contemplating replacing the single unit that is installed in the field. As NTCIP compliant units are available, these will be evaluated accordingly.

Communications Network. The communications network for the corridor is an IP/Ethernet-based system. This type of network by default is compliant with NTCIP 2104, Subnetwork Profile – Ethernet and 2202, Transport Profile – Internet. These standards define how to exchange data over Ethernet and TCP/IP or UDP/IP networks. This network also sets up the physical and transport layer for the STARNET system once deployed between the City and the County.

SUMMARY

The Arden Corridor Investment has been a success from an institutional aspect. Implementing a Cost Sharing Agreement and subsequently balancing the funds spent within each jurisdiction clearly demonstrated the agencies' commitment to the project. Additionally, the provisions for transit signal priority in the future shows the multi-modal approach for this corridor.

Many of the challenges for the project were on the technical side, more specifically the integration of field elements with central system elements. The full integration of the field controllers with the central system software is not complete with several challenges. Also, the last minute product additions to the project without any detailed assessment and evaluation of the products have proved to be a substantial issue.

The primary goal of providing a fiber optic infrastructure between the City of Sacramento and the County of Sacramento was achieved. This infrastructure now set the stage for a very important link in the STARNET Program. The agencies acknowledge that a large part of the funds were spent on the infrastructure that is the most important part of the project.