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PREFACE

Presented in this document is a national research program on Freeway Operations. It is the result of two years of deliberation by members and friends of the Committee on Freeway Operations and by individual members of the Research Subcommittee charged with this assignment.

The research program consists of 11 separate research projects. The total cost of this research program is estimated to be $4.65 million over a 4-year period.

CONTENTS

INTRODUCTION

FREEWAY OPERATIONS — CURRENT STATE-OF-THE-ART

Historical Background

Freeway operations emerged as a visible technical discipline with the introduction of the first freeway surveillance and control systems in the early 1960s. Original systems concentrated on optimizing traffic flow with a secondary emphasis on motorist information and incident management. Initial systems showed promise but grew slowly due to the high cost of technology, high operating and maintenance costs, and a lack of dedicated funding sources.

The rapid advancement in microprocessor and communications technologies during the 1980s helped to reduce the capital and maintenance costs and expanded the opportunities for innovative approaches to traffic management. The emergence of Intermodal Surface Transportation Efficiency Act (ISTEA) funding, the increased public support for Intelligent Transportation Systems (ITS), and the need for defense industry conversion have created even greater opportunities for advancing the art of freeway operations.

Systems involved in the management of freeway operations are typically called Advanced Traffic Management Systems (ATMS) and are often combined with Advanced Traveler Information Systems (ATIS). Nearly all medium and large urban centers in North America have some type of system in design or operation. The need for such systems is expected to grow based on: (1) increased travel demand (and congestion), (2) the need for air quality management, (3) increasing demand for comprehensive, reliable, real-time travel information, and (4) potential safety benefits.

Today's Systems

The vast majority of systems rely on wire loop detectors imbedded in the pavement to obtain traffic information. The use of television cameras for monitoring, incident confirmation, and traffic management activities is fairly common. Information gathering and communications is one of the most fundamental needs, and it is still one of the most costly aspects of an ATMS. Many promising technologies are emerging in this area that require further development. Not only traffic characteristics, but also quality of flow will have to be monitored.

All systems employ a traffic operations center to consolidate and analyze data with the assistance of a computer system. Computer algorithms to detect incidents, screen data, and make traffic management predictions and decisions are still in their infancy. As systems expand in size and complexity, the effectiveness of a human operator is diminished. Great advances are required in this area in order to realize the full benefits of ATIS and ATMS.

Traditionally, changeable message signs have been used to convey information to drivers. Highway advisory radio is also being widely used. The media, public and commercial carriers are all interested in acquiring more traffic information in a wide variety of formats. As more information becomes available, human factors issues become more significant.

The optimizing of freeway flows has traditionally been accomplished through ramp metering. More sophisticated control algorithms, and the use of "mainline" metering are also being developed. In certain systems lane-specific displays have been used to smooth traffic flow and provide warnings.

Historically, ATMS have relied on telephone and coaxial cable communications systems to tie together the field infrastructure, the operations center, and external users. By the late 1980s, systems were beginning to use fiber-optic cables due to their superior bandwidth and lower operation costs. Today, there is great interest in cellular radio and satellite communications.

As the information gathering and dissemination and the management capabilities of traffic operations centers have increased, they have become valuable and essential tools to the management of incidents, special events, and even the daily operation of the transportation agency. Partnerships are often formed with emergency services, transit agencies, and internal construction and maintenance personnel. The effective and coordinated operation of all these resources continues to be a challenge.

Over the past thirty years a wealth of documentation has been produced on both the theory and practice of traffic management on freeways. However the advancement of technology, the need for integration within a more complex transportation infrastructure, and the need for more cost-effective solutions have created an impetus for more research and development effort than ever before.

RESEARCH PROGRAM DEVELOPMENT

The mission of the Research Subcommittee of the Transportation Research Board's Committee on Freeway Operations is stated below:

> Advise the Committee on current research in Freeway Operations. Prepare documents for Committee issuance on such matters as research problem statements and potential funding sources.

As part of this mission, one of the Research Subcommittee's objectives is to periodically prepare a TRB Circular on a Research Program for Freeway Operations which includes the latest selection of freeway operations research needs in the form of research problem statements.

The Subcommittee began the process of developing a new list of research problem statements at the 1992 mid-year meeting in Newport Beach. At this meeting, committee members were asked to submit their ideas for research topics. The subsequent list of 18 proposed research problem descriptions was presented to the Committee for consideration and discussion during the January 1993 TRB meeting. Numerous Committee suggestions on revision, consolidation, and deletion of projects were noted. One of the suggestions from the Committee was that additional problems should be selected from the *Federal IVHS (ITS) Program Recommendations for Fiscal Years 1994 - 1995* prepared by ITS America. These problems should be included in the list submitted for Committee ranking. These suggestions were followed and a Committee voted on the resulting list of 21 research problem statements. The results of this vote were presented for discussion at the 1993 mid-year meeting in Seattle. The Committee made further suggestions on consolidation of some projects and reduction of some of the larger projects. These suggestions were incorporated in the final revised packet of 11 research problem statements that were presented to the Committee at the January 1994 TRB meeting. This set of problem statements was approved by the Committee for publication.

The Research Subcommittee then set about the task of reviewing priorities and setting up a timetable for a four year research program that would include these 11 problem statements.

PROGRAM HIGHLIGHTS

PROGRAM OVERVIEW

The proposed Freeway Operations Research Program is grouped into three research categories: Surveillance & Control Technologies, Communications, and Traffic & Demand Management. The total anticipated funding requirement for the eleven research projects is $4.65 million. The estimated time for completion of this research program is four years with the proposed start date October 1, 1995 and the estimated completion date September 30, 1999.

PROJECTS BY RESEARCH CATEGORY

The titles for the eleven research problem statements and estimated project costs are listed by research category below. The project number indicates the ranking of these projects by the Freeway Operations Committee (i.e., #1 represents the research project receiving the most votes from the committee, and so forth).

	Surveillance and Control Technologies (5 projects, $1.70 million)	
1	Cost/Effectiveness of Alternative Freeway Surveillance Techniques	($300k)
4	Vehicles as Traffic Probes	($400k)
10	Queue-end Warning Systems	($300k)
8	Freeway Management Center Displays	($400k)
11	Technology Transfer from Other Fields to Freeway Operations	($300k)
	Communications (3 projects, $1.60 million)	
2	Communication System Architecture Requirements for Delivery of ATIS and ATMS Services	($500k)
3	Testing and Assessment of Wireless Communications Technologies	($600k)
9	Hazmat Communication System Test Bed	($500k)
	Traffic & Demand Management (3 projects, $1.35 million)	
5	Impact of Traffic Management Systems on Air Quality	($600k)
7	Improved Integration of Freeway Data for Real-Time Demand Management	($500k)
6	Improved Predictive Algorithms of Freeway Flow for Real-Time Demand Management	($250k)

SUMMARY PROJECT DESCRIPTIONS

A summarized description of each problem statement including suggested possible sources of funding is presented in this section. The complete set of research problem statements is included in Appendix A.

1. *Cost/Effectiveness of Alternative Freeway Surveillance Techniques for Various Urban Scenarios*

Objectives: Examine various levels (type, duration, size, scope) of freeway surveillance and determine cost-effectiveness of each level of surveillance considering 1) information needs of an urban area, 2) ability of the surveillance system to meet the information needs, 3) approximate costs, and 4) institutional issues which may affect implementation.

Cost: $300,000 Duration: 18 months
Category: Surveillance & Control
Funding Source: FHWA, NCHRP

2. *Communications System Architecture Requirements for Delivery of ATIS and ATMS Services*

Objectives: First, determine, at a general functional level, the communications system functional requirements (e.g. protocols, bandwidth, data rates, survivability, redundancy, etc.) for the various elements (cameras, detectors, etc.) and services (e.g. mayday, congestion monitoring, route guidance, etc.) of ATMS and ATIS currently available. Then, for each of these elements, identify the existing and promising communications infrastructure in terms of performance, reliability, cost, flexibility, and expandability. This will result in a matrix with the communications requirements for ATMS and ATIS services on one edge and the communications facilities (e.g. ISDN, T-1, DS-1, DS-3, OC-1, OC-3, etc.) available from local carriers on the other edge. Secondly, use the information from above to recommend communication hardware independent protocols to support the next generation of ATMS and ATIS.

Cost: $500,000 Duration: 24 months
Category: Communications
Funding Source: FHWA

3. *Testing and Assessment of Wireless Communications Technologies for ATMS and ATIS*

Objectives: Aggregate results of research performed to date in wireless communications by transportation management systems. Establish a "look ahead" at emerging wireless communication technologies and evaluate their application to ATMS and ATIS. Establish preliminary applications guidelines and key considerations for design and implementation of air path communications systems. Identify the economics and performance of terrestrial and satellite based communication and relate these to the functional communications requirements of ATMS and ATIS. Identify two or three wireless technologies for test and evaluation of performance, reliability, operating constraints, and cost effectiveness in the framework of an existing ATMS/ATIS system.

Cost: $600,000 Duration: 30 months
Category: Communications
Funding Source: FHWA

4. *Vehicles as Traffic Probes: Cost Effectiveness of AVI Systems and Required Vehicular Sample Size*

Objectives: Determine the minimum sample of vehicle probes needed for reliable traffic data. Determine the cost-effectiveness of such vehicle probe systems relative to other surveillance systems.

Cost: $400,000 Duration:24 months
Category: Surveillance & Control
Funding Source: FHWA

5. *The Impact of Traffic Management Systems on Air Quality*

Objectives: Determine the impact of traffic management systems on air quality for use in trade-off analyses. Through the use of case studies, quantify these impacts for various scenarios.

Cost: $600,000 Duration: 24 months
Category: Traffic & Demand Management
Funding Source: FHWA, EPA

6. *Improved Predictive Algorithms of Freeway Flow for Real-Time Demand Management*

Objectives: Develop improved methods of predicting freeway congestion for anticipatory ramp metering and diversion strategies. Test the performance of such predictive algorithms on an existing freeway system.

Cost: $250,000 Duration: 24 months
Category: Traffic & Demand Management
Funding Source: FHWA

7. *Improved Integration of Freeway Data for Real-Time Demand Management*

Objectives: Identify critical information processing issues and develop strategies for integrating information from multiple data sources. Develop additional software for data verification and missing data replacement.

Cost: $500,000 Duration: 30 months
Category: Traffic & Demand Management
Funding Source: FHWA

8. *Freeway Management Center Displays*

Objective: Develop guidelines for the number of monitors and types of displays used in Freeway Management Centers.

Cost: $400,000 Duration: 24 months
Category: Surveillance & Control
Funding Source: FHWA, NCHRP

9. *Hazmat Communication System Test Bed*

Objectives: Provide a test bed for possible hazmat applications of advanced technologies and new institutional structures to address concerns of emergency responders. Investigate how the evolving new "infrastructures" could be employed to provide emergency responders with immediate hazard information at an accident. Develop specific applications that could be tested in subsequent years.

Cost: $500,000 Duration: 24 months
Category: Communication's
Funding Source: FHWA, FEMA

10. *Queue-End Warning Systems*

Objective: Develop a cost-effective concept for a queue-end warning system for use on North American freeways.

Cost: $300,000 Duration 24 months
Category: Surveillance & Control
Funding Source: FHWA

11. *Technology Transfer from Other Fields to Freeway Operations*

Objectives: Develop and circulate a statement of technology needs for freeway operations to practitioners in non-transportation fields and request their inputs. Perform a thorough examination of different fields that encompass technologies that could be transferred to freeway operations, e.g. utilities, defense, and space. Develop a preliminary database of "transferable" technologies to freeway operations.

Cost: $300,000 Duration: 24 months
Category: Communication's
Funding Source: FHWA, NCHRP

IMPLEMENTATION PLAN

RESEARCH PROJECT PRIORITIES

The freeway operations research project priorities were established by the Research Subcommittee based on priorities suggested in the original research statements and consideration of the 4-year time frame. The subcommittee identified three priority levels: immediate needs, mid-term needs, and longer term needs.

The projects identified with each level are listed below:

Immediate Needs

1. Cost/Effectiveness of Alternative Freeway Surveillance Techniques.
2. Communication System Architecture Requirements for Delivery of ATIS and ATMS Services.
3. Testi ng and Assessment of Wireless Communications Technologies.
5. Impact of Traffic Management Systems on Air Quality.

Mid-Term Needs

4. Vehicles as Traffic Probes.
7. Improved Integration of Freeway Data for Real-Time Demand Management.
10. Queue-end Warning Systems.
11. Technology Transfer from Other Fields to Freeway Operations.

Long Term Needs

6. Improved Predictive Algorithms of Freeway Flow for Real-Time Demand Management.
8. Freeway Management Center Displays.
9. Hazmat Communication System Test Bed.

PROPOSED TIME AND BUDGET SCHEDULE

The proposed time and budget schedule for the freeway operations research program is summarized in Table 1. A starting date of October 1, 1995 and a completion date of September 30, 1999 is assumed for the program.

TABLE 1 PROPOSED TIME AND BUDGET SCHEDULE

Category		Research Problem Statement	FY 1995—96	FY 1996—97	FY 1997—98	FY 1998—99	Total ($000)
Surveillance & Control Technologies	1	Cost/Effectiveness of Alternative Freeway Surveillance Techniques	200	100			300
	4	Vehicles as Traffic Probes		200	200		400
	10	Queue-end Warning Systems		150	150		300
	8	Freeway Management Center Displays			250	150	400
	11	Technology Transfer from Other Fields to Freeway Operations		200	100		300
Communications	2	Communication System Architecture Requirements for Delivery of ATIS and ATMS Services	250	250			500
	3	Testing and Assessment of Wireless Communications Technologies	150	250	200		600
	9	Hazmat Communication System Test Bed			200	300	500
Traffic & Demand Management	5	Impact of Traffic Management Systems on Air Quality	300	300			600
	7	Improved Integration of Freeway Data for Real-Time Demand Management		200	200	100	500
	6	Improved Predictive Algorithms of Freeway Flow for Real-Time Demand Management			125	125	250
TOTAL PROGRAM			900	1650	1425	675	4630

APPENDIX A FREEWAY OPERATIONS RESEARCH PROBLEM STATEMENTS

PROBLEM STATEMENT NUMBER 1

Cost/Effectiveness of Alternative Freeway Surveillance Techniques for Various Urban Scenarios

A number of different freeway surveillance techniques are being used today and will be used in future Advanced Transportation Management Systems (ATMS). Some systems use heavily instrumented automated surveillance techniques. Others rely on probe vehicles to provide travel information. Still others use combinations of instrumented freeways and probe vehicles. Most systems supplement their monitoring information with information from CB radio, cellular telephone, and patrol vehicles. Some systems monitor 24 hours a day and others monitor during peak hours. The approximate size and scope of the data collection system varies widely depending on the extent of the freeway system, the size of the urban area, the level of traffic congestion, and the availability of funds. Urban areas which are developing freeway surveillance plans need information on the levels of surveillance appropriate to meet both short term and long term needs. The study shall possibly categorize urban areas into a number of scenarios based on size, extent of freeway system, congestion levels, funding, etc. and recommend different levels of surveillance deemed economically beneficial for each of the chosen scenarios. The study should build on the results of ongoing research investigating the accuracy, reliability, and cost-effectiveness of alternative surveillance and detection techniques.

Objectives

Examine various levels, type duration, size, scope of freeway surveillance and determine the relative cost-effectiveness of each level of surveillance considering:

1. Information needs of an urban area;
2. Ability of the surveillance system to meet the information needs;
3. Approximate costs — perhaps of a relative nature; and
4. Institutional issues which may affect implementation.

Key Words

Freeway Surveillance, Traffic Management

Related Work

Research currently being done for FHWA by Hughes Aircraft Corporation and JHK is testing the various types of alternative surveillance and detection techniques. Test beds for this research are located in:

Minneapolis; one freeway site and one arterial site;
Orlando; one freeway site and one arterial site;
Phoenix; one freeway site; and
Tucson; one arterial site.

Study should be concluded early in 1994. There is also a new FHWA contract awarded to Minnesota DOT to test inobtrusive urban traffic data collection.

Priority

Moderate to High

Costs

$300,000

User Community

FHWA, State DOTs

Implementation

Results will directly influence the design and cost of surveillance systems built in the U.S.

Effectiveness

Very important if urban area monitoring requirements are enforced by FHWA.

Duration

1½ years

PROBLEM STATEMENT NUMBER 2

Communications System Architecture Requirements for Delivery of ATIS and ATMS Services

Communications for ATIS and ATMS is the single most important and costly element. The potential for successful system implementation and operation is largely influenced by the communication architecture and infrastructure selected. Today, there is a growing array of technology options available, each with strengths and weaknesses for a particular ATMS/ATIS application. While DOT's presently own and operate communications systems for ATMS/ATIS, the combination of the national ITS architecture with the notion of a national information highway and an existing global Internet suggest that the application of communication architecture's and infrastructures to ATIS and ATMS must be closely examined.

Objectives

First determine, at a general functional level, the communications system functional requirements (e.g. protocols, bandwidth, data rates, survivability, redundancy, etc.) for the various elements (e.g. cameras, vehicle detectors, etc.) and services (e.g. mayday, congestion monitoring, route guidance, etc.) of ATMS and ATIS currently available. Then, for each of these elements, identify the existing and promising communications infrastructure in terms of performance, reliability, cost, flexibility, expandability. This will result in a matrix with the communication requirements for ATMS and ATIS services on one edge and the communications facilities (e.g. ISDN, T-1, DS-1, DS-3, OC-1, OC-3, etc.) available from local carriers on the other edge. Secondly, use the information from above to recommend communication hardware independent protocols to support the next generation of ATMS and ATIS. This will be done in a context to clearly recognizing that the communication problem is central to ITS efforts.

Key Words

ATMS, ATIS, Communications Systems, Technology Survey

Related Work

FHWA National ITS Architecture Projects

Priority

High; a large investment of public funds is being made in the planning, design, and implementation of ATMS and ATIS. A broad survey and evaluation of available technologies may expedite planning and design activities and help reduce ignorance and bias, thus improving cost effectiveness.

Costs

$500,000

User Community

FHWA, Traffic Engineering Departments of States and Municipalities, ITS America

Implementation

Results of study will influence the planning and design of near term ATMS and ATIS implementations and will identify promising technologies for further development.

Effectiveness

Has the potential to increase the effectiveness and functionality of ATMS and ATIS, while reducing the cost of the communications portion of the systems.

Duration

2 years.

PROBLEM STATEMENT NUMBER 3

Testing and Assessment of Wireless Communications Technologies for ATMS and ATIS

ATMS and ATIS efforts show an increasing need for wireless communication systems that are high performance, flexible, cost-effective, and reliable. There is a proliferation of both earth-based wireless communications technologies, and satellite-based wireless technologies. Since the communications system is a major portion of a project's capital and/or operating costs a clear understanding of the tradeoffs, in different types of wireless communication, is necessary to enable

an informed decision on the selection of applicable technologies for individual ATMS and ATIS projects.

Objectives

Aggregate results of research, performed to date, in wireless communications by transportation management systems. Establish a "look ahead" at emerging wireless communication technologies and evaluate their application to ATMS and ATIS. Establish preliminary applications guidelines and key considerations for design and implementation of air path communications systems. Identify the economics and performance of terrestrial and satellite based communication and relate these to the functional communications requirements of ATMS and ATIS.. Identify two or three wireless technologies for test and evaluation of performance, reliability, operating constraints and cost effectiveness in the framework of an existing ATMS/ATIS system.

Key Words

ATMS, ATIS, Wireless, Communications Systems

Related Work

State of the art wireless communication study sponsored by the Washington State Dept. of Transportation and executed at the University of Washington in Seattle.

The Pennsylvania Department of Transportation's Satellite Communications Demonstration Project, scheduled for start-up of operations in late 1994, will test and evaluate the feasibility of VSAT technology for freeway CCTV surveillance and incident management communications restoration using both stationary CCTV cameras and a mobile CCTV-VSAT communications platform.

Priority

High; there is a large investment of public funds being made in the planning, design, and implementation of ATMS and ATIS. An assessment and field test of currently available communications technologies will reduce technical risks, expedite planning and design activities, and potentially reduce system risks.

Costs

Survey, Assessment, and Limited Field tests: $600,000

User Community

FHWA, Traffic Engineering Departments in States and Municipalities, ITS America.

Implementation

Results of the study may influence the planning and design of near term ATMS and ATIS implementations.

Effectiveness

Has the potential to increase the functionality and cost-effectiveness of the communications portion of ATMS and ATIS.

Duration

2½ years.

PROBLEM STATEMENT NUMBER 4

Vehicles as Traffic Probes: Cost-Effectiveness of AVI Systems and Required Vehicular Sample Size

Automatic Vehicle Identification (AVI) systems are becoming increasingly popular in the country. Applications include automatic toll collection and traffic surveillance to name a few. AVI data is viewed as a potential source of traffic surveillance for emerging ATMS systems. AVI systems can relay information about conditions of the traffic stream in real-time. Recent information on the effectiveness of several AVI systems for incident detection has been very encouraging. This is particularly important because incidents cause over 65% of the total traffic congestion in urban areas. It is possible that vehicle probe systems may be more cost-effective than other surveillance systems in collecting information to support ATMS projects. However, it has not yet been determined as to what percentage of the vehicles using the roadway need to serve as probe vehicles to provide reliable data. An experiment needs to be designed to study this problem. Ideally, the location should possess an AVI system currently operational and should also possess another accepted traffic surveillance system such as loop detectors or video imaging systems. The project should also rely on any previous information on the usefulness of vehicles as traffic probes that may be available from Pathfinder, ADVANCE, and TravTek projects; the Houston Smart Traveler project; the California INRAD

project, and the New York City TRANSCOM project. The results of the study shall recommend the adequate percent of vehicles needed as probes for future candidate locations with AVI implementation. The findings shall be extended to compare the costs of obtaining quality data from AVI against other systems. Since a considerable difference in the maintenance costs of an AVI system compared to the others is expected, a life cycle cost analysis shall be performed as part of the study. This shall assist in the accurate estimation of the benefit/cost analysis of future AVI systems.

Objectives

Determine the minimum sample of vehicle probes needed for reliable traffic data. Determine the cost-effectiveness of such vehicle probe systems relative to other surveillance systems.

Key Words

Automatic Vehicle Identification (AVI), Vehicle Probes, Traffic Surveillance

Related Work

Several AVI techniques are being used in various field tests and toll collection systems. Pac-Tel's Tele-Trac and Facilitech systems are some well known AVI Systems. The ADVANCE project did some theoretical work on the number of probes needed. The TRANSCOM TRANSMIT project will do more. The proposed research should refine sample size determination and cost-effectiveness assessment.

Priority

This project should rank medium high to high in priority.

Costs

$400,000

User Community

FHWA, State DOTs

Implementation

Utilization of results by Traffic Surveillance Centers nationwide.

Effectiveness

The results may indicate whether a vehicle probe system is effective in incident detection and congestion management. If so, it could have cost implications.

Duration

2 years

PROBLEM STATEMENT NUMBER 5

The Impact of Traffic Management Systems on Air Quality

As part of the Intermodal Surface Efficiency Act of 1991, Congestion Mitigation Air Quality Funds (CMAQ) have been allocated for non-attainment areas. It has also been determined that the installation of traffic management systems are eligible for this funding category. One of the concerns which has been expressed by the environmental organizations is that, while traffic management systems may increase roadway efficiency, they will also attract more traffic and increase rather than decrease emissions.

As before and after evaluation of several soon to be traffic management systems should be performed. An analysis of different case studies; i.e., freeway traffic management systems, signal coordination of major arterials, and signal coordination system networks will provide valuable information for trade-off analyses regardless of the funding source.

Objectives

Determine the impact of traffic management systems on air quality for use in trade-off analyses. Through the use of case studies, quantify these impacts for various scenarios.

Key Words

Traffic management, Air Quality, Congestion Mitigation

Related Work

Very little

Priority

High

Costs

$600,000

User Community

State DOTs, Metropolitan Planning Organizations, FHWA, EPA

Implementation

The results of this work will provide the needed documentation for maximum utilization of CMAQ funds and for other trade-off analyses.

Effectiveness

High

Duration

2 years

PROBLEM STATEMENT NUMBER 6

Improved Predictive Algorithms of Freeway Flow for Real-Time Demand Management

Current freeway ramp metering programs react to congestion after it occurs. We need improved predictive algorithms of freeway flow to anticipate congestion and, by early metering and diversion, prevent it from occurring whenever possible. Algorithms that can be used on-line in a real time metering situation at key stations where bottlenecks form and key stations upstream from such recurring congestion points may significantly reduce, and in some cases, eliminate recurring queues. New technologies such as video imaging systems can be used to develop good data bases for the calibration of such predictive algorithms. Application of neural networks and other forecasting techniques should be investigated.

Objectives

Develop improved methods of predicting freeway congestion for anticipatory ramp metering and diversion strategies. Test the performance of such predictive algorithms on an existing freeway system.

Key Words

Ramp Control, Predictive Flow Algorithms, Freeway Congestion , Traffic Management.

Related Work

Preliminary work in Seattle, investigating application of neural networks and other forecasting techniques to historical data for use in freeway congestion prediction.

Priority

Moderate. Necessary information for improved freeway control, traveler information systems, possible incident detection, and other traffic management uses.

Costs

$250,000

User Community

State DOTs, Traveler Information Systems, FHWA.

Implementation

Eventual implementation in ramp control systems as on-line, real-time metering algorithms.

Effectiveness

Potential for elimination or significant reduction of some freeway delays due to recurring congestion.

Duration

2 years

PROBLEM STATEMENT NUMBER 7

Improved Integration of Freeway Data for Real-Time Demand Management

The success of ATMS requires accurate information on traffic conditions that can be efficiently processed and disseminated to users and controllers in a real-time fashion. However, there has been a proliferation of multiple source data in various formats and various levels of accuracy that makes this difficult. We need to develop improved strategies for integrating multiple sources of input data into a synthesized form and provide for increased accuracy and speed in freeway management response.

Objectives

Identify critical information processing issues and develop strategies for integrating information from multiple data sources. Develop additional software for data verification and missing data replacement.

Key Words

Traffic Information, Traffic Management, Information Processing, Traffic Software

Related Work

The SMART Corridor project is developing an expert system to demonstrate a "smart" information processor. Research at the University of Washington (UW) in Seattle is addressing the identification and correction of freeway loop detector errors. There is also a data fusion project being conducted at the UW and sponsored by the Washington State DOT.

Priority

Moderate to High; good information is the backbone of ATMS and ATIS systems.

Costs

$500,000

User Community

FHWA, State DOTs, Traveler Information Systems

Implementation

Implementation in Freeway Management Systems across the nation.

Effectiveness

Has the potential to reduce implementation and operating costs for ATMS systems while improving their accuracy and efficiency.

Duration

2½ years

PROBLEM STATEMENT NUMBER 8

Freeway Management Center Displays

Develop guidelines for the number of monitors and types of displays used in Freeway Management Centers.

Objectives

Freeway management centers are being developed around the country with vastly different numbers and types of displays to monitor CCTV units. Some centers use one monitor for each CCTV unit in the field; others show selected images on a handful of monitors. The cost of displaying these images is more a function of the communications involved in bringing these images back to the control center than the actual cost of the monitor, and can be quite expensive. Human operator response in a freeway center will depend in large measure on the type and format of the information presented. Guidelines on the optimal or reasonable number of display monitors and display designs would be useful to organizations planning new facilities. This might be a function of the miles of roadway under surveillance, the number of operators who will be operating the system, the existence of reversible lanes or some other parameter.

Key Words

Freeway Management, Traffic Control Center, CCTV, Monitors

Related Work

There is considerable activity in the field of Freeway Management, but it needs to be integrated. A current FHWA study, "Design of Support Systems for ATMS Control Centers" may address aspects of this problem.

Priority

Moderate

Costs

FY 1994 — $250,000 FY 1995 — $150,000

User Community

FHWA, AASHTO, State DOTs

Implementation

The results of this work could be applied immediately in the design of new control centers.

Effectiveness

If properly applied, the results of this research could help new management centers operate more cost-effectively.

Duration

2 years

PROBLEM STATEMENT NUMBER 9

Hazmat Communication System Test Bed

One of the major problems in freeway incident management is the difficulty of getting immediate information on hazardous materials spilled at the scene of an accident. CVO corridor demonstration projects such as HELP/Crescent and I-75 are developing the basic institutional and technological "infrastructures" that could address this problem. These include vehicles equipped with transponders, automated readers to access information from the transponders at state borders, a central data base and communication system between participating states, and interstate cooperative agreements for data sharing and reciprocity.

The proposed project would investigate how the evolving new "infrastructures" could be employed to provide emergency responders with immediate hazard information at an accident. Technologies that would be studied include an on-board remotely readable electric transponder containing the bill of lading, a reference number for a database containing the bill of lading, or a contract number for a source with 24-hour access to the bill of lading. The study would build on current research in this area and provide a testbed for applications of emergency response to hazmat accidents.

Objectives

Provide a test bed for possible hazmat applications of advanced technologies and new institutional structures to address concerns of emergency responders. Investigate how the evolving new "infrastructures" could be employed to provide emergency responders with immediate hazard information at an accident. Develop specific applications that could be tested in subsequent years.

Key Words

Hazmat, Incident Management, CVO

Related Work

This study would complement a current, broader study of advanced technologies for application to hazmat transportation, and would also complement the Congressionally mandated National Academy of Sciences study which will identify ITS corridor projects as a potential testbed for the application of new technologies for hazard identification in highway transportation.

Priority

Moderate

Costs

$200,000 for initial research
$300,000 for operational test

User Community

FHWA, State DOTs

Implementation

Could be implemented by State DOTs participating in current or planned CVO corridors.

Effectiveness

Has potential to produce considerable savings in costs and delays involved in incident removal.

Duration

2 years

PROBLEM STATEMENT NUMBER 10

Queue-end Warning Systems

In the congested urban freeway environment, queuing of traffic can develop quickly due to both recurring congestion and incidents. The abrupt transition from high speed flow can create a significant safety hazard. Typically, more than 30% of urban freeway accidents can be attributed to encountering queuing conditions. These accidents create further delay and increase the potential for additional accidents. Queue warning systems in the Netherlands and Glasgow have shown considerable promise in addressing this problem.

With the proliferation of planning and design activities related to advanced traffic management systems throughout North America, much of the infrastructure that will be used for the next twenty years is now being designed and built. Although a queue-end warning system may not be available for widespread deployment in the near future, a concept should be developed now in order to ensure the ATMS being designed today have provisions for queue-end warning in the future. The proposed project would study the effectiveness of current queue-end warning systems and the feasibility of further enhancements or developments.

Objectives

Develop a cost-effective concept for a queue-end warning system for use on North American freeways.

Key Words

Congestion, Queue-End Warning

Related Work

A variety of reports related to the design and operation of lane controls signs in Glasgow and the Netherlands.

Priority

High. Needs to be coordinated with new planning and design activities related to ATMS that are currently underway or planned for the near future.

Costs

$300,000

User Community

FHWA, Traffic Engineering/Traffic Management departments of states and large municipalities. Consultants.

Implementation

If the concept appears promising, the next step would be a field demonstration.

Effectiveness

Potential for substantial accident and delay reduction for busy urban freeways.

Duration

2 years

PROBLEM STATEMENT NUMBER 11

Technology Transfer from Other Fields to Freeway Operations

Freeway network operation is a relatively new arena in the transportation field. Although analogies between

traffic flow and fluid flow have been suggested in the past, parallels between the management of various networks and the management of freeway networks are scarce. Network management techniques from other fields may be applicable to both recurrent and non recurrent congestion. Similarly, other fields such as defense and space may offer similar solutions. For example, a robot that was designed for sample collection and analysis for a remote area on earth or in space might be adapted for use in a freeway hazardous material spill.

The mechanism for technology transfer already exists in the form of FHWA's T^2 program. Although the program focuses on a "better way of doing something" among professionals within the transportation field, cross pollination between transportation and other fields would be beneficial. The study should develop a concise statement of technology needs for different aspects of transportation engineering and research that could be widely circulated to practitioners in non-transportation fields. This would be complemented by the establishment of a liaison group (perhaps through FHWA, or TRB and the National Academy of Sciences) which would direct non-transportation professionals to professionals within the transportation field who could evaluate and disseminate information on the potential usefulness of each "new" technology.

Objectives

Develop and circulate a statement of technology needs for freeway operations to practitioners in non-transportation fields and request their inputs. Perform a thorough examination of different fields that encompass technologies that could be transferred to freeway operations, e.g. utilities, defense, space. Develop a preliminary database of "transferable" technologies to freeway operations.

Key Words

Network management, surveillance and control, communications technology, traffic management system, traffic monitoring, incident management.

Related Work

White House technology reinvestment project. Project California. Defense firms have implemented, on a limited scale, technology conversion from defense to transportation via the ITS program. Area that could be explored is the management of utility networks since there are similarities between utility and traffic networks. Utilities operate their networks from a central facility and employ access control to manage flow in the networks below theoretical capacity.

Priority

Moderate to High. The transfer of existing mature technologies from different fields to freeway operations would enhance the current research effort and minimize the "re-invention of the wheel."

Costs

$300,000

User Community

Federal Highway Administration, State DOTs, Consultants.

Implementation

The research findings will broaden traffic engineers' database of available solutions for an efficient freeway system management.

Effectiveness

The transfer of technology between different fields and freeway operations will minimize the "learning curve" of developing and implementing new technologies that have already been in use.

Duration

2 years