Title

Institutional Challenges to the Development and Deployment of ITS/ATS Systems in California

Authors

Horan, Thomas A.
Hempel, Lamont C.
Bowers, Margo

Publication Date

1995-05-01

CALIFQRMA PATH PROGRAM
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

Institutional Challenges to the Development and Deployment of ITS/ATS Systems in California

Thomas A. Horan
Lamont C. Hempel
Margo Bowers

California PATH Research Report
UCB-ITS-PRR-95-17

This work was performed as part of the California PATH Program of the University of California, in cooperation with the State of California Business, Transportation, and Housing Agency, Department of Transportation; and the United States Department of Transportation, Federal Highway Administration.

May 1995

ISSN 1055-1425

Institutional Challenges to the Development and Deployment of ITS/ATS Systems in California

November, 1994

Thomas A. Horan
Lamont C. Hempel
Margo Bowers

Institute for Applied Social and Policy Research
The Claremont Graduate School
Claremont, CA 91711

ABSTRACT

This report provides an overview of the key institutional challenges that could affect the development and deployment of Intelligent Transportation Systems/Advanced Transportation Systems (ITS/ATS) technologies in California. The findings of the study are based on a series of in-depth interviews and review of research related to "non-technical" constraints both in California and at the national level. Based on this review, the study outlines three core areas that require attention: research collaboration--which focuses on public/private partnerships in the development of new technologies; regional management--which focuses on the coordination of metropolitan planning and deployment of ITS/ATS systems, and stakeholder acceptance--which focuses on the institutional and user acceptance needed for ITS/ATS systems to be successful. After describing how each of these three areas are manifest in California, the report then provides an inventory of relevant lessons that could be learned from other experiences occurring around the country, including at the national level. The report also highlights various social science methods that could be utilized in addressing these key institutional constraints. The study concludes by outlining major research implications of the findings, and provides summary recommendations for developing a broad-based, robust program in California aimed at the resolution of these constraints.

Keywords: Intelligent Transportation Systems, Technology Assessment, Institutional Issues, Policy Analysis, User Acceptance, Public/Private Sector Partnerships

PREFACE AND ACKNOWLEDGMENTS

This reports documents research performed for the state of California, Department of Transportation (Caltrans), under contract #SA1110-2061MB-MOU 115. The study was conducted through the California Partnership for Advanced Transit and Highways (PATH) at the University of California, Berkeley.

The authors wish to acknowledge Stein Weissenberger, Randolph Hall, and Mark Hickman of PATH, and Wes Lum, George Smith, Keith Christensen, and Jim Tashjian of Caltrans for their comments during the course of this study. The authors also wish to acknowledge the activities of Kathy Gumbleton and Mary Clark in preparing materials in support of the report.

EXECUTIVE SUMMARY

Intelligent Transportation Systems (ITS) and related advanced transportation system (ATS) technologies are increasingly seen as having great promise for improving the nation's surface transportation system At the federal level, support for the development and testing of ITS/ATS technologies has increased dramatically over the last few years and, through funds provided by the Inter-modal Surface Transportation Act of 1991 (ISTEA), six year support could exceed $1 billion. The state of California has also committed to aggressively pursue the use of ITS/ATS technologies and has been a major player in the advancement and deployment of these technologies.

For ITS/ATS products and services to be effective, they must be successful in resolving a broad range of institutional, legal, and societal challenges, collectively known as "non-technical" constraints. Recent research efforts have been undertaken to better understand and identify the range of these non-technical factors that could affect ITS/ATS deployment and as a result, the literature is now replete with inventories of potential institutional constraints. However, this in itself does not help in organizing and prioritizing issues that need to be addressed through future research and policy action. This study was conducted to assess the *key* institutional and policy challenges confronting the California ITS/ATS program, and, in the process, move toward a more integrated understanding of *specific* areas that warrant immediate attention.

The study entailed an extensive review of the emerging literature on "non-technical" issues in ITS/ATS, as well as approximately 15 in-depth interviews with experts representing both California and the national program. Based on information obtained about the status, direction, and unique features of the California program, three core areas are described as capturing major concerns at the institutional and policy level: research and development collaboration, regional management, and stakeholder acceptance. The research collaboration area addresses the challenges associated with public/private collaboration in developing and deploying ITS/ATS technologies. The regional management area focuses on the challenges associated with testing and deploying these technologies within the context of complex metropolitan transportation systems. The stakeholder acceptance area recognizes the crucial role that multiple stakeholders play in ensuring or preventing the success of ITS/ATS systems.

For each of these areas, the study team also compiled and reviewed recent and ongoing related activities around the country that have implications for the California program, as well as identified a range of methodological approaches that can be used to study the issues involved. For example, in the area of research and development collaboration, there have been a series of national case studies addressing various strategies for achieving public/private sector cooperation in ITS. In the area of regional management, the challenges to regional deployment are being considered at both the corridor level (e.g., I-95) and at the metropolitan level (e.g. early deployment studies around the country). And in the area of stakeholder acceptance, field tests evaluations (e.g. SmarTraveler) and related focus groups are beginning to uncover aspects of user and institutional acceptance.

The goal of this review was not only to identify important non-technical issues confronting the California ITS program, but to do this in a manner that could assist the California program in prioritizing its institutional research needs. Based on discussions and feedback from the Caltrans/PATH sponsors, three decision criteria were developed to permit this sort of ranking. These criteria are: program relevance, research relevance, and cost-share potential These criteria were used to rank 11 potential research subjects that were identified as a consequence of the program review. Recognizing budget constraints, three issues, one from each core area, were further highlighted as warranting immediate attention. These are:

Research Collaboration - Identification of private sector interests and concerns on entering into partnerships in California,

Regional Management - Incorporation and synthesis of innovative institutional and market mechanisms in corridor and field operational tests, and

Stakeholder Assessment - Development of structured forum to solicit and consider CA environmental interests and concerns about ITS/ATS.

The study concludes with a series of program recommendations aimed at strengthening the analytical ability of the California program to address these and related institutional issues. The first recommendation follows the identified research needs and recommends that each of the major issues be addressed through the Caltrans/PATH program The second recommendation notes the importance of addressing these and other institutional issues through partnerships, in order to access expertise in a variety of disciplines (such as social science and market research). The third recommendation notes the value of integrating institutional assessments with broader testing and deployment studies, so as to facilitate cost-effectiveness as well as close association with deployment. The forth recommendation considers the need to conduct strategic exercises in areas not covered by this review, such as institutional challenges to the deployment of ITS in rural areas.

The study closes by noting how several system studies--such as the national architecture program-- are finding that the technical and non-technical elements are inextricably linked: an understanding of one is not valuable without an understanding of the other. The major challenge for the California research program will be to develop information that can translate this generality into a practical deployment-oriented program of activities and policies.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Emergence of Institutional Issues

Within a few short years, intelligent transportation system (ITS), and related advanced transportation system (ATS) technologies have emerged from relative obscurity to become a highly-touted prospect for improving the surface transportation system.1 At the federal level, support for the development and testing of ITS/ATS has gone from just over $2 million in 1989 to close to $200 million in 1994. Through funds provided by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), six year support for ITS/ATS could exceed $1 billion.

California has been a major player in the advancement and deployment of ITS. Indeed many credit the early work done in California as providing the initial leadership for the program (see Shladover, et. al. 1993) While the state retains a strong national reputation for its work in automated vehicle control, the New Technology Research Program now encompasses the full range of technological applications (Caltrans, 1993). These applications aim to bring immediate as well as long-term improvements to the state's highway, street, transit, and rail systems.

For ITS/ATS products and services to be effective, they must be successfully deployed amidst a host of facilitating and inhibiting institutional, legal, and societal influences, known collectively as "non-technical" constraints. Recently, a range of efforts has been initiated to better understand which non-technical factors could most affect ITS/ATS performance. One review of this literature cited over 50 papers and reports that addressed one or more institutional issues. (Booz, Allen & Hamilton, 1993). While this emerging "laundry list" aids in understanding the range of possible institutional influences, it does not aid in organizing and prioritizing issues to be addressed through research and policy action. Nor does it aid in understanding which issues are most pressing for a state like California, which is moving aggressively to deploy ITS/ATS services over the next several years.

Overview of Study

We conducted this study to assess key institutional and policy challenges confronting the California ITS/ATS program; that is, we sought to move beyond merely listing possible influences, and toward a more integrated understanding of areas that warranted attention by the state ITS/ATS program. Moreover, we sought to do this in a manner cognizant of

---

[1] The term intelligent transportation systems (ITS) has evolved as the nationally accepted term for the technologies formerly referred to as intelligent vehicle highway systems (ITS). The state of California, uses the term advanced transportation systems (ATS) to encompass a broader range of technologies that includes ITS.

the lessons that could be learned from related experiences occurring around the country and at the national level. For this reason, the focus of our review is two-fold: it identifies key issues that are arising in the state (Section 2), and then considers these issues within the context of the national program and related research (Section 3). After a brief consideration of methods which could be used to assess non-technical issues (Section 4), the findings fi-om both the California and nationwide review are integrated and considered into research implications and summary recommendations for program action (Section 5).

Scope and Methodology

The study was deliberately designed to provide a "preliminary overview", as opposed to a definitive treatise on the issue. Such an approach was taken in light of the need for timely information that could be used to develop an institutional issues program in California. In the lexicon of evaluation research, it is scoped as a formative assessment rather than a summative assessment, meaning the focus is on developing information to be used in forming a program rather than assessing it (Rossi and Freeman, 1993).

In order to serve this objective, the study--by necessity--required the timely acquisition of information and insight pertaining to non-technical challenges. We limited both our scope and methodology to ensure this timeliness. On the issue of scope, we deliberately focused our review on the near to mid-term (5-10 year) application of ITS/ATS technologies in major metropolitan areas around the state. Most transportation funds and conceivably, most ITS funds will be spent within this domain, so it provided a justifiable focus. Nonetheless, we recognize that rural and inter-regional applications are also vital, but felt that the institutional issues associated with these areas are sufficiently unique to justify independent analysis. For similar reasons, we have not focused very heavily on commercial vehicle operations, as they also have unique institutional items (e.g. transparent borders) which warrant independent attention. While these scoping decisions necessarily limited the range of our findings, they do allow the report to consider the interrelated themes which surround near-term metropolitan deployment.

In terms of methodology, our review focused on the information and insight provided by experts, as well as by the emerging literature on institutional issues. We conducted approximately 15 in-depth interviews with experts representing both California and the national program Each of these interviews was guided by an interview guide covering a full range of non-technical constraints, and each interview was subsequently summarized according to the major issues raised. In addition to these interviews, a number of follow-on interviews were conducted to fill remaining information gaps. Appendix A contains a listing of the interviews conducted for this study.

We also conducted an extensive review of the relevant literature both in the ITS/ATS area as well as in related transportation and policy areas. This review involved executing several electronic searches, as well as obtaining numerous institutional issues reports that were published during the course of the study. As the literature on non-technical

constraints to ITS is still preliminary, we supplemented our review with related transportation and policy analyses pertinent to the constraint under consideration. To aid in our analysis, working summaries were prepared for a select number of key reports, including each of the non-technical studies prepared for the congressional report on non-technical constraints. Appendix B provides a complete bibliography of reports related to non-technical ITS constraints.

A third noteworthy feature of our methodology was stakeholder interaction throughout the process. As our study was aimed to assist in the formation of a state-level institutional issues program an essential aspect of our analysis was the solicitation of input and feedback by PATH and Caltrans representatives during the course of our review. We held several briefings to present findings and solicit sponsor perspectives. (The outcome of this process is described in Section 5.) These meetings provided a useful and necessary "reality check" on our findings.

Strengths and Limitations

The strengths and limitations of our review flow rather directly from the design choices noted above. In terms of strengths, the primary advantage to the approach is that it allows for relatively timely input in the institutional arena at a time when the program is taking shape in California. Further, it is designed in a manner that is sensitive to the lessons being learned around the country while at the same time recognizing California's unique role in the national program Third, the study is designed to develop research and program information that is responsive to the needs, concerns, and interests of PATH/Caltrans sponsors.

In terms of weaknesses, there are several limitations to the study. As noted in the scope, the study does not (and could not) attend to several non-technical domains, such as rural and commercial applications. In terms of the methodology, the reliance on existing written and verbal inputs means the findings are very dependent on current state of the art. Hence the study's findings can be subject to change as constraints are solved and new issues unfold. Finally, there are inherent limitations in conducting "institutional research' when the sponsors are significant institutional players. Given the research focus of our research--rather than a management audit focus--we primarily addressed institutional issues surrounding the metropolitan deployment of ITS/ATS. As such, we did not concentrate our review on Caltrans/PATH activities, though we have made observations and suggestions where appropriate (see Section 5). While such a management based analysis could produce useful information to improve the state ITS/ATS program it was not within our charter to do so.

2. KEY INSTITUTIONAL AND POLICY ISSUES

Overall, there is an increasing appreciation of the crucial influence institutional and policy issues have on ensuring the success of ITS/ATS technologies and services. In part, this is the result of a series of studies begun at the national level to assess various non-technical influences, and in part it is the result of a range of experiences actually occurring around the country. Given California's ambitious and wide-ranging ITS/ATS program each of the institutional and policy issues recognized invariably has some application or implication for the state program. For example, Appendix C provides an example of the types of institutional issues raised during the course of our review, and salience often associated with the issue within the state of California.

However, California is unique in several important ways, and this conditions how the institutional and policy elements should be viewed. Among the distinguishing features of the California ITS/ATS program are that it is increasingly linked to the economic ('job creation) needs of the state, that it will entail a widespread level of early deployment, and that it will invariably be conducted in a "fishbowl" setting, particularly with regard to possible environmental implications. These and related attributes suggest certain areas where the state program will find itself on the "cutting-edge" of non-technical resolution.

Three Core Areas for Attention

Consistent with these unique features of the California program our review has lead us to propose three core areas that capture major concerns at the institutional and policy level. These are: research and development collaboration, regional management, and stakeholder acceptance. As shown in Table 2.1, these areas encompass a range of issues that can be subject to research, analysis, and action. While there is overlap among the issues, they each are distinctive in that they highlight unique institutional dynamics that confront the state program The research collaboration area addresses the challenges associated with pubic/private collaboration in developing and deploying ITS/technologies. The regional management area focuses on the challenges associated with testing and deploying ITS technologies within the ISTEA context of metropolitan transportation systems. The stakeholder acceptance area recognizes the crucial role that multiple stakeholders play in ensuring or preventing the success of ITS/ATS systems. Each core area will be addressed in turn.

Table 2.1: Overview of Core Institutional Areas

	RESEARCH COLLABORATION	REGIONAL MANAGEMENT	STAKEHOLDER ACCEPTANCE
Sample Elements	Private Sector Interests and Concerns (anti-trust, intellectual property rights); Public Sector Interests and Concerns (SBIR, procurement), Partnership Challenges (CRADA, contracts).	Regional Visions, Demographic Changes, Regional Planning, MPO Role and Staffing, Early Deployment, Operational Maintenance and Funding	Institutional Acceptance, Environmental Implications, Public Acceptance, Market and User Demand
California Example	Issues Raised by the CCST Proposal for Center for Transportation Innovation	Issues Raised by Orange County Early Deployment Study	Issues Raised by Travinfo Field Operational Test
National Research Example	SRI (1994) on Defense Industry Barriers to IVHS/ATS participation	Booz, Allen, and Hamilton (1993) Study on Institutional Impediments to Metropolitan IVHS systems	Author D. Little's study (Parish, 1994) of Market Research Impacts on Electronic Toll Collection, Cellular Phones, and Automated Vehicle Identification.

Research and Development Collaboration

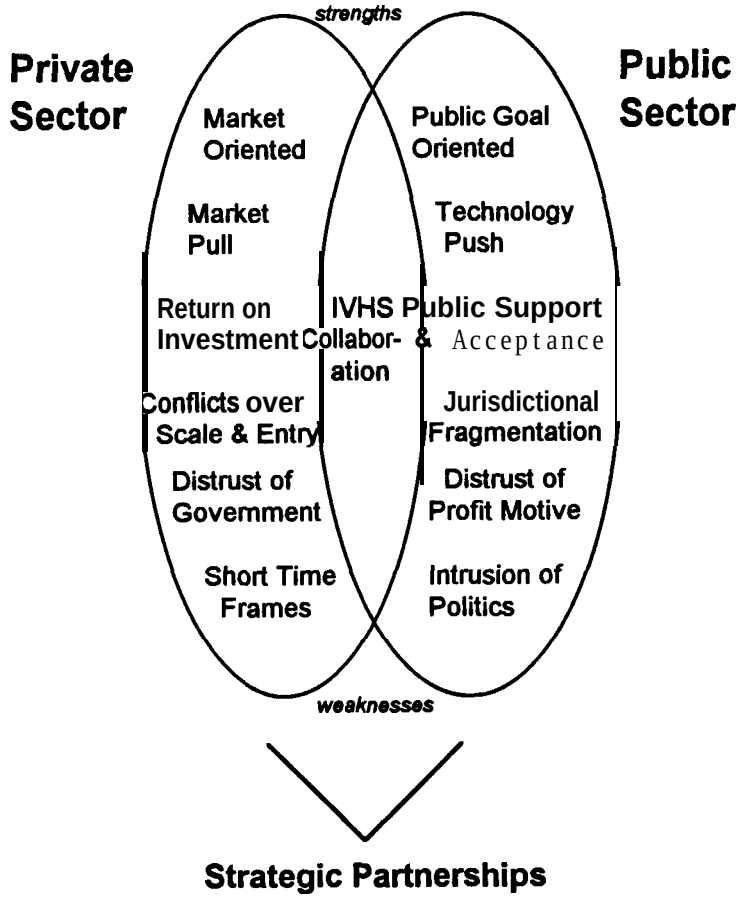
Overall indicators for the rest of the nation suggest that the long recession is finally over, except in California where state has lost an estimated 7% of its workforce since 1990 (Myers, 1994). As a result, a plethora of panels, public/private councils, and committees have been formed to capture the interest of public officials and gamer resources for technology development (Gomez and Olmos, 1993; Petruno, 1994, Flannigan, 1993). A myriad of studies detail steps to transform California into a manufacturing center for high technology transportation, particularly electric vehicle and ITS (Parrish, 1993, Shields, 1993). Much of the optimism results from the substantial sums planned for public works and the excess capacity within defense firms which could be utilized.

Because of California's economic conditions, the state has taken an aggressive role in the commercial/economic competitiveness aspects of ITS. For example, Project California has identified ITS as one of the top six areas to focus on for creating high value jobs in the region and an "ITS Alliance" has been formed to forward that agenda (Project California, 1993). A related effort is underway to participate in the automated highway consortium. Unlike many other aspects of ITS which focus on deployment (see below), these activities fall more in the areas of technology development and commercialization--ground rather unfamiliar to transportation agencies.

Our review revealed challenges associated with both the private and public sector aspects of ITS research collaboration in California. Figure 2.1 summarizes dynamics associated with public/private partnerships on ITS in California. As noted in the Figure, both parties bring several important attributes to the partnership; for example, the private sector brings its orientation toward the market demand, whereas the public sector brings its orientation to public goals. As the nature of the ITS program places high value on bringing the private sector into partnerships with Caltrans and other public sector agencies, there is a need to understand the interests and concerns of ITS-related industries, while at the same time ensuring the achievement of public goals.

A common theme among the private sector representatives we interviewed was that the California ITS program had yet to establish mechanisms which are sensitive to private sector concerns, though efforts were acknowledged to be underway (cf. Parsons, 1994; Schreder, 1994; Younan, 1994; Kolstad, 1994). For example, Kolstad sees the standard RFP/procurement practices as mitigating against the possible involvement of small businesses in ITS, as these mechanisms require significant administrative resources (Kolstad, 1994). Similarly, Schreder points out that the prospects of partnering with the state on major ITS initiatives can essentially mean that the company has to internally fund the development of two applications: one for the state and then an official application (Schreder, 1994).

Figure 2.1
OVERVIEW OF PUBLIC/PRIVATE PARTNERSHIP ISSUES



This is not to say there is not appreciation among the private sector about possible gains to be made from participation in ITS/ATS. As has been noted by Project California, the state can expect to encounter early market demand for ITS/ATS products and services and many companies are exploring different roles in meeting this potential demand (as well as the unfolding nationwide and worldwide demands). (For example, Appendix D provides a list of California companies that are active in ITS America.) However, the immediate market for ITS/ATS is limited and, according to many analysts, potential market risk is an under-appreciated issue (Robertson & Roberts, 1992). Some of our interviewees noted that the ITS market is insufficiently developed and understood at this time to warrant big investment which may require years to generate returns; this can particularly inhibit the participation of small businesses (Kolstad, 1994). This is where the state ITS/ATS is seen as potentially playing an important role: providing partnership support to companies who are interested in exploring the market, yet unable or unwilling to make major investments because of market uncertainties (CCST, 1994).

The prospects of public/private partnerships in ITS--while generally revered in the literature--should perhaps more accurately be viewed as beneficial "shot-gun" marriages. Among the private sector representatives there is reluctance to enter into such partnerships yet--at the same time--a recognition that such partnerships could be necessary to fund early exploration of ITS/ATS. From the private sector point of view, the ability of the state ITS program to streamline its processes and procedures to be "less bureaucratic" can be a key to improving the attractiveness of such partnerships (Parsons, 1994). Competing policy directions such as between new highways, demand management, or road pricing may also reduce the interest of businesses which view the investments as too risky (Deakin, 1989).

On the public sector side, both the literature and the interviews revealed an overall awareness of the possible benefits from public/private collaboration in ITS (see FHWA, 1993). Most of ITS user services are expected to be market-based, and hence the potential for partnering with the private sector is significant. According to Lockwood (1994), among the many advantages that such partnerships could bring to the California program are: (1) reduced costs by contracting out services (2) increased affordability of deployment through cost-sharing of investment; (3) generation of needed funds through commercialization; (4) development of greater market responsiveness in line with for-profit orientation; and (5) direct access to the latest technology.

Our review identified a host of activities occurring in the state that relate to these ITS research collaboration issues and concerns. For example, the California Council on Science and Technology (CCST) is developing a proposal for establishing an Advanced Technology Research Center, and the Caltrans New Technology Program is drafting a Program Plan for California and initiating an "ITS Alliance". At the regional efforts, activities such as the Southern California Economic Partnership ("The Partnership") aim to bring together public and private sectors parties to forge regional solutions to

transportation, environmental and economic problems All of these activities represent major opportunities to explore public/private partnerships in California.

Efforts such as these have heightened expectations on the potential of ITS for the state. From the vantage of public/private cooperation, several interviewees noted the need for the state to articulate its priorities in the advanced technology area, so as to inform the private sector of investment priorities, reduce investment uncertainties, and facilitate collaboration with industry (Schreder, 1994; Savitt, 1994; Shields, 1993,). ISTEA calls for economic assessment of technologies, but current evaluation techniques cannot account for impacts on productivity or other indirect effects (Mudge and Griffin, 1992). However, objective, unbiased evaluations would permit prioritization of products and services on the basis of social, economic and market trends, and provide the basis for sound market analyses by suppliers (CCST, 1994).

Different phases of technology development and deployment may call for different institutions, those which have significantly evolved or are newly created (Parsons, 1994). Assemblyman Katz' bill, AB 3096, opens the door for a private, non-profit innovation center to advance the state's transportation interests. A recent report sponsored by the California Council on Science and Technology endorses an innovation center which would support a variety of hard and soft scientific endeavors to inform the legislature regarding the viability of technologies while pursuing commercial opportunities. The proposed legal and organizational structure would exist outside the state government bureaucracy, create opportunities for more innovative contracting and procurement, and rely on public/private ventures for commercialization and applied research. This commercialization effort would be responsive to business outlook and market forces in support of technologies with a high probability of commercial success. (CCST, 1994).

The prospect of a new advanced transportation research center renews interest in the nature and complexities not only of public/private partnerships, but those involving the California academic community as well. The California ITS/ATS program has had a long standing partnership with the University of California system through the California PATH program. PATH has served as the nexus and provided academic support for several universities in the state program Proposals such as the CCST highlight the evolving nature of academic support for ITS/ATS in California, a situation increasingly sensitive to regional tensions between northern and southern California (Ome, 1993; Katz, 1994).

In sum the need for an "articulating force" that can weave together the strengths of existing efforts in a manner that actively engages the private sector while avoiding unnecessary and costly bureaucratic inefficiencies of the public sector (Williams, 1994; Schreder, 1994; Savitt, 1994; Parsons, 1994). Interaction between business, government and regulatory bodies can cause a business to be more attractive to potential investors (Robertson and Roberts, 1992). Often stated in both our interviews and the literature was private sector interest in greater involvement with both governmental agencies and ITS forums so that transportation officials may gain greater familiarity with the world of private concerns and practices (Savitt, 1993; Younan, 1994; Parsons, 1994). ITS is often

cited as the natural successor transportation program to the Interstate Highway program of the last three decades. One of the major differences to be dealt with if this, indeed, turns out to be the case, is the need in ITS for a strong R&D collaboration between the public and private sectors. Unlike the Interstate program the public sector does not appear to be willing or able to provide the funding for the entire ITS program on its own. And, because of the potential for the private sector to realize economic benefits from successful development and implementation of these technologies it is in its best interest to develop strong collaborative agreements with the public sector to perhaps help offset some of the initial costs of the required research and development efforts. The time has certainly come for forward motion in this area.

Regional Management

A unique feature of the ITS/ATS program is its co-mingling of research, testing, and deployment (Feamsides, 1993). While this facilitates the availability of state-of-the art technologies, it raises a host of institutional uncertainties that need to be addressed to ensure credible application of these technologies to California's metropolitan transportation problems.

The most central element that arises in this transfer is the regional context into which ITS services and products are to be deployed. Recent federal legislation, particularly the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, have reinforced the need to consider transportation investment impacts on the entire "metropolitan transportation system" (Dahms, 1993). This and related legislation (e.g. the Clean Air Act Amendments of 1990), have further noted the need to consider the impact of transportation investments on other community goals (e.g. air quality), and to do so in a manner which encourages participation by a broad range of the public.

Institutional and policy issues arise along three tiers: regional visions, regional plans, and regional implementation. The first tier--regional visions--is the most ephemeral, yet, perhaps the most understated. As ITS represents an ambitious attempt to deploy an advanced communications layer onto the transportation system it inevitably raises the question of how this initiative fits within the overall vision of a region's future. While efforts such as the national systems architecture project are providing input on the national technical vision for ITS, each region--including the major metropolitan areas in California--will need to consider the role of ITS and related advanced technologies within their communities (Rowe, 1993). For example, in southern California, a major consideration would be to understand the impact of various social and demographic forces on regional transportation priorities, including ITS (Wachs, 1993). A master plan is needed for multi-modal transportation to address the influx of lower income immigrants (O'Connell, 1993). Societal issues, such as access to health care, biker and pedestrian-friendliness, and transportation for the elderly and urban poor have also been cited as worthy considerations for ITS planners (Waller, 1994).

The integration of ITS with regional transportation plans represents the premier institutional exercise at the regional level (Dahms, 1993). ISTEA has reinforced the regional planning process, including its consideration of a host of environmental and social factors (see STPP, 1993). Further, it has linked the regional planning process to programming priority. As noted by both interviewees and the literature, it is incumbent upon ITS to move under the regional planning process in order to justify its use of transportation funds and its linkage to overall transportation goals (Dahms, 1993; Lam 1993). While there are several levels of institutional challenges associated with regional deployment, the achievement of multi-modal ITS plans is particularly complex. As has been noted in two recent California early deployment studies, the institutional challenges are equally if not more difficult than technical ones (see JHK and Associates, 1993; Markowitz and Georgevich, 1994). For example, the recent multi-modal plan for Orange County noted: "Perhaps the most significant challenge of the Orange County study was to reconcile the overall vision of an integrated, multi-modal transportation management and information system to serve the public, with the needs, concerns, responsibilities, and financial limitations of 31 cities plus several regional agencies" (Havinoski, Leonard & Delgado, 1994). This sentiment was echoed in a recent article about the San Francisco early deployment study: "The building of institutional 'infrastructure' is as critical as the more usual capital investments for the ultimate success of early ITS deployment" (Markowitz and Georgevich, 1994).

The institutional complexities associated with metropolitan applications of ITS gives rise to the need for leadership and partnerships. In Los Angeles--as elsewhere--the existence of a champion for ITS can have demonstrable effects on the deployment success of these technologies (Howitt, 1994). However, the political incentives for supporting ITS/ATS programs are not as apparent as they are for other more fashionable programs such as transit (O'Connell, 1993). From an institutional point of view, ISTEA encourages Metropolitan Planning Organizations (MPOs) to take a leadership role within metropolitan areas. While this encouragement can lead to greater involvement by MPOs in ITS--such as MTC support for Travinfo--the MPOs are confronting additional challenges (such as Clean Air Act compliance) which are already taxing their resources.

A related constraint in California is the continuing budget problems on both the state and local levels that can influence the nature and level of public sector support. At the state level, budgetary uncertainties can influence the extent to which Caltrans will be able to support ITS as well as other transportation improvements. At the local level, similar budgetary constraints can influence the level of support for ITS by local governments. For example, both the aforementioned Orange County Plan and the upcoming Congested Corridors plan assume significant budgetary constraints (Smith, 1994), and the Smart Corridor has had to contend with significant revenue shortfalls being experienced by Los Angeles county (O'Connell, 1993). This challenge is further complicated by the "crisis in governance capacity" that has resulted as regional problems become so significant that they exceed the capacity of local governments to solve by themselves (Kirlan, 1990). Following years of declining technical capability and loss of revenues from non-transportation sources, MPOs may not have sufficient data or administrative capacity to

gear up rapidly for their new role (Prendergast, 1994). These complications manifest significant staffing challenges to local agencies who must train and/or hire staff to deal with ITS/ATS problems (Urban Institute, 1993). In addition, fiscal restraints often prevent skilled staff from interacting with one another at distant or national meetings (Ome, 1993).

The actual deployment of ITS/ATS user services in California raises a host of concerns that have yet to be fully appreciated or addressed. First and foremost among these is the issue of operations and maintenance. As several interviewees noted (Rowe, 1994), ITS systems could pose a significant financial burden on localities that are already experiencing financial shortfalls. Others have noted that market distortions occur as a result of public purchasing restrictions (Savitt, 1994; Rude, 1993). Certain capital equipment investments may be chosen over less expensive mechanisms to accomplish the same ends primarily because those are allowable costs. Innovations in funding and maintaining these systems could be crucial a component of their long term success.

Because California has been and will continue to be a leader in early deployment of ITS, it must understand how to interface ITS systems within the regional decision-making process, and to do so in a matter which promotes public/private innovation. There are a variety of activities in California related to this area. For example, the "Southern California Corridor" project will need to develop institutional relationships among a host of jurisdictions from Los Angeles to the Mexican border, and would be a key opportunity to consider regional vision, planning, and institutional coordination issues. The Travinfo project in San Francisco is already providing insight into the public/private partnerships at the regional level. And the Smart Corridor in Los Angeles is providing important early deployment experiences on financial programming for ITS. While these projects will have technical elements and challenges, they also represent major opportunities to develop new institutional arrangements which can transcend traditional institutional roadblocks.

Stakeholder Acceptance

The transportation policy environment represents a confluence of interest groups, public and private sector organizations, and various segments of the public (Sussman & Klien, 1993). Participation and acceptance (or acquiescence) by these various factions is necessary for ITS systems to be successful. Thus a key is to "build coalitions" for ITS systems involving the appropriate actors, which can vary by the type of system being deployed (Horan & Howitt, 1994). A related aspect is to incorporate public desires and preferences into the design of ITS systems, considering issues such as environment, equity and privacy.

Several factors make the issue of stakeholder acceptance particularly key in California. First, as mentioned above, California is expected to experience early deployment of ITS, making stakeholder acceptance a tangible issue for the state. Second, the state traditionally has a high level of interest group awareness and participation in the

transportation policy process. Lastly, with the large ITS product and service capability centered in California, stakeholder acceptance of consumer products in the state is key to further development in the country (see Lappin, Sloan, & Church, 1994). For these reasons, ongoing stakeholder analysis and outreach is warranted.

There are (at least) three levels of stakeholders who could affect the successful deployment of ITS/ATS in California: interest groups, general public, and users/markets. At the interest group level, there are a host of groups that could raise institutional and policy concerns associated with ITS. The most visible of these is likely to be the environmental interest groups, given the active role that these groups already play in the transportation arena (Dahms, 1993). According to several of the experts interviewed, acceptance or opposition by environmentalists represents a major "wild card" for the program (for example, Hyman, 1993; Lowe, 1993). Early indications are that there are aspects of ITS (e.g. automated vehicle identification [AVI], advanced public transportation systems [APTS]) that can be seen as forwarding environmental priorities, while other aspects (e.g. automated highway systems [AHS]) have triggered decidedly negative reactions from the environmental community (Replogle, 1993; Lowe, 1993). Based on the constructive outcomes of several national level forums, there is an immediate opportunity to establish similar mechanisms within the state. In California, these groups would include the Sierra Club, Coalition for Clean Air, Union of Concerned Scientists, National Resources Defense Council, Environmental Defense Fund, Planning and Conservation League, California League on Conservation Voters, and Citizens for a Better Environment (Markowitz, 1994).

In addition to environmental groups, there are a host of community interests that ultimately need to be considered during the course of ITS deployment. ISTEA has ushered in a new era of participation in transportation decision-making and the same context will apply to ITS as it reaches development (see Munnich, 1994). For example, one area for concern and outreach could be on the equity impacts of ITS. While ITS/ATS may not be any more skewed in it's distribution of costs and benefits than other transportation investments, it may be more open to attack as being elitist (Wachs, 1993). Outreach to community groups and considerations of services which reach an ever broader spectrum of citizens may be necessary to ensure ongoing support by these groups.

At the level of general public acceptance, there is a need to understand the range of public acceptance for various ITS initiatives. The public investment side of ITS will undoubtedly rely on taxpayer support, and consequently it will be important to know the extent to which ITS programs are ahead or within the domain of public acceptance (Horan, 1993). As one interviewee noted, it is sometimes necessary to deploy a program that operates ahead of public opinion in order to produce desired transportation effects, and rely on post-hoc education and outreach programs to close any gaps (O'Connell, 1993). However, it is equally important not to get too far ahead of public acceptance, for this could cause a backlash such as occurred with the Santa Monica Diamond Lane in the 1970s. While many ITS services will not have this level of visibility others will (e.g. advanced traffic management systems [ATMS] versus [advanced vehicle identification

AVI]-based congestion pricing). There is also a desire on the part of transportation officials to hear more from taxpayers regarding their interests, interests that will not be fully developed without adequate public education regarding potential technologies.

The user is the ultimate customer for ITS, and the ability to craft the services around user needs is a fundamental requirement of the program (Burwell, 1993; Luce, Richard, and Lum, 1992; O'Donnell, 1993). For many products, California represents early testing experiences. For example, a recent market research report notes the importance of congested metropolitan areas in providing early markets for advanced traveler information technologies, and notes that California contains four of the top ten congested regions: San Diego, Los Angeles, San Francisco, and San Bemadino-Riverside (Lappin, Sloan, and Church, 1994).

Another area where California is at the forefront relates to the travel characteristics of different cultural groups (for example, see Ho, 1994). According to Pisarski (1994), a forthcoming update of Commuting in America will highlight the travel patterns of new immigrants as a major dynamic affecting future transportation performance (Pisarski, 1994). California, which has an immigration rate among the highest of any state, will invariably confront the issue of how to deploy ITS in a multi-ethnic, multi-cultural setting. An important feature to be analyzed would be a differentiated understanding of the potential users (e.g., commuters, the elderly, ethnic differences), and a refined sense of those that fall within the domain of the private sector, and those user services which relate to public policy goals (e.g. the Americans with Disabilities Act) (see Waller, 1994).

Crosscutting Summary

Implementation of ITS/ATS has the potential to represent a "new way of doing business" for California transportation policy makers. While the era of highway construction relied upon strong public sector guidance and funding, the era of ITS comes at a time of significant change in the state. The ongoing transportation and economic conditions have created a number of institutional and political challenges through which the ITS program must navigate, and with skillful navigation could result in significant benefits. These unique conditions include: high expectations for ITS (e.g., not only transportation impacts, but economic/industry impacts as well); pronounced budgetary and administrative constraints encumbering public sector supporters such as Caltrans; complex metropolitan institutional arrangements (e.g. Los Angeles and San Francisco), and unparalleled diversification of the marketplace (e.g., as represented by the ongoing immigration influx).

While these factors make California a unique proving ground for overcoming institutional obstacles and developing institutional innovation, this is not to say that there are not lessons that could be learned from other experiences around the country. There are such lessons, and these are considered in the next section.

3. INVENTORY OF RELATED ACTIVITIES

Given that ITS/ATS is a national program with many activities occurring throughout the United States, it is useful to draw from related experiences in devising successful policies, programs and practices to overcome institutional and policy challenges. In particular, efforts being sponsored by the federal government have particular application for California, as do related activities being conducted in areas such as the Midwest and the East Coast. In this section we provide an overview ("inventory") of related activities around the country that have implications for the California ITS/ATS program. (Additional information on items covered in this chapter are contained in Appendix B).

Overall, the most noteworthy research activity in the ITS/ATS institutional and policy arena is the effort by the Department of Transportation to prepare a report to Congress on non-technical constraints to ITS (Marchessault, 1993). This report, which was released in late 1994, provides a status report on many non-technical challenges to ITS deployment, including: barriers to private sector participation, impediments to metropolitan traffic management coordination, acquisition and procurement issues, the role of standards, staffing and educational needs, antitrust issues, liability concerns, privacy issues, intellectual property constraints, and environmental implications. The report is a synthesis of a range of experiences and studies conducted around the country on these subjects. It also prominently features a series of studies commissioned by the department to support their data collection efforts (see Appendix B for a listing of background "non-technical" studies). We discuss these and other major reports within the context of our three core areas[2].

Related Research Collaboration Experiences

The issue of research collaboration (including partnering) is a new area for transportation policy and California has undoubtedly taken the most aggressive role in linking ITS/ATS to potential economic benefits from commercialization. Because California is--and intends to remain--in a leadership position in this area, it must take an active role in conducting its own inquiries for effective research and consortia action, as demonstrated by the Transportation Innovation Center initiative.

Nonetheless, work at the national level has highlighted the challenge to achieving public/private partnerships. For example, a recently completed study by SRI (1994) examined "Institutional Barriers to ITS/ATS: Company Interviews and Case Studies." This study, which focused on defense firm participation in ITSIATS noted several barriers to effective partnerships at the national level. These included four industry-based barriers:

---

[2] Because the primarly data analysis efforts for this report occurred prior to the release of the Non-Technical Report to Congress, this section highlights the implications of the various background studies which were done in support of and are consistent with findings of the final report to Congress.

market unfamiliarity - lack of knowledge of non-defense government procurement processes and evaluation criteria, little or no experience in dealing with multiple customers and users;

technology-push orientation - commitment to high-level technology solutions in markets with different requirements;

risk adverse culture - tradition of low risk approach and caution in the market place, lack of internal transportation domain knowledge and expertise;

financial constraints - retaining defense-configured financial infrastructure with high overheads and little flexibility;

The study also uncovered several barriers on the public sector side which inhibited successful partnerships. These included:

dialog gap - lack of opportunity to interact with defense customers, limited information and dissemination modes to defense industry;

technology gap - lack of in-house technological sophistication as well as standards and protocols;

industry knowledge - little understanding of how the defense industry operates;

cost requirements - solicitation requirements often incompatible with business practices, particularly cost share and no fee provisions.

While the SRI report notes the need to overcome these barriers through enhanced communication channels, it offers no programmatic suggestions for enhancement of public/private partnerships with this segment of the market. Further, an area not addressed by the SRI, but which is similar in its dynamics is the involvement of national labs in ITS. Several labs (such as Sandia and Lawrence Livermore) have become active in ITS (Polk, 1993). Much of the direction for federal lab involvement is evolving from the national defense and technology conversion issue, and how this develops could have influences on California's approach to working with national labs.

While the defense-related partnerships have important effects for those states with such industries, the most common partnership issues confronting states pertain to local operational test and deployment projects. The John A. Volpe National Transportation Systems Center has recently completed a review of institutional issues surrounding seven different operational tests around the country: Crescent, Advance, Advantage 75, Transcom/Transmit, Travtek, and Advantage 75, and Westchester Commuter General. The seven volume report on these cases studies provides a rich source of data on many issues, including challenges to public/private partnerships and strategies to overcome these challenges (U.S. DOT, 1994a, 1994b, 1994c, 1994d, 1994e, 1994f, 1994g).

The Volpe study focused on the kinds of institutional and legal impediments that were being encountered in the formation of these tests. Their findings suggest that four kinds of barriers are being encountered: (1) organizational and management barriers -- which entail a host of management and communication challenges between the public and private sectors; (2) regulatory and legal challenges -- which include administrative burdens of multiple partner agreements, including legal issues such an intellectual property rights; (3) human and facilities resource issues -- which highlight the need for local project management leadership as well as sufficient resources; and (4) financial and market uncertainty issues -- which include concerns about cost-sharing, subsequent costs, and undetermined willingness to pay.

Based on these findings, the report offers 11 lessons for future ITS/ATS undertakings, most of which relate to public/private sector partnership challenges. For example, the authors contend that public/private partnerships require wide-ranging leadership as well as substantial lines of communication, information exchange, and perhaps most important of all, flexibility. The report did not uncover any "show-stoppers" but rather provided multiple examples of inefficiencies that impede projects, and strategies to develop more effective mechanisms. For example, the study noted the differences between the private sector problems experienced in Travtek versus ADVANCE. The private sector partners in the TravTek project did not face the degree of internal communications problems faced by the private sector partner in ADVANCE. This was because federal requirements to ensure appropriate cost sharing among partners were less explicit for TravTek than for ADVANCE. According to the report, the approach used in TrevTek had many desirable traits in that it appears that significantly fewer resources were spent on the overhead necessary for audits and accounting of each partner's share.

Finally, the report offers a series of recommendations, one of which is to develop information packets to assist those entering into partnership arrangements in ITS. The Department of Transportation is following up on this recommendation by developing a workshop package for localities covering the "nuts and bolts" of partnership opportunities, challenges, and strategies (Pearson, 1994). These activities can provide useful information to the California program as it seeks to promote partnership arrangements around the state.

In addition to the federal assessment of institutional issues and challenges, several states have institutional research programs (typically with associated universities--see Appendix B). In Michigan, the ITS/ATS program has been analyzing various institutional programs for several years (see Chen, et. al, 1990) One distinguishing feature of the Michigan program is their inclusion of legal issues. A recent review conducted by University of Michigan professor Kent Syverud provides a comprehensive assessment of various legal barriers (Syverud, 1993) This review highlights how most of the potential legal hurdles--such liability and intellectual property rights--are quite manageable, but that involved actors--such as the state of California-- have to be active in structuring appropriate

arrangements. In fact, he uses several examples from California in his review and of innovative mechanisms for managing risks such as liability.

In an effort to encourage greater local experimentation with public/private partnerships, FHWA is sponsoring a series of workshops around the country. These workshops highlight new and emerging partnership arrangements, such as the SmarTraveler system in Boston, Massachusetts and the various ITS partnerships in Minnesota. Participants in the workshop are encouraged to consider how these and related examples could be applied to the deployment of ITS in their own region. (The workshops have been or will be conducted in at least for metropolitan areas, including San Antonio, Texas; Chicago, Illinois, Fort Lauderdale, Florida, and Los Angeles, California.)

Related Regional Management Experiences

In the area of regional coordination, the advent of ISTEA has raised the awareness of inter-jurisdictional issues across the country. The US Department of Transportation has released a study entitled "Institutional Impediments to Metropolitan Traffic Management Coordination," which focuses on regional deployments of ATMS systems (Booz, Allen & Hamilton, 1993). The study includes a comprehensive review of the institutional literature, as well as case studies of six metropolitan areas (Atlanta, Austin, Baltimore, Detroit, Los Angeles, and Rochester). Because of its breadth, the study provides a useful overview of regional concerns for ATMS deployment, and highlights three key barriers: awareness of ITS, need for organizational cooperation, and concern over availability of funding. The study also concluded--among other things--that MPOs were generally not equipped to pursue their inherited role as gatekeepers for ITS/ATS deployment. As such, the report suggests the need to examine the California MPO's capacity and information needs in order to make informed decisions about ITS.[3]

The report--which was conducted in preparation of DOT's non-technical report to Congress--highlights the difference between regional governance versus regional government. It cites several interviewees throughout the states as saying that a "superagency" for ATMS is rather unrealistic, but coordinating task forces on management are very realistic. Atlanta is cited as an example of the later, with a task force having been formed by the local MPO (Atlanta Regional Council).

Beyond the Volpe Center cases, referred to earlier, a number of other regions are moving toward regional governance of ITS/ATS deployment. For example, the Boston area is working on a regional system architecture that will recognize existing agency prerogatives, while providing a format for data and information exchange (Nwedpfff & Pepin, 1994). In

[3] An analysis of MPO ITS information needs could also assist in developing modeling systems for these decisions, such as the PLANiTS system being developed at UC Berkeley (see Kanafani and Khattak, 1994.)

addition, the Federal Highway Administration is supporting "early deployment studies" throughout the country (47 funded to date); these will provide opportunities for communities to initiate ITS/ATS planning efforts, and it is hoped, will consider the institutional connection with the metropolitan planning process (Lam 1993). (As noted in Section 2, several of these are being conducted in California as well). While these studies are not principally aimed at addressing institutional issues, they often become a key part of the plan. As Sucher (1994) noted regarding the New Jersey study, "The institutional side of the ITS planning process presented even more obstacles than the technical issues to overcome in developing the ITS deployment program."

At the "congested corridor" level the I-95 Northeast Corridor Coalition (transportation agencies from Virginia to Maine) provides an example of steps taken to ensure institutional coordination--particularly between the public and private sectors. Given that their activities are ahead of the Southern California Corridor, the I-95 Corridor Coalition can serve as a model for the types of institutional and policy activities that may be considered as the Southern California Corridor develops. The I-95 Corridor Coalition recently released 10 requests for proposals (RFPs) for studies identified in its business plan, three of which fall in the institutional area: public/private sector outreach, user needs and marketability, and intermodal outreach and information exchange. The scope of these general investigations covers issues that have been identified in this review, and therefore represent the types of studies that could insure the incorporation of "non-technical issues" in the Southern California Corridor development. A recent workshop on public/private issues was hosted by the I-95 Consortium: the proceedings will highlight public/private issues that confront corridors (Lockwood, 1994).

There are important lessons outside of the corridor venue as well. In particular, there are instances where localities are dealing with staffing and expertise limitations by turning increasing levels of operations over to the private sector. A recent study by the Urban Institute investigated the magnitude of these potential staffing challenges (Urban Institute, 1993). The study found that, while in the long term the existing educational and market infrastructure will produce an adequate supply of ITS professionals, near-term budgetary constraints may limit to ability of agencies to adequately manage their ITS programs. Consistent with these findings, many communities are confronting acquisition and management limitations to ITS. For example, Tarnoff and Batz (1994), report on how Transcom's TRANSMIT project overcame potentially insurmountable obstacles to the timely procurement on an ETTM based surveillance system. Faced with competing procurement specifications and an estimated six-month-plus procurement process, the project sponsors (including NJ DOT and NYS DOT) opted to assign procurement management to the system consultant, while retaining overall oversight responsibilities. Tarnoff and Batz conclude that:

> While the assignment of construction and inspection responsibilities to the design consultant may not be applicable to all circumstances, it proved to be an extremely successful approach for the TRANSMIT project. With the use of this approach, the system implementation time was reduced by at least three months

(and possibly more) because it reduced the PSE review and contract letting requirement of the overtaxed public sector contracting staffs. It also permitted rapid resolution of problems relating to differences of administrative and technical procedures that exist among the participating agencies."

The prospect of multimodal systems brings unique challenges to the institutional capacity of regions. A recent study by Hanson and Qureshi (1993) demonstrates the complications that can arise when transit agencies attempt to adopt innovative technologies. Their study examined the adoption experiences of transit agencies in seven regions, three in California and four from other parts of the country (Baltimore, MD; Tidewater, VA; Kansas City, MO; Contra Costa County, CA; Bakersfield, CA; and Orange County, CA). The case studies uncovered a number of complexities associated with transit procurement of systems (such as automated vehicle location systems [AVL]). For example, while some agencies initially viewed new systems as providing cost savings through labor reduction, in fact there were additional or equal staffing requirements to run the new system. The authors report that experiences such as these can lead transit operators to be very concerned about unexpected cost escalation due to new technologies.

Finally, the national systems architecture project represents a major attempt to analyze the overall deployment challenges to ITS and how these can be mitigated through either architectural design and/or an "evolutionary deployment strategy". The first phase of this analysis entailed four teams, each being tasked with developing a proposed architecture and deployment strategy. As part of this analysis, each team assessed the potential influence of 11 non-technical factors on system deployment: first-user benefits, cost-benefit allocations, environment-energy implications, inter-jurisdictional implications, liability, antitrust, patents, privacy, and standards. Appendix E contains such an analysis by the Rockwell team on which both the author (Horan) and Caltrans/PATH participate (see Rockwell, 1994). This analysis, which will be integrated with the Loral approach in Phase II, highlights those institutional elements that can be greatly mitigated through appropriate architecture design (e.g. antitrust) versus those that inherently have strong deployment implications. Regarding the latter, an emerging consensus is that an open-distributed architecture increases the need to develop mechanisms (e.g. interface standards and/or agreements) to allow for seamless operation across various independent systems.

Related Stakeholder Experiences

It is interesting if not ironic to note that the non-technical report to Congress does not include an analysis of stakeholder acceptance, whereas institutional (including Congressional) and user acceptance is widely viewed as being crucial to the success of the program. At the national level, ITS AMERICA has actively pursued outreach on a number of levels. For example, they have established a systems architecture consensus task force which includes representatives from a variety of interest groups (ITS AMERICA, 1994). They have also engaged in an outreach program consisting of both products (e.g. videos), and processes (speakers bureaus, regional forums).

While these national efforts represent an important attempt to promote ITS/ATS to various segments, there has not been a systematic attempt to understand what the stakeholders and various public factions expect from ITS. For this reason, the Department of Transportation is initiating a series of efforts aimed at a set of user/public acceptance issues (Elliot, 1993). As is noted below, these studies represent timely opportunities for the state of California to develop its own stakeholder assessment while cooperating with the national program

One area where the California has already engaged in national-level collaboration (and as such could represent a model for future collaboration) is in dealing with a visibly important stakeholder constituency: the environmental community. Specifically, Caltrans/PATH have co-sponsored three conferences on the environmental issue. The first conference, held in Monterey, California, served as the first official forum where the environmental aspects of ITS were debated by a range of experts and representatives. This discussion highlighted significant technical and non-technical gaps that needed to be addressed, ranging from differences on the ITS vision to significant uncertainties with regard to ITS forecasting models (See Gifford, Hot-an, and Sperling, 1993). Subsequently, two additional workshops have been undertaken to address these gaps. The National ITS and Air Quality workshop was held in Diamond Bar, CA and focused on the technical issues in measuring the air quality impact of ITS (see Horan, 1993). The workshop resulted in a research agenda for improving analytical tools and is currently being implemented by the Department of Transportation. The third workshop, scheduled for early June, 1994, will focus on major policy issues surrounding environmental implications of ITS/ATS. This conference represents the culmination of this series, and has set the groundwork for analysis specifically focused on the California program.

While institutional acceptance (such as by public agencies and interest groups) is needed to maintain political support for ITS, the ultimate success depends on support by users, both in terms of the general public and customers for commercial products. One important source of information on user acceptance will be the various operational tests that are underway around the country. Much of this information pertains to the value of traffic information provided via ATIS systems. For example, a preliminary assessment conducted of the SmarTraveler system in Massachusetts found that approximately 30% of the callers surveyed reported altering travel behavior as a direct result of the audio information they received by calling the SmarTraveler information line (Juster et al., 1994). The analysis found that demand for and use of information was particularly acute during periods of inclement weather as well as during the holidays. However, only a very small percent (under 1%) noted that such information was used to change modes; the most typical change was in time of travel.

While the SmarTraveler system evaluation suggests that commuters will take advantage of high quality traffic information, both the SmarTraveler findings and other assessments suggest that this does not equate to willingness to pay. For example, NYNEX (a SmarTraveler participant) has reported that charging for the SmarTraveler call would result in a 35% drop in usage. Similarly the Travtek study in Florida has found that while

97% of renters found the technology useful, only 51% saw it as applicable for daily commute driving, and cost was a major impediment for potential commuter users (Willis, 1994).

The conflicting dynamic between the apparent attractiveness of the information and reluctance to pay for it places the ITS program in a difficult position, for it represents the "murky middle" between a publicly sponsored and a privately sponsored enterprise. Several national efforts have begun to disentangle this "murky middle" of public and consumer demand; and California could both benefit from the information being developed (such as the aforementioned DOT initiative), and participate in further data collection.

While most analyses have rightly focused on the end user, ITS user services actually affect a variety of customers (Ome, 1993). And in this sense, customer satisfaction is a concept that can cover institutional as well as end-user customers. This concept has particular application to system-based applications, such as the Travinfo project in the San Francisco Bay area. These system projects have a host of customers, ranging from public sector users (for traffic management) to private sector users (both at the wholesale and retail level.) As noted earlier, the congested corridor experiences of other states (particularly the I-95 corridor) also have implications for these market assessments in California. The business plan for the I-95 corridor calls for a major market assessment to be conducted in the corridor. The purpose of this project, which is fairly major in scope is to define who the customers are for the corridor and what services would best fit with end-user needs. As noted by Hal Kassoff, Chairman of the I-95 Corridor Coalition, this is consistent with the mission of the coalition: "The vision is customer driven, it is focused on communication with customers"(Kassoff and Kuciemba, 1994).

Lessons Summary

In sum, there are many ongoing activities that can provide lessons and insights for the California ITS/ATS program Nonetheless, a proactive effort will be needed to ascertain what steps should be taken in the state to advance research collaboration, to ensure successful regional management, and to enhance stakeholder acceptance. In some cases, collaboration with other parties--such as the federal government--can reduce the burden of conducting the necessary research, and improve its diffusion to other areas experiencing similar constraints. In other cases, the research will need to focus on impediments unique to the state. And on some issues, lessons learned from other experiences can reduce the time and cost to develop an effective solution in California. In the next section we consider some of the approaches that could be taken in conducting non-technical studies, and then, in the final section, specific research and program actions will be suggested for the California program.

4. APPLICATIONS OF POLICY RESEARCH METHODOLOGY

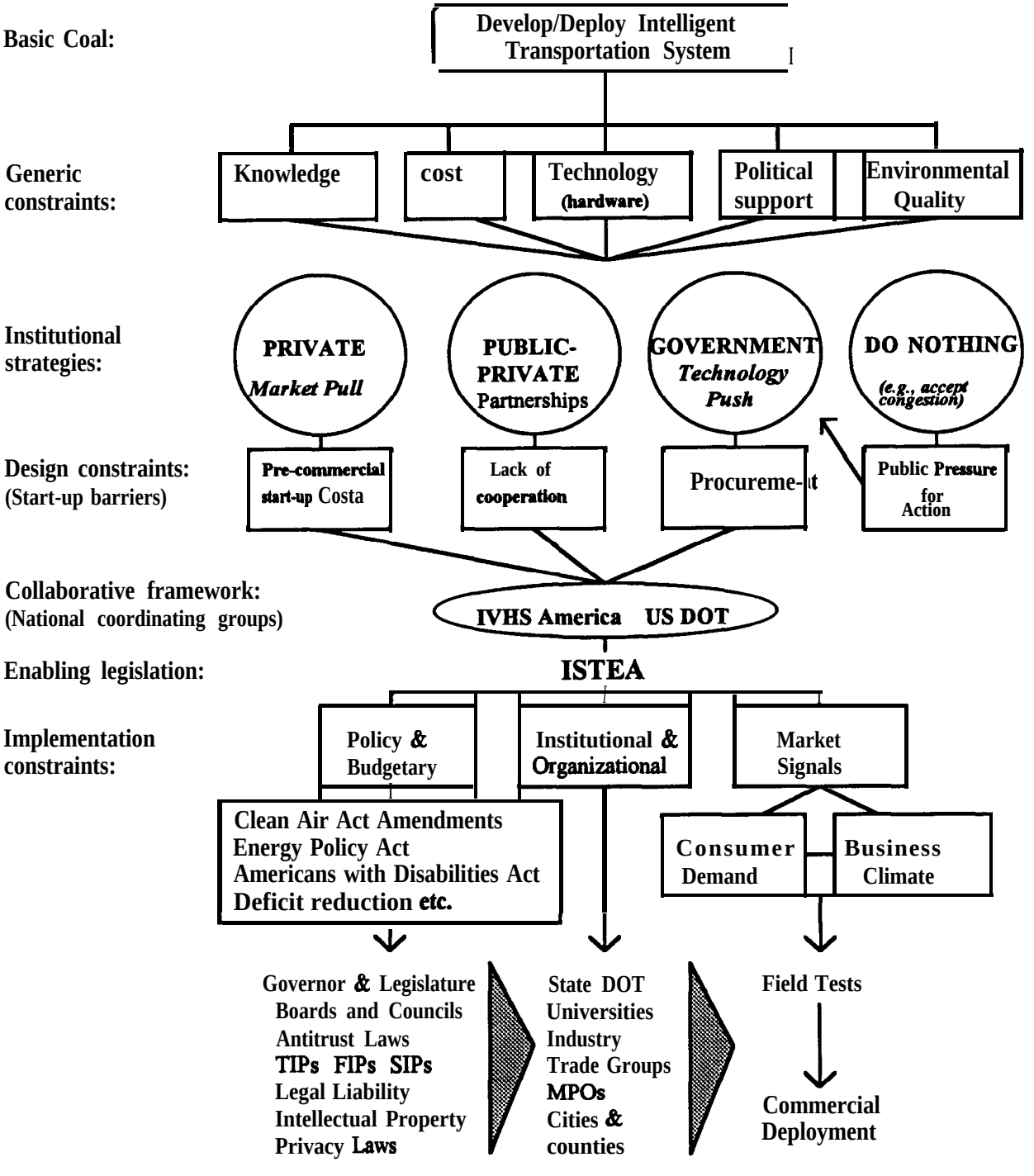
It is one matter to highlight the need to understand institutional and policy issues in California, it is another matter to design appropriate studies to produce this information. While the role of the engineering, computer and related systems sciences to ITS/ATS development is generally recognized and utilized, the corresponding role of the applied policy sciences to ITS/ATS is still emerging. The series of studies commissioned for the non-technical report to Congress provide a vignette of the analysis styles inherent to applied policy research. These analytic styles include: a qualitative synthesis -- as was conducted on the impacts of ITS/ATS on the environment; case study analysis -- as was conducted in the review of metropolitan institutional impacts; and economic analysis -- as was conducted in the study on educational and staffing issues in ITS. These examples illustrate the types of ITS non-technical questions that can fruitfully be addressed through applied policy research. This section provides an overview of a fuller range of methodological approaches that can be taken to study issues of research collaboration, regional management, and stakeholder acceptance.

Constraints Overview

One way to appreciate the non-technical barriers that stand in the way of rapid deployment of ITS is to trace systematically the constraints that arise at each stage of implementation -- from conceptual design to full-scale operationalization. An abbreviated constraints map of this sort is presented in Figure 4.1. Assuming that ITS deployment is the goal it treats all other variables as either bridges or barriers to that goal. Unlike a critical path diagram or a technology-centered risk assessment, the constraints map attempts to show how limitations in knowledge, finance, hardware, political support, and ecological carrying capacity can influence the strategies of public and private actors and institutions interested in ITS. It also displays how these strategies are linked to key enabling policies (i.e., ISTEA), which must later be reconciled with cross-cutting policies (e.g., Clean Air Act Amendments, Energy Policy Act, Americans with Disabilities Act), and made compatible with co-evolving organizational structures and market forces. As suggested by Dunn (1994), constructing such a constraints map can highlight the range of non-technical issues influencing ITS/ATS deployment; and hence could form the basis of non-technical analyses.

Figure 4.1

CONSTRAINTS MAP OF A.T.S. IMPLEMENTATION



Hempel, 1994

Studying Research Partnerships

At the broadest level, the assessment of ITS/ATS must consider the current changes in technology policy occurring throughout the United States. The national technology policy debate is having a profound effect on both public and private investment patterns, antitrust enforcement, intellectual property, public-private collaboration, and even international cooperation (Branscomb, 1993). What has been described as the new realities of "hypercompetition" (D'Aveni, 1994) is resulting in a wide-ranging reconceptualization of the old technology-push and market-pull strategies of the past. California is centrally involved in this debate, as demonstrated by the range of initiatives and analysis of technological interventions (For example, see Project California, 1993). Analytical tools that have been used in this debate include macro-level economic analysis, micro-level assessments of technical skill supply and demand, and comparative analysis of competing policy initiatives. Addressing ITS/ATS as a technology policy would invariably involve these tools, as well as the crosscutting considerations of other economic and technological forces in California.

Such social impact studies of advanced transportation technologies draw on a vast domain of policy research and technology assessment literature (see Tomatzky and Fleisher, 1990). The Congressional Office of Technology Assessment has pioneered many of the tools and concepts used in the field, but it has been aided by dozens of academic STS (science, technology, and society) programs that have arisen in the past 15 years, offering a rich set of interdisciplinary approaches and resources for this purpose. Some of the most intriguing research has been performed by social psychologists, urban planners, and political scientists who have investigated the perceived risks and unintended consequences of large-scale technology deployment (for example, see Hall, 1980; Danzinger, 1985).

Recent partnership experiences in ITS suggest the need to include administrative and legal components to partnerships assessments. While major reviews suggest that there are no major legal hurdles to forming pre-competitive agreements, analysis of their impacts invariably involves an assessment of the legal/administrative hurdles encountered and overcome by participating parties (see Syverud, 1993).

Studying Institutional Capability and Stakeholder Acceptance

The analysis of how institutions can carry out their ITS responsibilities requires a knowledge of public administration, business administration, as well as a knowledge of urban planning for traditional transportation programs and new information technology programs. Similar to the study of research collaboration, it is essentially an interdisciplinary endeavor: it seeks to understand how organizations can equip themselves with the necessary skills, talents, and resources to adopt new technologies and have them perform effectively.

A major tool of institutional analysis is the use of case studies. For example, the aforementioned study on metropolitan institutional issues featured case studies of six regional experiences with ATMS (Booz, Allen, & Hamilton, 1993). A similar study on transit innovations entailed seven case studies of transit properties (Hansen, 1994). As has been noted in case study methods texts (e.g. GAO, 1991), such approaches provide in-depth detail on how organizations are adopting to technological challenges. Nonetheless, additional techniques can be used to obtain information on organizational capacity. Expert interviews can provide insight into the challenges being faced in conducting metropolitan deployment. Also operational field tests can provide an ongoing source of information on institutional experiences. Mitre (1994) has been developing guidelines which could be used in conducting operational test evaluations, although there is a limited ability to standardize in this area.

Economic analysis also contributes to institutional assessments, for a key constraint of many public organizations is their ability to afford the new technologies. These analyses can include traditional cost-benefit analyses as well as full social cost analysis (Stough and Maggio, 1994). For example, Mudge and Griffin (1993) demonstrate the range of direct and indirect effects ITS systems can have. From an institutional point of view, the distribution of these costs (and benefits) across the various agencies can be key to the viability of ITS systems.

A final key institutional area is understanding the agendas, coalition behavior, and relative power -- both visible and latent -- of major stakeholder groups. We have already emphasized the importance of environmental stakeholders in California's ITS/ATS programs. Such analysis can take both quantitative and qualitative dimensions. On the quantitative side, there is a technique known as feasibility assessment technique (FAT) that could be used to measure a particular advanced transportation technology's deployment feasibility in California. Some policy researchers (e.g., Dunn, 1994) use the technique to produce a precise feasibility score, thus allowing for quantitative prediction (probabilistic assessment) of implementation success or failure.

A more qualitative approach is to construct a process by which the various stakeholders are provided an opportunity to input into the decision-making process. At one end of this spectrum is the traditional public hearing that has been used in transportation. However, as ISTEA has encouraged broader participation, more in depth matters are being considered such as the creation of advisory and focus groups (STPP,1994). From a research point of view, focus groups provide particularly useful mechanisms for ascertaining the views from different stakeholders. A number of focus group applications are currently being used in ITS, with promising results (see Horan and Baker, 1994).

Studying Public and Market Acceptance

Institutional impact analysis is ultimately concerned with matters of acceptance. Understanding the nature and significance of barriers to public and institutional acceptance of ITS in California could involve everything from ethnographic and demographic research to studies of public attitudes and expectations, and of how issue framing by television and the print media affects those attitudes and expectations. Such research would be used to facilitate the development of a user-friendly ITS vision for the state, and to assist in the design of institutions and public outreach programs that will advance that vision.

In order to identify and analyze the state's public acceptance issues, one must measure the response of different target populations living in California (e.g., by age, income, gender, driving profile, etc.), examine the interaction of market acceptance, social acceptance, and institutional acceptance across both public and private sectors, and compare findings for the state with national studies of public acceptance that are underway. A major objective would be to identity unique characteristics of California and its people that may affect ITS development and deployment. The ultimate purpose would be to identify and to measure the views and perspectives of current and soon-to-be drivers in such a way that future design and implementation of ITS systems will better reflect the needs and priorities of potential end users of ITS technology in this state.

A traditional tool for measuring public acceptance is survey research and related public opinion polling. These methods provide a relatively cost-effective mechanism for understanding public sentiment on a variety of issues (see Babbie, 1993). In the case of ITS/ATS, the public can be queried about their awareness and acceptance of a range of technologies, and this information can help insure that the services are deployed in a manner consistent with public expectations.

There are, however, limitations in assessing sentiment for complex technologies when the public has little familiarity with the services being considered. As noted by Sperling and colleagues (see Kurani, Turrentine and Sperling, 1994) in their study of EV usage, actual experience can change one's opinion toward the technology. For this reason, a variety of simulators are being developed to aid in providing ITS/ATS style scenarios for drivers and users. Kroutsopoulos, Polydoropoulou, and Ben-Akiva (1994) reviewed seven ATIS simulators located around the world (with two in California). They found that these devices were being used to assess a variety of ATIS behavior and acceptance issues, but that field tests were still needed to ensure the validity of findings.

The success of ITS is predicted on the market acceptance of services and products, and therefore, market research has an important role in helping public and private sector stakeholders understand the market. The Volpe Center has developed a series of white papers that aim to assist in the application of market research techniques to ITS (see ATIS Market Research papers prepared for Volpe Center, 1994). One of these white papers focuses on methods, and notes how focus groups and survey research are key for uncovering perceptions about technology use, including willingness to pay. The paper

also summarizes measurement approaches: measurement of actual usage through travel logs, yoked studies, or other natural use experiences can provide valuable data on how products are actually used.

As shown in Table 4.2, these methods are being employed in a variety of operational field tests. This suggests not only that the methods are considered valuable by operational field test managers, but also that these tests are becoming an increasingly important source of market data. The implications for California are straight-forward: the operational field test evaluations are a valuable opportunity to develop information on market acceptance. In conducting these tests, more traditional traveler behavior research can be done as well to analyze the use of ITS to inform trip decision-making (see Khattak, et al., 1994). One of the most important areas for additional research involves the time-value of money and the money value of time used in traffic congestion studies. Other research areas of vital interest involve the determination of consumer preference hierarchies and identification of the attributes that influence preference formation (e.g., age, gender, income, travel time sensitivity, etc.)

Table 4.2 - Evaiuation Techniques

	Smart Traveler	DIRECT	Advance	FAST-TRAC	Pathfinder	TravTel	H.S.C.	Genesis	SMART Corridor
Camera Car		✓		✓		✓			
Focus Groups			✓	✓					
Natural Use Studies	✓	✓	✓	✓	✓	✓	✓	✓	
Network Surveillance	✓			✓		✓		✓	✓
Network Modeling		✓		✓		✓			
Surveys: Telephone mail out	✓		✓	✓	✓	✓	✓		✓
Test Market	✓								✓
Yoked Studies		✓		✓	✓	✓			

From Whitworth, 1994

The Relevant Research Community

The expertise needed to perform technically strong and credible institutional analyses can be found at universities and private sector companies throughout California, as well as at collaborating universities throughout the country. Indeed, the diffuse nature of disciplines needed for assessing non-technical challenges in many ways mirrors the disciplinary challenges already being addressed on the technical issues in ITS. For example, in California, PATH program has sought to link various departments from throughout the UC system and other interested universities. A similar network will ultimately be required to develop the range of expertise needed to conduct in-depth assessments of non-technical issues. Such a network could include the following intellectual assets:

- Technology/partnerships -- California Consortium for Transportation Research and Development (consortia), Cal State LA (partnerships), Santa Clara University (legal), Claremont/GMU (technology policy), San Jose State (policy)

- Regional/Institutions -- UCLA (planning), UC Berkeley (planning), USC (planning economics); Claremont/GMU (organizational/management)

- Stakeholder/Market -- UC Davis (environmental); UC Irvine (traveler behavior), UC Berkeley (traveler behavior), Claremont/GMU (stakeholder/public acceptance).

This listing is far from exhaustive, and admittedly focuses on the resources familiar to the authors. Other universities, national laboratories, and the private sector also have capabilities in these areas. For example, JPL and Lawrence Livermore have emerging programs, as do a variety of California-based aerospace and transportation consulting firms. These all represents potential contributors to the development of effective strategies for overcoming non-technical constraints.

Methods Summary

A variety of disciplinary skills are needed to address the institutional and policy challenges noted in this report. These include (in alphabetical order) business administration, economics, jurisprudence, political science, psychology, public administration, sociology, and urban planning. These disciplines provide the conceptual and methodological tools that can aid in producing valid and reliable information on "non-technical" constraints and opportunities. At the conceptual end of the spectrum policy mapping--such as through constraints maps--can assist in understanding the range of actors and factors involved in achieving the policy goal of deployed ITS/ATS systems. At the methodology end, legal and social science techniques can be used to assess mechanisms for ensuring public/private, regional, and stakeholder acceptance. A key need and opportunity for the California program will be to develop mechanisms for engaging with and integrating these diverse approaches and resources in useful ways for addressing and resolving institutional and policy issues in ITS.

5. CONCLUSIONS AND RECOMMENDATIONS

As the 21st century approaches, transportation policy-makers and planners are confronted with the enormous task of devising new transportation systems to meet the changing needs of metropolitan areas. ITS/ATS technologies and services represent innovative yet challenging approaches toward improving system performance. And while the technical challenges are daunting, the non-technical constraints are clearly imposing as well. Given California's ambitious program the state will need to bring its resources and expertise to bear on resolving these constraints, so that the potential performance gains of ITS/ATS can be realized.

The goal of our review is to assist in this effort by identifying a range of non-technical issues which merit further consideration, and to do so in a manner that could assist the state ITS/ATS program in prioritizing research needs. While our primary method for performing this analysis was to synthesize the results of research reports and interviews, we recognized the importance of soliciting input from Caltrans/PATH sponsors on our findings and implications. Consequently, we held several briefings, and based on discussions and feedback from these meetings, possible research implications were considered with regard to three decision criteria: program relevance; research relevance, and cost-share potential.

The program relevance criteria refers to the extent to which the non-technical issue has applicability to the issues currently being confronted by the state ITS/ATS program The research relevance refers to the extent to which social science and related research methodologies can fruitfully be brought to bear on the issues. Ideally, those issues that combine high program relevance and high research relevance would be most suited for initial action; those with high research relevance but lower program relevance could be considered more discretionary, unless significant cost-sharing potential makes them attractive. Those with high program relevance and low research relevance could be subject to program action, though not necessarily reliant on research.

Research Implications

Table 5.1 presents a ranking of the institutional research issues based on these criteria. As noted in the table, each of the three core areas contains issues which are relevant to program concerns, can be addressed through research, and/or have cost-share potential. In total, we highlight eleven research subjects that warrant attention based on our study findings. Recognizing budget constraints, we further identify three issues (one from each core area) that appears to be of pressing importance. We further identify six ongoing issues and two other issues that could be addressed as funding permits, and/or through research partnerships. While obviously subjective, the table nonetheless presents relative priorities distilled through our analysis and through work sessions with program sponsors.

TABLE 5.1 RESEARCH IMPLICATIONS

POTENTIAL INSTITUTIONAL ISSUE	Program Relevance	Research Relevance	Cost Share Potential	RATING
Stakeholder Assessment				
Development of structured forum to solicit and consider CA environmental interests and concerns about IVHS/ATS.	HIGH	HIGH	LOW	◆◆◆
Analysis of key public and market acceptance factors affecting the success of IVHS/ATS program in the state.	MED	HIGH	HIGH	◆◆
Analysis of demographic influences on IVHS/ATS programs in metropolitan areas.	MEDLOW	HIGH	MEDLOW	◆
Regional Management				
Incorporation and synthesis of innovative institutional and market mechanisms in corridor and field operational tests.	MEDHIGH	HIGH	MED	◆◆◆
Understanding of regional/MPO staffing and information requirements for multi-modal IVHS decision-making	HIGH	MED	LOW	◆◆
Use of IVHS strategies within the context of community social and transportation goals, including use of information highway	MEDLOW	HIGH	LOW	◆
Research Collaboration				
Identification of private sector interests and concerns	MEDHIGH	HIGH	MED	◆◆◆
Development of innovative models for effective public/private partnerships.	EIIGH	MED	MEDHIGH	◆◆
Assessing administrative constraints to effective partnerships.	HIGH	MEDLOW	MED	◆◆
Crosscutting/Other				
Analysis of procurement and operations challenges to the sustainability of IVHS deployments.	HIGH	MEDLOW	MED	◆◆
Analysis of crosscutting policy implications of IVHS development within California.	MED	HIGH	MED	◆◆

Scale: ◆◆◆ Pressing ◆◆ Ongoing ◆ As funding permits

In the area of stakeholder acceptance, environmental groups and general user acceptance are two areas warranting immediate attention[4]. A focus on the former is warranted as it has been clearly identified as a key potential constraint, the timing is viewed as pressing from a programmatic viewpoint, and research skills (such as focus groups) can be applied to conduct a structured inquiry. Complementing this approach is a need to focus on general user acceptance. While not as pressing, it is nonetheless key to the success of the program is highly salient to the California program can employ market research techniques, and has significant cost-sharing possibilities with federal and private sector partners.

A less pressing research project--but one that could provide interesting insight--is to assess the influence of demographic changes on the market for ITS/ATS. Major metropolitan areas will be going through significant changes due to immigration (and related population changes), and this information could help understand the multi-cultural context into which ITS must be deployed.

The issue of regional management represents an area where we believe research could complement major efforts occurring around the state. This is particularly true for the Southern California Corridor and related operational field tests. The Southern California Corridor will represent a major showcasing of ITS/ATS in the state; moreover--as demonstrated by the I-95 corridor-- it represents an important opportunity to implement new institutional arrangements. Other field tests, such as the Travinfo project, also represent important research projects from an institutional as well as technical point of view. Therefore, crosscutting analyses of these experiences can bring forth important lessons for institutional arrangements throughout the state, and could be done in a cost-effective manner by integrating them into ongoing corridor/field test assessments. As these assessments are currently being planned, initiation of a crosscutting institutional effort is pressing from a timing perspective.

While not as pressing, the prospective involvement by metropolitan planning organizations in ITS programming decisions raises an emerging concern about their decision-making capacity. As the Volpe studies have demonstrated, some MPOs have expressed concern about lack of information and staffing capability to make informed decisions on ITS/ATS. Even though California has some of the most highly regarded MPOs in the country, there is still concern about their role in ITS. Consequently, analysis of MPO activities, interests and concerns, could help ensure their needs are considered in the statewide institutional program Two related areas for exploration would be the intermodal and financial challenges being confronted by MPOs and their views on the appropriate implementation paths for ITS/ATS to achieve multi-modal and financially self-sustaining goals.

[4] Appendix G contains a scope of work for assessing these stakeholder and user issues; such an investigation will comprise the follow-on phase to this study.

A related but not pressing regional management issue has to do with how ITS fits within an overall regional vision, not only regarding transportation, but also other community and social goals. Given the ongoing budget constraints of metropolitan regions, there is a need to understand how policies can be mutually reinforcing. In the case of ITS/ATS, it provides an opportunity to consider how these advanced technologies can be integrated with other developments, such as the information highway, to deliver a range of transportation and non-transportation benefits.

The area of research collaboration has obvious and major implications for the success of the ITS/ATS program in California: the commercialization of these technologies is a principal thrust behind the private sector interest in the program. This need is inherent in the CCST proposal to establish a Center for Transportation Innovation, which would be charged with conducting broad-based technology assessments, including several of the areas identified in our review. For this reason, it could be premature to initiate a separate research program on commercialization issues. One possible exception relates to the stakeholder issue: research could be conducted on private sector views toward partnerships in the state. Our interviews revealed a widespread sentiment that greater attention should be paid to private sector viewpoints on partnerships. Early conduct of such a study could help clarify the nature and extent of these viewpoints, and identify programmatic steps that could be taken to attend to them. An emerging and related issue would be to incorporate these viewpoints and related lessons from around the country into specific models for cooperation between the public and private sector.

Finally, we note two crosscutting issues that are emerging as important issues in the state and therefore could warrant research attention. The first pertains to the entire administrative and public funding apparatus that surrounds ITS/ATS. Every public program invariably has to contend with the obstacles created by procedures intended to safeguard public funds, and ITS/ATS is no exception. Indeed, given the private sector component to ITS, there are expectations for the state program to move expeditiously to be a nationwide leader. An exploration of administrative and funding innovations that could serve this mission would demonstrate an active stance toward removing unnecessary administrative burdens.

The second area pertains to the larger policy context that surrounds ITS/ATS. There are myriad policy goals for which these technologies are being offered, yet there has not been an explicit delineation of how various policies reinforce or conflict with one another. For example, the relationship between the research collaboration initiatives in ITS/ATS and the defense conversion initiatives in the state have yet to be fully explored and/or realized. Crosscutting policy analysis can help transportation policy makers understand the interconnections between ITS/ATS and other economic, social and environmental issues and policy.

Summary Recommendations

Our findings and research suggestions have both immediate and long term implications for the California ITS/ATS program. At the most basic level, they can be seen as providing unambiguous support for the concept of a broad-based and robust institutional issues program at the state level. Each of the issues identified above requires some level of attention and the Caltrans/PATH program is a logical node (if not nexus) for orchestrating such inquiries in a manner which balances the criteria of program relevance, research relevance and program applicability. However, there are a host of other stakeholders (such as the private sector and the federal government) which would also have an interest in the issues addressed and the answers uncovered, and therefore a broad view of partnerships toward institutional issues should also be taken. The following summary recommendations embody these concepts.

Recommendation #I: The Caltrans/PATH Program should devise an institutional issues program that addresses key stakeholder acceptance, regional management, and research collaboration issues and concerns.

Our findings suggest that the state ITS/ATS program should pursue a diversified range of topics, as the issues that confront the state are quite dynamic. In our review, we identified a host of activities in each of the three areas which would warrant attention, given circumstances and funding. Moreover, there are areas that our review did not cover (e.g. legal and anti-trust issues) where the state program has a legitimate interest in advancing the items and hence should.

Within the broad range of possible research items falls the subset that deserve high priority attention. As is demonstrated in the above implications, the determination will be subject to a number of empirical, subjective, and budgetary factors. Based on our use of three such criteria (program relevance, research relevance, and cost-sharing potential) we developed a prioritized list for possible research. The Caltrans/PATH program could draw from these in deciding the portfolio of projects to be supported over the next several years based on their own program and budgetary considerations. The more general point of this recommendation is that the program should deliberately aim to have a more broad-based institutional portfolio in its strategic and program planning agenda.

Recommendation #2: The Caltrans/PATH program should establish new partnerships in its efforts to resolve institutional constraints.

The Caltrans/PATH research program has developed around the core technical challenges associated with developing and deploying ITS/ATS systems. Addressing institutional issues implies--almost by definition--that alternative arrangements may be needed. At a minimum, the expertise for addressing non-technical challenges falls more in the social science and related urban planning domains, and new bridges need to be built to these disciplines. In addition, the private sector perspective is a major consideration in ITS and

mechanisms for including this perspective can provide important reality testing to the research program

A related issue is the implications of institutional findings on sponsoring agencies, such as Caltrans and PATH. Given their premier role in guiding the ITS/ATS program in the state, findings from institutional studies can have implications for the ways in which these organizations manage ITS/ATS research and program activities. However, innovations in traditional roles for research conduct, reporting, and utilization might be needed to ensure that the state ITS/ATS program can benefit from institutional assessment information ("the good, the bad, and the ugly") to improve its own organizational practices.

While there are many issues and implications imbedded in these observations, one simple and concrete area for advancement would be to complete the implementation of an institutional issues task force (or PATH focus group) along the principals identified in this study. That is, it should consider a broad range of issues, it should seek new partners in a collaborative manner, it should encourage suggestions on developing institutional innovations in ITS/ATS. The activities of this task force could be considered within the context of a state ITS Alliance as well.

Recommendation #3. The Caltrans/PATH program should seek diversified financial support for institutional issues research, building on related studies as well as supporting stand-alone studies in needed areas.

Many of the institutional issues we have identified are part of the circumstances surrounding particular implementations, and as such could be assessed (and financially supported) within the context of these implementations. For example, the Travinfo project is a useful setting to study public-private sector partnerships, and the Southern California Corridor project represents an important venue for assessing many of the regional management issues. By "piggybacking" institutional assessment on to these and related activities, it not only ensures closer integration with actual testing and deployment projects, it allows for spreading of the costs for the institutional issues program across the various funding sources. This permits the limited funds devoted for institutional issues to be focused on key gaps and related crosscutting analysis. Such a diversified approach can ensure the development of a robust institutional program even within the severe budgetary constraints that confront the state of California.

Recommendation #4. The Caltrans/PATH program should conduct similar strategic exercises for items not considered in this review.

As noted in the introduction to this report, the study scope was by necessity limited to the metropolitan deployment of ITS/ATS. While we are confident that the three core areas--and the issues contained therein--are justifiable and defensible, this is not to suggest that the entire spectrum of institutional issues has been covered. There are issues unique to rural applications, to commercial vehicle applications, and to the legal implications of the

program As time and resources permit, strategic analyses similar to those described in this study should be considered for these areas as well.

Concluding Comments

Investigations of the technical requisites of ITS/ATS deployment have tended to far outpace investigations of its policy and institutional implications. While engineering considerations have understandably attracted most of the attention and funding, there appears to be a growing recognition within the ITS community that so-called "non-technical" issues may ultimately play just as influential a role in ITS adoption and deployment as straightforward matters of technical performance, systems integration, and cost. Public acceptance and ITS conformity with policies originating outside the transportation sector have already surfaced as pivotal issues in development and implementation. Future advances of pre-commercial ITS technology will depend heavily on the political will budgetary resources, administrative capacities, and issue-attention cycles of public officials and government agencies. Understanding and managing these non-technical issues will be much easier with the help of concepts and tools developed by policy researchers and other social scientists.

We hope that this review is viewed as the first step toward establishing an ongoing dialogue and forum for: (1) identifying key institutional areas, (2) obtaining needed information through a range of research activities, (3) engaging a broad spectrum of the research community, and (4) developing information useful to the various stakeholders engaged in the California ITS/ATS effort. Our own follow-on efforts will strive to achieve this objective both through targeted analysis of a selected subset of the implications noted above, and through more general support for integrating associated ITS/ATS institutional efforts occurring throughout the state as well as--where appropriate--throughout the country.

Ultimately, the non-technical issues identified in this report should become an integral aspect of an overall assessment approach to ITS. Several major ITS/ATS system studies such as the national system architecture program are finding that the technical and non-technical elements are inextricably linked in ITS: an understanding of one is not valuable without an understanding of the other. The major challenge of the California research program is develop information that can help translate this generality into a practical program of activities and policies. Our report aims to be a useful first step in this direction.

6. REFERENCES (CITED IN TEXT)

Babbie, E. 1993. *The Practice of Social Research.* Belmont, CA: Wadsworth Publishing Company, sixth ed..

Batz, T. and Tarnoff, P. 1994. Institutional Issues in Transcom/Transmit Project. Presented at the IVHS AMERICA Annual Meeting, Atlanta, GA, April 17-20.

Ben-Akiva, M., A. Polydoropoulou, H. Koutsopoulos and P. Whitworth. *Public Acceptance and User Response to ATIS Products and Services: Modeling Framework and Data Requirements.* Prepared for the John A. Volpe National Transportation Systems Center, Cambridge, MA.

Booz, Allen and Hamilton, 1993. *Institutional Impediments to Metro Traffic Management Coordination:* Task 5 - Final Report, Volpe National Transportation Systems Center.

Branscomb, L., ed. 1993. *Empowering Technology: Implementing a U.S. Strategy.* Cambridge: MIT Press.

Burwell, D. 1993. Is Anyone Listening to the Customer? *IVHS Review,* Washington, D.C., Summer.

CCST (California Council on Science and Technology). 1994. A Center for Transportation Innovation. Draft Report prepared for California Department of Transportation.

Caltrans (California Department of Transportation). 1993. Strategies for the Caltrans New Technology Development Program Sacramento, CA: Caltrans (March 10 draft).

Chen, K., R. Ervin, R. Marans, J. Nystuen, F. Stafford, K. Syverud, S. Underwood. 1990. Socioeconomic Aspects of Intelligent Vehicle-Highway Systems. IVHS Technical Report-90-12

D'Aveni. R. *1994. Hypercompetition: Managing the Dynamics of Strategic Maneuvering.* New York: The Free Press, forthcoming.

Dahms, L. 1993a. Executive Director, Metropolitan Transportation Commission. Personal interview, October 7, 1993.

Dahms, L. 1993b. IVHS and Metropolitan Transportation Systems, *in Will IVHS Transform Transportation System Effectiveness?* Washington, D.C. : IVHS AMERICA.

Danzinger, J. 1985. Social Science and the Social Impacts of Computer Technology. *Social Science Quarterly,* 66: 1, March, pp. 3-21.

Deakin, E., 1989. *Opportunities and Constraints for Advanced Highway Technologies, A Speculative Analysis.* Berkeley, CA: California PATH Program Research Report UCB-ITS-PRR-89-7.

Department of Transportation. 1994. *Intelligent Vehicle Highway Systems Institutional and Legal Issues Program.* Federal Highway Administration, Washington, DC.

Dittmar, H. 1993. Command Performance: Turning Transportation Around to Serve Communities. *Surface Transportation Policy Project Bulletin,* Volume II, Number 3.

Dunn, W. 1994. *Public Policy Analysis: An Introduction.* Englewood Cliffs, NJ: Prentice Hall, 2nd ed.

Elliot, C. 1993. Federal Highway Administration. Personal interview, October 27.

Feamsides, John, 1993. Institutional Considerations in the Evolutionary Development of IVHS. ASCE, paper in printing.

Flanigan, J. 1993. Diversity of Business in Region May Spell Renewal. *Los Angeles Times,* December 6, Al.

GAO. 1991. *Case Study Evaluations.* Washington, D.C. : General Accounting Office. Transfer paper, 10.1.9.

GMU (George Mason University). 1994. *Transportation Policy Program,* Fairfax, VA.

Gifford, J., T. Horan and D. Sperling. 1993. IVHS Policy--A Call to Action: report of a Workshop on Institutional and Environmental Issues. IVHS AMERICA, Annual Meeting, Newport Beach, California.

Gomez, J. and D. *Olmas.* 1993. Wilson Will Form *High* Technology Council. *Los Angeles Times,* October 3 1, Dl.

Hall, P. 1980. *Great Planning Disasters.* Penguin.

Hanson, M. and M. Qureshi. 1994 Transit Operator Innovation with Advanced Information Technologies. California PATH Research Report UCB-ITS-PRR-18, Institute of Transportation Studies, University of California, Berkeley.

Havinoski, G., B. Leonard and D. Delgado. 1994. Orange County IVHS Study: A Regional Approach to Strategic IVHS Planning. Transportation Research Board, 73rd Annual Meeting, January 9- 13.

Ho, A. 1994. Understanding Asian Commuters in Southern California: Implications for Rideshare Marketing. Transportation Research Board, 73rd Annual Meeting, Washington, D.C., January 9-13.

Horan, T., Editor. *1993. Proceedings of the National IVHS and Air Quality Workshop,* Diamond Bar, CA., March 29-30.

Horan, T., and A. Howitt. 1994. Institutional and Policy Assessment of IVHS. IVHS *Review,* IVHS AMERICA, Washington, D.C., Winter/Spring.

Horan, T. and P. Baker. 1994 *Public Acceptance of Automated Highway Systems: Annotated Bibliography.* George Mason University, Fairfax, VA.

Howitt, A. 1994. Executive Director, A. Alfred Taubman Center for State and Local Government, Harvard University John F. Kennedy School of Government. Personal interview, January 18.

Hyman, W. 1993. Urban Institute. Personal interview, December 22.

I-95 Northeast Corridor Coalition. 1994. Summary of Workshop Proceedings: Public/Private Partnerships in the I-95 Northeast Corridor. Newark, NJ, November 15- 16.

JHK & Associates. 1993. *Orange County Intelligent Vehicle/Highway Systems Study.* Action Plan, November.

Juster, R and A. Powell. 1994. An Evaluation of the SMARTRAVELER ATIS Operational Test. Paper prepared for the IVHS AMERICA 1994 Annual Meeting, Atlanta, GE, April 17-20.

Kassoff, H. and S. Kuciemba. 1994. The I-95 Corridor Coalition: Advancing Intermodal IVHS in a Complex Institutional Context. IVHS AMERICA, 1994 Annual Meeting , Atlanta, Georgia, April 17-20.

Katz, R 1994. Presentation before California Consortium for Transportation Research and Development. April.

Khattak, A., A. Kanafani and E. LeColleter. 1994. Stated and Reported Route Diversion Behavior Implications on the Benefits of ATIS. Presented at the 73rd Annual Meeting of the Transportation Research Board. Preprint No 940394, Washington, D.C., forthcoming in *Transportation Research Record.*

Kirlan, J. 1990. *The 2000 Partnership Growth Management Working Group.* Report to the 2000 Partnership, March .

Klein, H. 1993. Reconciling Institutional Interests and Technical Functionality: The Advantages of Loosely-Coupled Systems. Proceedings of the IEEE-IEE Vehicle Navigation and Informations Systems Conference. Ottawa, Canada, October 12-15.

Kolstad, J. 1994. Senior Vice President, Vorad Safety Systems. Personal interview, February 7.

Koutsopoulos, H., A. Polydoropoulou and M. Ben-Akiva. 1994. *Public Acceptance and User Response to ATIS Products and Services: The Use of Travel Simulators to Investigate the Response to Traffic Information.* Prepared for the John A. Volpe National Transportation Systems Center, Cambridge, MA.

Kurani, K., T. Turrentine and D. Sperling. 1994. Electric Vehicle Owners: Tests of Assumptions and Lessons on Future Behavior from 100 Electric Vehicle Owners in California. Paper presented at Transportation Research Board, 73rd Annual Meeting, Washington, D.C.

Lam L. 1993. ATMS Planning: Linking up with the MPO and the Section 134 Process. in *Proceedings: Surface Transportation: Mobility, Technology, and Society.*

Lappin, J.E., S.M. Sloan, and R.F. Church. 1994. A Market Analysis of the Commercial Traffic Information Business. John A. Volpe National Transportation Systems Center. Prepared for: Office of Policy Development, Federal Highway Administration, Washington, D.C.

Lappin, et al. 1994. A Primer on Consumer Marketing Research: Procedures, Methods, and Tools. John. A. Volpe Center, Cambridge, MA.

Lockwood, S. 1994. Farradyne Systems, Inc. Personal interview, May 19, 1994.

Lowe, M. 1993. *Smart* Car *54,* Where Are *You? Washington Post,* Washington, D.C., December, 12, 1993.

Luce, L., H. Richard and W. Lum 1992. The Influence of Human Factors and Public /Consumer Issues on IVHS Program. *Proceedings, IVHS Policy: A Workshop on Institutional and Environmental Issues.* Monterey, CA, April 26-28. George Mason, University, Fairfax, VA

Markowitz, J. 1994, Metropolitan Transportation Commission, Personal Interview, April 20.

Markowitz, J. and J. Georgevich. 1994 San Francisco Bay Area IVHS Early Deployment Plan. IVHS AMERICA 1994 Annual Meeting, Atlanta, Georgia, April 17-20.

Marschessault, T. 1993, Office of the Secretary, DOT, Personal interview, October 27.

MITRE. 1994. *Institutional Evaluation Guidelines.* Draft report.

Mudge, R. and C. Griffin. 1992. Approaches to the Economic Evaluation of IVHS Technology. *Proceedings, IVHS Policy: A Workshop on Institutional and Environmental Issues.* Monterey, CA. George Mason University, Fairfax, VA.

Munnich, L. 1994. Models for Cooperation of IVHS and the Environment. Draft report, Hubert H. Humphrey Institute of Public Affairs, Minneapolis, MN.

Myers, D. 1994. Economists Revise rattled Outlook. *Los Angeles Times,* February 11, D2.

Nwedpfff and Pepin. 1994. Boston Regional Systems Architecture. Presented at the IVHS AMERICA Annual Meeting,, Atlanta, GA, April 17-20.

O'Connell, C. 1993. Caltrans District 7. Personal interview, October 1.

O'Donnell, J. 1993. Examination of Public Acceptance of IVHS Products and Services. Presentation at 72nd Annual TRB Meeting, January 10-14. Washington, D.C.

Ome, D. 1993. California PATH program (now at ESL/TRW). Personal interview, October 3.

Parish, T. 1994. *Case Studies of Market Research for Three Transportation Communication Products.* Prepared for the John A. Volpe National Transportation Systems Center, Cambridge, MA.

Parrish, M. 1993. Study Maps out Road to Southland Revival. *Los Angeles Times,* October 13, Dl.

Parsons, R 1994. Consultant. Personal interviews, March 8 and 11.

Pearson, J. 1994. Klick, Kent & Allen. Personal interview, April. 19, 1994.

Petruno, T. 1994. The Next L.A.: Reinventing Our Future. *Los Angeles Times,* February 13, T19.

Pietrzyk, M. 1993. *Analysis of Automatic Vehicle Identification: Technology and Its Potential Application on Florida's Turnpike.* Center for Urban Transportation Research. University of South Florida College of Engineering.

Pisarski, A. 1994. New Commuting Trends. Presentation at ITE International Conference, LaJolla, CA, March.

Polk, A. 1993. A Haven for Defense Contractors: IVHS. *IVHS Review,* Washington, D.C., Fall.

Prendergast. 1994. MPOs Become VIPs. *Civil Engineering,* April.

Project California. *1993. Blueprint for Energizing California's Economic Recovery,* Irvine, CA: California Council on Science and Technology, October.

Replogle, M. 1993. *IVHS at Risk.* Environmental Defense Fund. Washington, D.C.

Robertson G., and M Roberts, 1992. Intelligent Vehicle Highway Systems: Private-Sector Investment Capital and Regulatory Issues. Proceeding, IVHS Policy: A Workshop on Institutional and Environmental Issues, Monterey, CA. George Mason University, Fairfax, VA.

Rockwell, 1994, *IVHS Architecture: Evolutionary Deployment Strategy,* Report Prepared for the National IVHS Architecture Program Federal Highway Administration,

Rossi, P. and H. Freeman. *1993. Evaluation: A Systematic Approach, Fourth Edition. Newbury Park, CA:* Sage Publications.

Rowe, E. 1994. City of Los Angeles (retired). Personal interview, March.

Savitt, D. 1994. Hughes Aircraft, Personal interview, November 11.

Schreder, K. 1994 Rockwell International. Personal interviews, January 6 and March 11.

Shaldover, Steven, Roy Bushey, and Robert E. Parsons. 1993. California and the Roots of IVHS. *IVHS Review,* Spring, p.27-34.

Shields, D. 1993. Executive Director, California Council on Science and Technology. Personal interview, December 20.

Smith, G. 1994. Supervisor of Transportation Planning, New Technology Program Caltrans. Personal interview, May.

SRI International. 1994. -Institutional Barriers to IVHS/ATS: Company Interviews and Case Studies. Arlington, VA: SRI International, March.

Stough, R. and M.Maggio. 1994 Evaluating IVHS/ITS Transportation Infrastructure in a Metropolitan Area, paper presented at Korea-US Symposium on IVHS, June 7- 10.

Sucher, P. 1994. The IVHS Early Deployment Planning Program Obstacles to Successful Completion. Paper prepared for IVHS America 1994 Annual Meeting, Atlanta, GA, April 17-20.

Syverud, K. 1993. Legal Issues and IVHS. Paper prepared for Federal Highway Administration, Washington, D.C.: US Department of Transportation.

Tomatzky, L. and M. Fleisher. 1990. *The Processes of Technological Innovation.* Washington, D. C. : National Science Foundation.

The Urban Institute. 1993. IVHS Staffing and Educational Needs. Washington, DC.

U.S.DOT. 1992. Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment. *Searching For Solutions: A Policy Discussion Series.* Federal Highway Administration. Number 3.

U.S.DOT. 1994a. IVHS Institutional Issues and Case Studies: TRANSCOM/TRANSMIT Case Study. DOT-VNTSC-FHWA-94- 13

U.S.DOT. 1994b. IVHS Institutional Issues and Case Studies: Advantage I-75 Case Study. DOT-VNTSC-FHWA- 10.

U.S.DOT. 1994c. IVHS Institutional Issues and Case Studies: Advance Case Study. DOT-VNTSC-FHWA-94-9.

U.S.DOT. 1994d. IVHS Institutional Issues and Case Studies: Lesson Learned. DOT-VNTSC-FHWA-94- 14.

U.S.DOT. 1994e. IVHS Institutional Issues and Case Studies: TravTek Case Study. DOT-VNTSC-FHWA-94-12.

Wachs, M. 1993. University of California. Personal interview, October 8.

Waller, Patricia F., 1992. New Evaluation Horizons: Transportation Issues for the 21st Century. *Evaluation Practice* 13(2), 103-115.

Waller, P. 1994. IVHS and Social Policy. *IVHS Review,* Winter/Spring.

Whitworth, P. 1994 *Public Acceptance and User Response to ATIS Products and Services: The Role of Operational Tests in Understanding User Response to ATIS.* Prepared for the John A. Volpe National Transportation Systems Center, Cambridge, MA.

Whitworth, P., S. Sloan and J. Lappin. 1994. *ATIS Market Research: A Survey of Operational Tests and University and Government Research.* Prepared for the John A. Volpe National Transportation Systems Center, Cambridge, MA.

Williams, R. 1994. Program Manager, Office of Strategic Technology. Personal interview, January 7.

Willis, D. 1994. Executive Director, AAA Foundation for Auto Safety. Personal interview, March.

Younan, Z. 1994. Vice President of Sales and Marketing, Amerigon Corporation. Personal Interview, February 2.

7. APPENDICES

APPENDIX A
PRIMARY AND SUPPLEMENTAL INTERVIEWS

INTERVIEWS

Primary:

Lawrence Dahms	Metropolitan Transportation Commission
Cindy Elliott	US Department of Transportation
Caltrans Staff	New Technology Program
William Hyman	Urban Institute
Charles O'Connell	Caltans District 7
Donald Ome	California PATH program (now at ESL/TRW)
Robert Parsons	Consultant
Craig Roberts	IVHS America
James Kolstad	Vorad Safety Systems
Tom Marchesault	US Department of Transportation
Donald Savitt	Hughes Aircraft
Donald Shields	California Council on Science and Technology
Rohit Shuckla	Los Angeles Economic Development Corporation
Ken Schreder	Rockwell International
Zaya Younan	Amerigon Corporation
Martin Wachs	University of California at Los Angeles

Supplemental:

Elizabeth Deaken	University of California at Berkeley
Michael Frietas	Federal Highway Administration
Keith Gilbert	AAA of Southern California
Debbie Gordon	Union of Concerned Scientists
Steve Lockwood	Parsons Brinkeroff
Marcia Lowe	Worldwatch Institute
Joel Markowitz	Metropolitan Transportation Commission
Ed Rowe	City of Los Angeles (retired)
John Stevens	Assemblyman Katz office
John Steams	Navigation Technologies
Patricia Waller	University of Michigan Transportation Research
Ronald Williams	Office of Strategic Technology
Dave Willis	AAA Foundation for Auto Safety

State Information Interviews

Jack Brown	Florida Department of Transportation
Charley Hall	Virginia Department of Transportation
George Herndon,	Florida Department of Transportation
Tom Humphrey,	Massachusetts Institute of Technology
Kunwar Rajendra,	Michigan Department of Transportation
Brian Smith,	Virginia Transportation Research Council
Gloria Stoppenhagen,	Houston Metropolitan Department of Transportation
Jim Wright,	Minnesota Department of Transportation

APPENDIX B:
INVENTORY ITEMS

As discussed in Section 4, there are a host of activities occurring with regard to institutional issues, many of which are occurring at the federal level. We conducted several activities to inventory the status of institutional analysis, including electronic searches, obtaining of draft and final federal reports, and interviewing representatives from active states on their institutional activities. While the key findings from this review are contained in Section 4, this appendix provides additional detail for any follow-up activities that may be desired. The appendix includes key federal studies (Part I), activities occurring in selected states (Part II), and a complete bibliography (Part III).

Part I: National Level Activities

Federal Institutional Issues Program

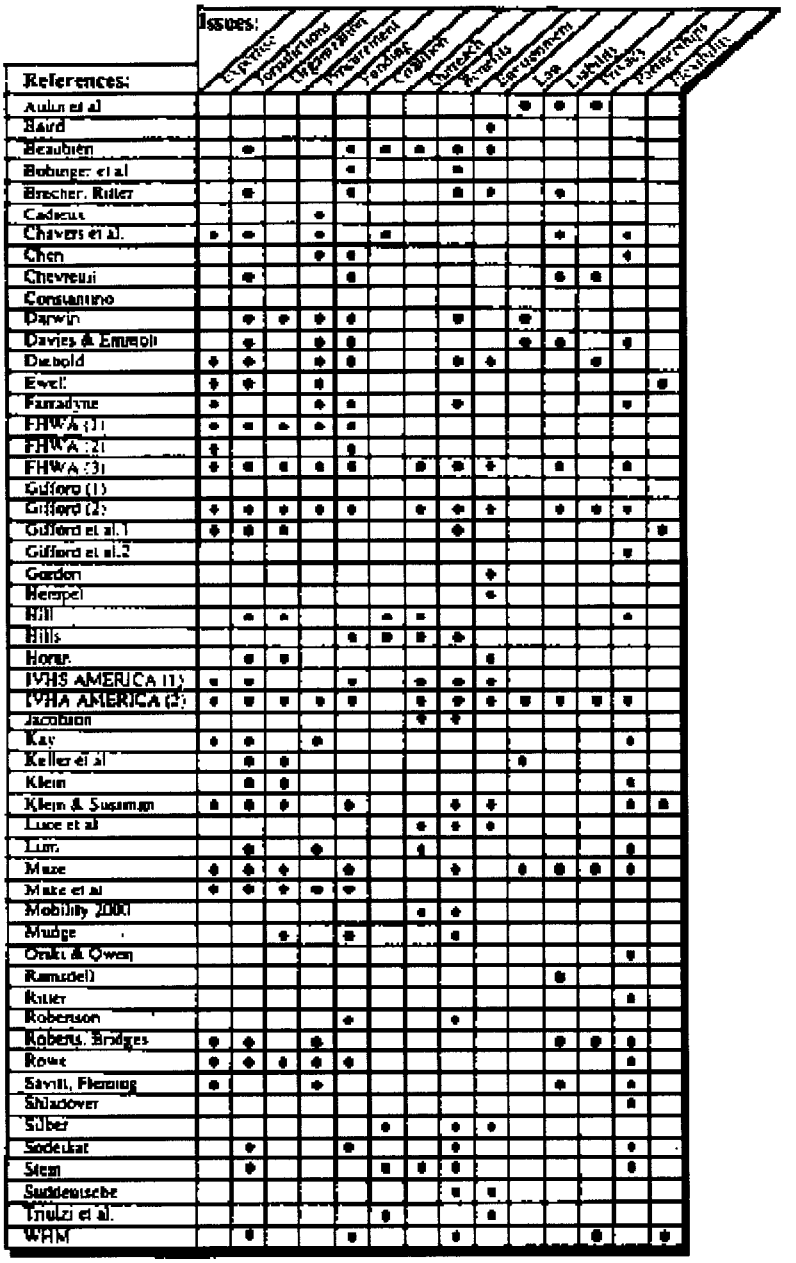
The federal government has initiated a research program to investigate the full range of institutional issues. Budgeted at approximately $5 million for FY 1995 it will include activities noted in each of three core areas, as well as several studies in the legal/administrative area. The Department has recently published a document summarizing the program (DOT,1994) , and it can be obtained from the Institutional Issues Team Leader, Cindy Elliott.

Several of the recently completed federal non-technical reports where conducted pursuant to the Non-technical Report to Congress. Table B. 1 presents an overview of these reports. Of these reports, the Booz, Allen and Hamilton study provides the most comprehensive overview of institutional issues. The study includes a synthesis of approximately sixty reports in the following areas: expertise, jurisdictional, organizational procurement, funding, coalition, outreach, benefits, environment, law, liability, privacy, partnerships and flexibility: The following Table B.2 summarizes the issues covered by the reports reviewed; a listing of citations mentioned in the table is also included.

Table B. I Background Studies in DOT Report to Congress on Nontechnical Constraints

AUTHOR/CONTACT	STUDY TITLE
Belair, Robert, et.al.	*"Privacy Implications Arising from Intelligent Vehicle-Highway Systems,"* (December 8, 1993).
Booz-Allen & Hamilton	*"Institutional Impediments to Metro Traffic Management Coordination,"* September 13, 1993
Calkins, Stephen.	*"IVHS and Antitrust: A Preliminary Assessment,"* September 1993
Federal Highway Administration.	*"Public and Private Sector Roles in Intelligent Vehicle Highway Systems Workshop,"* April 1992.
George Mason University, Institute of Public Policy.	*National IVHS and Air Quality Workshop Proceedings,"* March 29-30, 1993.
IVHS America.	*"IVHS Public/Private Partnerships: Managing the Legal Issues Workshop,"* Dallas, TX, January 25-26, 1993.
IVHS America Legal Issues Committee, Procurement Task Force.	*"Procurement Issues in IVHS Development and Deployment,"* April 23, 1993.
Jack Faucett Associates	*"Qualitative Assessment of IVHS Emission and Air Quality Impacts,"*
Nossaman, Guthner, Knox and Elliott	*"Intellectual Property Rights and the National IVHS Program* (December 1, 1993) prepared under FHWA Contract DTFH61-96-C-00087
Nossaman, Guthner, Knox & Elliott.	*"Intelligent Vehicle Highway Systems and State Sovereign Immunity for Torts...;* FHWA Contract DTFH61-93-C-0087 (1993)
Syverud, Kent..	*"Legal Constraints to the Research, Development, and Deployment of IVHS Technology in the United States,"*
The Urban Institute.	*"IVHS Staffing and Educational Needs,"* September 1993

EXHIBIT 3-2
Institutional Issues Empirical Literature Review



BOOZ, ALLEN, & HAMILTON REFERENCES

Aulin, K., A. Corfdir, "Implementation Aspects Concerning Legislation and Standardization," DRIVE Conference on Advanced Telematics in Road Transport, Brussels, February 199 1.

Baird, Jan, "IVHS and Transportation Demand Management: Meeting the Challenges Together?," IVHS Policy: A Workshop on Institutional and Environmental Issues, Asilomar, April 1992.

Beaubien, Richard "ATMS: Seven Steps to Deployment," *Proceedings of the IVHS AMERICA 1992 Annual Meeting,* May 1992.

Bobinger, R., T. Flowerdew, A. Hammond, V. Himanen, H. Keller, "Context and Framework of DRIVE Transportation Evaluation," DRIVE Conference on Advanced Telematics in Road Transport, Brussels, February 1991.

Brecher, Aviva, and Ritter, Gary, "Institutional and Environmental Issues: Lessons from Other Technologies," IVHS Policy: A Workshop on Institutional and Environmental Issues, Asilomar, April 1992.

Cadieux, Gena, "Government Procurement: Successful Decision Making When Uncle Sarn Is Your Customer," *Proceedings of the IVHS AMERICA 1992 Annual Meeting,* May 1992.

Chavers, Todd, Daryl Fleming, and Steven Hogan, "Resolving Institutional Barriers to Effective Traffic Management, *Proceedings of the IVHS AMERICA 1992 Annual Meeting,* May 1992.

Chen, Kan, and Frank Stafford, "A Sociotechnological Perspective on Public-Private Partnership for IVHS Infrastructures," FHWA Workshop on Public and Private Sector Roles in lntelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Chevreuil, M., "IRTE Implementation Draft Plan and the Particular Need for European Traffic Information Exchange," DRIVE Conference on Advanced Telematics in Road Transport, Brussels, February 199 1.

Constantino, Jim, "IVHS Strategic Plan for the United States," *Transportation Quarterly,* 46:4, October 1992.

Darwin, Richard, "IVHS Deployment and Public/Private Sector Issues: The Purely Private Model," FHWA Workshop on Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Davies, Peter, and Neil Emmot, "An Analysis of Public/Private Cooperation in European. Japanese and North American IVHS Efforts," FHWA Workshop on Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Diebold Report, "Infrastructures for the 21st Century: A Progress Report on the Information-Based Infrastructure Project," The Diebold Institute for Public Policy Studies, Inc., 1992.

Ewell, Wallace, "Structuring Traffic Management Systems to Facilitate Integration with IVHS Innovations," *Transportation Quarterly,* 46:4, October 1992.

Farradyne Systems, "Economic Issues Associated with the Definition of Public/Private Roles in the Deployment of IVHS," FHWA Workshop on Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Federal Highway Administration (FHWA) (1), "Traflic Control Systems, Operations and Maintenance. FHWA Expert Panel Report," January 10, 1992.

Federal Highway Administration (FHWA) (2) "Operation and Maintenance of Traffic Control Systems," Office of Program Review, September 1990.

Federal Highway Administration (FHWA) (3), *Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment,* August 1992.

Gifford, Jonathan, (I) "IVHS/RTI Institutional and Environmental Issues: A Strategic Policy Research and Outreach Agenda for the U.S.," Vehicle Navigation and Information Systems (VNIS) Conference, Oslo, September 1992.

Gifford, Jonathan, Daniel Sperling, and Thomas Horan (2), "IVHS Policy -- A Call to Action: Report of a Workshop on Institutional and Environmental Issues," *Proceedings of the IVHS AMERICA 1992 Annual Meeting,* May 1992.

Gifford, Jonathan, Brien Benson, Kingsley Haynes, Roger Stough (1), "Evaluating Institutional1 Effectiveness: Development of Concepts and Methods for Incorporation into IVHS Operational Field Tests," FHWA Workshop on Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Gifford, Jonathan (2), Summary of Institutional Issues Meeting, Tactical Planning Project Scoping, June (Washington D.C.) and July (Chicago), 1992.

Gordon, Deborah, "Intelligent Vehicle/Highway Systems: An Environmental Perspective," IVHS Policy: A Workshop on Institutional and Environmental issues, Asilomar, April 1992.

Hempel, Lamont, "Exploring the Transportation-Environrnent Nexus, IVHS Policy: A Workshop on Institutional and Environmental Issues," Asilomar, April 1992.

Hill, Christopher, "State and Local Institutional Issues in IVHS" IVHS Policy: A Workshop on Institutional and Environmental Issues, Asilomar, April 1992.

Hills, P., N. Thorpe, "Traffic-Demand Management in Urban Areas: The Role for Pricing," DRIVE Conference on Advanced Telematics in Road Transport, Brussels, February 199 1.

Horan, Thomas, "Evaluating IVHS: Key Issues in Institutional and Environmental Assessments of IVHS Technologies," IVHS Policy: A Workshop on Institutional and Environmental Issues, Asilomar, April 1992.

IVHS AMERICA(I), Advanced Traffic Management Systems Committee, "Guidelines for ATMS," IVHS AMERICA, May 1992.

IVHS AMERICA(2), *Strategic Plan for Intelligent Vehicle-Highway Systems in the United States,* May 1992,

Jacobson, Leslie, "Marketing ATMS and Measuring the Benefits," *Proceedings of the IVHS AMERICA 1992 Annual Meeting 1992.*

Kay, Jack, "Design and Deployment Alternatives ATMS and ATIS Components of IVHS," FHWA Workshop on Public and Private Sector Roles in intelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Keller, H., Schlichter, H.G., Wolters, W., "Concept for a Cooperative Transpont Management for the Greater Munich Area," PROMETHEUS 3rd Workshop, Torino Italy, April, 1990.

Klein, Hans, "The Design of an Institutional Framework for Cooperation in IVHS," *Proceedings of the IVHS AMERICA 1992 Annual Meeting,* May 1992.

Klein, Hans, and Joseph Sussman, "Institutional Issues in IVHS," FHWA White Paper, September 1991.

Luce, Laura, Hal Richard Wesley Lum, "The Influence of Human Factors and Public/Consumer Issues on IVHS Programs," IVHS Policy: A Workshop on Institutional and Environmental Issues, Asilomar, April 1992.

Lum, Wes, Untitled Paper at FHWA Workshop on Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Maze, T.H., and Maggio, Mark, "Institutional Barriers and Opportunities for I.V.H.S. In Commercial Vehicle Operations: An Iowa Case Study," Midwest Transportation Center, Iowa State University, February 1992.

Maki, Robert, and David DeVaughn, "Guidelines for Implementing Advanced Traffic Management Systems (ATMS)," *Proceedings of the IVHSAMERICA 1992 Annual Meeting,* May 1992.

Mobility *2000, Proceedings of a Workshop on Intelligent Vehicle Highway Systems,* San Antonio, Texas, 1989.

Mudge, Richard, "An Approach to the Economic Evaluation of IVHS Technology," IVHS Policy: A Workshop on Institutional and Environmental Issues, Asilomar, April 1992.

Orski, C. Kenneth, and Roben Owen, "Opportunities for Private Sector Involvement in the Deployment and Operation of Advanced Traveler Information Systems," FHWA Workshop on Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Ramsdell, Edward, "Tort Liability and IVHS Today," *Proceedings of the IVHS AMERICA 1992 Annual Meeting,* May 1992".

Ritter, Gary, "Public-Private Issues in IVHS Deployment: Report on the April 1992 FHWA Conference," *Proceedings of the IVHS AMERICA 1992 Annual Meeting,* May 1992.

Roberts, Craig, and Sadler Bridges, "lnstitutional Issues in the Strategic Plan," IVHS Policy: A Workshop on Institutional and Environmental Issues, Asilomar, April 1992.

Robertson, George, "Intelligent Vehicle Highway Systems: Private-Sector Investment Capital and Regulatory Issues," IVHS Policy: A Workshop on Institutional and Environmental Issues, Asilomar, April 1992.

Rowe, Edwin, "IVHS Deployment and Public/Private Sector Issues," FHWA Workshop on Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Savitt, Donald, and Daryl Fleming, "Enhanced Procurement Procedures and Other Solutions to Maximize Private Sector Involvement in IVHS," FHWA Workshop on Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Shladover, Steven, "Public-Private Partnerships for Evolutionary Development of AVCS in the PATH Program, " *Proceedings of the IVHS AMERICA 1992 Annual Meeting,* May 1 992.

Silber, Sigmund, "IVHS Deployment and Public/Private Sector Issues," FHWA Workshop on Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Sodeikat, H., "Dynamic Route Guidance and Traffic Operations in Germany," ISATA Conference, Florence, June 1992.

Stein, David, "Ways to Improve Traditional Opportunities for IVHS Development & Deployment," FHWA Workshop on Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment, April 1992.

Suddeutsche Zeitung, "The Ever-Valid Pandora's Law Stands Between Frustrated Drivers and Intelligent Roads," 24 September 1992. English version in *The German Tribune,* No. 1535, 9 October 1992.

Triulzi, U., H. Swahn, G. Argyrakos, M. Giaoutzi, K. Petrakis, "A So&-Political Approach to RTI Implementation Process, The SIRIUS Experience," DRIVE Conference on Advanced Telematics in Road Transport, Brussels, February 1991.

WHM Transportation Engineering Consultants, "Presentation on HELP/Crescent," submitted to the HELP/Crescent Evaluation Committee, 15 June 1992.

Part II: State Level Activities related to IVHS Non-Technical Issues

In addition to the national efforts, we sought to uncover state and local institutional efforts as well. Information on most of these efforts were available through the literature or conference presentations. In addition, we contacted representatives from several states (Florida, Massachusetts, Michigan, Minnesota, Texas, Virginia) to see what activities were being conducted in the institutional area.[1]. A general finding of this review was that states typically considered institutional issues within the domain of project they were supporting, while independent (and complementary) efforts were being conducted by universities within the state. The following provides details of these contacts.

Florida

Mr. Jack Brown, Chairman of the IVHS Task Force for the Florida DOT reported that the need awareness level on non-technical issues has been increasing through operating experiences from the electronic toll road and commercial vehicle operations (CVO) projects being conducted. The IVHS state coordinating council under the Florida DOT established state-wide policies for local project managers in the area of IVHS deployment. Identification of non-technical issues has principally occurred through feasibility reports for IVHS deployment projects, such for traffic management centers.

Contacts

University of Florida
Transportation Research Center
Dr. Charles E. Wallace, Director
5 12 Weil Hall
Gainesville, Fl. 32611
Tel. (904) 392-0378

University of Southern Florida
Michael C. Pietrzyk, Sr. Research Associate/IVHS Program Manager
Center for Urban Transportation Research
Tampa, Florida
Tel. (813) 974-9815

State of Florida, Department of Highway Safety and Motor Vehicles
Fred 0. Dickinson, III, Executive Director
Tallahassee, Fl. 32399
Tel. 904-488-6084

'Subsequent to this state review, we also contacted reprentatives of the I-95 corridor coalition (e.g. Lockwood, 1994), and have incorporated information from this multi-state effort directly into Section 4

Florida Department of Transportation
Mr. Jack Brown, Chirman,IVHS Task Force
605 Suwannee St.
Tallahassee, Fl. 32399
Tel. (904) 488-4284

Mr. Frank Carlile
Assistant Secretary for Transportation Policy
Tel. (904) 922-5820

Mr. George Herndon
Commercial Vehicle Operations
Advance 75 Project
Tel(904)488-5596

Massachusetts

The state of Massachusetts has progressed from identification of issues towards the development of a specific action agenda to deal with non-technical issues. Dr. Tom Humphrey of MIT has been conducting research on *inter-organizational issues* associated with the Central Artery Highway and Third Harbor Tunnel project. MIT and Harvard are conducting a joint research study in association with the New England Electronic Toll Collection and Traffic Management Croup to establish *common standards.* Harvard is also doing case studies on inter-jurisdictional coordination.

The IVHS strategic plan developed for the Boston Metropolitan area was designed to specifically avoid any action requiring inter-jurisdictional change over the short term. Short term plans were limited to actions which individual agencies could pursue independently. Medium term plans call for addressing institutional issues through the identification of internal organizational changes required in order to achieve the long range goal of coordination across agencies.

Contacts:
Harvard University
Dr. Arnold Howitt
John F. Kennedy School of Government
79 John F. Kennedy Rd.
Cambridge, MA 02138
Tel.617-495-4571

Massachusetts Institute of Technology
Dr. Tom Humphrey
Dept. of Civil & Environmental Engineering,
IVHS Program
77 Massachusetts Ave., Bldg. 1, Room 153
Cambridge, MA 0 1239
Tel. (617) 253-4978

Massachusetts Highway Department
Mi-. Sergio Luchian
Central Artery Highway Project and the Third Harbor Tunnel
1 South Station, Boston, MA 02 110
(617) 951-6146

Mr. Bill Steffens
Massachusetts Bay Transportation Authority
10 Park Plaza
Boston, MA 02116
(617) 722-5752

Michael Swanson, Deputy Secretary
Executive Office of Transportation and Construction
10 Park Plaza
Boston, MA 02116
(617) 973-7040

Mr. Mike Costa
(617) 739-7315

Michigan

The state of Michigan is starting to explore non-technical aspects of IVHS deployment, in particular, the environmental, legal and institutional aspects. For example, in the operational field test "DIRECT" (Driver Information Radio using Experimental Communication Technologies), evaluation of user benefits, and other non-technical issues were stated as the primary goal for phase 1 of this project. The state has also become a member of the "North Carolina Consortium on Commercial Vehicles-Institutional Issues" to evaluate and develop recommendations for IVHS institutional impediments at the interstate level.

The University of Michigan, Transportation Research Institute was recently established as an IVHS Research Center of Excellence by the FHWA and was given a substantial grant to increase their IVHS acquisitions. The College of Engineering and the UMTRI have published many reports on IVHS institutional and policy issues including public-private sector partnerships, user acceptance, and liability.

Contacts:

University of Michigan
Dr. Robert D. Ervin, Head, Engineering Research Division
29 10 Baxter Road
Ann Arbor, Michigan 48 109
Tel. (3 13) 936-1066

Transportation Research Institute
Dr. Patricia Waller
Director, Transportation Research Institute
Tel. 3 13-936-1046

Michigan Department of Transportation
Dr. Kunwar Rajendra
Engineer of Transportation Systems, State Transportation Building
425 West Ottawa St.
Lansing, Michigan 48909
Tel. (517) 335-2893

Michigan, Federal Highway Administration
Mr. Morrie Hoevel
315 W. Allegan St. Room211
Lansing, MI 48933
Tel. 517-377-1884

Minnesota

The University of Minnesota has taken an active role in conducting research on environmental aspects of IVHS. The Humphrey Institute will co-sponsor a conference on IVHS and the Environment in June, 1994 in Washington, D.C. In the area of CVO issues, implementation has been difficult due to various barriers including non-technical ones. Dr. Fred Buyer has just completed a report funded by the FHWA which included issue identification for CVO implementation. While he believes that the state is still at the embryonic stage of IVHS deployment the state has been actively exploring a range of issues and projects, including the

Guidestar program with it's passenger focus. The IVHS Institute is also undertaking a broad range of studies, though most focused on technical issues.

Contacts:

University of Minnesota
Center for Transportation Studies
Robert C. Johns, Actiing Director
500 Pillsbury Drive, SE
Minneapolis, MN 55455
Tel. (612) 626-1077

Dr. Lee Munich, Director of IVHS and the Environment Study
State and Local Policy Program Humphrey School
Tel. (612) 625-7357.

Mr Dennis Foderberg
Director IVHS Institute
TEl. (612) 626-1071

Minnesota Department of Transportation

Ms. Kathy Erickson
Project Manager
Tel. (612) 296-8533

Mr. Jim Wright
Guidestar Project Manager
Tel. (612) 296-8567

Mr. Mike Sobolewski
IVHS-Guidestar Office
Tel. (612) 296-4935

Texas

Institutional research is treated as a cross-cutting issue in all IVHS state projects according to Dr. Sadler Bridges, Interim Director of the Texas Transportation Institute. The state has been primarily involved with IVHS applications to traffic management, public transit and border mobility. The TTI at Texas A&M University was recently established as an IVHS Research Center of Excellence by the FHWA. At the University of Texas at Austin, Dr. Michael Walton is conducting a study that will be synthesizing the findings from many of the state Commercial Vehicle Operations institutional reports funded by the Federal Highway Administration.

The Houston Metropolitan Department of Transportation has been dealing with institutional issues related to their operational field test "Smart Commuter" on an ad-hoc basis. Their main area of concern has been with intellectual rights to software. Gloria Stoppenhagen, project manager for Houston Metro, feels that there have been strong and positive efforts at establishing a dialog between state and local agencies to deal with technical and non-technical coordination issues.

Contacts:

Texas A&M University
IVHS Research Center of Excellence
Texas Transportation Institute,
G. Sadler Bridges, Interim Director
College Station, Texas 77843-3 135
Tel. 409-845-1711

University of Texas at Austin
Dr. C. Michael Walton
Dept. of Civil Engineering
Tel. 5 12-471-492 1 Fax: 5 12-47 l-4995

Texas Department of Transportation
Mr. William Burnett, Executive Director
Dewitt C. Greer State Highway Building
125 E. 11th St., Austin, TX 78701
Tel. (5 12) 305-9501

Houston Metropolitan DOT
Gloria Stoppenhagen, Project Manager, Project Management Department
1201 Louisana, P.O. Box 61429, Houston, Texas 77208- 1429
Tel. 713-739-6953

Virginia

The state strategic plan has identified some non-technical issue areas, such as organizational changes required for IVHS deployment. The Transportation Research Council has just recently completed a study on procurement practices which identifies ways to improve the procurement process to better accommodate the faster pace of technological change in the IVHS area. According to Mr. Hall of V-DOT, procurement has been the leading non-technical issue area in their IVHS deployment projects.

Mr. Brian Smith of the TRC, the policy research arm of V-DOT stated that non-technical issues have been more challenging in their experience than the technical ones. He also identified the need for greater research collaboration between V-DOT, Virginia Tech and George Mason University other participating research centers to gain more synergy among their efforts.

Among the universities, George Mason has had the most ambitious institutional issues research program with close to $5 million in federal and local grants to study a range of issues on the topic. Several reports have recently been completed as part of a cooperative agreement with FHWA, and the university as been at the forefront regarding IVHS and Environmental Issues. The university also participates in the Centers for Excellence, Systems Architecture, and Automated Highway efforts being led by the Department of Transportation.

Contacts:
George Mason University

Roger Stough
Associate Director,
Institute of Public Policy
George Mason University
Fairfax, VA 223 10
703/993-2280

Virginia Tech
IVHS Research Center of Excellence
Center for Transportation Research
Director, Professor Antoine Hobeika
1872 Pratt Dr., Suite 1575
Blacksburg, VA 24060-6363
Tel. 703-23 l-7740

Virginia Transportation Research Council
Mr. Brian Smith
Charlett sville
Tel. (804) 293-1900 (Main)

Virginia Department of Transportation
Mr. Charley Hall
Traffic Engineering Division, 995 Corridor Project
Richmond, VA
Tel. (804)786-677

PART III: SUPPLEMENTAL BIBLIOGRAPHY (ORGANIZED AROUND THREE CORE AREAS)

Research Collaboration

Baxter, W.F. 1985. "Antitrust Law and Technological Innovation," Issues in Science and Technolonv, 1 (2).

Brown, Harold. 1992. The Government Role in Civilian Technolonv: Building a New Alliance. John Hopkins, School of Advanced International Studies, Center for Strategic International Studies.

California Council on Science and Technology. 1993. Project California: A Blueprint for Energizing California's Economic Recover-v. Report, October 1993.

California Department of Transportation. 199 1. Transportation Technology Development in California: Program and Policy Review. Sacramento, California.

California Department of Transportation. 1988. Berkeley Workshop: Multistate/Private Sector Cons. For R, D & D On Advanced Technology For The Highway, Berkeley, CA., March 24-25, 1988.

Castle Rock Consultants. 1992. An Analysis of Public/Private Cooperation in European, Japanese, and North American IVHS Efforts. Prepared for FHWA workshop on Public and Private Sector Roles in IVHS Deployment, Washington, D.C.

Chen, K. and F. Stafford, 1992. "A Socio-technological Perspective on Public and Private Partnership for IVHS Infrastructures." Prepared for FHWA Workshop on Public-Private Sector Roles in IVHS Deployment, Washington, D.C.

Churchward, Victor, T. Keamey, Inc. and B.J. Riordan, Jack Faucett Associates, Inc. 1993. "Industry Studies of the Relationship Between Highway Transportation and Productivity." Transportation Research Board Conference Session, Jan. 12.

Council on Competitiveness. 1991. Gaining New Ground: Technology Priorities for America's Future . Washington, D.C.

Cray, Dan. 1992. "Hughes in intelligent highway market drive; puts technology on road at facility in race to establish industry standard." Electronic News, May 25, 1992, v38, n1913, pp27.

Deakin, Elizabeth, 1989 "Opportunities and Constraints in IVHS," Richmond, CA: PATH Report.

Deakin, Elizabeth A. and William L. Garrison. 1985. "Private Sector Funding for Urban Transportation: Some Comments on Public-Private Partnerships." ITS-Berkelev, June, 1985.

Dingle, Julie. 1991. "Intelligent Vehicle-Highway Systems - Public/Private Partnerships." Presented at the ASCE Conference, Minneapolis, August 2 1, 1991.

Donovan, J. 1994. Conversion and the Cooperative Reorganization of Production: A Case of the CALSTART Consortium. Thesis submitted at the Massachusetts Insititute of Technology, February.

Farrell, J. and G. Saloner. 1985. "Standardization, Compatibility and Innovation." 16 Rand Journal of Economics 70.

Federal Highway Administration. 1992. "Assessing the Relationship Between Transportation Infrastructure and Productivity." Washington, D.C., US Department of Transportation.

Federal Highway Administration. 1992. Public and Private Sector Roles in IVHS Deployment Washington, D.C., Department of Transportation.

French, Bob. 1994. International Comparison of IVHS Development. in Progress. IVHS America Committee Report, Washington, D.C.

Gnoffo, Anthony. 1993. "The Defense Industry Focuses on Highways." Philadelphia Inquirer, Sec. D, pp.1, Col. 2, March 28, 1993.

Grubba, John. 1990. The Effect of IVHS Liability Issues on Intergovernmental Cooperation. Road Commission for Oakland County, Pontiac, Michigan.

Halloran, James V. 1992. "Standardizing electronic toll collection." In Symposium on the Transportation Land Use Air Quality Connection: the Role of Pricing and Market-based Strategies (1992 Lake Arrowhead, Ca.) UCLA Extension, Los Angeles, Cal.

IVHS America. 1993. "IVHS Public/Private Partnerships: Managing the Legal Issues Workshop." Summary Proceedings prepared by the Federal Highway Administration based on a workshop held in Dallas Texas on January 25-26, 1993.

Kash, D. and R. Rycroft. 1993. Nurturing Winners with Federal R & D. *Technology Review,* October-November, 58.

Kay, Jack L. 1992. "Design and Deployment Alternatives ATMS and ATIS Components of IVHS." Prepared for FHWA workshop on Public and Private Sector Roles in IVHS Deployment, Washington, D. C.

Keller, John J. 1992. "AT&T, Lockheed Plan to Co-Market Intelligent Vehicle Highway Systems." Wall Street Journal, April 13, 1992 (Sec. B, pp. 10e, Col. 1).

Karlsson, Tage. 1990. Road Transport Informatics: Current Global Projects. Statens Vag-och Trafikinstitut Conference Proceedings on Road Safety and Traffic Environment in Europe in Gothenburg, Sweden (Linkoping, Sweden) , pp. 103 - 115.

Kash, Don, 1990. Perpetual Innovation: The New World of Competition. New York, Basic Books.

Leonard-Barton, Dorothy. 1985. "Experts as Negative Opinion Leaders in the Diffusion of a Technological Innovation," Journal of Consumer Research, Vol. 11, March, 1985.

Lockwood, Steve, 1994 I-95 Conference Proceedings, Rockville, MD: forthcoming

Mudge, R and D. Ashanuer. 1990. Enhancing U.S. Competitiveness Through Highway Investment: A Strategy for Economic Growth. Prepared for the American Road Builders Association.

National Center for Advanced Technologies (NCAT). 1990. The NCAT Strategy--Key Technologies for the Year 2000, National Center for Advanced Technologies, 1250 Eye Street, N.W., Washington, D.C.

Nayak, P.R , A.B. Boghani, and G.E. Spencer. 199 1. Fostering. Innovations in Transportation: Perspectives on the Innovation Process and Stakeholders' Roles. A.D. Little, Inc., Cambridge, Ma.

Nygard, Mads. 1992. "Automatic Traffic Control in Norway: Functional and Political Issues." In Vehicle Navigation and Information Systems Conference (3rd: 1992 Oslo, Norway) Vehicle Navigation and Information Systems Conference record of papers. (Institute of Electrical and Electronics Engineers, New York) p. 67-72.

Orski, C. Kenneth; and Robert B. Gwen. 1992. "Opportunities for Private Sector Involvement in the Deployment and Operation of Advanced Traveler Information Systems." In: Public and Private Sector Roles in IVHS Deployment; Seminar, Rockville, MD.: U.S. DOT, Federal Highway Administration :

Ramsdell, Edward L. 1992. "Tort Liability and IVHS Today." In Surface Transportation and the Information Age. Proceedings of the IVHS America 1992 Annual Meeting (Newport Beach, California, May 17-20) Vol. 1. IVHS America, Washington, D.C., pg. 157-163.

Ramsdell, Edward L. 1993. Tort Liability and IVHS: Problem or Illusion? IVHS America, Washington D.C.

Roberts, Mark A. 1992. "IVHS Strategies." Alex. Brown & Sons. Surface transportation and the information age : Proceedings of the IVHS America 1992 Annual Meeting. Newport Beach, CA, May 17-20, 1992. Vol. 1. Washington, D.C.: IVHS America, pp. 304-308.

Rogers, E.M. 1962. The Diffusion of Innovations. New York, Free Press. Republished in 1983.

Savitt, Donald A. and Daryl S. Fleming. 1992. "Enhanced Procurement Procedures and Other Solutions to Maximize Private Sector Involvement in IVHS." Prepared for FHWA workshop on Public and Private Sector Roles in IVHS Deployment, Washington, D.C.

Shladover, Steven E., Michael Dearing, Paul Bouchard, and Roy Bushey. 1992. 'Public-Private partnerships for Evolutionary Development of AVCS in the PATH Program." In: Surface Transportation and the Information Age. Proceedings of the IVHS America 1992 Annual Meeting, Vol. I. Washington D.C.: IVHS America. pp. 341-6.

Stafford, Frank P. And Kan Chen. 1992. Economic Aspects of Public-Private Partnerships for the Provision of Roadway Services. Ann Arbor, MI: University of Michigan, Transportation Research Inst. 19 pp.

Syverud, Kent. 1993. IVHS Legal Issues: Perceived or Real. University of Michigan, Transportation Research Institute, Ann Arbor, Michigan.

Syverud, Kent. 1993. "Legal constraints to the research, development and deployment of IVHS technology in the United States." In Intelligent Vehicle Highway Society of America 3rd Annual Meeting Conference Proceedings, IVHS America, Washington, D.C. pp. 418-436.

Syverud, Kent. 1992. A Bibliography of Legal Constraints to the Research and Development and Deployment of IVHS Svstems in the United States. University of Michigan, Transportation Research Institute. Ann Arbor, Michigan.

Syverud, Kent. 1990. "Liability and Insurance Implications of IVHS Technology." Automated Highway/Intelligent Vehicle Svstems. Society of Automotive Engineers, Warrendale, PA pp. 83-96.

Tarnoff, Philip. 1992. "Economic Issues Associated with the Definition of Public/Private Roles in the Development of IVHS." Prepared for FHWA workshop on Public and Private Sector Roles in IVHS Deployment, Washington, D.C.

Thompson, Gregory L., B. Weller, and E. Terrie. 1993. "New Perspectives on Highway Investment and Economic Growth." Transportation Research Board.

Tornatzky, L. and M. Fleisher. 1990. The Processes of Technological Innovation.,...

Underwood, S.E., K. Chen and R. Ervin. 1992. "The Future of Intelligent Vehicle-Highway Systems: A Delphi Forecast of Markets and Sociotechnical Determinants." 69th annual meeting of the Transportation Research Board, Washington, D.C., January 7-11, 1990, Transportation Research Institute, Ann Arbor, MI.

Underwood, S., K. Chen and R Ervin. 1991. "IVHS Driving Forces and Barriers," The Private Carrier, January 1991, pp. 26-27.

Wolfe, Bob and Mark Anderson. 199 1. "Minnesota Department of Transportation in the Marketplace." TRR 1305 (269-272)

Regional Management

Chavers, J., Fleming D. and Hogan S. 1992. "Resolving institutional barriers to effective traffic management." In Institute of Transportation Engineers 62nd Annual Meeting. Compendium of Technical Papers, Washington, D.C., p. 95-99.

Feamsides, John J. 199 . "Institutional Considerations in the Evolutionary Development of IVHS," (ASCE Paper in printing).

Horan, Thomas A. and Jonathan L. Gifford. 1993. 'New Dimensions In Infrastructure Evaluation: The Case of Non-Technical Issues in IVHS." Policy Studies Jrnl 21 (2) 347-356.

IVHS AMERICA. 1991. "Public Agency Support is Key to IVHS Program Success," IVHS AMERICA Vol. 1, No. 2.

Johnston, Robert A., et.al. 1989. "A Policy Analysis of Automating Urban Freeways." AATT Conference, San Diego, Ca., February 5-8, 1989.

Petruno, T. 1994. The Next L.A. : Reinventing Our Future. Los *Angeles Times,* February, 13, T19.

Rowe, Edwin. 1992. "Los Angeles Smart Corridor Project." Los Angeles Dept. of Transportation, Los Angeles, California, December 8, 1992.

Rowe, S. Edwin. 1991. "Public Agency Issues in the Implementation of IVHS," In Applications of Advanced Technologies in Transportation Engineering.

Rowe, Edwin. 199 1. "Public Agency Issues in the Implemention of IVHS." In Applications of Advanced Technologies in Transportation Engineering. second international conference, American Society of Civil Engineers: New York, pp. 126- 130.

Stearman, Brian, F. Cahoon and J. Treber. 1993. IVHS Technologies and Metropolitan Traffic Management Operations, IVHS AMERICA Conference, Washington, D.C.

Tyre, Marcie J. and Wanda J. Orlikowski. 1993. "Exploiting Opportunities for Technological Improvements in Organizations." Sloan Management Review. Vo135 (1)13-26.

US Department of Transportation. 1992. California Smart Traveler System Prepared by Robert W. Behnke, Aegis Transportation Information Systems, Inc., for the Office of Technical Assistance, Federal Transit Administration, February.

US Department of Transportation. Forthcoming. Reference for Institutional Evaluations. Michael Freitas, FHWA/Michelle Brahaney, Mitre Corporation.

Volpe National Transportation Systems Center. 1993. Institutional Impediments to Metro Traffic Management Coordination. Final Report and Appendix prepared by Booz, Allen & Hamilton, September 13, 1993.

Vostrez, J. 1989. "Vehicle/Highway Automation: Policy Issues and Strategies in California," In Vehicle/Highway Automation, SAE Special Publication SP-791, August, 1989.

Stakeholder Acceptance

Baird, Jan K. 1992. "Overcoming Institutional Barriers to New Technology: A Case of Southern California." In Transportation, Information Technology and Public Policy. IVHS Policy: A Workshop on Institutional and Environmental Issues. Asilomar Conference Center, Monterey, California April 26-28, 1992. George Mason University, Institute of Public Policy and University of California, Davis, Institute of Transportation Studies.

Barabba, Vincent P. and Gerald Zaltman. 1991. Hearing the Voice of the Market: Competitive Advantage through Creative Use of Market Information. Boston: Harvard Business School Press.

Bedford, G. M. 1992. "IVHS And The Mobility Of Older Americans." In: Surface Transportation and the Information Age. Proceedings of the IVHS America 1992 Annual Meeting, Vol. I.Washington D.C.: IVHS America.

Bonsall, P. and M. Joint. 1991. "Evidence on drivers' reaction to in-vehicle route guidance advice." University of Leeds. Institute for Transport Studies. in: International Symposium on Automotive Technology & Automation (24th : 1991: Florence, Italy). 24th ISATA International Symposium on Automotive Technology and Automation, Florence, Italy, 20-24 May 1991. Croyden, UK: Automotive Automation Limited, Croyden, England. Pp. 39 l-40 1.

Boyce, D., A. Kirson, and J. Schofer. 1991. "Design and Implementation of ADVANCE: The Illinois Dynamic Navigation and Route Guidance Demonstration Program" Ppr. No. 912786 (415-426), Proc. of the 2nd Annual Vehicle Navigation and Information Systems Conference, IEEE, Toronto.

Brand, JE. 1990. "Attitudes toward advanced automotive display systems: feedback from driver. Focus group discussions. Final report." Brand Consulting Group University of Michigan Transp Research Institute. Washington D.C.: Federal Highway Administration.

Breuning, Siegfried M. 1976. 'Measuring and Interpreting Consumer Preferences." In Daniel Brand, ed. Dual-Mode Transportation' Special Report No. 170. Washington D.C.: Transportation Research Board. Pp. 307-324.

Burwell, David G. 1993. "Is Anybody Listening to the Customer?" IVHS REVIEW Summer 1993 (17-26).

Byrd, L.G. 1993. "Expediting Product Acceptance in Highway Programs." TR News 168, Sept.-Oct. pp.24-5.

Cameron, M. 199 . "Transportation Efficiency: Tackling Southern California's Air Pollution and Congestion." Prepared for the Environmental Defense Fund and the Regional Institute of Southern California, Los Angeles, Ca.

Conroy, Patrick J. 1990. 'Transportation's Technology Future: Prospects for Energy and Air Quality Benefits." TR NEWS June, pp.32-37.

Dudek, C., G. Weaver, D. Hatcher, and S. Richards. 1978. "Field Evaluation of Messages for Real Time diversion of Freeway Traffic for Special Events." TRR. 682 (37-45).

Duffy, Barbara Poitas. 1993. 'Focus Groups: An Important Research Technique for Internal Evaluation Units." Evaluation Practice 14(2),133-139.

Everett, Peter B. and Lucie K. Ozanne. 1994. "Marketing Theory and Urban Transportation Policy." Ppr. No. 930048. Transportation Research Board, Annual Meeting, Washington D.C. Jan. 10-14, 1994.

Federal Highway Administration. 1992. "Transportation and Air Quality: Searching for Solutions."

Friedman, Michael S. 1993. "Privacy and Security Issues for ETTM Technology." In International Symposium on ETTM Technology, 2nd Annual Conference, New York: International Bridge, Tunnel and Turnpike Association ,Washington, D.C.

Gifford, J.L., T.A. Horan, and D. Sperling (eds.). 1992b. Transportation, Information Technology; and Public Policv. Fairfax, VA: George Mason University,; and Davis, CA: University of California Davis, Institute of Transportation Studies.

Gordon, Deborah. 1991. Steering a New Course: Transportation, Energy and the Environment. Washington, D.C.: Island Press.

Gordon, Deborah. 1992. "Intelligent Vehicle/Highway Systems: An Environmental Perspective." In: Gifford, J.L., T.A. Horan, and D. Sperling (eds.). Transportation, Information Technology, and Public Policv. Fairfax, VA: George Mason University,; and Davis, CA: University of California Davis, Institute of Transportation Studies.

Gourdin, Kent N. ; and Patricia E. McIntyre. 1992. "Demand for IVHS in Charlotte, North Carolina : A Marketing Study." Transportation Quarterly. Vol. 46 (2). April, 1992, pp. 205-217.

Green, Paul; and Jonathan Brand. 1992. "Future in-car information systems : input from focus groups." Warrendale, PA: Society of Automotive Engineers.

Harkins, John K. 1993. "An Industry Perspective on IVHS" IVHS REVIEW. Summer, 1993 pp. 85-90.

Horan, Thomas A. 1993. National Evaluation Issues in Intelligent Vehicle-Highway Systems. Testimony before the House Appropriations Committee on Transportation and Related Agencies.

Horan, Thomas A, ed. 1993. National IVHS and Air Quality Workshop Proceedings. Diamond Bar, Ca. March 29-30.

Jacobson, Leslie N., G. Scott Rutherford, and Ruth K. Kichen. 1992. "Public Attitudes Toward the Seattle Area HOV System and the Effectiveness of the HERO Program." TRR 1299 (55-62).

Jou, RC., H. S. Mahmassani and T. Joseph. 1992. "Daily Variability of Commuter Decisions: Dallas Survey Results. Interim Report." Texas University, Austin: Center for Transportation Research.

Kanafani, Adib, Asad Khattak and Joy Dahlgren. 1994. "A Planning Methodology for Urban Transportation Systems." Paper presented at Transportation Research Board, 73rd Annual Meeting, Washington D.C.

Kanaan, Ammar Y. 1993. "The Economic Effects of Implementing Electronic Toll Collection and Traffic Management Systems" In: Transportation Research Board 72nd Annual Meeting, Washington, D.C. TRB.

Khattack, A. J., J.L. Schafer and F.S. Koppehuan. 1993. "Commuters' En Route Diversion and Return Analysis and Implications for Advanced Traveller Information Systems". In Transportation Research, Part A Vol: 27a Issue Number: 2. pg 101-I 11.

Knodel, John. 1993. 'The Design and Analysis of Focus Group Studies." In: Morgan, David L (ed.) Successful Focus Groups: Advancing the State of the Art. Newbury Park, CA: Sage Publications.

Koppehuan, F. and E. Pas. 1980. "Travel-choice Behavior: Models of Perceptions, Feelings, Preference, and Choice." TRR. 765 (26-33).

Kurani, Kenneth S., Thomas Turrentine, and Daniel Sperling. 1994. 'Electric Vehicle Owners: Tests of Assumptions and Lessons on Future Behavior from 100 Electric Vehicle Owners in California." Paper presented at Transportation Research Board, 73rd Annual Meeting, Washington D.C.

Lowe, Marcy D. 1993. 'Road to Nowhere." World Watch (May/June)27-34.

Luce, Laura, Hal Richard, and Wesley S.C. Lum 1992. "The Influence of Human Factors and Public/Consumer Issues on IVHS Programs." in Gifford, J.L., T.A. Horan, and D. Sperling (eds.). Transportation, Information Technology, and Public Policy. Fairfax, VA: George Mason University,; and Davis, CA: University of California Davis, Institute of Transportation Studies.

MacKenzie, James J. , RC. Dower and D.D.T. Chen. 1992. "The Going Rate: What it Really Costs to Drive." World Resources Institute. Washington, D.C.

Marans, RW. 1991. "User Acceptance of Intelligentt Vehicle-Highway Systems (IVHS): Directions for Future Research. In: The Intelligent Vehicle Highway Society of America. First Annual Meeting, Reston, Virginia, March 17-20, 1991. IVHS America, Washington D. C..

Mazmanian, D. and J. Nienaber. 1979. Can Organizations Change? Environmental Protection, Citizen Participation, and the Corns of Engineers. Washington, D.C., The Brookings Institution.

The National Highway Traffic Safety Administration. 1992. "Field Test of Automated Speed Enforcement in Michigan: Effects On Speed and Public Opinion." University of Michigan Transportation Research Insititute, Michigan.

Nelson, David 0.; Melanie S. Payne and Timothy J. Tardiff. 1982. "Assessing Consumer Market Potential for Electric Vehicles: Focus-Group Report." TRR No. 882. 1982. Pp. 13-18.

O'Donnell' John. 1993. "Examination of Public Acceptance of IVHS Products and Services." Paper presented at Transportation Research Board, 72rd Annual Meeting, Washington D.C.

Parviainen, J. A.., W. G.Atkinson and M. L. Young. 199 1. "Application of Micro-Electronic Technology To Assist Elderly And Disabled Travellers." Transportation Development Centre, Quebec.

Perez, William A., Rebecca Fleischman, Gary Golembiewski, and Deborah Dennard. 1993. "TravTek Field Study Results to Date." In Surface Transportation: Mobility, Technology and Society: Proceedings of the IVHS America 1993 Annual Meeting. Washington, D.C.: IVHS America, pp. 667-73.

Pietrzyk, Michael C. 1990. Analysis of Automatic Vehicle Identification Technology And Its Potential Application On The Florida Turnpike: Technical Memorandum 2. Center for Urban Transportation Research and The Florida Department of Transportation.

Schofer, Joseph L., Asad Khattak, and Frank S. Koppelman. 1993. "Behavioral Issues in the Design and Evaluation of Advanced Traveler Information Systems." Transportation Research Vol. 1C (2) 107- 117.

Shladover, Steven E. 1993b. "Potential Contributions of IVHS to Reducing Transportation's Greenhouse Gas Production." Transportation Research.

Sobey, Albert J. 1990. "Business View of Smart Vehicle-Highway Control Systems." Journal of Transportation Engineering, vol. 116 no.4. July/August. pp461-478

Stafford, Frank P. 1990. "Social Benefits of IVHS Systems," Socioeconomic Aspects of Intelligent Vehicle Highway Systems, University of Michigan IVHS Technical Report 90-12, pp. 44-52.

Turrentine, T; Sperling, D; Hunger-ford, D. 1991. "Consumer acceptance of adaptive cruise control and collision avoidance systems." In: TRR N 13 18 pp 11 8- 12 1. TRB.

Underwood, Steven E. 1990. "Social and Institutional Considerations in Intelligent Vehicle-Highway Systems," Socio-economic aspects of IVHS, University of Michigan IVHS Technical Report 90-12, August, 1990 pp. 15-43.

Waller, Patricia F. 1992. "New Evaluation Horizons: Transportation Issues for the 21st Century." Evaluation Practice 13(2), 103- 115.

Wenger, M., J. Spyridakis, M.D. Haselkom, W. Barfield, and L. Conquest. 1990. "Motorist Behavior and the Design of Motorist Information Systems." TRR: 1281 (159-167).

Wootton, H.J.; and A.C. Brett 1986. "Route information systems: signposts of the future?." In: International Conf. on Road Traffic Control (2nd: 1986 : London). NY, NY: Inst. of Electrical Engineers. Pp.15-17

Ygnace, Jean-Luc. 1991. "An Example of Consumer Acceptance of Route Guidance Technologies." Program on Advanced Technology for the Highway (Calif.). Washington, D.C. : Transportation Research Board, National Research Council.

General

Apogee Research, Inc. 1989. "Current Literature on Highway Investment and Economic Development." Prepared by Apogee Research, Inc. for the FHWA.

California Path Program. 1992. Potential Payoffs from IVHS: A Framework for Analysis. Path Research Report No. UCB-ITS-PRR-92-7, Prepared by the Rockwell International Science Center.

Chang, Edmond. 1991. P.E., "Toll Collection Based on AVI Technology," Technical Quarterly, Vol. 6, Issue 2, March, pp. 10-13.

Chen, K., and R.D. Ervin. 1990. "American Policy Issues in Intelligent Vehicle-Highway Systems," Socioeconomic Aspects of Intelligent Vehicle Highway Systems, University of Michigan IVHS Technical Report 90-12, pp. 2-14.

Chen, K. and R Ervin. 1990. "American Policy Issues in Intelligent Vehicle-Highway Systems," Socio-Economic Aspects of IVHS, University of Michigan IVHS Technical Report 90-12.

Chen, K. and RD. Ervin. 1990. "Intelligent Vehicle-Highway Systems: U.S. Activities and Policy Issues," Technological Forecasting and Social Change, 38 (4).

Chen, K., and RD. Ervin. 1989. "Developing a Program in IVHS in America," Proceedings of the 20th International Symposium on Technology and Automation, Vol. 2, Florence, Italy, May 29-June 2, 1989.

Congress, U.S. 1991. ISTEA Act: "Intermodal Surface Transportation Efficiency Act of 1991, P.L. 102-240, 105 Stat. 1914.

David, Yves. 1990. "Evaluation of the Perspectives of Driving Aids Based on Short Range Transmission Links between Ground and Vehicles and between Vehicles," VTI Rapport, Vol. 364-A' pp. 91-102.

Davies, P; Ayland, N; Hill' C; Rutherford, S; Hallenbeck, M; Ulberg, C. 1991. "Assessment Of Advanced Technologies For Relieving Urban Traffic Congestion." NCHRP Rept. Issue No. 340, 103pp. Transportation Research Board.

Deakin, Elizabeth. 1987. "Transportation in California: Problems and Policy Options through the Year 2000." ITS -Berkeley, Fall, 1987.

Dupin, Chris. 1991. "Transport Companies Roll ALong with ED1 Plans," The Journal of Commerce, May 28, pp. 3C.

Federal Highway Administration. 199 1. "National Program Plan Intelligent Vehicle Highway Systems Commercial Vehicle Operations High Priority National Program Area," Washington, D.C., February 22, 1991.

Goulias, KKG., MAson, JM, Jr. 1993. "Planning The Resolution of IVHS Issues Via A Staged Development Approach." In ITE Journal Vol: 63 Issue Number: 2 Pag. 33-40.

IVHS America, Evaluation and Costs Committee. 1992. Summary of IVHS Benefits. Committee Workshop Proceedings, San Diego, California.

Kanafani, Adib. 1987. Towards a Technology Assessment of Highway Navigation and Route Guidance. Berkeley, CA. Institute of Transportation Studies, University of California. 14 pages.

Marchessault, Thomas E. Forthcoming. Non-Technical Report to Congress. Washington D.C., U.S. Department of Transportation. (forthcoming)

Michigan, University of, Transportation Research Institute. 1990. Socioeconomic Aspects of Intelligent Vehicle-Highway Systems. IVHS Technical Report-90-12.

U.S. Department of Transportation. 1994. Intelligent Vehicle Highway Systems Nature Program Plan Federal Highway Administration, Washington, D.C.

U.S. Department of Transportation. 1990. "Moving America, New Directions, New Opportunities - A Statement of National Transportation Policy Strategies for Action," February.

U.S. General Accounting Office. 1991. Smart Highways: An Assessment of their Potential to Improve Travel. Report No. GAO/PEMD-91-18. Washington D.C. GAO.

U.S. Office of Technology Assessment. 1989. Advanced Vehicle/Highway Systems and Urban traffic Problems. Washington D.C. OTA.

Volpe National Transportation Systems Center. 1992. "Project Plan: An IVHS Benefits Assessment Framework." Cambridge, Massachusetts.

APPENDIX C:
IVHS/ATS GOALS, ISSUES, AND SALIENCE LEVELS FOR CALIFORNIA POLICY MAKERS

POLICY GOALS	*KEY ISSUES*	*ISSUE SALIENCE* (*level ofattention received*)
MOBILITY	Congestion	High
ENVIRONMENTAL QUALITY	VehicleEmissions	High
SAFETY	Highway accidents; incident detection and verification	Medium-High
ACCESSIBILITY	Ease of travel for disabled & low income people	Low
ECONOMIC PRODUCTIVITY	Regionalcompetitiveness	High
ENERGY CONSERVATION	Fuel consumption	Low
CITIZEN INVOLVEMENT	Open decisionmaking and planning process	Medium
CONSUMER SATISFACTION	Perceptions of performance and reliability	High
SECURITY	Anti-theft use and use in traffic enforcement	Medium
PRIVACY	Intrusive surveillance --tracking of drivers	Medium
LEGAL SUFFICIENCY	Tort liability	High
PUBLIC-PRIVATE COOPERATION	Different organizational cultures and incentive structures	Medium
INTERGOVERNMENTAL COOPERATION	Interjurisdictional issues & fragmentation	Medium
FUNDING ADEQUACY	Stable and continuous R,D,& D funding	High
INTERNATIONAL COMPETITIVENESS	PacRim trade; Asian and Eurpoean IVHS/ATS development	High
SUSTAINABILITY	Foresight capacity -- long-term environmental & social livability	Low
INTELLECTUAL PROPERTY	Multi-party ownership and non-disclosure agreements	Medium
DUAL USE TECH- NOLOGY CONCERNS	Use and potential abuse of GPS systems	Low
FLEXIBILITY	Expandability, redundancy, open architecture	Medium
EVALUATION	Data base support for transportation planning and operations	Low

APPENDIX D:
Selected California IVHS Suppliers

Project California IVHS Focus Group Members:

Aerojet Electronic Systems Division
Allied Signal Aerospace
TRW Military Electronics and Avionics Division
Northrop Advanced Technologies
Science Applications International Corporation (SAIC)
Rockwell International
Hughes Aircraft Company
Litton Industries, Inc.
Infotech Development Co.
Defense Conversion Strategies

Other IVHS-Related Companies:

Amerigon, Los Angeles
Auto Talk, Inc., Santa Clara
Cambridge Systematics, Inc., Berkeley
Clarion, Gardena
Colwell-Kirkland International, Sunnyvale
ESL/TRW, Sunnyvale
E-Fax Communications, Inc., Oakland
ETAK, Inc. (Murdock Publishing), Menlo Park
Greenbrier Inter-modal, Walnut Creek
Honda R&D North America, Inc., Torrance
Hughes Transportation Management Systems, Fullerton
IBI Group, Irvine
International Teletext Communications, Inc., Sunnyvale
JHK and Associates, Inc., Emeryville
Lockheed Advanced Commercial Products, Sunnyvale
Lockheed IMS, San Francisco
Metro Dynamics, Palo Alto
National Engineering Technology, La Mirada
Econolite, Anaheim
Nova Electronics, San Jose
OCTEL Communications Corporation, Milpitas
10 1 On Line, San Francisco
Pulse-Corn Corporation, Monterey
SAIC, San Diego
Titan, San Diego
SRI International, Menlo Park

SAVI Technology, Palo Alto
Shadow Broadcast Services, San Francisco
Strategic Mapping, Santa Clara
Sumitomo Electric USA, Inc., Santa Clara
Systems Control Technology, Inc., Palo Alto
TRW/EAEL, Redondo Beach
Travel Assist, Moraga
Trimble Navigation Ltd., Sunnyvale
U.S. Commlink, San Leandro
Zexel USA Corp., Sunnyvale
Loral AeroSys, Palto Alto
Systems Technology, Inc., Hawthorne
JFT Associates, Pacific Palisades
Alcoa Electronic Packaging, Inc., San Diego
Vorad Systems, Inc., San Diego
Abratique & Associates, Los Angeles
Allied Signal, Inc., Torrance
Alpine Electronic, Inc., Torrance
American Honda Motor Co., Torrance
American Telephone & Telegraph, Fullerton
Bechtel Corporation, San Francisco
Cambridge Systematics, Inc., Berkeley
Centennial Engineering, Inc., Pleasanton
Cue Paging Corp., Irvine
Cylink, Sunnyvale
DeLeuw, Cather & Co., Irvine
Detector Systems, Inc., Stanton
E-Lite Ltd, Canoga Park
Eaton Corp., Sacramento
Electric Road Corp., Irvine
Farradine Systems, Inc., Orange
Fujitsu Ten Corp., Torrance
Gannett Fleming, Inc., Anaheim
High Technology Automation-DVC, Los Angeles
IMRA America, Inc., Davis
Intermetrics, Inc., Huntington Beach
Isuzu Technical Center, Cerritos
Javelin Electronics, Torrance
Kaman Sciences Corp., Santa Monica
Marketing Resource Concepts, Newport Beach
Mazda Motor Corp., Irvine
Metro Traffic Control, Inc., San Francisco
National Semiconductor, Santa Clara
Navigation Technologies, Sunnyvale
Nichimen America, Inc., Santa Clara

Nippondenso Technical Center USA, Inc., Carlsbad
Pulse-Corn Corp., Monterey
PacTel Teletrac, Inglewood
Penske Corp., El Monte
Raytheon Co., Goleta
SEI Information Technology, San Francisco
Safetran Traffic Systems, Inc., Santa Maria
Safety Research Associates, Inc., La Canada
Shadow Information Systems, Los Angeles
Sumitomo Electric USA, Torrance
Sverdup, Irvine
Tempo America, Camarillo
Terrapin Corp., Garden Grove
The News Corporation Ltd., Los Angeles
Toyota, Torrance
UMA Engineering, Inc., Irvine
Westin Engineering, Inc., San Jose
Wilbur Smith Associates, Inc., Oakland

APPENDIX E:
SELECTED EXCEPTS FROM SYSTEM ARCHITECTURE INSTITUTIONAL ANALYSIS: ROCKWELL TEAM

4. Institutional Issue Considerations

The objective of this section is to describe and assess the non-technical issues of the system architecture. A set of non-technical, socio-economic problems that challenge IVHS, IVHS architecture, and IVHS deployment strategy are presented and discussed in the same order as suggested by the FHWA guidelines for the Evolutionary Deployment Strategy deliverable. These problem issues are identified, analyzed, and evaluated in terms of how they affect (or are affected by) the architecture, and the extent to which they have or can be mitigated either through the architecture design, or through the evolutionary deployment strategy. Recommendations or mitigations are suggested to facilitate timely, least risky, and progressive IVHS system development and deployment.

The greatest challenge of the deployment strategy is to establish guidelines for intelligent implementation of the architecture allowing skillful navigation through the numerous, complex socio-economic deployment challenges. The strategy has to mitigate some unique conditions of IVHS development and deployment, which include, but are not limited to, the following:

- Unprecedented high expectations of IVHS, which go beyond simple improvements to the transportation system to include grand socio-economic and environmental benefits.
- High cost of producing, deploying, and maintaining the hardware and software systems.
- Uncertain benefits that can be realized only under long-term investment plans.
- Budgetary constraints of participating organizations.
- Unwillingness and/or the inability of the public sector to move the entire IVHS program on its own.
- Potentially difficult organizational changes that might be required to introduce IVHS.
- Complicated metropolitan-institutional arrangements required for regional management of IVHS.
- Complex interoperability requirements among regions and across state lines.
- Unparalleled diversity of the market place, geography of regions, and the demographics of user communities.

In establishing a correspondingly comprehensive analytical framework for the deployment strategy, it is useful to reference a three-domain socio-economic-technical model, which is presented in Figure 4-l and originally suggested in the Rockwell system architecture proposal. The first domain of the model is "technical," where the issues of design and engineering of systems reside. The second domain is "economic," where cost-benefit questions and funding issues affecting the system development and deployment are addressed. The third domain is "societal" and it encompasses the organizational, the institutional, and the individual (behavioral) issues surrounding M-IS deployment. Figure 4-l shows how the issues of sections 4.1 through 4.10 are distributed throughout the three domains. Much of the emphasis in the subsequent sections will be on the societal domain and, to a lesser extent, on its intersection with the economic and technical domains. The technical domain will receive least attention as it is taken care of in the physical architecture and other documents.

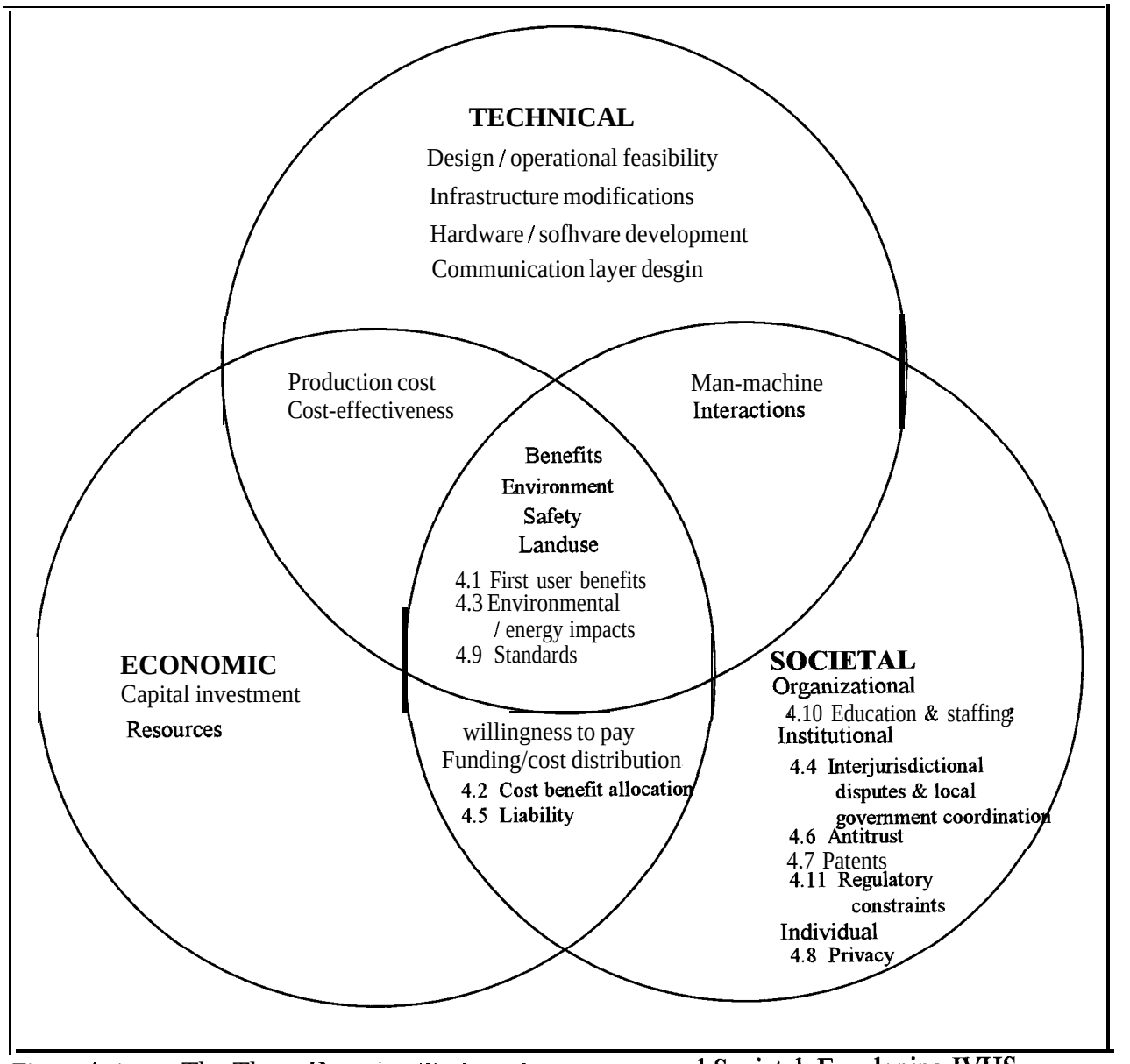


Figure 4-1: The Three Domains, Technical, Economic, and Societal, Enveloping IVHS Development and Deployment

Issues affecting IVHS deployment within the three domains can be analyzed using quantitative methods, qualitative methods, or both. Clearly, quantitative methods of analysis are suited for the technical domain. In the economic domain, qualitative as well as quantitative analyses are used. Benefits analysis, for example, would have quantitative parameters such as measured reduction in travel time, number of accidents, fatality rate, and so forth. On the other hand, some non-technical constraints are best assessed using qualitative methods such as focus groups and interviews. For example, in Phase I a major source of qualitative information was the input provided by the Advisory Committee (see Evaluation Plan), and, in particular, the structured information that was provided at an all day meeting session (see Appendix E). This input was

complemented by analysis of both architectural material (e.g. risk analysis), and general IVHS reports on non-technical constraints.

The following is a presentation of this non-technical analysis along the dimensions requested in the FHWA guidance. As noted above, the orientation of the analysis is the potential impact of the various non-technical constraints on the architecture, and how these are either mitigated through architecture design or through the evolutionary deployment strategy. No attempt has been made here to comprehensively present each general issue, as there are a host of reports that already do so, including both the national and local levels. [1] Rather than repeating these reviews, the focus on this section is the issues' relevance to architecture implementation. Table 4-l provides an overview of these relationships, highlighting (in light and dark boxes) those market packages most affected by the associated non-technical constraint. The nature of these influences is described in the appropriate non-technical section below. In addition, several appendices provide additional detail on key non-technical constraints to the Rockwell architecture (e.g., interjurisdictional coordination, standards, privacy) as well as additional detail on non-technical outreach/analysis (e.g. advisory group input on non-technical constraints.)

[1] *See* FHWA *Non-technical Constraints and Barriers to Implementation of Intelligent Vehicle-Highway Systems.* Washington, D.C.: U.S. Department of Transpiration. See *also* Horan, T, *Institutional Challenges to the Deployment of IVHS in California*, Berkeley, CA: California PATH Program, June, 1994 (draft).

Table 4- 1: Institutional Issue Categories and Market Packages.

	Market Packages	Institutional Issues										
		First User Benefits	Equity	Environment/ Energy	Interjurisdictional Issues	Liability	Antitrust	Intellectual Rights	Privacy	Standards	Education and Staffing	Regulatory Constraints
APTS	Passenger and Fm Management	•	■	□					■	0	□	
	Transit Vehicle Tracking	□	□	□							□	
	Transit Security		■	□					□		□	
	Transit Operations Planning	□	□	□	□				[redacted]	□	0	
	Transit Maintenance		□	□							□	
ATIS	Broadcast Based ATIS	■	■	□						■	□	
	Interactive ATIS with Infrastr Route Plan		■	□	■	□			■	■	□	
	Interactive ATIS with GIS, GPS and ATIS		□	□		□				■	□	
	Mayday Support		■		■				□	■	□	
	Parking Management		■							■	□	
	Billing Support		■						■	□	□	
	In Vehicle Signing		■		■	□				■	□	
ATMS	Basic Traffic Monitoring /Management	□	■							□	□	
	Area Wide Traffic Management		•		■					□	0	
	Traffic Prediction		□								□	
	Travel Demand Management		□	■	■				■	■	□	
	Automated Toll Plaza	■	□		■				■	■	□	
	HOV Lane Management		□	■	□				■	■	□	
	Reversable Lane Management		□		□					■	□	
	Probe Vehicle Instrumentation		□		■				□	■	□	
CVO	Vehicle Tracking and Dispatch	□	■						□		□	
	Material Tracking	□	■								□	
	Credentials	■	■		■				■	■	□	
	Safety for CVO		□		■					■	□	
AVSS	Onboard Safety		■			■		□			□	
	Private Vehicle Safety		■			■		□			□	
	Driver Visability Improvement		■			■		□			□	
	Advanced Vehicle Longitudinal Controls		■			■		□			□	
	Automated Highway System		□		■	■		□	■	■	□	
	Intersection Collision Avoidance		■			■		□		■	□	
EM	Emergency Response	■	□		■					□	□	
	Emergency Vehicle Maintenance		□								□	

4.1 FIRST USER BENEFITS

The provision of early benefits is central to the success of IVHS, and therefore needs to be a major consideration in system architecture design and implementation.

4.1.1 Architecture Assessment

The Rockwell architecture insures the provision of first user benefits, both in terms of its logical and physical architecture, as well as in its evolutionary design. Regarding the former, the architecture supports first user benefits through its definition and use of market packages. Market packages allow for modular deployment of IVHS functionality in a manner linked to specific user benefits. In contrast to an architecture which would tightly integrate a range of user services--thereby raising the cost of such a bundle--the modular approach facilitates the ability to implement specific market packages aimed at delivering early benefits to users.

4.1.2 Deployment Implications

The actual mechanism for ensuring such early benefits is the evolutionary deployment strategy. As noted below, the strategy places a high priority on deploying those market packages associated with early benefits. In terms of specific market packages, the evolutionary deployment strategy provides for early system benefits by encouraging the deployment of several market packages. Early deployment of the following packages would facilitate early benefits to a variety of uses (see Table 4-1): passenger and fare management (APTS), broadcast based ATIS, automated toll plazas (ATMS), and credential services (CVO). These services will ensure that a wide range of beneficiaries receive early benefits from IVHS. Passenger and fare management services will provide tangible benefits (in terms of increased convenience, etc.) to transit users. Broadcast-based ATIS will provide for wide dissemination of traffic information. Early deployment of credentials will aid the productivity of the nations truckers and trucking companies.

4.2 COST-BENEFIT ALLOCATIONS

By relying on existing and emerging infrastructures to the maximum extent possible, the proposed architecture ensures the maximum marginal benefits per IVHS cost expended.

4.2.1 Architecture Assessment

The design of the market packages link what ever costs there are with the beneficiaries of those costs, providing a natural guard against unfair cost allocations. Further, the market package design provides a range of options, from low cost--moderate benefit, to high cost--high benefit, thus providing a range of options for users.

In terms of allocations between public and private sectors, the architecture adheres to the general institutional arrangements that surround transportation and communications infrastructure and thereby imposes no major shifts in allocation of costs between the consumer and the public sector. For example, the high-end functions for ATIS are allocated to the vehicle, in keeping with the principal that these features should be the domain of consumer purchasing decisions, rather than considered an element of the public infrastructure.

The allocation of market packages between the public and private sectors has corresponding implications on the allocation of benefits across various users. The designation of market packages provides different gradations of functionality, from low end to high end. In addition to the aforementioned early beneficiaries (see 4.2.1), low end functionality ensures that IVHS benefits are available to a wide spectrum of users: from low-income users to high income users, from large cities to small towns.

4.2.2 Deployment Implications

The evolutionary deployment strategy supports the equitable allocation of costs and benefits by focusing public investment on low level market packages that provide the widest benefits. As can be seen in the various scenarios (Chapter 6), early attention is placed on basic traffic and transit management and information services in urban areas, and commercial and safety provisions (e.g. Mayday) in rural areas. Moreover, as the deployment is predicated on existing and emerging infrastructures, the costs per user are lower than would otherwise be the case. For example, in the area of traffic information, the use of the cell-based infrastructure makes information readily available to the growing cellular market, rather than introducing an entirely new infrastructure that would have to initiate an entirely new market.

As noted in Table 4-1, there are a host of market packages associated with the equity issue, particularly those with significant public/private partnerships (e.g. ATIS, CVO, AVSS). The core concern across these market bundles is that public funds not be used to unduly benefit a small segment of society that can afford the service. This concern is mitigated by focusing the evolutionary deployment strategy (and related federal investment), on those market packages that would provide the widest benefit to consumers and users (see Section 4.1), including the provision of basic safety.

4.3 ENVIRONMENT / ENERGY IMPACTS

A major goal of contemporary transportation policy--as exemplified by provisions of ISTEA and CAAA--is to deploy transportation systems which minimize adverse environmental impacts, and where possible, promote environmental gain.

4.3.1 Architecture Assessment

By providing an open, modular architecture, regions will have the flexibility to choose, support, and fund those modular elements that best address the transportation and air quality challenges within their region. That is, by not (over)prescribing system design, the Rockwell's architecture facilitates the ability of regional entities such as Metropolitan Planning Organizations (MPOs) to design regional IVHS implementations in keeping with their own priorities. Indeed, the institutional element of the Rockwell architecture explicitly recognizes the role of these and other public agencies in transportation policy, and has designed market packages that are uniquely suited to such public policy needs (e.g. transportation demand management; electronic toll collection, HOV Lane Management).

While the current FHWA listing of user services focuses on air quality dimensions, the modular design of the Rockwell architecture would permit new functionality and subsystems to be developed in order to incorporate new elements as required. For example, in addition to the

emerging need to feature remote sensing, other forms of onboard sensing (not only of emissions but also energy usage) could become technological feasible over the next several years. The integration of IVHS subsystems with these onboard systems could represent a new wave of clean car technology which the Rockwell architecture could accommodate (for example, through the creation of an environmental management subsystem.)

4.3.2. Deployment Implications

The evolutionary deployment strategy encourages the early application of IVHS for air quality and related environmental purposes. The rationale for this support is straightforward: with close to 100 of the nation's metropolitan areas struggling to achieve the gains mandated in the CAAA, IVHS architecture deployment must provide guidance if it is to be relevant to the public decisions confronting most of the metropolitan areas in the country. There are two mechanisms for supporting this application: guidance and financial aid. Strategic policy guidance could be provided for deploying IVHS in non-attainment areas; such guidance would assist regions' in tailoring market packages to their specific attainment policies. In terms of financial incentives, funds for deploying clean air strategies (such as the CMAC program) could be considered for those market packages aimed for non-attainment areas. Specific market bundles for achieving these goals include: passenger and fare management (APTS), travel demand management, electronic toll collection, and HOV Lane Management.

4.4 INTER-JURISDICTIONAL DISPUTES & LOCAL GOVERNMENT COORDINATION

According to the 1992 IVHS America Strategic Plan, certain system architectures will be superior to others because of their "institutional implications." This emphasis on the institutional implications is justified. The institutional framework of the deployment strategy is pivotal to successful *regional* deployment because, as the Strategic Plan indicates, "Most institutional issues arise from the integration of different components of the transportation system into a single [super] system That interconnection of parts requires the interconnection of the institutions associated with those parts."

4.4.1 Architecture Assessment

Institutional issues cover a wide gamut from inter-jurisdictional, (both public-public and public/private) to intraorganizational (such as training and staffing). The Rockwell architecture explicitly recognizes the importance and the challenge of these issues by incorporating them into an institutional layer within the system's physical architecture. The implication of this is two fold: 1) in a manner similar to the reliance on existing and emerging infrastructures, the Rockwell approach relies on existing and emerging institutional structures for the delivery of IVHS products and services, and 2) by doing so, the approach acknowledges the challenge of achieving institutional support and coordination for an open architecture.

The range of institutional issues affected by the IVHS architecture is quite broad, encompassing both the strengths and weakness of both the public and private sectors (see Figure 4.4. 1- 1). As delineated in Appendix F, these entail a host of individual issues, ranging from government

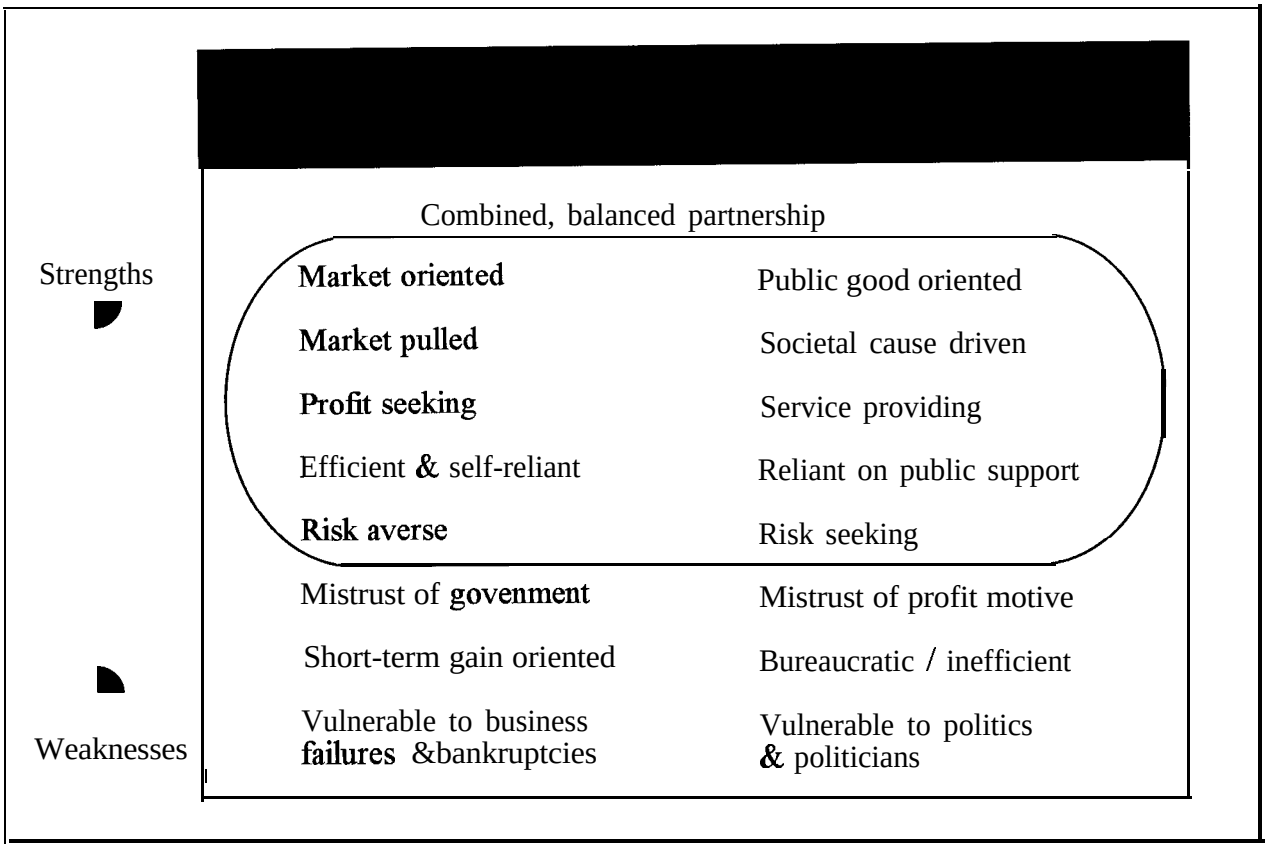


Figure 4.4.1-1: Strengths and Weaknesses of Private and Public sectors

procurement issues, to private sector concerns about partnerships. Many of these constraints will await IVHS regardless of the architecture chosen, while some are uniquely associated with the Rockwell approach. In particular, the issue of inter-jurisdictional coordination (on the pubic sector side) and standards (on the private sector side) are two key challenges to the distributed open systems approach inherent in the Rockwell architecture.

4.4.2 Deployment Implications

The evolutionary deployment of IVHS will need to address the major institutional challenges associated with the Rockwell Architecture. As noted by the Risk Analysis (see section 5.3.3), these include the issues of institutional cooperation, funding and budget stability, and system integration challenges. The principal effort to mitigate these risks is to minimize the extent to which early deployment requires new levels of institutional cooperation while at the same time creating incentives for achieving such cooperation over time.

While the need for public sector cooperation pervades IVHS, in the near term it is most acute for the ATMS bundle, as this bundle provides much of the sensing and traffic management information utilized by many of the other market packages (see Section 2.3). Consequently, a key aspect of the evolutionary deployment strategy is to ensure the timely implementation of areawide traffic management centers; this can be done through technical guidance, and financial incentives for timely implementation. Other market packages which could warrant similar treatment include

emergency response (EM), passenger and fare management (APTS), and credential checking in CVO; all of these can produce early benefits but entail significant institutional cooperation for these benefits to occur.

The need for public-private sector cooperation is, in the long run, the most significant challenge facing IVHS. The AVSS market packages, for example, require unprecedented changes in the automobile to achieve system goals. In the near to mid-term the ATIS and CVO market bundles will be heavily, dependent on private sector participation. From a deployment strategy perspective, the process by which regions' devise architectural implementation plans will serve as an important opportunity to develop inter-jurisdictional and public/private agreements. These partnerships can be encouraged by an evolutionary deployment strategy which provides guidance on partnerships to localities and to develop open standards approaches which will encourage private sector participation.

4.5 LIABILITY

Tort liability is a major area of concern in surface transportation. State Departments of Transportation confront millions of dollars in liability claims annually, as do the automobile manufacturers.

4.5.1 Architecture Assessment

The Rockwell system architecture aims to minimize any additional liability by imposing no major shifts in legal responsibility: both the subsystems and the market packages follow the distribution of costs and ownership typically associated with transportation.

Nonetheless, there are several market packages which could pose liability concerns. In the near term, the liability concern is most often associated with the ATMS and ATIS market bundles. According to the FHWA Non-technical Report to Congress, there is considerable case law to suggest that the public sector would retain significant liability responsibility for ATMS systems, unless their development deviated from specified standards. The allocation of responsibility for route guidance is less clear, though there have been cases (for example, in Virginia) where the public agency assumed responsibility for adverse consequences due to faulty directions. In any case, the FHWA report--based on a series of supporting analyses--concluded that liability does not represent a significant near term constraint, and that potential concerns can be addressed through the IVHS program (see Deployment Assessment section below).

In the long term, the most significant liability concern pertains to the AVSS market bundle, and in particular, to those AVSS that assume control of the vehicle. Given that the deployment of these market packages are in the 20-year-plus time frame, this non-technical constraint does not represent an immediate impediment to IVHS deployment. Rather, it represents a non-technical concern that can be addressed over the course of the AHS Consortium.

4.5.2 Deployment Implications

Because the Rockwell architecture does not represent a major shift in liability responsibility, there are not any legal changes required to implement the architecture. Nonetheless, deployment steps can be taken to minimize the exposure of participating parties. This includes the development of

adequate performance standards for IVHS market packages, the testing of new market packages (through operational field tests, etc.) to obtain data on the performance of new market packages relative to the standards, and the ongoing education and training of IVHS professions to ensure that products and services are delivered in a competent manner.

4.6 ANTITRUST

In devising a nationwide system architecture for IVHS deployment, it is important to ensure a "level playing field" for private sector participation in the provision of goods and services.

4.6.1 Architecture Assessment

The open, modular architecture facilitates such participation and, conversely, does not encourage closed proprietary systems. As a result, the risk for unfair market dominance--at least as achieved through architecture decisions-- is minimized. As with any sphere of economic activity, the development of markets and assurance of competition will be the proper domain of the US Department of Justice and related communications and transportation regulatory agencies (as specified in the institutional layer of the architecture).

With regard to the market packages, anti-trust issues would conceivably be most relevant to those areas that had significant private sector involvement (e.g. the ATIS, AVSS bundles). However, even in these cases, the potential for anti-trust problems appears minimal. According to the aforementioned FHWA Non-technical Report to Congress, the federal government has passed several major pieces of legislation (such as the National Cooperative Research and Production Act of 1993) which aim to minimize anti-trust actions brought against joint ventures. The report concludes that anti-trust is not a manifestly important constraint to IVHS deployment. And given the extent to which the Rockwell architecture mirrors existing institutional arrangements, it is not an inherent constraint of the architecture either.

4.6.2 Deployment Implications

Even though anti-trust does not appear to be a central constraint to architecture deployment, it will still be important to ensure that deployment of IVHS is done in a competitive manner. The deployment strategy, therefore, features an open systems approach to standards development (as described in Section 4.9), which will encourage vendors and suppliers to participate in the program and guard against unnecessary market dominance in IVHS.

4.7 PATENTS

Because many of the IVHS packages involve public and private cooperation, there can be concern (and disputes) about the retention of property rights.

4.7.1 Architecture Assessment

While such a concern is not unique to the Rockwell approach, it nonetheless is an inherent concern as many of the ATIS and AVSS packages rely on new products and services being developed. Presentations at a recent national IVHS Workshop on Intellectual Property Rights revealed that current federal policy encourages private sector participation and retention of property rights, whereas state and local governments can have more limitations and restrictions in

the use of public funds. These complications are reflected in the institutional layer of the Rockwell architecture, which delineates the interrelationships between the various levels of governments and the private sector.

4.7.2 Deployment Implications

Guidance for the state and local governments can assist in ensuring that concerns about design and product patents do not unnecessarily retard the deployment of IVHS market bundles. Experiences with the operational field tests suggest that interagency agreements can be reached and actions can be taken to devise public/private accords on intellectual property rights. Nonetheless, many discoveries and breakthroughs will be encountered. Copyrighting and patenting products produced by teams with public and private funds and interests can be extremely complex. There is, and will continue to be, a need to clarify and remove many ambiguities surrounding proprietary interests of involved parties (e.g., what can/cannot be confidential, who owns what, who should be informed of what, when, by how much, etc.). While the open nature of the Rockwell architecture provides opportunities for the private sector, there is nothing inherent in the architecture which should complicate the process of arriving at mutually acceptable agreements in this area.

4.8 PRIVACY

There are widespread concerns about loss of privacy associated with various IVHS market packages. This includes concerns over surveillance, disclosure of personal information, and loss of privacy in commercial settings.

4.8.1 Architecture Assessment

Being a distributed system the Rockwell architecture is susceptible to security and privacy breaches, and in this regard, actions can be taken in the deployment of the architecture to ensure that confidentiality and privacy are maintained. Other features of the architecture directly contribute to reducing privacy concerns. For example, the architecture does not rely on passive probes, a mechanism which--if used could allow for unwanted surveillance of travel. The institutional element of the architecture is also significant in that it highlights the ongoing role of the courts and regulatory agencies in balancing public rights to privacy with the (sometimes) competing rights of law enforcement agencies to ensure public safety.

4.8.2 Deployment Implications

A range of actions will need to be taken to ensure sufficient privacy associated with IVHS market packages. This can include the development of guidance and agreements for protecting identities of individuals to building in technical safeguards to relevant subsystems, for instance the billing subsystem Like many other aspects of IVHS, it should be noted that the challenge of maintaining proper confidentiality of information is not unique to these market bundles. Other industries, for instance the banking industry, have successfully implemented distributed systems with significant privacy and security requirements. To the extent that IVHS market bundles can rely upon these or similar mechanisms, they will benefit from extant security systems. For example, both the banking and communications (e.g. cellular) industry have billing systems which could be applied to a variety of market packages, including passenger and fare management, travel demand management, and electronic toll congestion.

Regarding surveillance, there are fewer parallels and extant practices to aid IVHS market package integration. The key issue pertains to an individuals exception for privacy, and related public objections to "big brother" type practices. While the courts have generally ruled that actions on the highway should not be considered "private" (see FHWA,1994), it is nonetheless important that architecture implementation minimize intrusion through surveillance. Thus, supporting guidelines should be developed to assist in deploying surveillance-oriented packages. The packages would include interactive ATIS with Route Planning, HOV Lane Management, and (to some extent) CVO vehicle tracking and dispatch. A more complete discussion of privacy issues is provided by Professor Glancy (Rockwell Team Member) in Appendix D.

4.9 STANDARDS

The main driving need for standards is not so much about the technical "interface" issue, as about the whole *confluence* of technical, economic, and societal issues. Standards may be viewed as the end result of a variety of technical, managerial, economic, social, and legal factors and may indeed appear very technical.

4.9.1. Architecture Assessment

The Rockwell Architecture acknowledges this junction of issues by:

- The three level model (Institutional, Transportation, and Communication) of the Physical Architecture as the most natural or fundamental guidance for *where* the subsystem interfaces are and will occur.
- Emphasis on utilizing *existing* infrastructure with planned evolutionary migration to more integrated and sophisticated deployments.
- Attention and sensitivity to what level and scope of mandated architectural standards is understandable and manageable for all parties, especially within the near-term stages of deployment.

The above attributes of the Rockwell Architecture address the original mandate for development of an IVHS system architecture and standards. That mandate was motivated by the objective for compatibility and interoperability *across* regional boundaries, and more specifically, for the two functional areas of IVHS that are mostly affected by this objective, namely (1) Advanced Traveler Information Services (ATIS), and (2) enforcement, permitting, and compliance systems related to Commercial Vehicle Operations (CVO) and Electronic Toll Collection (ETC).[2]

From the perspective of multi-jurisdictions or regions, the above functional areas frequently involve incompatible equipment (i.e., as in ETC, CVO, and ATIS) or multiple sources/ destinations of information requiring standards for interconnectivity and for data interpretation (i.e., as in ATIS). Section 4.4 enumerates, in a more complete manner, the key inter-jurisdictional interfaces that need coordination and specification. Several of the nation-wide equipment interface standards are already in progress. The relative priority and mechanisms used to specify the subsystem (external) interfaces and an anticipated time frame are discussed in the deployment

[2] IVHS Primer, Transportation Research Circular, Transportation Research Board, July 1, 1993, page 9.

strategy. From the standpoint of encouraging early deployment and leveraging existing infrastructure, the subsystem interfaces that are *internal* to any center (e.g., a TMC) will be much lower priority than the interfaces external to the centers.

As originally suggested, the enormous existing assets and infrastructure within each of these three levels are the fundamental driving factor that must be accommodated by the architecture that will ultimately be implemented.

Guidance for standards establishment within the Rockwell Team physical architecture is presented in Figure 4.9.1-1. One of the key roles for the architecture in realization of IVHS user services is as a framework guiding the establishment of standards which will ensure nationwide interoperability. As presented in the figure, several levels of standardization, ranging from no standard (unconstrained interface) to complete standardization of transport, signaling and application layer protocols are suggested. In general, the minimal level of standardization necessary to achieve nationwide interoperability is suggested by the diagram. The following rules were used in making the standards assignments

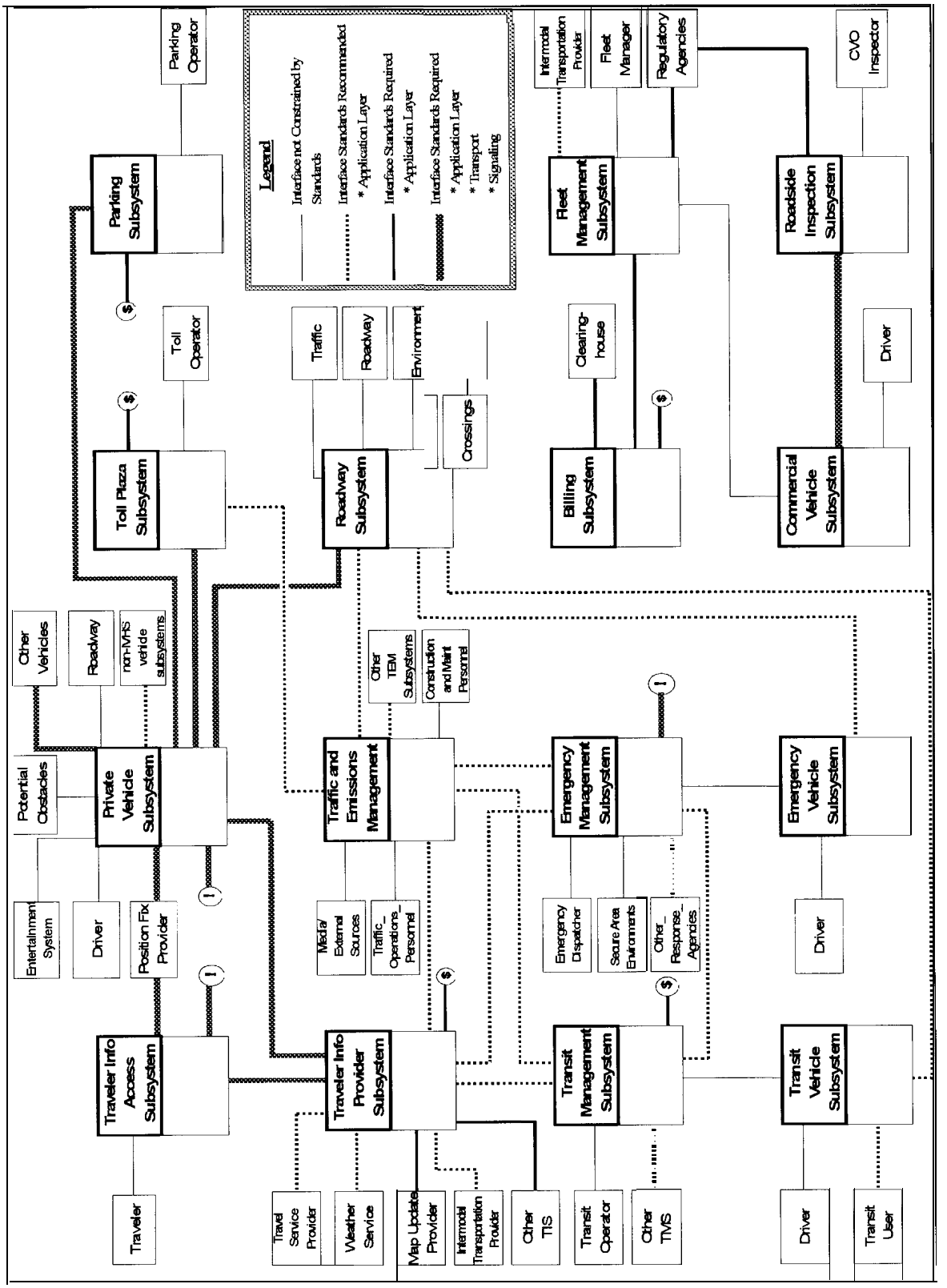


Figure 4.9.1-1: Physical Architecture Framework for Standards

1. Interfaces between subsystems which are operated and maintained by a single authority do not require standardization to achieve national interoperability. In cases in which the equipment on both sides of the interface is owned and operated by the same entity, the communication mechanisms and protocol which are used is transparent to the remainder of the architecture. In some cases, national standards for these interfaces are still attainable and beneficial since they may consolidate a market to achieve economy of scale efficiencies (e.g. Traffic Management Subsystem to Roadway Subsystem). Such standards would also support an optional level of interoperability which would allow various cooperative control options to be implemented based on regional preference. In other cases, the sheer range of application-specific interfaces precludes efficient national standardization. No national standard is recommended for the interface between the Fleet Management and Commercial Vehicle subsystems since the nature of the interface is so dependent on fleet type.
   Examples: Traffic Management Subsystem to Roadway Subsystem, Fleet Management Subsystem to Commercial Vehicle Subsystem.

2. Those interfaces that connect subsystems which may be operated by different agencies (interface can cross jurisdictional and/or regional boundaries) should be standardized. This standardization facilitates the sharing of information between agencies across jurisdictional boundaries. National standards mitigate issues as boundaries change and new requirements for information sharing develop over time.
   Example: Traffic Management Subsystem to Transit Management Subsystem, Traffic Management Subsystem to Traveler Information Service Provider.

3. Interfaces to the mobile subsystems (vehicles, traveler information access subsystems) in the architecture are rigidly enforced since the same mobile subsystem should be able to roam the nation and use the local infrastructure to support IVHS services. Standards are required for all interfaces to mobile subsystems except where both the mobile subsystem and interfacing infrastructure are owned and operated by the same user.
   Examples: Traveler Information Service Provider to Traveler Information Access Subsystem, Roadway to Private Vehicle, Commercial Vehicle to Roadway Inspection Station.

4. As a minimum, application layer protocol specifications should be included in the standard. This degree of standardization provides some latitude in selection of the medium/frequency and signaling protocol used to exchange the application data to support regional preference. Standards which govern the interface to mobile subsystems should also include transport and signaling layer protocol specification to ensure the mobile subsystem can make use of the local infrastructure to support IVHS user services regardless of where in the nation it is.

Based on these recommendations, the standards associated with each of the market packages can be determined. These dependencies are derived and highlighted in Table 4.9.1-1. The table includes a summary of all subsystem interfaces supported by each market package for which a standard is recommended or required. Based on this assessment, an overall standards dependency rating is provided for each market package in the right-most column in the table.

Table 4.9. l-l: Market Package Standards Dependencies

	Market Packages	Standard Interfaces Supported	Standard
APTS	Passenger and Fare Management	Transit User - TVS TMS - BS	❑
APTS	Transit Vehicle Tracking		
APTS	Transit Security		
APTS	Transit Operations Planning	TMS - EMS/ TEM/ TIPS	❑
APTS	Transit Maintenance		
ATIS	Broadcast Based ATIS	TIPS - PVS/TIAS TIPS - TMS/TEM/EMS	■
ATIS	Interactive ATIS with Infrastr Route Plan	TIPS - PVS/TIAS TIPS - TMS/TEM/EMS/BS/TIPS	■
ATIS	Interactive ATIS with GIS, GPS and ATIS	TIPS - PVS/TIAS TIPS - TMS/TEM/EMS/BS/TIPS	■
ATIS	Mayday Support	EMS - TIAS/PVS	■
ATIS	Parking Management	PS - PVS/BS	■
ATIS	Billing Support	BS - TMS/TIPS/TPS/PS	❑
ATIS	In Vehicle Signing	RS - PVS	■
ATMS	Basic Traffic Monitoring/Management	TEM - RS/TIPS	❑
ATMS	Area Wide Traffic Management	TEM - RS/TIPS/EMS/TMS/TEM	❑
ATMS	Traffic Prediction		
ATMS	Travel Demand Management	TEM - RS/TIPS/EMS/TMS/TEM TIPS - PVS/TIAS	■
ATMS	Automated Toll Plaza	TPS - PVS	■
ATMS	HOV Lane Management	TEM - RS/TIPS	❑
ATMS	Reversable Lane Management	ITEM - RS/TIPS	cl
ATMS	Probe Vehicle Instrumentation	TEM - TIPS - PVS	■
CVO	Vehicle Tracking and Dispatch		
CVO	Material Tracking		
CVO	Credentials	FMS - BS RIS - CVS	■
CVO	Safetv for CVO	RIS - CVS	■
AVSS	Onboard Safety		
AVSS	Private Vehicle Safety		
AVSS	Driver Visability Improvement		
AVSS	Advanced Vehicle Longitudinal Controls		
AVSS	Automated Highway System	TEM - RS - PVS	■
AVSS	Intersection Collision Avoidance	TEM - RS - PVS	■
EM	Emergency Response	EMS - TEM/TIPS/TMS	❑
EM	Emergency Vehicle Maintenance		
Legend		Recommended standard supports market package	❑
		Required standard supports market package	■

Standards dependencies are "soft" in that an absence of published standards will be a negligible deterrent (perhaps even viewed as a potential opportunity) to the product developer pursuing new markets. Historically, standards have followed commercial markets rather than led; it is assumed that this general principle will be repeated for IVHS deployments. Where there is clear benefit (e.g., existing market opportunity) to early deployment, it is understood that many market package deployments will occur before the related standards are available. Such early deployments will ultimately be at risk since any pre-existing equipment may be in conflict with the standard which is finally adopted. The alternative, to somehow regulate entry to the market until the standards are complete is neither viable nor attractive. Early deployments are necessary to provide the standards bodies an understanding of all the issues at hand; they provide valuable input to ensure the standards which are finally adopted are viable.

4.9.2 Deployment Implications

The key deployment consideration in the area of standards is the reliance on partnerships and alliances for institutional cooperation and technical collaboration to achieve mutually identified goals and objectives.

- Relies heavily on existing infrastructure, organizations and any related existing standards to allow *early* deployment of "islands" of capabilities and cost-effective benefits.
- The Physical Architecture related "Interface Standards" are identified as being 'located' between the key architecture elements, packages, and bundles. These standards (already existing or when actually developed) describe and specify data formats and communication protocols.
- Internal interfaces contained within the identified subsystems will not be specified. This means, for instance, that a traffic management subsystem may be deployed in many different ways without violating the architecture.
- Risk mitigation strategies will be recommended and supported that relate to software development cost reductions and procurement planning to better assure the integration of TMC software provided by multiple vendors. This general subject is often referred to in the software/ computer industry as specifying and designing "Open Systems". These matters are treated as deployment support rather than architectural interface standards, even though such strategies may include some form of standards and practices. Open system standards is a process that is the subject of ongoing activity (outside of IVHS) by many government and private groups. The Phase II stage of the Architecture will investigate and make relevant recommendations in this area.
- Any interventions (concerning architectural compliance) are based on the institutional element of the architecture and would normally take the form of encouraging stakeholder involvement, creativity, commitment, and inter-jurisdictional cooperation through:

    - Minimal intervention in the regional and local levels of the public sector, while also providing.. .
    - Reasonable policy guidance and support for cost effective procurement from multiple vendors, and.. .
    - Strategic investments to maintain the cost-feasibility of IVHS.

To recap, the recommended Physical Architecture framework is open and adaptable to support the full range of services by

Planning and acquiring **support** for specific User Services within the Socio-economic Layer and defining **the specific user external data interface requirements** for those services.

Using (existing) and/or structuring (possibly new) **data-collection, data-processing** and **data-storage** functionality for a range of User Services within the Transportation Layer.

Defining and/or recommending **information transfer channels** and **protocols** within the Communications Laver.

Additional detail on standards development can be found in Appendix G.

4.10 EDUCATION AND STAFFING

The education and staffing requirements to deliver IVHS products and services will represent a significant challenge to the transportation and communications industry. While reports by the Urban Institute suggest that this demand will be met through the market place, there is nonetheless the challenge of ensuring that appropriate training steps are taken to ensuring the successful implementation of the IVHS.

4.10.1 Architecture Assessment

The open systems approach taken by the Rockwell team necessitates appropriate training so that informed decisions can be made in choosing particular market packages to be deployed. Such training would encompass the technical elements of the architecture, as well as the non-technical elements associated with its deployment. The training would also facilitate knowledge and participation by both the public and private sector.

4.10.2 Deployment Implications

While the issue of education and training transcends architectural implementation, there are important connections: training will be needed commensurate with the gradual evolution of the architecture so that the architecture is used in devising public and private sector deployment scenarios. In order for an architecture to be successful, it must be implemented, and in order for it to be implemented, it must be understood. Developing companion training courses on utilizing the IVHS architecture would help fulfill this goal. For example, an early training need would address the development of regional architecture approaches and public/private approaches to deploying architectural elements. Training requirements for systems integration will increase as deployment of the architecture increases. In keeping with other elements of the Rockwell architecture, the use of existing educational infrastructure would be encouraged as a mechanism to provide such training

4.11 Regulatory Constraints

As recognized by the institutional layer of the Rockwell Architecture, the deployment of the IVHS systems architecture involves a host of investment and procurement decisions. While some of these decisions will fall within the normal purview of the public and private sector, many of the market packages will represent significant challenges to both sectors.

4.11.1 Architecture Assessment

On the public sector side, high-technology procurements are generally viewed as difficult for the public sector for they are not amenable to low-bid procurements, etc. Also, establishment of public/private partnerships in the deployment of market-packages can evoke concerns about various practices, such as retention of intellectual property constraints. While the Rockwell architecture does not inherently mandate such new arrangements, they are inherent to IVHS and therefore need to be addressed as part of the deployment.

4.11.2 Deployment Implications

The deployment of IVHS market packages needs to recognize that procurement and related regulations--while not major impediments--can delay the achievement of needed early benefits and increase the costs for all sectors. Consequently, a diversity of approaches for encouraging IVHS systems architecture deployment will need to be followed. This includes guidance on procurement streamlining and public/private partnerships, standards development to promote open product development, and strategic financial incentives to promote efficient and innovative investment action. In terms of market packages, the issue of procurement streamlining is expected to influence public sector related bundles--such as ATMS and APTS--while partnership constraints will most directly affect packages within the ATIS and CVO bundles.

5. Proposing a Strategy

This section develops the evolutionary deployment strategy for the Rockwell Team architecture. Because the Rockwell Team approach emphasizes an open architecture, the strategy does not (over)prescribe a particular implementation. Rather, the strategy focuses on actions which can support IVHS implementation decisions in the public and private sector.

After defining basic terms in paragraph 5.1, a general guiding strategy is presented in paragraph 5.2. Paragraph 5.3 expands on this basic strategy through explicit definition of deployment mechanisms that are required in response to the issues and assumptions presented in sections 2 through 4; this material constitutes the majority of section 5 and represents the essence of the Evolutionary Deployment Strategy defined by the Rockwell Team

5.1 What is "Evolutionary Deployment Strategy"

An understanding of the strategy presented in this document requires a shared definition of what is meant by "evolutionary deployment strategy". Each of the three words is integral to understanding subsequent analyses.

Evolutionary refers to an adaptive sequential ordering of deployment stages and/or services.

Deployment is the implementation activity. User services are implemented through market packages defined in the Physical Architecture document and summarized in section 2. Three stages of deployment may be considered:

> Initial deployment -- when a user service first exists in an operational setting. The key word is operational -- the service is not experimental or a demonstration project. Moreover, the financial and institutional structures are operational as well, e.g., funding responsibilities are being borne by the individuals/groups in the way that is designed for the life of the system not just the start-up period.
>
> Threshold deployment -- is a level of deployment that triggers a new level of service quality or the introduction of a new service component. Deployment thus incorporates market penetration, that is, the service is actually used rather than just available. Threshold deployment is the minimal level of deployment for efficient operation of that service and may also constitute the minimal level of deployment for efficient operation of a related service (as a result of interdependencies).
>
> Full deployment -- is achieved when there is widespread usage of that service well in excess of threshold conditions to achieve system efficiency.
>
> Deployment also takes place in more than one dimension. If the system architecture is perceived as composed of different-sized blocks, construction proceeds from the laying of the first block to the completed edifice through three primary dimensions: Time -- when a specific element is put into operation, Space -- where a specific element is put into

operation, and, Level of sophistication -- the technical capabilities and specifications of the service.

Strategy implies that there is a plan for transforming the architectural concepts into an operational capability. The selection of stages and/or services is not arbitrary or random; rather it is the product of systematic analysis. The overall strategy encompasses mechanisms for implementing the IVHS architecture through the defined market packages.

5.2 Basic Strategy

A general statement of the strategy follows:

Deployment will be based on key architecture features, andperformed in a manner responsive to user and market needs, while at the same time responsive to public sector needs for an institutionally-viable, safe, multi-modal transportation infrastructure.

Recognizing the generalized nature of our basic strategy, Table 5.2-1 provides both techniques for implementing the strategy as well as references to supporting analyses contained in this document and companion documents developed under the IVHS Architecture Development Contract.

Consideration for technological feasibility, market acceptance, and institutional issue resolution as specified in the basic strategy implementation yield a series of time-sensitive objectives. Table 5.2-2 characterizes the incremental deployment of increasingly sophisticated services at increasing levels of penetration.

As presented in the table, the implementation evolves:

- Through the roadway hierarchy beginning with the most traveled routes and ending with the lightly traveled secondary streets and rural roads.

- Starting with deployment in high value commercial and transit vehicles (where the relatively high cost of initial technology deployments is more effectively absorbed) and moving to lower value private vehicles as the services become less expensive.

- To satisfy increasing user expectations as services become more sophisticated. Information services may progress from uniform broadcasts (everyone gets the same information) to interactive personalized services (subscribers receive information tailored to their specific needs) to system-wide coordinated services (personalized information reflects previous information distributions). Control services begin by supplying advice and warnings which do not dilute user control. As technology improves, institutional issues are resolved, and user confidence is increased, more control responsibility can be automated. Where appropriate, fully automated systems may be realized.

- In the degree of integration as independent products are installed on a limited basis and then integrated and expanded to service broad geographic regions.

Table 5.2-l: Strategy Implementation

Strategy Statement	Strategy Implementation	Basis In Architecture Analysis
'Deployment will *be based on key architectural features.."*	Consider the market packages as a central deployment unit.	Physical Architecture
	Focus early deployment on market packages that: 1. provide basic technical dependencies for near term services, and 2. stimulate new IVHS services and products.	Physical Architecture Initial Cost Analysis Institutional Analysis (Sect.4)
	To the extent possible, rely on existing/emerging infrastructure and manifest markets.	Physical Architecture Initial Cost Analysis
..in a manner responsive to user and market needs	Target first deployed services to specific segments of society who are interested in trying smart technologies, able and willing to buy IVHS systems, and pay for services.	Initial Cost Analysis Institutional Analysis (Sect.4) Feasibility/Risk Analysis
	Respond to specific individual needs, preferences, and limitations of travelers and system users.	Feasibility/Risk Analysis
	Deploy services in a manner which encourages system ownership, providing identifiable niches for investment and market development.	Initial Cost Analysis
	Deploy services in a manner that minimizes the possibility of invasion of privacy.	Institutional Analysis (Sect.4)
.,while at the same time responsive to public sector needs for an institutionally viable, safe, multi-modal transportation infrastructure.	Begin deployment with those subsystems and services that will yield the highest payoffs at the lowest costs with the least risk, building off of existing deployments where possible.	Performance/Benefits Analysis
	Deploy systems with minimal reliance on interjurisdictional arrangements, while providing incentives and/or mitigation measures for deploying interjurisdictional systems.	Institutional Analysis (Sect.4) Feasibility/Risk Analysis
	Balance the deployment of IVHS systems so as to minimize adverse environmental impacts, and where possible, achieve environmental gains though market-based and multi-modal strategies.	Institutional Analysis (Sect.4)
	Implement mechanisms to ensure continued funding for operation and maintenance after systems are deployed.	Initial Cost Analysis Feasibility/Risk Analysis Institutional Analysis (Sect.4)
	Establish standards to ensure performance, safety, and interoperability of the system.	Institutional Analysis (Sect.4)

Table 5.2-2: General Deployment over Time

Category	Time Phase		
	Early	Mid	Late
Deployment (Transp.)			
Infrastructure	Freeways	Arterials	Streets and Roads
Vehicle	Buses, Trucks	High-end Autos	Automobiles
Capabilities			
Information	Broadcast	Personalized	Fully Coordinated
Control	Warning/Advisory Systems	Partial Automation	Full Automation
Integration			
Systems	Individual subsystems	Integrated subsystems	Nationwide interoperability
Geographic	Jurisdiction	Regional	Area-wide

5.3 Deployment Support Mechanisms

The Rockwell Team deployment strategy encourages the natural evolution of IVHS through market development and appropriate public sector decision-making, and intervenes only where necessary to stimulate and ensure the achievement of system inter-relationships, system goals (e.g. safety), and deployment of key technical dependencies. Based on the institutional element of the architecture, the intervention can take a variety of forms. Three key dimensions are:

- Policy guidance -- at the most general level, the evolutionary deployment strategy should provide implementation guidance to implementing agencies and participating companies.

- Standards Management -- this extends guidance to be more directive: to manage the physical interfaces defined by the architecture and the institutional interfaces required for its deployment. The development of standards and protocols is a key feature as are inter-jurisdictional cooperative agreements.

- Strategic Investment -- at the most direct level, the architectures' evolutionary deployment strategy should have implications for, if not encourage, strategic investment in key elements in order to encourage the development of IVHS benefits and to encourage related private sector activity. The need to maintain the cost-feasibility of IVHS is a key constraint

APPENDIX F:
Demonstration of Feasibility Analysis Technique

The FAT method essentially consists of four steps: The first involves a canvassing of major stakeholders for their current views on a key issue. These views are recorded as +1 (pro), - 1 (con), or 0 (neutral) and then a subjective estimate from 0 to 1 is made of the issue's salience level for each stakeholder (i.e., probability that it will adopt and sustain the coded position). The resulting issue positions are arrayed on a continuum showing intensity of support or opposition, with scores ranging from + 1 to - 1, and 0 representing indifference or neutrality. The second step involves subjective measurement from 0 to 1 of each stakeholders available resources (e.g., FTE staff, budget, PAC money, access to expertise/information, prestige of lobbyists, legitimacy in eyes of the Public, ability to mobilize membership). These are then ranked (step 3) in terms of how much of its available resources each stakeholder is willing to commit to support its issue position.

This ranking reflects the reality of having to decide where to focus among competing issue areas. As a final step for those wanting to make their subjective judgments quantitatively explicit, the initial coded position (+1, -1, or 0) is multiplied by the probability (O-l salience level), which is then multiplied by the available resources and the resoure rank to achieve a feasibility assessment score. Table X provides a simple illustration of the technique applied to a hypothetical AHS deployment issue. The values used are for illustrative purposes only and in no way reflect the authors estimates of how California stakeholders would actually influence the feasibility of AHS deployment. The real value of the technique is not its ability to quantify and predict, but rather its ability to force policy analysts to make explicit their subjective judgments about stakeholders in a systematic fashion.

Table F. **1**

HYPOTHETICAL AHS FEASIBILITY ASSESSMENT

Stakeholder	Probability Position	Fraction of Coded (salience)	Available Resources	Resource Rank	Feasibility Score
Governor	+1	0.8	0.2	0.4	0.192
Legislature	+1	0.4	**0.5**	0.8	0.160
Aerospace Industry	+1	0.9	0.7	1.0	0.630
Clean Air Coalition	-1	0.9	0.8	0.6	-0.432
Mass Media	-1	0.1	0.5	0.2	**-0.010**

Index of total feasibility (TF) = F = 0.54 = 0.11 Adjusted total feasibility = 0.183

n 5

APPENDIX G:
Phase H Research Tasks

The findings of our Phase I study were reviewed with Caltrans/PATH sponsors. Among the principal findings was the need for closer attention to public acceptance issues, particularly those involving the state's environmental community (see Section 5). Consequently, the consensus of the research team and PATH/Caltrans sponsors was that Phase II of the research project would focus on environmental and user acceptance issues. This appendix outlines the tasks that would be involved in Phase II.

PHASE HRESEARCH PLAN

The principal objectives of Phase II will be to: (1) identify major environmental stakeholders, (2) invite their participation in regional focus group meetings, (3) assess their views and positions with regard to a range of IVHS applications, (4) relate findings to other stakeholder interests and to acceptance issues involving the general public, (5) examine the interaction of market acceptance, social acceptance, and institutional acceptance, and (6) compare findings for California with national studies of public acceptance that are underway. A major goal will be to identify unique or unusual characteristics of California stakeholders that may strongly affect the state's IVHS development and deployment. There are four major tasks to accomplish these objectives.

Task A. Refine Approach and Synthesize Materials on Environmental/Acceptance issues

- Conduct a working session to refine study and outreach approach. This session would be conducted after the National IVHS and Environment Conference in order to incorporate findings or lessons from this conference into California approach; it would also consider methods and strategies used in related IVHS outreach approaches.

- Prepare a preliminary working paper on IVHS and Environmental Issues. This working paper would have two uses: 1) provide preliminary issues for policy and research consideration in Caltrans/PATH program based on several workshops, and 2) provide the basis for a summary paper to be used in focus group meetings with environmental professionals.

Task B. Conduct Regional Meetings on Environmental/ATS Issues

- Organize and conduct up to three focus group meetings with IVHS/environmental professionals. Proposed locations are: