CHAPTER 8

BUSINESS PLAN

This chapter describes a recommended Business Plan for the Corridor-wide surveillance system. The development of the Plan was based on the work accomplished in the other five tasks of the SR/I Project. The Plan consists of the following four key elements:

+ Recommended Surveillance System Operational Test Program. This program consists of nine inter-related projects described in Section 8.1. These projects, were designed to capture the key conceptual design features of the Corridor-wide surveillance system developed under Task 4 and discussed in Chapter 6.

+ Candidate Funding Opportunities and Cost Sharing Schemes among Coalition Members. Various funding opportunities beyond the traditional funding sources for traffic surveillance are described in Section 8.2. Cost sharing schemes are described in the same section and cover both capital costs and operating and maintenance costs.

+ Surveillance System Deployment and Cost Schedule. The deployment time frame of the Corridor-wide surveillance system is assumed to be between the years 1996 and 2005. Within this time frame, three deployment milestones were assumed (i.e., 1998, 2000, and 2005) for developing the estimated cost schedule. The details of the system deployment and cost schedule are described in Section 8.3 of this chapter. This section also contains a budget plan for surveillance system operations and maintenance.

+ Potential Public/Private Co-Ventures In Surveillance. This element of the Business Plan, Section 8.4, describes the needs and general considerations for public/private co-ventures. It also explores the opportunities for the private sector to join with the public sector to collect and provide surveillance information for ITS applications.

The detailed description of the Business Plan begins in the next section with the description of the recommended field operational test projects.

8.1 RECOMMENDED FIELD OPERATIONAL TESTS

The recommended Field Operational Tests (FOTs) for this SR/T Project are based on the results of Task 1 (System Goals and Objectives), Task 2 (Existing System Inventory), Task 3 (Technology Assessment), and Task 4 (Systems Requirements and Conceptual Design). The findings of these tasks are detailed in Chapters 2 through 6 of this report.

As a prelude to the description of the recommended FOT projects, a brief background on the U.S. DOT field operational test program is provided, along with the key considerations for developing the recommended test concepts. The purpose of the latter is to provide a rationale and a system framework from which the recommended test concepts can be integrated into the Corridor-wide surveillance system during deployment.

8.1.1 Overview of U.S. DOT Operational Test Program

Field Operational Tests are a U.S. DOT-sponsored program to provide a transition between the R&D activities and field deployment of technologies. ITS operational tests are conducted as cooperative ventures between the U.S. DOT and a variety of public and private partners, including state and local governments, private companies, and universities. The participating U.S. DOT administrations are the Federal Highway Administration (FHWA), the National Highway Traffic Safety Administration (NHTSA), the Federal Transit Administration (FTA), and the Research and Special Programs Administration (RSPA). The general Federal role is to act as a leader and a catalyst, and to ensure adequate emphasis on public benefits. The U.S. DOT also guides the design and conduct of the project evaluation to ensure that the project is independently evaluated on a national program scale.

An operational test is a limited-scale field deployment of existing technology, R&D products, and institutional and regulatory arrangements in a real-world environment. The tests permit an evaluation of how newly developed ITS technologies work under real operating conditions, and assess the benefits and public support for the product or the system.

The U.S. DOT has in the past solicited proposals three times for ITS operational tests from the public and private sector partnerships. Currently, a number of FOTs are ongoing and cover a wide range of ITS user services as defined in the National ITS Program Plan (IVHS America, 1994).

However, FOTs for the I-95 Corridor have a special significance and are different from the regular open FOT solicitations. The National ITS Program Plan has identified four priority Corridors in the country, of which the I-95 Corridor is one. Operational tests are intended to be negotiated with these Corridors each year based on the plans of the region and the required activities identified in the National ITS Program Plan. This offers an excellent opportunity for the Coalition to receive funds without the usual competitive solicitations. Since the I-95 Corridor FOT funds are specially designated funds, the negotiation process for funding allocations with the US. DOT is expected to be much simpler. Because the funds are already set aside for the Corridors, they are expected to receive the necessary funds, as long as the Coalition follows the Operational Test guidelines.

One important aspect of the operational tests is the evaluation of technology. The proposer for the test needs to provide a scheme for an independent and comprehensive evaluation of the test. The independent test evaluator should be brought into the process when the project is underway. The evaluation scheme needs to follow the guidelines provided by the DOT for operational tests funded in whole or in part with Federal ITS funds. The salient features of the evaluation guidelines are:

+ Evaluation goals should be consistent with the National ITS Program Plan.

+ The U.S. DOT will be evaluation coordinator for all operational tests.

+ Evaluation will be conducted by an independent party.

+ An evaluation plan needs to be prepared in the early phases of the operational test.

+ A funding plan for the evaluation phase needs to be accounted for.

8.1.2 Considerations for FOT Concept Development

The purpose of FOTs is to evaluate the utility and merit of ITS technologies and services in a real-world setting so as to bridge the gap between R&D and the deployment of proven technologies. To successfully fulfill this purpose for the I-95 Corridor-wide surveillance system, a number of considerations regarding the choice of technologies and the needs of the Coalition must be examined. The purpose of this section is to describe those considerations as a basis for developing the recommended surveillance FOT concepts.

Technology Considerations

A number of potential surveillance technologies have been identified in the Technology Assessment (Chapter 4) of this Project and incorporated into the system conceptual design. These technologies may be categorized as follows:

+ Land-based, point detection systems such as acoustic, infrared, or video image processing.

+ Land-based, wide-area detection systems such as “long-range” radar (bi-directional, covering approximately 6 miles of roadway) and vehicle probes.

+ Airborne detection systems using radar and infrared imaging technologies.

Although all potential technologies identified during the course of this Project may be good candidates for FOTs, the desire to use the FOT funds effectively and the Corridor’s ITS application needs influence the choice of technologies to be recommended for testing. The effective use of FOT funds implies that the Coalition should focus on testing technologies that may have region-wide application or impact, as opposed to those that may have only local impact and can be tested outside the Corridor. This consideration suggests that the FOT priority should be placed on concepts that employ wide-area surveillance technologies. This priority is further reinforced by the recent effort of the FHWA [through the Jet Propulsion Laboratory, (JPL)] to develop advanced traffic surveillance and detection technologies for traffic management. This effort will focus, in the near term (deployed in 3 to 5 years), on traffic management applications for grid system coordinated intersections and freeways. In the long term, it will focus on traffic management applications for priority corridors, including arterial streets and freeways. The near-term effort seems to encompass similar land-based, point detection technologies identified in this Project. Thus, it would be beneficial to the Coalition, and to the FHWA, that FOT concepts be focused on wide-area surveillance.

The results of the system goals and objectives survey conducted during Task 1 of this Project, as discussed in Chapter 2, show that the Coalition places a very high priority on incident management. To effectively manage traffic incidents, especially those that have regional and Corridor impacts, Coalition member agencies should be able to detect and verify an incident, to divert traffic to available alternate routes, and to control the upstream traffic demand in a timely manner. This ability requires a surveillance coverage of all mainline roads and their potential diversion routes. Since the existing surveillance coverage along the Corridor-designated roads is inadequate, wide-area surveillance technologies seem to be a preferred choice to efficiently fill the surveillance gaps.

In addition to the above technology considerations, the recommended FOT concepts should address the institutional and organizational arrangements and challenges that exist in the real-world setting of the I-95 Corridor Coalition. These considerations regarding the Corridor-wide surveillance system are discussed in the following paragraphs.

Institutional and Organizational Considerations

The mission of the I-95 Corridor Coalition is to promote and foster cooperation and coordination among the member agencies. To successfully accomplish this mission, potential institutional and organizational issues need to be identified, understood, and overcome. These issues are anticipated for the implementation and deployment of the Corridor-wide surveillance system because one of its fundamental design elements is the ability to intearate and share surveillance information among the agencies (public-public partnership), and between the public sector and the private sector (public-private partnership).

Currently, issues involving information integration and sharing are not completely identified, nor are they fully understood. An operational test is an ideal platform for these issues to surface and be addressed before deployment. Thus, the recommended FOT concepts should provide a mechanism for identifying and resolving non-technical issues which are essential to the operation of the Corridor-wide surveillance system. The approaches to solving the non-technical issues also provide a basis to refine and formalize the operational responsibility framework defined in this SR/T Project.

Multi-Project Integration Considerations

The *I-95 Corridor Coalition Business Plan* currently contains 21 projects, many of which are the corner stones of the envisioned I-95 Corridor Intelligent Transportation System. To ensure the creation of an integrated, seamless ITS for the Corridor, an understanding of how individual projects are integrated conceptually and operationally is essential. The conceptual integration has been accomplished through the ongoing inter-project coordination efforts; and the operational integration will be accomplished in the FOT phase. For the operational integration of projects to be successful, multi-project integration opportunities must be considered during the FOT concept development. The purpose of this subsection is to identify such integration opportunities for this Corridor-wide Surveillance System Project.

Since the purpose of the Corridor-wide surveillance system is to collect and provide information to enable the implementation of various ITS services, there are many opportunities for the surveillance FOTs to be integrated with other FOTs or services. The integration will not only offer a more efficient use of the Coalition’ s FOT resources, but also will provide an opportunity to conduct an end-to-end evaluation of the integrated system. The latter is important because the benefits offered by the surveillance system can be more meaningfully evaluated. The opportunities to integrate this Project with the current I-95 CC Projects in a FOT environment are as follows:

+ Project #1 - Information Exchange Network. Validate the ability to exchange surveillance information for integration, and to disseminate regional surveillance information to various Coalition member agencies.

+ Project #2 - Incident Management – Detection, Response, and Operations. Collect probe data from service patrol vehicles and integrate human surveillance information supplied by incident management agencies. This data will aid in the development of response plans and their refinement based upon test data. This effort is critical to inter-jurisdictional incident management and coordination.

+ Project #4 - Commercial Vehicle Operations. Share vehicle weight data (axle and gross weight) and commercial truck volume data for pavement management, safety planning, and traveler services planning. There are also opportunities to share HAZMAT carrier tracking data for incident response planning.

+ Project #5 - Public/Private Sector Outreach. Develop and refine public/private partnership arrangements in surveillance data collection and sharing.

+ Project #8 - Traveler Information Services. Validate traveler information needs to support trip planning, intermodal transportation, and real-time route choice analysis.

+ Project #9 - Coordinated VMSlHAR Svstem. Validate en route traveler information needs and standardize surveillance information contents for VMS and HAR displays.

In addition to the FOT integration considerations for ongoing projects, the surveillance FOT concepts should account for other projects that are being planned. These considerations will provide operational insight into the future projects to ensure a successful deployment of an integrated I-95 Corridor ITS. The opportunities for the surveillance FOTs to support future projects are:

+ Project #10 - Communications Infrastructure Opportunitres. Assess the needs and evaluate the means to best transfer surveillance data from the field to an operations/control center. The FOT results to support this project should cover both the urban and rural conditions existing in the Corridor. Joint opportunities with Projects #I8 (Emergency Response System) and #19 (Rural Mayday/800 Call-in System) may be available and should be explored.

+ Project #11 - Technology Exchange and Training Program. Explore training requirements for the tested surveillance technologies.

+ Project #12 - Intermodal Outreach and Information Exchange. Investigate technical and institutional issues regarding the exchange of route condition information for vehicle probe information with transit operators and private fleet operators such as delivery trucks and taxi cabs.

+ Project #13 - Passenger/Freight Supply and Demand Analysis. Evaluate and explore options to collect travel demand statistics from the surveillance system. This project is closely related to the defined functional requirements of the surveillance system to provide transportation system planning data.

+ Project #15 - Corridor-wide AVI/ETTM Feasibility. Define Corridor-wide system requirements and specifications for AVI/ETTM probe data collection.

+ Project #16 - Feasibility of Regional Communications Centers. Validate surveillance data fusion and aggregation techniques to produce regional and Corridor-wide surveillance information.

+ Project #18 - Emergency Response System. Integrate probe data and locate incident through the use of AVL-equipped service patrol vehicles. In addition, technical and organizational issues related to a Corridor-wide service patrol program may also be examined. This project is closely related to Project #lO (Communications Infrastructure Opportunities) and Project #I9 (Rural Mayday/800 Call-in System); therefore, joint opportunities should be explored.

+ Project #19 - Rural Mayday/800 Call-in System. Assess the operational and communications requirements for incident detection using telephone call-in and/or automated/semi-automated Mayday signal transmitters.

+ Project #20 - Corridor-wide Decision Support/Expert System. Assess the operational feasibility of artificial intelligence applications in surveillance data processing and fusion.

With the above considerations, a number of surveillance FOT concepts have been developed. The following sections describe these recommended concepts.

8.1.3 Overview of Surveillance FOP Program

The Corridor-wide surveillance FOT program is intended to be a multi-year program that focuses on testing new technologies and coordinated operational procedures. The thrust of the program is to provide surveillance information to support incident management, intermodal coordination, and traveler information applications. For the purpose of concept formulation, no specific geographic location for the operational tests is suggested. The absence of the specific location at this time also provides the Coalition with the flexibility to determine how and where the conduct of the tests would best serve the Coalition member agencies.

The objectives of the Surveillance FOT Program include:

+ Assessing the feasibility of integrating surveillance information from multiple sources. These sources may include existing surveillance assets, new technologies, public agencies, and private organizations.

+ Identifying and formulating institutional arrangements that would enhance the cooperation among agencies and organizations participating in the collection and use of surveillance information.

+ Determining the most feasible technology or technologies that may be deployed Corridor-wide.

+ Gaining the necessary information for the Coalition to prepare its Corridor-wide Surveillance System Deployment Plan.

This FOT program is composed of nine projects with each covering an aspect of the surveillance system conceptual design. The recommended projects are designated as Project S.1 through Project S.9 (the letter S denotes *Surveillance)* and briefly described below. The detailed description of each project is provided in Sub-section 8.1.4.

+ Project S.1: Region-wide Information Integration. Its main objective is to create and test a mechanism for fusing surveillance data from multiple sources and organizations. The data will be supplied by systems of other FOT projects or agencies, and by the existing surveillance assets (e.g., loop detectors). The fused data will be available for use by all ITS applications that are concurrently tested.

+ Project S.2: Service Patrol Vehicle Probe Integration. This is intended to be a joint effort with the I-95 CC Project #2 (Incident Management) in which AVL and two-way communications equipment will be installed on service patrol vehicles. The vehicle location data provided by the AVL system will be used to support incident management and vehicle fleet management functions, while the vehicle tracking data will provide probe information for the surveillance system. The tracking of service patrol vehicles has already been implemented in some areas of the country (e.g., Los Angeles and San Francisco). However, the thrust of this test is to assess the feasibility of using the derived probe data as a source of surveillance information, and the potential to expand the service patrol operations Corridor-wide.

+ Project S.3: Cellular Telephone Traffic Probe Integration. The collection of traffic probe data from cellular telephone signals is being operationally tested in the Washington D.C. area (between April and May 1995). If the results are promising, this technique is expected to be employed widely in the Corridor and the need to integrate its data with other data from sources will arise. The purpose of this recommended operational test is then to investigate the data integration issues.

+ Project S.4: Transit Vehicle Probe Integration. Many transit properties in the Corridor use or plan to use AVL technologies to track their vehicles to enhance schedule adherence. For those vehicles that travel along the designated Corridor’ s roads, their tracking data may be used as probe data in surveillance. The purpose of this FOT project is to integrate the transit vehicle probe data with other surveillance data.

+ Project S.5: Public/Private Surveillance Information Exchange. The purpose of this project is to assess the feasibility of collaborating with private organizations that collect traffic surveillance data for their ITS services (e.g., Shadow, Metro Traffic Control, and SmartRoute Systems). Besides the technical feasibility, institutional issues regarding public/private partnership will be examined.

+ Project S.6: Multi-Sensor Surveillance Aircraft. Aerial surveillance using aircraft can cover a large road network and provide a bird’ s eye view of traffic conditions. With the recent defense technology conversion initiatives, airborne sensor technologies (radar and infrared imaging) and air-to-ground communication technologies can further enhance the surveillance capability of an aircraft. The radar sensor can detect vehicular traffic at a range in excess of 60 miles with a coverage area of 360i in azimuth. These technologies are being used in non-defense applications (such as border surveillance) that have similar requirements as those of the Corridor-wide traffic surveillance (e.g., detect and track vehicle movements). The purpose of this recommended FOT is to assess the feasibility of using a multi-sensor surveillance aircraft for regional traffic surveillance, including its ability to complement other land-based traffic surveillance systems.

+ Project S.7: Aerostat Traffic Surveillance. This surveillance system is similar to that of the multi-sensor surveillance aircraft but with a stationary aerostat (tethered to a ground mooring) as the airborne platform. The aerostat carries an air-to-ground radar, IR imaging system, and TV camera. Because of the stationary nature of the aerostat, it may have a role in supporting ITS applications that require a continuous surveillance coverage of an area. This recommended project will assess the feasibility of the aerostat surveillance system and its complementary aspects to other systems.

+ Project S.8. Wide Area land-based Radar Sensor. This sensor technology offers a larger surveillance coverage compared to many existing point detection systems. It monitors traffic in both the upstream and downstream directions of its location and can cover distances of up to 3 miles in each direction. The output of this sensor includes the distribution of traffic density and traffic speed within the sensor' s detection range. This output may be used to detect traffic congestion and determine the congestion location. The sensor is still under research and development and expected to be available in the latter part of 1995.

+ Project S.9: Road Weather Information Integration. The survey results conducted for Task 2 of this Project have indicated that Road Weather Information Systems (RWIS) are currently in use by many member agencies. The data provided by the RWIS may be used to formulate traffic advisory information and trip planning information. The purpose of this test is to assess the feasibility of using RWIS data, combined with other traffic surveillance data to generate wintry travel advisory information.

Among the nine recommended projects, Project S.l (Region-wide Information Integration) is the core that ties all other projects together and should be initiated first. Other projects may be implemented in an approximate time order as shown in Figure 8-1. This order, however, may be changed depending on factors such as funding availability and the availability of existing systems at the test site (e.g., transit AVL system) to accommodate the recommended tests.

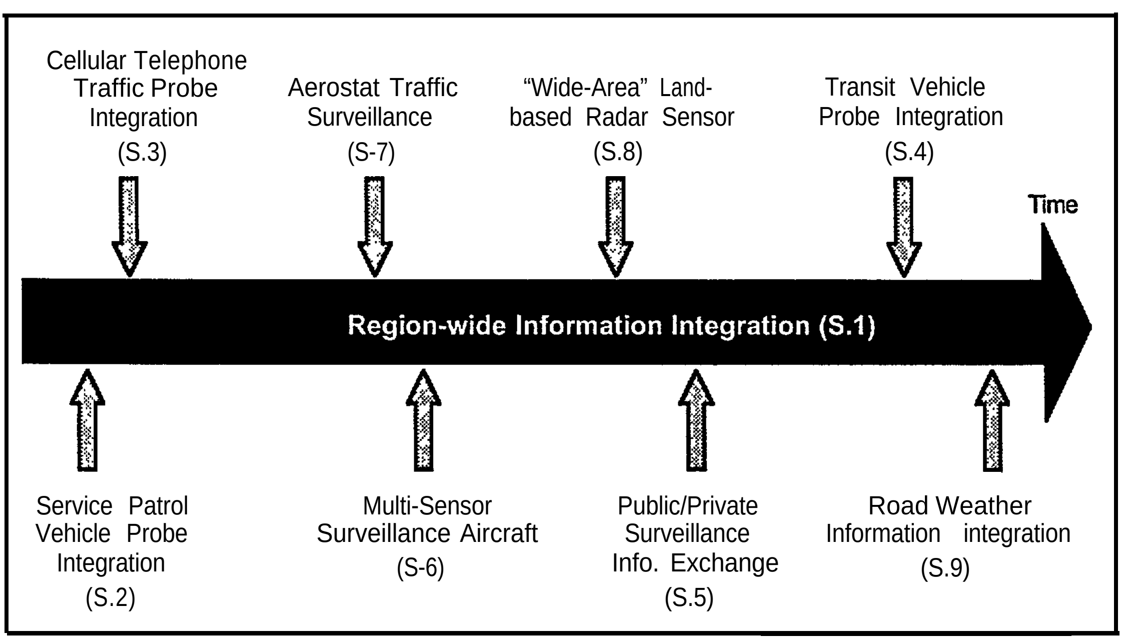

Figure 8-1. Proposed Phased Implementation of the Recommended FOT Projects

The details of each FOT project are described in the next section.

8.1.4 Recommended Surveillance FOT Projects

8.1.4.1 Project S.1: Region-wide Information Integration

The purpose of this project is to assess the feasibility of gathering and integrating surveillance information from various agencies and organizations to create a region-wide surveillance database. This database will be used to support regional traffic management, enhance transit operations (e.g., real-time routing and time of arrival estimates), provide traveler information services, and support Corridor-wide surveillance situation awareness.

The scope of the project is illustrated in Figure 8-2 in which the region-wide information integration mechanism is denoted as a “system” rather than a “physical node” in the Corridor ITS. The reason is that when the operational test is completed, decisions regarding the allocation of the system’s functionalities for deployment will be made. If the functionalities are to be centralized, a physical node in the Corridor ITS will exist; otherwise, they may be distributed to various traffic management systems or travel information systems within a region.

In this operational test, data integration will be performed for multiple centers representing Traffic Management Agencies, Transportation Authorities (AVIETTM data and other traffic surveillance data), Transit Agencies, Public Safety Agencies (a generic name denoting agencies that are responsible for incident response and management), and Commercial Traffic Reporting Organizations. The rationale here is that the Corridor-wide surveillance system should utilize available information sources to the maximum extent possible to be effective and efficient. The Project’s scope also includes the integration of data from the other eight surveillance FOT projects briefly described in Section 8.1.3.

Although the scope of this project depends on the initiation of other related FOT projects, it can be implemented in phases according to the schedule of the overall surveillance FOT program. The initial phases will focus on the design of the overall system and the integration of existing data sources (e.g., loop data). This way, early benefits of an integrated system may be realized and lessons can be learned for the subsequent integration efforts.

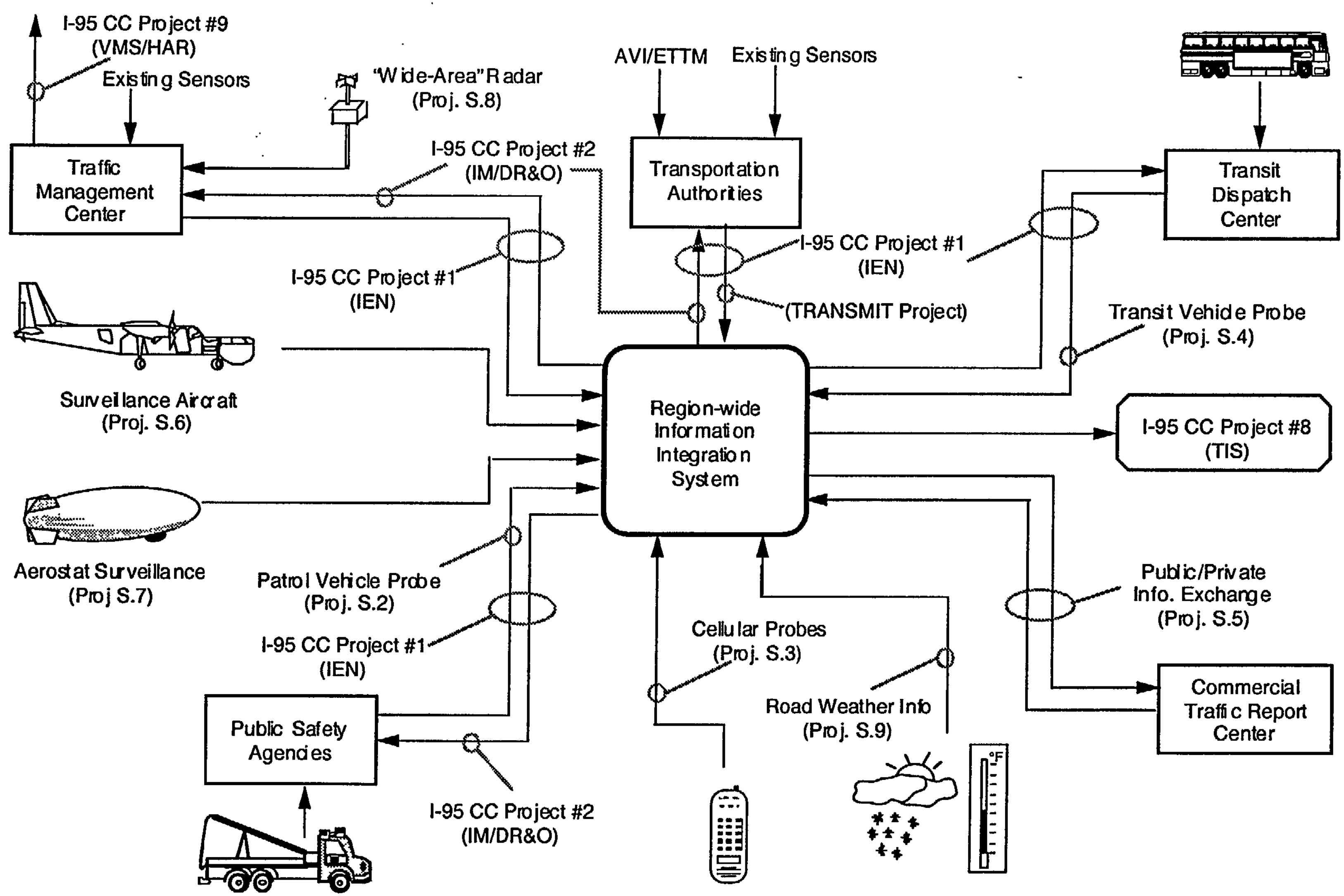

Figure 8-2. Scope of the Region-wide Information Integration FOT Project (S.1)

The specific objectives of this Project are as follows:

- To evaluate the technical, economic, and institutional feasibility of surveillance data integration and sharing. This evaluation will help to determine what technology requirements are needed to develop an integrated surveillance system. These requirements will identify the types of technologies and their operational environment that would best serve the Corridor’ s needs. It will also help to define the institutional arrangements and operational responsibilities of each participating member. Specifically, this evaluation could include defining the surveillance data protocols, standardizing the required software for data conversion, and defining the required data structure necessary to operate a region-wide surveillance database. This evaluation will provide the Coalition members with a viable precedent for use in future ITS integrated systems development and information coordination across multiple jurisdictions. This effort is the next logical step in developing an integrated Corridor-wide surveillance system.

- To formulate Corridor-wide deployment concepts for feasible wide-area surveillance technologies that have inter-jurisdictional applications.

- To formulate lessons learned for the following I-95 CC Projects:

  - Project #10 - Communications Infrastructure Opportunities.
  - Project #11. Technology Exchange and Training Program.
  - Project #12. Intermodal Outreach and Information Exchange.
  - Project #13. Passenger/Freight Supply and Demand Analysis.
  - Project #15. Corridor-wide AVI/ETTM Feasibility.
  - Project #16. Feasibility of Regional Communications Centers.
  - Project #20. Corridor-wide Decision Support/Expert System.

8.1.4.2 Project S.2: Service Patrol Vehicle Probe Integration

The survey results conducted for Tasks 1 and 2 of this Project have indicated that many member agencies operate service patrol vehicles to detect, verify, and respond to traffic incidents. This trend is likely to continue as indicated by the survey respondents and by the description of the I-95 CC Project #18 (Emergency Response System). To enhance the operations of service patrol, computer-aided dispatch and automated vehicle location (CAD/AVL) technologies may be employed. These technologies can provide service patrol vehicle probe data as a secondary source of surveillance information. The purpose of this Project is to assess the feasibility of collecting the probe data, and to evaluate the effectiveness of the service patrol operations in regional incident detection, response, and management (which is also a purpose of the I-95 CC Project #2). The concept of this Project is illustrated in Figure 8-3.

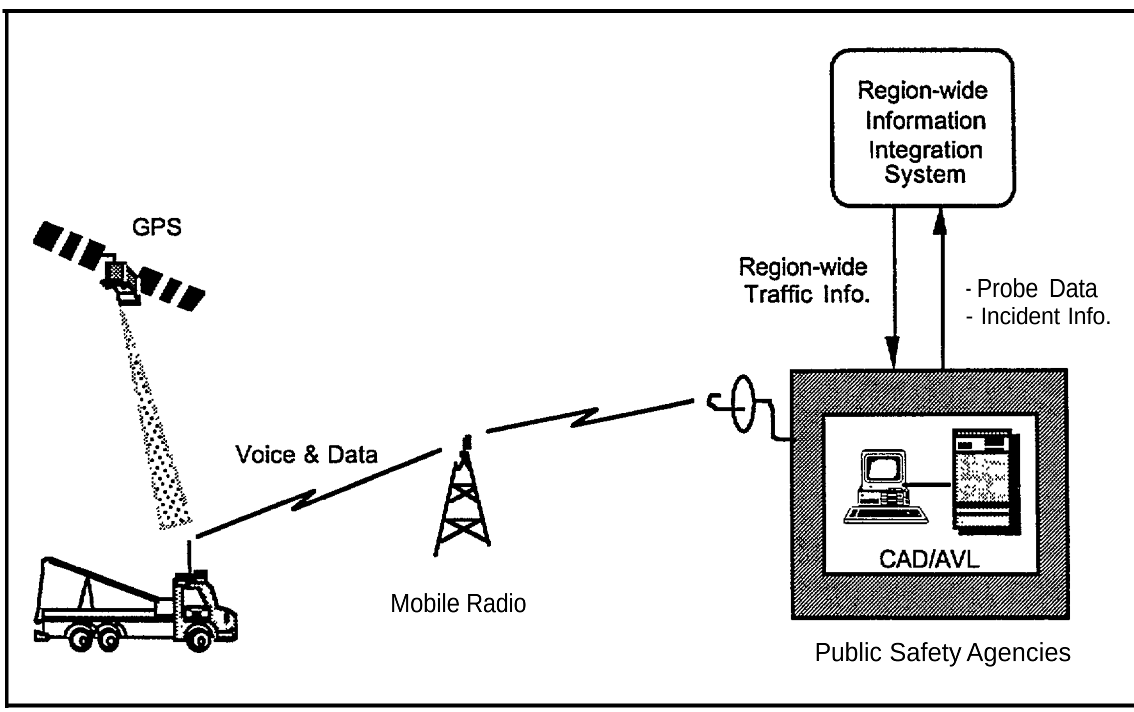

Figure 8-3. Service Patrol Vehicle Probe Concept

The objectives of the Service Patrol Vehicle Probe Integration Project are:

+ *To extract and formulate probe data from the CAD/AVL database.* Probe data formulation must properly associate patrol vehicle operations with the collected data. While patrol vehicles are en route to a disabled vehicle or performing routine patrol operations, probe data can be used for travel time estimation. While patrol vehicles are assisting disabled vehicles, probe data may be used for incident management strategies.

+ *To assess the feasibility of using region-wide surveillance information for service patrol vehicle routing and assignment.* This assessment will contribute to the development and refinement of service patrol operational concepts, such as the decision to use fixed-routes, flexible routes, or a combination of both.

+ *To identify and resolve issues regarding organizational privacy and inter-jurisdictional probe data collection and integration.*

+ *To formulate lessons /earned for the 1-95 CC Project #18 (Emergency Response System) and Project #19 (Rural Mayday/800 Call-in System).*

+ *To investigate the feasibility of sharing mobile communication resources among agencies that operate AVL systems (e.g., between a Transit Agency and a Public Safety Agency as shown in Figure 8-4)* . Since radio frequency is scarce, the ability to share this resource will enable a wide-spread application of AVL technologies in the Corridor. The results of this investigation will support the I-95 CC Project #10 (Communications Infrastructure Opportunities).

8.1.4.3 Project S.3: Cellular Telephone Traffic Probes Integration

This Project may be viewed as an extension of the ongoing FOT Project in the Washington, D.C. metropolitan area. If the technology shows promise in traffic surveillance and incident detection, it would be a viable candidate for early deployment. Because of this reason, the emphasis of this recommended FOT Project will be on issues related to the Corridor-wide surveillance system deployment. The following issues may be of interest:

+ Should the probe data be processed and fused at the local level or regional level?

+ How much impact would this technology have on the future investments in the Corridor-wide surveillance system?

+ What is the role of the private sector in the deployment of this surveillance “service”?

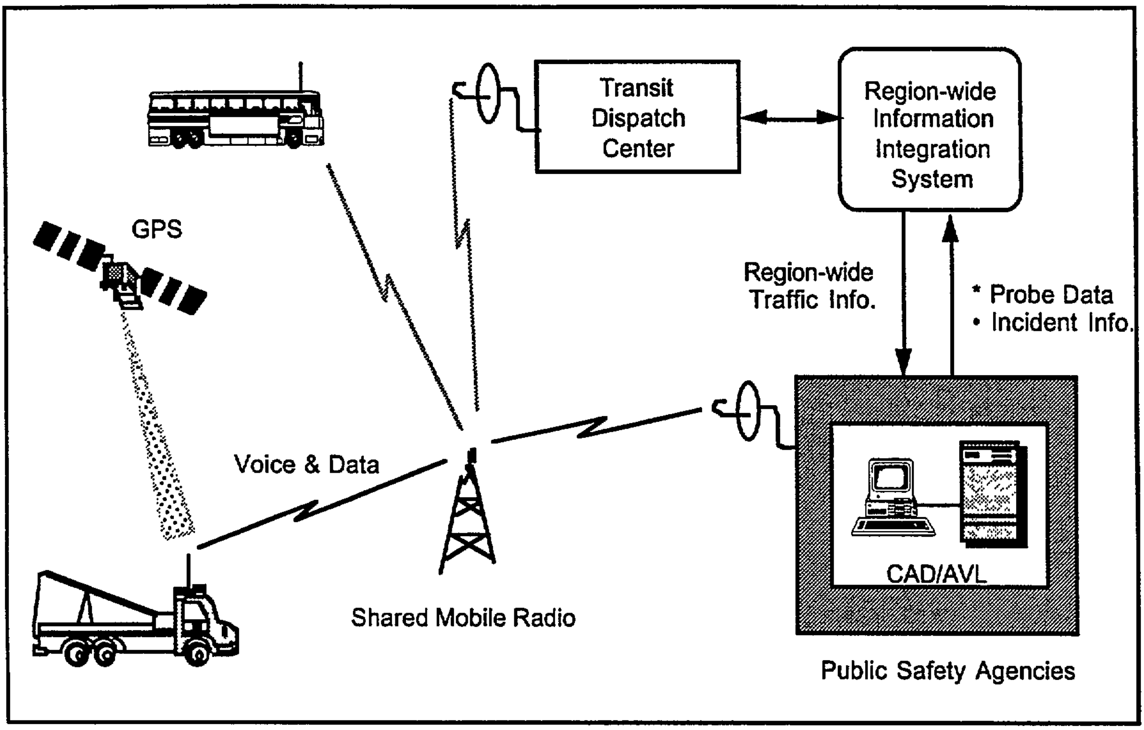

Figure 8-4. Concept of Mobile Radio Resource Sharing

In addition to addressing the above issues, this Project will provide operational insight into the upcoming I-95 Corridor Coalition's Project #18 (Emergency Response System) and Project #19 (Rural Mayday/800 Call-in System).

8.1.4.4 Project S.4: Transit Vehicle Probe Integration

The use of Computer-Aided Dispatch and Automated Vehicle Location (CAD/AVL) technologies to enhance transit services and vehicle fleet management has gained popularity in the transit industry. In addition, there is a strong desire within the Coalition to enhance intermodalism according to the goals and objectives surveys conducted at the beginning of this Project. Because of these reasons, the purpose of this recommended FOT project is to explore operational opportunities that will further strengthen cooperation among modal agencies.

The FOT objectives regarding the integration of transit vehicle probe data are similar to those of the FOT Project S.2 (Service Patrol Vehicle Probe Integration) and briefly described below:

- To extract and formulate probe data from the transit CAD/AVL database (only probe data along the designated Corridor roads will be collected).

- To assess the feasibility of using region-wide surveillance information for transit vehicle rerouting during traffic incidents and congestion, and for estimating the vehicle's time of arrival at predetermined locations along the Corridor's road network.

- To identify and resolve issues regarding organizational privacy and inter-jurisdictional probe data collection and integration.

- To investigate the feasibility of sharing mobile communication resources among agencies that operate AVL systems (as discussed earlier in Section 8.1.4.2).

8.1.4.5 Project S.5: Public/Private Surveillance Information Exchange

The survey results obtained form the I-95 CC Project #8 (TIS) have shown that there are a number of private organizations in the Corridor (e.g., Shadow, Metro Traffic Control, etc.) who collect and provide traffic information to their customers. Some of these organizations have existing arrangements with the public sector to exchange information, but on an individual basis. The purpose of this operational test is to provide an opportunity and evaluate the potential to expand the public/private collaboration, especially in surveillance information exchange.

The objectives of this Project are:

- *To establish a technological mechanism and an institutional arrangement to enhance the* exchange *of surveillance information between the public sector and the private sector.* The fulfillment of this objective will help validate the public/private co-venture opportunities developed in this SFUT Project and the principles for partnership developed in the TIS Project.

- *To identify technical and non-technical issues that might hinder this partnership, and to search for solutions to those issues.*

- To establish a model, if appropriate, that may be used as a basis for other public/private partnership arrangements in the Corridor.

The exchanged information will be integrated at the regional level as outlined earlier in the description of the Region-wide Information Integration Project S.l.

8.1.4.6 Project S.6: Multi-Sensor Surveillance Aircraft

Aerial surveillance from helicopters and small airplanes has been used since the 1960's by many police authorities and commercial radio stations to detect incidents and provide route advisory information to motorists. The primary means of gathering surveillance information has been a human observer onboard the aircraft, or an observer and a CCTV camera with a communication link to a ground station.

Many studies have been conducted to assess the feasibility of aerial surveillance. However, conclusive evidence was not available to show that aerial surveillance was economically feasible in comparison with other methods of surveillance. There are currently two FOT projects in Montgomery County, Maryland and Fairfax County, Virginia to evaluate the feasibility of aerial surveillance using CCTV cameras and air-to-ground data links. Preliminary assessments from the agencies testing these systems have indicated that aerial surveillance m contribute significantly to incident management but not so much in incident detection. Given today's traffic environment where 65 percent of urban freeway delay is due to non-recurring incidents, it may be worthwhile to re-evaluate the feasibility of aerial surveillance, but with advanced airborne sensor technologies.

With the ongoing initiatives to develop dual-use technologies for defense and non-defense applications, military sensor technologies are making their way to civilian applications. Although public information sources have not revealed any airborne surveillance technologies specifically designed for vehicular traffic surveillance, there are systems that have similar functionalities that may be applicable and should be considered for field operational tests. The primary purpose of this project is then to assess the technical and economic feasibility of using aircraft with air-to-ground surveillance and communication technologies in traffic surveillance. This assessment will also account for the ability of the aircraft to augment the ground surveillance equipment and to be an element of an integrated traffic surveillance system. The initiation of this kind of project will also spark the interest of the defense electronic industry to develop airborne surveillance solutions and/or services that will meet the traffic surveillance needs of the Corridor.

To illustrate the capability of an airborne surveillance system, the information collected during the Technology Assessment Task of this Project on a Multi-Sensor Surveillance Aircraft (MSSA) is used. This information was provided by Westinghouse Electric Corporation who has integrated airborne sensors for a non-defense air, maritime, and ground surveillance aircraft. The ground surveillance capability of this aircraft may be suitable for this aerial traffic surveillance operational test project.

The Westinghouse MSSA is equipped with a radar (APG-66 used on the U.S. Air Force F-16 fighter aircraft), an infrared and day (or television) imaging system, a sensor fusion work station, and a data link system to a ground station (with more than 90 miles in communication range). The radar can detect traffic movement on the ground (in the Ground Moving Target Indicator mode) at a range in excess of 60 miles with a coverage area of 36Ot in azimuth. This radar coverage is equivalent to a circle with a 60-mile radius, sufficient to contain the Washington and Wilmington metropolitan areas, or the Philadelphia and most of the New York metropolitan areas. A geographical representation of the potential aerial radar surveillance coverage for the Corridor is shown in Figure 8-5. This representation is only illustrative rather than conclusive.

The minimum detectable vehicle speed by the radar is about 7 mph, and maximum detectable speed is about 60 mph. The radar reports may be used to cue the IR imaging and day imaging system for detection verification (e.g., congestion and incident verification) or vehicle tracking to measure link travel speed. The IR and day imaging system is able to discriminate individual vehicles at a range in excess of 9 miles (which gives an equivalent coverage of a circle about the size of the Capital Beltway). For the purpose of congestion or incident confirmation using the IR and day imaging system, the confirmation range may be longer.

The specific objectives of this FOT project are:

+ *To evaluate the technical feasibility of an MSSA* as *a component of the Corridor-*wide *surveillance* system. The vehicle detection and tracking performance of the MSSA will be evaluated for both urban and rural traffic conditions. Its incident detection and verification potential will be assessed, and its role in assisting incident management will be evaluated. The evaluation will be conducted using a number of flight patterns to be developed. Examples of possible flight patterns are shown in Figure 8-6. During the operational test, the operational availability of the MSSA during adverse weather conditions will also be assessed and accounted for in the cost/benefit evaluation.

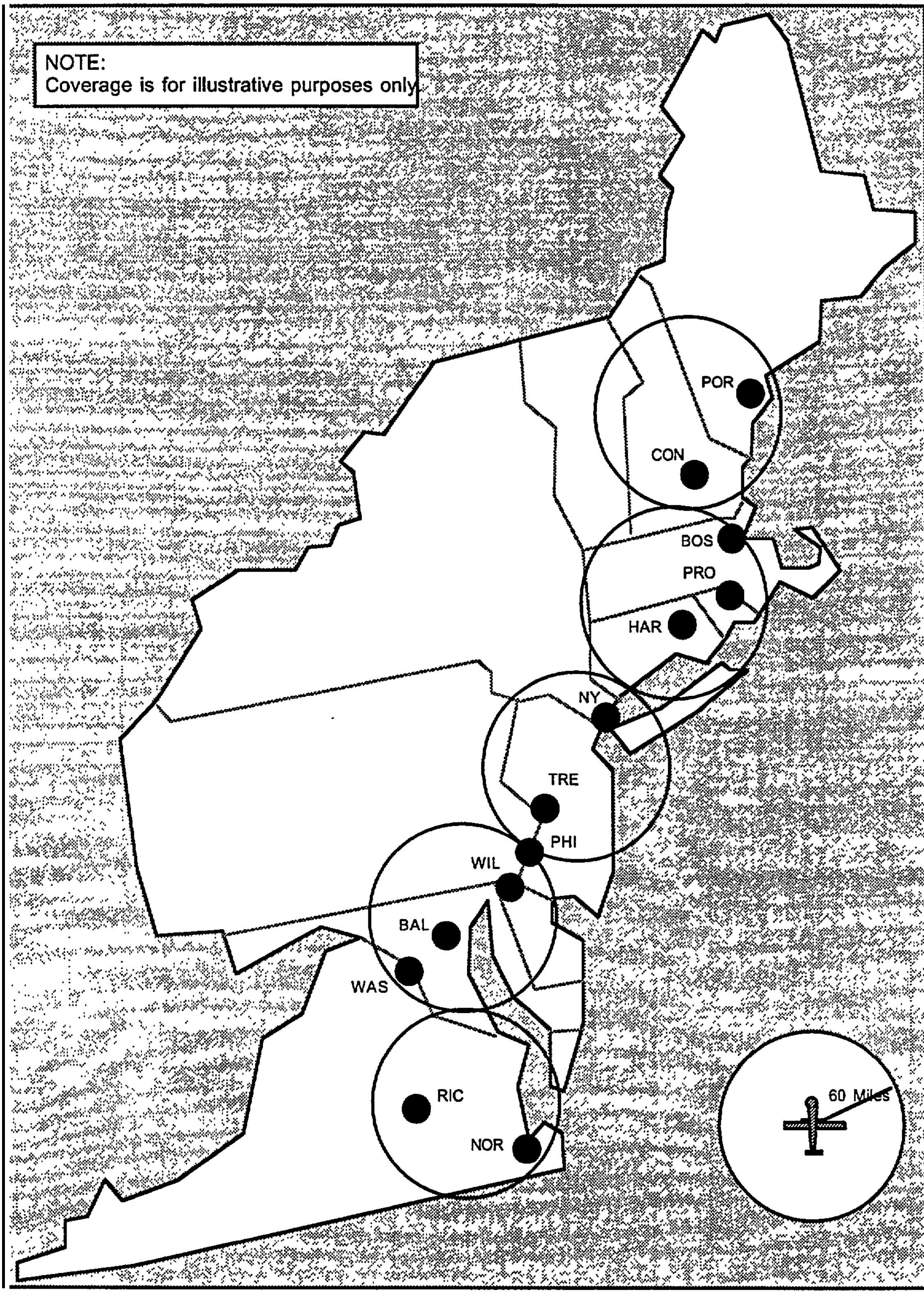

Figure 8-5. Geographical Representation of Potential Aerial Radar Coverage without Considering Flight Patterns

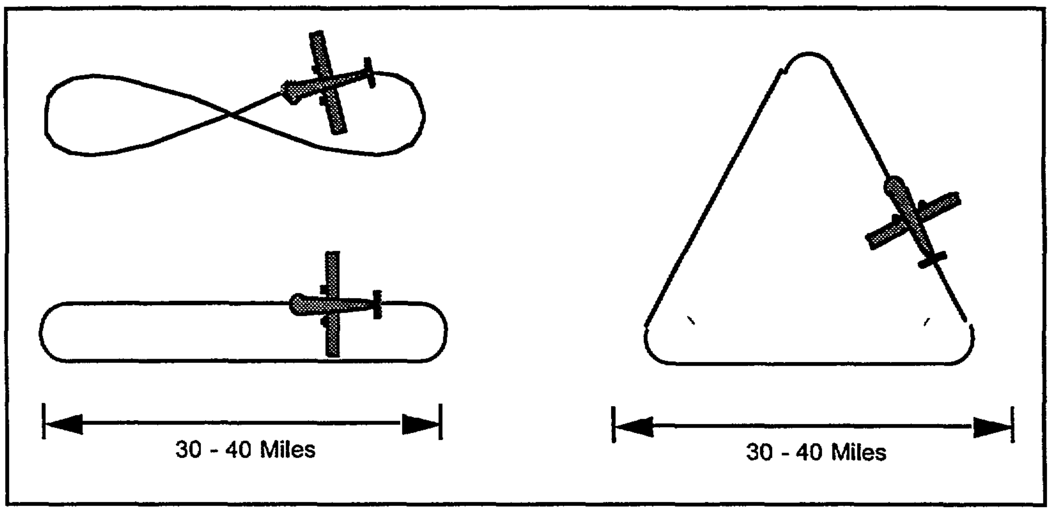

Figure 8-6. Possible Surveillance Flight Patterns

- *To refine the systems operational concepts (if the system proves to be technically feasible) to determine the number of aircraft that would be needed and the optimal flight patterns to sufficiently cover the Corridor-wide surveillance needs.*
- *To assess the economic feasibility of an MSSA, including its life-cycle cost and benefit, and other future applications such as pollution monitoring (using a multi-spectral camera, for example) and pavement/structure conditions monitoring.*
- *To explore public/private partnership opportunities (including those for the private sector to provide aerial surveillance services) and technology transfer issues (e.g., training).*

During the field operational test, sensor data from the MSSA will be sent to the region-wide information integration system to be fused with other data. The fused data will be disseminated to systems involved in the test as described earlier in Project S.1.

8.1.4.7 Project S.7: Aerostat Traffic Surveillance

The purpose of this recommended FOT project is to assess the feasibility of an aerostat that carries a similar sensor suite as that of the Westinghouse MSSA. The aerostat is a stationary surveillance platform which is 32 meters long (105 feet), tethered to a ground mooring, and operates at 2500 feet altitude without FAA restrictions. It can be transported by truck and deployed at strategic locations according to seasonal traffic changes (e.g., holiday travel). This system is being planned for proof-of-concept testing by Nichols Research Corporation, in cooperation with the Virginia DOT. The test will be conducted in Elizabeth City, North Carolina between June and October 1995. The technical information described below was extracted from that provided by Nichols Research Corporation.

The aerostat sensor suite includes the Westinghouse APG-66 radar, an IR imaging camera for day/night operation, and a television camera with zoom capability. The radar has a 360^o coverage with a 60-mile traffic detection range. The IR and TV cameras (made by Versatron) are capable of resolving all vehicle classes at ranges up to 50 miles in clear weather conditions. Either camera can be commanded manually (or automatically in the future using "event recognition" algorithms) to point towards a desired location with a desired magnification level to resolve the traffic situation of interest. The complete system includes control consoles with graphic user interface; and automatic image analyzers to detect traffic flow patterns and choke points, and to alert the operator to situations that require human intervention.

Track and image data from all sensors are sent to the ground using a fiber-optic cable in the tether. Command and control signals for the sensors are sent through the tether up to the aerostat. For the recommended operational test, sensor data will be sent to the region-wide information integration system by means of land lines or telephone modems.

Since the aerostat is a stationary airborne platform, it is susceptible to high winds aloft which, for example, may occur as much 10 to 15 percent of the time in the Norfolk area. In such cases, the aerostat must be stowed. In addition, because of the stationary nature of the aerostat, the line of sight from the monitored roads to the aerostat's sensors may be blocked by the urban infrastructure, creating undetectable zones within the sensor coverage. Thus, according to the system' s developers, the aerostat may be better suited to non-urban deployments.

The objectives of the aerostat surveillance FOT project are:

+ *To evaluate the technical feasibility of the aerostat surveillance system as a component of the Corridor-wide surveillance system.* The vehicle detection and tracking performance of the aerostat will be evaluated for mainly rural traffic conditions, but its urban traffic surveillance performance will also be observed. Its incident detection and verification potential will be assessed, and its role in assisting incident management will be evaluated.

+ To refine the systems operational concepts (if the aerostat surveillance system is technically feasible) to determine the number of systems that would be needed to sufficiently meet the Corridor-wide surveillance needs.

+ To assess the economic feasibility of the aerostat system, including its life-cycle cost and benefit.

+ To explore public/private partnership opportunities (including those for the private sector to provide aerial surveillance services) and technology transfer issues.

8.1.4.8 Project S.8: "Wide-Area" Land-based Radar Sensor

In an extended effort to review and assess surveillance technology for Task 3 of this Project, information on the *Low Cost Advanced Roadway Traffic Sensor* (LCARTS) was discovered. The LCARTS is being developed by Mirage Systems in Sunnyvale, California. It is a wide-area, low frequency (10 MHz to 2000 MHz), low-power, continuous wave radar. It is capable of monitoring a 6-mile stretch of a multi-lane roadway, making it more attractive to other point detection systems. The LCARTS can be mounted on a pole on one side of the road (see Figure 8-7), avoiding traffic interruption during installation and maintenance. It monitors traffic in both flow directions and on both upstream and downstream sides of the sensor. The technical information described below was extracted from the literature provided by Mirage Systems.

The LCARTS' design performance parameters under research and development include:

+ Range Coverage: Up to 3 miles in each upstream and downstream direction.

+ Minimum Detectable Traffic: One vehicle.

+ Average Speed Coverage: 3 to 100 mph.

+ Minimum Speed Range: 1 mph.

+ Minimum Update Time: Once per Second.

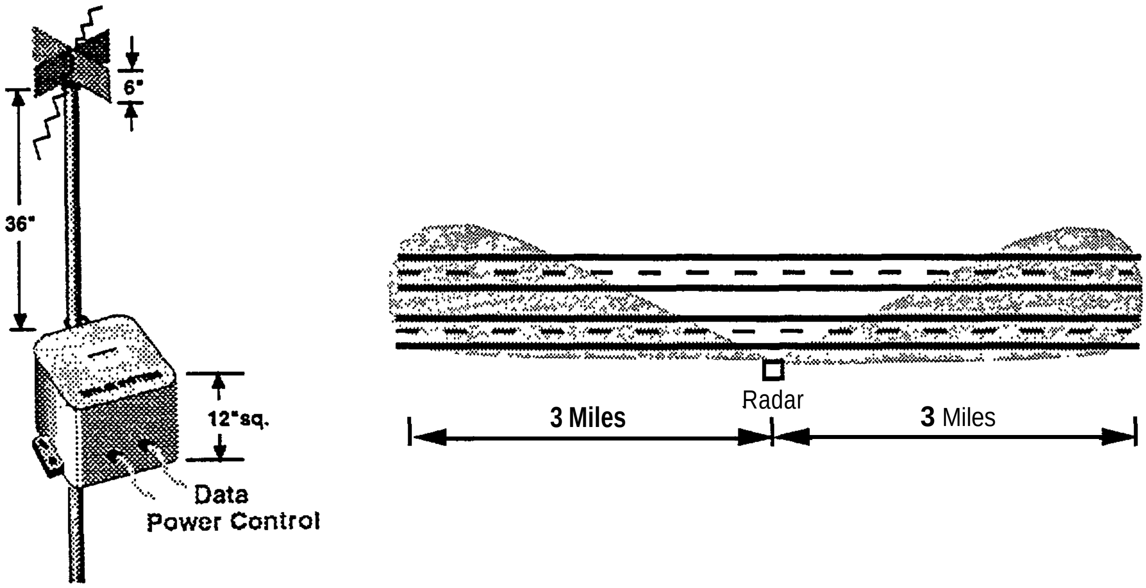

Figure 8-7. Features of the Low **Cost** *Advanced Roadway Traffic Sensor (LCARTS)*

The LCARTS can provide the following types of data for traffic surveillance:

+ Raw Traffic Flow Data: Traffic density versus range and speed.

+ Statistics of Raw Data (e.g., average values): Density versus range or speed; and speed versus range.

+ Incident Detection Data: Status and location.

The sensor data can be automatically processed to provide a three-dimensional display of traffic density (vehicles per range cell), range from sensor, and vehicle speed. Such a display is illustrated in Figure 8-8.

The purpose of this recommended FOT is to assess the technical, economic, and operational feasibility of the LCARTS. The specific objectives of the test include:

+ *Assess the technical performance of the LCARTS in both urban and rural traffic monitoring and incident detection applications.* Special attention will be placed on determining the line-of-sight requirements to achieve the maximum detection range. The line-of-sight to the LCARTS may be restricted by the roadway geometric characteristics in both vertical and horizontal directions, and the presence of other structures such as bridges and road signs.

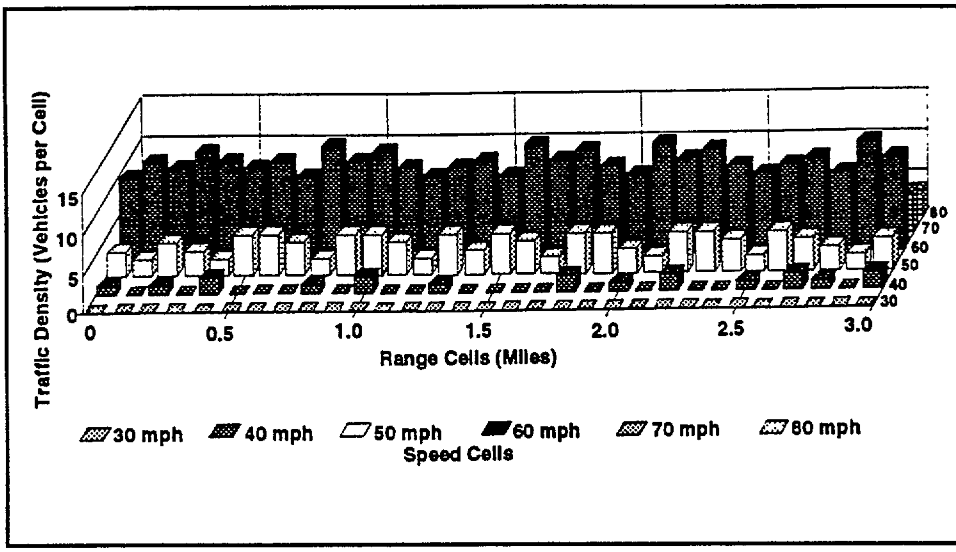

Figure 8-8. Three-Dimensional Display of Traffic Data Provided by the LCARTS

- *Determine the optimal spacing and installation location of the LCARTS.*
- *Compare the technical and cost performance of the LCARTS with other existing point detection systems.* This comparison requires that the LCARTS units cover the same stretch of roadway that has existing sensors.

8.1.4.9 Project S.9: Road Weather Information Integration

The survey results conducted for Task 2 of this Project have indicated that Road Weather Information Systems (RWIS) are currently in use by many member agencies. The purpose of this recommended FOT is to assess the feasibility of integrating and sharing the RWIS information to enhance incident prevention due to weather conditions along the Corridor designated roads. This weather incident prevention may be enhanced through inter-jurisdictional, coordinated snow removal operations, road surface treatment operations, and the dissemination of weather travel advisory information.

The objectives of this FOT project include:

- Identify technical and institutional issues related to the integration of RWIS data and develop approaches to overcome these issues.

+ Assess the costs and benefits of using the integrated data to assist in coordinated road clearance operations.

+ Assess the feasibility of using the RWIS data to develop and disseminate both pre-trip and en route travel advisory information.

The evaluation of this FOT project should be performed in conjunction with other test activities conducted in I-95 CC Project #2 (Incident Management), Project #8 (Traveler Information Services), and Project #9 (VMS/HAR).

8.2 FUNDING OPPORTUNITIES AND COST-SHARING SCHEMES

The purpose of this section is to identify possible funding opportunities for which the Coalition would qualify. These possible funding sources could be used to cover the costs of implementing an integrated surveillance system. In addition to identifying possible funding opportunities for the Coalition, it is also necessary to develop applicable cost-sharing schemes. A cost sharing scheme must be developed for the design, construction, operations, and maintenance costs. Funding potentials were examined for sources that are external to the agencies as well as non-traditional sources, internal to the agencies. The following is a discussion on of both the potential funding opportunities and cost-sharing schemes.

8.2.1 Funding Opportunities

The primary sources of funding for IVHS are from the Federal government, State and local governments, and various private organizations. Several reports have been generated which provide detailed information on the specific funding sources and legislation. The discussion which follows outlines those applicable funding sources for which the I-95 Corridor would qualify.

<u>Federal Funding</u>

The Federal funds for transportation improvements have been re-authorized under the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). The programs importance to local, regional, and state decision makers are described under three titles of the Act: Title I – Surface Transportation: Title Ill - Federal Transit Act; and Title VI - Research. The 1991 ISTEA legislation authorized $151 billion toward transportation system improvements for Federal fiscal years (FFY) 1992 through 1997. Although the act earmarked a program for ITS R&D, other funds are available for ITS implementation. Table 8-1 shows the ISTEA authorized funds.

Table 8-1. Funds Authorized by the ISTEA

Program	6-year Funds, in billions
National Highway System	$21.0
Interstate Construction/Substitution	$8.1
Interstate Maintenance	$17.0
Surface Transportation Program	$23.9
Bridge Program	$16.1
Congestion Mitigation/Air Quality Program	$6.0
Intelligent Vehicle Highway Systems	$0.6
Safety	$1.8
Congress Demonstration Projects	$5.0
Other Highway	$18.8
Mass Transit	$31.5

The following provides a discussion on various federal transportation programs/subprograms for the implementation of the Corridor-wide surveillance system for which the Coalition may qualify.

<u>Intelligent Vehicle and Highway System (IVHS)</u>

IVHS funding is mentioned under “Title VI: Research” of ISTEA, which authorized $660 million nationally for 6 years through FFY 1997. This is divided into $501 million for an IVHS Corridors program and $159 million for other IVHS research and development. Surveillance systems are the primary step in implementing the IVHS strategies. Funding is targeted for operational tests for the evaluation of emerging technologies and are not to be used to create infrastructure. At least 5 percent of the Corridors Program funds are for innovative, high-risk operational or analytical tests.

For each of the fiscal years 1993 throughl997, the authorized IVHS Program funding level is $113 million per year ($86 million for the Corridors Program plus $27 million for other activities). The FHWA, which administers these funds and directs them to individual projects, has identified four priority corridors in ozone non-attainment areas to receive funds under the Corridors program. These four corridors are in Houston, Chicago, Southern California, and the Baltimore/ Connecticut (Eastern) Corridor.

Operational Tests

In March 1993, the DOT designated four sites as participants in the IVHS Priority Corridor Program, following the seven specific criteria provided in the ISTEA. These sites will become national test beds for IVHS and, in many ways, will be where the public is first introduced to IVHS. Over the long term, funds spent on each corridor site, along with funds that this money leverages, will result in the establishment of an IVHS infrastructure that will support continuing deployment of IVHS technologies and services. Operational test projects will be negotiated each year with the sites, based on the plans of the region as well as the national interest in advancing the IVHS program. In this way, the Priority Corridors help to support the comprehensive IVHS Operational Field Test program as these areas move towards deployment of integrated IVHS applications. In addition, Corridor Program funds at these sites can support certain planning, feasibility, and conceptual efforts. The I-95 Northeast Corridor is one of the priority corridors that has been identified.

The IVHS Operational Test Program bridges the gap between IVHS research and development activities and full-scale deployment of proven technologies. Emphasizing development of true partnerships between public and private sector entities, these tests are especially critical to fully evaluating the effectiveness of innovative IVHS technologies and institutional arrangements under real-world conditions. The U.S. DOT has special funds available for operational tests within the designated Priority Corridors. In accordance with ISTEA, the maximum share of an operational test funded from Federal funds, including ITS funds, cannot exceed 80 percent. The remaining 20 percent must be from non-federal sources and must consist of either cash, including substantial equipment contributions which are wholly utilized as an integral part of the project, or personnel services dedicated full-time to operational test purposes for a substantial period, as long as these staff are not otherwise supported with Federal funds. The non-federal funds may come from State, local government, or private sector partners.

Funding levels vary significantly from one operational test to another and are primarily based on size, complexity, and funding commitment by each of the participating partners. Federal ITS funding for the operational tests selected from the open solicitation in FY 1993 and FY 1994 ranged from $200,000 to $5.5 million, with the majority falling in the $1 to $2 million range.

A discussion the operational test has been provided in Section 8.1; however, it should be noted that the operational test program does not support full-scale deployment. It is meant for only limited deployment of new technologies; however, one objective of the Study Team is to develop the operational tests in such a way that the standalone individual tests can eventually become a part of the Corridor-wide surveillance system. Thus, operational tests conducted in the Corridor may be envisioned as an integral part of the deployment, and this source of funds can play a significant role in the early years of the Corridor-wide surveillance system deployment.

IDEA Program

Transportation Research Board has an R&D program called IDEA (categorized as IVHS-IDEA, NCHRP-IDEA and TRANSIT-IDEA), which is also federally funded. This program may be another funding source for relatively smaller tests. The IDEA program receives proposals on an ongoing basis and the current notice of solicitation is valid until the end of 1996. The IDEA projects are grouped into two types: those for facilitating investigation of new concepts for potential application to practice (Type I), and those for novel applications of proven concepts, results, or conversion technology products to practice (Type 2).

A Type 1 project is generally a concept feasibility study that investigates a new or unproven concept for potential application. The result or product from a Type 1 project might not be ready for application or marketing to mainstream practice. The IDEA funding for a Type 1 project is usually in the range of $25,000 to $100,000 (maximum). The duration of Type 1 projects ranges from a few months up to, but not exceeding, 1 year. Cost sharing is recommended, but not required, for a Type 1 IDEA project.

A Type 2 project is generally a product application that investigates novel applications of an existing or proven concept, or conversion technology that has not been applied for ITS. The IDEA funding for a Type 2 project can be in the range of $75,000 to $250,000 (maximum). A Type 2 proposal that exceeds $100,000 must include cost sharing. The required extent of cost sharing is negotiable and may vary based on the amount over $100,000, the potential impact of the project to ITS practice, the availability of other investigative results from internal research by the proposer or by others, and the size and type of business and mainstream business activities of the proposer. All Type 2 projects should be completed in about 1 year, but the actual time frame is negotiable.

Surface Transportation Program (STP)

The Surface Transportation Program (STP) is a new program described in Section 1007 of the ISTEA. The Act authorized $23.9 billion over 6 years for the STP program nationwide. In addition, funding from Interstate Reimbursement (Section 1014) and other equity adjustments are transferred to the STP account. These funds can be used for construction, reconstruction, rehabilitation, resurfacing, restoration, and operational improvements of highways and bridges: capital costs for transit projects; carpool projects: highway and transit safety improvements; highway and transit planning, research and development; capital and operating costs for traffic monitoring, management, and control facilities and programs: transportation enhancements; transportation control measures; development of management systems: and wetlands mitigation efforts. Operational improvements include traffic surveillance and control equipment, computerized signal systems, motorist information systems, integrated traffic control systems, incident management programs, and transportation demand management facilities, strategies, and programs. In summary, funds under this program can be used for any surface transportation capital project on any road, except those functionally classified as local or rural minor collectors. Federal STP allocations include two set-aside funds. Ten percent of these funds are for Safety Programs, and another ten percent for Transportation Enhancements Activities which encompass a broad range of environmental-related activities. The other STP allocations are flexible funds and distributed among State and regional agencies such as Transportation Management Areas (TMAs), Metropolitan Planning Organizations (MPOs), and Regional Transportation Planning Organizations (RTPOs). Fifty percent of the STP funds can be distributed to areas within a state based on the state' s relative share of population between urbanized areas (200,000+ population) and other areas. The remaining 30 percent can be used in any area of the state.

The basic Federal share, payable on account of any project requesting STP funds, is 80 percent. However, certain safety and traffic operational activities (e.g., priority control systems for emergency vehicles at signalized intersections) may have a share of 100 percent.

While there is obvious application of flexible STP funding to capital expenditure for IVHS and traffic management projects, its application to operations and maintenance is not so well defined. There is provision at the Federal level for making such expenditures eligible; however, current local guidelines indicate that local agencies should provide funding for operations and maintenance.

Under this program, member state agencies can fund the surveillance deployment. The states must demonstrate that a certain percentage of these funds are actually spent in these urbanized areas.

National Highway System (NHS)

The NHS funding program, created by the ISTEA, mandates a wide array of highway and transit projects within the 155,000-mile NHS corridors. The NHS designation is underway. During the interim period, the NHS has been defined to include all interstate highways, principal arterial& and strategic defense highways and connectors. The NHS is funded at $21 billion over the 6 years of ISTEA, apportioned in the same way as the STP.

Under the NHS, “start-up” funding for traffic management and control systems can be provided for up to 2 years. Also, eligible projects include operational improvements to the NHS and operational improvements to non-NHS highways in an NHS corridor. Therefore, NHS provides a major opportunity for ITS funding on principal arterials and corridor systems, although the use of NHS funds for operations and maintenance may be limited (JHK and Associates, 1993).

Congestion Management/Air Quality Program (CMAQ)

This program provides $6 billion over the life of ISTEA to non-attainment urban areas under the Federal Clean Air Act. Funds are distributed to states based on their population in non-attainment areas. Areas with very poor air quality are given greater weight in the formula.

Eligible projects for CMAQ funds include transit-related projects and Transportation Control Measures (TCM) outlined in the Department of Ecology’ s State Implementation Plan to meet emissions control goals. Traditionally, ITS and traffic management programs have been viewed as being effective in reducing fuel consumption and pollution, although their effect on Vehicle Miles Traveled (VMT) is yet to be established. The Federal share for most eligible activities is 80 percent or 90 percent if used for certain activities on the Interstate System. Some activities, including traffic signalization and certain transit-related ITS elements may be eligible for funding at 100 percent (JHK and Associates, 1993).

Other Internal Funding Sources

These potential sources of funding are internal to an agency, but used for other purposes that have close relationships with the Corridor-wide surveillance system. The purpose of identifying these sources is to explore opportunities for other internal agencies to collaborate in the collection and use of the Corridor-wide surveillance information.

+ Highway Planning Funds. The traffic flow and characteristics data collected by the Corridor-wide surveillance system contribute significantly to the generation of the highway planning database. Data such as Average Daily Traffic (ADT) and Vehicle Miles of Travel (VMT) can be automatically extracted and compiled in the surveillance system, offering accurate and timely information for facility planning activities. Because of this potential service of the surveillance system, opportunities to share the surveillance system' s costs should be considered.

+ Highway Safety Funds. A component of the designed Corridor-wide surveillance system monitors road hazard conditions such as fog and road debris. The purpose of this surveillance component is to enhance traffic safety and therefore may be eligible for safety improvement funds at the State and Federal levels. Another potential contribution of the surveillance system to traffic safety improvement is the accident database that it generates and maintains. This database may be used to support traffic safety improvement planning activities.

+ Highway Maintenance Funds. The maintenance of the Pavement Management System database requires extensive road conditions surveys to be performed periodically. These surveys can be very costly and time consuming. Since the Corridor-wide surveillance system will have an extensive communication network and a sophisticated data processing capability, it can contribute to the collection of pavement management data such as vehicle axle weight and vehicle classification, along with traffic demand statistics. This service can reduce the highway maintenance data collection cost; therefore, opportunities to share the surveillance system deployment cost with highway maintenance agencies may be available.

+ Air Quality Management Funds. The funding to support air quality monitoring may come from external sources such as the EPA. Since air quality data collection systems may be integrated with the Corridor-wide surveillance system to minimize data communications and processing costs, opportunities for such service integration and cost sharing may be viable and should be considered.

Private Partnership Opportunities

The private sector is deemed to have an important role in reducing the Corridor-wide surveillance system deployment costs. Various types of partnerships may be possible with private companies, depending on the nature of their business. Five categories of private partners have been identified as follows:

+ Information Service Providers (ISP).
+ Defense/Aerospace electronics firms.
+ Communication companies.
+ AVL service provider.
+ Fleet operators.

Each of these categories has a different objective, and hence separate partnership scenarios may exist for each of them. A well thought-out public-private partnership can offer opportunities to benefit both the public and private sectors. Specific partnership opportunities are discussed in Section 8.4 of this chapter.

The partnership with the private entities does not necessarily mean that the private sector will need to provide cash toward the implementation of the Corridor-wide surveillance system. The benefits may arise from the reduced need for the public sector to invest in the surveillance infrastructure. For example, if the vehicle location and tracking techniques using the existing cellular telephone infrastructure becomes feasible, a public/private partnership to expand this surveillance can reduce the needs to install other types of vehicle detection systems.

8.2.2 Cost-Sharing Schemes Among Members

This section briefly discusses potential cost-sharing schemes among the I-95 Corridor Coalition members for both the capital costs and the operating and maintenance costs. The discussion also identifies the advantages and disadvantages of each of the schemes.

Capital Cost

Three schemes are proposed for sharing the capital cost of the surveillance system among the I-95 Coalition members.

+ Scheme #1: Divide the capital cost equally among Coalition members. Under this scheme, all members of the I-95 Corridor Coalition will contribute equally to the construction and implementation cost of the surveillance system. The advantage of this scheme is that it will provide equal ownership of the surveillance system and will be functional regardless of the physical location of the equipment or the location and size of the member agency.

+ The main drawback of this scheme is that it does not distribute the capital cost on a percentage of use basis. As an illustration, assume that a large percentage of the capital cost will be spent on surveillance equipment to be located in the NY, NJ area. This equipment will render little benefit to the Maine Turnpike Authority, which under this scheme, would have contributed the same amount of funds as the NJ Highway Authority. Another disadvantage of this scheme is that the member agencies do not have equal funds available to dispense on such a project. If this scheme is implemented, it might lead to delays in the work programs and changes to the scope of work because of the lack of funds.

+ Scheme #2: Allocate the capital cost based on the physical location of the surveillance equipment, with the cost of the communication equipment being equally divided among the members. The advantage of this scheme is that agencies assume ownership of the equipment located within their jurisdictional areas (assuming that each agency benefits the most from the equipment installed on its system). The disadvantage is that all member agencies who do not operate a facility (e.g., TRANSCOM) would not contribute to the capital cost of the surveillance equipment.

+ Scheme #3: Allocate capital cost based on weights given to each of the participating members. This scheme involves developing a model for distributing capital costs among the member agencies based on a combination of weights. The weights can be determined based on the physical location of the equipment, the amount of information to be given to the member organization and the financial capabilities of the member organization. The capital cost of the communication equipment and any other Corridor-wide equipment would be equally divided among all members.

As an illustration, assume that the percentage of total surveillance equipment to be located at a certain facility is L%. Also, assume a certain system usage value of U% (100% if the agency will maximize its usage of the surveillance system, 10% if usage will be kept to a minimum), and a certain financial contribution ability factor, F% (100% if the agency's financial capabilities are excellent, and 0% if the financial capabilities are poor).

Given that there are *n* member agencies on the I-95 Corridor Coalition, then for any agency *x*, the weight is determined as:

$$w_x = (aL\% + bU\% + cF\%)/(a+b+c):$$

a, b, and c are weighting factors to be determined by the Coalition and the total weight, W, is the sum of the weights of all of the agencies.

Let:

C = Capital Cost

CM = Cost of communication and other Corridor-wide equipment

CE = C - CM; CE is Equipment Cost

Then:

Cost Share for Agency $x = CM/n + CE'(w_x/W)$

The advantage of this scheme is that it takes into consideration the issues relating to physical location of equipment, financial abilities of the agencies, and usage of the surveillance system. The disadvantage is that it may be difficult to select and agree to values for the parameters, especially with respect to usage of the surveillance system.

Operations and Maintenance Cost

- Scheme #1: Divide the operating and maintenance cost equally among all members of the coalition. This scheme assumes that all member agencies will be using the surveillance system on an equal basis. The advantage of this scheme is that it allows all agencies to participate in the operating and maintenance cost whether the equipment is located on their facilities or not. This would ensure consistent and uniform maintenance activities Corridor-wide. The disadvantage is that it does not take into consideration the issue of usage of the system.

- Scheme #2: Allocate operating and maintenance cost based on phvsical location of the equipment. This scheme assumes that an agency' s usage of the surveillance system is proportional to the percentage of equipment located on its facility. The advantage of this scheme is that agencies would enjoy the flexibility of managing the operation and maintenance contracts for the equipment located on their respective facilities. The disadvantage is that agencies which do not operate any physical facility would not participate in the operating and maintenance cost.

- Scheme #3: Divide a portion of the operating and maintenance cost equally among all members of the coalition and divide the remainder based on weights that are a function of system usage. Under this scheme, the percentage use factor discussed above will have to be determined and used in calculating the operating and maintenance cost share for an agency. The advantage of this scheme is that it does allow the members which do not operate any facilities to contribute to the operating and maintenance cost. Also, this scheme takes into consideration the usage of the system. The disadvantage of this scheme is the difficulty in estimating the usage factor for each agency.

Given that there are 36 Coalition members with various levels of transportation facilities, surveillance needs, and funding capabilities, the development of a cost-sharing scheme equitable and acceptable to all members is a complex task. The proposed cost-sharing schemes described above are, thus, only meant to be a starting point from which Coalition members' input can be sought and potential institutional implications analyzed. Furthermore, a feasible cost-sharing scheme cannot be developed without a consensus-building process with all Coalition members. Therefore, it is premature at this time to recommend any of the potential cost-sharing schemes for the Corridor-wide surveillance system. However, this study is the first completed project of the Coalition. It is recommended that other ongoing and future relevant projects take into consideration these alternative schemes in order to develop a consistent cost-sharing framework.

8.3 DEPLOYMENT AND COST SCHEDULE

This section describes a scheme for a phased deployment of the I-95 Corridor-wide surveillance system and contains a summary of the estimated deployment and annual operations and maintenance costs. This deployment schedule was developed based on the anticipated needs of the Coalition derived from the results of the goals and objectives survey. In addition, the projected technology availability was used to estimate the major deployment milestones.

8.3.1 Deployment Assumptions

The implementation scheme was developed for the following two types of road network:

+ Urban interstates and arterials.

+ Rural interstates and arterials.

These road networks have different surveillance requirements based on the nature of their traffic and the needs of their operating agencies. Therefore, different strategies were assumed for implementing a surveillance system on these roadways. This led to different deployment schedules and different deployment cost estimates for these roadways.

Each type of roadway will employ a different mix of surveillance hardware. To help determine the deployment level at each milestone, the surveillance system components were grouped as follows:

+ Basic traffic surveillance and communication infrastructure. This includes the communication system infrastructure, vehicle detectors, CCTV equipment, and call boxes on freeways and arterials. This basic surveillance system will provide the functionality necessary to support basic incident detection and management, and traffic control, including real-time adaptive signal and ramp controls. In addition, the surveillance system components which support incident detection should be deployed first. The advantage of this strategy is that other ITS services requiring traffic surveillance data utilize the information gathered by the incident detection system.

+ Road condition sensors. These include weather sensors (both air and pavement surface conditions) and fog/visibility sensors.

+ Air quality sensors. These include sensors that measures the air pollution concentration.

+ Weigh-in-Motion (WIM) sensors. These include sensors that estimate the weight of a vehicle while the vehicle is in normal motion on a roadway.

+ Aerial surveillance. This includes tethered and non-tethered vehicles that carry surveillance equipment. It is intended to cover gaps and augment other land-based surveillance assets. A single aircraft can cover both urban and rural areas. However, the cost for aerial surveillance was included in the rural area surveillance only in order to avoid double-counting the item in the cost estimate.

For the purpose of this report, aerial surveillance equipment was grouped separately, because it will be deployed on a slower schedule than the rest traffic surveillance equipment. This slower schedule will allow time for the evolution of the aerial vehicles as well as the airborne surveillance equipment itself.

The following assumptions are made about future technology:

+ Satellite-based cellular telephone systems, such as Globalstar or Iridium, will be operational by 1997 in order to support data communication with sensors on Rural Interstates and Arterials in areas not currently covered by commercial cellular telephone systems.

+ The product resulting from the current FHWA efforts to develop advanced traffic sensors will be commercially available by the beginning of 1998.

+ Improved integrated freeway and arterial control systems suitable for urban areas will be developed and tested by 1998.

8.3.2 Deployment Schedule

The surveillance equipment will be deployed in the lo-year period between 1996 and 2005. A 10-year period was selected for three reasons:

+ To allow sufficient time to deploy the surveillance systems.

+ To spread the deployment costs over a lo-year period, enabling agencies to generate funds and funding sources.

+ To allow time for wide-area surveillance technologies to evolve.

The initial deployment will be performed from 1996 to 1998. The intermediate deployment will be completed by the end of the year 2000. During the 5-year period from 1996 to 2000, the majority of the total deployment will be achieved. The final deployment will be accomplished by the end of the year 2005. The deployment schedule of each type of equipment on each type of roadway will be based on the following deployment priorities.

The coalition member agencies place incident management as the highest priority, according to the goals survey (Chapter 2). Therefore, basic traffic surveillance system equipment that is involved with incident detection is given the highest deployment priority. The communication system infrastructure, is given a high priority for the reason that it is needed before other sensor systems can be deployed.

WIM systems will also be deployed to support pavement management systems, to support the regulation enforcement aspect of Commercial Vehicle Operation, and to support Federal requirements for Traffic Monitoring Systems (TMS). The federal legislation for TMS requires all states to continuously gather traffic volume, vehicle classification, and vehicle weight data. In turn, this requires states to implement WIM systems quickly in order to be compliant with the federal regulations.

Air quality sensors are also critical in monitoring the environment to determine if the standards of the Clean Air Act Amendment are being fulfilled near roadways. These systems will also be given a high priority for deployment.

Table 8-2 shows the planned phased deployment schedule for the Urban Interstate and Arterial road network. The deployment of vehicle detectors (part of basic traffic surveillance and communication infrastructure) is assumed to be low in the first 3 years because of the desire to incorporate the advanced traffic sensors and advanced integrated control systems. It is assumed that these systems will be commercially available in 1998. The 10 percent completion of installment of basic traffic surveillance and communication infrastructure represents systems from operational tests and installation of systems at critical locations. The quick deployment of the road condition sensors (80 percent complete by 1998) is based on the assumption that few units are needed; because pavement surface conditions and ambient temperature at a single point are valid in a large area surrounding that point. Additionally, visibility sensors are to be placed in isolated areas which are prone to fog. The early completion of the air quality sensors (80 percent by 1998) is based on the importance of monitoring environmental conditions in an urban area and also on the low density of units required to monitor the roadway. WIM systems will be deployed at a uniform rate throughout the 10-year deployment period.

Table 8-2. Assumed Deployment Schedule for Urban Interstates and Arterials

Surveillance Group	1998	2000	2005
Basic traffic surveillance	10%	50%	100%
Road condition sensors	80%	100%	100%
Air quality sensors	80%	100%	100%
WIM sensors	30%	50%	100%

Similarly, Table 8-3 shows the planned phased deployment schedule for the Rural Interstate and Arterial road networks. The rural interstates will deploy road condition sensors, air quality condition sensors, and WIM sensors using the same deployment phasing profile as Urban Interstate roads. The basic traffic surveillance and communication infrastructure will be deployed using a quicker profile than was used for urban interstates; because the surveillance equipment density required to meet the objectives in rural areas is low, which in turn makes the deployment cost relatively low, allowing a rapid deployment schedule. The deployment of aerial surveillance will be performed at a slow pace. The 20 percent deployment by the year 2000 reflects aerial surveillance operational tests. The majority of the deployment will be performed from 1999 to 2005. This is based on the availability of advanced traffic sensors as well as the development and testing of aerial surveillance technologies.

Table 8-3. Assumed Deployment Schedule for Rural Interstates and Arterials

Surveillance Group	1998	2000	2005
Basic traffic surveillance	20%	80%	100%
Road condition sensors	80%	100%	100%
Air quality sensors	80%	100%	100%
WIM	30%	50%	100%
Aerial Surveillance	10%	20%	100%

8.3.3 Cost Schedule

Appendix J, as discussed in Chapter 7, contains the basis for the deployment cost estimates. Appendix J provides the cost estimate for a nominal 10-mile segment of an Urban Interstate and Arterial roadway segment. The estimate is based on the baseline equipment configuration scenario as defined in Chapter 7. The costs for the nominal 10-mile segment are broken down by surveillance equipment type so that estimates may be altered for individual surveillance deployment plans. Appendix J also estimates the costs per mile and by surveillance category of other deployment strategies. Using these figures and the number of urban and freeway miles for the entire Corridor, the total cost of the minimal deployment can be estimated. The total cost of minimal deployment (in 1995 dollars) of the urban and rural systems are $1,422 million and $722 million, respectively. The estimated cost for the total system implementation is nearly $2.2 billion over 10 years. It is to be noted that these costs account for the sensors and communication systems and do not include the cost for TMC.

Table 8-4 shows the estimated costs for the full minimal deployment of each of the surveillance groups. Table 8-5 shows the annual costs of deployment. These costs were computed by using linear interpolation of the data in Table 8-4 based on the deployment profile schedules shown in Tables 8-2 and 8-3.

Table 8-4. Estimated Cost of Full Deployment

Area Category	Surveillance Group	Cost[1] ($ Million)
Urban Interstates and Arterials	Basic Traffic Surveillance	1,382
	Road Condition Sensors	17
	Air Quality Sensors	11
	WIM Sensors	12
	Subtotal	*1,422*
Rural Interstates/Arterials	Basic Traffic Surveillance	686
	Road Condition Sensors	8
	Air Quality Sensors	9
	WIM Sensors	10
	Aerial Surveillance	39
	Subtotal	*751*
	Total	*2,173*

Table 8-5. Estimated Yearly Implementation Costs

Surveillance Group	Cost[1] ($ Million)									
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Urban Interstates and Arterials										
Basic Traffic Surveillance	46.1	46.1	46.1	276.5	276.5	138.2	138.2	138.2	138.2	138.2
Road Condition Sensors	4.4	4.4	4.4	1.7	1.7					
Air Quality Sensors	3.0	3.0	3.0	1.1	1.1					
WIM Sensors	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Total Urban Cost	*54.7*	*54.7*	*54.7*	*280.5*	*280.5*	*139.4*	*139.4*	*139.4*	*139.4*	*139.4*
Rural Interstates and Arterials										
Basic Traffic Surveillance	45.7	45.7	45.7	205.8	205.8	27.4	27.4	27.4	27.4	27.4
Road Condition Sensors	2.1	2.1	2.1	0.8	0.8					
Air Quality Sensors	2.3	2.3	2.3	0.9	0.9					
WIM Sensors	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Aerial Surveillance	1.3	1.3	1.3	2.0	2.0	6.3	6.3	6.3	6.3	6.3
Total Rural Cost	*52.4*	*52.4*	*52.4*	*210.5*	*210.5*	*34.7*	*34.7*	*34.7*	*34.7*	*34.7*
Combined Cost	*107.1*	*107.1*	*107.1*	*491.0*	*491.0*	*174.1*	*174.1*	*174.1*	*174.1*	*174.1*

[1] 1995 dollars

The estimated yearly implementation costs are plotted as shown in Figure 8-9. The first 3 years are used as the preparatory stage. An average cost of $107 million (5 percent of the total cost) per year is incurred. The major thrust of deployment will be in the fourth and fifth years with an average of $491 million (23 percent of the cost) per year. The last 5 years of deployment use $174 million (8 percent of the cost) per year.

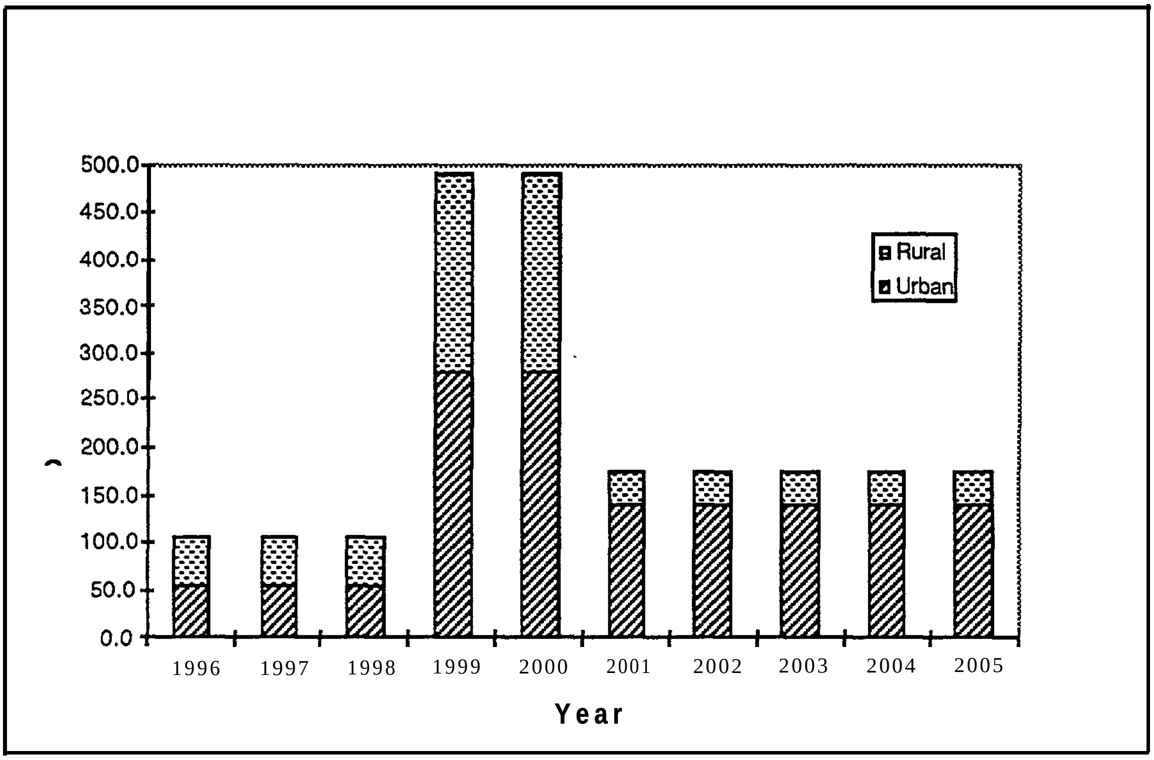

Figure 8-9. Yearly Financing Schedule

8.3.4 Budget Plan for Operations and Maintenance

The installation of the surveillance systems for the I-95 Corridor will require establishing an operations and maintenance program.

The operation and maintenance cost of the field equipment is directly related to the number of field locations within the jurisdiction of the agency. The majority of the field equipment are the roadside sensors for vehicle incident detection and surveillance. These sensors include in-pavement and over-the-pavement sensors, and surveillance equipment, such as the CCTV installations. This equipment is proposed for installation at half-mile intervals along urban freeways, at specific locations on rural freeway and at specific locations on urban and rural arterials. The other roadside field equipment consists of non-incident detection items such as pavement condition sensors, WIM, air quality, and weather stations. These non-incident field items constitute approximately 10 percent of the installation cost of the field equipment, and less than 10 percent of the maintenance and operating cost. The low maintenance cost for the non-incident field items is, in part, due to the fact that the service crews required for the maintenance of the incident detection and surveillance equipment should be able to provide service to the additional 10 percent of non-incident detection equipment without additional cost. There will be some minor additional costs due to the need for spare parts, but a failure or inactivity of a non-incident detection sensor can be tolerated for longer periods of time than an incident detection unit. Fewer spare stock parts are required, because they can be ordered as needed. The smaller inventory will also reduce maintenance costs.

The cost of the field personnel is based upon the number of field personnel, which is estimated at five, one foreman or supervisor, and four technicians. The technicians are equally divided between standard field maintenance work and electronic maintenance. Although the estimate does not include overtime operations, such extended operations maybe required at certain times depending on the type of field equipment failures encountered. It is assumed that the repair of the incident detection system will take first priority, followed by the surveillance system and the environmental monitoring system (e.g., air quality sensors).

The second item of operations and maintenance is the cost of the field operations. This item has two major components: operations and maintenance costs of the maintenance equipment, and the operations cost of the field equipment and sensors located at the roadside. The first item, maintenance equipment, includes the vehicles and supplies required for the maintenance of the sensors and detectors. The maintenance crew will require aerial lift trucks (bucket trucks) and communication cable repair vehicles. The most common problem, second only to the “knock-down” of roadside equipment, will be damage to the communication system. Much of this damage has been observed to be caused by other contractor operations. As stated above, the supply of spare parts will influence the cost of the maintenance operation; but the system should only keep those critical parts in stock, relying on ordering the more non-critical replacement parts as required.

The cost of operating the field detector and surveillance system is the least expensive item in the total cost of the proposed system when taken on a unit basis. A roadside sensor usually requires less than 100 watts to operate. The total cost for electrical power for all sensors in the entire Corridor system has been estimated at approximately $135,000 per year, or an average of $25 per mile.

The last item under operations and maintenance cost is for the aerial surveillance system. There are several systems available, from balloons with cameras, to helicopters and high-tech surveillance aircraft. The number of such devices or aircraft was assumed at ten for the Corridor because they would generally be used in the rural areas. The estimated yearly operations and maintenance costs (excluding personnel due to the lack of information) for the entire Corridor for this item is approximately $10,950,000.

A method of reducing the impact of the cost of operations and maintenance is to substantially reduce the number of field locations, and to share TMC facilities with other agencies. The reduction in the number of incident detection stations can be done by changing the distance between stations, but the reduction must be significant to accomplish a significant reduction in maintenance costs. Therefore, the only method of reducing maintenance and operating costs may be to share TMC facilities between several agencies as appropriate.

8.4 PUBLIC/PRIVATE CO-VENTURES IN SURVEILLANCE

From the earliest efforts in Intelligent Vehicle Highway systems, it has been recognized that the deployment of advanced technologies throughout the transportation infrastructure will require the involvement of both the public and private sectors. As a result, significant effort has already been expended in developing an understanding of how public/private partnerships can be fostered and how such partnerships can be exploited to solve systemic transportation problems and provide a profitable market for private industry.

The purpose of this section is first to provide a review of existing work on the needs, issues, and models for a public/private partnership in ITS. This knowledge serves as a framework for the future formation of various types of public/private co-ventures in the development and deployment of the I-95 Corridor-wide surveillance system. The review is based largely on the results of two efforts: a study performed by JHK and Associates entitled “VENTURE Washington, IVHS Strategic Plan for Washington" performed in 1993, and the proceedings of the November 1993 Workshop on Public/Private Partnerships in the Northeast Corridor, sponsored by the I-95 Corridor Coalition.

The second purpose of this section is to describe the potential opportunities for public/private co-ventures in the area of surveillance. The identification of these potential opportunities was based on the contacts made during the progress of this Project, the survey results of the Traveler Information Services Project (Project #3), and the vision of a mature ITS in the Corridor.

8.4.1 The Need for Public/Private Partnerships

The need for public/private partnerships is both financial and technological: financial because the public sector cannot afford to deploy ITS technology throughout the transportation system with its limited resources: and technological because public agencies are not typically familiar with the new technologies and need to rely on private sectors expertise. The private sector needs public sector involvement to help develop markets for its technological solutions and, in many cases, to use the public right-of-way. Generally, public/private partnerships are essential in today's environment to bring advanced technology to solve transportation problems.

The principal role of the public sector is to establish the climate and infrastructure to encourage private investment. It identifies the size and types of ITS market segments, sets standards and protocols, and resolves legal barriers, such as privacy and liability. The private sector' s role is to provide advanced technology products, perform research and development of technologies and systems, and act as a consumer purchasing ITS products, systems, and services. The private sector includes manufacturers, consulting firms, software and system suppliers, facility management firms, secondary service suppliers (maintenance, communications, and training companies), technology vendors, investors, auto and travel clubs and customer/users, and commercial vehicle operators. The private sector also includes universities who perform advanced research, either independently or in cooperation with private industry, including private consulting firms.

8.4.2 Issues of Public/Private Partnerships

Several key issues are associated with the development of public/private partnerships. These include an understanding of the mutual sharing of risks and rewards, the need for early federal involvement when federal dollars are committed, the need for adaptability of both the public and private sector with respect to their business practices and policies, and the need for development of national standards to allow multiple technology suppliers to develop compatible products and to facilitate competition, thereby driving technology prices down. New public/private partnerships also raise legal/administrative issues, such as procurement constraints, revenue and cost sharing restrictions, inhibitions to commercialization, intellectual property rights, rate regulation issues, and liability. Some of these issues are further expanded in the following paragraphs.

Risks and Rewards

One of the principal benefits of partnership is technology deployment and operating expenditures and risks may be shared. With a partnership comes a mutual commitment to achieve a common goal and the opportunity for each party to benefit from the new working relationship.

The public sector may become more customer-oriented, capitalizing on private sector market experience: and the best available technologies may be deployed faster, because of private sector involvement. The private sector benefits from the partnership by gaining access to the infrastructure and market, and by gaining a better understanding of the objectives and problems faced by the public sector.

Accessibility and Marketability

To attract private involvement/investment, the Coalition must demonstrate that it has accessible assets, an accessible market, and policy mechanisms in place which will build a mutually beneficial relationship with the Coalition. Disincentives to private entities, as noted in the workshop proceedings, include time-consuming public sector decision making, non-standard technical specifications combined with onerous contractual terms and conditions, and public retention of intellectual property rights. As stated by AT&T' S Market Management Director, timeliness and decisiveness are important to retaining a competitive edge; just as there is competition among agencies for a limited pool of public resources, there will be competition in the public sector for the limited pool of private sector resources. Hence, the Coalition must demonstrate the market potential of its assets and establish policies which address the business needs of the private sector as partnering relationships are developed.

Public/private partnership examples already exist in the Corridor in the form of revenue/cost-sharing through leasing and joint development of state rights-of-way and facilities, and provision of commercial road services. Partnerships have already been established to share cost burdens of installation of a fiber-optic communication system. By cost-sharing system development with a communication system provider in exchange for access to agency owned rights-of-way, the public burden was significantly reduced. The New Jersey Highway Authority has developed different arrangements to take advantage of its right-of-way "assets" by leasing excess space in conduits developed for its own use or by contracting for conduit construction (and use of excess ducts) in its right-of-way by private communication entities. The result: reduced deployment costs ti a revenue source for the authority.

Other revenue sources for the public sector include in-room, in-office, and in-house traveler information services. Surveillance data is required to generate detailed up-to-the-minute traffic status and traveler information for both travelers and commuters. Private subscriptions for traveler information services provide pre-trip planning and route guidance. This includes providing detailed information on the current and anticipated traffic conditions for specified routes, and providing alternative route guidance. In addition, multi/intermodal transportation information, including bus and rail schedules and schedule adherence, parking fees and availability, and airline schedules, could be provided to participating subscribers. Also included in this service, could be information on intermodal transfer locations and multimodal schedules. The Traveler Information Service could also provide subscribers with a detailed cost analysis of various travel modes, including both travel time and money. Hotels and resorts could offer these services, as well as destination information (restaurants, clubs, sporting events, and places of interest), to guests as an amenity or on a fee basis. Participating hotels could provide printed route guidance/maps and other guest-specified information. Advertisers of special events or points could also pay for space or time on the system.

Federal Involvement

Early federal involvement can minimize obstructions to the development of public/private partnerships due to misinterpretation of federal requirements and constraints. The use of federal dollars in "local" projects usually involves specific restrictions in how the money can be used.

Such restrictions must be clearly understood by all parties involved, prior to making commitments in the partnering process, which would later be canceled, souring the developing relationships.

Adaptability

Both the public and private sectors must adapt their respective standard work conduct practices to avoid policy-based or "entrenched philosophy"-based impediments to the process. The new roles associated with the partnerships will confront the "institutional cultures" of each sector. Public/private partnerships bring a new "culture", and barriers to partnering may be, in many ways, more perceived than actual.

Technology Standards and Procurement

The development of national standards will provide access to the transportation market to many technology providers, facilitating competition and lowering technology costs. It will also remove the perception of a partnership as a "sole-source" deal. The size of the market represented by the Coalition, has the potential to establish "de facto" national standards for advanced ITS technologies.

As an example, the E-ZPass Interagency Group of six toll entities in the tri-state New York Metropolitan area are in the process of procuring and deploying a regionally compatible Electronic Toll and Traffic Management (ETTM) system covering 1500 miles of roadway, and 40 percent of all toll transactions in the United States. Because of the lack of a national standard and the need to issue a system specification for bidding, which did not exclude potential vendors, the Interagency Group established a joint procurement process. The process focused on defining the critical elements to achieve compatibility and used a "least common denominator" request for technology, providing for technology upgrade migration paths to accommodate the specific needs of the various agencies in the group. To minimize exposure to "single sourcing", the Interagency Group established multiple sourcing and indemnification procedures and used testing, warranties, and incentives to reduce the risks of deployment of new technology. From the vendor' s perspective, the need to protect proprietary technology, and the need for a "level playing field" in which to compete with other vendors and technologies, emphasized the importance of a functional or performance system specification, which did not favor any one vendor, technology, or system architecture.

8.4.3 Partnership Structures and Procurement Models

Successful public/private partnerships typically have a number of factors in common:

+ Political acceptance of the partnership' s arrangement from the start at the policy level, the staff level, and by the general public.

+ Flexibility to negotiate terms.

+ Clear identification of partners and responsibilities.

+ Standard and protocol definition.

+ Early resolution of legal issues, particularly tort liability responsibility.

+ Private sector ownership of intellectual property rights or the right of first refusal for development for new hardware, software, system architecture, etc.

The lessons learned from these successful partnerships have been used to define potential partnership structures and procurement models as described below.

8.4.3.1 Partnership Structures

The JHK report for the IVHS Strategic Plan for the State of Washington identified three categories for public/private partnerships:

+ Public Initiative: Private Partners.

+ Private Initiative: Public Partners.

+ Public Initiative: Public Partners.

The last category is represented by the I-95 Corridor Coalition itself. This type of partnership is a multi-agency initiative established for the implementation of systems requiring interagency cooperation and coordination for optimal traffic and transit management. In particular, the I-95 Corridor Coalition was formed in response to the US DOT ITS Program designation of the I-95 Corridor as a "priority Corridor" in recognition of its "important multimodal transportation role and the challenges of traffic congestion, air quality and capacity constraints, thus making it eligible for FHWA Corridor Program funding."

The structure or working relationship of the various agencies within the partnership or coalition may take several different forms, including:

+ One agency assumes the role of the lead agency with support and assistance from other agencies.

+ A joint power of authority is instituted where all agencies within the system are represented equally and management is contracted by the authority.

+ Local agencies enter a joint agreement with a regional agency responsible for bidding and contracting any work on behalf of the affected agencies.

Partnerships from private initiatives, motivated in part by a desire to establish a market presence by developing new products or to expand the market for existing products, are formed for access to public information or to public rights of way. An example of a private initiative is the TravTek project in Orlando, Florida. The I-95 Corridor presents potentially attractive opportunities to the private sector, given the multistate scale of the potential market and the buying power represented by the Coalition. This "buying power" also has the potential to establish de facto ITS technology standards, which will allow more suppliers to enter the market, encouraging competition, and reducing the cost of technology.

8.4.3.2 Alternative Procurement Models

The procurement process established by the Interagency Group for the procurement of the regional ETTM system (i.e., E-ZPass) highlighted the need to identify alternative procurement methods for ITS technologies in general. Because several agencies were involved in the group, the experience also pointed to the desirability of establishing a separate business entity to manage the procurement, administration, and ongoing operations for the group.

Partnerships established as public initiatives with private partners can be traditional arrangements where projects/programs are controlled by the public sector and private firms are limited to the construction of ITS infrastructure and the supply of products and equipment. Non-traditional approaches can be negotiated where the private firms participate in research, development and operation of the ITS technologies. Partnerships generally include the following types:

+ Cooperative agreements.
+ Contracting.
  - Design/build (architectural).
  - Engineer/contractor (turnkey).
  - Performance specification (private sector specifies the technology).
  - Use of consultants.
+ Franchise arrangement.
+ Negotiated procurements/service agreements.
+ Procedures under the Federal Technology Transfer Act of 1986.
  - Technology transfer.
  - Techniques/models.
  - Non-U.S. models.

Experience with ITS deployment life-cycles indicates that the characteristics of this type of work are not necessarily well suited to the traditional engineer/contractor procurement approach. The characteristics of various alternative implementation approaches available to the transportation authority, including the standard Engineer/Contractor, Program Manager, and Design Build are described in what follows.

Engineer/Contractor

Under this approach, the Agency typically enters into a contract with an engineering firm in order to prepare the ITS detailed design, and document the design using the Agency's PS&E standards. The work is then tendered, often to a prequalified group of electrical or systems contractors, and generally awarded to the lowest bidder.

The nature of the ITS work typically requires expertise in various specialized technologies. For this reason, the prime contractor will have to subcontract significant portions of the work to apply the required resources and expertise to provide a turnkey system. In many cases, the majority of the value of the work will be oriented towards field construction and hence electrical contractors typically act as prime. The prime contractor must subcontract expertise required to deal with high technology components of the implementation such as communications, CCTV, information technology, and various types of specialized field devices. The success of the project depends directly on the prime contractor's ability to effectively coordinate and manage these high technology subcontractors and suppliers.

The administering Agency (i.e., owner) has the responsibility of ensuring conformance with tender specifications as well as overseeing testing and commissioning of the system. Because this role requires specialized technical expertise, the authority will often contract engineering services for construction administration or technical support. The consulting engineer will perform a variety of duties including review of contractor submissions, assistance in resolution of technical issues, witnessing of tests and training, and overall progress monitoring.

The typical design and construction time frame for this approach is in excess of 2 years. This amount of time can be problematic in a high technology environment in that the nature and specification of the products upon which the tender documentation was based may change, thereby creating problems in administering the contract. The prime contractor may not have adequate knowledge or expertise to administer subcontracts and suppliers under these circumstances. Experience has shown that extensive time and effort is required at the beginning of the construction process to approve components to be supplied by the contractor.

Program Manager

Under this approach, the program manager is designated by the Authority as the agency responsible for overall coordination and administration of the project. The program manager prepares a preliminary design and subsequent implementation plan for review and approval of the Agency. Based on this agreement on system scope, the program manager prepares a series of parcels of work as required to implement the various aspects of the system using the Agency's standard contracting processes (i.e., work orders, purchase orders, tender). The work is awarded to a variety of agencies, possibly including the program manager itself, based on their specific area of expertise. The program manager is responsible for coordinating the various streams of efforts and ensures technical compatibility. Under a systems integration phase, the program manager integrates the various subsystems and components into a fully functional system.

One benefit of this approach to the Agency is that the program manager serves as a single point of contact for accountability and applying direction to the program. The contractual arrangements between the program manager and the Agency are typically a negotiated service agreement based upon the conceptual system scope. As unforeseen events over time (such as program funding or evolution of technology) may impact the desired system scope, the program management approach offers more flexibility for the system development to respond.

The typical implementation time-frame for this approach would be 1.5 to 2 years, as some activities such as detailed design and hardware procurement can proceed in parallel. The success of this approach depends on the expertise of the program manager. To provide comprehensive program management services, the firm must have demonstrable experience in all phases of the ITS system life-cycle, from feasibility assessment through to operations and maintenance.

Design/Build

Under this approach, the Agency contracts with one entity for the design and construction of a turnkey system. The entity (often a consortium) is responsible for all aspects of the ITS deployment, including detailed design, procurement, construction, and integration. The Agency assumes the role of monitoring the activity of the design/build program.

Because initial price negotiations are based on a preliminary design, the design/build contract will typically incorporate a “30 percent detailed design submission” which acts as an opportunity to renegotiate contract construction terms if the design is revealing significant variances from the scope of the preliminary design.

While not widely used in North America, the design/build approach has gained widespread acceptance for transportation projects overseas. It offers the advantage to the Agency of a single entity with turnkey responsibility for delivering the project. Because technical coordination and administration are internal to the design/build team, administrative effort is reduced and implementation time-frames of 1 to 1.5 years can be achieved. Of the implementation approaches discussed herein, the design/build approach is the least flexible in terms of altering project scope/configuration and responding to external influences on the program.

8.4.3.3 Alternative Public/Private Partnership Models

To date, public-private partnerships in this country have typically followed the model adopted by the FHWA Operational Test Program. However, this model is not appropriate for the long-term development, deployment, and operation of ITS systems. Under most of these operational tests, financing is provided by both public agencies and the private entities involved, whether this contribution be monetary or services rendered. There is rarely a revenue stream resulting from these projects. Therefore, the private entities’ willingness to participate and provide financing is usually only a result of their desire to obtain exposure in the ITS field and the fact that the operational test is of a short-term nature. The partnership would not be sustainable over the long term and, therefore, the operational test model is not appropriate for the long-term development of ITS systems. As a result, it will be necessary to develop new models for private involvement in ITS deployment and operation. The following discussion summarizes models featuring differing levels of public and private sector responsibilities for financing, planning, and operation of the new and existing transportation systems and facilities (Washington State Transportation Policy Plan, 1992). While these models have not yet been adopted for use in the ITS industry, they are typical of the models that will be developed in the near future.

For new facilities, the following models have been developed.

+ Build Operate Transfer (BOT). In this most common public-private model, a private firm finances, builds, and operates a new system, obtains revenue from an associated revenue stream, and then transfers ownership to the public sector following expiration of an agreed-upon lease term.

+ Build Transfer Operate (BTO). A private firm finances and builds the system, and then leases the facility to the public sector for a set term, and collects lease revenues.

+ Build Own Operate (BOO). A private firm assumes permanent responsibility for financing, constructing, and operating the system fi the firm in effect is granted a perpetual franchise. The public sector' s role generally regulates service and safety issues, and sometimes, rate of return. The private entity recoups its investment through associated revenue streams.

+ Super Turnkey. Sometimes called "design-build", this model features the integration of facility design, construction and financing, through a comprehensive team or consortium. The public agency is protected from some of the risks associated with facility financing, design and construction, which are private sector responsibilities. At the completion of the construction phase, the private consortium "turns the keys" over to the public sector for operation.

For existing facilities, the following models have been developed.

+ Buy Build Operate (BBO). A private entity buys an existing system, improves it and then becomes the operator. This model works best for rehabilitation and reconstruction projects. Since the government does not have ownership or control, the public sector' s role is more limited under this model than under other approaches. The private entity receives revenue from associated revenue streams.

+ Lease Develop Operate (LDO). A private firm leases an existing system, expands it, and operates it under contract with the public sector. The facility is publicly owned, and the government receives lease payments for the term of the agreement, while the private firm draws from the revenue streams. This model is well suited to situations in which there are outstanding grants or bonds, which would make ownership difficult.

+ Contract Add Operate (CAO). A private firm assumes responsibility for an existing facility, improves it, and introduces a revenue stream (such as operating it as a toll facility) until agreed-upon revenues are earned. The government retains ownership. This model works well for existing facilities in need of rehabilitation or significant enhancement. Its benefits are that the imposition of tolls can be temporary (until the costs of the improvements plus a rate of return are covered), and that the financial risks of facility enhancement or repair are borne by the private sector.

8.4.4 Potential Co-Venture Opportunities

There are many potential opportunities for public-private ventures for the I-95 Corridor-wide surveillance systems. Table 8-6 lists the identified categories of private entities that may have interest in the Corridor-wide surveillance "services".

Table 8-6. Potential Co-Ventures Opportunities in Surveillance

Category	Surveillance Opportunities	Type of Project	Examples of Potential Partners
Information service providers	Common interest areas for gathering traffic surveillance information.	- Operational tests - Deployment	Metro Shadow Traffax Warner Cable Wayfinder AAA Discover America
Defense/Aerospace electronics firms	Application of defense sensors in transportation domain.	- R&D - Operational tests - Deployment	Hughes Loral Pilatus Britten Norman Westinghouse
Communication companies	Communication of surveillance data, especially for rural area communication.	- Operational tests - Deployment	Iridium Loral (Globalstar) Bell Atlantic
AVL service providers	Vehicle probe data collection and incident detection.	- Operational tests - Deployment	Bell Atlantic Cellular One Teletrac/Airtouch
Fleet operators	Exchange of probe data and traffic condition information.	- Operational tests - Deployment	Taxi fleet, delivery services

8.4.4.1 Information Service Providers (ISP)

This is possibly the most important category of private entities that may have a long-term partnership with the public sector in various opportunity areas. Both public agencies and ISPs require surveillance information. Public agencies need the information mainly for traffic management purposes, while ISPs need the information for dissemination purposes. This is a common ground on which many partnership opportunities can be created. The partnership scenarios include operational tests and actual deployment of surveillance system within the Corridor with a focus to the collection of surveillance data of common interest. Opportunities also exist in sharing the collected data. The SmartTraveler Operational Test is an example of such a partnership concept.

The Project #8 (Traveler Information Services) Study Team has surveyed the ISPs listed in Table 8-6. The survey results have shown a keen interest among this group for possible public-private partnerships.

8.4.4.2 Defense/Aerospace Electronics Firms

Many defense surveillance systems have high potentials for application in the ITS domain. Some technologies have already undergone applications in transportation through the companies' own initiatives and Government defense conversion programs. These companies have a vested interest in testing the capabilities of their defense products when applied to the transportation domain as traffic or environmental sensors. Potential scenarios for private-public partnership include: (1) R&D projects to develop products meeting the Coalition' s surveillance needs, (2) operational tests for new sensor systems, and (3) deployment of surveillance technologies.

During the course of this project, dialog with the potential defense/aerospace electronics firms revealed obvious interest in expanding their products to markets outside their traditional field. However, these firms have indicated a desire for an opportunity to understand the surveillance requirements and needs of the Coalition, and to demonstrate the applicability of their technologies. This desire may be satisfied with opportunities to form a partnership with the Coalition to conduct field operational tests. These opportunities will help the Coalition to find technologies outside the traditional surveillance domain, and help the defense/aerospace electronics firms to focus on developing visionary solutions for the Coalition. Among the possible solutions is the provision to create surveillance services to reduce the surveillance investment needs and minimize the risk of the Coalition member agencies.

8.4.4.3 Communication Companies

Currently, one constraint in the deployment of surveillance systems in rural areas is the lack of communication infrastructure. Since it is not practical to install hard-wired communication links along the rural segments of the roadways, the transfer of data from the field to a control center mostly depends on wireless communication. However, the current cellular communication infrastructure is also not available in many of rural areas.

Recently, private companies have initiated efforts to provide a global communication coverage using satellite communications. These services will be available as early as 1997. The relevance of these communications technologies in ITS is that they are integrated with the terrestrial telephone communications network, making their services accessible to a large population of travelers and to agencies that use leased lines for communications.

The satellite communication will not only provide the data communication for surveillance devices, but also will provide a means to communicate with traffic control devices such as VMS, HAR, and variable speed limit signs. Partnership with the communication companies can be formed for operational tests as well as full-scale deployment of the Corridor-wide surveillance system in particular, and traffic management systems in general. This communication service will be beneficial in areas where existing communication infrastructure does not exist or is inadequate.

8.4.4.4 AVL Service Providers

This category represents the companies that are capable of providing vehicle location services for commercial ITS applications such as fleet management or traveler information services. The vehicle location information can provide average link travel time and speed in real time. This type of information can augment the Corridor-wide surveillance database and reduce the infrastructure needs of the Coalition.

The vehicle tracking technology using the cellular telephone infrastructure may offer promising opportunities for a public/private partnership. Because the cellular telephone infrastructure is currently available in many areas of the Corridor, the cost for additional instrumentation to collect probe data may be minimal. This makes the partnership appealing to both the public and private sectors.

8.4.4.5 Fleet Operators

The use of Computer-Aided Dispatch and Automated Vehicle Location (CAD/AVL) technology in private vehicle fleet (such as taxis and local delivery) dispatching, tracking, route guidance, and navigation is expected to be widespread in the future. Since fleet operators would need traffic conditions data to effectively support those real-time applications and could provide probe data from their vehicles, a partnership to exchange information may be beneficial to both parties.

8.5 SUMMARY AND CONCLUSIONS

The purpose of this Business Plan is to serve as an initial “road map” for the continuing development and deployment of the Corridor-wide Surveillance System. To fulfill this purpose, an integrated surveillance field operational test program was developed. It consists of nine key projects addressing the main theme of the surveillance system design concept. This theme emphasizes the integration of existing and future surveillance technologies and services from multiple sources, and multiple agencies and organizations within the Corridor. It also emphasizes the testing of technologies that can contribute to an area-wide surveillance picture of the designated Corridor road network. The objectives of the recommended field operational test projects are not only to assess the technical and economic feasibility of new or existing technologies, but also to cover the many institutional challenges to be overcome to ensure the success of the Corridor-wide Surveillance System.

The second element of this Business Plan dealt with the potential cost sharing schemes among member agencies to build, operate, and maintain the Corridor-wide Surveillance System. The intent here was to explore ways that Coalition members may equitably share the costs and benefits of the system. These schemes are only the starting point for further analysis and consensus building among all Coalition members that would lead to a sound solution to this important deployment issue. The plan also identified the possible funding sources and opportunities for the implementation of the system.

Given the surveillance system conceptual design and its cost estimates developed from other tasks of this Project, an evolutionary deployment plan was formulated. A 1 O-year deployment time frame was assumed with three major milestones projected for the years 1998 (initial system capability), 2000 (intermediate system capability), and 2005 (full system capability). The implementation costs of the system at these milestones were also estimated. A budget plan for operations and maintenance of the system concludes the developed system deployment plan.

The last element of the Business Plan described the issues and principles of public/private partnerships and presented potential partnership opportunities in the Corridor-wide surveillance information services. The Business Plan also serves as an initial basis for exploring and formulating future partnerships that are mutually beneficial to all parties.

Because of the dynamic nature of a business plan, the Plan developed in this Project would naturally be refined, modified, and updated to meet the evolving needs and vision of the Coalition. To this end, this Business Plan serves the purpose of providing the needed starting point for future updates and improvements.