FHWA Scanning Report on Traffic Management and Traveler Information Systems

FHWA's Scanning Program

U.S. Department of Transportation
Federal Highway Administration

November 1997

Notice

The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official policy of the U.S. Department of Transportation.

The metric units reported are those used in common practice by the persons interviewed. In some case, they have not been converted to pure SI units since the level of precision implied would have changed.

The U.S. equivalents to the foreign currency amounts appearing in this report are based on approximate rates of exchange in effect during the time of the study tour.

The U.S. Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear herein only because they are considered essential to the objective of this document.

This report does not constitute a standard, specification, or regulation.

FHWA International Technology Report on

Traffic Management and Traveler Information Systems

Prepared by the study tour team

Wayne Berman
FHWA

Steve W. Clinger
FHWA

Gene S. Donaldson
Montgomery County

John Duve
SANDAG

David R. Gehr
Virginia DOT

Gregory M. Jones
FHWA

Jerry L. King
Metropolitan Transit Authority

Steve Kuciemba
Maryland SHA

Joseph F. Ligas
Illinois DOT

Pamela P. Marston
FHWA

James R. Robinson
Virginia DOT

Dennis Symes
FTA

Juan M. Morales
J.M. Morales & Associates

and

Transportation Technology Evaluation Center (TTEC)
International Technology Research Institute (ITRI)
Loyola College in Maryland
Baltimore, MD 21210

Prepared for

Federal Highway Administration
U.S. Department of Transportation
Washington, DC 20590

November 1997

FOREWORD

This report presents the findings of the study team on a Federal Highway Administration (FHWA) International Scanning Tour to the countries of Finland, Sweden, the Netherlands, and England. The tour was unique in that it represented the first time that a scanning tour was made to these countries expressly for the purpose of learning about innovative applications of technology to improve the traffic management and traveler information services provided by public-sector agencies. An important goal for the study team was to learn and identify policies, programs, technologies, and techniques that may have applications to U.S. experiences in traffic management and traveler information services.

While there were many opportunities to see the technologies in place and operating, the scanning tour also offered the more important opportunity for policy, programmatic, and implementation discussions to take place on a peer-to-peer basis. The visit became a true technology transfer experience for the U.S. delegation and for our hosts in each country. Each of our hosts expressed a strong desire to continue the cooperation because traffic management and traveler information programs are viewed as vital components of their country's transportation systems.

The study team represented a geographic cross-section of public-sector transportation professionals actively involved with the deployment of technology to improve traffic management and traveler information systems under their jurisdictions. The groups represented both highway and public transport interests at the Federal, State, and local levels in the U.S. While technology transfer occurred with the Europeans, it also occurred within the study team itself—an important side benefit of the tour. The relationships made and the information exchanged by the study team members will be an important legacy of the scanning tour.

The report presents the study team's findings through the four country summary sections, an applications section, a recommendation section, and a section on opportunities for future cooperation. In addition, a few of the study team provided testimony on personal observations and insights that they gained as a result of the scanning tour. This is also provided in one of the last sections of the report. Finally, the report contains a number of appendices that give additional insights on the trip. Of note is the appendix listing the Internet World Wide Web (WWW) addresses that were available in the countries visited.

Finally, the report is intended to facilitate further cooperation between the U.S. and the countries visited in the areas of traffic management and traveler information. All the countries faced budget problems and understood that expanding highway capacity is no longer the most viable, environmentally sound option for moving people and goods more efficiently. The application of technology approaches to addressing transportation issues and traveler demands is an area that will offer greater opportunities for scanning tours such as this in the future.

Wayne Berman
Study Team Leader

ACKNOWLEDGMENTS

The panel members wish to thank all the host transportation ministries, agencies, researchers, and private firms for their gracious hospitality and for sharing their time and experiences with the scanning team. Without exception, the team was warmly received in every country and by every official.

The panel is also appreciative of the amount of professional preparation, effort, and attention to detail provided by these agencies and their staffs. Much was learned from each country. Furthermore, doors to future cooperation and technology transfer were widely opened.

The panel would like to specially recognize a few individuals for their kindness and dedication to our panel: Mr. Olli Nordenswan, Mr. Kari Karessuo, and Mr. Risto Kulmala of the Finnish National Road Administration; Mr. Christer Jacobson and Mr. Hans Torring of the Swedish National Road Administration; Mr. Laurens Schrijnen of the Ministry of Transport, Public Works and Water Management in the Netherlands; and Mr. Ian Holmes of the Highways Agency in England.

Special thanks are also due to the Federal Highway Administration, Office of International Programs, for encouragement, guidance, and support.

Finally, our gratitude goes to the Transportation Evaluation Center (TTEC) at Loyola College in Baltimore, Maryland, for its coordination of the team and production of this report and to TTEC's liaison office, American Trade Initiatives, Inc., for arranging the meetings and escorting the team.

Contents

Page

FOREWORD iii

ACKNOWLEDGMENTS iv

EXECUTIVE SUMMARY ix
- Introduction ix
- Selected Highlights xi
- Report Organization xiv
- Findings xv

1.0 BACKGROUND AND INTRODUCTION 1
- 1.1 Purpose 1
- 1.2 Panel Members 1
- 1.3 Itinerary 2
- 1.4 Format of the Report 3
- 1.5 Background 4

2.0 FINLAND 6
- 2.1 Background 6
- 2.2 Organizational, Policy, and Funding Issues 7
- 2.3 Planning and Research Issues 8
- 2.4 Technical and Design Issues 11
- 2.5 Public Acceptance and Marketing 12
- 2.6 Training and Continuing Education 13
- 2.7 Observed Catalog of Practice 13
- 2.8 Themes and Trends 23

3.0 SWEDEN 24
- 3.1 Background 24
- 3.2 Organizational, Policy, and Funding Issues 25
- 3.3 Planning and Research Issues 26
- 3.4 Technical and Design Issues 26
- 3.5 Public Acceptance and Marketing 27
- 3.6 Training and Continuing Education 27
- 3.7 Observed Catalog of Practice 28
- 3.8 Themes and Trends 34

4.0 THE NETHERLANDS 36
- 4.1 Background 36
- 4.2 Organizational, Policy, and Funding Issues 37

4.3 Planning and Research Issues 38
4.4 Technical and Design Issues 40
4.5 Public Acceptance and Marketing 40
4.6 Training and Continuing Education 41
4.7 Observed Catalog of Practice 42
4.8 Themes and Trends 47

5.0 ENGLAND 49
5.1 Background 49
5.2 Organizational, Policy, and Funding Issues 50
5.3 Planning and Research Issues 51
5.4 Technical and Design Issues 52
5.5 Public Acceptance and Marketing 53
5.6 Training and Continuing Education 54
5.7 Observed Catalog of Practice 54
5.8 Themes and Trends 60

6.0 FINDINGS AND TRANSFERABILITY TO THE UNITED STATES 62
6.1 Policy and Program Findings 62
6.2 Applications to the U.S. Experience 64
6.3 Insights 65

7.0 OPPORTUNITIES FOR FUTURE COOPERATION 73

8.0 RECOMMENDATIONS 75

LIST OF ACRONYMS AND ABBREVIATIONS 77

Appendices

A Panel Members 79
B Amplifying Questions 81
C Topics Discussed and Points of Principal Contact 83
D Internet WWW Addresses 93

Figures

1 Map of Northern Europe xi
2 Map of Finland 6
3 TMS Display 11
4 The E18 Weather-Controlled VMS Display 19
5 A Road Weather Station on E18, Near Kotka, Finland 20
6 Info-Terminal at a Rest Area on E18, Near Kotka, Finland 21
7 Map of Sweden 24
8 Road Traffic Management Center in Gothenburg, Sweden 28
9 GOTIC KomFram System 32
10 KomFram Info-Terminals at a Local Store 32
11 Map of The Netherlands 36
12 The MTM System on the Amsterdam Ring Road 43
13 The Rotterdam Traffic Control Center 45
14 Map of The United Kingdom 49
15 Police Officer in the London Orbital Motorway Traffic Control Center 56
16 Ray Morris explains the Southampton SCOOT System 58

EXECUTIVE SUMMARY

Introduction

This executive summary highlights the findings of a U.S. study panel that examined traffic management and traveler information systems in Finland, Sweden, the Netherlands, and the England. Sponsored by the Federal Highway Administration (FHWA), the scanning tour was conducted December 1–17, 1995. The panel focused on how European public sector agencies develop and implement policies, plans and programs to facilitate the deployment of advanced traffic management and traveler information systems, and reviewed and documented specific efforts being conducted in the four countries visited (see Figure 1).

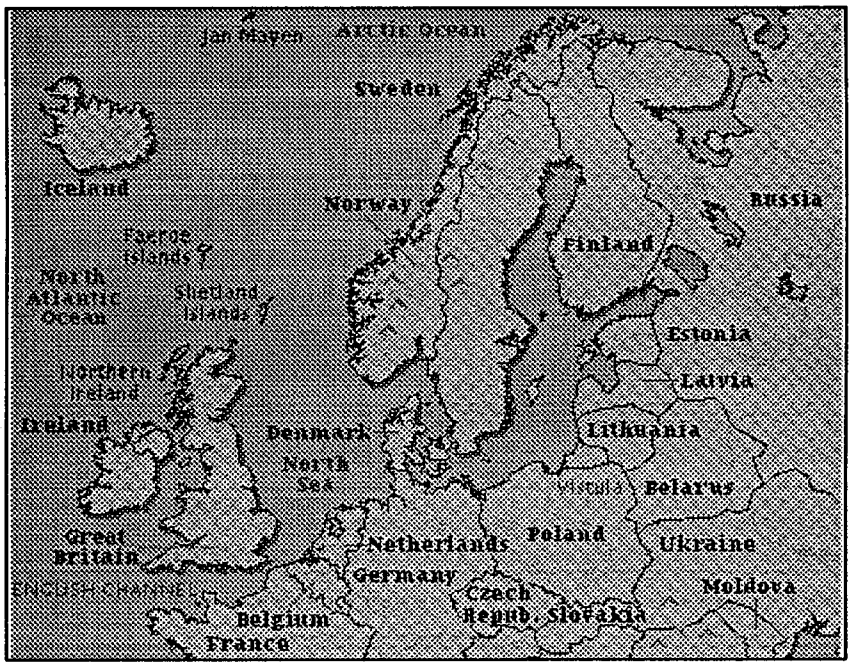

Figure 1. Map of Northern Europe

Traffic congestion is not a problem unique to the U.S. In fact, it is a significant problem in many parts of the world. As congestion continues to increase everywhere, the conventional approach of building more roads will not always be a viable solution. In many cases, building new roads compounds congestion problems by inducing unforeseen demands for travel by auto.

As in the U.S., many countries are applying advanced technologies as tools for alleviating traffic congestion and improving mobility. These technologies have great potential as congestion-management applications, particularly for traffic management and traveler information systems.

Pre-trip traveler information to provide the latest road conditions and information about public transport arrivals is also becoming part of congestion management programs, particularly in

shopping areas and in large employment centers. This type of information can be provided through telecommunication services at home or in the office, television monitors at kiosks, telefax machines, or voice mail services. Traveler information services are considered a key ingredient in an integrated program for congestion management.

Finland, Sweden, the Netherlands, and England were identified as nations in which government agencies have made significant progress and play significant roles in the broad deployment of advanced technologies for traffic management and traveler information systems. In these countries, traveler information services, either pre-trip or en-route, are essential parts of congestion management policies.

The study group was specifically interested in the policies, plans, and activities that these countries have established to facilitate the deployment of advanced technologies in the following areas:

- Traffic management
- Traffic signal systems
- Incident management
- Transit management
- Electronic toll/fare payment
- Traveler information systems

Also of interest were specific programs related to financing, public-private partnerships, technology designs, training, marketing, and user acceptance.

The team represented diverse perspectives and geographical areas and consisted of 12 people from the Federal Highway Administration; Federal Transit Administration (FTA); the State Departments of Transportation of Illinois, Maryland, Virginia, and Wisconsin; a metropolitan planning organization; and a metropolitan transit authority. These included representatives of the U.S.' four high-priority corridors (I-95, Chicago, Houston, California). The leader of the delegation was Wayne Berman of the Federal Highway Administration. (A list of team members can be found in Appendix A.)

The panel jointly prepared a list of amplifying questions that were provided to the hosting agencies abroad before the team's visits (see Appendix B). Each country prepared a series of technical presentations and site visits that would facilitate discussion of the panel's questions. In addition, the team met with a variety of officials who were responsible for or involved with the design, implementation, and deployment of advanced technologies in their respective countries. Topics covered in the presentations are listed in Appendix C, along with the names and addresses of personnel the panel met with.

The four countries visited have deployed a variety of advanced technologies projects, and are planning deployment of several others in the near future. Each has different reasons for deploying

advanced technologies for traffic management and traveler information systems, which may be outlined as follows:

Country	Motivations
Finland	Weather-related traveler information, motorist safety
Sweden	Traffic and transit information, weather information
Netherlands	Congestion management, goods movement, desire to discourage auto travel
England	Traffic management and transit

It is important to understand motivations because they establish the focus for applications of advanced technologies in each country. The focus in the U.S. may vary by State; however, the overall national goal is improving mobility and managing congestion.

The study tour provided an excellent learning experience during which technical contacts were established and opportunities for future cooperation were identified. An added bonus of this trip was the technical interaction among panel members themselves, which will undoubtedly result in better coordination, communication, and cooperation in the future.

Selected Highlights

To provide an overview of the team's findings, a few highlights are presented below.

Finland

In Finland, the vast terrain and harsh climate present exceptional challenges to the Finnish Road Administration (Finnra). Finnra provides all road users—drivers, bicyclists, and pedestrians, alike—with means of traveling conveniently and safely. It also cooperates with others in the transport sector to plan, maintain, and improve the overall system. Information on road and surface conditions and traveler information are regarded as basic road services, and Finnra constantly researches new designs for road signs and information displays that will keep road users aware of traffic problems and road conditions. Finnra gives high priority to environmental issues, regarding both the planning of traffic schemes and road maintenance.

The weather-controlled signs along E18 in southern Finland, between Kotka and Hamina, is an excellent example of how technology is being applied to improve safety and inform motorists of road conditions. A suitable driving speed is determined and displayed automatically, based on weather information received from sensing stations and sensors embedded in the pavement. Variable message signs (VMS) display pictorial and textual information on conditions and speed limits. Several roadway weather monitoring stations provide driving-condition data, such as fog and icing conditions, to traffic control centers, so drivers may be alerted and maintenance (salting) crews deployed. A state-of-the-art communication network, mostly based on cellular technology, allows data to be easily accessed and utilized.

Sweden

ARENA, an operational test site in west Sweden, has helped demonstrate advanced technologies in that country. ARENA is a Swedish National Road Administration (SNRA) project in which field tests are used to ascertain how road traffic may be improved through information technology. The project began in Gothenburg in 1992 and field tests are conducted with the cooperation of industry and other organizations, allowing researchers, operators, designers, manufacturers, and suppliers to work together. The various systems were deployed in stages, from laboratory tests, via prototypes and pilot tests, up to implementation.

In another project, field trials for Traffic Information and Navigation for Gothenburg (TANGO) were conducted in 1994 to demonstrate dynamic route guidance combined with traffic information.

The Netherlands

The Netherlands has historically been a transportation gateway to Europe. Accessibility to the economic centers of the Port of Rotterdam and Amsterdam's Schiphol Airport is the focus of a road transport policy that is based on the need to make more efficient use of the existing infrastructure. The policy emphasizes reducing the growth of automobile traffic and seeking safer, more efficient ways of transporting goods and people. Officials recognize that traffic management will neither eliminate traffic congestion nor increase the capacity of the primary road network. However, an *integrated policy* that combines traffic management, car-use regulation, parking management, incentives to use transit, and, possibly, road pricing is the key to improving mobility and accessibility to economic centers.

The team also observed the Motorway Traffic Management System (MTM) implemented on the Amsterdam Ring Road in 1991 and is now in operation on more than 200 of the approximately 2,100 km of motorways in the Netherlands. MTM consists of VMS mounted on overhead sign trusses at about 700 m apart in urban areas and at longer intervals in outlying areas. (See Figure 13). Variable message signs consisting of fiber optic matrices are located over each lane and provide lane-use information using a green "arrow" or red "X" and by posting speed limits. Speed limits are displayed above each lane and are intended to slow traffic gradually as it approaches congestion ahead.

Normally speed limits are set to 120 km/h (72 mph) or 100 km/h (63 mph), near urban areas, and traffic volumes up to 2,400 vphpl (vehicles per hour, per lane) are limited to speeds of 80–90 km/h (50–55 mph). In congestion situations, MTM signs are used to warn motorists of queuing ahead and to display gradually reduced speed limits—usually from 90 to 70 to 50 km/h, depending on conditions. Consequently, use of the lowest advisory speed of 30 km/h, formerly set due to non-compliance, has been discontinued, and now speed limits are established based on fully automated, computer-driven algorithms. The algorithm for the speeds is based on average speeds as measured by loop detectors for determining potential queuing and any incidents.

The messages displayed are automated as well, though manual operation is also utilized for message selection. Fog and glazed-frost detection are also part of the signaling system and it can also be used to provide alternate-route guidance information by recommending one side of the Ring Road instead of the other.

By the year 2000, the MTM will be in operation on about 900 km of motorways in the Netherlands. It is expected to improve traffic flow, reduce non-recurring congestion, and improve safety.

England

In England, a national project similar to MTM involves equipping motorway gantries and approach ramps with fiber optic signs to display mandatory speed limits. The signs on the M25 controlled motorway indicators (CMI) will display red rings to indicate the mandatory nature of the speed limit.

Speed limits are set automatically depending on the volume traffic sensed by loop detectors. When volumes are high, the speed limits are reduced incrementally. Drivers who do not obey the speed limits are detected by overhead radar, their vehicles photographed, and are subject to prosecution by police. The speed limit signs are supplemented with VMS, and, on some routes, an automated system follows cars for 10–30 km to fully control speed on the whole route.

The system is based on the concept that drivers must drive more slowly and carefully in order to arrive at their destinations more quickly. Experience of similar systems in Europe has shown that an even flow of traffic stands a greater chance of getting through peak periods with fewer accidents and without significant delay, as compared to fast-moving traffic that must brake suddenly.

The system has been successfully operated and maintained. Two reasons for this were suggested (i) all equipment was fully tested and certified, and its maintenance is the responsibility of the supplier, and (ii) the implementation of *standards* allowed products from various manufacturers to be integrated into a fully operational system. Also, the system evolved over a period of 15 years and included integrated research along with user input.

In Southampton, the ROMANSE (Road Management System for Europe) project is providing accurate and timely traffic and travel information in a *multimodal* environment. The project utilizes a multimodal traffic and traveler information center to collect and disseminate real-time transport network information. The goal of the ROMANSE project is to encourage use of public transport by providing accurate information about the locations of buses and their arrival times at stops, all in real-time. This is done through a system called STOPWATCH, which uses Automatic Vehicle Location (AVL) technology to relay information to changeable displays. The system also provides preemption to buses at traffic signals by incorporating the AVL with the Split, Cycle,

and Offset Optimization Technique (SCOOT) traffic signal coordination system operating in the city.

Waiting passengers are able to see the route number of the nearest three buses, their destinations, and an accurate estimate of when each of them will reach the stop. The key to the system is a small computer fitted aboard each bus. As a bus moves along its route, it picks up signals from a series of roadside beacons, and the signals pinpoint the bus' position to an accuracy of 10 m.

The on-board computer constantly updates this information and sends it via the bus radio to a central control computer in the ROMANSE Traffic and Traveler Information Center (TTIC) in Town Quay. The central computer uses an algorithm to accurately estimate when the bus will arrive at the stop and then sends the information to the electronic signs along its route.

Visually impaired travelers can benefit from the "talking" version of STOPWATCH. A digitally recorded voice announces the approaching bus service, route numbers, final destinations, and the number of minutes until arrival. The system is activated by a hand-held trigger when the user is approximately 5 m from the display. Triggers are available free of charge to the visually impaired.

The SCOOT system in Southampton also has the ability to restrict traffic flows into congested areas of the city. Incident-detection logic is provided by ASTRID/INGRID both from the SCOOT data and from 14 closed-circuit television (CCTV) cameras. The software utilizes CCTV input to recognize unusual traffic movement on the control-room monitors and identify specific traffic problems, such as accidents and stalled vehicles. This is accomplished by continuously scanning the camera picture and comparing the images over time to identify areas with stationary vehicles. If incidents are detected, an alarm alerts the center operators.

A network of VMS deployed throughout the city provides route guidance, available parking information, and incident information.

Report Organization

The report is divided into eight sections, the first of which is this executive summary. Section 1.0 of the report discusses the purpose and composition of the panel. It is important to understand that different perspectives and backgrounds were represented on the panel. This section also includes discussion of issues that influenced the panel's recommendations.

Sections 2.0 through 5.0 present country summaries for Finland, Sweden, the Netherlands, and England, covering areas such as agency organization, planning and research issues, technical and design issues, public acceptance, marketing, and training. Also included in these sections are descriptions of the technologies observed during the trip for the six priority areas of interest to the panel. These areas are as follows:

1. Traffic management
2. Traffic signal systems
3. Incident management
4. Transit management
5. Electronic fare/toll collection
6. Traveler information systems

In addition, a brief synopsis of the trends observed in each country is included.

In Section 6.0, some of the technologies observed abroad are applied to the U.S. experience. Section 6.0 also includes insights of the individual panel members. These papers describe how they benefitted from the tour, things that they observed, and how, in their opinion, advanced technologies can be deployed in the U.S.

Section 7.0 discusses opportunities for future cooperation between the U.S. and each of the countries visited. It is an attempt to describe how countries can learn from each other and to identify areas in which international cooperation is recommended.

Section 8.0 includes the panel's recommendations for specific activities that could be implemented in the U.S.

Four appendices are included. Appendix A includes the list of panel members, their addresses and contact numbers. Appendix B includes the amplifying questions provided to the host countries in advance. Appendix C presents a table of topics discussed, by country, and the name of the principal contact person. Appendix D includes some Internet (World Wide Web) addresses learned during the trip. These addresses can be accessed to obtain additional and on-going information on-line.

Findings

At the end of the trip, the panel discussed their experiences and findings. It is interesting to note that each panelist has his/her own perspective and individual knowledge about the application of technologies for traffic management and traveler information systems in the U.S.

Each was asked to describe their experiences and findings during the trip and to relate them to activities being conducted in the U.S. These were summarized and the recommendations listed below were developed. These recommendations, the panel feels, would accelerate the deployment of traffic management and traveler information systems in the U.S.

1. **Deployment of advanced technologies should be fully integrated**. System integration, or the ability of independent systems to communicate and share information, is critical to the successful deployment of advanced technologies. Integration should be accomplished

at the policy and technical levels and should expand across all transportation modes, jurisdictional boundaries, and disciplines (police, transit operators, highway agencies).

2. **A true balance between planning and deployment of advanced technologies must exist**. This balance should recognize the evolutionary nature of these technologies and be flexible enough to allow for it. It should also include realistic schedules for successful deployment, integrating the various modes of transport.

3. **Deployment of advanced technologies should be integrated into transportation policy at the Federal, State, and local and regional levels**. This would allow for a national "vision" of the application of these technologies in the future at all levels.

4. **Development of standards should be given a high priority**. Activities in this area should include adopting existing standards from other industries, where appropriate, encouraging testing and certification, encouraging the private sector to have a major role in the development of standards, and using the public sector's purchasing power to influence their development.

5. **The users perspective should be integrated into the planning, deployment, and operation of advanced technologies**. Specific mechanisms should be implemented to ensure that products and projects fulfill needs and are understood by the public. The public sector should pay close attention to ensure deployment is closely tied to user interests and needs.

6. **Operation and maintenance should be part of an integrated Intelligent Transportation Systems (ITS) program**. Integration should include dedicated funding vehicles and information sharing. Sophisticated systems should be properly operated and maintained in order to be reliable and successful. A commitment to operating funding and staff is essential.

7. **A *national* ITS "vision" should be created**. The U.S. Department of Transportation (DOT) should take a strong lead in providing a vision and framework for the focused deployment of ITS technologies and services nationwide. The efforts of such entities as ITS America, the Transportation Research Board, and others should be given a specific direction to facilitate and accelerate the deployment on an integrated system. This vision would allow both the public and private sectors to work in unison with a common goal of the successful deployment of integrated and compatible systems. Using the regional transportation-planning process, criteria should be developed to prepare plans for the incorporation and deployment of this vision.

1.0 BACKGROUND AND INTRODUCTION

1.1 Purpose

The Traffic Management and Traveler Information Systems Panel was organized as part of the Federal Highway Administration's International Scanning Program to exchange information with counterparts abroad and study international technologies for potential domestic applications. The program has been in effect since 1992 and resulted from the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA), which authorized visits to international institutions by panels of U.S. transportation officials and specialists. Subsequent to the visits, the panel publishes a report of its findings for distribution among the U.S. and international transportation communities.

The Traffic Management and Traveler Information Systems Panel focused on how European public sector agencies develop and implement the policies, plans and programs that are necessary to facilitate the deployment of traffic management and traveler information systems. The panel reviewed and documented such efforts as well as panel sharing information on U.S. policy initiatives and programs.

Finland, Sweden, the Netherlands and England were identified as nations in which government agencies that have made significant progress and play significant roles in the broad deployment of advanced technologies for traffic management and traveler information systems. Specifically, the panel was interested in the policies, plans and activities related to the following:

- Traffic management
- Traffic signal systems
- Incident management
- Transit management
- Electronic toll/fare payment
- Traveler information systems

Also of interest were issues and activities related to financing, public-private partnerships, technology design, training, marketing, and user acceptance.

1.2 Panel Members

The panel was composed of the representatives listed below; their addresses and telephone and fax numbers appear in Appendix A.

Wayne Berman, FHWA, Washington, DC, Team Leader
Steve W. Clinger, FHWA, Baltimore, MD
Gene S. Donaldson, Montgomery County, MD
John Duve, San Diego Association of Governments, San Diego, CA

Gregory M. Jones, FHWA, Fort Worth, TX
Jerry L. King, Metropolitan Transit Authority, Houston, TX
Joseph F. Ligas, Illinois DOT, Schaumburg, IL *(the Netherlands and the UK only)*
Dennis Symes, FTA, Washington, DC
Juan M. Morales, J.M. Morales & Associates, Reston, VA *(Report Facilitator)*
David R. Gehr, Virginia DOT, Richmond, VA *(the Netherlands only)*
Steve Kuciemba, Maryland SHA, Baltimore, MD *(the Netherlands only)*
Pamela P. Marston, FHWA, Baltimore, MD *(the Netherlands and the UK only)*
James R. Robinson, Virginia DOT, Richmond, VA *(the Netherlands and the UK only)*

It is important to note that representatives of the four high-priority corridors in the U.S. participated in the panel. The Federal, State, and local sectors were represented in the panel, and this diverse group enabled balanced discussions with the host countries. The interaction that took place among the panelists themselves may result in more cooperation, communication, and technology-sharing in the U.S.

1.3 Itinerary

The tour started in Helsinki, Finland, on December 2, 1995, and ended in London, England, on December 17, 1995. The panel also visited Gothenburg, Sweden; Amsterdam, Rotterdam, and The Hague, in the Netherlands; and Southampton, England. To prepare the European hosts, team members compiled a list of amplifying questions that were provided in advance (see Appendix B). The panel did not intend to have each of the questions answered; they were provided to guide the discussions and presentation along the subjects of interest.

Organizations and agencies that the team met with are listed below. A complete list of topics discussed, sites visited, and contact persons is included in Appendix C.

Finland

- Finnish Road Administration (Finnra)
- Helsinki Metropolitan Council
- Ministry of Transport and Communications
- Technical Research Center of Finland (VTT)

Sweden

- Swedish National Road Administration
- Gothenburg Traffic Information Center

The Netherlands

- Ministry of Transport, Public Works and Water Management
- Schiphol Airport
- The Royal Dutch Touring Club (ANWB)
- Transport Research Center

England

- Highways Agency
- Hampshire County Council
- Southampton City Council

1.4 Format of the Report

The report consists of the following sections:

	Executive summary.
1.0	Introductory information.
2.0-5.0	Country summaries for Finland, Sweden, the Netherlands, and England covering areas such as agency organization, planning and research issues, technical and design issues, public acceptance and marketing, training, and observed trends. To the extent possible, the *planned and observed* advanced technologies for each country in the six priority areas of interest to the panel are discussed. This section does not include all the activities being conducted in these countries, but only the ones that the panel observed or discussed during the trip. Also, visits to certain countries were longer, and therefore more thorough than others. This is reflected in the report.
6.0	A narrative of how some of the technologies discussed abroad could be applied to the U.S. experience and personal insights prepared by individual panel members. These insights include descriptions of how panel members benefitted from the tour, things that they observed, and how, in their opinion, the technologies could be applied in their agencies and areas of responsibility.
7.0	A discussion of opportunities for future cooperation between the U.S. and each of the countries visited. This is an identification of areas and countries that should be followed up on through in-depth technical exchanges and cooperative or coordinated research.

8.0 The panel's recommendations, including specific activities that could be implemented to facilitate the deployment of traffic management and traveler information systems in the U.S.

Four appendices are included. Appendix A includes the list of panel members, their addresses and contact numbers. Appendix B includes the amplifying questions provided to the host countries in advance. Appendix C presents a table of topics discussed, by country, and the names of the principal points of contact in each country. Appendix D includes some Internet (World Wide Web) addresses learned during the trip. These addresses can be used to obtain additional and on-going information on-line.

1.5 Background

Since 1990 the movement toward applying advanced technologies to better utilize existing infrastructure and capacity, improve safety, and protect the environment has escalated. Many components of the so-called ITS program are already operational in the U.S. Systems such as integrated traffic control systems, traffic monitoring, advanced traffic management, automatic vehicle identification and electronic toll collection, and traveler information systems can be found in several locations in the U.S. Each system relies on a core of communication, detection, and data processing technologies. But these are stand-alone solutions to current transportation problems and not necessarily viewed as integrated systems capable of sharing information.

Furthermore, several private sector ITS products are being introduced into the marketplace. As these products are being purchased, the need has arisen to ask if these systems will, in the future, ever have the capacity to be integrated.

When the scanning review was conducted, the deployment of ITS for traffic management and traveler information systems in the U.S. was at a crossroads. The real question about the deployment of advanced technologies in the U.S. was whether it would occur with some degree of integration and consistency among public and private sector cooperation, open architectures, accepted standards, and interoperability.

Another issue being debated was the definition of a national ITS vision. Without a unifying and inspiring vision it cannot expected that consumers and politicians, providers and professionals, public officials and private entrepreneurs will generate the homogeneous energy, coordination, and resources necessary for a timely and rational deployment of ITS. The need to identify specific core components of ITS products and services was considered an important element of this vision.

Also considered critical was the need to set a national goal that would bring the national ITS vision into clear focus by defining specific elements of ITS technologies that should be implemented by a specified time. Included in that goal would be the widespread deployment of

specific core components to ITS products and services that add significant value, that are affordable, and are achievable within a reasonable period of time.

In that light, the tour was planned. The countries selected for this tour had already deployed several ITS systems. The had done so with a significant involvement from the public sector and also through innovative public-private partnerships. Some were working on standards and architectures and some were not, choosing instead to let the marketplace dictate the technology.

It was the mission of the panel, then, to investigate how these countries have gone about deploying these systems, study the standards and protocols, if any, they established and examine the organizational structure and policies that made them possible. In doing so, it was expected that several applications to the U.S. experience would become apparent, and that important lessons would be learned.

2.0 FINLAND

2.1 Background

Finland is a country of forests, islands, and thousands of lakes; a quarter of its land lies north of the Arctic Circle (see Figure 2). It is inhabited throughout, though two thirds of its population of 5 million live in urban areas. Helsinki, the capital and largest city, has slightly over half a million residents and is the center of an urban area with over a million people, referred to as the Helsinki Region.

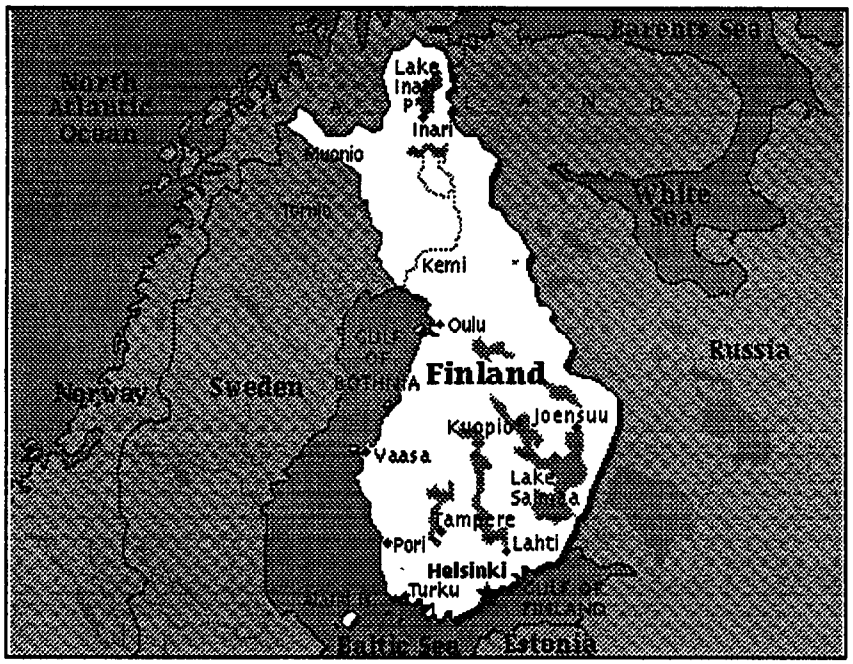

Figure 2. Map of Finland

Finland has 2.2 million automobiles and a road network of 370,000 km. Ninety-four percent of passenger traffic and 66 percent of goods transport take place on the roadways. Severe winters pose a great challenge for road and rail transport. Busy main roads are usually kept clear; to ensure traffic safety—roads are plowed, sanded, and salted. Over 1,000 tons of sand and over 100 tons of salt are used each year, but spreading salt harms the environment and its use is being reduced by rationing the methods and equipment employed.

Also critical are the provision of real-time information on traffic, road, and weather conditions and the provision of VMS and guidance for optimal route selection and timing. Advanced technologies are being used for these purposes, particularly along E18 between Kotka and Hamina, in southern Finland.

2.2 Organizational, Policy, and Funding Issues

Roads in Finland are the responsibility of Finnra, which manages, plans, designs, constructs, and maintains all public roads. Finnra has the responsibility of keeping the road network in excellent condition and providing a reliable and safe transport network, regardless of the weather. In response to the often difficult conditions, they have been forced to continuously improve operations management and economic efficiency.

The goal of Finnra's traffic policy is to develop traffic and traffic conditions economically, efficiently, and objectively to improve operating preconditions for industry and commerce, the well-being of the people, and the quality of the environment. Congestion leads to expenses that should be minimized; therefore, the most important aspect of their traffic policy is to ensure that necessary transportation is available with as little congestion as possible, using the most advantageous modes of transport. Their goal is to provide safe and economical transport to all road users.

It is interesting to look at Finnra's road management principles:

- Guaranteeing day-to-day mobility will be of prime importance.
- Traffic safety will remain a central goal.
- Speed will not be the most important element, but rather reliable, fluent, disturbance-free mobility and uniform speed limits that are adapted to the needs of road users.
- The importance of the environmental aspects in road management will increase.

Finnra is an agency under the Ministry of Transport and Communications, the budget of which is determined and approved by the Minister of Transport and Communications after specific goals and objectives are agreed upon for the upcoming year. The objectives are "shared" among Finnra's districts and funds are distributed. For example, a goal for next year might be to reduce the number of injury-causing accidents by 60. Certain districts may be assigned a fraction of those accidents to reduce and a budget to accomplish it. Funding comes from the general tax and there is no earmarking for transport purposes. On the average, only 10 percent of collected taxes is used for transportation purposes.

As in many countries, Finland is experiencing a trend toward privatization. For example, they expect to privatize their maintenance and operations functions by the year 1997. Most of their privatization efforts are driven by the European Union, which Finland joined in 1994.

Public transport is primarily provided by private companies, municipal transport corporations , the Finnish State Railways, the state owned airline company, FinnAir, and private taxis. Municipal transport corporations and other coach companies operate in larger cities and in the Helsinki Region. Helsinki operates tram and metro systems in addition to buses.

The public transport operations are heavily subsidized due in part to the fact that Finland is a large country with a rather sparse population. General fare subsidy is allocated to rail traffic to keep the ticket prices moderate, and a separate subsidy is paid for maintaining the ridership on unprofitable routes. Intercity bus and airline traffic in Finland are self-supporting. The infrastructure required by public transport systems is built and maintained by the governing authorities.

In the specific area of telematics, Finland's areas of emphasis are based on the country's technological strengths and the weather and traffic conditions. These emphasis areas are as follows:

- Logistical applications
- Increased need for information on road conditions and their dynamics
- Radio and cellular network based information systems
- Payment systems for public transport
- Management of public transport

The public sector will be responsible for the control and coordination of development and for the construction of the needed telematics infrastructure, always within the European standards. Projects concerned with the development of this infrastructure and services over the period of 1995-1999 will be divided into the following main categories:

- Transport telematics architecture
- Travel and traffic information services
- Traffic management and control services
- Public transport services
- Goods transport services
- Traffic safety systems
- Smart card systems for transport

The objective is that, by 1999, transport telematics will have become firmly established as an integral part of the Finnish transport system, and that a high level of Finnish expertise will have been gained in this field through research and development (R&D) efforts. Furthermore, the aim is to cultivate Finnish industrial development in this field, so that its production will be suitable for international markets, improve European competitiveness, and further national and European progress towards the realization of the "Information Society."

2.3 Planning and Research Issues

The rugged terrain and harsh climates of Finland are exceptionally challenging for the transportation agencies, and the Finns have been forced to continuously improve their operation management to maintain their economic viability. Planning and research activities originate from a strong national pride in its people's ability to adapt to the elements and develop positive responses to change.

It is a goal of the Finnish telematics program to provide safe and economical travel. Environmental responsibility also is a major concern. A second objective is to support the general economic competitiveness in industry and in the promotion of the "information society." While these programs have been designed to respond to user needs, the implementation of advanced technologies functions appears to be the direct result of strong public-sector leadership rather than user request for service and assistance. The recognition of the ability of advanced technologies to improve services has been sufficient to warrant public sector investment in these technologies. Although greater interest by the public and industry is desired, sufficient interest exists to support investment and improvements.

Finland invests more than Fimr75 million (US$20 million) in advanced technology programs, which has resulted in many programs, including weather and traffic monitoring systems, particularly along the E18 motorway.

Research activities have led to the deployment of new winter maintenance programs and evaluation of studded tires, unobtrusive driver-behavior measuring systems, smart card evaluations, recommended-headway systems, and hazardous conditions warning systems. Finland has taken the approach that monitoring safety can be improved by alerting drivers to the conditions ahead, and these systems have been well received.

A comprehensive program of telematics applications and research has been established through 1999. Many of these activities support the ITS work by the European Union (EU), and EU funding is available for these programs.

The planning of road network development in Finland is based upon accurate information concerning the existing network, traffic, national economy, land use, and other relevant factors. Planning and forecasting processes are well established in Finland. For example, in 1994 Finnra produced a road management "Vision 2005" that outlines the focus areas and goals of road management listed below. The plan describes the 10-year development program required by the Ministry of Transport and Communications and the focal areas of road network maintenance. It also stresses preserving the environment, which will govern activities as the new century approaches.

1. Development of communication systems
2. Increasing international cooperation
3. European unification
4. Raising awareness of environmental protection

They also realize that increases in traffic, changes in the needs of customers, and the demands for productivity placed on the public sector will bring even more challenges. Maintenance and development of service policies are vital to Finnra. They can be guaranteed by developing Finnra's organization, methods and systems of control, personnel, and operating methods.

The Helsinki Metropolitan Area Council has also developed its Helsinki Metropolitan Area Transportation System 2020 Plan. This plan is based on a comprehensive transportation study that contained information about traffic conditions and other analyses. The plan recognizes the importance of the transportation system in keeping Helsinki livable, competitive, and attractive to businesses. It establishes objectives regarding the following:

- Land use
- Public transport
- Car traffic
- Walking and cycling
- Commercial traffic
- Traffic safety
- Environmental issues
- Economy
- Implementation

Both Finnra and the Helsinki Metropolitan Area Council consider the existing road network to be adequate for the future. The national road network is also considered to be complete; only a few new roads are proposed to serve crosstown traffic.

Transport research in Finland is mainly conducted through the Communities and Infrastructure division of the VTT, whose goal is to satisfy the needs of Finnish business and public-sector decision makers. VTT is the largest research center in the Scandinavian countries and employs 2,600 people, of which 150 work at VTT Communities and Infrastructure. They have expertise in road and traffic engineering, transport, urban planning, municipal technology, ground engineering, and other public works construction. Three-quarters of the center's funding comes from the public sector, mainly Finnra and the Ministry of Transport and Communications, the rest comes from private-sector research and from international contracts.

In Finnra, transport telematics R&D was collected under the umbrella of a Traffic Management Research Program for the years 1993-1996. The objective of the program was to make traffic management and transport telematics known as true alternatives to traditional road construction and planning by the following methods:

- Increasing expertise concerning management and transport telematics.
- Performing controlled R&D in cooperation with research institutes, universities, municipalities, and the private sector.
- Assessing potential telematics solutions and their suitability to Finnish conditions.
- Promoting the implementation of proven solutions.

Finnra uses the 350 km long E18 corridor through the south of Finland from Turku to the Russian border as a test site for telematics applications. The existing infrastructure and the varying climatic conditions form an especially suitable platform for weather-related traffic management,

information systems, and mobile telematics services. Transport telematics R&D is carried out in close cooperation with neighboring countries, especially Sweden, and partly within the EU Fourth Framework Program, 1995–1998.

2.4 Technical and Design Issues

Finnra developed management systems for the fields of work they cover: strategic planning, planning and design, construction, maintenance, services for road users, and resource management.

To use these management systems efficiently, Finnra developed various data banks, such as the road data bank, road condition data bank, bridge data bank, etc. These data banks are utilized in various Finnra systems, such as the Traffic Monitoring System (TMS), which provides real-time traffic control, guidance, and automatic short-term forecasting. The number and types of vehicles, their time of passing, speed, direction of travel, lane, and at some stations, axle load and weight of vehicles are recorded 24 hours a day. Data are then sent automatically to central computers. Each of the 200 stations is also accessible at any time for real-time observation with a computer that has the TMS processing program. Real-time traffic flow can also be seen on the screen through animated graphics. Figure 3 shows a TMS display being accessed through cellular communications.

Figure 3. TMS Display

Road Weather Information System (RWIS) is an automated information system that provides real- time data and forecasts on road-weather and road-surface conditions. It serves as a tool for winter maintenance management, enabling maintenance crews to plan and carry out preventive actions against dangerous driving conditions at any time.

The number of road weather stations in Finland is about 200, and the number of traffic monitoring stations is also about 200. Road weather monitoring video cameras (both stationary and floating) complement the information gathered from the road weather stations. Three weather radars serving the southern part of Finland are located in Turku, Helsinki, and Kouvola.

The whole of Finland has RDS (Radio Data System) coverage that began operation in 1994. RDS-TMC (traffic message channel) transmissions were scheduled to start in 1996.

Finland has close to one million cellular phones for a population of five million, most of which use the Global System for Mobile Telecommunications (GSM) standard for communications. The whole country has GSM coverage, and in the beginning of 1996 over 10 percent of drivers had access to GSM phones in their vehicles. Two GSM operators also provide transport related services.

Other management systems supported by Finnra include a pavement management system, a bridge management system, an oversize transport route planning system, ground penetrating radar, and the SmartMap system for the management of geographical road data.

In the telematics architecture area, Finland's aim is to construct a road transport telematics infrastructure that allows telematic services to interconnect with one another and interface with different modes of transport and to be compatible within the European community. The systems must be open so they can be applied and operated without depending on any particular equipment manufacturer.

2.5 Public Acceptance and Marketing

Most of Finnra's programs are based on needs. Because they are addressing a need, mainly related to road conditions and traveler information, public acceptance is not difficult to achieve—information that is needed is provided. Most of Finnra's traveler information systems have been well received.

Marketing is not formally conducted. The systems that have been deployed are considered simple and easily understood by the public. A good example are the weather controlled variable speed limit signs along E18, which have been well accepted by the public. It should be noted that VTT conducts research, as needed, on the various systems before they are deployed.

Research on public acceptance and human factors is being conducted at the VTT as part of the winter road maintenance and incident detection programs. Focus groups and surveys of road

users are organized to determine appropriate signing and message content. Such research led to further refinement of VMS and the elimination of extraneous symbols, such as the "snowflake" on caution signs. Typically, public acceptance research and marketing are done by the contractor support to Finnra. Finnra officials did not identify any significant issues on barriers to public acceptance—they believe that as long as they can design programs to address nationally identified needs (such as road maintenance, safety and the environment) the public will be accepting. The research, surveys, and focus groups that are conducted are intended to refine, improve, and advance demonstration and test projects before wider implementation is accomplished.

Small-scale user surveys are carried out every year, for example, to assess trip information needs and how users prefer to receive the information.

2.6 Training and Continuing Education

There is no formal training activity for Finnish advanced technologies efforts. Generally, the contractor installing or designing a system is required by the contract to provide training to key personnel who will then train others. In cases, on-the-job training is viewed as a training activity.

The Institute for Highway and Maritime Education (IHME) is a channel through which Finnra provides international training. IHME's training consists of postgraduate courses for professionals. The target groups are senior management staff and middle management, and courses are designed to meet specific needs and last from two to four weeks. The Institute takes responsibility for planning the training programs, conducting the training, and for all logistical arrangements.

Domestic training is provided through Finnra's national training organization and in cooperation with the participating technology transfer organizations. Publications on road technology and management are provided on request, and videotapes are also available. A newsletter in English called *FinnContact* is published quarterly to inform of road technology and available resource materials.

In the past, other training (technical and technician level) in Finland has been conducted on an *ad hoc* basis, but development of the Finnish Technology Transfer Center may change that. The center was established in 1993 with the cooperation of FHWA, and, though its main purpose is to exchange technology between the U.S. and Finland, the center will provide training.

2.7 Observed Catalog of Practice

Traffic management

Most of Finland's traffic problems are in the metropolitan areas, particularly around Helsinki; however, traffic management is a fairly new concept in Finland. In the past, congestion, or the lack of capacity, was not seen as a major problem. Travel times from Helsinki's city center have

remained fairly unchanged since the early 1980s, both for public transport and cars. The operating conditions for car traffic have been maintained and improved for commercial traffic.

The average speed of buses in central Helsinki is between 18 and 30 km/h in the morning rush hours, 19–32 km/h during the day, and 16–33 km/h in the evening rush hours. The measured average speed of cars in central Helsinki is between 15–30 km/h in the morning rush hours, 20–35 km/h in the day, and 15–25 km/h in the evening rush hours.

Car ownership has decreased due to improved public transport services and increasing environmental concerns. Car traffic, however, has increased in outer Helsinki, whereas it has declined in inner Helsinki, due in part to a parking policy that is visibly enforced.

A study for developing a traffic management system for the Helsinki metropolitan area was completed in February 1994 and forms the basis for developing a traffic management system for the main city roads. Traffic management, which incorporates, among other functions, traffic information and traffic control, is therefore becoming an important activity in addition to road building and maintenance. The objectives of the traffic management system are to improve the smooth flow of traffic, improve traffic safety, and reduce environmental impact caused by traffic through making better use of existing roadway capacity. The main areas of traffic management are demand management, traffic information, and traffic control.

The traffic management system for main roads in Finland will be developed incrementally from the existing activities and technical systems in place. The focus will be on the following areas:

- Monitoring of traffic and road conditions
- Demand management
- Traffic information
- Traffic control
- The traffic management center
- Incident management

A traffic management center does not currently exist, but plans exist to build one in the near future. Activities concerning traffic information and traffic control will be concentrated in this center. This way, the essential interaction between information and control will be maintained. As a basis for real-time traffic management, a comprehensive monitoring system will be necessary.

Traffic control is the responsibility of the local road authorities, but traffic information is viewed as a more complex issue that concerns the whole country. Therefore, the Central Road Administration has been so far responsible for developing a service center for road traffic, and Finnra district offices are responsible for road weather services.

It should also be noted that in the Helsinki area, a Finnra program called Management of Traffic in Helsinki Urban Surroundings (MATHEUS) is dealing with current and future traffic

management issues. MATHEUS includes several projects, which are listed below. The subjects of these studies are indicative of Finnra's priorities in traffic management.

- Congestion-warning system on the main western entrance motorway.
- Centralized control system for traffic signals on roads managed by Uusimaa Road District.
- Computer-based general planning and maintenance management system for road destination.
- Signing along arterials in the capital region.
- Dynamic route guidance system on motorway/parallel road between Jarvenpaa-Mantsala.
- On-line road traffic monitoring system in the capital region.
- Roadside information and control system on the route of E18 in the capital region.
- Traffic management center development in Uusimaa Road District.
- Overall architecture planning for MATHEUS.

Traffic Signal Systems

In Finland, traffic signals are the responsibility of local jurisdictions. Finnra does have a responsibility over signalized intersections that lay outside cities, but these are only a few (200–300). Traffic is not perceived as a large problem (due in part to the parking policy); signal systems are therefore not considered critical. Signal monitoring on the mainlines does exist, but its operation is mainly weather related.

Incident Management

The TMS described above is Finnra's primary incident management tool. It assists in the detection of incidents by recognizing fluctuations in traffic flow. Finnra relies on private cellular phones to report accidents, the technology for which is widespread and functions well.

The weather- and traffic-monitoring stations can also be used to detect incidents; however, they cannot provide information about the type of incident. TV cameras may be used for this purpose, if they exist in the area of the incident. The police are responsible for responding to and clearing incidents.

A winter maintenance quality patrol also detects and responds to incidents. The current practice is to have one or more monitoring patrols drive randomly selected routes at randomly selected times. Although the main function of these patrols is to make visual observations of driving conditions, they have been useful in detecting and responding to incidents.

Public Transport

Public transport in Finland is convenient, comfortable, and inexpensive. The Helsinki Metro links the center of the city to the eastern suburbs, and metro trains run at 5-minute intervals during peak periods, every 10 minutes at other times. Helsinki has 8 tram lines, and the same tickets can be used for all modes of public transport.

The Helsinki Metropolitan Area Council is responsible for coordinating the public and private transit agencies in the Helsinki region. A transit operations center is in effect in Helsinki.

Finnish bus traffic is mainly operated by private enterprises; only the largest cities have municipal bus services. There are 400 bus companies that are members of the Finnish Bus and Coach Association. The Ministry of Transport determines only the maximum price for a 40-trip ticket, which is sold for trips of various lengths.

Local jurisdictions are responsible for local streets and transit operations. It is recognized that coordination of local and regional applications of future advanced technology programs will be necessary to provide integrated services.

A sophisticated public transport information system is scheduled to be in operation in the year 2006. Buses will have equipment capable of collecting information from within and outside the bus and for sending it to a central computer for data processing. The features of the bus equipment will be determined by the requirements of the data transmission and vehicle positioning and by the required functions and equipment of other systems, such as payment, passenger counting, and signal preemption systems. The computer will process the data and will control LED-based (light emitting diode) bus stop displays. Fleet management systems of the bus operators will be an integral but independent part of the system.

In addition to the dynamic information system, automatic public-transport route information machines, terminal information systems, and a demand-responsive public transport system are being planned as part of the Finnish transport telematics program (1995–1999).

Finnra is also taking part in public transport projects. In the Helsinki Metropolitan Area, Finnra, the cities, and the public transport operators are cooperating on a Park-and-Ride Pilot Project. The possibility of persuading car users to switch to public transport with much better information through schedules in real time, for example, is being surveyed at five locations in Helsinki.

Electronic Toll/Fare Payment

Payment device technology in Finland is well advanced. Since the mid-1980s, the Finnish Ministry for Transport and communications has pursued a program of developing automated electronic payment and debiting systems. Responsibility for conducting development was assigned to the Payment System Steering Group (PSSG), appointed by the Ministry in 1991. The PSSG has since

conducted smart card trials in public transport around the country. The committee's findings about electronic payment systems became the basis for the planning, design, and implementation of the growing number of debiting systems currently used for public transport payment in Finland.

Several smart card trials have been conducted in Finland as a result of their work. The committee has taken full account of available technology, current standards, application requirements, and clearing of payments. One of the primary considerations was to fully consider the systems from the users point of view.

Smart cards are plastic, credit card-sized cards that contain an I/O (input/output) interface and one or more circuits incorporating memory and possibly control logic or a microprocessor. The physical characteristics (dimensions, location of contacts, transmission protocols, etc.) of these cards have been standardized by the International Standards Organization (ISO).

The committee also had the task of accounting for existing and foreseeable standards relevant to smart card and electronic payment technology and accommodating these standards in all phases of system design and implementation. Other standards from the telecommunication industry have also been adopted. Knowledge of existing standards has been used as the foundation for writing a set of Finnish specifications that recommend guidelines for defining the functional operation of these systems. These specifications follow a policy of developing systems are technologically flexible and independent of particular equipment suppliers. They have been written with absolute cognizance of existing technological capability as well as anticipated technological evolution.

The specifications have been divided into eleven parts, each concentrating on one operational part of the smart card system. As enumerated in the specifications, the parts are:

0. General Description
1. Security Architecture and Concepts
2. Cards
3. Security Module
4. Interfaces of Application Programs
5. Application Architecture and the Information Content of the Payment Device
6. Equipment
7. Data Communication Interfaces
8. Maintenance
9. Quality Control and Acceptance Procedures
10. Distribution and Management System

The PSSG also developed specifications for public transport smart card-based payments to support the implementation of open payment systems enabling the integrated and crossover use of ticket products. The PSSG proposed that all smart card-based payment systems for public transport implemented in Finland should comply with the specifications set forth as far as possible.

Because of this standardization, incorporating smart cards into buses and other public transport systems has not been difficult. Various smart card trials are being conducted as a result, specifically, in the towns of Kotka and Seinajoki, in the Helsinki Metropolitan Area, and in the cities of Turku and Oulu. The experience is positive and, with the exception of the Helsinki Metropolitan Area, all the trial systems have already been implemented.

An interesting smart card application is the City Card. The City Card is a smart card for use within the limits of a specific city by residents receiving services provided by the city. It can be used for paying small fees, such as fees for tennis court or swimming pool usage, parking fees, tolls, taxicab rides, or public transport fares.

Customer surveys were conducted and the City Card received a favorable response. Service providers, too, look favorably upon the use of the City Card from the perspective of expanded clientele and more efficient fee collection.

Recognized benefits of this system include reductions in ticket printing and handling costs, improved efficiency for payment clearing and fund transfers, reduced operating costs, improved quality of business-operations data, and enhanced flexibility of customer services. Other indirect benefits are the technical and institutional coordination and integration that must take place for these systems to work.

Future work will account for the questions raised during these trials and strive for cooperation and exchange of information among all parties interested in using this technology. The next phase will also look at security and privacy issues.

Within the EU there are several on-going traffic sector research programs studying the use of smart cards in various application areas. The Ministry of Transport and Communications follows these projects and it maps out Finnish companies' desire and capacity to participate in future projects. Also the international standardization work is of great importance to Finland; such efforts will influence the direction of future developments.

Traveler Information Systems

Traveler information is one of the most important responsibilities of Finnra. In Finland, there is little traffic congestion, so the emphasis is on information on weather and traveler advisories. All traveler information is also seen as a good road safety measure. Travelers who are aware of traffic conditions—volumes, speeds, road weather, maintenance, accidents—can take notice of the given information when deciding whether to drive and which routes to use. They can also be prepared for the road conditions and any expected delays associated with driving in bad weather conditions.

There are several goals that Finnra tries to reach, as noted below:

- Communication from all data sources to the media should be as automatic as possible.

- Data processing and deduction should also be automatically arranged.
- Experts should be employed only on special occasions—in most cases, the editors of the information should be able to make reports.
- All parties should have the same information on the service level to avoid contradictions.
- Output of the information should be easily interpreted by end users.
- Information and forecasts should be up to date.
- Information and forecasts should be easily available to the road users.
- Data collection and deduction should be dynamic, so that the effects of information can be noticed and estimated in real time.

The weather controlled signs along E18, between Kotka and Hamina, are excellent examples of these traveler information principles put to practice. A suitable driving speed is determined and displayed *automatically,* based on weather stations and information received from sensors embedded in the pavement. There are several slippery road warning VMS along the whole corridor, which extends for about 350 km through southern Finland. On a 14 km section there are 36 automatic weather and road surface condition controlled speed limit signs and 5 information signs on the eastern part of the corridor near Kotka. Road weather stations and traffic monitoring stations exist at 30 km intervals along the corridor. The weather monitoring centers have immediate access to these stations. Figure 4 shows a VMS terminal on E18.

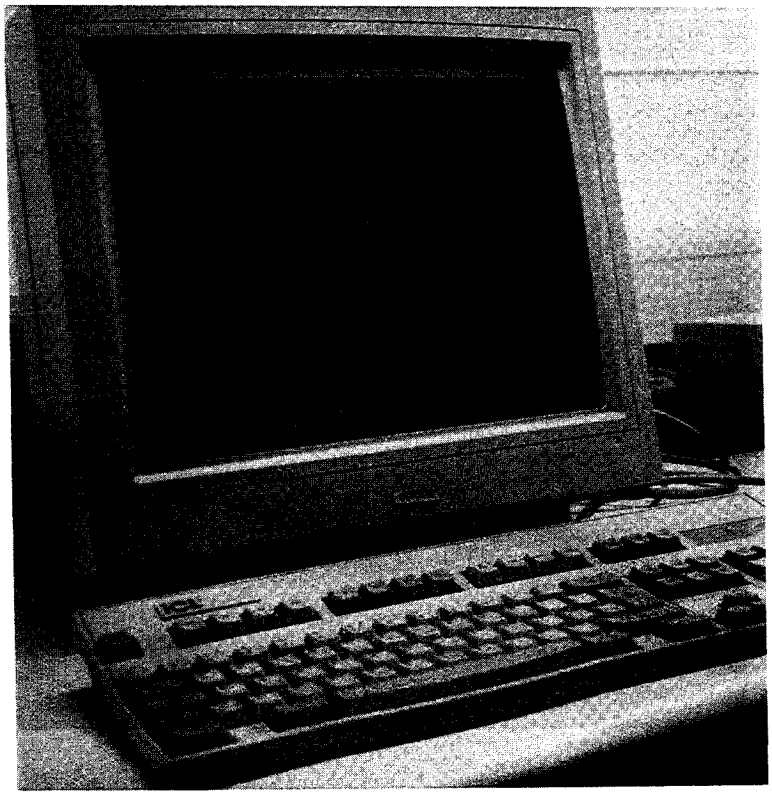

Figure 4. The E18 Weather-Controlled VMS Display

The road weather stations use sensing equipment known as DM31, manufactured by VAISALA to monitor and warn about road conditions leading to dangerous driving conditions. Four sensors can be attached to one DM31 station. Measurements on the sensor surface provide information about surface state and give short term warnings and alarms for frost or ice formations. It can also estimate water layer thickness and the concentration of deicing chemicals. This information is useful to plan for future chemical applications. Remote stations, DM31R, offer the possibility of making surface measurements up to 1 km from the main station. Figure 5 shows the road weather station on E18, near Kotka.

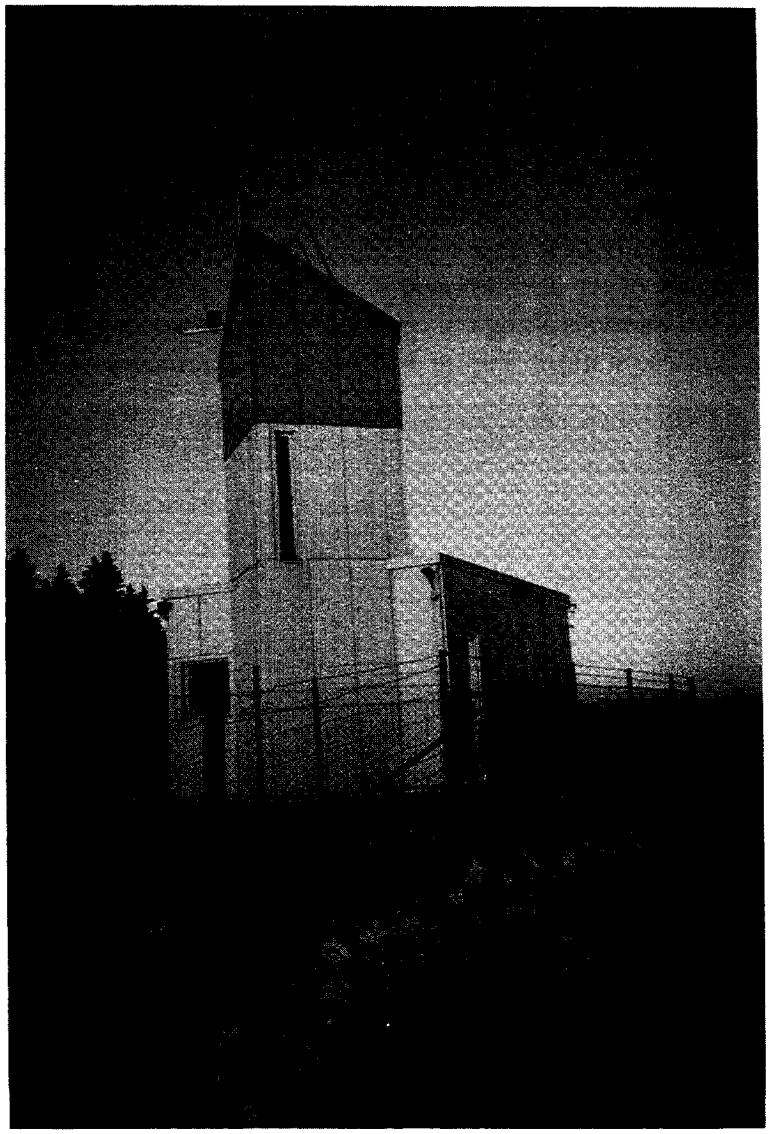

Figure 5. A Road Weather Station on E18, Near Kotka, Finland

Other VAISALA equipment used at the weather stations includes the ROSA (Road Surface Analyzer) Ice Warning System and road sensor interfaces.

The VMS give pictorial and textual information on conditions and speed limits. Several roadway weather monitoring stations are used to provide data such as fog and icing conditions to traffic control centers so drivers can be alerted and maintenance (salting) crews can be deployed. A vast communication network, mostly based on cellular technology, allows this data to be accessed and utilized.

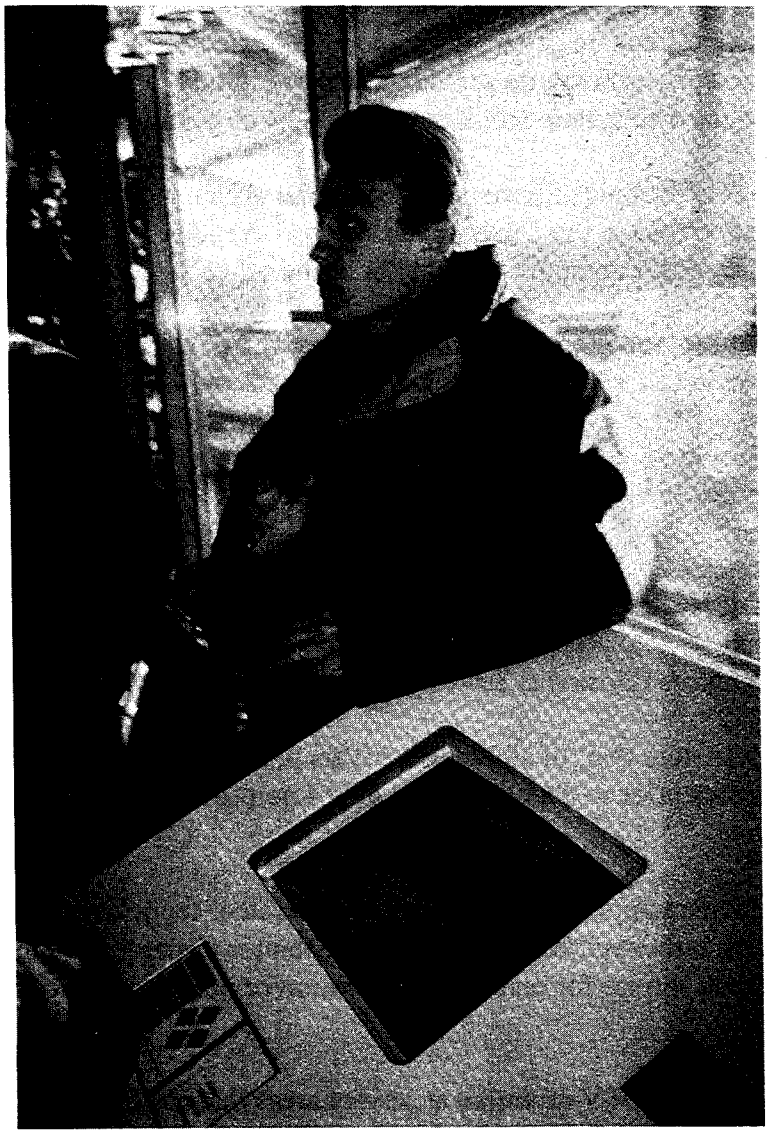

Figure 6. Info-Terminal at a Rest Area on E18, Near Kotka, Finland

Road users can obtain information before and during trips about prevailing road and traffic conditions. Information is always available via TV, radio, Internet, RDS-TMC, in-vehicle information systems, telephone services, VMS, and info-terminals at service stations and border stations. For example, a picture of the Russian border near Hamina is available at rest areas nearby and through the Internet (http://www.tieh.fi.8001/index.htm). This pictorial information is used by truckers to estimate their delay in crossing the border. National information networks, or teletext, provide access via TV or modem to real-time weather data as well as forecasts. Figure 6 shows an info-terminal in a rest area on the E18, near Kotka.

Another traveler information project is the Dynamic Timetable Information and Bookkeeping Services. Passengers will be given information on public transport timetables and prices in electronic form, concentrating on providing information on journeys requiring more than one mode of transport. The system will also enable seat reservation and ticket purchasing.

TeleSampo is an electronic information service that is being tested in southeastern Finland. It provides access to the service database of the Road Weather Service System via a public network accessible by personal computers at home or at the office.

The public has been polled to determine which information service they use the most. The results were as follows, in order from most to least important.

1. Local radio
2. Speed and temperature displays along the road
3. Radio Suomi
4. Newspaper
5. Maps of work zones
6. Teletext
7. Infomonitors (kiosks) at service stations

It is interesting to note that, of all Finnish drivers polled, 44 percent had obtained information about their journey prior to departure, and only 4 percent had never used any information about road conditions.

Local and regional radio stations broadcast road weather reports regularly. The reports are sent to radio stations from the regional Road Weather Monitor Centers 1–4 times a day. Finnra also has a 24-hour telephone service for recorded information or personal service on road conditions and construction.

There are 60 Road Info TV-monitors at service areas that are updated using data-TV service from the Finnish Broadcasting Company. Additional pages of information can be sent manually from the Traffic Information Center.

The PC-based road weather information monitors (kiosks) at service areas gather information from the Road Weather Service System every twenty minutes. Road conditions are presented using icons on a map, and the interface is especially designed for public use.

A real-time transit information system is currently being planned by the Helsinki Metropolitan Council. The system will display arrival and route information at bus stops using either LED or LCD (liquid crystal display) displays. The target year for implementing this system is 2006.

2.8 Themes and Trends

Finland recognizes the importance of technology in assisting with their winter maintenance and traveler information systems. It has one of the most advanced communication networks in the world and the Finns intend to take full advantage of it in the transport field.

As Europe is becoming increasingly integrated, Finland is looking toward making their communication technologies more accessible. The general principle is that obstacles preventing entry into the technology market must be removed by facilitating the licensing system and by narrowing the gap between the filed and actual business operations. The transport industry will certainly benefit from this.

Mobile phone services have rapidly expanded in Finland in the 1990s. The European standard, the digital GSM network, has expanded and is fully utilized. At present, Finland's GSM services already cover Europe, the Middle East, Asia, and Oceania. (It should be noted that the U.S. has adopted the CDMA (Code Division Multiple Access) standard and not the GSM.)

3.0 SWEDEN

3.1 Background

Sweden's motivations for the application of advanced technologies are similar to Finland's—traveler information as related to weather and road conditions. In addition, Sweden experiences congestion problems, particularly in the capital city of Stockholm (see Figure 7). (Note: The panel did not visit Stockholm).

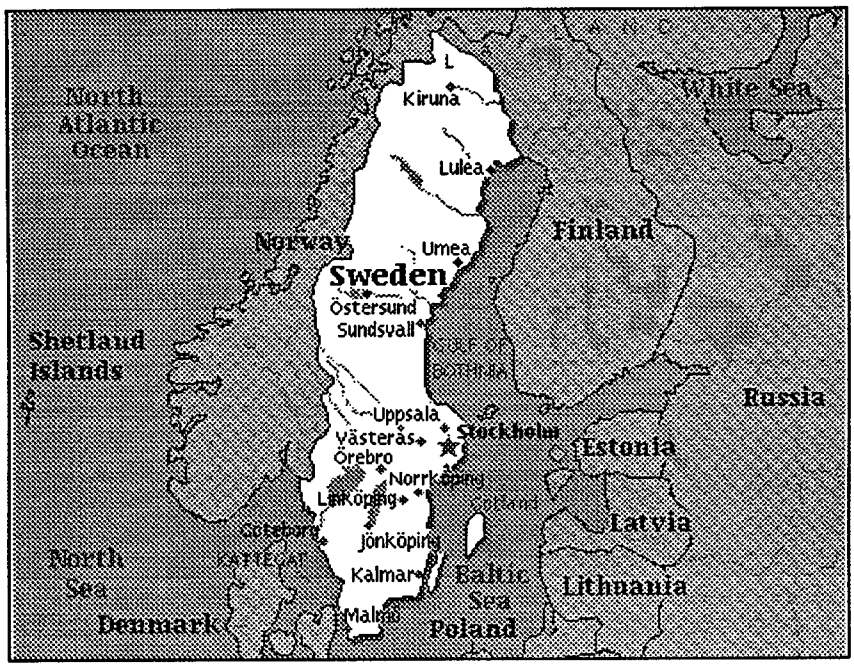

Figure 7. Map of Sweden

The Swedish government recognizes the importance and potential of applying advanced technologies to congestion problems and appointed the Delegation for Transport Telematics to investigate issues concerning the implementation of information technology in the transport sector. The Delegation addresses transport policies, the framework around the applications, implementation strategies, and special actions. Its mission also includes initiating debate and informing the public about the possibilities and limitations of advanced technologies or transport telematics. Its aim is to use information technology to reach more efficient, safer, and more environmentally-friendly transports.

Sweden's involvement with the EU is also apparent, in the context of transport telematics. For example, one of the largest projects in the DRIVE II research program is the System of Cellular Radio for Traffic Efficiency and Safety, or SOCRATES, the purpose of which is to develop systems for ATT. Sweden's TANGO is one of four projects within SOCRATES that

involves a number of partners working together—authorities, car manufacturers, electronic and computer industries, telecom operators, and research institutions.

3.2 Organizational, Policy, and Funding Issues

The SNRA is a state agency, including 7 regional offices, that is responsible for a 400,000-km national road network. The SNRA has also the national responsibility for the road traffic sector, including vehicles, driver licensing, traffic safety, and environmental issues. There are 280 cities that have local road responsibilities for road investment and maintenance, traffic safety, and environmental factors. The SNRA is responsible for all major roadways outside the limits of cities.

In general, SNRA funding is limited to the national road network; local municipalities are required to provide their own funding. There is interagency coordination between the SNRA and the local cities.

SNRA's road policy targets are as follows:

- Managing the roads
- Safeguarding the capital
- Maintaining the environment
- Ensuring the road network's contribution to effective use of resources
- Achieving a satisfactory standard

Safety is a major concern and a priority area. In 1994, Sweden had the same number of roadway fatalities as in 1947, with ten times the number of vehicles.

Swedish engineers, both in the public and private sectors, have developed several advanced technology projects, in spite of little policy in this area. SNRA has clearly taken the lead, with staff working primarily in Stockholm and Gothenburg. Sweden is blessed with the key ingredients of successful transportation systems—heavy ridership on public transit (both rail and buses), an adequate highway system, and relatively low automobile ownership.

The ARENA Program is the focus of the Swedish ITS program and plays an important role in the structuring of ITS technologies in Sweden. ARENA projects are divided into four main categories that are priority areas in Swedish transport policies. These areas are as follows:

1. Traffic control
2. Traffic information
3. Winter road maintenance
4. Traffic safety

Although there appears not to be a high demand from the public for advanced technologies and traveler information systems, the private sector and local government have joined to promote this

technology. SNRA provides full time staff in the Gothenburg traffic and transit ITS field and provides an outstanding program in which communication currently takes place with transit riders and will ultimately be available to automobile drivers.

Sweden's organizational structure appears to be more than adequate to lead in the deployment of advanced technologies. The private sector, currently operating the bulk of public transport, will need profit incentives or at least a break even condition to pursue advanced technologies programs.

3.3 Planning and Research Issues

Formation of the Delegation of Transport Telematics is a clear indication of the planning considerations given to advanced technologies in Sweden. Although the Delegation was planned to have a two-year lifespan (1995-1996), its work will determine the application of advanced technologies in Sweden in the future. Among other tasks, the Delegation was to review existing legislation and regulations to assess whether those documents were appropriate in view of the opportunities created by advanced technologies. This task also included considering and proposing new or supplementary legislation to regulate the use of the new technology.

An interim report of the Delegation's work was to be presented by February 15, 1996, and its assignment was to be completed by the end of 1996.

The introduction of more advanced forms of transport telematics in Sweden will depend on the possibilities of international solutions being agreed upon. The European Conference of Ministers of Transport (ECMT) has adopted several resolutions concerning the need for European harmonization in this field and, conjointly with the EU and other organizations, has appointed a special committee to chart the legal and administrative problems associated with application of computers and telecommunications in the transport sector. It is important to notice that the availability of more advanced forms of transport telematics will be possible thanks to the traffic policy defined by the Riksdag (the Swedish Parliament).

Transport research in Sweden is mainly conducted by universities such as Chalmers University of Technology.

3.4 Technical and Design Issues

Advanced technologies systems in Sweden are designed by a combination of in-house personnel and consultants. Coordination between municipalities and the state is very limited, as is interaction between the police and transportation officials.

Sweden is active in the development of standards that meet the European standard, and traffic management centers are being developed. An existing traffic management center is located near the city of Gothenburg with some traffic monitoring and information capabilities and is used to

test technologies that will be deployed in other areas of the country. Transportation safety is one of Sweden's higher priorities, and technologies are being developed or planned that will enhance the safety of the transportation system.

Sweden has determined, through internal review and the experiences of other countries, that the use of advanced transportation technologies has an excellent benefit/cost ratio. Sweden must use advanced transportation management technologies to make their transportation system more efficient. A major construction project to build a new ring road that consists primarily of tunnels around Stockholm is underway . Advanced transportation management systems are being designed into the system. Advanced vehicle identification (AVI) technologies for toll collection will be considered for the Stockholm system. Funding will be budgeted for the operation and maintenance of advanced technologies.

3.5 Public Acceptance and Marketing

Public acceptance and marketing research are areas of importance for national policy; however, few studies in this area have been completed. The National Delegation for Transport Telematics had public acceptance and market research activities on their long-term program agenda. The long-range program of public transport and road improvement in Stockholm will include research in this area, especially for electronic toll collection on the ring road. More marketing research on the proposed Stockholm ring road is necessary to determine the acceptance of long tunnels and toll facilities with automated toll collection systems.

Some market research has been done for the ARENA traffic management project and for the TANGO route guidance and driver information project. The goals of the research are to identify which suppliers are available, what information road users want, and the market segmentation of potential users, i.e., who the users may be. From its beginning, the coordination and field trials that have been part of the ARENA project have involved all parties.

Public acceptance is often achieved by making sample products available and measuring responses to the service. The process often results in improvement of the product, which was true of the public transport information system for trams and buses, the Gothenburg Traffic Information Center, known as GOTIC. (See the Traveler Information Section for more information of the GOTIC project.)

3.6 Training and Continuing Education

Training appears to be informal; no formal training effort is underway at the present, but planning is underway to develop a training effort. The skills required for traffic signal systems, motorway control systems, VMS and rerouting signs are not presently available and need to be developed. For each function, the experiences required are being documented. Training programs will be developed to accommodate the needs in the future.

The education aspects of the TANGO projects have been studied. SNRA understands that working with police and fire officials is not an easy task, but will work with those groups to ensure that information is provided correctly. All information operators should have knowledge about the purpose of the information that is being provided. Other skills that SNRA recognizes to be needed are traffic engineering and geographical familiarity with the areas in which the information will be collected and transmitted. Training programs designed to address these issues will be developed.

3.7 Observed Catalog of Practice

Traffic Management

Traffic management is of major importance in Sweden, and a road traffic management center exists in Gothenburg (see Figure 8). Its four main purposes are (i) maintaining contact with traffic, (ii) providing information, (iii) managing incidents, and (iv) and controlling traffic.

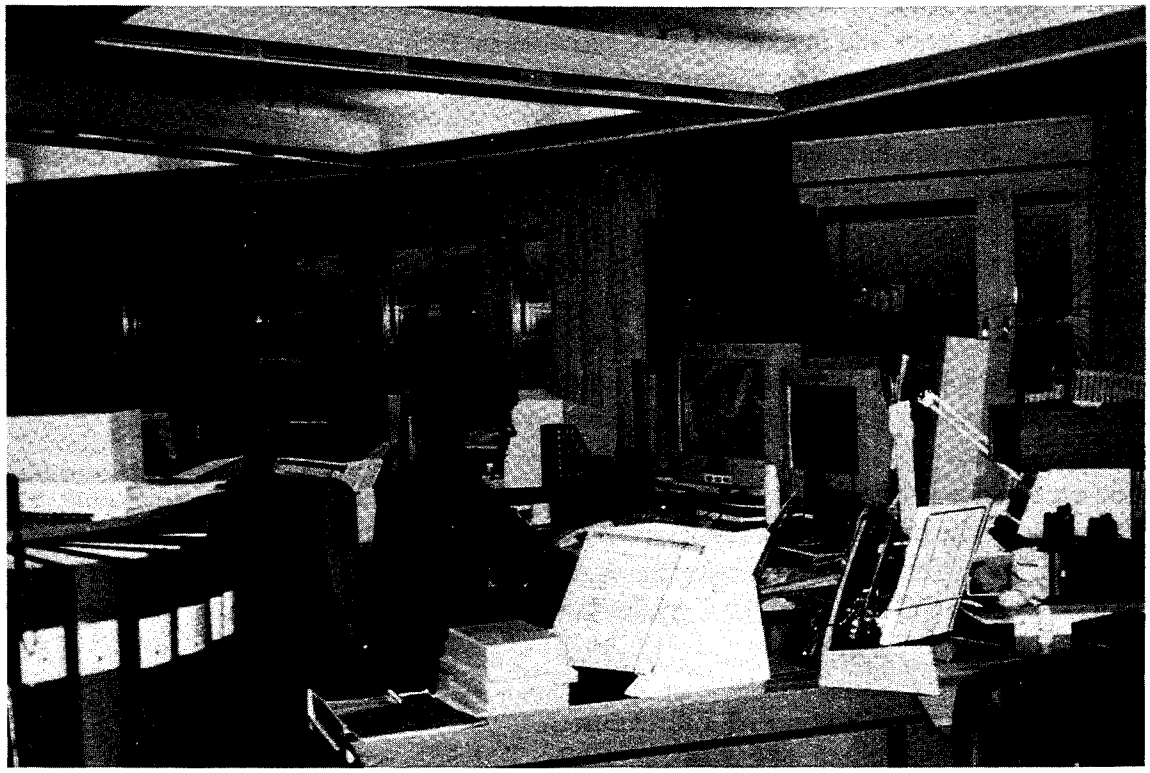

Figure 8. Road Traffic Management Center in Gothenburg, Sweden

ARENA, a test site for West Sweden, has helped demonstrate advanced technology applications in traffic management. ARENA is a Swedish National Road Administration project that uses field

tests to ascertain how road traffic can be improved by information technology. The project began in Gothenburg in 1992 and involves conducting field tests with the cooperation of industry and other organizations. This allowed researchers, operators, designers, manufacturers, and suppliers to work cooperatively even at the trial stages. The various systems were deployed in stages, from laboratory tests, via prototypes and pilot tests, to implementation. ARENA is a prime example of how advanced technologies can be tested to evaluate their traffic management applications. The project has contributed to the development of several advanced technological concepts, such as a mobile, portable system for trip planning, applications to VMS, the traffic message channel, and TANGO (see below).

Sweden is also involved in the SOCRATES project. SOCRATES is developing techniques for using cellular radio as the basic communication medium of IRTE (Integrated Road Transport Environment). Regardless of the equipment found in vehicles, the services provided to customers, or communication medium used, all services and products will be defined as part of the SOCRATES concept, as long as there is a two-way radio communication. Its goal is to achieve commercially successful, pan-European implementation of ATT services based on SOCRATES.

A part of SOCRATES, TANGO is one of Sweden's most complete and technically advanced road transport telematics projects. TANGO is geographically limited to Gothenburg; i.e., the market investigations, testing, and field trials were limited to that city. In TANGO, a navigation system installed in a car utilizes the combination of a road network stored on a compact disc (CD) and satellite positioning to provide the driver with guidance to a destination. The Gothenburg controlled trials were conducted in 1994 using dynamic road guidance and resulted in reduced travel times and safer driving conditions.

The core function of TANGO is dynamic route guidance based on continuously updated information from a traffic control center. The system relies on its database and on roadway detectors as well as other sources of information, such as the police and emergency services; vehicles themselves are also used as probes. Utilizing an advanced traffic model, a computer analyzes the traffic flow, predicts congestion, and estimates travel times. The information is packaged and transmitted to the vehicles using a digital two-way radio network. At first the mobile packet data network Mobitex will be used and eventually the European mobile telecommunication standard, GSM, as well.

The navigation system of TANGO consists of a computer that uses the road network stored on a CD and satellite positioning to provide drivers with guidance information. The guidance instructions are presented to the driver by a synthetic voice or information can also be presented as pictures and text. European standards will ensure that the information is presented in the same way everywhere, and in the language of that country.

The seven regional traffic management centers of SNRA have been enhanced to include not only providing information to road users, but also traffic management. The aim is to develop working

models of how disruptions in traffic, such as incidents, can be handled by the road management traffic center and other parties, such as police.

Traffic Signal Systems

Traffic signals are the responsibility of local jurisdictions in Sweden. Most intersections with traffic signals are isolated, meaning that the signals are not coordinated into a system.

In 1994, a test trial was carried out using a new method of traffic signal control at isolated intersections in which actuated traffic signals can give priority to public transport. It was found that this type of control resulted in a 10 percent improvement in efficiency.

For coordinated traffic signal systems, through ARENA, a new Italian system was adapted and tested in 1993. The system, known as Utopia, also allows public transport to be given priority and utilizes exit detectors to allow the passage of platoons that have already been given the green light at the previous intersection. The trials yielded excellent results and were extended in 1994 to include all intersections in the Opalen area of Gothenburg.

Incident Management

Currently, incident management is conducted on an *ad hoc* basis with little formal coordination between the police and the transport officials. The police determine when an "incident" occurs without input from transportation officials. This will not be the case when the Stockholm ring road is completed. Full monitoring will be possible and a coalition of partners (i.e., police, emergency vehicles, etc.) will be formed.

Accident reporting has also being improved through ARENA. In the past, the main source of accident information was the police, but a system is being developed through which information is provided by hospitals and insurance companies, as well as police. Information is sent to central computer systems where it is compared and analyzed to create databases of accidents and damage. The system also includes a digital map database that describes precisely the sites of accidents.

In the spring of 1995 SNRA/ARENA installed six VMS' on all the major entrance roads to Gothenburg that were integrated with ARENA's platform for traffic control and traffic information. In addition, ARENA currently has traffic prediction models that collect information from about 50 loop stations that predict traffic flow and can, thereby, identify potential accident locations. SNRA intends to use these models to follow up on the work of the traffic management centers.

The 7 regional traffic management centers of SNRA have gradually increased their scopes to include not only providing information for road users but also traffic and incident management.

The primary goal of the project is to develop working models of how disruptions in road traffic can be handled by road management traffic centers and other parties.

Public Transport

Sweden has a high rate of public-transport usage, and the Swedish government has a strong commitment to making their public transport systems efficient, effective, and reliable.

Gothenburg Traffic and Transit Authority operates a transit information system, called KomFram, which presents real-time information for 280 trams and 50 buses and full-fleet implementation is underway. KomFram, which translates to "Get There!," is a real-time system for planning, influence, information, and follow up, characterized by specific goals in each of the areas below. Figure 9 shows the KomFram Control Center.

- Planning: planning of timetables, traffic signal control methods.
- Influence: operation of traffic control center, dynamic control of traffic signals, priority (preemption) to public Transport and emergency vehicles at traffic signals, information about alternate routes.
- Information: information to passengers about actual time of arrival, possibilities of transfer to bus or tram, causes of disruption, etc., information to commercial drivers and others.
- Follow-up: statistics relating to quality in the form of punctuality, passenger frequency, income from tickets, etc.

KomFram consists of an infrastructure in the form of a communications network, routines for communication and message management, several databases, and a number of specially adapted applications and services. It collects and manages information about traffic and facilitates communication among all units in the system—the traffic control center and passenger information service, the vehicles, traffic signals, signs at bus/tram stops, etc. Bus stop displays at shopping centers, in vehicles, at home, and at work present transit information to people. Figure 10 shows a typical KomFram information center inside a local store.

The Gothenburg transit authority is responsible for traffic, parking, and transit services, but actual services are purchased from both the public and private sectors. While transport services are directly operated by a contractor, the transit authority operates the passenger information service.

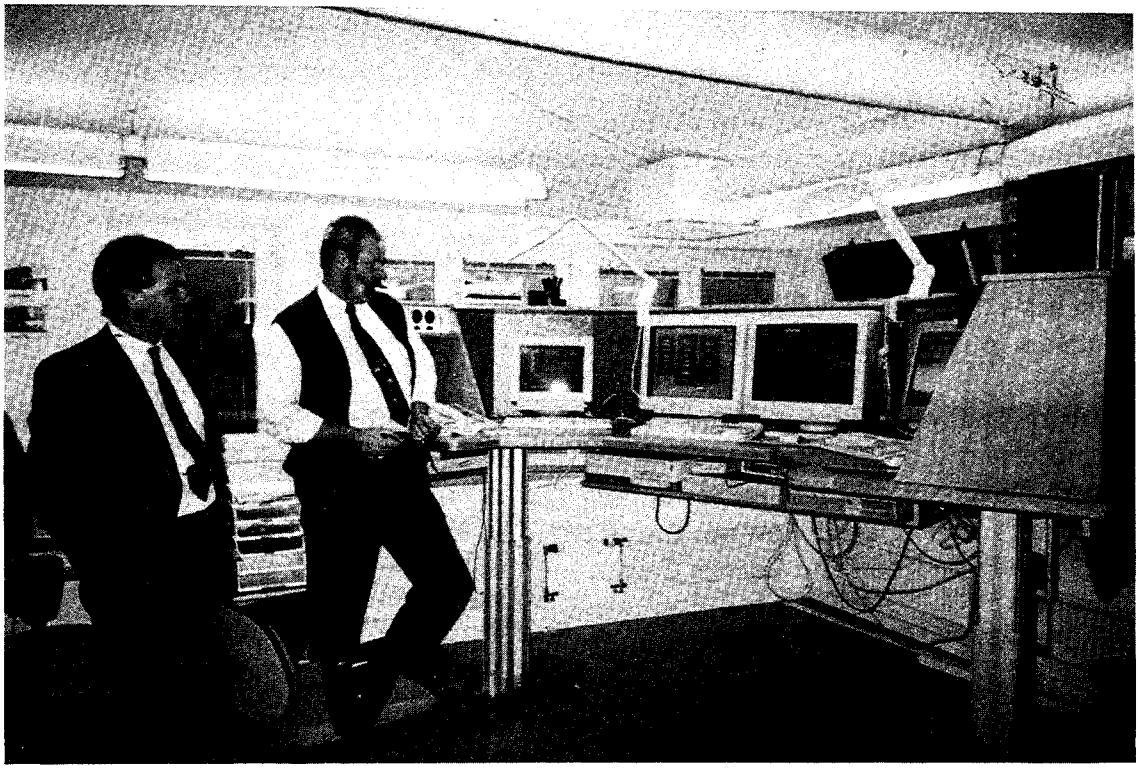

Figure 9. GOTIC KomFram System

Figure 10. KomFram Info-Terminals at a Local Store

Electronic Toll/Fare Payment

Policies governing the collection of tolls in Sweden are demonstrated in the Stockholm region, where they are delineated by a mechanism known as the Dennis Agreement. This agreement, among the National Rail Administration, National Road Administration, and Stockholm Transport, is composed of a variety of measures designed to improve the environment, increase accessibility, and promote development.

The agreement represents investments of over SKr 40 billion (US$7 billion) and includes development of a trunk route network for buses, construction of the Stockholm Ring Road, and construction of the Outer Bypass Route. It establishes that all infrastructure investment in Stockholm is to be paid for by tolls and that all public transport investment will be paid for by the Government on an equal basis. In other words, tax revenues will be invested in public transport while roads and other road-related investments will be financed with tolls collected. In the context of the Dennis Agreement, toll collection is considered a tax, not a user fee.

In collecting these tolls, the prerequisites listed below have been established by law.

1. The system must have an anonymous payment option (to address the privacy issue).
2. Manual payment must be possible.
3. Less than 7 percent of the collected tolls may be spent on operation.
4. The system in Stockholm must be interoperable with the eventual Gothenburg system.

Various electronic toll collections systems are being considered for the tunnel-based Stockholm Ring Road, along with their full integration with transport telematics programs. The current plan is to use an "electronic purse" system, with microwave communication, to allow users to add money to a smart card-type device or "purse" in order to utilize the ring road.

The Gothenburg-tested system, known as Automatic Debiting for Sweden (ADSW), is based on a smart card that is credited with a prepaid amount and inserted in a tag fitted to each vehicle. When the vehicles pass a toll station, the tag establishes the communication with the roadside using a magnetic reader, and the appropriate toll is debited from the card immediately and automatically. If no payment is made, the vehicle's license plate is photographed. Vehicles that do not have the smart card technology will also be photographed for later payment. The next step being considered is to integrate other services on the smart card, such as parking and public transport.

Traveler Information Systems

The TANGO project, previously described, is an example of the state of the practice in traveler information systems in Sweden. Information is viewed as a tool that can be used to optimize physical resources and increase the capacity of a system by achieving the right combination of physical resources and expanded information services.

Another good example of a traveler information system in Sweden is the GOTIC project. GOTIC is a forum in which research and practical tests in the field of traveler information systems are carried out by researchers and companies operating in the public transport industry. Its objective is to increase the standards of quality and effectiveness of public transport for the benefit of the national economy, the environment, and road safety, as well as the quality of life for Swedish citizens. Full-scale testing and demonstration of the KomFram system was conducted as part of GOTIC.

GOTIC is unique in that it provides a forum for research, development, and marketing for people who have different approaches and needs—researchers, passengers, manufacturers, decision-makers, and others. The development of GOTIC is governed by their combined creativity and visions.

Another example of a traffic information system in Sweden is the Dynaguide Info System developed by Volvo for the new pan-European RDS-TMC system. Using an in-vehicle display, information on current traffic conditions can be obtained at any time by the driver. One of the main advantages of the system, which works by receiving coded messages, is the ability to display information in a driver's preferred language.

RTI, or Road Transport Informatics, is the technology used by the Dynaguide Info System. RTI research is being conducted in conjunction with other projects, including the auto industry's Prometheus Program and the EU DRIVE project. RDS is the channel used for transferring messages to road users and TMC is the message coding system. Communication takes place via the FM network, and the system uses GPS (Global Positioning System) to establish the location of the vehicle.

The Dynaguide Info System has undergone full-scale tests over a 2-year period in Gothenburg, as well as in Paris and Minneapolis.

3.8 Themes and Trends

Sweden has recognized the potential of advanced technologies to assist with solving transport-related problems and is proceeding with deployment. They also understand the necessity of working within the standards of the EU for existing systems to be compatible with those of the future. With that in mind, the Swedish have taken the time to test projects, and the government has appointed a Delegation for Transport Telematics to investigate the consequences of advanced technologies for the private sector, along with its other assignments.

Also important is the fact that they have a clear vision of the kind of intermodal transport system that advanced technologies can bring, both in the private and public sector. It is hoped that this vision will bring about a homogeneous system in the future, without the need to develop a system architecture. Sweden rejects the development of a system architecture as it restricts technology

deployment. In other words, they feel that an architecture developed today may not necessarily accommodate future technical developments.

The growing relationship between the public and private sectors is an important trend in Sweden, and the recognition that cooperation between the public and private sector is crucial for the development of any ITS project is significant. All trials being conducted through ARENA have a strong private-sector involvement. The private sector is generally responsible for telecommunications, though there is an effort underway for local governments to install fiber optic cable systems.

Present and future directions of advanced technologies appears to be a balance between the driver and society with including (i) information, (ii) warning, (iii) recommendation (advisory), (iv) assistance, and (v) control aspects, in that order of importance.

Finally, the international involvement of SNRA will increase in the near future. As Sweden now is a member of the EU, ARENA will have a greater financial opportunity to actively participate in European joint ventures. Continued investment in the development of travel planning services, systems for intelligent speed control and navigation systems based on the SOCRATES concept are also likely. The integration of information from environmental sensors to allow traffic to be diverted from areas with high emission levels is another important area.

4.0 THE NETHERLANDS

4.1 Background

The transport of people and goods is not only a fundamental condition for nearly all economic and social activity in the Netherlands, but contributes significantly to the gross domestic product. In addition to providing direct revenue from transport, a strong transportation system is important for the role that the Netherlands fulfills in the international transportation of goods.

In 1995, the contribution of the transport sector to the gross domestic product was approximately 8 percent. In addition, the transport and distribution sectors account for almost 7 percent of the total employment in the Netherlands—around 370,000 people.

Figure 11. Map of The Netherlands

The Port of Rotterdam and Amsterdam's Schiphol Airport serve as two of Europe's main distribution centers for both people and goods (see Figure 11). Thirty-five percent of Europe's freight is handled by Dutch companies. Efficient performance of the transportation system is critical to the success and accessibility of Rotterdam and Schiphol and, ultimately, to the Netherlands' ability to serve as the "Gateway to Europe."

In recent decades Dutch society has undergone major changes. As a result of developments in the economy, in social aspects, and in physical planning, automobile ownership in the Netherlands has increased dramatically. Today, the Netherlands has the highest number of cars per square kilometer in the world. In the 1960s and 1970s expansion of the primary road network followed

increases in the number of cars as closely as possible. The primary road network ties together congestion-free regions, economic centers, and large cities. In the 1980s it became clear that building more roads could not keep up with the rapid growth in traffic volumes. Selective accessibility, improved use of the existing infrastructure, and heavier investment in public transport became critical.

The share of local and regional traffic using the primary road network in urban areas has increased sharply. In the last 10 years car traffic on the primary network has increased by 40 percent, and growth of traffic over all Dutch roads during the same period was about 20 percent.

Congestion concentrates in and around large urban areas. The direct economic impact resulting from road congestion on the primary road network amounted to over f.1.4 billion in 1994 (US$950 million). Of this, 10 percent was suffered by goods transport, 65 percent by passenger business traffic, 15 percent by commuter traffic, and 10 percent by other traffic, including public transport. The number of congestion hours is projected to increase by 13 percent by 1998, 80 percent of which will occur during the rush hours, while the rest will be due to incidents.

A continued increase of congestion on the primary road network is viewed as a critical problem in attracting new business. For companies, the smooth and reliable transport of people and goods is an important factor in deciding whether to set operations in the Netherlands. The Dutch transportation policies, are therefore directed toward minimizing congestion in order to protect the accessibility of transportation hubs and provide for the mobility of its citizens and visitors while making use of its existing infrastructure. These policies also recognize that technological developments play an important role in the continuous evolution of transportation systems, that strategic transport policy has to incorporate the technology factor and should take into account the possibilities and effects of technological options.

4.2 Organizational, Policy, and Funding Issues

Dutch policies are directed at limiting and controlling congestion while making more efficient use of the existing infrastructure. Traffic management is viewed as an important tool for achieving efficient utilization. The Cabinet has decided to greatly expand the existing traffic management program on the primary road network for which the Ministry of Transport, Public Works, and Water Management has allocated a budget from now until the year 2000 of f.1.6 billion (US$1.1 billion).

The Ministry is responsible for the following areas in the Netherlands:

- Transport
- Infrastructure
- Water management

- Telecommunications and the postal system
- Meteorology

The Minister of Transport is a member of the Dutch Cabinet and bears political responsibility in addition to the following:

- Protecting the land against encroaching water.
- Ensuring the sustainable development of the various water systems.
- Sustaining mobility and communication options that benefit the Dutch and international societies.

Seven directors-general are charged with the implementation of policy in these fields, two of which are directly involved with roadway transport issues. The Director-General for Public Works and Water Management is responsible for "the safe and unimpeded movement of traffic on waterways and roads," and the Director-General of Transport ensures "the integration of transport policy, both national and international." Both departments combined bear all responsibilities related to roads and road policies in the Netherlands.

Against the backdrop of improving the accessibility and livability of the Netherlands, particularly in its western part, the following policy goals have been formulated for traffic management on the primary road network:

- To guarantee that the primary road network fulfills its network function.
- To increase the reliability (and, therefore, safety) of the primary road network.
- To promote the preferential treatment of target user groups.
- To improve local traffic flow on the primary road network.

Implementation of these goals should lead to observable benefits for road users from better throughput, greater reliability, and greater traffic safety.

4.3 Planning and Research Issues

Transport planning and land use policies are significant parts of the Ministry's activities. This planning is the direct result of the transport strategy and the individual steps it dictates, as explained below.

Step 1. *Tackle problems at the source*. Vehicles must be made clean, economical, and safe. Expansion of the infrastructure must be curbed.

Step 2. *Manage and restrain mobility*. Ensure the number of kilometers traveled is reduced through measures such as encouraging people to work close to home or ensuring that major residential and industrial areas are easily reached by public transport.

Step 3. *Improve alternatives to private cars.* Raise the standards and comfort of public transport, improve facilities for cyclists, and encourage carpooling. Persuade people to use their cars less often.

Step 4. *Targeted accessibility of roads.* Assess expansion of roads on a case-by-case basis rather than a uniform, nationwide basis.

Step 5. *Strengthen foundations with support methods.* Communication networks, interagency cooperation, enforcement, and research activities need to be strengthened.

This step-by-step approach will help the Netherlands maintain accessibility within the constraints set by the concept of a sustainable society. European cooperation is vital in this approach because some of the measures, particularly standardization, cannot be undertaken on a national level alone.

The next step in the Netherlands' planning process is to translate the strategy into specific targets and planning policies. For example, controlling public transport fares, developing a parking management policy, defining a modal-split target, or implementing a pricing policy.

Transport research in the Netherlands is conducted through the Netherlands Transport Research Center (AVV), an advisory unit within the Ministry that employs about 400 people. The AVV is responsible for support research and policy. Its spectrum of activities is broad and covers subjects in road, rail, water, and air transport. The AVV also provides policy recommendations, acts as a knowledge transfer point, and provides information and basic data on traffic and transport to the Ministry. (A large proportion of the research and part of the collecting and processing of data is also subcontracted to outside institutes and private consultants.)

The AVV acts as an intermediary between those requesting research policy makers) and those supplying it (the research market). It has the following four departments:

1. Infrastructure, Design, and Operations
2. Transport, Safety, and Environment Studies
3. Statistics and Data Management
4. Strategic Research and Program Coordination

Basic products include traffic data, traffic management systems, mathematical models, standards for design, and special courses.

A unique aspect of the AVV is its involvement in "anticipatory research," a term used to refer to strategic research conducted to anticipate future demands for policy support and innovate the existing body of knowledge and expertise. It focuses on questions connected with possible developments in the longer term. Ten percent of the AVV's activities and budget are dedicated to anticipatory research.

4.4 Technical and Design Issues

The Ministry's primary involvement in telematics is related to management of the physical infrastructure, enforcement, purchasing and application of existing knowledge and equipment on the market, and applied research. The Ministry is also "the orchestrator and driving force when it comes to creating conditions" for the deployment of advanced technologies. It may initiate projects, provide information about telematics, promote standardization, or coordinate market initiatives.

Industry expects and receives clear information from the Ministry on strategy development and the main concepts at the interface between telematics and traffic and transport. These concepts define the technical developments in the area of telematics. Five concepts, as defined in the Telematics in Traffic and Transport Policy document and progress report, have been assigned priority according to their strategic importance. These are as follows:

1. *Chain approach to freight transport.* To foster and create conditions for the further development of communications and proper use of telematics applications in freight transport.

2. *Dynamic traffic management.* To ensure that the infrastructure operates efficiently by controlling and regulating traffic and enhancing throughput capacity as well as safety.

3. *Multimodal travel information.* To allow the traveler to make a more conscious choice of mode, by providing comparable information on all relevant modes.

4. *Chipcard (smart card) technology.* To ensure the coordinated introduction of chipcard technology within the domain covered by the Ministry.

5. *Telematics infrastructure.* To help build a fully-fledged telematics infrastructure for the traffic and transport sector.

4.5 Public Acceptance and Marketing

Public acceptance and marketing are built into the Dutch policies for transport telematics, and the team observed how this phase fits within the overall Dutch telematics development model. This model is an approach to the way in which large ITS projects can be undertaken on the basis of cooperation between government and external parties. The projects can be phased and the links among the various phases are listed below.

- Strategy
- Cooperation
- Public relations
- Pilots

- Market orientation
- Migration
- Implementation
- Information and evaluation

The public relations, the market orientation, and the information and evaluation phases are related to public acceptance and marketing. Joint efforts to make projects known among the intended target groups are carried out. There's also a "lowering of the threshold" towards the new technology—the public's willingness to accept new technologies. A market analysis, based on the four Ps' of the marketing mix (product, price, place, and promotion) is also conducted. Collecting and analyzing information about the project is also critical to the eventual acceptance of the technology.

A unique example of public relations is the Infrastructure Laboratory, or InfraLab, of the Department of Waterways and Public Works. The purpose of InfraLab is to build bridges between citizens and government by finding and testing new ways in which the Department and the public could work together to achieve a suitable main road infrastructure. It also provides a mechanism by which to conduct public hearings that include full participation by the citizens.

InfraLab's goals are as follows:

- Listen to users and citizens
- Involve citizens and organizations
- Have "users/citizens" and "experts" meet
- Create clear processes and procedures
- Generate quick and supported results

InfraLab staff meets with people living in a particular area to discuss their quality of life and accessibility; citizens are asked to define their problems in priority order. Second, they meet with experts to conduct a creative search for solutions. Finally, the group develops an action list from the selected solutions.

This method enables fulfillment of the needs of society in traffic and transport, provides an adequate and rational procedures to manage the input of citizens, and seeks creative solutions for infrastructure. Various projects have utilized this method successfully; and the Utrecht-Amersfoort A28 motorway and the Wassenaar A44 motorway are good examples.

4.6 Training and Continuing Education

There are no formal training and continuing education components in the Dutch transport telematic policy, though the need for them is implied throughout its policy documents. Transport

telematics are a technical matter and the need for trained and qualified personnel to both operate and maintain sophisticated systems is obvious and understood.

The AVV does, however, develop and administer courses through its expertise centers.

4.7 Observed Catalog of Practice

Traffic Management

Traffic management is well advanced in the Netherlands. Most of the primary road network is instrumented with loop detectors for traffic management purposes, which allows for direct action where there are risks of congestion. Ramp metering is operational in three locations in the Netherlands, and VMS are also used to inform motorist of travel conditions. Plans are to have this information transmitted directly to road users and vehicles in the near future.

Measures taken by the road authorities to actively control or regulate traffic in order to use the infrastructure as effectively as possible when congestion occurs are imminent. Developments in technology are enabling real-time information to be gathered, transported, and processed on a large scale, making it possible for road authorities to tailor countermeasures to actual traffic situations. This is the dynamic component of traffic control.

Transport authorities recognize that the introduction of a computerized system on the motorway network is a complex process. It does not make sense, they say, to fully deploy measures with which no experience has been gained. Part of the technology required is still in the development stage and should be carefully tested, modified, and fine tuned. Only then is full-scale deployment advisable.

The Dutch experience to date in the field of dynamic traffic assignment has been the development of tried-and-tested systems for traffic signals. Other systems are being introduced, such as Dynamic Route Information Panels (DRIPs), ramp metering, and radio traffic information. DRIPs are message signs mounted over and alongside roads on which information about alternate routes can be displayed. The goal is to have about 60 DRIPs in place by 1998, mainly on the ring roads around Amsterdam and Rotterdam.

The team also observed the MTM implemented on the Amsterdam Ring Road in 1991 and now in operation on more than 200 of the approximately 2,100 km of motorways in the Netherlands. MTM consists of VMS mounted on overhead sign trusses at about 700 m apart in urban areas and at longer intervals in outlying areas (see Figure 12). Variable message signs consisting of fiber optic matrices are located over each lane and provide lane-use information using a green "arrow" or red "X" and by posting speed limits. Speed limits are displayed above each lane and are intended to slow traffic gradually as it approaches congestion ahead.

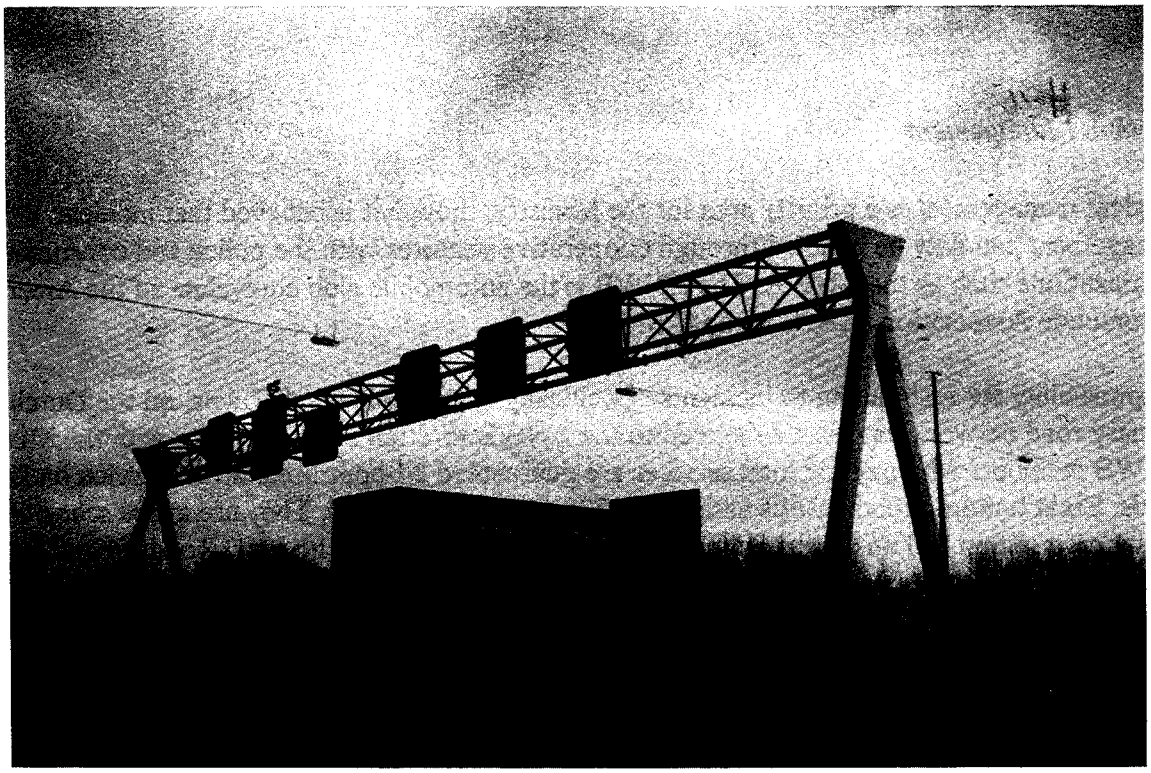

Figure 12. The MTM System on the Amsterdam Ring Road

Normally speed limits are set to 120 km/h (72 mph) or 100 km/h (63 mph), near urban areas, and traffic volumes up to 2,400 vphpl (vehicles per hour, per lane) are limited to speeds of 80–90 km/h (50–55 mph). In congestion situations, MTM signs are used to warn motorists of queuing ahead and to display gradually reduced speed limits—usually from 90 to 70 to 50 km/h, depending on conditions. Consequently, use of the lowest advisory speed of 30 km/h, formerly set due to non-compliance, has been discontinued, and now speed limits are established based on fully automated, computer-driven algorithms. The algorithm used for posting recommended speeds is based on average speeds measured by the same loop detectors used for analyzing potential queuing and detecting incidents.

Message-display systems are automated as well, though manual operation is also utilized for message selection. Fog detection is also part of the signaling system and it can be used to provide alternate-route guidance information by recommending one side of the Ring Road instead of the other.

By the year 2000, the MTM will be in operation on about 900 km of motorways in the Netherlands. It is expected to improve traffic flow, reduce non-recurring congestion, and improve safety.

Traffic Signal Systems

Responsibility for the operation and maintenance of traffic signals lies principally with the local municipalities. The Ministry's policies are directed specifically towards the primary road network.

Incident Management

Incident management is a priority area for the Ministry, though it is believed that incident management can only be handled through cooperative ventures with the police and consumer organizations such as the ANWB. The ANWB is the automobile club equivalent of the American Automobile Association (AAA) in the U.S.

Responsibility for responding to incidents, specifically automobile breakdowns, on the Dutch primary road network has been delegated to the ANWB through a joint venture with the Ministry. ANWB members who pay for road services are guaranteed 24-hour breakdown service on Dutch roads. Eight hundred road patrols assist over 725,000 people a year. They are at the scene of a breakdown within half an hour, and most repairs are performed on the spot. Roadside call boxes and cellular phones are used to call the ANWB; over 3,000 call boxes nationwide are connected directly to the ANWB's four control rooms. The control rooms are in direct contact with the Dutch National Police Agency.

Nonmembers who wish to receive the road service are given the opportunity to join the ANWB on the spot. Currently, 54 percent of all Dutch drivers are ANWB members.

ANWB is also under contract for the design, construction, deployment, and maintenance of the national signposting network.

A sophisticated freeway surveillance system is in place to monitor the city of Rotterdam, particularly at city tunnels, such as the Benelux Tunnel. The system utilizes loop detectors and video surveillance cameras to detect accidents and provide incident management. Figure 13 shows the inside of the Rotterdam Traffic Control Center.

Public Transport

Public transport policy in the Netherlands has two main goals for the near future. First, is selective improvement of public transport through improvements in the infrastructure, especially in urban areas. Second, is reduction of operational deficits. In addition, the Ministry is dedicated to increasing the modal split of public transport by 40 percent.

Public transport plays an important role in congestion management. If public transport is attractive to users, more people will choose it as a mode rather than driving private automobiles. Investment in infrastructure for city and regional transport should improve the capacity and quality of service so that it may better compete with automobiles. New high-speed lines will be introduced to connect the Netherlands with the European network of high-speed trains.

Telematics plays an increasing role in public transport service. Less delay, transfer guarantees and up-to-the-minute travel information in particular are improved through use of telematics.

Figure 13. The Rotterdam Traffic Control Center

It is important not to forget bicycles, which continue to have a strong modal split in the Netherlands. In the city of Delft, a phenomenal 40 percent of all daily trips are done by bicycle. Dutch policy is to continue to improve conditions and facilities for cyclists, in order to boost riding speeds, and to increase comfort and safety. Well-maintained bike paths, and more importantly, the adaptation to the overall transport infrastructure are critical. There is also an emphasis on providing bicycle parking. Cyclists receive the highest priority, are provided with a separate right of way paralleling the roadway, and have a dedicated signal phase at many locations. This emphasis is highlighted in the Dutch Bicycle Master Plan.

Measures for bicycles in the Netherlands are as follows:

- Cycleway networks and special facilities, such as dedicated lanes
- Color-coded asphalt paving for bicycle lanes
- Two-way traffic for bicycles in one-way streets
- Special lanes near traffic lights
- Special short-cuts to the right to avoid traffic lights

- Bicycle stands and grips
- Dedicated signal phases
- Shelters

Trams and buses are given priority at intersections through signal preemption techniques. Intersection movements are controlled individually, with the goal of minimizing idle time.

Electronic Toll/Fare Payment

Currently, there are no toll roads in the Netherlands. However, its new pricing policy is seen as an important supplemental instrument to be used to influence automobile usage, based on scope, time, place, and method of transport. In the long term, partly based on EU initiatives, road pricing may serve as a tool to curb congestion.

In accordance with a Parliamentary directive, some kind of pricing strategy to achieve targets of general policy must be implemented by the year 2001. They recognize that pricing strategies are not popular but are committed to their implementation.

Smart card technology is being considered as a method of implementing eventual pricing strategies by improving and simplifying payment functions. Within the reference framework, the Ministry, in conjunction with industry, is developing strategies for introducing various smart card applications. The Ministry recognizes that automatic identification and tracking are key technologies for enabling the flow of information and goods to be integrated.

Traveler Information Systems

Better information is essential to improve the reliability of the primary road network. Working with the private sector, the Ministry is expected to encourage the introduction of such systems, and will also emphasize the creation of favorable conditions, such as a monitoring system and the encouragement of standardization. The Ministry does not see a role for itself in the distribution of information.

In addition to the systems described above, by 1998 the Ministry plans to create the conditions necessary for the introduction of a nationwide RDS-TMC system that will provide drivers with route information around the clock. RDS-TMC is currently being tested in the "Rhine Corridor" pilot project. A dynamic route guidance system is planned for the year 2000.

The "Rhine Corridor Project" is being undertaken jointly by the Netherlands and Germany . It uses RDS-TMC technology, taking advantage of spare FM signal capacity. The technology is being tested on the heaviest truck-traffic route in Germany, which connects to a motorway in the Netherlands. The test involves 250 specially-equipped test vehicles that receive Radio Traffic Information (RTI) via digitally-coded messages. It requires a special in-vehicle decoder, and at this time the information is still limited. Traffic information can be selected by region and by road

number and in the motorist's own language. The system has both visual and audio message capability. The Netherlands has selected audio rather than graphical message displays because of safety concerns.

A related DRIVE project is the ATT-ALERT (Advanced Transport Telematics—Advice and Problem Location for European Road Traffic) R&D project. This project involves the design of new features for ALERT protocol for RDS-TMC, location referencing, incorporates public transit and Park-and-Ride lot information, and researches new broadcast media.

Another activity is the INTERCHANGE DRIVE II, Project V2021. This project is unique because for the first time, a network of traffic and travel information centers will be created. Its goal is to establish a pan-European network of real-time traffic/travel information exchange among European traveler information centers and, more importantly, to develop standards of data communication among these centers. Furthermore, the project involves development of European standards for information exchange, management, and messaging.

4.8 Themes and Trends

The Netherlands is poised to take full advantage of the transport telematics revolution. Authorities have taken the necessary measures and created the necessary framework to allow for the successful deployment of advanced technologies. They also realize that telematics is a tool to fight congestion and not a measure itself, and that congestion problems will be difficult to resolve without utilizing telematics. Furthermore, they resolve that some degree of congestion is inevitable, thus their focus will remain on increasing mobility and accessibility.

The Dutch Government realizes that many usable technologies will become available in the near future to assist in managing the increasing traffic congestion problems. Research into efficient applications of new technologies and the development of a legal framework will be given priority; participation in national and international research programs will continue. An example of this is the Euro-Delta test site where an international consortium is given the opportunity to test new systems in practice in the Dutch context.

The Netherlands represents a good example of government policies and programs that are possible with full cooperation and consensus among interested parties. All agree that something needs to be done to protect their quality of life. Within Parliament and among public and private organizations, there is a high level of support for intensified traffic management programs.

The next logical step of standardization is coming to the forefront. Working globally means seeking to arrive at worldwide standards. Liberalization of the telecommunication market, as initiated by national government and by the EU, will soon be of extreme importance. New and existing services will be encouraged and create market opportunities. A good example is the GSM network that will become the European standard.

Dutch policies in transport telematics and traffic management will help the country to remain the Gateway to Europe by providing for the efficient movement of people and goods. Their involvement in various European ITS projects, such as DRIVE, Prometheus, and others will continue.

5.0 ENGLAND

5.1 Background

The trunk road network in England (see Figure 14) has significant capacity problems. Over 90 percent of passenger travel and over 60 percent of freight movements are by road. The 10,500-km (6,500-mile) motorway and trunk road network accounts for less than 4 percent of the total mileage of roads in England, but the network is used for about one third of all automobile journeys and about half of all lorry journeys.

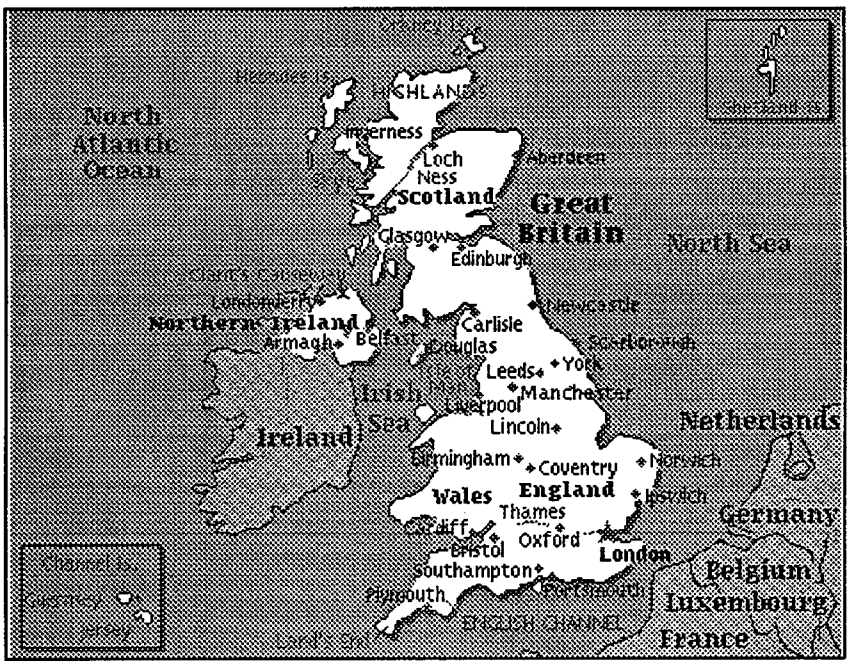

Figure 14. Map of The United Kingdom

The Government's policy is to reduce the need to travel and influence the rate of traffic growth. However, current projections indicate traffic may still more than double by 2025. Motorists, and others who use trunk roads or are affected by them, expect better service. The safety and convenience of all those who use British roads—private and business motorists, public transport operators, freight customers, pedestrians, bicyclists, and equestrians—are among their prime concerns. Yet concern about the environmental effect of traffic and of road building is growing. An acceptable balance between the environmental loss and financial costs and the economic, environmental, and safety benefits of improving traffic flows is critical. Public funds available for roads have also been reduced as the Department of Transport plays its part in reducing public expenditure and promoting private sector investment.

Balancing conflicting demands and delivering the best possible quality of service from the trunk road network within the financial resources available is a challenging task.

5.2 Organizational, Policy, and Funding Issues

The Highways Agency is a new executive agency, established in 1994. It is an agency of the Department of Transport, under the Secretary of State for Transport, and is responsible for the executive functions of managing and maintaining the trunk road network and delivering the Government's program of trunk road improvements schemes.

The Highways Agency's front-line operations are the responsibility of two directors. The Network Management and Maintenance Director is responsible for the management and maintenance of the existing network, including traffic control, driver information, development planning issues affecting the network, and the design and construction of small network improvement and safety schemes. The Road Programme Director is responsible for supervising the planning, design, and delivery of all major new motorway and trunk road schemes.

In addition to the two mentioned above, the Highway's Agency has other divisions. The Strategy Director has responsibility for corporate affairs including corporate and business planning and development and performance monitoring. Finance, procurement, and lands are the responsibility of the Finance Director. The Human Resources Director oversees planning, personnel and training issues. The Civil Engineering and Environmental Policy Director is responsible for R&D, engineering and environmental policy and standards and innovation throughout the Agency.

The Secretary of State for Transport remains responsible for overall government policy on trunk roads in England, and for determining the strategic framework and the financial resources within which they operate. For the Highways Agency, Ministers have set the strategic aim of securing the delivery of an efficient, reliable, safe and environmentally acceptable trunk road network.

The Government's overall strategy for trunk roads is to accomplish the following:

- Contribute to the Government's target of reducing road casualties by one third by the year 2000 (compared with the annual average from 1981–1985).
- Give full weight to both the environmental and economic costs and benefits associated with the use, construction, and maintenance of trunk roads and to strike a balance accordingly.
- Improve the efficiency of the Highways Agency every year.

The Agency's over-arching objective is to make the most efficient use of the motorway and trunk road network. The key objectives are to:

- Provide the best possible service to road users and those affected by roads.
- Manage new construction and maintenance programs to secure the best value for the money.

The Secretary of State for Transport has also assigned the Highways Agency the following key tasks in support of the strategic objectives:

- Deliver the program of trunk road schemes on time and at cost.
- Reduce the average time taken to deliver trunk road schemes.
- Maintain the trunk road network cost effectively by delivery every of a structural maintenance program.
- Improve the information supplied to road users through improved signing and better information about roadworks.

5.3 Planning and Research Issues

The Agency's research program reflects the responsibilities and duties of those parts of the Department of Transport encompassed within the Agency. In particular it has a strong focus on technical issues in the basic engineering disciplines and in network operation and management. The Agency's goals are to make the most efficient use of the road network and to secure the delivery of an efficient, reliable, safe, and environmentally acceptable trunk road network. Consequently the Highways Agency's emerging R&D strategy widens the scope of research programs to include issues such as improving procurement and management efficiency, developing performance and satisfaction measures, providing added value to road users such as route guidance and driver information, and the future role and operation of a strategic road network.

The current research program also relies heavily on a single research organization, the Transport Research Laboratory (TRL). Currently, TRL is considered an executive agency of the Department of Transport, but the Secretary has announced his intention to privatize it. Research is conducted independently and in collaboration with other partners, such as the Central Transport Group of the Department, other Government departments and agencies, and public and private entities.

Funding for TRL is derived mostly from private contracts. Currently, only about 25 percent of funding is from direct government support.

The European Commission proposes substantial research on road transport and on the application of telematics to road transport in the EU's Fourth Framework Program of R&D. The Agency will take an active part in the development of these programs and will collaborate with them through individual projects.

The results of research are generally published and implemented through the development of standards, specifications, and other guidance for designs, construction, operation, and maintenance of the trunk road system. These will increasingly be international standards and the Agency has an active role on European Standards Committees, International Standards Organization (ISO) committees, and related committees.

The Agency plans to spend £13 million in research during 1995–96 to maintain the reliability of the network. The network operation, management, and maintenance research program is aimed at making the best use of the existing road network through measures such as controlled flow motorways, high occupancy vehicle lanes, ramp metering, and tidal flow (reversible lanes). Research is intended to developing effective control strategies, providing better information and advice, and investigating new traffic management techniques and new technologies. Research also investigates the use of a wide range of vehicle detector systems and driver information systems, including the development of those buried in pavements and the use of satellites to monitor flow and congestion.

5.4 Technical and Design Issues

In England, there is considerable activity in the field of communication standards that strongly encourage "open systems architectures." An open system is one that complies with a widely-accepted standard for communications with other systems, with the aim that systems procured from different sources and from different manufacturers can communicate with each other. In the past, this has been difficult to achieve because manufacturers protect their markets by keeping key elements of their systems and products proprietary. The British Government and its Department of Transport promote international standards for system interconnection, which should improve this situation.

To that effect, they have developed a centralized communication system known as the National Motorways Communication Systems 2 (NMCS2). The first systems were installed around the M25 in 1988, controlled from police control rooms in Chigwell, Welwyn, Heston, and Godstone. Eventually all 33 existing control rooms will be upgraded to NMCS2, gradually phasing out the old systems of telephones and an earlier version, NMCS1.

NMCS2 has the ability to support more advanced equipment, allowing for more automation and improving transmittal performance. As a result, NMCS2 reduces the cost of installation and operation compared to previous motorway communication systems and provides a better long-term foundation for future expansion.

NMCS2 is essentially a communication system that provides facilities whereby the police control various electronic devices on motorways and answer calls made on the emergency telephone network. Each NMCS2 communication system is controlled by a central computer system, which includes operator workstations. Each of the 33 control centers provides a facility to communicate with motorway devices within their control area, but they also communicate with each other via a national network and allow remote access for logging and maintenance purposes. The maintenance facility may be based wherever the maintenance contractor may be based. These systems monitor the motorway network throughout England.

The design of the NMCS2 allows for over 100,000 separate device addresses, but each device will require a certain amount of processing capability, as well as the ability to vary the amount of data transmitted.

The system is normally operated by the police, and the control site is often located at a site that has additional functions, that is, is not dedicated. It is often the case that operators are not dedicated to this task and may combine it with patrolling or other duties. Therefore, the system must be operable with a minimum of training. Because NMCS2 systems are operated by the police and because there are over 30 police authorities involved, user and operational requirements for NMCS2 are coordinated through the Association of Chief Police Officers.

The Government believes that NMCS2 provides a communication infrastructure that is flexible and capable of meeting the challenges of future telematics technologies. The system architecture also facilitates addition of new devices as they are developed and needed. Some of the systems currently being evaluated include the following:

- Automatic incident detection
- Ramp metering
- Meteorological systems (anemometers and fog detection systems)
- Closed-circuit television.

It is also important that all equipment that supposedly complies with the NMCS2 must be fully tested before it can be purchased and put in operation. All equipment is fully tested and certified prior to its deployment. Maintenance is the responsibility of *the supplier*, who remains under contract for as long as their equipment is operational.

Part of the NMCS2 is the MIDAS (Motorway Incident Detection and Automatic Signaling) subsystem. The MIDAS subsystem is located in the control room and is connected to NMCS2 equipment via a local area network (LAN). MIDAS gives an NMCS2-equipped control office with the capability of automatically setting signals and VMS in response to traffic conditions. The MIDAS subsystem has two distinct signal and sign setting functions—queue protection and controlled motorways.

5.5 Public Acceptance and Marketing

The Highways Agency recognizes the importance of customer service, whether customers are road users or those affected by the roads. Customer surveys, the Road User's Committee, and other public relations activities are used by the Agency to understand what the customers want, and to improve ways of communicating what the Agency is doing to meet their needs.

The Agency conducts regular customer surveys to assess the needs of trunk-road users and those affected by trunk roads. They also consult other authorities, statutory bodies, the public, and other

interested parties about options and proposals for national schemes, including the use of scheme-planning conferences.

5.6 Training and Continuing Education

As in the other countries visited, education and training appear to take place on the job. It is important to notice, however, that in England maintenance is the responsibility of the supplier, who remains under contract while their system is in operation. In that way, training and education from the operations and maintenance point of view, is the responsibility of the supplier.

A comprehensive training strategy plan was outlined by the Highways Agency for 1995–1996, but details of the plan were not available at the time of the scanning tour. The Agency is committed to creating an organization where all staff are equipped with the skills needed to make an increasingly valuable contribution towards its goals and objectives.

5.7 Observed Catalog of Practice

Traffic Management

Maintaining the reliability of the road network against the backdrop of rising traffic volumes is a critical task in England. New construction will continue to play an important part in improving the performance of the network by relieving congested stretches of motorway and bypassing towns and villages. However, the focus will increasingly be on getting the most out of the existing network by pursuing ways of improving traffic management through such initiatives as the pilot of controlled motorways and improved driver information. With the increased traffic load being placed on the trunk road network, protection of past investment and proper maintenance are considered vital.

The M25 Controlled Motorway Pilot Scheme is the most visible traffic management project in England. The southwestern quadrant of M25 is one of the busiest stretches of road in Europe, with an average daily traffic level of 200,000. Peak volumes are close to 10,000 vehicles per hour. The M25 scheme is designed to regulate and smooth traffic, and improve throughput by controlling speeds.

The project involves equipping motorway gantries and approach ramps with fiber optic signs and the ability to display mandatory speed limits. The signs of the CMI are equipped with red rings to indicate the mandatory nature of the speed limit.

Speed limits are set automatically, depending on the volume of traffic sensed by loop detectors. When volumes are high, the speed limits are reduced incrementally. Drivers who do not obey the speed limits are detected by overhead radar, their vehicles photographed, and are subject to prosecution. The speed limit signs are supplemented with VMS.

The system is based on the notion that drivers must more drive slowly and carefully in order to arrive at their destinations more quickly. Experience with systems in Europe has shown that an even flow of traffic stands a greater chance of getting through peak periods with fewer accidents and without significant delay, as compared with fast traffic that brakes suddenly.

The system is turned off during periods of heavy congestion. As traffic slows to a crawl, drivers are not able to maintain posted speeds consistently. Therefore, to retain the public's confidence in the system, signs are turned off during those periods.

MIDAS loops are located on each lane, providing the information to control offices via MIDAS roadside stations. Each control office has a MIDAS subsystem that analyzes data transmitted either by the loops or from detected traffic accidents. When MIDAS detects the formation of queues, it automatically sets appropriate speed limits.

The over-the-road photographic equipment is based on existing Doppler radar technology. It was modified for gantry-mounting and linked directly to the CMI. Speed-enforcement cameras are set by independent optical and electric interfaces to enforce the required speed limit by photographing rear license plates. Enforcement occurs only if the optically and the electrically set limits agree, so the camera takes two photographs to enable a distance/time measurement of speed to confirm a violation. The cameras are portable so they can be relocated to ensuring that their locations are unknown to drivers.

Since the introduction of the enforced speed limit system, travel times and the number of accidents have been reduced. Preliminary data indicated that drivers are responding well to the mandatory speed limits.

Traffic Signal Systems

The SCOOT urban traffic control system, developed by TRL in collaboration with the UK traffic systems industry, is being used for signal control throughout England. SCOOT is an adaptive system that responds automatically to variations in traffic flow, based on real-time information fed from detectors embedded in roadways. A central minicomputer communicates once per second with SCOOT intersections, recalculating signal timing based on up-to-minute information it receives.

SCOOT is being used in over 130 towns and cities in the UK and overseas. Travel time surveys in the cities of Worcester and Southampton determined that control by SCOOT reduced delays substantially as compared with vehicle-actuated, non-coordinated signal operations. Typical reductions in delays were 23 percent in Worcester and 30 percent in Southampton.

In the city of Southampton, the SCOOT system has been linked to other systems and has proven effective. There, the SCOOT system has been integrated with VMS, transit information systems, and parking management systems.

SCOOT requires a lot of traffic data for it to be effective. Detectors are required on each link, and installing and installation and maintenance of loop detectors are significant elements of the cost of a SCOOT system. In addition, CCTV is used extensively to monitor traffic on the network.

Incident Management

Incident management is a main activity of the Highways Agency and is viewed as a was of serving the customer.

All NMCS2 systems are operated by the Police. Figure 15 shows a police officer inside the London Orbital Motorway Traffic Control Center. There are over 30 police authorities involved in incident management, and all incident management activities are coordinated through the Association of Chief Police Officers.

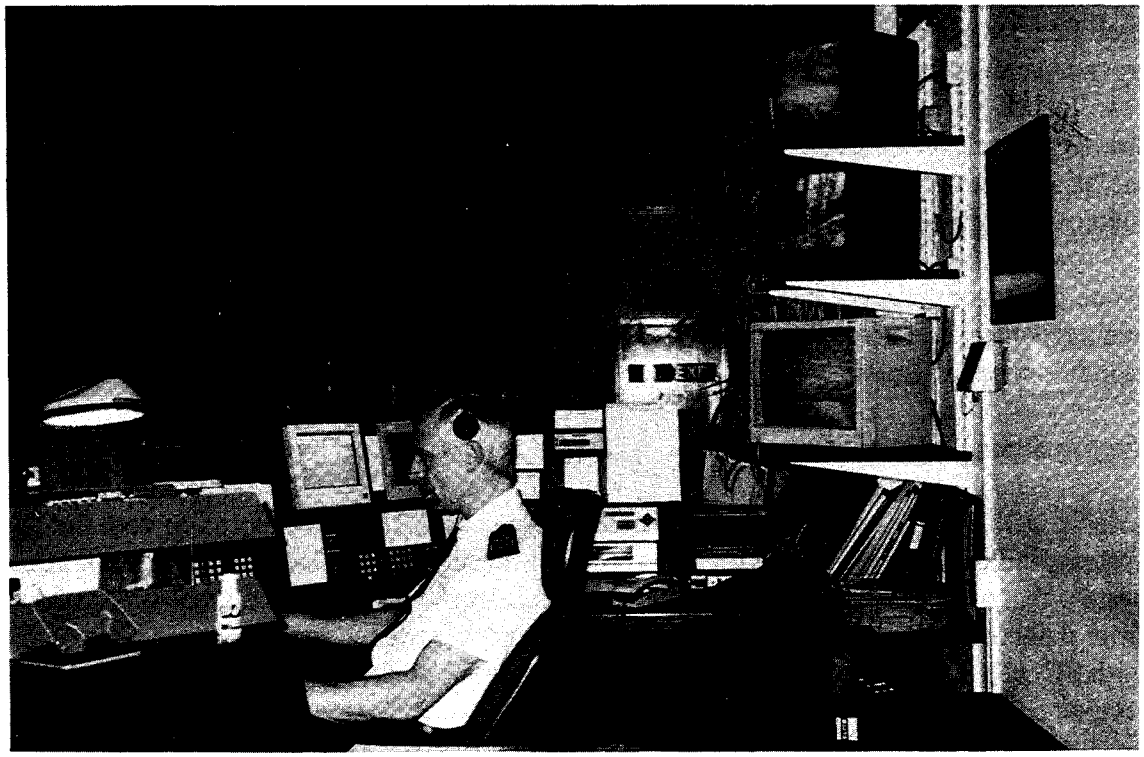

Figure 15. Police Officer in the London Orbital Motorway Traffic Control Center

When an incident occurs on the motorway system it is automatically detected by the active NMCS2 system. To aid drivers, call boxes are positioned along the motorways, usually sighted in pairs (i.e., one for each direction) at approximately 1.5 km intervals. Convenient positioning prevents stranded motorists from crossing the travel way to get to a telephone, thereby decreasing

their chances of being struck by moving traffic. All calls come directly to the police-staffed control center for resolution. Cellular phones are also used to notify the police of incidents in the motorway system. Marker posts are also provided to aid motorists identifying their locations and determining the direction to the nearest call box.

Police operators can control telephones and motorway signs from the same location and from the same terminal. The ability to have complete control from a single location has proven successful in England.

Public Transport

The public transport modal split is high in urban areas. Sophisticated transit management systems, such as the ones in Southampton and London, exist throughout the country. Most systems have a strong traveler information component associated with them, partly attributable to the Highways Agency's philosophy that they must serve their customers. See below for information on the Southampton traveler information system.

Electronic Toll/Fare Payment

None were discussed.

Traveler Information Systems

ROMANSE is a cooperative project operating in Southampton that emphasizes the need for improved information systems to provide travelers with the information necessary to make better choices about their journeys. The system builds on the existing advanced, real-time adaptive traffic control (SCOOT) and parking management systems in operation in the city.

The project was formed in 1991 by public- and private-sectors organizations that were interested in transport issues. The consortium secured government funding in 1992 and signed an agreement for partnership with the cities of Cologne, Germany and Piraeus, Greece.

ROMANSE's objectives are to accomplish the following:

- Provide accurate and timely traffic and travel information to enable travelers to make informed choices.
- Encourage more people to use public transport.
- Improve the efficiency of the transport system.
- Provide planners and decision makers with improved transport information.

ROMANSE's strategic information system (SIS) provides an overview of the transport environment displayed on a digital map. Comprehensive geographic and statistical information is

provided. Traffic and travel information is displayed in real-time on the SIS and stored in the system's database, which may be used to plan future management strategies.

The key function of SIS will be to integrate a variety of network information through a common reference point provided by a detailed description of the road network. Once referenced, information can be displayed in the correct map position relative to a variety of different information themes. The real-time, map-based information can be considered as a series of layers that form the basis of traffic and traveler information.

A key element of ROMANSE is encouraging public transport use by providing accurate information about the location of buses and accurate, real-time arrival times at bus stops. This is accomplished with a system called STOPWATCH, which uses AVL technology to relay information to changeable displays at bus stops. The system also provides preemption for buses at traffic signals by incorporating the AVL with the SCOOT system. Figure 18 shows Urban Transportation Centre (UTC) Manager Ray Morris describing Southampton's SCOOT System.

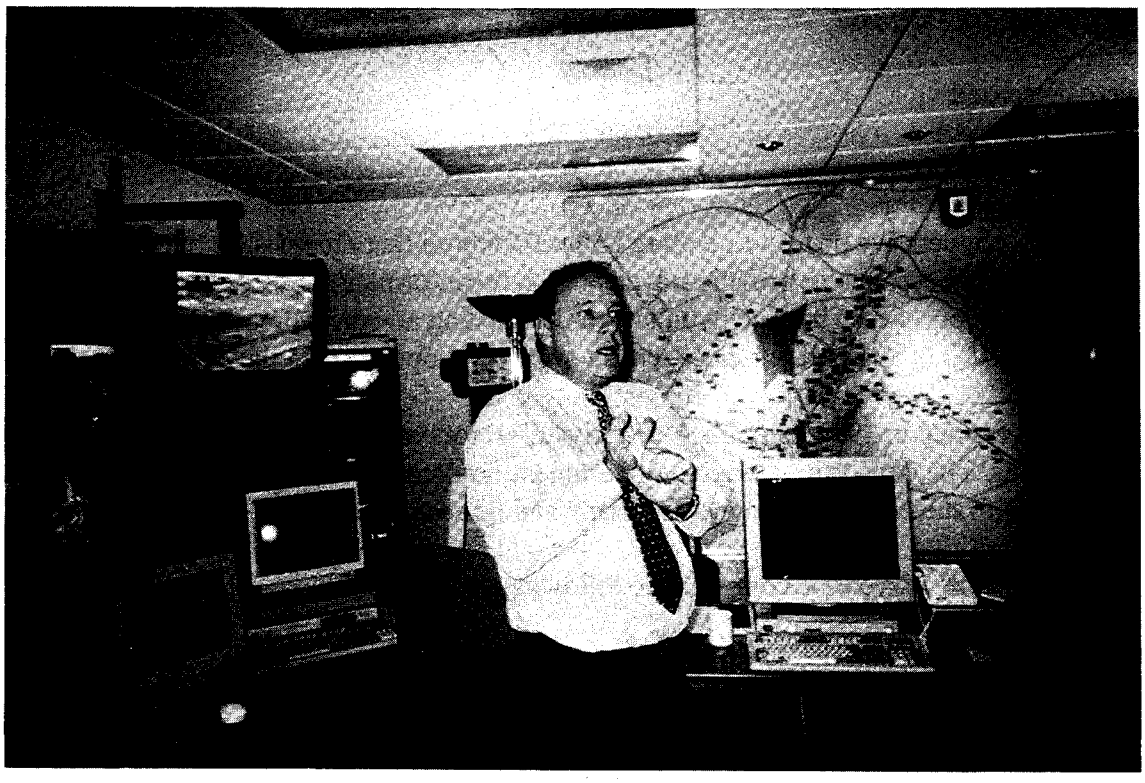

Figure 16. Ray Morris explains the Southampton SCOOT System

Waiting passengers are able to see the route number of the nearest three buses, their destinations, and an accurate estimate of when each of them will reach the stop. The key to the system is a small computer fitted aboard each bus. As a bus moves along its route the computer picks up

signals from a series of roadside beacons, and the signals pinpoint the bus' position to an accuracy of 10 meters.

The on-board computer constantly updates this information and sends it via the bus radio to a central control computer in the ROMANSE TTIC in Town Quay. The central computer uses an algorithm to accurately estimate when the bus will arrive at the stop and then sends the information to the electronic signs along its route.

Visually-impaired travelers can benefit from the "talking" version of STOPWATCH. A digitally recorded voice announces the approaching bus service, the route numbers, final destinations, and the number of minutes until arrival. The system can be activated by a hand-held trigger when the user is approximately 5 m from the display. Triggers are available free of charge to the visually impaired.

The SCOOT system in Southampton also has the ability to restrict traffic flows into congested areas of the city. Incident-detection logic is provided by ASTRID/INGRID, both from the SCOOT data and information from 14 CCTV cameras. The software utilizes CCTV input to recognize unusual traffic movements on control room monitors and identify specific traffic problems, such as accidents and stalled vehicles. This is done by continuously scanning the camera picture and comparing the images over time to identify areas with stationary vehicles. If incident conditions are detected, the computers bring them to the attention of the center operators.

A network of VMS deployed throughout the city provides route guidance, available parking information, and incident information. The traffic and travel information is collected by the TTIC and disseminated by radio, teletext, VMS, and electronic displays at bus stops.

Three types of VMS that were all designed specifically for the ROMANSE project are utilized: route guidance, parking information, and mobile signs. Route guidance signs are designed to help motorists plan their travel while in progress. Parking information signs display the number of open spaces available in each city parking lot. Mobile signs are used during special events and planned roadworks. The project uses an advanced computer simulation package to identify the best alternative routes in the event of a major incident. Each sign displays information and messages as transmitted from the ROMANSE TTIC via radio. Messages are selected from a menu approved by the Department of Transport.

TRIPlanner terminals (kiosks) and information display units (IDUs) are used to give travelers comprehensive real-time information for trips by both public transport and car. The terminals have touch screens on which a traveler inputs starting point, destination, date, and time of a trip. The TRIPlanner then computes the details of the trip by both public transport and car and displays the information in the user's choice of three languages: English, French, or German. For trips by public transport, written instructions and maps are displayed on the screen. For car trips, the best route is shown. In addition, the information can be printed. Travelers who do not have access to a terminal may call the TTIC's hotline for personal, up-to-the-minute information.

Another example of a traveler information system used in the UK is the privately funded and operated Trafficmaster® system. Using a display mounted on an automobile dashboard, Trafficmaster® gives an accurate picture of motorway traffic as it occurs. The system consists of sensors on the motorways linked to a control center that processes the information and sends it to the display units. Sensors are mounted in pairs, one for each direction, on motorway bridges, usually 3.2 km (2 mi) apart. These all-weather, infrared devices sense the vehicles passing underneath them and measure their speeds.

Each bridge site has its own microprocessor that calculates a 3-minute rolling average speed for the site to measure the number of vehicles passing the site. Each bridge site transmits the information to a control center, but only if the average speed drops below 48 km/h (30 mph). At that speed, congestion is assumed to begin. Communication takes place via Trafficmaster's® own radio transmission system.

The center operates 365 days a year, 24 hours a day and collates all the information sent from the sites and from other sources. The information is analyzed by a central computer and, together with a narrative, is transmitted using a radio paging network to Trafficmaster® units in subscriber cars. The information is updated every 3 minutes.

The Trafficmaster® units are specially-designed, portable radio receivers that display a map of the motorways. When the control center transmits a problem, it is displayed on the map as a flashing square in which an arrow indicating the direction of the hold up and the average speed at that point. The length of the queue can be assessed by the number of squares flashing. The display unit is an after-market device that is adaptable to many vehicle types.

Full coverage of the UK motorways currently exists. This system was endorsed by the Secretary of State for Transport as an example of government initiative supporting innovative technology.

5.8 Themes and Trends

In England, experience over the past several years has highlighted the dynamic environment in which the Highways Agency must operate. This experience emphasizes the need to change their approach and methodology in many areas in order to have the flexibility to respond to policy changes and other unexpected demands that may be placed upon the Agency.

The Agency realizes this and is structuring itself to be responsive. Their overriding objective in meeting challenging targets is to get the best out of their network—making the best use of the existing infrastructure, maintaining it, and upgrading with new road schemes where appropriate. This is coupled with the need to continue to improve the responsiveness of the service they provide to their customers, whether actual road users or those affected by roads. Their goal is to build the Agency into one that is business-like with a clear focus on customer needs. The coming years will also see major developments in the Agency's information system and technology

strategies to support their long-term objectives. Making the most effective use of new and existing information and communications systems is key to their ability to deliver.

The Government believes that NMCS2 provides a communication infrastructure that is flexible and capable of meeting the challenges of future telematics technologies. Adherence to standards will continue to be a key to the integration of systems in the future.

6.0 FINDINGS AND TRANSFERABILITY TO THE UNITED STATES

A central focus of the Traffic Management and Traveler Information Systems Scanning Team was to identify what important and innovative concepts, programs, policies, projects, and practices can be applied to the U.S. Based on the observations of the Scanning Team, much has been learned that can be applied to Federal, State, and local government agencies in the U.S. This section presents this information in three categories: overall policy and program findings, potential project applications, and personal team member insights.

6.1 Policy and Program Findings

1. ***The scanning tour confirmed that U.S. efforts to achieve system integration in the deployment of advanced technologies are appropriate and need to remain as an important national strategy.***

All of the countries that were visited on the tour realized that system integration, that is the ability of independent transportation systems to communicate and share information, is critical to the successful, and sustained, deployment of advanced technologies. While each country approached the deployment of technology in varying ways, and for various reasons, it was clear that system integration was viewed as having important benefits and was considered to be an important strategy. System integration strategies were found to be accomplished both at the policy and technical levels and included expansion across all transportation modes, across jurisdictional boundaries, and across disciplines (police, transit operators, highway agencies).

2. ***The scanning tour highlighted the important balance the must exist between planning and the deployment of advanced technologies.***

In each of the countries visited, there existed a recognition, and indeed an understanding, that the deployment of advanced technologies was evolutionary. Given this recognition, the planning that was necessary for any transportation improvement, accounted for the evolutionary nature of the advanced technologies to be used. Planning was flexible in nature and was done for the sake of improving the operation and performance of the transportation system; it does not just focus on implementing advanced technologies. The planning address realistic schedules for successful deployment, integrating the various modes and systems of transport, costs, and budget constraints.

3. ***The scanning tour showed the benefits of incorporating the deployment of advanced technologies into transportation policy at the Federal, State, and local and regional levels.***

It was observed that each of the countries visited articulated national policies that emphasized the need to use advanced technologies to better manage the operation of the transportation system. For economic, environmental, and other reasons, these countries understood that they could not build their way out of traffic problems and looked to technological approaches. The policies also helped to create a national vision for technological approaches and was reinforced at the local and/or regional levels. Thus a national policy or vision often became a guide for local and\or

regional decisions on the use of advanced technologies for traffic management. The observation points out the programmatic benefits of creating a national vision for applying these technologies as a guiding policy at all levels of government.

4. ***The scanning tour confirmed that the development of standards should be given a high priority.***

All of the countries visited were, to varying degrees, working towards key standards that would be essential for system integration. The activities that were generally underway in this area included adopting existing standards from other industries when appropriate, encouraging testing and certification, encouraging the private sector to have a major role in the development of standards, and using the public sector's purchasing power to influence the standards development.

5. ***The scanning tour reinforced the need to integrate the user's perspective into the planning, design, deployment, and operation of advanced technologies.***

To varying degrees, all of the countries visited had some effort to identify and understand the user's perspective in the planning, design, deployment, and operation of advanced technology systems. Market research to understand public needs and gain public acceptance was generally done as part of the project; however, the goals and level of intensity of the market research effort varied. In each country, specific mechanisms were implemented to ensure that products and projects fulfill needs and are understood by the public. It was clear to the scanning team that the public sector needs pay close attention to ensure that deployment is closely tied to user interests and needs.

6. ***The scanning tour confirmed the need to integrate operation and maintenance considerations and costs into all programs deploying advanced technologies, e.g., ITS.***

All the countries visited on the tour understood the need to factor into their traffic management and traveler information implementation plans and programs the costs of operation and maintenance of advanced technology systems. The costs always included long-term maintenance activity as well as education and training programs. In the early stages of advanced systems implementation, private contractors were generally responsible for operation and maintenance activities; however, the longer-term vision was to train public sector staff to handle these functions. There was a commitment on the part of the public sector to properly maintain and operate advanced technology systems that are being implemented. In most cases this meant having integrated policies with dedicated funding vehicles and information sharing. All countries put into place policies and programs to ensure advanced traffic management and traveler information systems were properly operated and maintained for service and customer reliability.

7. ***The scanning tour noted the important benefits of creating a national vision for the implementation of advanced technologies in traffic management and traveler information systems.***

In all four countries visited on the tour, each one had, to varying degrees, a national vision for implementing advanced traffic management and traveler information systems. The vision was

often created at the national level and served as a guide for other regional and local efforts to implement advanced traffic management and traveler information systems. In some case the vision was created in collaboration with other regional and local governments. In cases where the advanced systems were implemented on nationally-owned roads, the vision was at least understood and supported by regional and local government. Very often, the national government took a strong lead in providing a vision and framework for the focused implementation of advance traffic management and traveler information technologies and services nationwide. The efforts of entities such as auto and transit user groups, national transportation research organizations, and universities were given a specific direction by the national government to facilitate and accelerate the implementation of advanced systems for traffic management and traveler information. This national vision allowed both the public and private sectors to work in unison with a common goal of the successful implementation of integrated and compatible systems. In many cases, regional transportation-planning entities developed plans and criteria that incorporated projects and programs in support of the national vision.

6.2 Applications to the U.S. Experience

There is no question that seeing is believing. Many traffic management and traveler information projects using advanced technologies were observed during the scanning tour, and some of those technologies can be studied for potential application to the U.S. This section outlines some of these technologies.

Weather-controlled roadway, E18, Kotka-Hamina, Finland. This project has direct application to the U.S. In the State of Minnesota, a similar project, called MinnRoad, is under development, and similar projects in the U.S. could benefit from the Finnish experiences with weather monitoring. Weather-sensing and monitoring instrumentation has direct application in the U.S. The integration of predictive models using thermal mapping is also unique and warrants consideration.

Recommended headway display, Finland. Variable displays based on individual vehicle speeds, vehicle types, and road surface conditions have proven useful in reducing the risk of rear-end collisions, especially during inclement weather conditions. They provide a reference to drivers as to the appropriate headways.

The City-Card, Finland. One smart card for several services in the same city is a project worthy of consideration. The ability to pay for transit services and other modes of transportation with the same card should enhance the ability to use various modes of transportation and should increase ridership.

Providing transit information to passengers on a real-time basis, Gothenburg, Sweden. The city has an control center dedicated to providing information to transit passengers, including schedules, routes, statuses of buses and rail vehicles, delays, etc. When a system is easy to use, it attracts ridership; this concept could be helpful in attracting new riders.

Pricing strategies to reduce auto travel, the Netherlands. The concept in the Netherlands is that if you wish to drive, you must pay. Payment could take various forms, from lost time (the Netherlands is sending the message that drivers should expect and *will experience* and some kind of congestion level) or monetary payment. The Government is fully behind the implementation of a pricing strategy, and the public understands that something must be done to protect their quality of life and their mobility. The Government also understands that if it wishes to promote other modes, such as bicycles and walking, the necessary facilities must be provided. Similar efforts with respect to congestion pricing are being piloted in the U.S.

Designated truck lanes, near Rotterdam, the Netherlands. The concept involves widening the far right lanes of expressways and reserving those lanes for trucks. Enforcement is accommodated by video image processing cameras every 300 m. Passenger cars are not permitted in those lanes, but violations were low; each day about 30 violators are fined automatically. The lanes begin and end in sections without any exits to avoid weaving problems. Conclusions of the pilot implementation were that truck volume needed to be significant for this concept to be effective. Areas in the U.S., that have a high truck volume for which an express lane can be developed, may want to explore the feasibility of this concept.

Motorway Traffic Management System, the Netherlands. This technology has direct application for high-volume urban areas in the U.S. Automatic incident detection, traffic smoothing, and a 5-percent capacity increase are its main characteristics.

The M25 Controlled Motorway Pilot Scheme, London, England. This an example of a project that evolved from simple beginnings to become a sophisticated ITS project. The testing and standardization of the project components deserve special attention. Both testing and standardization have contributed to lower costs and continuing operation, and it could be argued that this project is an example of the benefits of standards. The traffic smoothing concept itself has proven successful on high-volume freeways around the country and should be studied further. In addition, photography could be used for enforcement, particularly when the owner of the vehicle, and not the driver, is held responsible for the violation.

ROMANSE Project, Southampton, England. This is a true multimodal project, incorporating transit, incident management, traffic control, and traveler information into a single control center in a medium-sized city. Real-time transit information at transit stops also merits consideration for implementation in the U.S. This type of information would be especially beneficial in cities with tourist attractions that are served by transit.

6.3 Insights

Some of the scanning tour members chose to provide their own personal insights and perspectives on the people, places, and projects that they visited. Their comments and personal perspectives follow.

Pamela P. Marston
Transportation Management Engineer
Federal Highway Administration
Baltimore, MD

I wasn't sure what to expect from the foreign transportation officials, but at the first meeting on my first day (the Netherlands), I was surprised to learn that they have many of the same problems we have in the U.S. During the first few presentations it was evident that although the Netherlands, which is roughly the size of Massachusetts, and the U.S. are half a world apart, their problems with transportation vs. environment, increasing vehicle miles traveled (VMT), and public sector reorganization are not based on geography or relative size. The English Ministry also noted that their VMT are increasing with no new capacity expansion planned. In this age of fiscal belt tightening, having to do more with less in all aspects of transportation became an interesting topic of discussion. However, one philosophical difference between the U.S. and the Netherlands is that their Minister of Transport went to the public and said that a certain level of congestion was to be expected and tolerated given the size of their network. The Dutch approach is to try to control and mitigate unexpected delays and nonrecurring congestion realizing that a certain level of congestion is a given function of the roadway capacity. If the public chooses to drive their car, particularly during the peak period, then they will have to live with a given level of congestion. In the U.S., we might want to considered this philosophical approach.

Looking at the existing systems in the Netherlands and in England, I think that the U.S. is not behind in deploying ITS. Although the Europeans do have more technologies and products deployed, they are all individual and don't seem to "talk" to one another. Many of the engineers with whom we spoke agreed that soon their systems will have to be integrated and that it will most likely be a difficult process due to nonstandard interfaces and proprietary systems. I also noted that their projects tend to be narrow in scope and are very focused on a particular problem or geographic area. Both the Netherlands and England have a very nationalistic approach to their transportation issues; policy is adopted by the Federal level and the regional and Local jurisdictions must adhere and administer the policy. In the U.S., we are trying to integrate systems from the beginning, using an architecture-based approach. My impression from this trip is that the integration between systems, modes, and jurisdictions must be done at some point for a truly successful transportation system to exist. In this case, the Dutch and English are having to do it later, while the U.S. community is trying to do it now.

I was very impressed with the emphasis on standards that exists in the Netherlands, and especially in England. Although the projects are narrowly focused, and don't seem to integrate with other systems easily, within the system standardized equipment is very important. In England, the Ministry specifies standardized equipment that can be purchased from more than one manufacturer so that they can maintain their systems at a reasonable cost. Both the Dutch and English test and certify equipment at certain standards so they are assured of a specified level of performance. They also work with the European community so that equipment and products in

one country can be recognized across borders, and only those firms that have a certificate may bid on a project. One very important aspect of this is that their specification documents are very functionally oriented. A functional specification is one way of assuring the most innovative designs.

Joseph F. Ligas
ITS Program Manager
Illinois Department of Transportation
Schaumburg, Illinois

The variety of traffic management and information initiatives being undertaken in the Netherlands and England were impressive. The melding of traditional management systems with new technologies can best be described as building on proven systems. It was also apparent that in the development of information systems that there was a balanced approach to support transit and highway systems.

The commitment to a high level of public transit continues even though there has been some mode shift to the private auto. Real time information on schedules and delays is available at all major rail facilities. The passenger information at rail stations and transfer facilities have been in place for some time. These systems appear to be very well received, and true to the building block approach, there are additional efforts underway to provide information at bus stops. Empirical evidence on the success of the bus stop program was not as readily available. Direct application of real-time transit information systems is one area where technology is available and systems can be easily developed for direct use in parts of the U.S. with rail systems.

In development of traffic management systems, deployment is also based on a building block approach, using tried and true technologies and supplementing with newer developmental systems. The use of induction loops continues to be a preferred alternative. Active management of traffic centers by police and operations staff in rather traditional roles continues.

The approach toward partnerships with the private sector appears to be most effective where working relationships were established. Where long established relationships existed with private sector, efforts were moving ahead very well. Where new concepts and partnerships were beginning, a more cautious approach was used. This would seem to be similar to what is happening in the U.S. A continued dialogue among the countries visited and the U.S. would be beneficial to report on successes of partnering.

In reflecting on the scanning tour, it becomes obvious that there are many varied rationales for decision making for the countries visited. In one case, decisions might be made to support a particular industry; in another, commitment to a social or economic policy is more important. In all cases, however, there seems to be strong support for technological improvements to improve the efficiency and operation of the transportation system.

The importance of this tour might not be so much what technology was directly transferable, but rather what commitments were necessary to develop new concepts. It was apparent that successes were based on a commitment of policy and staff. It was also apparent that acceptance by the public was important. Perhaps this realization is exemplified in the Netherlands where the commitment to involvement in the technology development efforts of the European community is

very strong. The involvement leads to systems being developed in the Netherlands which are well coordinated and generally well received by the public. State and local agencies in the U.S. need to follow a similar model and not only commit to local implementation, but also be cognizant of and supportive of national and international development efforts.

(Mr. Ligas joined the tour in the Netherlands. His thoughts are primarily based on experiences in the Netherlands and in England.)

Gene S. Donaldson
Montgomery County, Maryland
Department of Transportation*

As someone who has been responsible for implementing Montgomery County's Advanced Transportation Management System (ATMS), which has grown from a computerized signal system installed in 1980 to the ATMS, featuring advanced technologies that provide real-time transportation control, monitoring, and information capabilities, the tour was an excellent opportunity to see firsthand the capabilities and status of advanced transportation systems in Europe. I would like to thank the U.S. Department of Transportation for this rare opportunity, and a special thank you to our host countries and all the people that took so much time to ensure that our visit was informative and pleasurable. Loyola College, Alexandra Doumani, and Joe Conn for an outstanding job of arranging our visits and all the behind the scenes work that made the trip a success. The tour was an excellent opportunity for me to discuss with my counterparts from all over the U.S. and the U.S. Department of Transportation the status and future of ITS in the U.S.

My personal goals for the trip were to find out the "real status" of advanced transportation technologies in Europe and if there are technologies or processes that we could implement in our ATMS. I wanted to find out if Montgomery County was moving in the right direction with plans to implement and integrated transit/traffic management systems. I also wanted to determine the local role in the development and implementation of advanced technologies in the countries we visited. When the opportunity presented itself, I wanted to ask the users of the systems what they felt about the technologies that were being deployed.

During and after the trip it became evident that there were several major factors that affected the countries we visited, the U.S., and Montgomery County.

- Road construction due to a variety of factors will not keep pace with demand.
- Management of the existing transportation infrastructure is a critical and essential component of any transportation program.
- The use of advanced technologies must be included in a transportation management program.
- Transportation management requires the integration of all modes of transportation.
- The increased use of transit is essential to the future of transportation in major urban areas. This will require the development of safe, convenient, responsive, and easy-to-use transit systems.

---

*Gene Donaldson is no longer with the Montgomery County Department of Transportation. He is now with the Delaware Department of Transportation. He took this trip while with the Montgomery County Department of Transportation.

- Training of qualified personnel to design, operate, and maintain the advanced transportation systems of today and tomorrow must be included in any transportation program.
- Operation and maintenance funding must be included as part of a planned transportation management program.
- Education of elected officials to the benefits of advanced transportation systems is critical to the success of a transportation management program.
- The transportation system user must be educated to the benefits of advanced systems and must be involved in the design and implementation process.
- Evaluation of technologies must be a continuous and shared process so that the successes and failures are readily available to those responsible for funding, designing, operating, and maintaining advanced systems. Technology advancements are based on both failures and successes.
- Public/private partnership can be successful, but the public sector will have to take the lead in the establishment of these partnerships.
- Safety is a critical component of an advanced transportation management program.
- Behind every successful transportation management program is one or more "champions." Every effort should be made to find and cultivate these champions.
- Successful transportation management involves multiple agencies and disciplines. This includes transportation, police, fire and rescue, and environmental protection agencies.
- Standards must be established, but the evolution process of standards must be recognized. The computer and communication industry is based on continuously evolving technologies. Experimentation and testing must not be delayed by waiting for a standard to be created.
- Planning is a critical component but must not delay testing and implementation.
- The establishment of a cost effective and expandable communication system is an essential component of an advanced transportation system.

I found during the trip that each of the countries was having the same transpiration problems that we are having in Montgomery County. These countries have taken very similar steps to address their transportation problems to those steps we have taken. Did I bring home new ideas? The answer is without a doubt, yes. Did I bring home a sense that the U.S. and Montgomery County are on the right track? The answer is yes. Was there much technology we could bring to the U.S. or Montgomery County? The answer is no. Most of the technology exists in the U.S. at this time. Can we continue to learn from the countries we visited? The answer is yes, we must continue to learn from each other. There is more to the application of advanced transportation technologies than the "whiz-bang" hardware and software. People and processes are critical components.

What stood out for me from each of the countries we visited:

- Finland - The application of technologies to transportation safety. The excellent R&D activities and capabilities. Their commitment to and use of sophisticated communication and information systems.
- Sweden - Dedicated R&D. Experimentation and testing. Information systems. Excellent transit and traveler information system in Gothenburg.
- Netherlands - Control and monitoring systems. Strong R&D. Substantial national funding for the application of advanced transportation technologies.
- The United Kingdom - Control and monitoring systems. Application of technologies for enforcement and safety. Southampton for beginning to implement an integrated transit/traffic management system.

On the negative side, there appeared to be very limited integration of transit and traffic in each of the counties. There was very limited coordination or involvement between the national transportation and local transportation agencies.

On the user side. My conversations with the users of the transportation systems indicated that they wanted more transportation information and that information needs to be more timely and accurate. This sounded very familiar.

The trip reconfirmed my belief that we are all spinning around on this big blue marble with very similar problems, hopes and expectations. Through programs that support the open and free exchange of ideas and technologies we can ensure the future of those that follow us and the future of transportation systems.

If I can answer any questions or be of any assistance, please contact me.

Gene S. Donaldson, Chief
Transportation Systems Management Section
Department of Transportation
101 Monroe Street, 11th fl.
Rockville, Maryland 20850
E-mail: GSD@mailcenter.dot.co.montgomery.md.us

7.0 OPPORTUNITIES FOR FUTURE COOPERATION

This study identified many opportunities for future cooperation with all countries and agencies visited as well as among the panel members.

In the fields of intelligent highway systems and telematics, the ability to identify and acquire information, technical materials, and documents (e.g., journal articles, research reports, conference proceedings, standards, regulations, policies) is critical. This trip resulted in many technical contacts in countries that are pursuing and have deployed advanced technology projects.

The United States can benefit immensely from the experiences of the countries visited. This is true not only of the technical aspects of the field, but also of the policy and organizational aspects. The study team makes the following specific recommendations for future interaction and future cooperation:

- **The Internet**. All the countries visited have access to the Internet. While electronic mail is one way to communicate through the Internet, World Wide Web homepages can be used to inform others about developments and on-going activities. Appendix D contains a list of Web addresses identified during the study tour.

- **Professional exchanges**. Many of the agencies visited have problems similar to those in the United States. In many instances, these agencies have taken completely different approaches to try to resolve those problems. In other cases, specific technologies have already been developed to address the problems. For example, the United States can benefit from experiences such as the use of cellular technology for transport applications in Finland, the ITS visions of Sweden, the national policies developed in the Netherlands, or the testing and specifications of the England. Similarly, these countries can benefit from the experiences we have had in the United States, particularly in congestion management. A program can be developed to allow professionals to travel abroad and learn these policies and technologies. Such a program would avoid "reinventing the wheel" in many areas and would take advantage of existing expertise at the source.

- **Joint projects**. Opportunities for international collaboration do exist and should be exploited. A series of ITS-related joint projects with participation from two or more countries could accelerate the process of ITS deployment. Joint projects that focus on technology implementation and on benefits can be seen as non-threatening to potentially competing organizations and nations and further exploit the opportunities for international collaboration.

- **Establishment of and coordination with technology transfer (T^2) centers**. The Technology Transfer Program in the United States is successful, and other countries have also established their own centers. Efforts should be made to encourage other countries to further develop their own centers and promote direct cooperation with centers in the United States that share similar problems. For example, the Finnish T^2 center has established strong ties with the Minnesota T^2 center, in part because they share similar

weather conditions. Similar ties with other countries and T^2 centers in the U.S. should be fomented.

8.0 RECOMMENDATIONS

Based on the observations highlighted above, on the several presentations and projects visited, and on the expertise and technical background of the panel members, the following recommendations, the panel feels, would accelerate the deployment of advanced technologies in the U.S.

1. **Deployment of advanced technologies should be fully integrated**. System integration, or the ability of independent systems to communicate and share information, is critical to the successful deployment of advanced technologies. Integration should be accomplished at the policy and technical levels and should expand across all transportation modes, across jurisdictional boundaries, and across disciplines (police, transit operators, highway agencies).

2. **A true balance between planning and deployment of advanced technologies must exist**. This balance should recognize the evolutionary nature of these technologies and be flexible enough to allow for it. It should also include realistic schedules for successful deployment, integrating the various modes of transport.

3. **Deployment of advanced technologies should be integrated into transportation policy at the Federal, State, local, and regional levels**. This would allow for a national "vision" of the application of these technologies in the future at all levels.

4. **Development of standards should be given a high priority**. Activities in this area should include adopting existing standards from other industries, where appropriate, encouraging testing and certification, encouraging the private sector to have a major role in the development of standards, and using the public sector's purchasing power to influence their development.

5. **The users' perspective should be integrated into the planning, deployment, and operation of advanced technologies**. Specific mechanisms should be implemented to ensure that products and projects fulfill needs and are understood by the public. The public sector should pay close attention to ensure deployment is closely tied to user interests and needs.

6. **Operation and maintenance should be part of an integrated ITS program**. Integration should include dedicated funding vehicles and information sharing. Sophisticated systems should be properly operated and maintained in order to be reliable and successful. A commitment to operating funding and staff is essential.

7. **A *national* ITS "vision" should be created**. The U.S. DOT should take a strong lead in providing a vision and framework for the focused deployment of ITS technologies and services nationwide. The efforts of entities such as ITS America, the Transportation

Research Board, and others should be given a specific direction to facilitate and accelerate the deployment on an integrated system. This vision would allow both the public and private sectors to work in unison with a common goal of the successful deployment of integrated and compatible systems. Using the regional transportation-planning process, criteria should be developed to prepare plans for the incorporation and deployment of this vision.

LIST OF ACRONYMS AND ABBREVIATIONS

ADSW	Automatic Debiting for Sweden
ANWB	Royal Dutch Touring Club
ATT	Advanced Transport Telematics
AVI	Advanced Vehicle Identification
AVL	Automatic Vehicle Location
AVV	Netherlands Transport Research Center
CCTV	Closed-Circuit Television
CD	Compact Disc
CDMA	Code Division Multiple Access
CMI	Controlled Motorway Indicators (England)
DOT	Department of Transportation
DRIP	Dynamic Route Information Panel
ECMT	European Conference of Ministers of Transportation
EU	European Union
f.	Netherlands Guilders
FHWA	Federal Highway Administration
Fimr	Finnish Markaa
FM	Frequency Modulation
FTA	Federal Transit Administration
GOTIC	Gothenburg Traffic Information Center
GPS	Global Positioning System
GSM	Global System for Mobile Telecommunications
IDU	Information Display Unit
IHME	Institute for Highway and Maritime Education (Finland)
IRTE	Integrated Road Transport Environment
ISO	International Standards Organization
ISTEA	Intermodal Surface Transportation Efficiency Act
ITRI	International Technology Research Institute
ITS	Intelligent Transportation Systems
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
MATHEUS	Management of Traffic in Helsinki Urban Surroundings
MTM	Motorway Traffic Management System (the Netherlands)
NMCS	National Motorways Communication System
PSSG	Payment System Steering Group (Finland)
R&D	Research and Development
RDS	Radio Data System
ROMANSE	Road Management Systems for Europe (England)
ROSA	Road Surface Analyzer
RTI	Road Transport Informatics
RWIS	Road Weather Information System

SANDAG	San Diego Association of Governments
SCOOT	Split, Cycle, and Offset Optimization Technique
SKr	Swedish Krone
SHA	State Highway Administration
SNRA	Swedish National Road Administration
SOCRATES	System of Cellular Radio for Traffic Efficiency and Safety
T^2	Technology Transfer
TANGO	Traffic Information for Navigation in Gothenburg
TMC	Traffic Message Channel
TMS	Traffic Monitoring System
TRL	Transportation Research Laboratory (England)
TTEC	Transportation Technology Evaluation Center
TTIC	Traffic and Traveler Information Center
UTC	Urban Transportation Centre
VMS	Variable Message Signs
VMT	Vehicle Miles Traveled
VTT	Finnish Technical Research Center
WWW	World Wide Web

APPENDIX A: Panel Members

Wayne Berman
Highway Engineer
Federal Highway Administration
400 7th Street, S.W.
HTV-31, Room 3404
Washington, DC 20590
202-366-4069
202-366-8712
wberman@intergate.dot.gov

Steve W. Clinger
Urban Mobility/ITS Specialist
Federal Highway Administration
10 S. Howard St., Suite 400
Baltimore, MD 21201
410-962-3815
410-962-4586

Gene S. Donaldson
Chief, Transportation Systems Mgmt.
Montgomery County
Department of Transportation
101 Monroe Street, 11th Floor
Rockville, MD 20850-2589

John Duve
Senior Regional Planner
San Diego Association of Governments
First Interstate Plaza
401 B Street, Suite 800
San Diego, CA 92101
619-595-5368
619-595-5305
jdu@sandag.cog.ca.us

David R. Gehr, Commissioner
Virginia DOT
1401 E. Broad St.
Richmond, VA 23219
804-786-2711
804-786-2940

Gregory M. Jones
Urban Transportation Engineer
Federal Highway Administration, HNG-06
819 Taylor St., Room 8A00
Fort Worth, TX 76102
817-334-4379
817-334-4144
gmjones@intergate.dot.gov

Jerry L. King
Deputy General Manager
Metropolitan Transit Authority
1201 Louisiana
PO Box 61429
Houston, TX 77208
713-739-4077
713-652-8998

Steve Kuciemba
Maryland State Highway Administration
7491 Connelley Dr.
Room 150
Hanover, MD 21076
410-787-5884
410-582-9469

Joseph F. Ligas
ITS Program Manager
Illinois Dept. of Transportation
Office of Planning and Programming
120 Center Court
Schaumburg, IL 60195
847-705-4800
847-705-4803

Pamela P. Marston
Transportation Management Engineer
Federal Highway Administration
10 S. Howard St., Suite 400
Baltimore, MD
410-962-3814
410-962-4586
ppmarston@intergate.dot.gov

Juan M. Morales
J.M. Morales & Associates, P.C.
11323 Woodbrook Lane
Reston, VA 22094
703-787-0221
703-787-0256
jmmassoc@aol.com

James R. Robinson
ITS Director
Virginia Department of Transportation
1401 East Broad Street
Richmond, VA 23219
804-786-6677
804-225-4978

Dennis Symes
Department Chief
Federal Transit Administration
TRI-11
400 Seventh Street, SW
Washington, DC 20590
202-366-0232
202-366-3753

APPENDIX B: Amplifying Questions

The following questions about the implementation of advanced technologies were transmitted to the hosting agencies before the panel's visit. The questions focus on the following six areas of interest: (i) traffic management, (ii) traffic signal systems, (iii) incident management, (iv) transit management, (v) electronic toll/fare collection, and (vi) traveler information systems.

1. Organizational, Policy, and Funding Issues

1.1. What policies/legislation govern and control the deployment of advanced technologies in your country?
1.2. How is your agency structured or organized (particularly to facilitate the deployment of advanced technologies)? Please provide an organizational chart, if possible. Discuss staff size.
1.3. What are the responsibilities of the organization in the planning, design, operations, safety, and maintenance of advanced technologies?
1.4. Where in this organization are the following tasks conducted? A. Research, B. Planning, C. Design, D. Operations, E. Maintenance, F. User Acceptance, G. Financing.
1.5. Are you organized to operate at a local or at a regional (i.e., national) level? Why? Describe advantages and disadvantages.
1.6. Describe how projects are funded. How are funds made available?
1.7. Please describe the integration/coordination of transit/highway programs as related to advanced technologies. Describe your support of public transit.
1.8. What are the roles of local and regional agencies? What is the role of the private sector (particularly in cost sharing and public-private partnerships)?
1.9. Please describe any environmental considerations.

2. Planning and Research Issues

2.1. Describe your planning process for implementing advanced technologies, including public participation/involvement. Specifically, how do you determine which technologies to implement or pursue?
2.2. Describe your research program.
2.3. Describe your procurement process as related to the application of advanced technologies.
2.4. Do you try to influence land use patterns and other demographic factors?
2.5. What is your primary impetus for deploying advanced technologies? Is it an economic decision, based on safety considerations, a desire to improve mobility, or some other factor?
2.6. How do you determine the extent of information desired/needed by transit users (schedules, maps, etc.)?
2.7. Describe your operational/demonstration test program.

3. Technical and Design Issues

3.1. How do you design your systems? In-house? Hired consultants?
3.2. What analysis tools do you utilize?
3.3. What inter-regional/inter-agency coordination exists? Specifically, describe inter-agency coordination (fire, police, etc.) to properly respond to freeway incidents.
3.4. Do you have design standards? If you do, how were they developed?
3.5. Do you operate a traffic management center? If you do, please describe its operation.
3.6. How are safety aspects considered?
3.7. What human factors do you consider in the design of advanced technologies?
3.8. How do you determine the benefits/impacts of advanced technologies? What is your benefit/cost experience in implementing advanced technologies?
3.9. Please describe your advanced technologies-related maintenance and operation activities, including continuing funding.
3.10. How do you measure/monitor system performance? Describe the impact on mobility and safety.
3.11. What is your transit/auto mode share in your metropolitan areas?

4. Public Acceptance and Marketing

4.1. What research has been done in this area? What are the results?
4.2. How is public acceptance achieved?
4.3. At what point in your decision-making process is the public involved?
4.4. What marketing activities do you conduct? Who conducts them?
4.5. What is your experience working with the public?
4.6. Are there any issues/barriers to gaining consumer acceptance of advanced technologies?

5. Training and Continuing Education

5.1. What specific skills/qualifications do you require from your employees? Please specify for the various technical levels.
5.2. Do you provide in-house training to your employees? Please describe the process, including funding.
5.3. How do you assess your training needs, including skills necessary to design, operate, and maintain advanced technologies?
5.4. What sources of training do you have available to you?
5.5. What is being done to address staffing needs (contract personnel, inter-agency pooling, etc.)?

APPENDIX C: Topics Discussed and Points of Principal Contact

For additional information on the topic shown, you may contact the people listed below. (Note: All persons listed speak English.)

FINLAND

Topic/Site	Contact
• E18 Weather-Controlled Road Near Kotka • Traffic Management in Finland • Traffic Management Research Programme • TELMO	Mr. Kari Karessuo Finnish National Road Administration PO Box 33 FIN-00521, Helsinki, Finland Tel: 358-0-1487-2041 Fax: 358-0-1487-2236 E-mail: karikare@tieh.fi
• Finnish Road Administration Organization • Finnra Funding	Mr. Raimo Tapio Deputy Director Finnish National Road Administration PO Box 33 FIN-00521, Helsinki, Finland Tel: 358-0-1487-21 Fax: 358-0-1487-2236
• E18 Telematics Research Program	Mr. Eini Hirvenoja Finnish National Road Administration PO Box 33 FIN-00521, Helsinki, Finland Tel: 358-0-1487-2423 Fax: 358-0-1487-2236
• Traffic Monitoring System (TMS)	Mr. Raimo Sallanmaa Finnish National Road Administration PO Box 33 FIN-00521, Helsinki, Finland Tel: 358-0-1487-21 Fax: 358-0-1487-2775

• Road Weather Service System • Weather Monitoring Equipment • ROSA • Road Weather Stations • DM31 Stations	Mr. Taisto Haavasoja VAISALA Oy PL 26, FIN-00241, Helsinki, Finland Tel: 358 0 894 91 Fax: 358 0 894 9227
• Traveler Information Systems	Ms. Maritta Polvinen Finnish National Road Administration PO Box 33 FIN-00521, Helsinki, Finland Tel: 358-0-1487-2415 Fax: 358-0-1487-2662
• National Traffic Information Center	Mr. Jorma Helin Finnish National Road Administration PO Box 33 FIN-00521, Helsinki, Finland Tel: 358-0-1487-2520 Fax: 358-0-1487-2803
• Weather Monitoring • Traffic Control Centers • MATHEUS	Mr. Pentti O. Karvonen Finnish National Road Administration PO Box 33 FIN-00521, Helsinki, Finland Tel: (90) 1541 Fax: (90) 154 2395
• VTT • National Telematic Strategy • Finnish Research Programs • Transport Telematics at VTT • Safety Effects of Incident Warning Systems	Dr. Risto Kulmala VTT Transport Research PO Box 1902 FIN-02044 VTT, Finland Tel: 358 0 456 4594 Fax: 358 0 464 850 E-mail: risto.kulmala@vtt.fi
• Research and Development • Strategic Planning	Mr. Olli Nordenswan Finnish National Road Administration PO Box 33 FIN-00521, Helsinki, Finland Tel: 358-0-1487-2511 Fax: 358-0-1487-2236

• Technology Transfer • Education Programs • *FinnContact* Newsletter	Mr. Arto Tevajarvi Technology Transfer Engineer Finnish National Road Administration PO Box 33 FIN-00521, Helsinki, Finland Tel: 358-0-1487-2032 Fax: 358-0-1487-2275 E-mail: finnt2@tieh.fi
• Automatic Surveillance Studies	Ms. Rita Rathmayer VTT Transport Research PO Box 1902 FIN-02044 VTT, Finland Tel: 358 0 456 4585 Fax: 358 0 464 850
• Effects of Weather Warning Systems	Mr. Pirko Rama VTT Transport Research PO Box 1902 FIN-02044 VTT, Finland Tel: 358 0 456 4585 Fax: 358 0 464 850
• Driver Behavior in Finland	Dr. Juha Luoma VTT Transport Research PO Box 1902 FIN-02044 VTT, Finland Tel: 358 0 456 4585 Fax: 358 0 464 850
• Unobtrusive Instrumented Car for Human-Machine Interface Studies	Mr. Leif Beilinson VTT Transport Research PO Box 1902 FIN-02044 VTT, Finland Tel: 358 0 456 4585 Fax: 358 0 464 850

SWEDEN

Topic/Site	Contact
• International Affairs	Mr. Christer Jacobson Swedish National Road Administration Ambassador S-781 87 Borlange, Sweden Tel: 46 243 759 27 Fax: 46 243 759 80
• Swedish National Research Administration	Mr. Hans Torring Swedish National Road Administration S-781 87 Borlange, Sweden Tel: 46 243 758 66 Fax: 46 243 753 04
• Swedish Delegation for Transport Telematics	Ms. Marika Jenstav Head of Secretariat Swedish Delegation for Transport Telematics Ministry of Transport and Communications S-103 33 Stockholm, Sweden Tel: 46 8 405 37 31 Fax: 46 8 791 45 52
• ITS Developments in Sweden • ARENA Field Trials • ITS in Balanced Communication Spaces • A Vision of Future Mobility in Sweden	Mr. Kent Eric Lang Project Coordinator ARENA S-405 33 Gothenburg, Sweden Tel: 46 31 63 50 00 Fax: 46 31 63 52 74

• The Stockholm Case • Electronic Toll Collection • The Dennis Agreement	Ms. Gunilla P. Olsson Swedish National Road Administration Region Stockholm PO Box 4202 S-171 04 Solna, Sweden Tel: 46 8 757 68 55
• Gothenburg Traffic Information Center (GOTIC) • Gothenburg Public Transport Systems • KomFram	Mr. Anders Kabjorn City of Gothenburg Slussplatsen 1 S-411 06 Gothenburg, Sweden Tel: 031 63 59 00 Fax: 031 15 50 79 E-mail: anders@tkgbg.se
• Automatic Debiting Systems • Toll Collection Systems • Pricing Policies in Sweden	Mr. Jonas Sundberg Swedish National Road Administration S-781 87 Borlange, Sweden Tel: 46 243 758 59 Fax: 46 243 755 57
• ARENA • Traffic Information Systems • Traveler Information Systems	Mr. Torbjorn Biding ARENA Project Manager S-405 33 Gothenburg, Sweden Tel: 46 31 63 50 00 Fax: 46 31 63 52 73
• Public-private Partnerships in Sweden	Mr. Jan Olov Ericson President, Vaginfo PO Box 4202 171 04 Solna, Sweden Tel: 46 8 757 68 90 Fax: 46 8 29 46 89

THE NETHERLANDS

Topic/Site	Contact
• Ministry of Transport, Public Works and Water Management • Policy Issues	Mr. J.P.J.M. Remmen, Director Ministry of Transport, Public Works and Water Management PO Box 20901 2500 EX The Hague, The Netherlands Tel: 070-351 6102 Fax: 070-351 6591
• Passenger Transport Programs	Mr. Laurens M. Schrijnen Ministry of Transport, Public Works and Water Management Division of Traffic Facilities PO Box 20901 2500 EX The Hague, The Netherlands Tel: 31703516678 Fax: 31703516591
• Second Transportation Structure Scheme • Policy Issues	Mr. M.J. Zandstra Ministry of Transport, Public Works and Water Management PO Box 20901 2500 EX The Hague, The Netherlands Tel: 070-351 6465 Fax: 070-351 6591
• Regionalization	Ms. J.J.H. van Spronsen Ministry of Transport, Public Works and Water Management PO Box 20901 2500 EX The Hague, The Netherlands Tel: 070-3517883 Fax: 070-3516591

• Traffic Management in the Netherlands	Mr. A.J.B. Lohman Ministry of Transport, Public Works and Water Management PO Box 20901 2500 EX The Hague, The Netherlands Tel: 070-3519062 Fax: 070-3518794
• Dynamic Traffic Management • Amsterdam Dynamic Traffic Management	Mr. F.J.M. de Mol Ministry of Transport, Public Works and Water Management PO Box 3119 2001 DC Haarlem, The Netherlands Tel: 023 301654 Fax: 023 301731
• Port of Rotterdam	Mr. Jan W. Koeman Manager, Transport and Logistics Port of Rotterdam PO Box 6622 3002 AP Rotterdam, The Netherlands Tel: 31-10-489-41-68 Fax: 31-10-489-65-10
• Amsterdam Schiphol Airport	Mr. Hans J.C.A. Bakker General Manager Amsterdam Schiphol Airport P.O. Box 7501 1118 ZG Luchthaven Schiphol Amsterdam, The Netherlands Tel: (020) 6014044 Fax: (020) 6014552
• The ANWB (Royal Dutch Touring Club)	ANWB PO Box 93200 2509 BA Gravenhage, the Netherlands Tel: 070 3 147 147 Fax: 070 314 69 69

•	Dutch National Police Agency	Mr. Jan Malenstein Head of TIC Dutch National Police Agency PO Box 100 3970 AC Driebergen, The Netherlands Tel: 31 343 535 565 Fax: 31 343 531 355
•	Transport Research Center	Mr. Ambrosius Baanders Head, Transport Research Center PO Box 1031 3000 BA Rotterdam, The Netherlands Tel: 31102825740 Fax: 31102825642
•	The Rotterdam Metropolitan Planning Organization	Mr. B.N. de Koning Manager of Strategic Policies Stadsregio Rotterdam PO Box 21051 3001 AB Rotterdam, The Netherlands Tel: 31 10 417-3072 Fax: 31 10 417-2709
•	Public-Private Partnerships in the Netherlands	Mr. Jacques W.D. Peters Twijnstra Guddle Consultants PO Box 907 3800 AX Amersfoort, The Netherlands Tel: 033 467 7777 Fax: 033 467 7666
•	Pricing Policies in the Netherlands	Ms. Silvia de Ronde Bresser Ministry of Transport, Public Works and Water Management PO Box 20901 2500 EX The Hague, The Netherlands Tel: 070-3516442 Fax: 070-3516591

ENGLAND

Topic/Site	Contact
• The M-25 Controlled Motorway Pilot Scheme • Traffic Management in the UK • Evolution of Motorway Communications • NMCS2 • MIDAS	Mr. Brian Harbord Highways Agency Houlton Street Bristol BS2 9DJ UK Tel: 0272-878216 Fax: 0272-878447
• Highways Agency • Trafficmaster® • Traveler Information Systems	Mr. Ian Holmes Highways Agency Room 12/31 St. Christopher House Southwark St., London SE1 0TE UK Tel: 0171-921-4196 Fax: 0171-921-4899
• ROMANSE Project and All Its Elements	Mr. Andy Wren Hampshire City Council Ariadne House Town Quay Southampton SO14 2AQ UK Tel: (01703) 336759 Fax: (01703) 337020
• Southampton Traffic Control Center • SCOOT	Mr. Ray Morris UTC Manager Southampton City Council Marland House Southampton SO14 7PR UK Tel: 01703 334810 Fax: 01703 337020

- Hampshire County Council
- ROMANSE
- Southampton Traveler Information Systems

Mr. Ken Laughlin
Chief Traffic Engineer
Hampshire County Council
The Castle Winchester
Hampshire, SO23 8UD
United Kingdom
Tel: 01962 846893
Fax: 01962 870301

APPENDIX D: Internet WWW Addresses

Internet (WWW) Address	Includes
http://www.tieh.fi.8001/index.htm	Finnra Today (including links to several other www pages, including many in the U.S., a picture from the border with Russia, updated twice an hour; more)
http://www.vtt.fi/yki/yi6/yki6ese.htm	Technical Research Center of Finland
http://www/minvenw.nl/enganderewwwsites/htlm	Dutch Ministry of Transport
http://www.echo.ln/programmes/en/DRIVE_2/html	DRIVE Program
http://www.glab.se/www/info/glinfo_english.html	Gothenburg Transport Information
http://www.glab.se/www/tis/tis_english.html	Gothenburg Traveler Information System
http://www.tkgbg.se.	Gothenburg Traffic and Transit Authority
http://www.minvenw.nl	Dutch Ministry of Transport, Public Works and Water Management
http://www.open.gov.uk/hiagency/highhome.htm	Highways Agency (UK)
http://www.open.gov.uk/index.htm	British Government On-Line
http://www.dcs.aber.ac.uk/~mkh2/npton.html	Northampton, England, homepage

*U.S. GOVERNMENT PRINTING OFFICE: 1997-436-062/80494

Publication No. FHWA-PL-98-010
HPI-10/11-97(1.2M)E