Deliverable For:

Gateway Cities Traffic Signal Synchronization and Bus Speed Improvement Project

I-5/Telegraph Road Corridor

Deliverables 16.1

Stakeholders' Operational Objectives and Individual City Reports (Expanded Area)

Draft

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Final (2.1 & 2.3)	October 3, 2001	Incorporated written comments from J. White and P. Smith
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Draft (16.1)	June 26, 2003	Included Cities of Norwalk and Whittier and intersections in the expanded area.

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1. INTRODUCTION

The County of Los Angeles Department of Public Works Traffic Signal Synchronization, Operation and Maintenance (SOM) program has proven successful in creating an institutional infrastructure to coordinate the activities of the agencies responsible for traffic signal operations in the County. A key feature of this infrastructure is the Forums - groups of bordering agencies created to encourage and promote inter-agency cooperation. These Forums have enabled funding to be targeted at infrastructure improvements along arterial and arterial/freeway corridors in the County's sub-regions. Such projects are a critical part of what will eventually be a network of integrated ITS systems in Los Angeles County and in Southern California.

The I-5/Telegraph Road Corridor is one such project which will result in arterial infrastructure improvements on north-south and east-west arterials along I-5 freeway in the South-East LA County (Gateway Cities) Forum.

As shown in Figure 1-1, the I-5/Telegraph Road Corridor project area consists of 277 intersections in 10 different jurisdictions, comprising 8 cities, the County and Caltrans.

The objective of this project is to design, develop and deploy Advanced Traffic Control system(s) (ATMS) in the corridor so that the signals in the Project area can be synchronized across the jurisdictional boundaries. This project concentrates on the needs of the agencies in this corridor with respect to signal synchronization and recommends improvements to field infrastructure (including controllers, loops, detectors, and communications) and central traffic control systems to meet those needs.

When successfully completed, each of the agencies responsible for traffic signal operations in the I-5/Telegraph Road Corridor will have full access to a ATMS that monitors and controls the traffic signals under their jurisdiction. Agencies will be able to synchronize their signals with neighboring agencies, and exchange traffic information in real-time. Agencies will also be able to exchange data with other agencies in the Gateway Cities region. This will allow the agencies to respond to recurrent and non-recurrent congestion in a coordinated fashion across the jurisdictional boundaries.

1.1. Relationship with the Countywide Arterial Management System

The County DPW has developed a system architecture for integrating Advanced Traffic Management Systems (ATMS) for arterial traffic control systems into a regional framework to support the above operational goals. This is the Information Exchange Network architecture (IEN) represented in Figure 1-2. This is the architecture that will be followed in the design of the I-5 Telegraph Road Project.

The IEN architecture supports traffic signal operations in three levels. The local level comprises the day-to-day, traffic signal operations carried out by the individual agency – signal timing, maintenance and response to local traffic conditions and events. The Corridor level supports inter-agency coordination and joint signal operations – coordination across jurisdictional boundaries, exchange of local traffic data, and joint response to traffic conditions and events that affect more than one jurisdiction. The final level is the regional level. This permits the arterials of regional significance to be monitored and managed as a single entity (as Caltrans does with the freeway system). Multi-agency, cross-corridor data exchange is supported permitting a countywide response to traffic conditions and major events.

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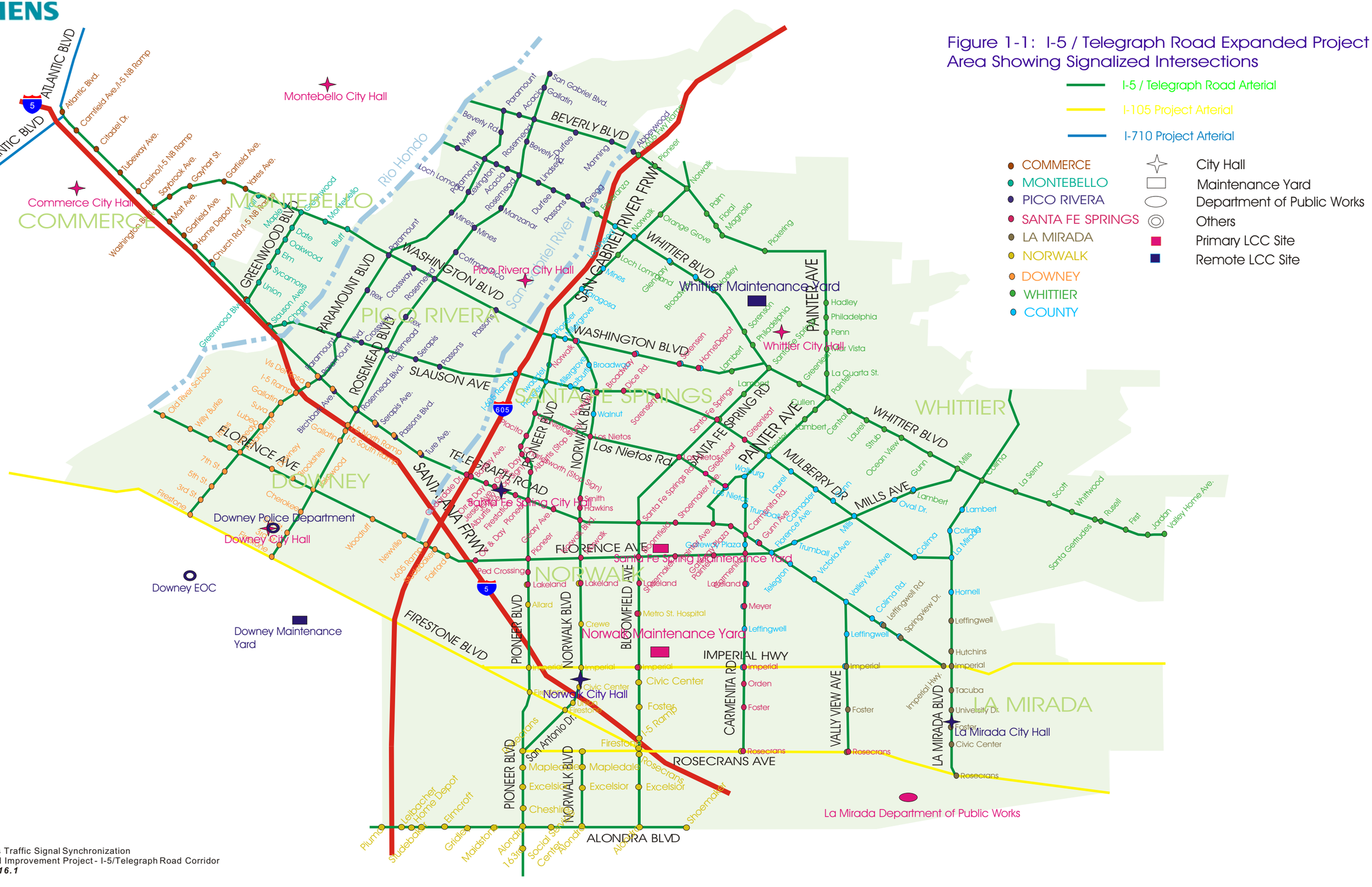
Figure 1-1: I-5 / Telegraph Road Expanded Project Area Showing Signalized Intersections



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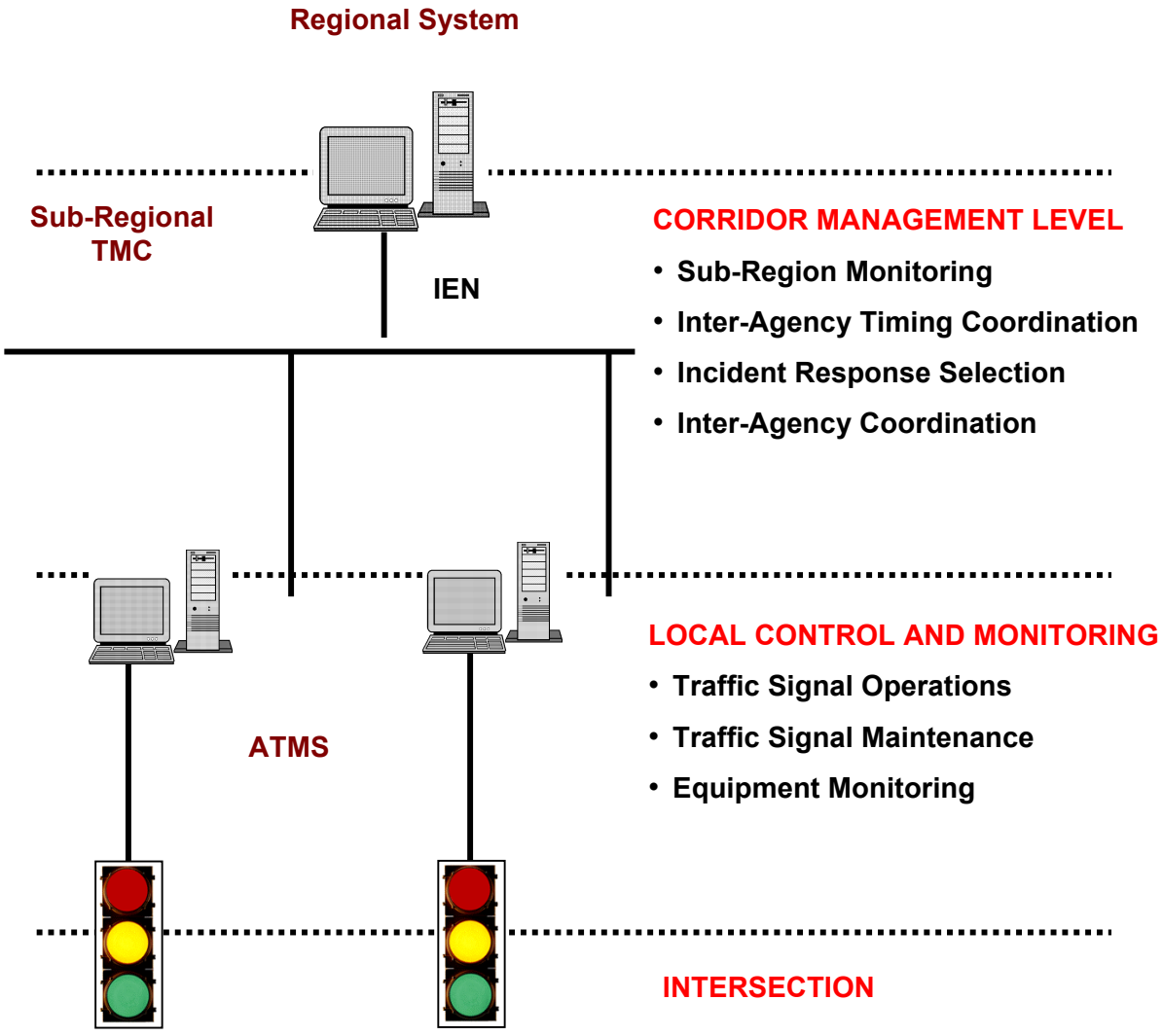
The physical elements of the architecture are ATMSs, interfaces between the ATMS and the regional system, workstations to display shared data (which may or may not be combined with the ATMS), and servers for the collection/transfer of data and to support corridor and regional functions. These components are connected via a communications network known as the Information Exchange Network (IEN). The design of the IEN is being developed as part of the East San Gabriel Valley (ESGV) Pilot Project. The initial application of this structure in the Gateway Cities region is being done under the auspices of the I-105 Corridor Project which has jurisdictions in common with the I-5/Telegraph Road Project.

Figure 1-2: The Information Exchange Network Architecture (IEN)



The I-5/Telegraph Road Project assumes the availability of the IEN at the corridor and regional levels. The project is focused upon the selection of traffic control systems and integration of those systems into the IEN at the local level. The eventual design will include IEN workstations at the local level. These are being defined as part of other projects. The design of the traffic control systems will, however, take into account the interface to the IEN and its requirements at the local level.

1.2. Purpose

This document presents the existing field and central traffic control system infrastructure in the project area and discusses the operational objectives of the agencies in the project area. The report satisfies deliverables 2.1, 2.3 and 16.1 of the project.

1.3. Methodology

In order to compile the information required for this task, representatives of the Siemens ITS team met with the individual agencies. The Siemens ITS team discussed the state of their field infrastructure (controllers, loops, communications) and central software and hardware; agency needs and plans for upgrading the existing equipment. One of the important issues discussed at these meetings was the current and proposed future operation of the signal systems. Appendix A contains presentation materials from these meetings. The key discussion items and points addressed were as follows:

1. Project Background
    - Project area
    - Countywide arterial management system architecture and location of functionality at the three levels:
        - Regional: Monitoring
        - Corridor: Operational coordination and event response
        - Local: Signal Operations and Management
    - Options for traffic control system configurations:
        - Dedicated ATMS for a City
        - ATMS shared between local agencies
        - City controllers under a regional agency (County or Caltrans) ATMS
    - Project Issues
2. Current Agency Equipment
    - Review of Agency Equipment
    - Collection of information
3. Current Operations
    - Review of staffing and operations
4. Equipment Upgrades
    - Explanation of potential upgrades to the agency's equipment
5. Future Operations
    - Discussion of the impact the integration of agency traffic control systems into a regional network could have on agency operations.

Field surveys were conducted to collect the missing data and to confirm the information collected at these meetings.

This report documents each agency's infrastructure in the project area and how agencies plan to operate the signals in the Project area in the future. Based on this information, the report presents recommendations for improvements to each City's traffic control options.

2. EXISTING CONDITIONS

This section presents the existing conditions of the 10 agencies in the Telegraph Road Corridor with respect to the traffic signal system operation. This information is divided into the following five categories:

- Traffic Controllers
- System Detection
- Central Traffic Control System
- Communications
- Traffic Signal System Operations and Maintenance

Appendix B presents in detail the information collected for each intersection in the Project Area. Appendix C presents figures depicting controller type/cabinet type and communication infrastructure for project intersections. Table 2-1 summarizes the information collected for each Agency. A discussion then follows the table.

Table 2-1: Project Cities System Inventory

Agency	Total Number of Signals	Number of Signals In the Project Area[1]	Type of Controllers/ Firmware	Responsibility For Maintaining Signals	TCS
Commerce	47	11	Type 170 / Bi Tran 200	PEEK/SMI Under Contract to the City of Commerce	QuicNet IV
Downey	52	31	Type 170 / LACO 1R	County	None
La Mirada	43	12	Type 170 / LACO 1R	County	None
Montebello	57	13	Type 170 / LACO 1R	PEEK/SMI Under Contract to the City of Montebello	None
Norwalk	78	38	Econolite	Norwalk	None
Pico Rivera	21	27	Type 170 / LACO 1R	• Santa Fe Springs • County (For the intersections on the Telegraph Road)	None
Santa Fe Springs	33	38	Econolite	Santa Fe Springs	None
Whittier	98	19	Econolite/Type 170	• Whittier • Caltrans	None
LA County	NA	46	Type 170 / LACO 1R	County	None
Caltrans	NA	53	Type 170 / C8	Caltrans	QuicNet II

[1] The number of signal intersections owned by the agency.
The Cities of Downey shares 5 signal with Pico Rivera.
The City of La Mirada shares 2 signal with County, 1 signal with Santa Fe Springs
The City of Norwalk shares 1 signal with Santa Fe Springs
The City of Santa Fe Springs shares 1 signal with Whittier and 1 Signal with County

2.1. Traffic Controllers

The Project area consists of 277 traffic signal controlled intersections. Except for intersections in the cities of Norwalk, Santa Fe Springs and Whittier, all intersections utilize Type 170 controllers. Cities of Norwalk, Santa Fe Springs and Whittier utilize two different types of Econolite controllers (ASC 8000 and ASC2).

Except for Caltrans and Commerce, all agencies that utilize type 170 controllers use LA County firmware. City of Commerce utilizes Bi Tran 200 firmware and Caltrans utilizes its own C8 firmware.

2.2. System Detection

Most intersections in the Project area are equipped with advanced loops on major approaches. The advanced loops are placed at a distance of 200 to 300 ft from the stop bar. In some cases, these loops are tied together across one or more lanes and hence can't be used for system detection.

2.3. Central Traffic Control System

Only the City of Commerce and Caltrans have an operational central traffic control system. The City of Commerce utilizes QuicNet IV System and Caltrans utilizes QuicNet II system from Bi Tran. However, in the City of Commerce only one intersection in the project area is connected to the central traffic control system. Caltrans utilizes their system to monitor the arterial signal at Rosemead Blvd./Telegraph Rd.

2.4. Communications

As shown in Figure 2.1, little communications infrastructure exists in the project area except along Telegraph Road, Whittier Blvd. and Rosemead Blvd.

2.4.1. Telegraph Road

The City of Commerce currently has twisted pair cable on Telegraph Road from Camfield to Washington Boulevard. There is a gap in the interconnect from Washington to Malt. There is a conduit from Malt to Garfield, but no interconnect exists in this conduit currently (the City has plans to install interconnect in this conduit but could not confirm a schedule). There is interconnect from Garfield to Home Depot Driveway. It could not be confirmed if City has a phone drop to relay the information from field to the QuicNet IV System at City Hall.

The three ramp locations (Camfield, Casino and Church) along I-5 have the City of Commerce twisted pair cable interconnecting them but it is not being used since at this time Caltrans and the City do not have an agreement to coordinate these signals.

The intersections at Paramount Blvd. and Birchbark Ave. are connected via a 7-wire interconnect. This interconnect is used by the Master at Birchbark to provide "Yellow Hold" to the intersection at Paramount Blvd.

The intersection at Rosemead Blvd. and Telegraph Rd. is hardwire connected to intersections along Rosemead Blvd. but not those on Telegraph Rd.

The two ramps at the 605 Freeway and the intersection at Orr and Day have a 7-wire interconnect. The master at the northbound ramp receives a "pulse" from Orr and Day Rd to provide coordination between the closely spaced intersections.

There is a 7-wire interconnect between intersections at Colima Rd. and Leffingwell Rd which is not being utilized.

The intersection at Imperial Hwy and Telegraph Rd. is hardwire connected to intersections along Imperial Hwy, but not to those on Telegraph Rd.

2.4.2. Whittier Boulevard

All intersections in the project area along Whittier Blvd. are owned and operated by Caltrans. Caltrans has installed Twisted Wire Pair to provide for signal operations using Master/Local configuration. Most of the interconnect comprises a 12 pair TWP except between Paramount Blvd. and Rosemead Blvd.

2.4.3. Rosemead Boulevard / Lakewood Boulevard

All intersections in the project area along Rosemead Blvd. (Between San Gabriel Blvd. and Telegraph Rd.) are owned and operated by Caltrans. Caltrans has installed Twisted Wire Pair to provide for signal operations using Master/Local configuration.

All intersections in the project area along Lakewood Blvd. (Between Telegraph Rd. and Firestone Blvd.) are owned by City of Downey. Currently, the city is in the process of installing fiber along this section.

2.5. Traffic Signal System Operations and Maintenance

The Cities of Commerce and Montebello contract out the operation and maintenance of their signals to a private contractor.

Caltrans operates and maintains its own signals using its in-house staff.

The Los Angeles County Department of Public Works operates and maintains signals for the Cities of Downey and La Mirada in addition to operating and maintaining their own signals.

The City of Santa Fe Springs operates and maintains its own signals and also signals for the City of Pico Rivera. However, the signals on Telegraph Road under Pico Rivera's jurisdiction are shared equally between the Cities of Pico Rivera and Downey. These signals are operated and maintained by the County under the County's contract with the City of Downey.

The cities of Norwalk and Whittier maintain their own signals using in-house staff.

In instances where the County operates and maintains signals for other Cities, the County is responsible for day-to-day operation of the signals, but is not responsible for signal equipment upgrades. The County is not 100% liable for these signals. When the Cities notice a problem with their signal operations, they make a maintenance call to the County. The Cities have the ability to change the timings on these intersections but it is expected that they keep the County informed of any such changes.

As part of Tier 1 improvements, the County works with the Cities to upgrade the signal equipment at the intersections and provide coordinated signal timing on a one-time basis along TSSP routes. This activity is carried out by the County as a regional agency and is independent of the County providing "maintenance" services to the Cities which do not have their own maintenance staff to carry out such activities.

All agencies utilize Time Based Coordination (TBC) method to operate a majority of the signals in coordinated mode during the day and “Free” operation at night. Some intersections are operated only in “Free” mode.

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Figure 2-1: I-5 / Telegraph Road Project Area Showing Interconnect Cable Location

- COMMERCE
- MONTEBELLO
- PICO RIVERA
- SANTA FE SPRINGS
- LA MIRADA
- NORWALK
- DOWNEY
- WHITTIER
- COUNTY

- 25 Pair
- 12 Pair
- 6 Pair
- 7 Wire
- Conduit Only

Note: Fiber is being placed between Telegraph Rd. And Firestone Blvd. on Rosemead Blvd./Lakewood Blvd.

3. OPERATIONAL OBJECTIVES

This section presents the operational objectives of the agencies. Each agency is represented in a separate subsection below:

3.1. Caltrans

Caltrans (District 7), as part of its broader intent of improving traffic management operations with local jurisdictions, expressed a willingness to work with the agencies in the Project area to improve signal coordination. The State does, however, wish to maintain control and operation of their own signals.

District 7 already has plans for the installation of a new central traffic control system called CTNET. This is scheduled to be installed as part of the Pacific Coast Highway (PCH) project and controllers would gradually be added to this system over a period of time.

It is currently proposed that the District's new Freeway Management System will, in the future, provide details of freeway incidents and events to local systems via the SHOWCASE network. This would enable the local traffic control systems to take action to respond to freeway situations. This should lead to increasing operational coordination between Caltrans and the signal operations agencies.

The Showcase project is a federally funded effort to provide for an early demonstration of the integration of advanced traffic management and traveler information systems within the Southern California Priority Corridor. The area encompassed by the corridor extends from the northern reaches of the Los Angeles metropolitan region in Ventura County, though the San Diego metropolitan region, to the U.S. /Mexican border. Anchored by the Interstate Highway 5, the area is bounded to the north by State Route 126, the northern boundary of Los Angeles County, and Interstate Highway 10; to the east by State Route 71 and Interstate Highways 15, 210, 215, and 805; to the south by the United States border with Mexico; and to the west by the Pacific Ocean. The term SHOWCASE Network refers to the physical network that will link the Caltrans TMCs within each region to the local TCCs within that region. This network is currently being designed under other projects.

It is important to take into account the SHOWCASE network as it forms the basis for the ITS architecture for the Southern California Region. Compatibility with the architecture and its communications will ensure that the County's systems will form part of the regional architecture and so benefit from information sharing and coordinated operations.

The local State office has no plans to upgrade local controllers. It should be noted that Caltrans headquarters is committed to the use of Type 2070 controllers in case of any future controller upgrades; this is a State of California specification. However, the State has not yet reached a firm conclusion regarding the choice of controller firmware.

Summary:

Operations: Caltrans wishes to be increasingly pro-active in their coordinated signal operations with local jurisdictions. This will be possible as coordination with local agencies is improved and supported by the regional integration of traffic management systems.

Maintenance: Caltrans will continue to use its own maintenance forces.

3.2. City of Commerce

The City has no Traffic Department *per se*; the assistant Public Works Director acts as the City Engineer. The City does not use the current QuicNet IV system, due to lack of interconnect and limited staff resources. There are no plans to increase staff but the City does want to be more active in signal operations.

The City feels that it needs to have in place a process to generate timing plans. Signal timings are currently only updated when a consultant has carried out a study. The City has no firm program for such timing projects. No automated collection of data is done due to the absence of system detectors.

Signal coordination across jurisdictional boundaries is of particular concern to the City. The City wishes to coordinate operations with adjacent agencies and Caltrans. A specific are of concern is that the City's traffic is affected by the I-5 freeway ramp operation. The City feels that video surveillance would be useful to help manage this problem and would support the installation of CCTV cameras on Telegraph Road within a one-mile radius of the I-5/710 interchange and at the intersection of Church Road and Telegraph Road.

For the same reason, the City would like to have access to Caltrans CCTV images of this area. Caltrans has developed a policy for distribution of video images from CCTV cameras along freeways. This does not permit a third party control of the camera but would allow an agency to select an image for viewing. Signal maintenance is carried out by SMI and the City has no plans to change the current arrangement. The City staff are, however, actively involved with signal problem reporting and ensuring response to reported problems. It is common for the City to receive calls regarding traffic problems. The City feels that this is possibly because of the high percentage of truck traffic. Trucking firms are particularly sensitive to congestion or signal problems leading to delays, and the impact of these traffic problems on other road users is magnified by the high percentage of truck traffic.

The Public Works Director has access to police radio and monitors it from his office on a radio handset and picks up on calls regarding traffic incidents and signal problems. Police are allowed to take control of signals to tackle such situations. The planned bringing together of the City Police Command Center, Sheriff's Dept., and Community Section division under one roof at the City Hall emphasizes this close working relationship with the Police.

The City's current traffic control system though operating well does not support some of the feature City would like their system to have for enhanced traffic operations. These features include the following:

- Automatic notification of traffic problems (congestion)
- Tracking of incoming fault/problem reports (including those from the public)
- Equipment fault tracking
- Accident/incident tracking and recording

Looking to the future, the City has already made the decision to upgrade the current signal system to provide improved functionality. The City expressed a willingness to delay the upgrade and make the system choice in concert with the I5/Telegraph Road project in order to take into account the projects' requirements.

For the new system, the City envisions workstations being located at three sites: the Police Command Center, Community Section Division, and Engineering Department. The City's Information Systems department would carry out system maintenance.

The City would like to see the use of emerging ITS standards in a future system and for future traffic signal control equipment. This can include the replacement of signal controllers and current traffic control system if these are required to reach the City's goals and provide the required support for future operations maintenance.

Summary:

Operations: The City of Commerce wants to improve mobility through improved signal timings, inter-jurisdictional coordination, CCTV surveillance, and using the traffic control system as a tool to support operations. This should be achieved while minimizing impact on the staff resources.

Maintenance: Will continue to use SMI, but wishes to also improve response to reported problems through functionality in an upgraded traffic control system and allow access to the system by other departments in the City.

3.3. Montebello

The City has limited staff resources and has no identified traffic engineering department as such. The City Engineer carries responsibility for traffic signal operations, but it was clear that the Public Works Director is also actively involved in signal issues. Currently, a consultant (PEEK) under contract to the City does signal timing.

The City does, however, wish to improve its signal operations without adding staff resources. To this end, the City expressed a desire to have its own Traffic Control System, while acknowledging a concern about the costs associated with the upkeep of communications.

The County has performed signal upgrades in the City as part of the County's TSSP improvement program, the City wants to stay with County specifications as far as any future upgrades to the traffic signal equipment is concerned.

Summary:

Operations: The City of Montebello wants to improve its signal operations through the installation of a traffic control system for the City and upgrades to signal equipment following LA County DPW practices. This should be achieved while minimizing impact on the staff resources.

Maintenance: Will continue to use PEEK.

3.4. Downey

The City of Downey has already identified traffic signal operations and the use of ITS as a priority item for the City. To this end, the City is in the process of developing a Master Plan for ITS deployment.

At this point, the City sees critical elements of this Master Plan being a City owned and operated traffic control system located in a traffic control center, with a city-wide communications network capable of carrying video images as well as data. The TCC would be networked for system access by other City departments such as emergency services.

The City Engineering Department believes it has sufficient staff for a higher level of signal operations, but recognizes that the staff is inexperienced. The City is, therefore concerned about system software maintenance and would like the Master Plan to address such issues.

The City recognizes the importance of maintaining signal timings and would like to use SYNCHRO in the future to develop timing plans. Functionality required of a future signal system would include the ability to generate alarms in congestion situations. In addition, the City would like to explore the possibility of using video cameras for incident detection.

Signal maintenance is carried out by the County, and the City has no plans to change this arrangement.

Summary:

Operations: The City of Downey sees the use of a new advanced traffic management system and City TCC as part of a new emphasis on signal operations. The City wishes to dedicate existing staff to signal operations and sees automated data collection, timing plan generation and incident detection as part of improved signal operations.

Maintenance: Will continue to use the County.

3.5. Norwalk

The City of Norwalk uses Econolite signal control equipment exclusively, and expressed a desire to continue using Econolite's equipment in the future. The City operates and maintains its own signal equipment and so it has already recognized the need for, and the benefit of, installing a traffic control system with full monitoring capabilities.

All City maintenance activities are carried out from City's maintenance Yard which includes street lights, sewer, power, traffic signals, water, etc. Thus, the City has sufficient resources, in terms of both equipment and staff to carry out maintenance. At this time, four staff members are dedicated to signal maintenance.

The City is very concerned about operation and maintenance issues and would like this Project to have a positive impact on the City's maintenance resources. The City indicated that at most one person would occasionally monitor the client workstations. City monitoring would likely be on an exception basis, relying upon alarms that are triggered during normal business hours. During off hours, it was suggested that the signal maintenance staff be paged or notified in some way. The City requested that the City maintenance staff be equipped with a laptop computer for remote access to the system.

The City is interested in deploying CCTV cameras at various locations but has no interest in deploying CMS. Due to staff and space limitations, an interface with the CCTV should be via a single system that could host multiple applications.

The City has a goal of improving its response to signal failures by locating system workstations at the City yard for signal maintenance staff and a workstation at City Hall for engineering staff. This will enable the signal staff to be better informed. The City does not expect any police involvement with the operation of the signal system.

The City would welcome improved inter-agency signal operations with the Cities of Santa Fe Springs and Downey, and Caltrans. In particular, the City would like to coordinate signals with Caltrans along Alondra Blvd., Firestone Blvd. and Rosecrans

Blvd. Recently, the City was able to communicate with one of the Caltrans signals along Firestone Blvd., by receiving a sync pulse using the AB3418 protocol. The City would like to do similar arrangements on other intersections and would like discussions with Caltrans regarding signal coordination.

It was also mentioned that the high percentage of truck traffic resulted in premature deterioration of inductive loop installations and the City expressed a desire to use video image detection cameras.

The City is also interested in responding to freeway events such as incidents – but stressed that the response must be automated and not reliant upon City staff being available to approve or implement actions.

The City has a transit department that runs the transit service in the City. The City is interested in the transit priority functionality in the traffic signal system to improve the transit efficiency.

Summary:

Operations: The City of Norwalk wishes to broaden the scope of its signal operations through inter-agency coordination, but requires a new traffic control system to provide the tools to do this within the bounds of current staffing.

Maintenance: Will continue to carry out signal maintenance using agency forces with improved effectiveness through automated fault reporting.

3.6. Pico Rivera

The City out-sources both signal operations and signal maintenance to the City of Santa Fe Springs. The City's signals on Telegraph Road, which Pico Rivera shares with the City of Downey, are operated and maintained by the County under Downey's maintenance contract with the County. Both Cities share the cost of maintenance.

The City of Pico Rivera finds it an inconvenience to have to request permission from the County to enter a City controller cabinet. They also feel that the changes the County has made to its maintenance procedures has degraded service. However, the City does not intend to use City staff for either operations or maintenance in the future and has no plans to increase staff either.

Coordination with Caltrans signals along Rosemead Boulevard is perceived as the single biggest operations problem at the moment.

Maintenance costs are a continuing issue in the City due to the "business orientation" of the City Council. For these reasons, the City would like to keep open the option of being able to bid controller maintenance to ensure competitive pricing.

The City sees that the provision of a traffic control system, and giving the maintenance provider a workstation on the system, could be a means to improving the performance of the contractor and response to problems. However, the City is sensitive to incurring extra on-going costs to sustain such a system and requested that, as part of this project, the County makes clear the maintenance costs of any proposed solutions for the City.

The City also wishes "do nothing"` to be considered as an option for the City.

Summary:

Operations: The City does not wish to add staff resources or take on any extra operational responsibilities.

Maintenance: Will continue to use the City of Santa Fe and County, but wishes to be able to effectively control and minimize any on-going costs.

3.7. Santa Fe Springs

The City of Santa Fe Springs uses Econolite signal control equipment exclusively, and expressed a desire to continue using Econolite's equipment in the future. The City operates and maintains its own signal equipment and so it has already recognized the need for, and the benefit of, installing a traffic control system with full monitoring capabilities. However, the City has experienced tremendous, unanticipated growth, accompanied by cuts in the City staff. There is considerable resistance to adding staff, with the result that the City does not see the possibility of dedicating current staff to "manning" a traffic control system.

Instead, the City has a goal of improving its response to signal failures by locating system workstations at the City yard for signal maintenance staff and station at City Hall for engineering staff. This will enable the signal staff to be better informed. The City does not expect any police involvement with the operation of the signal system.

The City would welcome improved inter-agency signal operations in general and along Telegraph Road in particular. An example given was the need to work closer with the County on signal timing for Carmenita Road and Norwalk Boulevard.

Other operational issues include the City's heavy truck traffic and regular traffic at the railroad crossing of Florence Avenue and Pioneer Boulevards. Crossing closures can be lengthy and can induce significant delays. To avoid these crossing delays, Telegraph Road is a viable alternative route. However, this would require advanced dynamic signing on approaches to the affected area, to make traffic aware of crossing closure.

It was also mentioned that the high percentage of truck traffic resulted in premature deterioration of inductive loop installations and the City expressed a desire for above surface detection to be considered.

The City is also interested in responding to freeway events such as incidents – but stressed that the response must be automated and not reliant upon City staff being available to approve or implement actions. Other system functionality desired was transit priority (rather than pre-emption) and a means to reduce the negative impact of Emergency Vehicle pre-emption.

City would like to run their intersections in free mode in light traffic conditions so this should be accommodated in any new system or traffic equipment.

Summary:

Operations: The City of Santa Fe springs wishes to broaden the scope of its signal operations through inter-agency coordination, but requires a new traffic control system to provide the tools to do this within the bounds of current staffing.

Maintenance: Will continue to carry out signal maintenance using agency forces with improved effectiveness through automated fault reporting.

3.8. City of La Mirada

The City of La Mirada is a County "contract" city and so the County operates and maintains the City's signals. The City is satisfied with this situation and has no desire to change the arrangement.

The City is very supportive of the project and will participate as much as possible, with the proviso that any costs the City may incur in doing so are kept "low". An example would be that, in addition to reporting signal equipment problems, the City would like to be able to view traffic conditions along Telegraph Road and have automated reporting of congestion. To achieve this, the City does not see a dedicated traffic control as necessary or desirable but felt that the controllers would be under a system at the County. Rather than have one or more fully capable workstations on this system located in a City facility, the City would prefer access by a web browser.

Summary:

Operations: The City of La Mirada sees the project as an opportunity to provide the County with improved capability for the continued operations and management of the City's signals while providing the City with better visibility of signal related problems

Maintenance: Will continue to use the County.

3.9. Los Angeles County

As champion of the regional integration and operation of signal systems, the County is wholly supportive of the project and its goals. The County has the intention of installing a traffic control system that would monitor the County's signals in the corridor. It would also, as necessary and approved by the relevant city department, control and monitor any signals that the County operates and maintains under contract.

This traffic control system is being selected as part of another Forum project according to requirements that have already been identified by the County.

Information sharing will be achieved through integration of the County's system into the Countywide Arterial Management System architecture.

Summary:

Operations: Signals in the corridor being operated and maintained by the County will come under the control of the County's future traffic control system.

Maintenance: The traffic control system will support the County's maintenance activity.

3.10. Whittier

The City of Whittier uses Econolite signal control equipment exclusively, and expressed a desire to continue using Econolite's equipment in the future. About 50% of the signals are equipped with ASC/2 controllers, the other 50% utilize older versions of Econolite controllers such as ASC-8000, KMC-2000, KFT-1800 etc.

Whittier Blvd., a major road within the City of Whittier is operated and maintained by Caltrans. The intersections on this road are equipped with Type 170 controllers utilizing Caltrans C8 software. Some intersections within the City are also operated and maintained by County.

The City utilizes in-house staff to maintain the signals owned by the City. The City has 3 maintenance technician staff and 2 traffic engineer staff (not full time).

The City has good working relationship with the surrounding cities and Caltrans and has no operational issues that need to be addressed as part of this Project.

The City's resources are very limited. Being a bedroom community, tax base is small and the City has no available funding to increase its operation and maintenance responsibility. The systems installed as part of this Project should be self-sustaining and require little effort on parts of the City forces to operate and maintain them.

The City does see the usefulness of having a central traffic control system but has no resources to devote to operation and maintenance of the system. Thus, the City would like that their signals be connected to the City of Santa Fe Springs system and the City be provided a workstation at the City Hall and City Yard for monitoring and controlling their signals.

The City is interested in deploying CCTV cameras at various locations but has no interest in deploying any CMSs. Due to staff and space limitations, an interface with the CCTV should be via a single system that could host multiple applications.

The City has Advanced loop detectors at many locations and has VIDS at three locations. The City prefers deploying VIDS over loops.

The City is served by many transit services including Whittier, Norwalk, MTA and Foothill. The County is working on a Whittier Blvd. /Washington Blvd. transit priority project.

Operations: The City of Whittier wants to improve its signal operations through the installation of a traffic control system for the City but does not wish to have the system. The City wants to continue using Econolite equipment and would like to upgrade older controller. This should be achieved while minimizing impact on the staff resources.

Maintenance: Will continue to use in-house staff.

4. UPGRADES

The objectives of this project can be summarized as being to synchronize signals along the I-5/Telegraph Road, to provide the Agencies with means to better manage their signals and to be able to exchange data with other agencies in the region. In order to meet these objectives various changes to traffic signal equipment will be needed. These changes will be in the form of modification, upgrade and installation of new equipment as categorized below:

- **Central systems**
    - Computer hardware
    - Computer software
    - Communications equipment
        - Central office (local area networks)
        - Field communications termination equipment
        - Central to central (wide-area networks)
- **Field Equipment**
    - Traffic signal controllers
    - Detection
- **Communications**
    - Communications media between the central and the controllers
    - Communications media between the traffic control systems in the corridor (center-to-center)
    - Communications to the Regional TMC

Justification for Upgrade

Upgrades will be needed in order to meet the project requirements. These requirements have been derived as a result of work in other Forum projects and a comprehensive list has resulted. In the case of **central systems**, the project requires the availability of a system in order to monitor and control the field equipment and collect traffic data. In addition the system must communicate at the corridor level in order to transfer data and receive requests to implement specific timing plans. Thus the project would fund the provision of a central system with these capabilities or the modification or upgrade of an existing system to provide these features. Also to be taken into account would be the support of non-proprietary communications protocols (see the discussion on field equipment, below) and the emerging protocols for communications between central systems (see the discussion on communications equipment, below). The latter is important as it could affect the availability of future Federal funds. Of particular relevance is the protocol for the County's Information Exchange Network (IEN) – the IEN forms the communications network for the Countywide Arterial Management System (CAMS).

Field equipment upgrades under the project would include the necessary modifications to the controllers to support the communications to the central. The project requires that non-proprietary, or open, protocols are used for any ATMS deployment. Two such protocols are currently available for use. The first is the result of the national standards activity sponsored by the FHWA; this is the National Transportation Communications for ITS Protocol (NTCIP). Recently issued rule making by the FHWA for ITS deployment mandates the use of such national standard protocols in order for projects to be eligible for FHWA funding once the standard has been adopted.

The implementation of NTCIP has met with mixed success. There are many instances of successful changeable message sign installations which are NTCIP compliant. This is not the case with the vehicle actuated traffic signal controllers. In the early days of NTCIP deployment, the lack of understanding of NTCIP and its implications for equipment and communications networks led to problems in its specifications in signal system procurement. In such cases, the result was that NTCIP was not deployed and another protocol was used in its place.

Implementation of NTCIP in central traffic control systems and controllers has required significant investment by suppliers. The systems using NTCIP have therefore needed extensive troubleshooting to resolve specification and implementation discrepancies between suppliers. Currently many suppliers of central system and controller equipment claim support for NTCIP; a relatively few systems have been deployed using NTCIP for controller communications. In mid-2001, the City of Mesa made operational the first deployment of traffic signal controllers using NTCIP for regular, day-to-day use. This has been followed by implementations in Englewood, CO and Springfield, IL. In addition, there have be other examples of operational tests involving the use of NTCIP.

The second protocol is the California standard AB3418. This is available in two forms, AB3418, and AB3418 Extended. The State of California has a mandate that if any controllers are replaced within the State, they must support the AB3418 protocol.

This protocol however defines messages pertaining to only signal status and signal addresses. In order for full central monitoring and control to be supported the AB3418 Extended protocol must be used. This is considered to be an open protocol (i.e. not proprietary) and would appear to provide the ability to support the project requirements.

The implementation of a NTCIP compliant system will require upgrades to controllers as well as to the communications infrastructure. These upgrades can prove to be very expensive both in terms of capital costs and on-going maintenance costs for the Agencies.

Under these circumstances, it is recommended that the minimum project requirement for field communications would be the use of AB3418 (Extended). It would then be left to the relevant agency to decide on the use of NTCIP.

The implications of the above discussion on communications protocols on different components of traffic signal systems are as follows:

- The controllers should support the AB3418(E) protocol
- The Central System should support the AB3418 (E) protocol and be shown to be capable of supporting NTCIP for field communications in the future.

As well as providing the network to connect the field equipment to the traffic control systems, in the category of **communications** the project should make provision for a corridor-wide communications network. This would also include any work needed on an existing communications network in order to support a change in the communications protocol if this resulted from the project. Since the direction of the industry is to move towards NTCIP compliant systems for both field-to-center and center-to-center communications, the communications system should be capable of supporting the relevant NTCIP protocol.

The center-to-center communications protocol resulting from the County's East San Gabriel Valley Pilot project is based upon the Common Object Request Broker (CORBA)

standard, as is the SHOWCASE communications network. CORBA is one of the Center-to-Center standards for NTCIP, the other being DATEX. Both protocols define the methods for the transfer of data between intelligent transportation systems. They differ in their approach. DATEX relies on the use of a common definition of the data in the systems (using what is known as a data dictionary). CORBA is based upon the object-oriented approach, where the definition of the data is in the object itself.

System detection is an essential component of these ATMS. The installation of suitable detectors to collect traffic data (system detectors) would be funded along with the necessary controller modifications for the transfer of traffic data to the central office. System detection should be capable of collecting volume and occupancy information on per lane basis and the central systems should be able to derive speeds for each lane.

Note that the choice of the detection system will not determine the need for controller upgrades.

4.1. Controller Upgrade Options

From the above discussion, it can be seen that, at this stage of the project, the accommodation and support for AB3418 (E) and NTCIP communications protocols by the central is an important consideration. Both protocols impose a significant processing requirement on the controller's processor. Experience with the County's LACO4 program would indicate that it is possible to accommodate AB3418(E) within a "standard" 170 configuration, although this may be controller firmware dependent. This is not with the NTCIP however, which cannot be accommodated without some form of controller upgrade, and may also require an upgrade to the communications infrastructure. This could be in the form of reconfiguring the communication network to reduce the number of devices per channel, pulling additional cable, or moving to a higher bandwidth medium.

A further consideration is that the processor that forms the basis for the Type 170 controller, the Motorola 6800 series processor, is out of production. Therefore, any new controller purchases will comprise an upgrade compared to an existing 170 controller.

All agencies in this corridor use Type 170 controllers with the exception of the City of Santa Fe Springs, which uses and wishes to continue to use Econolite equipment. This section discusses options for controller upgrades for these two situations.

It is noted that the County's policy for controller upgrades and the identification of a County standard is under review.

As far as national standards are concerned, there is an activity to develop a new, open controller standard known as the Advance Transportation Controller (ATC). The objective is to define a non-proprietary hardware platform for a controller and cabinet with associated operating system and defined programming interfaces. Given the requirements of this project, the ATC standard would meet the project needs. However, since the standard is still in the process of being adopted, recommending this for I-5/Telegraph project is premature. It should be noted that the 2070 controller is considered to be the current version of the ATC standard. It is recognized that the local agencies requirements should be accommodated when identifying any controller upgrade recommendations.

4.1.1. Type 170 Controller Up-grades

Since the traditional 6800 series processor is no longer available for standard 170 controllers, the need for a controller upgrade will be necessary in the future. There are several upgrade options available. The primary options and their key characteristics are as follows:

- **The 68HC11 Processor Board**
  - a CPU module having the same form factor as the 170E CPU board
  - manufactured by Safetran and McCain
  - runs existing 170 software with only minor modifications
  - hardware compatibility is limited to the Safetran Model 170E and McCain Model 170E controllers
  - provides support for AB3418E protocol but not for NTCIP communications
  - neither controller hardware nor software meets the ATC standard.

- **Replacement with a 170 ATC Controller**
  - utilizes the 170 controller chassis with a Motorola 68360 Micro controller board running OS9, giving it the equivalent performance of a 2070L controller
  - manufactured by Safetran
  - would allow the controller to run any programs designed for the 2070
  - software exists for the 170 ATC, which supports both AB3418 Extended and NTCIP (Siemens ITS' NextPhase) and is also under development (Wapiti)
  - is currently being deployed in Houston, TX, Portland, OR and by the States of Oregon and New Jersey.
  - can meet the software and hardware standard for ATC

- **A Memory Module Processor Board**
  - processor module that fits into the Memory Module slot of the 170 controller
  - manufactured by Safetran and McCain
  - has a built-in interpreter for 170 code, allowing the use of 170-native code
  - runs existing 170 software with only minor modifications
  - would enable support for AB3418E and NTCIP
  - architecture is not compatible with the either the hardware or software standards for 170 ATC

- **Replacement with a 2070 Controller**
  - first generation of the Advanced Transportation Controller (ATC)
  - available from EAGLE, Econolite, NAZTEC, Safetran, McCain, US Traffic
  - wide range of software from manufacturers and third party suppliers (e.g. Bi Tran Systems, ITC, Siemens ITS)
  - meets the ATC standard

- extensive deployment (including the City of Los Angeles)

4.1.2. Econolite Upgrades

At this moment, two controllers are available from Econolite that can support AB3418 (Extended) and NTCIP. These are the ASC/2 (a NEMA controller) and the Econolite 2070L. The 2070L represents a configuration of the 2070 series of controller specifications that does not use the VME chassis standard, but implements a less flexible, lower cost design.

The advantage for the agency in choosing a Type 2070 would be the availability of product from a number of different sources, hence ensuring competitive procurement. However, the 2070L is more expensive than the ASC/2 – a situation that is likely to remain for 12 to 24 months. The 2070L is available in a version that is compatible with NEMA cabinets (2070LN).

4.2. Central System Options

As described in Section 3, none of the intersections are equipped with any system detection or have any communications to the central. Except for City of Commerce and Caltrans, none of the Agencies have a central traffic control system. Two of the agencies contract with the Los Angeles County Department of Public Works for operation and maintenance, one agency contracts with another local agency, two agencies utilize a private contractor for signal operation and maintenance, and three agencies utilize in-house staff to operate and maintain their signals system. The agencies that contract out the signal operation and maintenance to others, want to continue this arrangement in future, but want the entity maintaining their system to have access to a central traffic control system and want a workstation at their facilities to be able to monitor the system status.

Figures 4.1 through 4.3 present the architecture options available to the City's for traffic control systems:

- **Controllers under a local system**

  Under this scenario, each City has its own independently operated traffic control system, which is interfaced into IEN. Each City is responsible for maintaining its system.

- **Controllers under a shared system with other local Cities**

  Under this scenario, two or more Cities' signals are connected to one traffic control system. The system resides in one City's TCC, the other Cities have a remote workstation at their site. Through this workstation, the Cities' can monitor and control intersections under their jurisdiction. The City that houses the Traffic Control System is responsible for maintaining it.

- **Controllers under a shared system with regional agencies such as County and Caltrans**

  Under this scenario, a local City's signals are connected to traffic control system of a regional agency such as County or Caltrans. The system resides at the regional agency's TMC, the local City has a remote workstation at its site. Through this workstation, the local City can monitor and control intersections under its jurisdiction. The regional agency that houses the Traffic Control System is responsible for maintaining it.

Given this and based upon the analysis presented in Section 3, the recommendations for the traffic control system approaches in each agency are as follows:

4.2.1. Caltrans

Intersections should be connected to Caltrans' future CTNET system at the District 7 TMC.

4.2.2. Commerce

The project should result in a fully functional traffic control system located in the City of Commerce. This can be achieved either by upgrading the existing Bi Tran system or replacement with a new system. Controller firmware should be upgraded/replaced to support AB3418E protocol and controllers should be upgraded/replaced if NTCIP communications needs to be supported.

The upgrade of the current Bi Tran system to support the interface to the County's IEN should be investigated.

4.2.3. County

Intersections should be connected to County's future traffic control system at the County TMC initially using AB3418E, and upgrading to NTCIP in the future.

It should be noted that section 3 also provides details regarding required functionality and equipment (workstation) location and support. These will be taken into account in defining the functional requirements for the various systems.

4.2.4. Downey

The project should result in a fully functional traffic control system located in the City of Downey. AB3418E should be used as the communications protocol with the capability to upgrade to NTCIP in the future to accommodate the City's desire to secure future funding for adding ITS system components.

4.2.5. Montebello

The project should result in project intersections being connected to a fully functional traffic control system located at the City of Downey. . Controllers should be upgraded in line with the County's policy for controller upgrades. Communications should initially use AB3418E, and upgrading to NTCIP in the future.

4.2.6. Norwalk

The project should result in a fully functional traffic control system located in the City of Norwalk. The City desires to maintain Econolite as its supplier of traffic control equipment. The selection of the traffic control system should take into account and emphasize support for Econolite equipment.

4.2.7. Pico Rivera

The project should result in project intersections being connected to a fully functional traffic control system located at the City of Santa Fe Springs. Communications should initially use AB3418E, and upgrading to NTCIP in the future.

4.2.8. Santa Fe Springs

The project should result in a fully functional traffic control system located in the City of Santa Fe Springs. The City desires to maintain Econolite as its supplier of traffic control equipment. The selection of the traffic control system should take into account and emphasize support for Econolite equipment, while supporting AB3418E, with future NTCIP support.

4.2.9. La Mirada

The intersections in the City of La Mirada should be connected to the County's traffic control system.

4.2.10. Whittier

The project should result in project intersections being connected to a fully functional traffic control system located at the City of Santa Fe Springs. The City desires to maintain Econolite as its supplier of traffic control equipment. The selection of the traffic control system should take into account and emphasize support for Econolite equipment, older controllers should be upgraded to support their connection to the traffic control system.

Figure 4-1: Local TCS Architecture For Controllers Under Local System

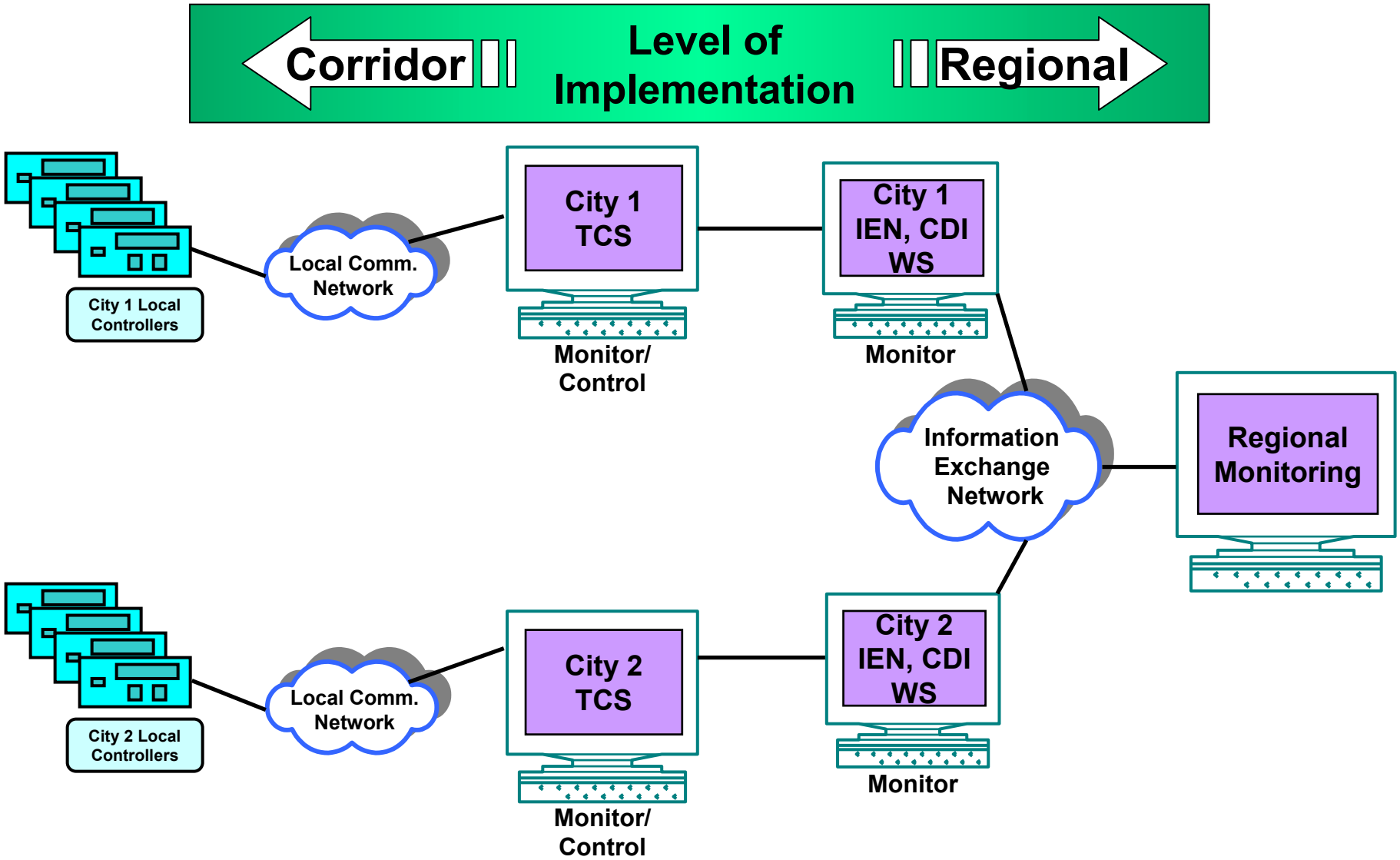


Figure 4-2: Local TCS Architecture For Controllers Under Shared System (Other Cities)

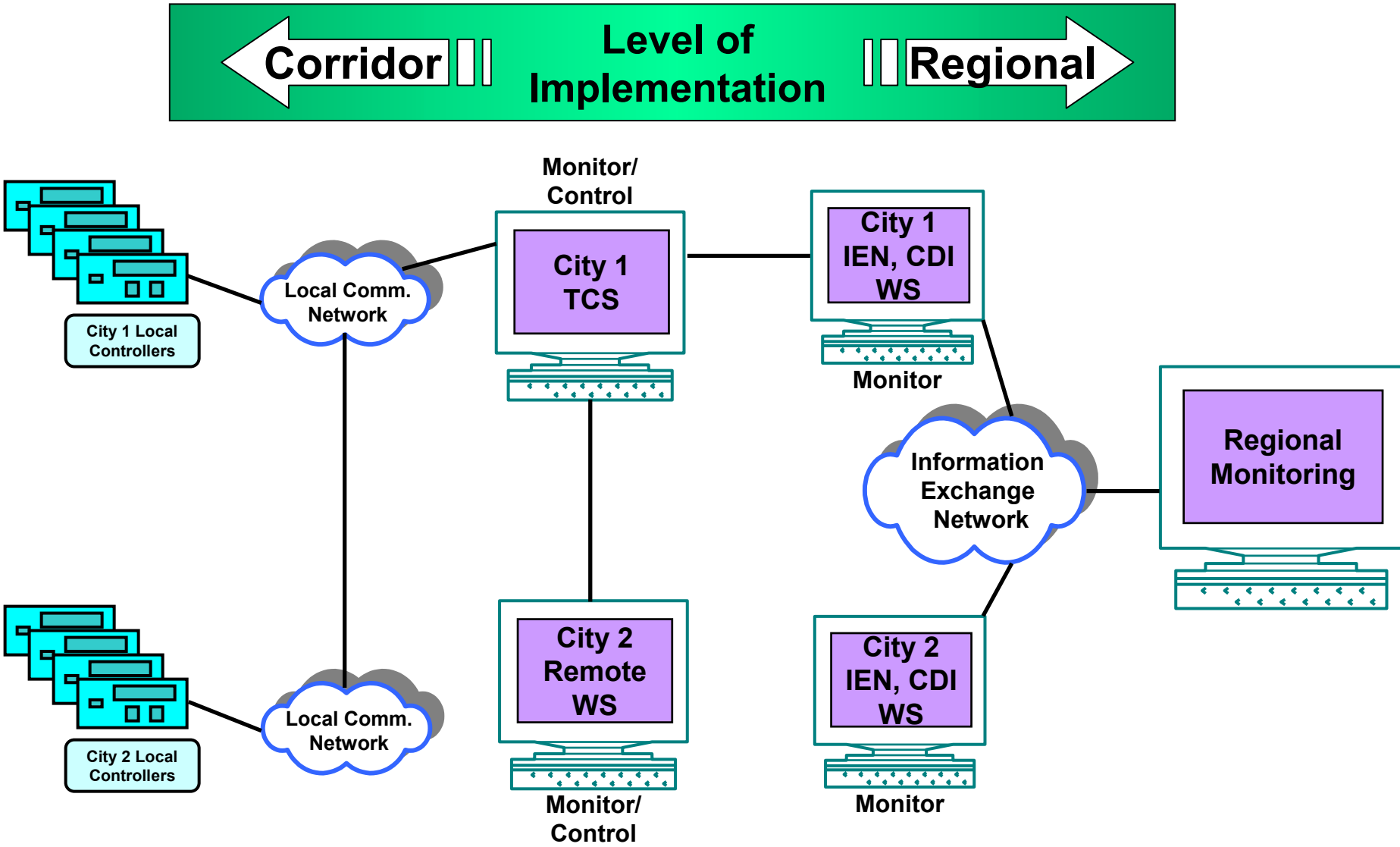
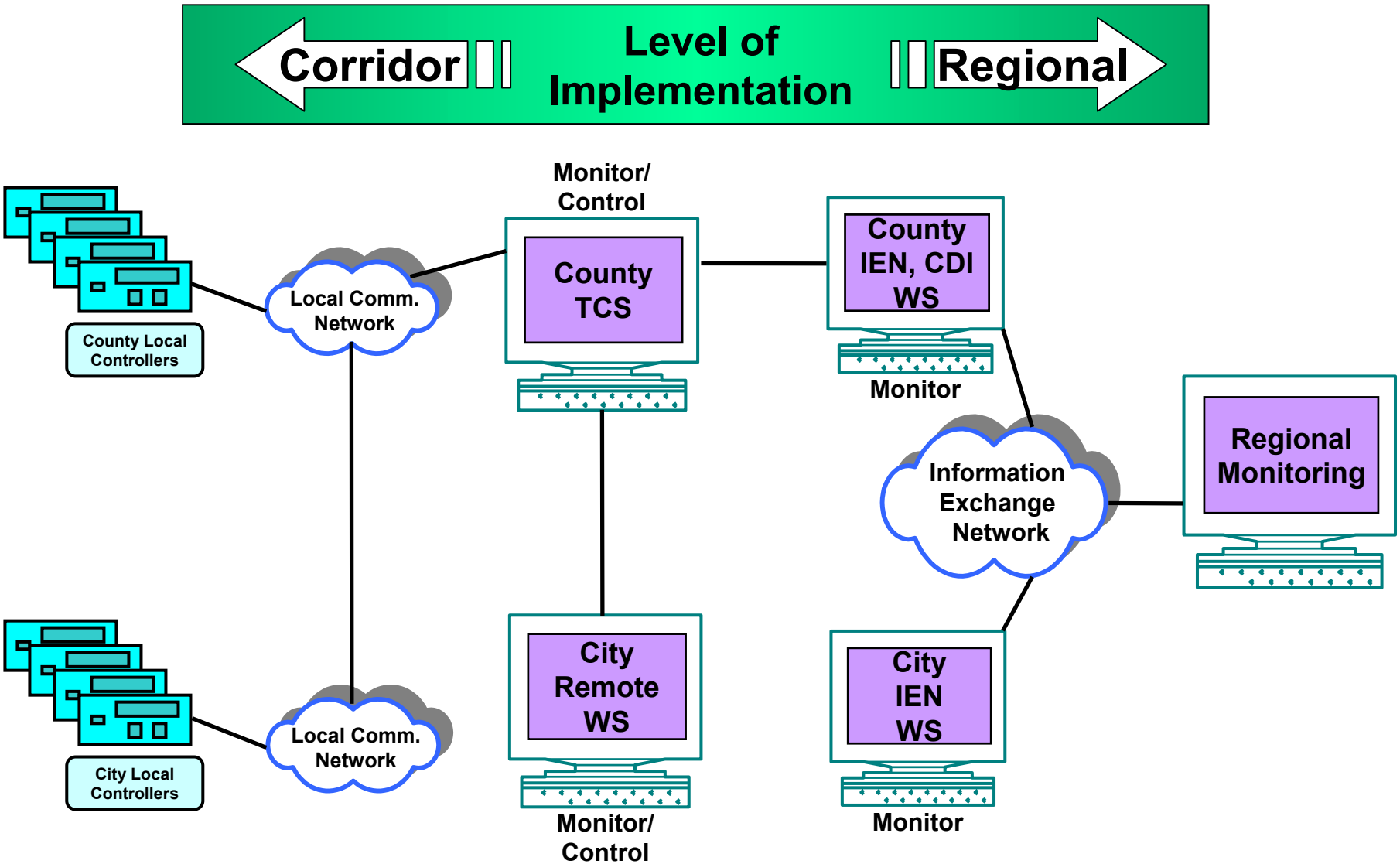


Figure 4-3: Local TCS Architecture For Controllers Under Shared System (Regional)



Appendix A: Presentation Used At the Pre-Design Meetings With the Stakeholder Agencies

SIEMENS

Appendix B: I5/Telegrapgh Road Traffic Signal System Inventory By Intersection

SIEMENS

Appendix C: Figures Depicting Communications Infrastructure for I-5/Telegrapgh Road Corridor