Santa Monica Freeway

SMART CORRIDOR

SMART CORRIDOR LESSONS LEARNED PROJECT

FINAL REPORT

APPENDICES

Prepared for:

LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

Prepared by:

TRANSCORE
An SAIC Company

35 South Raymond Avenue
Suite 200
Pasadena, CA 91105

March 31, 1999

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LIST OF COMMON ABBREVIATIONS AND ACRONYMNS

AM	Amplitude Modulation
ATCS	Adaptive Traffic Control System
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Transportation Management Systems
ATSAC	Automated Traffic Surveillance and Control
CAD	Computer Aided Dispatch
Caltrans	California Department of Transportation
CATV	Community Access Television
CCTV	Closed Circuit Television
CHP	California Highway Patrol
CMS	Changeable Message Sign
COTS	Commercial-Off-The-Shelf
CPFF	Cost Plus Fixed Fee
DSS	Decision Support System
FFP	Firm Fixed Price
FHWA	Federal Highway Administration
FSP	Freeway Service Patrol
GUI	Graphical User Interface
HAR	Highway Advisory Radio
HAT	Highway Advisory Telephone
ITS	Intelligent Transportation Systems
LADOT	City of Los Angeles Department of Transportation
LAN	Local Area Network
MOE	Measures-of-Effectiveness
MOU	Memorandum-of-Understanding
MTA	Los Angeles County Metropolitan Transportation Authority
O&M	Operations and Maintenance
PCB	Professional Capacity Building
PS&E	Plans, Specification, and Estimates
SATMS	Semi-Automated Traffic Management System
SC	Smart Corridor
SCOPE	Smart Corridor Operations Planning Element
SCTC	Smart Corridor Technical Committee
SOW	Scope-of-Work
SR	State Route
T&M	Time and Materials
TCS	Traffic Control System
TMC	Transportation Management Center
TV	Television
WAN	Wide Area Network

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TransCore would like to recognize the contributions of the following agencies and firms in the development of this document.

Smart Corridor Agencies:

- Federal Highway Administration (FHWA)
- California Department of Transportation (Caltrans)
- California Highway Patrol (CHP)
- Los Angeles County Metropolitan Transportation Authority (MTA)
- City of Los Angeles Department of Transportation (LADOT)
- City of Beverly Hills
- City of Culver City
- City of Santa Monica

Firms:

- Gardner Transportation Systems
- Science Applications International Corporation (SAIC)

APPENDIX A – UNIVERSAL THEMES

A.1 GENERAL COMMENTS

Smart Corridor Strengths

1. **Inter-Agency Coordination and Cooperation.** In working together, mutual trust and respect were achieved among Agencies with previously uncoordinated agendas for traffic management within the corridor. Agencies learned to regard the whole transportation system as a shared responsibility for a more effective product at a better price. Agencies also learned about how their individual actions may impact another Agency.
2. **Knowledge Gained through Technical Accomplishments.** Most interviewees believe that great technical accomplishments have been made on SC, and that much valuable knowledge has been gained through the program. Many believe that the technical accomplishments resulted in a system that is the most advanced of its type in the world.
3. **Individual Commitment and Dedication.** Many interviewees cited the strong personal commitment and dedication of many individuals as a strength of the SC program. Enthusiasm of the individuals involved in the program maintained momentum throughout the project's duration. Persons with a great deal of devotion and passion for the concepts supported the program tirelessly in order to make great strides.

Smart Corridor Weaknesses

1. **Staff Turnover**. Turnover, both at TransCore, and at the Agencies, impacted the project as corporate/agency "memory" was lost whenever a project member left. When new people were brought in, each had to tackle a significant learning curve. Often, new staff did not have the detailed knowledge of prior decision-making, so they tended to want to "re-invent" the issues/decisions previously made.
2. **Demonstration System vs. Operational System.** Differing opinions exist, both within and across Agencies and TransCore, as to whether the SC system should be a demonstration system, an operational system, a demonstration of an operational system, or an operational system to demonstrate concepts. Many Agency "differences-of-opinions" stem from the fact that various perspectives exist as to what are acceptable performance requirements for the system.
3. **An Ambitious and Complex Undertaking.** In retrospect, the scope of the SC program was overly ambitious considering the technology available at the time, and the resulting system took too long to develop. Both TransCore as well as the Agencies underestimated the complexity and the schedule/time that it would actually take to complete.
4. **Requirements Issues Were Pervasive.** It is clear that many of SC's perceived weaknesses stem from requirement issues. Requirement expectations unfolded and were either not articulated, or not captured, or both. For example, performance requirements were not addressed in relation to a robust, reliable system. Requirements were not clearly documented, baselined, or managed for changes. This situation often caused a requirement to not be understood in the same manner by all involved stakeholders.

Explanatory Note: *The Smart Corridor program spans two (2) eras of transportation system design philosophy. It has its roots in the "traditional" engineering approach represented by carrying out a Conceptual Design Study, followed by a Preliminary Design Phase, and then a Detailed Design Phase. The outputs of these phases are characterized by wordy documents that are descriptive in nature. While providing a good narrative format that transportation engineering professionals are familiar, this approach is not suited to meet the need to precisely convey the desired system functionality to the system developer.*

The deficiencies of this approach have been recognized, and there is consensus that more attention needs to be given to adopting a stricter "Systems Engineering" approach to system design and development. This approach lays great emphasis on the definition of Functions and Requirements; whereas a function describes "what" a system must do and requirement describes "how well" the function must be performed. The "Systems Engineering" approach uses a number of "shall" statements to succinctly describe it contents and is commonly broken down into concept-of-operations, user requirements, functional requirements, and detailed design phases.

In the latter stages of the SC project, specifically the GUI development in the Phase 2 implementation and the re-start of the SCEMIS contract, specific efforts were made to establish clear definitions and requirements for the remaining work. Interviews with participants have remarked on the benefits of these actions.

5. **Impacts of "New" Technology".** The SC program was not structured to keep up with rapidly changing technology. The project spanned more than a decade, during which unforeseeable technical evolutions came about. Overall, the project was not structured with the flexibility to respond to changes in technology, and only in specific cases were appropriate corrective actions taken when alternative solutions or approaches became available.
6. **System Reliability.** The current SC system is not reliable and crashes frequently. The lack of reliability is preventing further evaluation and extension of the SC concept in its current form.
7. **Risk Mitigation**. Risk mitigation activities were only performed in the latter stages of the project by TransCore. The participants as a group did not consistently consider what things might go wrong or determine what strategies could be used to mediate those risks.

APPENDIX B – FEDERAL/STATE PERSPECTIVE

GENERAL COMMENTS

Strengths

1. **Smart Corridor Concept**. Federal/State interviewees generally believe that SC represents a great concept; to coordinate traffic management tools in a seamless interface. They further believe that the implementation is a technical breakthrough; the best of its kind available. Collecting data from many diverse sources, providing an electronic communication system between field elements, and combining them to assist in traffic management has been shown to be useful. Operators and others generally believe that the rules-based expert system correctly implements defined rules for decision support. Some interviewees believe that traffic management today in the I-10 corridor is improved; it benefits motorists, making them more aware of alternate routes. The 1994 Northridge earthquake proved that the concept of corridor-wide traffic management is viable.
2. **Individual Commitment and Dedication.** Federal/State interviewees credit the successes of the SC program to individuals who were committed and dedicated to the concept. They mention enthusiasm as a strength of the persons assigned to the project. People did not give up on the concept, though the project spanned a long period of time.
3. **Learning Experience.** Most interview participants thought that SC provided an excellent learning experience. They feel that all of the Agencies are now more aware of institutional and technical issues in designing/developing/integrating systems. Furthermore, they feel that SC provided good education and awareness of multi-agency efforts. SC was also felt to have opened the lines of communication between the Agencies in order to provide an opportunity for traffic management coordination throughout Southern California.

Weaknesses

1. **Smart Corridor Project Scope.** Federal/State interviewees generally think that the scope of the SC project and its concept of operations are not well understood by all members (Agencies & JHK/TransCore). Comments included that the scope/concept was not well publicized; ambiguous, open to interpretation; and a good idea without a system view. In addition, some felt that the SC project's scope was too big, that a much smaller project with a more focused agenda was needed, and that a less ambitious scope should have been prepared.
2. **Schedule Slips.** Schedule slips were mentioned as a weakness by Federal/State interviewees. Interviewees believe that the schedule was over-ambitious and that the effort was underestimated by the Agencies and JHK/TransCore. The system, being new and novel, was not well understood at the outset; the complexity grew beyond anyone's expectations. Most believe that the scope of the concept grew over time, adding ideas and elements that increased the complexity. In addition, most felt that a faster turn-around time from inception to completion would have aided Smart Corridor; by the time the SC project was complete, some technology was already out-dated.

3. **Smart Corridor Software.** Some Federal/State interviewees mentioned that the SC software does not perform up to expectations, lacks needed capabilities/functionality, and is not as user-friendly as desired.

4. **Deployment Approach.** Most Agencies felt that Smart Corridor "tried to bite off more than it could chew" by trying to develop and deploy "everything at once". They felt that for a demonstration project, you must first have all the infrastructure facilities installed in the field and "up-and-running". This needs to be done in order to support the "new" system that is being developed/deployed. In addition, they felt that Smart Corridor would have benefited from an incremental/phased development approach.

5. **System Requirements.** Most participants feel that Smart Corridor's requirements should have been more "firm". It was felt that they were "...too much of a moving target..." because the SC system design was actually defined as the project progressed.

6. **Training.** Resources (e.g., money, time, facilities, etc.) should be provided for continuous training of Agency staff on Smart Corridor. In addition, some felt that instead of hiring TransCore to undertake/complete all of the Smart Corridor efforts, that Caltrans staff should be trained to do it.

STAKEHOLDERS AND OPERATIONAL OBJECTIVES

Strengths

1. **Smart Corridor Role vs. Agency Mission.** Agencies' roles were generally consistent with their own missions. Although some reliance on individuals existed, and some resource conflicts prohibited the best people from being involved, generally the missions of the Agencies were complementary with their roles on SC program and this was of benefit.

2. **Staff Assignments.** In terms of the skills/decision-making authority of the State staff assigned to SC, State participants express that Caltrans provided people appropriately skilled in transportation elements.

Weaknesses

1. **Agency Commitment.** Some Caltrans staff members felt that more commitment could have been demonstrated by their own headquarters or senior management for SC to be successful.

2. **Staff Turnover.** Many Caltrans interviewees mentioned that their Agency's staff training policy results in turnover on long programs. The policy results in people moving from project to project, and from department to department in order to advance their careers. In addition, many individuals assigned to the SC program also had responsibility for other projects and duties.

3. **Smart Corridor Concept.** Some State staff feel that they have a good understanding of Smart Corridor's scope & concept-of-operations as it stands now; most, however, feel they do not. They feel that the overall program scope changed over time to reflect better understandings of what the system should do, and what it could do given technical limitations. Although State participants generally believe that all of the Agencies agreed to the original concept, they believe that some people did not truly understand all the

implications in the same way (i.e., Agencies agreed from their own perspectives). They thought that the original concept was to use SC for daily traffic congestion; but then this concept has evolved to its current state. Currently, the concept is working; but on a smaller scale than was envisioned.

4. **Staff Experience.** Federal/State interviewees felt that none of the SC Agencies had appropriate systems design/development engineers involved.

INFORMATION NEEDS AND SHARING

Strengths

1. **Information Sharing.** Generally, most interviewees believe that Agencies were not overtly reluctant to share information. Any difficulties got better through inter-agency collaboration and cooperation gained through working together toward a common goal. Information sharing helped relationships and built trust among individuals across Agencies. It was felt that positive cooperation was attained through Smart Corridor.
2. **Human Factors and the Motoring Public.** Caltrans performed behavioral studies in the early 1970's and applied the results to SC. Public input was not desired on either SC technical elements or what was possible within SC. State participants expected the public would adapt to the system as built, and for any elements toward which the public reacted negatively, Caltrans would make changes as necessary. It was further believed that people would read the signs and take diversions in case of a major incident.

Weaknesses

1. **SCTC Meetings.** The SCTC and its meetings were not perceived as wholly valuable by most interviewees primarily because they did not contain a mechanism to ensure members would follow through on assigned action items and a number of decisions were revisited again and again.
2. **Senior Management Involvement.** In terms of information sharing with upper management, some interviewees believe that their senior management needed to be much better informed on SC issues in order that managers could make better-informed decisions.

OPERATIONAL IMPLICATIONS OF INFORMATION SHARING

Strengths

1. **Consensus Building.** Consensus within Smart Corridor was obtained through workshop discussions, diplomacy, and persistence. In terms of an integrating organization for SC's development, MTA was the non-partisan overseer to bring SC together. In addition, participants believe that TransCore served as a catalyst/integrating element to help build and maintain consensus, developed with Agencies' inputs.

Weaknesses

1. **Agency Coordination.** At times, it was difficult to coordinate all of SC's activities with so many Agencies.

DESIGN AND IMPLEMENTATION CONSIDERATIONS

Strengths

1. **Design Review.** Participants believed that all Agencies had sufficient opportunity to review the design as much as was desired.

Weaknesses

1. **Lack of a "Systems Engineering" Process.** Federal/State participants expressed that the SC program could have benefited from application of a pre-planned, disciplined, end-to-end systems engineering process.
    - A project of this size should plan ahead for technical evolution and mid-course corrections due to advancement of technology
    - The Acceptance Test plan should have been based upon the design
    - Some believe that design should not be tied to specialized hardware items
    - Others believe that the Smart Corridor Operational Planning Element (SCOPE) effort should have been completed before any system manager design began
2. **Design Activities.** Some believe that the Agencies should have participated more fully in providing input and in performing some design activities themselves. It was also noted that better, more interactive design reviews with the Consultant would have been beneficial, although most believe that the expertise to properly evaluate the technical design did not exist anywhere in-house.

    Explanatory Note: The SC system (as it stands now) follows very closely to the functionality and form of the system as presented in the "Smart Corridor Conceptual Design Study Project Workbook". Especially relevant are "Section 2: Smart Corridor Central System" and "Section 9: Expert System". In addition, the "Implementation Plan (October 1989)" contains a concept of operations and description of how components would work together. The delivered system follows these operational precepts.

    Difficulties in generating agreed-upon requirements were generally thought to exist both with the Agencies as well as the Consultant. Most participants believe that requirements evolved and crept as the program unfolded, and as different concepts were explored. Many believe that requirements should have been more clearly defined early in the program, baselined, and managed for subsequent modifications.

3. **Advancement of Technology.** According to Federal/State interviewees, the advancement of technology affected the SC program in the following manner:
    - The project took too long to complete, thus technology changes occurred and associated ideas evolved which contributed to requirements creep
    - Technical changes during the time period necessitated many changes in design, and limited the functions/capabilities delivered

PROCUREMENT STRATEGIES AND CONTRACTING OPTIONS

Strengths

1. **Infrastructure Contracts.** Field infrastructure contracts were not a problem.
2. **Contract Direction.** TransCore got their direction from the SCTC, not just the contracting Agency. TransCore elicited information from either the Agencies and/or SCTC, depending on which was easier, and was responsible for being responsive to all Agencies' desires. This was considered a strength, since all Agencies had influence in the decisions.

Weaknesses

1. **Contracting Process.** Federal/State interviewees generally believe that the multi-agency contracting process imposed unnecessary problems on the SC program and posed a difficult situation for the Consultant (due to differing policies across Agencies). However, the various Agencies took part in contracting based upon when and where funding could be found. In ideal circumstances, they believe that one single contract, and one lead agency, would have improved the program's success. Some interviewees suggested Caltrans would have taken the lead. Most believe that the contracting methods used were not flexible enough for the types of problems experienced. For example, SC software/data contracts with TransCore were difficult; staff turnover at Agencies and TransCore posed problems with contractual efforts.
2. **Ideas for Improvements.** Participants offered the following suggestions for contracting improvements:
    - Establish a technical oversight team
    - Scale down SC's scope
    - Plan for an integration phase
    - Issue a beginning phase contract to scope out the effort, document requirements, and sort out institutional policy differences, then follow up with a second phase to implement the effort
    - CPFF or T&M contracts must be used for the beginning phase, because neither the Agencies nor the Consultant can know ahead of time how to estimate for all the unknowns of the requirements and the institutional issues

OPERATIONS AND MANAGEMENT

Strengths

1. **Real World "Test".** It was felt that Smart Corridor successfully demonstrated its functionality and operational capabilities during the Northridge earthquake (January, 1994).

Weaknesses

1. **Caltrans' Expectations.** Caltrans feels that the delivered SC system does not perform up to their initial expectations. Although the State was seeking a demonstration system,

the current SC system is not felt to be stable/robust enough and needs upgrades or replacements to meet expectations. It is recognized, however, that it is difficult to integrate such a system together, (with different operating systems, different hardware and software platforms), into a stable/robust environment.

2. **O&M Staff Skills.** Regarding staff skills to operate SC, the Federal/State interview perspective seems to be that currently, a wide variety of skills are needed to effectively operate the system, including traffic management, software, hardware, civil engineering, communications, and electrical engineering (i.e., traffic signal background). Most believe that eventually, the SC system ought to be able to be operated by a technician rather than an engineer so that the SC operator should not have to be concerned with system trouble-shooting.
3. **Operational Policies.** Institutional barriers were mentioned by most interviewees as detracting from the SC program, for example, in the contracting process and in the establishment of operational policies. It was further observed that the SC operational policies have yet to be approved by all Agencies
4. **O&M Costs.** Operations and maintenance costs were not identified early on enough in the project nor were they committed funds.
5. **Maintenance Issues.** Federal/State interviewees stated that weaknesses within the maintenance process seem to stem from the fact that the current SC system performs in an unreliable manner. Most interviewees believe that TransCore needs to debug the system for awhile (some say one to two years) on a continual maintenance contract with quick responses based on operators' experiences. Some believe that the field elements also need better maintenance.
6. **Acceptance Tests.** Most participants feel that the SC acceptance tests were performed too quickly because they were conducted mid-way through the 60-day burn-in time.
7. **Ideas for Improvement.** The suggestions that follow were made by interviewees regarding potential improvement of SC's operations and management activities:
    - The SC system needs to be debugged and needs to get working more reliably
    - The CHP CAD interface needs to be added
    - Improved support/commitment needs to be demonstrated by senior management
    - SC needs to be staffed and operated 24-hours-a-day/7-days-a-week
    - An evaluation of SC is needed, and quickly

SHORT- AND LONG-TERM PLANNING NEEDS

Strengths

1. **Lead Agency.** Most interviewees believed that the factors in determining the lead Agency for various SC components were based upon which Agency had the necessary funding, or whichever Agency volunteered. Typically, interviewees believed that the Agency taking the lead for that component had the desire to accomplish the objective.
2. **SC as a Learning Tool.** Federal/State participants believe that SC provides a good learning mechanism; that both positive and negative SC elements should be used as

lessons learned. After its evaluation, Caltrans plans to re-use only those SC concepts/elements that properly "work" and show true benefit. Their intention is not to evolve SC to make it be the do-all, end-all system; instead, the plan is to capture best practices and apply them to other projects. Working elements from SC, as well as those from other systems, will be examined to determine the best elements; then Caltrans will make decisions on what to re-use and what to re-design.

Weaknesses

1. **Ideas for Improvement.** When asked about suggestions for improving the planning process, Federal/State interviewees offered the following recommendations:
    - A large project such as SC should be phased, incremental, with a long-term plan up front
    - Individual elements should be tested and demonstrated before adding in additional components and integrating all the pieces
    - Flexibility to technological changes should be built in to the plan and design
    - A shorter schedule should be planned for and accomplished
    - Early on, the issues regarding demonstration versus operational should be clearly established and communicated
    - The full commitment of all stakeholders should be ensured; decision-makers should sign a commitment document
    - Roles and responsibilities should be communicated and understood
    - Procurements should be streamlined

APPENDIX C – REGIONAL PERSPECTIVE

GENERAL COMMENTS

Strengths

1. **Agency Buy-In.** Regional interviewees believe that SC had an overriding success in that each Agency felt ownership and buy-in to the results. Many Agency turf issues were overcome through the project. Another strength mentioned was the ability to get the project implemented despite the lack of "formal" inter-agency agreements.

   Explanatory Note: *The SCTC decided that formal inter-agency agreements specifically addressing Smart Corridor operations (other than the regular inter-agency agreements for such items as transfer of project funds) would not guarantee support of its operations. It was felt that the project would have a better chance of success if the very Agency staff who would operate the SC system were involved in the planning and development of operations rather than follow imposed or mandated documents.*

   For this reason, the only formal agreement between the Agencies was a one-page "reaffirmation of support of the SC project" under the signature of the heads of the original SC Agencies. The exception to this is formal agreements between the Cities of Los Angeles and Beverly Hills and the Cities of Los Angeles and Culver City for signal operations.

2. **Technical Impact.** Operationally, SC is currently somewhat successful in managing traffic during incidents, and it has the potential to be highly successful. This is due to the fact that SC is on the forefront of technology, and allows for spin-offs of other technical ideas. Regional participants feel that SC is responsible for influencing other similar projects across the nation due to published works regarding its concept and successes. In addition, technical elements such as CCTV cameras and detectors represent assets of the SC program.

3. **Success Stories.** Regional participants described the following successes associated with SC:

   - Inter-agency cooperation and coordination was much improved
   - The SC project is a leader in the concept of traffic systems of its kind
   - It provides a successful demonstration of functions/capabilities (though it needs improved reliability)

Weaknesses

1. **Complex System.** Regional interviewees describe the SC system as too complicated, given our human limits and that it needs to be more user-friendly. In addition, they generally believe that the system has a failing in that not all of the functions work together at the same time, that it needs to more robust, and that it was not designed to fail gracefully.

2. **Lack of Commitment.** Regional interviewees expressed the opinion that upper management commitment was lacking from some participating Agencies. Interviewees believe that this lack of commitment led to many other problems for SC including the following:

- Conflicting priorities
- Lack of full cooperation
- Inadequate staffing
- Lost motivation
- Time delays
- Diminishing returns due to time delays

3. **Schedule Problems/Delays.** In terms of contributing factors to schedule problems, interviewees cite the following:
    - Bureaucracy at the larger Agencies
    - Unreasonable contracting rules and processes at the large Agencies; need improvements for quicker response
    - With contracting lags, certain aspects of the program seemed to fall through the cracks
    - Then when contracts got back in place, the time spent getting back on track was not efficient
    - Contracting and working with TransCore was more difficult than originally envisioned
4. **Advances in Technology.** Changes in technology also negatively impacted SC's schedule. Nobody could have predicted that so much change would occur in the computing business over SC's time period. The Agencies and the Consultant tried to make the appropriate technical adjustments during development, but this effort took longer than expected. However, it is felt that these adjustments made for a better product in the end.
5. **Ideas for Improvement.** When asked what could have been changed to improve the SC program, Regional participants offered the following suggestions:
    - Produce a system with greater reliability
    - Decrease staff turnover
    - Obtain more consistent commitment from Agencies regarding policies and follow-through
    - Provide more documentation regarding what the project evolved to
    - Develop and issue the SC maintenance contract much earlier in the planning/design process
    - Conduct the SC evaluation in order to obtain more data/information

STAKEHOLDERS AND OPERATIONAL OBJECTIVES

Strengths

1. **Agency Roles.** Regional interviewees believe that the Agencies' roles on SC are consistent and complementary with their own missions. In addition, interviewees believe

that LADOT's organizational structure, with a dedicated project staff, was supportive of the SC program.

2. **Project Scope.** The project scope was an idea that all members seemed to believe in at the project's outset.

Weaknesses

1. **Original Project Scope.** SC's original scope was to maximize resources and balance traffic. Expectations to achieve this goal were quite high, and some felt the scope was idealistic. Early on, the feasibility of SC did not meet original expectations. Later it seems, the scope shifted to SC only addressing incident management. The reason for the shift was partially dictated by the project's long time span, and partly to impediments that surfaced.
2. **Staffing.** SC's project staffing was not always adequate.
3. **Organizational Structures.** Regional interviewees believe that certain large Agency organizational structures somewhat hindered their abilities within SC to respond to contracting initiatives, obtain funding, and establish a core group of "correctly-experienced" people responsible to the project.

INFORMATION NEEDS AND SHARING

Strengths

1. **Agency Information Sharing.** According to Regional interviewees, a reluctance to share information was said to improve through a better understanding of the system requirements/design. In addition, due to this information sharing process, Agency relationships improved over time as institutional barriers lifted.
2. **Public Information Sharing.** Interviewees believe that a minimal amount of information was obtained from/released to the public in the beginning of the program. This level of sharing was thought to be appropriate since the public does not generally have the knowledge to provide meaningful inputs.

Weaknesses

1. **Agency Information Sharing.** Some Regional interviewees believe that substantial initial reluctance did exist with sharing information due to certain Agencies trying to protect their own interests. In addition, they believe that senior level commitment could have been better from some Agencies.

OPERATIONAL IMPLICATIONS OF INFORMATION SHARING

Strengths

1. **Consensus Building.** Regional interviewees agreed that consensus was maintained through frequent workshop discussions as well as focusing on a common goal; to keep traffic flowing. Time was well spent to resolve issues together, with occasional reminders of SC's objectives/mission. In addition, mutual respect and trust for one another helped workshop attendees reach consensus. TransCore assisted in this process and helped maintain consistency.

DESIGN AND IMPLEMENTATION CONSIDERATIONS

Strengths

1. **System Requirements.** Requirements were as well defined as they could have been at the beginning of SC. The collective group of Agencies provided TransCore with a unified view of requirements through the SCTC meetings. TransCore then assisted the Agencies in reaching consensus on the developed/desired requirements.

Weaknesses

1. **Design Interaction.** Regional interviewees expressed the opinion that the Agencies had very limited interaction with the Consultant's technical staff beyond the project manager, and especially did not have enough interaction with Atlanta developers. Additional focused meetings with representative technical staff (from Agencies and from TransCore) were recommended to reach common understandings on technical issues. In addition, difficulties with developing the SC requirements occurred due to the different interests of various people involved. Furthermore, participants felt that the Agencies did not perform adequate design reviews but realized that they also did not have the appropriate in-house staff resources to review the design effectively.
2. **Technology Impacts.** As requirements were unfolding, technology changed and new Agency systems were being developed. Thus, some equipment turned out to be different than originally planned. This in turn had ramifications on future requirements.

PROCUREMENT STRATEGIES AND CONTRACTING OPTIONS

Strengths

1. **Multiple Contracts.** Regional participants felt that the use of multiple contracts kept all the Agencies involved. Each Agency had a stake in SC's final outcome.

Weaknesses

1. **Contract Visibility.** SC's procurement processes and high visibility caused difficulties in obtaining increased funding without receiving negative backlash from the media; thus it was perhaps not as flexible as would have been liked.
2. **Getting Contracts "In-Place".** The mechanics of getting needed contracts in place in a timely fashion was a difficult issue for SC. Internal Agency contracting regulations were said to be constricting in that the Agencies' hands are tied to certain allowed regulations and permitted contracting options. In addition, internal Agency structures sometimes precluded accomplishing activities in the most effective/efficient way possible. Regional participants felt that perhaps smaller contracts would have proven to be more manageable than the huge ones and that pre-qualifying and authorizing certain "bidders" helps to keep projects proceeding smoothly.
3. **"One" SC Contracting Agency?** Regional participants felt that the multi-agency contracting process did quite possibly put the Consultant in a difficult position. However, it would be difficult to obtain buy-in from all Agencies without their contractual participation. Using multiple contracts on SC was the inevitable course of

action because this way, all Agencies had buy-in. MTA felt that they would find it difficult to be a prime Agency for contracting all SC efforts.

4. **Ideas for Improvement.** Regional interviewees offered several suggestions to improve SC's contracting methods as follows:
    - Recognizing that it was difficult to develop good requirements on SC, it was suggested that an initial contract be issued to explore and define requirements, followed by an incremental effort to implement selected requirements with realistic estimates
    - However, it was acknowledged that a 2-phased approach presents a risk of having one Contractor perform the analysis and another one performs the implementation
    - A FFP contract with a very well defined scope and all equipment procured by the Consultant is preferred by some Regional interviewees
    - It was suggested that the contract could have assured that the system be documented better, and that it become a turnkey system

OPERATIONS AND MANAGEMENT

Strengths

No "Strengths" were cited by these interviewees.

Weaknesses

1. **Staff Skills.** Regarding the right blend of staff skills to operate SC, Regional interviewees expressed that, along with their traffic operations skills, the operators must be open-minded to new systems and new user interfaces. Currently, some background in software systems is helpful to operators to allow them to troubleshoot system problems, but as the system becomes more stable, a software background should not be required for a successful SC operator.
2. **Operational Objectives Met?** Regional participants felt that, even though SC was accepted, it does not satisfy objectives because it is too unreliable, fixing one error seems to create other difficulties, longer testing was needed, and that a maintenance contract was needed earlier than it was put into place.
3. **Ideas for Improvement.** A variety of suggestions were made by Regional interviewees regarding improvement of SC's operations and management, as follows:
    - The SC system needs to become more reliable
    - The Agencies should be urged to use the SC system more
    - The system needs to be updated to perform all that it is supposed to do so as to prevent the Agencies from having an excuse not to use it
    - Although SC's operations seem to work adequately for bigger cities, it is difficult for smaller cities to operate due to limited resources and the desire to not outsource to the bigger cities

SHORT- AND LONG-TERM PLANNING NEEDS

Strengths

1. **Success Stories.** Regional participants cited the following successes within SC's planning efforts:
    - SC planted the seed for other similar technologies
    - SC helped foster needed inter-agency coordination
    - SC built upon existing ATSAC and SATMS systems; no one has anything that works better

Weaknesses

1. **Lead Agency.** According to Regional interviewees, the factors that determined the lead Agency for specific SC program aspects did not have to do with planning. The issues were somewhat political, and in some cases, it had to do with funding/contracting availability.
2. **Implementation of Planning Efforts.** SC is better conceptually than its implementation in system/software and technology. The SC software will probably not be replicated beyond its current boundaries; however, if SC software and hardware were updated to state-of-the-art technology, it would be used more frequently.
3. **Ideas for Improvement.** When asked what could be changed in the project planning process, Regional interviewees offered several suggestions, recounted below:
    - Perform risk analysis
    - Obtain a better universal understanding of the design
    - Keep a dedicated core group of people involved
    - Ensure total commitment from participating Agencies at the senior level
    - Develop a tighter, better-defined scope and more realistic expectations at the beginning, in order to plan ahead to deal with rapidly changing technology
    - Define the evaluation up front to enable "before" information to be captured as a baseline for comparison with "after" data

APPENDIX D – LOCAL AGENCY PERSPECTIVE

GENERAL COMMENTS

Strengths

1. **Technical Strengths.** Many of the strengths cited by Local participants concerned technical elements. Many participants believe that SC represents a "fantastic" concept that is ahead of its time, envisioned with foresight, and that it describes the technology of the future. Beyond SC's concept, many believe that the resulting implementation represents a technical breakthrough and that it is the forerunner of other similar projects. Basically, it is felt that SC provides an early model of what ITS should be. SC provides insight into what ITS projects can be done, what ITS needs to do to be successful, and what not to do. In fact, meaningful inputs can now be provided to the Southern California "SHOWCASE" ITS Priority Corridor.

   Specifically, Local interviewees described one of SC's technical strengths as its ability to connect legacy systems to the future, that it is the only system that performs what it does, and it solves problems that no other system has been able to solve. Several interviewees believe that when the SC system works, it operates as intended and that SC concepts should be expanded to other corridors. Other technical elements were mentioned as strengths:

   - SC Network
     - SC outlined the architecture of Agency interactions over a network while retaining autonomy of the individual equipment
     - The ability to electronically link and integrate multiple Agency's systems onto one workstation
   - Decision Support System (DSS)
     - The incident detection algorithms, threshold values, and response actions on arterial streets are considered successful
     - It is believed that the rules-based DSS correctly implements response logic that makes sense (and can be agreed upon by operators)
   - CCTV
     - CCTV cameras throughout the City, and the software controls with pan/tilt/zoom features enable operators to see what they need to see in terms of traffic flow
     - The CCTV/video system use of a fiber-optics communications network is a success
   - Communications
     - The electronic communication between field elements was cited as an asset to the program
     - Telecommunications knowledge/experience has been gained

- The SC telecommunications infrastructure is the first of its kind; a "model" of ITS infrastructure

- Learning Tools
  - Experience has been gained regarding emerging technologies (e.g., data fusion, centralized command and control across multiple Agencies, etc.), and the impact of these technologies on operations
  - Establishment of the ATSAC infrastructure and the diversion routing concept has been demonstrated
  - SC software was described as more advanced than either the Agencies or the public are capable of understanding; people do not comprehend the great feat that has been accomplished
  - SC became a leader in its traffic management concepts; a model to other regions

2. **Non-Technical Strengths.** Certain non-technical issues were also cited as strengths.
   - Knowledgeable staff and teamwork at and among both the Agencies and TransCore
   - Inter-agency cooperation and coordination was much improved
   - Some interviewees mentioned the work ethic and perseverance of the assigned staff as strength
   - Enthusiasm and commitment at LADOT working-level staff and upper management commitment were also noted
   - Good field people/field problem solving was mentioned, including the field staff's many capabilities:
     - Developing system specifications
     - Establishing communication requirements
     - Installing fiber-optics communications media
     - Building the network management system and video system
3. **Proof of Operations.** Several Local participants noted that the demonstrated utility of ATSAC and the adaptability of SC concepts during the Northridge earthquake (January, 1994) made SC the keystone of the National ITS program. During the earthquake's aftermath, SC's dynamic traffic control strategies worked, vehicle travel time was not severely impacted, and ATSAC was capable of absorbing all of the traffic diverted from the I-10/Santa Monica freeway. Many interviewees express the opinion that SC provides improved management of traffic that benefits motorists. It manages incidents, and provides drivers with more alternatives. Some say, however, that the public is unaware of these benefits, because the traffic management is transparent to them.
4. **LADOT Participation.** A general finding in cities outside Los Angeles is that their availability of resources is relatively limited, and they rely on LADOT's support to supplement their resources, technical expertise, and infrastructure for SC. One interviewee referred to LADOT as the "big brother" of the SC program. Another

interviewee offered the opinion that other cities should outsource SC responsibilities to LADOT.

Weaknesses

1. **Concept of Operations.** The first weakness cited by Local participant's deals with the SC program's concept of operations. While SC was described by some as a great concept, many interviewees believe that some people are still not convinced that the concept of traffic diversion has not been fully bought into by all members of the SC team. Some said that the City Councils care only about neighborhood issues, not traffic on the freeways. Their only incentive to participate was obtaining grant moneys. These individuals feel that there exists political reluctance to use SC as intended. Local interviewees indicated that council members and mayor offices worry that SC would cause too many motorists to use the arterial roads; and thus, political support in some cities is less than enthusiastic. Further, some say that the implemented system is not being received well, it is creating culture shock because people feel their job/decision making is being duplicated or replaced by a computer. This lack of trust or poor reception of the product seems to suggest a lack of total buy-in to the concept.
2. **Public Information Sharing.** A number of interviewees suggested that the public needs further information regarding the SC system. The public needs education so they understand what the system is and how to use it. Marketing is needed to help motorists know about it and be supportive of the concepts. One suggestion was to place a SC logo on arterial road signs. Another suggested the public needs to know how to tune in and use HAR.
3. **SC System Software.** Another weakness noted cites the current SC system's software inadequacies. The SC software was described as outdated, unfriendly, and inflexible. The most pervasive comment regarding the software involves its lack of reliability. Many interviewees complained that they couldn't keep it working. This is frustrating for the operator. Several interviewees discussed possible reasons for the unreliability, as follows:
    - The system is so complex and dependent on so many things
    - Some speculate that the database is the problem; it does not seem to be able to communicate over the networks
    - One speculated that a new design and communication strategy is needed
4. **Systems Engineering Process.** Local interviewees indicated that the Consultant did not seem to apply a disciplined systems and software engineering process. This "lack-of-process" is felt to have led to a number of problems in the system integration and in the delivered system's reliability. In fact, the SC system architecture is viewed by some as potentially an artifact of TransCore having a misinformed view of the SC system as a demonstration system only: not an operational system. Specifically, they feel that SC was not engineered to be robust and reliable.
5. **Schedule "Slips".** The reasons and responsibilities for SC's schedule slips were discussed extensively by the Local interviewees. They feel that the excessively long program schedule cast several negative impacts across the program as a whole and that people generally lost interest due to the lengthy schedule. In addition, technology

changed so drastically during the long implementation window that SC deployment was delayed in order to reflect the advancements. Much of the staff turnover was also directly attributable to the lengthy schedule.

Most interviewees articulated that no one single organization (i.e., Agency or Consultant) was to blame for all the schedule problems; that responsibility has to be shared. In fact, one interviewee places no blame at all, saying that the experience was new to everyone, and it was naturally underestimated through no one's fault. Schedule slip contributions attributed specifically to TransCore included the following:

- Staff turnover (especially noticed after the SAIC acquisition)
- GUI re-write
- Software development problems and rework
- Communications interface protocol development
- Poor system design; resultant system is not "powerful" enough
- Consultant underestimated the necessary level-of-effort

Schedule slips attributed to the Agencies in general included the following:

- Attempt to implement the big picture (grand project scope) all at once
- Implementation was not modular/phased in nature
- Implementation did not allow for in-process checks and balances

Several interviewees noted that State and Local bureaucracies contributed to schedule delays:

- Too many signature (approval) requirements
- Extensive procurement cycles
- State government political "bickering"
- Delays imposed due to internal/bureaucratic processes
- Project hiatus due to the lack of continuity in funding

6. **Requirements Development.** Joint responsibility (between Agencies and Consultant) was cited for problems associated with clearly defining user requirements to which all stakeholders could agree. Most agree that the first two or three years of the program represent wasted time during which users did not know or could not articulate what they wanted the SC system to do. Requirements grew as new ideas were developed and added on to the concept. Additionally, milestones that were developed at the systems level may have been misunderstood by some participants.
7. **What's the Consultant Up To?** Local interviewees generally believed that they did not have adequate visibility into the Consultant's processes or status. They felt that they could not properly ascertain whether TransCore had an accurate picture of their completion status or not.
8. **Ideas for Improvement.** When asked what could have been changed to improve the SC program, Local workshop participants offered the following suggestions:

- Produce a system with greater reliability
- Decrease staff turnover (Agency and Consultant)
- Apply a modular implementation; incremental development
- Use a careful systems approach
- Understand functional requirements first
- Solve Agency policy issues before going into design
- Re-design the software to be more modular, flexible, extendable, and modifiable
- Close the gaps between concept, requirements, design, and implementation
- Move to another platform besides OS/2
- Use an object-oriented approach to the software implementation
- Plan better and budget better
- Obtain more education on SC before joining the team to be able to make an informed decision as to whether to join the team or not
- Try to be on the "cutting" edge of technology, not the "bleeding" edge

STAKEHOLDERS AND OPERATIONAL OBJECTIVES

Strengths

1. **Agency Roles.** Generally, Local interviewees believe that most Agencies' roles on the SC program are now consistent with their own missions. Although some believe that they have evolved from early in the program, when they were somewhat off the mark. Roles of the various Agencies were described as complementary to one another. Roles within SC seem to remain relatively steady, with mostly good cooperation. Some role shifting occurred naturally as new contracts were released, this was not seen as unproductive. In addition, interviewees did not recommend adding or subtracting any Agencies from the SC team.
2. **LADOT Commitment.** Virtually all Local interviewees strongly believe that LADOT is fully committed and dedicated to the SC program. They mention that LADOT created a dedicated organization that was formed solely to support SC. This organization provides the direction needed for staff to be committed to the project, and is testimony to the Agency's full commitment.
3. **Program Scope.** Regarding the SC program scope, the "Concept Design" gave a good overview/wish list and theoretical concepts were agreed. What was supposed to be accomplished was mostly understood, especially throughout LADOT.

   The concept of incident diversion routing off the freeway is valid for SC. While it is true that most people will stay on the freeway, only a small percentage of cars need to divert in order to make a difference.
4. **Funding.** The original SC concept was used by LADOT/Caltrans to attract funding, LADOT to expand signal systems and Caltrans to improve the freeway system. Both

Agencies added enhancement features such as inter-agency coordination, DSS, GUI, etc., to entice FHWA funds.

5. **Staff Skills.** Regarding people assigned to the SC project, Local participants believe that the Cities did assign the correct people. LADOT was part of the solution and work efforts. Other Cities deferred their decisions to LADOT, but attended workshops to better understand the decisions.

6. **SC Operations.** The Agencies did not need to rely upon the implementation of SC; they each had their own infrastructures for traffic management. It was also observed that SC operations could be viewed at different levels (e.g., focus on information sharing, coordinate incident, etc.). A daily exchange of information between Agencies may be too ambitious at this point.

Weaknesses

1. **Program Scope.** Regarding the understanding of the SC program scope, Local participants believe that there was minimal understanding in how the program was going to accomplish its objectives. Although the concept was documented, it was not clear and concise. While LADOT believes their staff understood the concepts, they generally believe that Caltrans understood only to a lesser degree. Furthermore, it was felt that different Agencies had different agendas.

   Within SC, it was not clear which elements would/would not work. It was never envisioned how tough it would be to actually make SC's high-level design work in the field, especially when concepts were changed midstream. The SC concept is ambitious on paper, and even more difficult to implement given technical challenges. Local participants offered the opinion that the SC concept is solid for incident management and emergency medical service responses (IM/EMS), but perhaps not so for day-to-day operations.

INFORMATION NEEDS AND SHARING

Strengths

1. **Agency Information Sharing.** Most Local participants believe that reluctance to information sharing was not a problem. Some describe a level of conservatism in sharing information; others describe the information sharing as very open. Most interviewees believe that information sharing promoted understanding across the Agencies. It had a positive impact on discussions, improved teaming attitudes, and aided the coordination process. People across Agencies became friends and engineers across Agencies work together now to solve traffic issues. Information sharing brought the Agencies closer to a shared big picture, and enhanced adherence to operational needs among Caltrans and LADOT.

2. **Public Information Sharing.** Local workshop attendees voiced the opinion that the public was not and should not have been involved during requirements/design time. Public involvement would have been detrimental to the project, and would have kept it from progressing. LADOT did address human factor issues (such as appropriate signage on CMS, message creation, etc.), which are well documented from previous industry studies. LADOT is responsive to the public in that they are careful when selecting

diversion routes to minimize negative impacts to neighborhoods. Later in the project's lifecycle, the correct amount of information was shared with the public with the MTA acting as the SC public relations outlet.

Weaknesses

1. **Public Information Sharing.** A number of Local interviewees discussed information sharing with the public as an area for improvement. Most do not believe that more public involvement in planning/design stages would have been appropriate (see minority opinions). However, many voiced the opinion that the public could become better informed of SC's capabilities and how to use them. The process of disseminating information to the public is described as weak, and not working well. The average commuter probably does not have all the information needed inside their vehicle to use the system wisely, and may not necessarily respond as recommended by SC. A research project was suggested as a mechanism to determine how the user could best use all the different information available to make wise and informed choices. Also, interviewees suggest that since CMS/Trailblazer signs are not user-friendly, motorists do not understand the signs or their options, and thus ignore them.

OPERATIONAL IMPLICATIONS OF INFORMATION SHARING

Strengths

1. **Consensus Building.** Most interviewees agreed that consensus was maintained through frequent workshop discussions as well as phone calls, teamwork, give-and-take, and focusing on a common goal. It was recognized that this type of consensus building took more time but resulted in better coordination among all Agencies. The operational decision-making process occurred though scenario-reviewing sessions and discussions of "what-if" situations.
2. **SC Partnership.** SC was a fully distributed partnership project by design; no one Agency took control. Caltrans and LADOT each had their share of control. SC was a learning, iterative process where TransCore was responsible for getting direction and providing feedback from/to SCTC. In addition, TransCore took the lead in getting everyone to work together, and performed well in this role.

Weaknesses

1. **Consensus Building.** Some Local participants mentioned that consensus was difficult when it touched on institutional issues such as Local/State differences in policies.

DESIGN AND IMPLEMENTATION CONSIDERATIONS

Strengths

1. **Role of the Consultant.** Since SC's goals and objectives exceeded the technology of its time, TransCore was brought on-board to assist the Agencies in designing, developing, and implementing SC in such a manner that "everyone" would learn in parallel.

2. **Design Reviews.** LADOT had sufficient opportunities to review design and system architecture, although at design time, no one knew all the answers, neither Consultants, Agencies, or 3rd parties.
3. **LADOT Role.** Outside Los Angeles, other City participants expressed the opinion that LADOT's technical contribution was good, and that they had good information/insights, and that the other Cities rely on LADOT.

Weaknesses

1. **Requirements Development.** Most interviewees agree that a firm requirements specification did not exist at the project's start. This was a shared problem, in that Agencies did not know (or could not articulate) what they wanted the system to do. In addition, it was felt that TransCore did not elicit and manage requirements appropriately. Many interviewees mentioned that clear, agreed-to user requirements needed to be determined earlier in the program. In addition, requirements needed to be managed as the project unfolded.
2. **Design Reviews.** The fact that the SC technical development was performed in Atlanta might have prevented as many technical review opportunities as possible. However, experience did not exist within the Agencies to dispute TransCore's technical work. Agencies beyond LADOT are not perceived to have quite as good technical insights into SC. In addition, most Agencies overall did not have enough of the right technical people to review appropriately.
3. **Ideas for Improvement.** A number of improvements were suggested by Local interviewees for a more effective design process, as summarized below:
    - Team Approach
        - It was suggested that a team approach could have improved interaction
        - Programmers seemed to lack domain expertise in traffic management
        - Agencies in general had less than optimal coordination during technical design activities
        - A team design approach could have helped facilitate more coordination between the Agencies and the Consultant during the design process
    - Design Approach
        - A more extensive design approach that would provide more alternatives was recommended
        - Interviewees recommended applying a disciplined systems/software engineering process for all stages of development
        - Many Local interviewees suggested using a phased approach for the design, implementation, and test activities (i.e., "build a little, test a little")
    - Acceptance Tests
        - Interviewees noticed that the Agencies had no early contemplation of acceptance test plans

- Suggestions were made that the user should be involved in early development of test plans, and also in executing the tests

- Technical Elements
  - It was suggested that SC's design could have paid better attention to the communications network design from a systems perspective
  - The telecommunications networks should have been installed earlier, before other components
  - Respondents also expressed that they would have preferred that TransCore had designed for a turnkey system such that operators do not need to configure the software system themselves

PROCUREMENT STRATEGIES AND CONTRACTING OPTIONS

Strengths

1. **Multi-Agency Contracting Approach.** Most Local participants felt that SC's multi-agency contracting process was inevitable. This was the only way SC would have been possible. Each Agency had its own sources of funding and the desire to have a stake in the process. Local interviewees believe that, because each Agency had responsibility for a portion of the contracts, all Agencies had a stake in the collective outcome. Every Agency became a part of the program by sharing dollars, and had then a shared interest in the results. In addition, some contracts were easier to administer from one Agency than others. For political reasons, it was important to divide the contracts/money/control between all Agencies involved. It was felt that the price of a new experience was to have multiple contracts, no better alternative was suggested.
2. **Agency Determination.** Creativity was cited as a strength in the procurement and contracting processes. That is, agencies were able to initiate contract options through having a determined attitude ("where there's a will, there's a way").
3. **Santa Monica Perspective.** Santa Monica applies a contracting process that works well for them in terms of flexibility, modifiability, and providing the correct amount of checks and balances. Their interview process and committee review is seen as a benefit in assessing contract risks and issues prior to engaging the Consultant, while not imposing excessive bureaucracy.

Weaknesses

1. **Agency Insights into Contracting Process.** Many Local interviewees had little insight into the procurement strategies and contracting options. In fact, one interviewee noted that it is typical that engineers do not fully understand the finer points of contracting issues, and yet, mostly engineers are involved on the SC team. One such point deals with a Caltrans-supported maintenance contract, which has no provision for spare parts. A maintenance contract with software- and labor-only provisions is not sufficient; however, this issue was not coordinated with the correct people.

   Explanatory Note: *The only contracting method open for timely establishment of a maintenance contract was under the California Multiple Awards Schedule (CMAS). CMAS*

terms and conditions limited the amount of equipment that can be supplied to a maximum of 12.5% of the total contract.

2. **Software Development Efforts.** Some interviewees noted somewhat of a dilemma in terms of contracting for software development efforts. While Agencies generally prefer Firm Fixed Price (FFP) contracts for less risk to them, they recognize that software companies are generally not apt to accept a FFP contract to perform a risky, exploratory software development program. Also, interviewees noted that FFP contracts do not typically permit the degree of flexibility required to conduct an effort such as SC. However, the method by which the Consultant conducted and the Agencies managed the SC Time and Materials (T&M) contract did not disclose true project status. Thus, even though the Agency paid when billed, they were unaware (until it was too late) that TransCore's performance was behind expectations. It was suggested that a mechanism for providing measurable milestones must be in place to assure better insight into the Consultant's true status.
3. **Length of Contracting Process.** According to interviewees, acquiring appropriate funding was a lengthy process. Deciding upon appropriate hardware and then procuring the selected hardware took a long time. The process for equipment procurement could use streamlining. For example, some flaws existed in the purchasing strategies; fiber-oriented equipment was purchased, and then it was discovered that no compatible fibers were available for that equipment.

OPERATIONS AND MANAGEMENT

Strengths

1. **SC Operations.** Local interviewees indicated that the SCOPE process went well, the product is sound and acceptable. In addition, when SC is working, it satisfies LADOT's objectives in terms of functionality/capabilities. The Local Agencies are very dependent on having the system working reliably in order to meet their objectives. They need LADOT/Caltrans to keep SC maintained. In Beverly Hills, the perspective is that things are proceeding as well as expected (their system is still in the implementation stage). SC provides benefits to the City through the Traffic Control System (TCS), graphics, and coordination of intersections and signals.

Weaknesses

1. **Use of the SC System.** Several comments were made regarding more extensive use of the system, and more commitment to use the system. A suggestion was made to integrate operations into the daily activities of the center. Some Cities outside LA would like to have full-time 24-hour-a-day staffing, although it does not seem feasible given resource constraints. Interviewees would like to receive more training, including available features and how the system can be used. Better documentation was also requested.
2. **Staff Skills.** Regarding staff skills required to operate SC, Local interviewees indicate that the operator must have knowledge of basic traffic operations. Most said the operator must be technically-oriented and that the system should make recommendations only. The operator must be knowledgeable enough (and responsible/authorized) to accept the recommendations, or refuse them and determine a different course of action. The operator should not, however, be required to be able to trouble-shoot the software or

technical systems problems, though currently the system often poses technical problems that only a software-literate person can solve. Some said the operator must be patient enough to deal with the slow periods during which no incidents occur. Some interviewees suggest that the operator should be able to be trained with about one month of on-the-job training.

> ***Explanatory Note:*** *The expert system makes only recommendations to the SC operators. The SC system cannot take any control actions (e.g., signal timing, ramp meter, CMS, HAR, etc.) without the instigation of the action by the SC operator.*

3. **Maintenance Contract.** In terms of maintenance, interviewees recommend that a hardware and software maintenance contract with TransCore is needed throughout the evaluation period, until the long-term future of SC can be ascertained. Evaluation should begin soon → however, it is unknown how effectiveness measurements can be taken (i.e., collection of "before SC" data is not available, so it will be difficult to measure what percentage of motorists take a recommended diversion). It was also recommended that infrastructure maintenance be provided. It was suggested that during maintenance the SC database should be streamlined with less complexity. The data and data passing needs to be made simpler such that people understand it better. Interviewees also expressed needs for training, as well as documentation to be delivered during the maintenance phase.
4. **O&M Goals.** At SC's inception, LADOT had high goals and expectations; however, available technology was not ready to meet those goals. Better reliability over a longer period is needed for SC to meet LADOT needs. However, no performance requirements were established, and reliability was not part of acceptance testing. LADOT never envisioned SC to be disposable. It was always envisioned to be operational and reliable. The "demonstration" label was in reference to SC never having been done before rather than in reference to a first generation system.
5. **Ideas for Improvement.** Interviewees offered many suggestions to improve the operation and management of the SC system.
    - Many interviewees responded that the system's reliability should be improved; it locks up too often
    - However, several interviewees expressed that they are very unsure about how to accomplish improved reliability given the system's current state
    - The incident detection segment also needs improved calibration
    - The opinion was expressed that the software does not contain many successes, and that many bugs need to be worked out
    - Having developers at the operation site would alleviate the need for operators to record problems and try to translate them to the developers
    - Choose a different operating system, OS/2 is now obsolete; it needs to be upgraded, however, it is recognized that OS/2 was the best selection at the time

Further addressing improvements to SC's operations and management, several comments were made regarding the need to relay more information to the public, to better educate motorists, and maintain the system to make it work for the public.

- Interviewees suggest more information is needed in order to influence the driver to change their behaviors
- The suggestion was made to use make better use of broadcast media by sending the media increased information so traffic reporters can announce traffic conditions

SHORT- AND LONG-TERM PLANNING NEEDS

Strengths

1. **Lead Agency.** Most interviewees believed that the factors in determining the lead Agency for various SC components was based upon which Agency had the necessary funding, experience, and the knowledge to manage the contract. Typically, interviewees believed that the Agency taking the lead for that component had the desire to accomplish the objective.
2. **SC Concepts.** SC's concepts are still valid. The vision of SC for the future is that SC would become one part of an entire system throughout the basin. SC's general concepts should be extended to other regions. In terms of functionality, it is believed that a small set of core functions should be selected to be implemented and refined. The selection should be based on elements that would be most useful and of the most value to the program. The selected functions should be refined and made to work correctly and reliably, then others could be added. SC must be guided so as to ensure retention of the concept of freeway/arterial roadway coordination. An upcoming evaluation may provide further direction. In addition, the Southern California ITS Priority Corridor – SHOWCASE – is based on SC.

Weaknesses

1. **Long-Term SC Strategy.** Several interviewees are definitely unclear about the long-term strategy of the SC system, and feel that in order to move forward productively, a strategy needs to be developed and communicated to all involved. In fact, among a few interviewees, there was a sense of apprehension, or unsettled feelings, because they perceive a lack of vision, or a lack of understanding regarding the future of the SC program. For example, an interviewee stated that it is unclear whether future plans are to improve the present system, rebuild the system, or forget the whole idea. Many of the Local interviewees seem eager to understand the long-term strategy. Although SC's general concepts are desired to be extended, Local workshop participants do not suggest that the current software be extended beyond its current state, since it is fragile.
2. **Ideas for Improvement**. When asked about suggestions for improving the planning process, Local interviewees offered many recommendations, as follows:
   - More realistically cost/budget SC at the program's beginning
   - Pay attention to maintaining enthusiasm regarding the project (both people on the project as well as outside supporters)
   - Do not lose sight of the people issues of the assigned staff members; guard against burn-out and morale problems

- Establish a State-level management commission with a vision for managing traffic and helping the motorists
- Ensure that the goals are realistic and achievable
- Develop methods to move the program along faster (including issues of institutional inertia)
- Determine the requirements up-front, building a Software Requirements Specification to clearly define what is to be included in the system versus what will not be included
- Develop a roadmap for functionality
- Use modern methods to better elicit, document, baseline, and manage requirements and to understand how each Agency intends to operate given those requirements
- Choose practical requirements that are feasible in terms of technology, time, and money available, and that will serve the long-term strategy
- Be cautious about what is publicized and promised to the public → ensure that what is promised can be delivered (do not oversell the system's capabilities)
- Carefully examine long-term goals of the Agency and its ability to support such a program over the next decade
- Determine long-term needs regarding how all the Agencies will work with the system as well as the required effort needed to actually operate and manage the system
- Phase the system with milestones that would show working sub-system components to demonstrate progress and maintain enthusiasm for staff and policymakers
- Plan ahead with a master schedule in order to alleviate the problem that equipment might be purchased too soon and become outdated before it gets used
- Determine and define key roles and responsibilities early; publish an organization chart
- Plan ahead for training needs; the Agencies should really understand the system better
- Plan early for a system that appropriately supports/complements the experience level of the eventual system operators:
    - For example, when using knowledgeable operators, a complex expert system is probably not necessary; the operator's experience is better than the tool
    - Some suggest that the system could have been better to only identify incidents, leaving all decisions to the operator
    - Repeat the method used in SCOPE for operator method planning

- Do not permit the Consultant to use a fragmented team (e.g., developers in Atlanta)
- Use IEEE-style software verification and validation

APPENDIX E – TRANSCORE PERSPECTIVE

GENERAL COMMENTS

1. **Working SC System.** TransCore interviewees are generally proud that a working system was delivered for Smart Corridor and that the technology associated with that system is quite advanced. The TransCore interviewees feel that great technical accomplishments were made and described SC in the following manner:
   - A high-resolution, high-performance system
   - The most advanced of its type in the world
   - The most sophisticated system ever built
   - Beyond state-of-the-art; even futuristic
2. **Staff Dedication.** TransCore interviewees credit much of the successes of the SC program with the personal commitment and dedication of many individuals, both within TransCore as well as within certain Agencies. In addition, TransCore interviewees noted that a company turn-around in Phase 2 of the program improved commitment, leadership, and processes over Phase 1 activities. Process improvements included better scheduling, better requirements definition, and increased problem/change tracking.

   TransCore interviewees mentioned that, even after more than a decade; enthusiasm still exists for the SC program across the team. TransCore interviewees noted specific individuals within LADOT and TransCore who were willing to work diligently together to define what needed to be done. They mention success stories, such as the demonstrated ability to link together the legacy systems, and Caltrans' TrafficVision, with data that is distributed to television and radio station.
3. **Company Resources.** Another contributing asset to SC concerns SAIC's eventual commitment to contribute a great deal of company resources in order to complete its contractual commitments.

Weaknesses

1. **Staff Turnover.** TransCore staff turnover was a weakness to the SC program.
2. **Demonstration vs. Operational System.** From a TransCore perspective, the lack of consensus as to whether the SC systems should be a demonstration system or an operational system was a detriment to the program's success. TransCore interviewees suggest that their Clients' expectations were not fully understood and addressed. Additionally, some interviewees believed that Customer expectations evolved over time, from early expectations of a first-generation demonstration system to later expectations of a fully-operational system.
3. **Project Management.** According to TransCore interviewees, project management issues within TransCore had room for improvement on SC. Some interviewees suggested that for much of the project, they were unaware of any published schedule with actual milestones. They recall poor coordination/interaction between the Los Angeles and Atlanta teams. In addition, the TransCore Project Manager was not assigned full-time to SC, such that he was required to devote some of his time to other TransCore efforts;

whereas interviewees indicated that SC was a large enough project that it should have warranted a full-time project manager. Further, interviewees expressed that (especially early on in the project) some technical commitments were forwarded to the SC Agencies without an in-depth investigation into its feasibility or schedule realism.

4. **Systems Engineering Process.** TransCore interviewees believe that a lack of an internal disciplined systems and software-engineering process posed a weakness to the SC program. For example, interviewees indicated that a formal risk identification and management process was not applied. They also indicate that little, if any, Agency participation was involved in preparing the Acceptance Test Plan.

5. **Requirements Development.** Perhaps the most pervasive process weakness mentioned by TransCore interviewees deals with requirements engineering and management. Agency needs and expectations were not captured in a requirements document. In fact, TransCore lacked any form of a requirements baseline. An internal requirements engineering and management control process was not applied. Irrespective of capturing requirements in a document, TransCore experienced grave difficulties in eliciting/understanding Client requirements. TransCore interviewees suggest that the difficulties stemmed partially from their own naivete, and partially from the Client' inability to determine what was truly needed. Initial requirements described by the Agencies indicated that they had no clear picture of what they wanted in 1988, nor could they articulate their desires. It was difficult to understand the "gray" areas, and over time, requirements evolved (one said they "galloped"), and became a moving target. Furthermore, performance requirements were never coordinated with the Customers.

6. **COTS Usage.** Some commercial-off-the-shelf (COTS) products could not be thoroughly evaluated before inclusion in the project. For example, the initial expert system software, NEXPERT, did not possess internal algorithms that could reach the level-of-performance needed within SC. In addition, Sybase did not perform as advertised, and the OS/2 operating system-based applications software was not readily transferable. OS/2 was the best choice available at the time COTS selection was made.

7. **Schedule and Cost Growth.** A number of issues related to schedule and cost growth were mentioned by the TransCore interviewees, as listed below:

    - Estimates
        - TransCore had an inability to adequately estimate the job
        - Interviewees described the problem as "naivete"
        - Interviewees did not understand the sophistication and complexity of the system
    - Technical Direction
        - Inadequate technical direction was provided to Atlanta developers
        - This encouraged engineers to try to take logical guesses as to what they should be developing
        - Sometimes this led to re-work or other inefficiencies

- Perhaps a single-point of contact in Atlanta would have eased some of the communication inefficiencies between the Los Angeles and Atlanta-based teams

- Contracts
  - Some SC contracts took a long time to get approved and initiated by the Agencies
  - During lapses in project funding, some SC engineers were reassigned to other projects to continue their coverage
  - When SC funding became more available, the reassigned engineers could not always be pulled away from their new assignments
  - Thus, either new engineers were assigned, or SC was under-staffed, both of which resulted in inefficiencies
- SCOPE
  - The SCOPE project should have been completed before any software development began
  - The time expended performing software development prior to SCOPE was less effective because requirements were not firm
  - If engineering could have waited until after SCOPE, the system design could have been more cohesive because it could have taken full requirements into account
- SC Decisions
  - Technology changes that occurred in the midst of the project sometimes caused redirection of some efforts
  - The project took such a long time to complete that the technology is out of date and often performs in a substandard manner
  - Insufficient prototyping was used
  - Use of a distributed database was a serious design flaw (though it was corrected in Phase 2)

> ***Explanatory Note:*** *Most of the factors outlined above were recognized and corrected within Phase 2.*

8. **Ideas for Improvement.** When asked what could be done to improve the current implementation of the SC system, TransCore interviewees provided several suggestions, as listed below.
   - Hardware (e.g., workstations) and software (e.g., operating systems, database tool) need to be upgraded to newer technology/versions
   - Year 2000 patches need to be applied where necessary
   - A comprehensive system technical audit needs to be completed, followed by a clear plan for improvements

- A rigorous systems engineering process should be applied across the entire program, involving all the Agencies as well as TransCore

STAKEHOLDERS AND OPERATIONAL OBJECTIVES

Strengths

1. **Agency Roles.** Generally, TransCore interviewees believe that the Agencies' roles on the SC program were consistent/complementary with their own missions. TransCore interviewees generally agree that Agency roles/responsibilities have evolved, if at all, only in that some became more involved and/or better informed. Some TransCore interviewees also recognized that the Agencies are generally very cooperative and team-oriented in dealing with budget and schedule issues.
2. **LADOT Role.** LADOT's organizational structure was viewed as supportive and beneficial to the SC program. LADOT overlaid a SC organization on top of existing ATSAC project organization, which was seen as productive. In addition, LADOT was said to have shown efficiency and more decision-making authority in their involvement with SC (than some other Agencies). LADOT was also described as enthusiastic, with a project champion.

Weaknesses

1. **SCTC Meetings.** TransCore participants felt that some Agencies sent non-technical people to the SCTC meetings. This was seen as a detriment because technical representatives were not always in attendance at SCTC meetings when they would have been helpful.

Minority Opinions

1. **SCTC Meetings.** Some TransCore interviewees believe that TransCore could have served the program better by sending more technically-oriented staff (in addition to the Project Manager) to the SCTC meeting on a regular basis.

INFORMATION NEEDS AND SHARING

Strengths

1. **Agency Information Sharing.** Most TransCore participants believe that actual reluctanee was generally not a problem with information sharing, though some describe a level of conservatism in sharing information. Interviews indicated that it is seen as a big success that the Agencies now share information openly, and that information sharing has improved Agency relationships.

Weaknesses

1. **Public Information Sharing.** Several TransCore interviewees believe that the public should be more educated and informed of SC's available traveler information; public support is critical to its success.

OPERATIONAL IMPLICATIONS OF INFORMATION SHARING

Strengths

1. **Consensus Building.** Some interviewees believe that consensus could be built and maintained through debates and honest discussions at the SCTC meetings. Comments were made to suggest that the Agencies listened to one another and worked through issues until a shared consensus was reached. MTA was mentioned as being an aid to the consensus building process and helped to direct a shared focus on the big picture assisted in reaching consensus. In addition, TransCore took a role to try to focus discussions on process rather that people.

Weaknesses

No "Weaknesses" were cited by these interviewees.

DESIGN AND IMPLEMENTATION CONSIDERATIONS

Strengths

1. **Design Process Improvements.** In Phase 2 of the SC project (after SCOPE), TransCore interviewees noticed an improvement in internal processes (especially requirements control) that had a positive effect. Later in the program, internal risk assessments were performed. In addition, the weekly "Top-Ten Hit List" was noted as helping the team focus on the most important issues at hand.

Weaknesses

1. **Concept-of-Operations.** Interviewees generally believe that a firm Concept-of-Operations document was lacking on SC; this was viewed as a serious flaw. Important issues such as performance requirements, behavioral requirements, and whole-system interaction issues should have been fully described in such a document. Many interviewees would recommend ensuring that the development team has a better overall understanding of the big-picture concept-of-operations, especially during high-level design. This document could alleviate problems such as gold plating, or performing design in a piecemeal fashion, which does not contribute to a cohesive architecture. It also may have helped with the GUI hardware/software interface problems
2. **Ideas for Improvement.** TransCore interviewees offered many suggestions for improvements to the design process as follows:
    - The most pervasive recommendation is to apply a formal requirements management process, including requirements engineering, sign-off, and management
    - Also suggested was a formal system engineering process
    - More extensive use of prototypes was recommended, especially for user interface issues

- Other disciplined software engineering processes were suggested, including Configuration Management, risk management, and peer reviews, as well as training on applying such processes for all team members
- Improved documentation was also mentioned
- A dedicated team approach for Agencies, designers, and developers was recommended
- Applying modern techniques such as Unified Modeling language notations and analysis/design charettes were also mentioned as potential methods for improving the design process
- TransCore believes that improvements can be made in communications and relationships within functional teams (e.g., GUI teams, database team, expert system team), as well as teams that are geographically separated (e.g., in Atlanta versus Los Angeles). They recommend a better definition of roles and responsibilities across teams, and more reviews that include representative team members
- TransCore staff would recommend spending time evaluating COTS products for integrity and suitability before committing to their use in another SC-like program

PROCUREMENT STRATEGIES AND CONTRACTING OPTIONS

Strengths

1. **Contract Approach.** The "low bid" approach was avoided by the agencies in favor of a "best value" approach, which was considered a strength.

Weaknesses

1. **Contracts with Multiple Agencies.** From TransCore's perspective, SC consisted of a large number of contracts with several buyers and many different users. Each Agency was seen to possess separate objectives and this situation caused expectations and contractual obligations to be difficult to manage. A single point of contact (i.e., one Agency) would have been simpler.
2. **Different Types of Contracts.** A variety of contract types (e.g., Cost Plus Fixed Fee [CPFF], CPFF with a ceiling, FFP) were used on the individual contracts. CPFF with a ceiling was very difficult, and TransCore interviewees suggest they would not want to enter such an agreement again. Interviewees went on to say that CPFF with a ceiling is an inappropriate contracting option for exploratory-type software projects such as SC, because too many unknowns exist that cannot be predicted at the outset. They suggest that a SC-like program must be developed under a contracting option that allows for the flexibility to adjust scope and budget.
3. **Contract Approach.** Contracting could have been improved by using a multi-phased approach. The first phase is used to establish the requirements definition. Subsequent phases provide for the development according to that requirements definition. Then, all stakeholders must approve the detailed design document before beginning any software development. The Contractor must not accept a software development contract without defined/agreed-upon requirements.

OPERATIONS AND MANAGEMENT

Strengths

1. **Operations.** TransCore interviewees indicated that the SCOPE process went better than the earlier contracts. Some interviewees could not suggest improvements to SC's operations and management; they believe it is pretty good as it stands.

Weaknesses

1. **Staff Skills.** When asked about the right blend of staff skills, many TransCore interviewees indicated that a cross-section of skills is required for SC. They generally believe that the system should recommend solutions, but that the operator should be skilled and knowledgeable to know what is feasible, and should have the experience in traffic engineering to accept or reject the solutions. Further, they suggest the operator should be capable of multiplexing, have patience with inactive periods, and possess basic typing and computer skills.
2. **Maintenance Issues.** As for maintenance, TransCore interviewees recommended that it would have been beneficial to plan for maintenance from "day one" instead of being reactive. However, they believe that this issue was not contemplated up-front because the system was initially targeted to be a first-generation demonstration system only.
3. **Ideas for Improvement.** Some TransCore interviewees recommended a few improvements to the operations and management of the SC system:
    - First, they recommend that the future of SC be established and communicated, with plans to move ahead toward the long-term goals
    - They mention that more visible support by mid-level management in State Agencies would be beneficial
    - They recommend a formal concept-of-operations document

    Explanatory Note: *Products of the SCOPE project included Operational Procedures documentation.*

SHORT AND LONG-TERM PLANNING NEEDS

Strengths

1. **Lead Agency.** In general, TransCore interviewees believe that the factors used to determine the lead Agency for specific SC program aspects were based upon the Agencies' desires to keep activities evenly and logically allocated throughout the different Agencies involved. Some TransCore interviewees believe that the consensus papers, documenting who would develop which aspects, used during the first planning phase worked well.

Weaknesses

1. **Project Approach.** TransCore interviewees suggest that a multi-staged approach to SC's implementation could have vastly reduced risks and increased successes. In addition, they believe that inter-Agency collaboration could have occurred earlier.

APPENDIX F – TECHNICAL CONSIDERATIONS

INTRODUCTION

In this section, the workshop findings that involve the Smart Corridor's technical issues are presented. Information is described in terms of the component decision history, issues involved in the decision-making process, and what would you do over again (if given the opportunity). Technical considerations within the Smart Corridor project were discussed at all of the Agency Workshops conducted for this project. Data/information on the SC's chosen systems, technologies, and processes was only gathered in this manner; there was not enough time available within the "one-on-one" interviews to cover this topic. SC technical considerations covered the following topics:

1. Technical Elements
    - Incident Detection/Data Collection
    - Closed Circuit Television (CCTV)
2. Advanced Transportation Management Systems (ATMS)
    - Ramp/Connector Metering
    - Traffic Control Systems
3. Incident Management
    - Decision Support System (DSS)
4. Advanced Traveler Information Systems (ATIS)
    - Highway Advisory Radio/Highway Advisory Telephone (HAR/HAT)
    - Changeable Message Signs (CMS)
    - On-Line Access (i.e., Internet)
5. Systems Integration
    - Graphical User Interface (GUI)
    - Data Base Systems
    - Software/Operating Systems
    - Hardware Components
    - Communications Network
    - Integration Process
6. Acceptance Mechanisms
    - Test Procedures
    - Documentation

Basically, all of the workshop participants were asked to address these technical considerations with the following focus:

1. Decision History
    - Reason(s) why certain technical decisions were made
2. Key Issues
    - Issues considered in reaching these technical decisions
3. Looking Back…
    - What could/should have been done differently?

Workshop participants generally believe that the key issues considered in reaching these technical decisions centered around the following themes:

- Operability
- Maintenance
- Cost

Thus, each technical decision made was based upon consideration as to whether the element would fulfill operational requirements, in a maintainable fashion, with relative cost effectiveness. Oftentimes the Agencies were able to capitalize upon existing technical capabilities to enhance SC's technical effectiveness.

The sections that follow summarize the Workshop participants' expressed viewpoints regarding the technical elements discussed.

TECHNICAL ELEMENTS

Incident Detection/Data Collection

1. Caltrans capitalized on their existing incident detection/data collection technical capabilities to benefit SC. This collected data was provided to TransCore.
2. LADOT obtained funding for their incident detection improvements, including ATSAC core software, improvements (including additional instrumentation), and new infrastructure on arterial roads.
    - It is believed that LADOT's coverage is good, and that the existing operations and maintenance concerns are normal
3. The other cities (Culver City, Beverly Hills, and Santa Monica) have either added or plan to add inductive loops for arterial incident detection.
4. More second-source confirmation of incidents (e.g., via CCTV, LAPD, etc.) could enhance SC's incident detection capability.
5. Additionally, it is important to distinguish between the information sources (e.g., LAPD, LA Fire Dept, EMS, etc.).

    Explanatory Note: *The Smart Corridor system does provide this functionality.*

Closed Circuit Television (CCTV)

1. CCTV is generally perceived as a very useful technical element.
    - It performs a vital function within SC
2. The Agencies developed standardized requirements such as camera placement, height, control, etc. but not on the actual cameras used (i.e., the vendors providing the physical cameras).
    - Different vendors provided the cameras to the Agencies
        - Caltrans chose Javelin
        - LADOT chose COHU
    - These selections have not caused any apparent problems for SC
    - This indicates that as long as the vendor can meet the requirements specification, the physical camera used does not matter

Explanatory Note: *In the Smart Corridor systems, it was recognized that the important link for ensuring compatibility between Agency systems is in the manual control to central control unit link. As long as an operator could address the central control unit, then the camera could be controlled and the image viewed. This is reflected in Exhibit F.1.*

The SC system CCTV design developed a non-proprietary, Agency-owned communications protocol from the manual control unit (in SC's case a workstation) to the central control unit. This protocol was used by LADOT and the City of Santa Monica in the procurement of their CCTV systems and has guaranteed that these two Agencies can share CCTV control without the need to develop new software. Caltrans' CCTV system was designed for its overall District 7 freeway ATMS operations. Their CCTV system specification was of an "open standard" for all PS & E construction contractors; however, it was not designed specifically for the Smart Corridor CCTV system. Therefore, the SCEMIS contract has provided additional workstation software so that the Caltrans SC cameras can be controlled from a SC workstation.

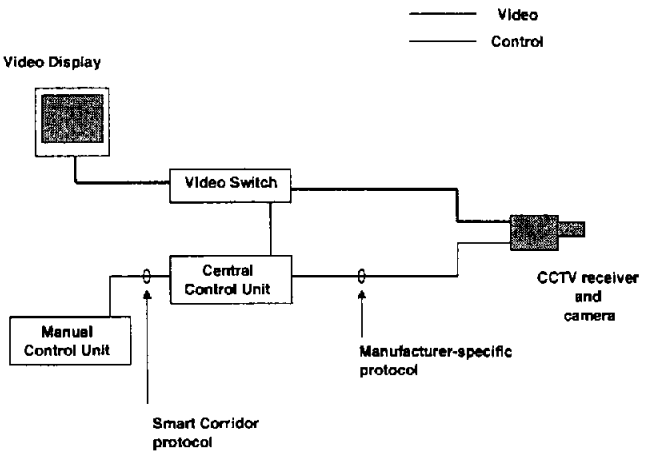

Exhibit F.1 – Typical CCTV System Components

3. Certain technical difficulties associated with integrating video insertion and control have been experienced.
    - This suggests that such needs should be coordinated in advance with the vendor
4. Development of X/Y coordinates within CCTV frame/image helped to establish dynamic presets within SC.

    Explanatory Note: *This functionality was used to confirm SC incident information (e.g., location, type, severity, etc.).*

ADVANCE TRANSPORTATION MANAGEMENT SYSTEMS (ATMS)

Ramp/Connector Metering

1. Ramp Metering
    - The SC system can select ramp meter rates at 86 ramp meter controllers to be used as response to freeway incidents
    - The ramp connector metering philosophy that was applied to SC is the same as that used in Caltrans District 7; the ramp meter programming takes many factors into account (e.g., freeway & ramp volume/occupancy, in-effect plan, time-of-day, etc.)
2. Connector Metering
    - The SC system was also designed to be able to control freeway connectors between I-405 and I-10 as well as between SR-110 and I-10
    - Caltrans expanded upon the ramp connector metering idea and was able to obtain increased funding to add freeway-to-freeway connector metering
    - Design was performed and components were installed for this purpose
    - Unfortunately, Caltrans studies indicated that there was inadequate storage capacity along the Smart Corridor freeway connector ramps and therefore decided that connector metering should not be used in SC
3. Workshop participants also articulated a desire to bring JHK/TransCore staff more up-to-date (i.e., through training) on ramp/connector metering.
    - It is possible that further education of the strategies and associated rationale would increase satisfaction and buy-in both within the SC program, as well as with the general public (i.e., the motorists)

Traffic Control System (TCS)

1. All Agencies perceive benefits gained through the inclusion of Traffic Control Systems within SC.
2. Signal timing plans can be selected through the SC system to alleviate arterial traffic congestion due to incidents.

3. LADOT, Beverly Hills, Santa Monica, and Culver City benefit through enhancements made to ATSAC.
4. Beverly Hills also received funding to deploy their own Citywide TCS.
5. Santa Monica also received funding to interface their TCS to ATSAC.
6. Caltrans received funding to place detector loops on streets and off-ramps for ramp/arterial coordination.

INCIDENT MANAGEMENT

Decision Support System (DSS)

1. Many Workshop participants expressed the viewpoint that SC's DSS element represents one of the program's highlights.
    - The original objective of the DSS was to provide an automated incident response planning process in order to assist SC operators in their decision-making process
    - Workshop participants describe the completed DSS as a "qualified" success:
        - Desired functions are implemented
        - However, SC operators do not receive as much assistance from DSS as was originally anticipated
2. The DSS was developed through an exceptional team effort involving all SC Agencies as well as the Consultant.
    - The SCTC presented the high-level requirements to TransCore
    - TransCore then worked closely with the Agencies to develop a detailed specification
    - Developed options were presented to the SCTC
    - The SCTC reviewed the options, examined the pros and cons of the options, and had the opportunity to influence the design
    - Continued DSS support (in terms of operations and maintenance) was factored into the process of determining the requirements and design for the DSS
3. As the Agencies learned more, the DSS became better developed through refinement meetings held with the Consultant.
    - LADOT Workshop participants, in particular, indicated that they were actively involved in influencing DSS detailed specifications
    - Other cities (e.g., Culver City, Beverly Hills, Santa Monica) were comfortable having LADOT representing their interests
    - Caltrans Workshop participants noted that while they felt they had the option of influencing specifications, they trusted the Consultant to make most of the decisions
    - SC Operators had the opportunity to provide input into the DSS design

4. A number of Workshop participants expressed satisfaction in the Consultant's capabilities/recommendations and their detailed requirements elicitation process associated with the DSS.

    - In general, Workshop participants indicated that if they were provided the opportunity to go back in time and start over with the DSS, that they would not change the methods used to design and implement it

    > ***Explanatory Note:*** *It is noteworthy that while the Expert System delivered meets the functionality originally identified for the DSS, the means of achieving this changed during the course of the project. The original choice for the expert system platform was Nexpert Object, a COTS package. As a result of the Phase 1 implementation, it was apparent that Nexpert Object lacked the performance that was needed for real-time use. In particular, traversing through the Nexpert Object link-node model was too slow. Prototyping using a rule base in C++ code and SC's own link-node model was done to investigate a custom solution. The results showed an order of magnitude improvement in performance. On the basis of this analysis, the SCTC approved the use of custom C++ based code to replace the Nexpert Object-based application.*

ADVANCED TRAVELER INFORMATION SYSTEMS (ATIS)

Highway Advisory Radio/Highway Advisory Telephone (HAR/HAT)

1. HAR/HAT probably represent the SC technical elements with the widest range of views by Workshop participants.

    - Some believe that the concepts are "good," worthy, and valid
    - Others describe HAR/HAT as outdated, not worthwhile of further investment, even "silly"
    - This dichotomy, explored further within this section, constitute a lesson in and of itself; that intense disagreement exists among SC team members regarding the value of the HAR/HAT concepts

2. Many Workshop participants believe that HAR/HAT concepts are sound and useful to the motoring public.

    - For example, when a motorist is caught up in a terrible traffic jam, that the motorist could tune the radio or call on a cell phone to get up-to-date accurate information and advice for potential detouring/diversion
    - For example, HAR/HAT concepts are viewed by some to be especially useful at event generation areas (e.g., around a stadium)
    - It was noted that the FHWA's checklist includes HAR/HAT

3. Other Workshop participants believe HAR/HAT concepts are outdated; that the media traffic reporters are already responding to the public's needs.

    - Some believe that HAR was a "silly" idea from the outset
    - Others believe that the idea had merit many years ago, but that over time, radio stations' traffic reporters have provided a suitable replacement for HAR/HAT

- Some believe that the public will not remember the HAT phone number, and will not use the capability
- Some participants believe that the HAR/HAT concepts should be dropped from SC in order to be able to concentrate on more important (or more viable) elements

4. Virtually all Workshop participants agree that the current technologies available to implement the HAR/HAT concepts are not acceptable.
    - JHK/TransCore provided the hardware and software designs that met Caltrans' stated specifications
    - However, due to limitations in currently available technology, the HAR/HAT capabilities do not perform all that is desired
5. The following list represents the Workshop participants' views regarding limitations/disadvantages of current HAR technology:
    - It is difficult to obtain a good frequency; the FCC regulates one frequency for one-corridor; SC needs a regional HAR frequency
    - Technology does not permit messages to be broadcast only within the problem area and only in the direction needed (e.g., eastbound motorists probably do not wish to hear messages regarding incidents in the westbound direction)
    - Implementation of HAR requires very high maintenance costs
    - The current HAR frequency is too low-powered:
        - Reception is "weak" and unclear, especially on arterial streets
        - Some Workshop participants further believe that reception on the freeway (from the LaBrea Ave. broadcast station) is unacceptable
        - The resulting opinion is that some motorists who try to use HAR may get frustrated at the poor reception and discontinue using it
6. The following list represents the Workshop participants' views regarding limitations/disadvantages of current HAT technology:
    - It currently takes too much time to get through the telephone menu options
    - The current voice used is of poor quality (choppy and unpleasant); obtaining a better voice recording is possible, but cost-prohibitive
    - The current HAT is not Year 2000 (Y2K) compliant; the estimated cost associated with performing Y2K remediation is approx. equal to the estimated cost to replace HAT with a totally new system
7. Workshop participants generally believe that increased Agency involvement with the media would be a more cost-effective return on investment and would better help the motorists.
    - The SC program would provide more data/information to the media on a more frequent basis
    - The media already receives information from Caltrans/CHP and TrafficVision

- Plans are in place to transmit data from CHP's Computer Aided Dispatch (CAD) system to the media

Changeable Message Signs (CMS)

1. Human factors associated with CMS (e.g., height, placement, angle, lettering, colors, and message content) were studied before SC implemented CMS technology.
   - Some studies were performed before SC's inception
   - Others were conducted as a part of the SC program itself
   - SC applied the results of the human factor research in the implementation of CMS technology
2. Full-matrix CMS have been installed on both the freeways (8 signs) and City of Los Angeles arterial streets (i.e., 5 full-matrix CMS, 16 Trailblazers) that allow a variety of messages to be displayed as a way of conveying information to motorists.
3. Caltrans already had equipment and policies established for CMS technology and applied these to SC.
4. LADOT based their first CMS on Caltrans' existing equipment → Model 550 red/green LED native.

   Explanatory Note: *The Model 500 is the incandescent bulb sign specification. LADOT took advantage of the Model 550 specification for a Light Emitting Diode (LED) based sign that had resulted from a City of Anaheim project with Caltrans District 12. This specification used a red/green LED combination due to the lack of a suitable amber LED. LADOT were able to take advantage of developments in the LED arena and implement a sign using the amber LED's.*

5. LADOT further established procedures that are more "liberal" (in terms of types of events that would trigger use of a CMS) than Caltrans. For example, LADOT will use CMS for Marathon announcements, whereas Caltrans typically would reserve the use of a CMS for major incidents.
6. Because of Caltrans' CMS use policy, most freeway CMS are "blank" most of the time.
   - A minority of Workshop participants believe that CMS should never be "blank"; CMS should always display a nominal message (e.g., current time/date, freeway conditions are "normal", etc.)
   - These same people believe that any non-blank message provides advantages in that it gets the motorist accustomed to the idea of reading the signs, and it also prevents the motorists from wondering if perhaps the system is broken, or bulbs are burnt out
   - Many Workshop participants believe that "blank" CMS do not create any problems, and that the current policy mitigates risks that the non-blank message may be incorrect, thereby creating distrust among the motorists

- Some believe that the policies for CMS use should be relaxed such that the signs could be used more frequently on the freeways to provide information to motorists more often

  Explanatory Note: *Caltrans have agreed to modify the current policy on sign use to adapt to SC's requirements.*

7. Some criticisms of CMS were expressed by Workshop participants.

   - Some cities avoid the use of CMS on arterial streets because they feel the visual aspect is negative for the City (e.g., signs are too large, use is ineffective, etc.)
   - LADOT believes that messages could be more effectively displayed using yellow LED lettering
   - Some believe that visual confirmation (via CCTV) of CMS messages is needed so that SC operators can be assured that the correct message is displayed; then, with greater assurance the SC operators would be more likely to display messages more frequently

8. An unfortunate string of coincidences has rendered Caltrans' CMS unable to electronically interface with SC.

   - When SC's software was being developed, Caltrans already had CMS systems that needed to be integrated into the SC system
   - This integration did occur, but later, Caltrans' CMS system front-end required a replacement; Caltrans' replaced CMS front-end does not currently interface directly with SC
   - Thus, in order for messages to appear on a Caltrans CMS, a SC operator must manually type-in a desired message
   - The current "SC Maintenance Contract" does not support an upgrade to allow SC to integrate electronically with Caltrans' CMS system

     Explanatory Note: *Caltrans could adopt LADOT's SC CMS software if they so desired.*

9. In addition to the full-matrix CMS, dynamic Trailblazer signs are used along SC arterial streets to display alternate routes to the I-10 freeway in response to incidents.

   - Workshop participants expressed that SC has revealed that Trailblazer signs are most effective over the roadway, not on the roadside
   - Some believe that Trailblazers' effectiveness could be enhanced by combining static data with dynamic information, and placing them at event-generation areas in addition to diversion routes
   - Trailblazer technology was developed "in-house" by LADOT based on existing/available "commercial-off-the-shelf" (COTS) hardware
   - Early attempts to meet the Trailblazer design requirements and recommendations of the Conceptual and Preliminary Designs resulted in signs whose cost was prohibitive for wide-scale deployment; LADOT experimented

with components readily available in their maintenance facility, resulting in a cost-effective solution employing a simplified design compared to the original intention

On-Line Access

1. The original concept to on-line access was via a dial-up modem (1995). As technology progressed and new options became available, the project idea evolved and increased in scope.
2. Internet capability exists. The next step is to establish an external Internet interface that will enable access to congestion and incident information via the World Wide Web.
    - On-line access to road situations via an Internet Web site is not yet implemented for SC, but the concept is in the process of being established
    - The intent is to allow Internet users to be able to check the Web site before leaving their home or office
    - LADOT is in the process of developing a standard interface to ATSAC for Internet access

    Explanatory Note: *SC currently supports an Internet interface, but lack of a connection to an external web-server is prohibiting access. Caltrans and LADOT policies do not permit SC to have a dedicated web-server. SCEMIS offers a 3rd party the opportunity to put SC information on a website.*
3. Most Workshop participants believe that an Internet Web site is a viable idea that would provide the potential for good public relations (i.e., making the public more aware of SC's benefits to motorists, and disseminating information to the drivers to allow them to plan their routes to avoid incidents).
4. Some believe this idea is more useful than HAR; however, education would be essential so that motorists would know the Web site and what it could do for them.
5. Others believe that not enough motorists have access to the Internet (in fact, some believe that most drivers do *not* have access) to make this an element that is worthy of it's associated costs.
6. Many Workshop participants expressed that, in order for the Internet on-line access to provide value, the implementation needs to be brought up to date with the state-of-the art in Internet technology.

SYSTEMS INTEGRATION

Graphical User Interface (GUI)

1. The SC GUI had to be developed twice; lessons learned from the first development effort were applied to the second iteration, which proved to be much more successful.
2. The first GUI was developed by the Consultant to poorly defined requirements.
    - In fact, Workshop feedback indicates that the first GUI development effort was launched much too soon

- Done before the Smart Corridor Operations Planning Element (SCOPE) was completed
- Done before the Agencies understood what functions the GUI needed to perform

- Some Workshop participants indicated that they were disappointed that the first GUI development effort was executed by the Consultant without prototypes or the opportunity for Agency interaction/reviews

> ***Explanatory Note:*** *The GUI Design presented in the Preliminary Design Report (June 1991) was used as the basis for an OS/2-based prototype using the GPF tool that the Consultant produced later that year. In January of 1992, the prototype was presented to the SCTC. In February and March of 1992, Agency representatives spent many hours with the Consultant's GUI development staff reviewing the prototype and bringing in design changes.*
>
> *One deficiency noted in the tool used was the lack of modeling of movement between screens. This is a critical aspect of the GUI design for incident management.*

- Others were more interested in functional requirements as opposed to how it was implemented
- Likely, all of the above factors contributed to "why" the first GUI effort was described as a "disaster

3. The process used to develop the second GUI went much better, and naturally resulted in a much more acceptable product.
   - Functional requirements were better defined
   - The GUI was developed using an open process that involved Agency users and showed intermediate deliverables
   - Agency users traveled to the Consultant's development site (Atlanta) to provide clarifications on requirements
   - Prototypes were developed that the Agencies were able to try, and feedback was provided to the Consultant
   - While the operating system (OS/2) posed some software limitations, the GUI managed these as best as possible in order to provide interactivity with the communications, ATSAC, and graphics
4. A lesson that has been learned by the Agencies from the second GUI development concerns on-going maintenance; it was noted that sufficient resources have not been allocated to allow JHK/TransCore to further enhance/modify the GUI based upon input by actual SC operators using the system.

Data Base Systems

1. Sybase was selected as SC's database environment.
   - Decision was based upon the Consultant's recommendation

- Decision was also based upon the use of the best available technology (i.e., the one that offered the most interoperability) at the time

  Explanatory Note: *As part of the Preliminary Design of the SC System, utility and tradeoff analyses were carried out for selection of databases, operating systems, expert system, and hardware environments for the system servers and the operator workstations.*

2. If given the opportunity to begin again, the SC Agencies would strive to obtain a database environment that is quicker; less complicated, more user-friendly, and easier to update.
3. In addition, they also would ensure that the selected database tool would support a mechanism to capture "before" data for an evaluation.

Software

1. In selecting an operating system, a process was applied as follows:
   - The Agencies specified known requirements (e.g., requirements for multi-tasking, 32-bit processing, support of a GUI, etc.)
   - The Consultant provided recommendations (along with pros and cons)
   - The SCTC reviewed the recommendations
   - Since the Consultant was hired for their expertise in similar systems, the Agencies relied on JHK/TransCore for a complete analysis and an optimal recommendation
   - The OS/2 operating system was selected based upon the best technology available at the time and its adherence to the known specifications
2. Unfortunately, some disadvantages of the OS/2 operating system were unknown, and some user needs were either unknown or unstated at the time that the decision was made; thus, OS/2 received criticism from the Workshop participants.
3. Many participants offered suggestions for requirements that should be stated if given the opportunity to revisit the operating system selection process. A representation of those requirements is recounted below:
   - Consider the Y2K issues associated with the OS
   - Consider and plan for maintenance costs (including personnel)
   - Clearly define roles and responsibilities
   - Plan ahead for expenditures and engineering efforts associated with continuously available software upgrades, in order to keep up with moving technology
   - Multitasking on Ethernet must be reliable with adequate bandwidth
4. Other suggestions were offered for requirements of the delivered SC software application (i.e., JHK/TransCore-developed code), as represented below:
   - The software should be modular, object oriented, and modifiable

- Source code should be delivered
- A variety of operational modes should be supported with ease
- Software upgrades must be planned for

Hardware

1. In selecting hardware components for SC, a process was applied as follows:
   - The Agencies specified known requirements
   - The Consultant provided recommendations (along with pros and cons)
   - The SCTC reviewed the recommendations
   - Since the Consultant was hired for their expertise in similar systems, the Agencies relied on JHK/TransCore for a complete analysis and an optimal recommendation
   - Sun computers and PCs were selected based upon the best technology available at the time and their adherence to known specifications
2. Many participants offered suggestions for requirements that should be stated if given the opportunity to revisit the hardware component selection process. A representation of those requirements is recounted below:
   - Postpone hardware procurement as long as practical
   - Once hardware is installed, continual upgrades must be planned for
   - Plan for the risks associated with vendors going out of business
   - Establish mitigation techniques
   - Plan ahead for maintenance issues, including establishing maintenance contracts, and planning for associated costs (including personnel resources)
   - Plan for hardware enhancements to keep up with technology
   - Establish an architecture that supports modularity (in order to contribute to a more adaptable system)
   - Where possible, implement the system with less specialized, more standardized, COTS hardware
   - Maintain a stock of spare parts
   - Define roles and responsibilities
   - Minority opinion; avoid PCs, use Sun workstations only
   - Minority opinion; avoid Suns, use high-end NT-based PCs

Communications Network

1. To fulfill the FHWA's desire to have a functioning SC system, priority was established for the communications networks, and the FHWA provided funding to assist the effort.

- Linking the various components of the SC system is an Ethernet-based communications network
- This takes the form of local area networks (LANs) within the Agency control centers, and connects these LANs using links to other control centers
- Workshop participants generally expressed that the SC communications network was the first of its magnitude, and that it constituted a technological success

2. Factors considered in the communications network design included the status of the existing field infrastructure and whether the Agency wanted/needed to keep their existing infrastructure or to upgrade.
    - LADOT capitalized on their previous experiences with smaller projects, and successfully upgraded their communications network to Fiber Optic (FO) links
    - Caltrans built upon their existing infrastructure and integrated into SC's communications network with some upgrades to their FO network
    - Santa Monica got some FO (for CCTV/video) and T1 links (for SC workstations)
    - Beverly Hills is using T1 lines (for SC workstations and TCS integration with ATSAC)
    - Culver City is using a leased 56 Kbps line (for SC workstation) and twisted-pair (for TCS integration with ATSAC)
    - FO connection between Caltrans TMC and ATSAC
    - FO backbone used for SC from downtown Los Angeles to the West Side
3. Keep CCTV video images (analog) separate from CCTV commands/control (digital).
4. Workshop participants offered some lessons learned and suggestions for improvement if given the opportunity to design a communications network for SC from "scratch".
    - Associated implementation costs should be identified at the outset of a project
    - Pre-planned maintenance for the system is critical; maintenance needs should be considered as a high priority and included in the budget
    - Roles and responsibilities should be clearly defined
    - A "shared" system requires special attention to definition and design so that sharing is facilitated
    - Long-term needs and risks should be considered for issues such as reliability, bandwidth, and even for determination of how deep to bury the fiber

Integration

1. The integration of the SC system, which was performed by JHK/TransCore, provided several lessons learned, although not all workshop participants are in agreement

regarding what would be the best way to approach it if given the chance to start over again.

2. In SC's case, the development of the software and the integration of the system was an iterative process.
    - Workshop participants generally agreed that JHK/TransCore was the most logical choice to perform the integration, given their experience with ATSAC and their knowledge of the software and integration components
    - Some went so far as to state that JHK/TransCore was the only entity with the capability to perform the integration
    - However, staff turnover at the Consultant posed problems with integration in that new people did not know enough about the system
3. Some SC integration could have been performed better if accomplished in a different sequence (e.g., SCOPE before any GUI development).
4. Some vendors were apparently not ready for open systems at the time that SC needed that support.
5. Most workshop participants agree that the SC system tried to integrate too many complex components at one time.
    - Some Caltrans participants expressed that, during integration, it became evident that the SC system had some serious flaws
    - However, the Agencies had already committed a great deal of resources (money, people, and time), and felt that it was too late to turn back
6. Many suggest that integration could have gone smoother if performed through a more modular/phased approach by thoroughly integrating and testing a selected subset of components before adding others into the system under test.
7. A minority opinion, though, felt that the integration as performed already consisted of too many iterations, which resulted in building the system more than once.

ACCEPTANCE MECHANISMS

Acceptance Test Procedures

1. Acceptance Testing for SC was performed according to documented test procedures.
    - The tests were carried out by the Agency staff according to the written test procedures
    - Consultant staff was on hand to answer questions and provide guidance during the tests
    - The SC subsystems were tested individually and generally passed the documented test procedures (please see item #'s 6 and 7)
2. Many problems existed with the Acceptance Test process used for SC that provide valuable lessons for future projects. The problems were shared by the Agencies and JHK/TransCore, and some of the problems experienced can be traced back to the requirements stage of the project.

- All Agencies are critical of the delivered SC system's reliability and performance
- Criteria associated with acceptable reliability and performance was not defined or agreed to between the Consultant and the Agencies
- Operational and maintainability responsibilities as they pertain to system acceptance were not defined
- Such criteria must be defined early in a project so that it can be designed into the system

3. Caltrans Workshop participants now believe that a better way would include having the Agencies involved in Acceptance Test definition/development/approval.
4. If the Agencies lacked the appropriate skills "in-house" to properly review the Acceptance Tests, they now believe it would have helped to seek a 3rd party for review.
5. Workshop participants generally agree that the Acceptance Test procedures (as written) were not comprehensive enough.
   - Many believe that they were written to ensure that the SC system would pass the tests
   - Tests were performed too quickly and should have been more thorough
   - The Agencies felt pressured to finish the work and pass the SC system, in order to demonstrate to partner Agencies that the contract was fulfilled
6. Acceptance Tests were performed in small pieces (i.e., demonstrate just one or two capabilities at a time).
7. Workshop feedback indicates that Acceptance Testing would have been more comprehensive and valuable if it had included subsystem testing as well as full-system capability testing (including tests for sustained performance and system "boundaries").
8. Some debugging occurred during the Acceptance Testing process.
   - This causes potential problems because changing software to affect one function can easily affect other functions that may have previously been demonstrated/accepted, and perhaps then should be re-tested (i.e., regression testing); however, re-testing is quite time- and labor consuming
9. Workshop participants pondered when Acceptance Testing should have been started.
   - Many participants noted that elements of the test planning process was not accomplished early enough (e.g., what would be tested, how, and to what performance standards)
   - This indicates that Acceptance Test plans and procedures probably should have been discussed and agreed-upon by all Stakeholders much earlier in the SC program
10. The concept of a "burn-in" period is advocated by many Workshop participants.

- It is believed that the SC system should essentially be tested for acceptance through two mechanisms:
  - 1st by passing comprehensive test procedures
  - 2nd by performing acceptably during a 30- or 60-day "burn-in" period of operational use

    Explanatory Note: *In actuality, these are precisely the steps that were followed. The SC system acceptance procedure included a 60-day period during which the system had to remain operational.*

Documentation

1. Workshop participants generally agree that the delivered SC system could have been better documented.
2. Better documentation is needed for many aspects of the SC system:
   - Operational Use (i.e., how to use the SC system)
   - Detailed Requirements (i.e., what the SC system does)
   - System Design (i.e., how the SC system was structured to meet the requirements)
   - Implementation (i.e., how the SC software performs its functions, how the SC system facilitates maintenance)
3. Detailed documentation requirements were not established early on in the SC program.
4. Many participants believe that documentation should be incorporated into the on-going "SC Maintenance Contract".

APPENDIX G - INTERVIEW QUESTIONS

Smart Corridor "Lessons Learned" Report

August 3rd, 1998

STAKEHOLDERS & OPERATIONAL OBJECTIVES

1. Do you believe that the Operational Objectives were articulated clearly?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

2. Do you believe that the Operational Objectives were understood and adopted by all of the Agencies and Team members?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

Do you believe that the Operational Objectives have changed during the course of the project (i.e., from 1988 until today)?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

3. Would you change the Operational Objectives today if you were developing a new Smart Corridor system?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

4. Was adequate staff available throughout the program?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

In addition to the above, we would also like to obtain your observations/opinions on the following areas:

1. Are the Agencies' role consistent/complementary with their mission?
2. How have the roles/responsibilities of the Smart Corridor Agencies evolved over time?
3. How did the individual Agency's organizational structure support/hinder Smart Corridor?
4. Looking back, would you add or subtract any Agencies to/from the Smart Corridor team?
5. What have the Agencies done to adapt to working in a cooperative multi-jurisdictional program?

INFORMATION NEEDS & SHARING

1. Was the information sharing process/mechanism used between the Agencies effective?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

2. Has the level of cooperation between the Agencies improved?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

3. Was there any reluctance to share information?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

In addition to the above, we would also like to obtain your observations/opinions on the following areas:

1. If there was any reluctance to share information, how was this overcome?
2. What impact has the information sharing process had on Agency relationships?
3. If you were starting over, how would you like to see the information developed and shared within the Smart Corridor team, upper management, and the public?

OPERATIONAL IMPLICATIONS OF INFORMATION SHARING

1. Did a viable, coordinated concept-of-operations emerge from the project?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

2. Did the Agencies clearly partition the areas of operational responsibility between them for Smart Corridor?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

3. Do all member Agencies seem to agree on the partitioning of operational responsibilities?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

4. Did the Agencies build and maintain consensus throughout the program's duration?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

In addition to the above, we would also like to obtain your observations/opinions on the following areas:

1. How have the Agencies built and maintained consensus throughout the program's duration?
2. What role(s) did each Agency maintain?
3. How was Agency interaction/coordination fostered?
4. How was the operational decision-making process developed, enacted, and enforced?

DESIGN CONSIDERATIONS

1. Were the methods used to design the system effective?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

2. Were the original user requirements translated into design considerations?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

3. Were any user requirement rejected due to their technical difficulties relative to benefit?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

4. Do you feel that any of the original design considerations were unrealistic?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

5. If so, were these concerns voiced to the appropriate parties?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

6. Has the advancement of technology during the life of Smart Corridor had an impact on the program?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

In addition to the above, we would also like to obtain your observations/opinions on the following areas:

1. What improvements would you bring-in to make the design process more effective?
2. What were the difficulties in generating a set of requirements that everyone could agree to?
3. How were the original user requirements judged on their technical merits prior to being translated into design considerations?
4. What steps were taken to mitigate any potential design risks?
5. How are the design considerations different/similar for the design of this "demonstration" system when compared to an "operational" system?
6. What impact has the advancement of technology during the life of Smart Corridor had on the program? Please elaborate…

PROCUREMENT STRATEGIES & CONTRACTION OPTIONS

1. Did the Agencies have any contract regulations that they were required to follow?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

2. Were the contracting methods used to procure and build the systems effective?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

3. Were the contract type(s) appropriate, given what you have experienced?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

4. Do you think that contact terms and conditions effectively managed the risk for the contracting Agencies?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

5. Do you think that the contract terms and conditions placed an unreasonable burden on the Contractors/Consultants?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

6. Were the original budget estimates realistic?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

In addition to the above, we would also like to obtain your observations/opinions on the following areas:

1. What procurement procedures were used in the implementation of the original Smart Corridor?
2. Which procurement procedures have been successful?
3. What could we do to improve internal Agency contract regulations?
4. How can the contracting methods used to procure and build Smart Corridor be improved?
5. What were the difficulties that arose in the past that could be used as risk control factors in a future procurement?
6. What changes would you like to see take place if the procurement was done over again?

OPERATIONS & MANAGEMENT

1. Were you satisfied with the development of the Smart Corridor Operational Procedure Element (SCOPE) process?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

2. Has operation of Smart Corridor elements proven to be satisfactory?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

3. Have your expectations been met?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

4. Were you satisfied with the development of the maintenance process?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

5. Has maintenance of Smart Corridor elements proven to be satisfactory?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

6. Have your expectations been met?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

7. Was planning for Smart Corridor operations and management adequately handled?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

8. Are there any institutional barriers in existence that have impacted Smart Corridor's operations and management activities?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

OPERATIONS & MANAGEMENT (cont.)

In addition to the above, we would also like to obtain your observations/opinions on the following areas:

1. What improvements would you bring into the SCOPE process?
2. What improvements would you bring into the maintenance process?
3. How was planning for Smart Corridor operations and management budget achieved?
4. From your perspective, what institutional barriers are in existence?
5. From your perspective, who is "in-charge" of Smart Corridor's operations?
6. What is the right blend of staff skills?
7. How can staff training be improved?
8. What considerations can be given in the design stage to reduce the level of operations and management required?
9. What can be done to improve the operation and management of the Smart Corridor system?

SHORT- AND LONG-TERM PLANNING NEEDS

1. Was the coordination between the Agencies for planning of the Smart Corridor aspects effective?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

2. Would you change the way project planning was done between the Agencies?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

3. Is there a process in place for furthering Smart Corridor-type deployments in Los Angeles County?

Absolutely YES	To Some Extent YES	To Some Extent NO	Absolutely NOT

In addition to the above, we would also like to obtain your observations/opinions on the following areas:

1. What were the factors that determined the lead Agency for specific Smart Corridor program aspects (e.g., SCOPE by LADOT, SCEMIS by Caltrans, System Manager by MTA, etc.)?
2. What would you change in the project planning process if you were developing a Smart Corridor again?

OVERALL SUMMARY

We would also like to obtain your observations/opinions on the following areas:

1. What are the successes/failures of the Smart Corridor system?
2. What can be done to improve the implementation of the Smart Corridor system?
3. What factors contributed to schedule adherence/non-adherence?
4. What were the causes of poor performance, schedule slippage, or cost growth?
5. In your opinion, what was the biggest obstacle to the deployment of the Smart Corridor system?
6. In your opinion, what was the biggest asset to the deployment of the Smart Corridor system?

TECHNICAL CONSIDERATIONS

Do you have any specific observations regarding the:

- Design Approach
- Alternatives Assessment
- Functionality

For the following Smart Corridor elements:

1. Incident Detection Elements
    - Inductive Loops
    - CCTV
    - CHP information
    - Others…
2. ATMS Elements
    - Ramp/Connector Metering
    - Intersection Control
    - Others…
3. Incident Management
    - Response Plans
    - Decision Support Systems
    - Others…
4. ATIS Elements
    - CMS
    - HAR
    - HAT
    - Trailblazers
    - Others…
5. Systems Integration Issues
    - Design & Development Approach
    - Operating Systems and COTS Solutions
    - Application Software
    - Hardware Components
    - Communications Elements
    - Integration Process
    - Test & Acceptance
    - Others…

APPENDIX H - PRIORITIZED INTERVIEW QUESTIONS

Smart Corridor "Lessons Learned" Report

August 20th, 1998

TOP TEN:

OVERALL SUMMARY

1. What are the successes/failures of the Smart Corridor system?
2. What can be done to improve the implementation of the Smart Corridor system?
3. What factors contributed to schedule adherence/non-adherence?
4. What were the causes of poor performance, schedule slippage, or cost growth?
5. In your opinion, what was the biggest obstacle to the deployment of the Smart Corridor system?
6. In your opinion, what was the biggest asset to the deployment of the Smart Corridor system?

STAKEHOLDERS & OPERATIONAL OBJECTIVES

1. Are the Agencies' roles consistent/complementary with their missions?
2. How did the individual Agency's organizational structure support/hinder Smart Corridor?

INFORMATION NEEDS & SHARING

1. If there was any reluctance to share information, how was this overcome?
2. What impact has the information sharing process had on Agency relationships?

OPERATIONAL IMPLICATIONS OF INFORMATION SHARING

1. How have the Agencies built and maintained consensus throughout the program's duration?
2. From your perspective, who is "in-charge" of Smart Corridor's operations?

DESIGN AND IMPLEMENTATION CONSIDERATIONS

1. What improvements would you bring-in to make the design process more effective?
2. What steps were taken to mitigate any potential design risks?

PROCUREMENT STRATEGIES & CONTRACTING OPTIONS

1. What procurement procedures were used in the implementation of the original Smart Corridor?
2. Which procurement procedures have been successful?
3. How can the contracting methods used to procure and build Smart Corridor be improved?

OPERATIONS & MANAGEMENT

1. What can be done to improve the operation and management of the Smart Corridor system?
2. What is the right blend of staff skills?

SHORT- AND LONG-TERM PLANNING NEEDS

1. What were the factors that determined the lead Agency for specific Smart Corridor program aspects (e.g., SCOPE by LADOT, SCEMIS by Caltrans, System Manager by MTA, etc.)?
2. What would you change in the project planning process if you were developing a Smart Corridor again?

2nd TEN:

STAKEHOLDERS & OPERATIONAL OBJECTIVES

1. How have the roles/responsibilities of the Smart Corridor Agencies evolved over time?

INFORMATION NEEDS & SHARING

1. If you were starting over, how would you like to see the information developed and shared within the Smart Corridor team, upper management, and the public?

OPERATIONAL IMPLICATIONS OF INFORMATION SHARING

1. How was the operational decision-making process developed, enacted, and enforced?

DESIGN AND IMPLEMENTATION CONSIDERATIONS

1. What were the difficulties in generating a set of requirements that everyone could agree to?
2. How were the original user requirements judged on their technical merits prior to being translated into design considerations?

PROCUREMENT STRATEGIES & CONTRACTING OPTIONS

1. What were the difficulties that arose in the past that could be used as risk control factors in a future procurement?
2. What changes would you like to see take place if the procurement was done over again?

OPERATIONS & MANAGEMENT

1. What improvements would you bring into the SCOPE process?
2. What improvements would you bring into the maintenance process?

3rd TEN:

STAKEHOLDERS & OPERATIONAL OBJECTIVES

1. What have the Agencies done to adapt to working in a cooperative multi-jurisdictional program?

OPERATIONAL IMPLICATIONS OF INFORMATION SHARING

1. What role(s) did each Agency maintain?
2. How was Agency interaction/coordination fostered?

DESIGN AND IMPLEMENTATION CONSIDERATIONS

1. What impact has the advancement of technology during the life of Smart Corridor had on the program? Please elaborate...

PROCUREMENT STRATEGIES & CONTRACTING OPTIONS

1. What could we do to improve internal Agency contract regulations?

OPERATIONS & MANAGEMENT

1. From your perspective, what institutional barriers are in existence?
2. What considerations can be given in the design stage to reduce the level of operations and management required?

4th TEN:

STAKEHOLDERS & OPERATIONAL OBJECTIVES

1. Looking back, would you add or subtract any Agencies to/from the Smart Corridor team?

DESIGN AND IMPLEMENTATION CONSIDERATIONS

1. How are the design considerations different/similar for the design of this "demonstration" system when compared to an "operational" system?

OPERATIONS & MANAGEMENT

1. How was planning for Smart Corridor operations and management budget achieved?
2. How can staff training be improved?

TECHNICAL CONSIDERATIONS

Do you have any specific observations regarding the:

- Design Approach
- Alternatives Assessment
- Functionality

For the following Smart Corridor elements:

1. Incident Detection Elements
    - Inductive Loops
    - CCTV
    - CHP information
    - Others…
2. ATMS Elements
    - Ramp/Connector Metering
    - Intersection Control
    - Others…
3. Incident Management
    - Response Plans
    - Decision Support Systems
    - Others…
4. ATIS Elements
    - CMS
    - HAR
    - HAT
    - Trailblazers
    - Others…
5. Systems Integration Issues
    - Design & Development Approach
    - Operating Systems and COTS Solutions
    - Application Software
    - Hardware Components
    - Communications Elements
    - Integration Process
    - Test & Acceptance
    - Others…