VIRGINIA PROGRESS

The Virginia Department of Transportation's Intelligent Vehicle-Highway Systems Strategic Plan

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PREFACE

This document describes the strategic plan for Virginia PROGRESS, the Virginia Department of Transportation's Intelligent Vehicle-Highway Systems (IVHS) *PROGR*am for an *E*fficient and *S*afe *S*ystem. The strategic plan was developed through the efforts of an internal VDOT planning committee. It is intended to guide VDOT activities in IVHS over the next twenty years.

There are three major sections in this document. Chapter 1, the Strategic Assessment, describes the need for IVHS in Virginia. Chapter 2 contains an overview of IVHS, including complete descriptions of the functional areas. Finally, Chapter 3 provides the detailed strategic plan for Virginia PROGRESS.

Interested readers are encouraged to track the development of Virginia PROGRESS in the publication, *IVHS Activities in the Virginia Department of Transportation*. This document, which is published semiannually by the Virginia Transportation Research Council, offers a complete summary of all VDOT IVHS activities, including project descriptions, contacts, and status.

CHAPTER 1

STRATEGIC ASSESSMENT

"It will take at least as long to develop and implement IVHS as it did the interstate highway system, and its impact will be at least as revolutionary." (1992)

Patricia F. Waller
University of Michigan

INTRODUCTION

An emerging group of advanced technologies and systems known as Intelligent Vehicle-Highway Systems (IVHS) have the potential to revolutionize surface transportation. IVHS promises enhanced safety and efficiency through the application of advanced technologies such as communications, electronics, and computer hardware and software. In fact, the United States General Accounting Office has estimated that IVHS will result in a reduction in travel times of up to 50 percent and produce safety benefits approaching $22 billion by the year 2010.

The Virginia Department of Transportation (VDOT) is in a strong position to develop a comprehensive IVHS program that will play a major role in meeting the transportation needs of the Commonwealth as well as provide significant contributions to the national IVHS development effort. In fact, VDOT has traditionally applied advanced technology to address transportation problems, and the Department is already active in IVHS. For example, the Northern Virginia Traffic Management System (TMS) has used modern surveillance and incident detection techniques to manage traffic on the region's interstates since 1985. Furthermore, VDOT has played an active role in national IVHS development through participation in the H.E.L.P. program and as a charter member of IVHS America.

Clearly, IVHS holds great potential. In order to realize this potential, VDOT is committed to Virginia PROGRESS, which is a program for IVHS research, development, and deployment. Commitment to such a program will certainly create technical challenges. Such a commitment will also require extensive institutional coordination, and it will expose legal issues that the Department has never faced. Such a major program requires a clear, well-formed strategy. This document, VDOT's IVHS Strategic Plan, will guide the Department in Virginia PROGRESS.

WHY IVHS?

IVHS can improve safety, reduce congestion, enhance mobility, minimize environmental impact, save energy, and promote economic productivity in our transportation system. It will multiply the effectiveness of future spending on highway construction and maintenance and will increase the attractiveness of public transportation. IVHS will be as basic a transportation raw material as concrete, asphalt, or steel rail.

from "Strategic Plan for IVHS in the United States"
IVHS America

SURFACE TRANSPORTATION NEEDS - IVHS SOLUTIONS

The fundamental surface transportation needs of the Commonwealth of Virginia are evident in VDOT's Mission Statement:

"To provide safe, efficient, effective, and environmentally sound highway and surface transportation systems now and into the Twenty-first Century."

Providing superior surface transportation is becoming more and more difficult. For example, in the 1980s, Virginia's population grew by 12 percent, whereas highway travel increased by *50 percent*. With this skyrocketing demand for mobility comes the potential for congestion, unsafe conditions, and the deterioration of the natural environment. Clearly, the need exists for a higher quality transportation system to meet these high mobility demands. To provide such systems, VDOT will need to use all available resources. As stated earlier, IVHS will be a fundamental raw material.

IVHS can help VDOT successfully meet its mission. IVHS represents a paradigm shift to the transportation/*information* infrastructure. Rather than rely on passive transportation facilities, IVHS uses information technology to actively control the facilities. This allows for enhanced safety and efficiency on the existing multi-modal transportation system while mitigating the environmental impacts.

In order to clearly define a vision for IVHS in Virginia, it is important to examine the ways in which IVHS can directly assist VDOT in meeting its goals.

Goal: "Preserve and maintain the existing highway and transportation systems to safeguard the capital investment, provide for the safety, convenience and comfort of the traveling public, and provide for the efficient movement of people and goods throughout the Commonwealth."

IVHS will support the substantial capital investment in Virginia's surface transportation system by improving the operating characteristics of the system. Through such IVHS components as advanced traffic management, traffic and navigation information systems, and advanced driver support systems, IVHS will make travel safer, more efficient, and more convenient to the citizens of Virginia.

Goal: "Design, construct, and regulate a superior highway system to enhance mobility and economic growth."

IVHS will become an integral part of a "superior highway system" in the future. In addition, IVHS promises to increase VDOT's ability to efficiently and effectively regulate the highway system. IVHS will provide "transparent" borders, thereby allowing commercial vehicles to operate more efficiently. This will promote economic growth. In addition, the monitoring of vehicle size and weight will be greatly improved with IVHS. Finally, it is expected that the IVHS development effort will lead to an active American IVHS industry, providing benefits to many of the high technology firms based in Virginia.

Goal: "Support and promote modal and multi-modal planning, transportation systems management, other transportation agencies and modes, and strategies to reduce urban congestion - building new highway facilities only where necessary."

IVHS is expected to prove especially beneficial in urban areas, promoting more efficient use of all surface transportation modes. In effect, this will increase capacity and reduce the need for new highway facilities. Through better system management, IVHS will improve the efficiency of high occupancy modes of transportation, such as mass transit and ride-sharing. In turn, by providing travelers with accurate and timely information, it is expected that IVHS will influence travelers to utilize the entire multi-modal transportation system most efficiently.

Goal: "Ensure efficient use of existing financial resources and enhance funding through innovative financing techniques, including public-private partnerships and privatization initiatives."

IVHS is currently being developed on a national level through innovative public-private partnerships. In fact, it is felt that IVHS presents an opportunity to develop a new working relationship between the public and private sectors.

Finally, IVHS holds the potential for solid markets for private firms, and their active participation in the development effort can be expected to continue.

Goal: "Improve productivity, quality of service, and cost reduction through the use of state-of-the-art technology, research, and managerial improvements."

In effect, this goal describes the purpose of IVHS. Through the application of advanced information technology, IVHS promises to improve the quality of surface transportation while reducing the high costs of new highway facility construction. In addition, IVHS's emphasis on system operations will encourage the various parties involved in surface transportation, such as police departments, local governments, state agencies, and others, to work together more closely. This can be expected to lead to dramatic improvements in the management of surface transportation.

As VDOT strives to meet its objectives, it is evident that IVHS will serve as an effective tool now and into the future. In order to reap the full benefits of IVHS, the Department must actively pursue the research, development, and deployment of IVHS.

"Because of the varied demands on our transportation system in Virginia, we have tested developing technologies for years - innovation is a way of life for VDOT."

Ray D. Pethtel
Virginia Department of Transportation

ONGOING IVHS ACTIVITIES IN VDOT

As a leader in the application of advanced technology to surface transportation, VDOT is already actively using IVHS. The Department's efforts in the area have been highly beneficial. In this section, two of VDOT's primary IVHS activities will be described. In addition, a summary of all current VDOT IVHS activities can be found in the document, *IVHS Activities in the Virginia Department of Transportation.*

TMS: *I-66/I-95/I-395 Traffic Management System*

The TMS is an essential component of the surface transportation system in the highly congested Northern Virginia region. Operational since 1985, the TMS monitors significant portions of the region's major interstates. This allows for active, efficient operation of these highway facilities.

The primary responsibility of the TMS is incident management. Loop detectors are installed throughout the system at 1/2-mile spacings (550 total) to monitor traffic flow and detect incidents. Closed circuit television (CCTV) is utilized to verify detected incidents and aid in incident management. A total of 48 CCTVs are installed in the TMS.

Another responsibility of the TMS is to provide congestion management. Twenty-six ramp meters are stationed throughout the network to regulate traffic flow onto the interstates during peak periods. In addition, one hundred variable message signs are used to provide travelers with information concerning network conditions. These signs provide information such as high occupancy vehicle (HOV) restrictions, openings/closings of the reversible lanes on I-395, and freeway conditions (accidents, congestion, etc.).

An area that is given high priority in the TMS is one of the region's major bottlenecks, the Woodrow Wilson Bridge. Nine CCTVs are used to monitor traffic conditions in the area of the bridge, and twenty-two variable message signs are used to pass on information to the traveler. This bridge surveillance activity is coordinated with the state of Maryland.

Finally, there are plans to expand the system significantly in the near future. As the HOV facilities of I-95 and I-66 are extended, additional CCTVs, ramp meters, and variable message signs will be added to the system.

The TMS represents a solid first step in deploying IVHS in the Northern Virginia region. It is expected that future IVHS projects in the region will be fully integrated with the TMS.

FASTOLL: *Dulles FASTOLL Project*

FASTOLL is an integrated toll collection system that has been designed to replace the existing standard manual system on the Dulles Toll Road. Although FASTOLL will continue to use both manual toll collection and automatic coin collection machines, it will also utilize a toll collection system based on automatic vehicle identification (AVI). The AVI system consists of three functional elements: a vehicle mounted-transponder (or tag), a roadside reader unit, and a computer system for data processing. FASTOLL will allow drivers to pay their tolls by deducting them from prepaid accounts as their tags are read. AVI-equipped vehicles will not need to stop as their tags are read, thus increasing the efficiency of the toll collection process.

There are a number of advantages expected from FASTOLL. First, the system will eliminate the delays caused by traditional toll booths, thereby increasing the utilization of highway capacity. Second, it will free personnel from the monotonous and hazardous task of collecting tolls. Finally, FASTOLL includes a new accounting system that should provide greater accuracy than the present system.

The experience gained with AVI through the FASTOLL system will be valuable in preparing for future applications of this technology. For example, it is intended that the design of FASTOLL be adaptable for future tolling applications throughout the Commonwealth. Furthermore, data obtained with AVI, such as travel times, may prove valuable in traffic management and future transportation planning efforts.

"IVHS has many risks, and one of the biggest is: can we organize ourselves to do it? It requires a unique blend of public and private actions. There can be no central control over the activities. Therefore, there is a need for a strategic plan, a greater need than you would have for similar projects." (1992)

Thomas B. Deen
Transportation Research Board

CONCLUSION

IVHS will become a basic resource to VDOT as it strives to meet its mission. In fact, IVHS has already started to make significant contributions to surface transportation in the Commonwealth. Furthermore, given the potentially lucrative markets for private firms and the federal government's active development effort, IVHS activities will most likely increase in Virginia, even without the efforts of VDOT.

However, there are significant risks involved for VDOT in an undirected approach to IVHS development.

- Given the large-scale national IVHS development effort currently underway, many key decisions will be made that will directly affect VDOT. For example, system architecture definition and the adoption of communication protocols will impact Virginia's IVHS projects. VDOT must have a clear and unified voice in the national effort.

- There are an enormous number of "players" in IVHS. Private firms, local governments, user groups, etc. all will have a major role in IVHS development. The Department must have a clear plan as to how to work with these groups.

- IVHS is multi-disciplinary in nature. VDOT must have internal coordination among divisions and districts.

- The real "pay-off" of IVHS will be the integration of systems. In order to ensure that individual systems will work well together, VDOT must take the lead in developing a comprehensive deployment strategy.

In order to realize the full potential of IVHS, it is critical that VDOT take an active role in research, development, and deployment. This document, the strategic plan, is an important first step. This plan will ensure that all available resources are used wisely, thereby achieving quick, orderly, and coordinated deployment of IVHS.

CHAPTER 2

IVHS OVERVIEW

"I do not think it can be overemphasized that we absolutely and positively have to have a paradigm shift if we are going to have success in IVHS." (1992)

William A. Leasure Jr.
National Highway Traffic Safety Administration

INTRODUCTION

IVHS is truly a paradigm shift in surface transportation. It represents a movement to the transportation/*information* infrastructure. In fact, this is what distinguishes IVHS from simply an application of advanced technology. For many years, technology has been used to enhance the function of various components of the transportation system. However, IVHS represents a commitment to utilizing information technology throughout the multi-modal transportation system to fundamentally improve the operations of the system. The scale of this ambitious, fundamental change in the surface transportation system clearly defines IVHS as a "megaproject" similar to such projects as the construction of the interstate highway system (Deen, 1992).

What are the technologies that will enable the development of the transportation/information infrastructure? Primarily, they are technologies that have been under development in industries such as telecommunications, defense, aerospace, and process control. The technologies include: satellite communications, fiber optics, video imaging, lasers, radio data systems, satellite positioning systems, artificial intelligence, and many others. However, it is not solely technology that defines IVHS. In fact, most of the technology is becoming relatively commonplace in our information intensive society. The promise of IVHS lies in the integrated application of information technology to achieve a truly multi-modal transportation system that operates with levels of safety and efficiency unachievable under the current system.

The concept of IVHS is in no way new. For example, a General Motor's exhibit at the 1939 World's Fair included a traffic control center communicating with drivers utilizing radio beacons (TRB, 1991). In addition, there has been implementation of isolated freeway traffic management systems and computer-controlled traffic signal systems for nearly 30 years. However, the isolation of such systems has severely restricted their effectiveness. Again, this illustrates the need for well-integrated IVHS to successfully address transportation needs.

Five functional areas of IVHS have emerged in recent years. These areas are: Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), and Commercial Vehicle Operations (CVO). Clearly, given the importance of system integration, these functional areas have considerable "overlap." However, they are useful in providing a structural framework in which to examine IVHS. In the following sections, each functional area will be described, enabling technology will be identified, and an example will be considered.

ADVANCED TRAFFIC MANAGEMENT SYSTEMS

Functional Description

ATMS is generally considered the "smart highway" component of IVHS; it performs two fundamental functions: system monitoring and system management.

The ATMS monitoring function consists of collecting real-time information needed for effective traffic management and for other IVHS functional areas. ATMS monitors traffic conditions (volumes, average speeds, link times) and public transportation system status. In addition, it is expected that ATMS will provide short-term predictions of upcoming traffic conditions.

ATMS promises to extend current traffic management capabilities primarily by providing faster response to dynamic conditions. Management functions include adaptive traffic signal timing, incident management, electronic toll and traffic management (ETTM), and work zone traffic management. Finally, ATMS will integrate management functions on freeway and surface facilities.

Enabling Technology

The monitoring function of ATMS will rely on vehicle detection systems and communication systems. First, a number of technologies may be utilized to collect raw data on the status of the transportation network. Vehicle detectors, such as inductive loops, video image detection systems, and systems based on radar, lasers, and ultrasonic technology may be deployed. Furthermore, system monitoring may be achieved through the use of vehicles as "probes," reporting on the conditions that they encounter. Clearly, wireless communications technology will play a key role in this approach. In addition, vehicle detection systems will require wide-area communication networks to transmit data to a management center. It is expected that media such as fiber optics and others pioneered in the telecommunication industry will be utilized.

The management function of ATMS will utilize some familiar technology. For example, computerized traffic signal systems and ramp meters will provide critical control measures. Beyond this, automatic vehicle identification (AVI) technology will be used in ETTM to make tolling facilities more efficient. Finally, software will play a critical role in the management function. Software will be relied upon to fuse raw data and extract information, predict conditions, identify incidents, optimize signal timings, and determine vehicle routes.

Example - Los Angeles Smart Corridor (Rowe, 1992)

This project is designed specifically to demonstrate the effect of ATMS on the efficiency and predictability of traffic flow in a high demand corridor. The project is unique in that it integrates management on both freeway and surface facilities in a corridor roughly 14 miles long and 2 miles wide. The underlying concept of the project is to "spread" demand over all facilities, thereby maximizing the utilization of capacity in the corridor.

An extensive surveillance system consisting primarily of loops and closed circuit television is utilized in the project. The data are collected in a centralized data base, which is accessible to all organizations in the corridor involved in traffic management. This centralized database allows for integrated control of all facilities. Finally, the project is using a sophisticated expert system to assist operators in management tasks.

ADVANCED TRAVELER INFORMATION SYSTEMS

Functional Description

The primary function of ATIS is to create intelligent travelers by providing them with accurate, timely information. ATIS will provide information to travelers in their homes, offices, vehicles, at major activity centers, and in public transportation facilities. One major function of ATIS will be the provision of navigation information. Travelers will have access to complete route guidance instructions. Furthermore, ATIS will provide dynamic information describing the status of the transportation system. This information will include travel time estimates, public transportation schedules, parking availability, and weather/pavement conditions. Finally, ATIS will provide safety features such as a May-Day capability for stranded travelers.

Enabling Technology

The success of ATIS depends on its ability to transmit information to travelers in a dynamic environment. There exist a wide variety of communication technologies that may be used in an ATIS. Some of the technology is widely utilized at this time primarily in supporting one-way communication. Examples of this include highway advisory radio and changeable message signs. More sophisticated systems are expected to utilize advanced two-way communications technology, such as radio data systems and spread spectrum data systems.

Positioning and navigation technologies will also play a key role in ATIS. Highly detailed digital map databases will be required. In addition, positioning technologies, such as global positioning satellites (GPS), dead-reckoning, and map-matching will be utilized. Finally, software will play a critical role in determining routes and managing navigation information.

User interfaces will be particularly important to ATIS. Information must be presented in a clear, nondistracting manner. Therefore, human factors engineering will play a critical role. Technologies that will support the user interface include voice synthesizers, touch-screen computers, and palm-top computers.

Example - TravTek (Rillings, 1992)

TravTek is a public-private venture in Orlando, Florida, demonstrating a sophisticated in-vehicle ATIS. TravTek provides drivers with information concerning navigation, route selection, current traffic conditions, as well as a "Yellow Pages" service. This information is presented to drivers on a 5-inch diagonal color video display with "touch-screen" capability and through a computer synthesized voice.

The in-vehicle equipment utilized by TravTek vehicles is extensive. A custom computer (Intel 80386 processor, 20 megabyte hard disk) is used for navigation and driver interface purposes. A second, similarly configured computer system is utilized for determining optimal routes. Finally, a GPS receiver is used to determine vehicle location.

As stated previously, communications are critical in ATIS. TravTek relies on a two-way communication system. Vehicles receive information from the traffic management center via an 800 Mhz data link. In addition, vehicles transmit link times and system status information back to the center via the data link.

ADVANCED VEHICLE CONTROL SYSTEMS

Functional Description

The objective of AVCS is to improve the operation of vehicles through driver assist systems and automated control systems. Driver assist systems improve the safety of vehicle operations by promptly alerting drivers to dangerous situations, thereby allowing for early action. Examples of such systems include collision warning devices and vehicle monitoring systems. Automated control systems provide full or partial automation of the driving task. Examples include automated steering systems, automated braking systems, automated acceleration systems, and fully automated highway facilities. Automated systems promise to improve safety and increase capacity through a reduction in necessary vehicle headways.

Enabling Technology

AVCS is the most technically advanced functional area of IVHS. Sensor, communication, control, and electromechanical actuation technologies, which were largely developed in the aerospace industry, provide the foundation for AVCS. Sensors, such as those based on laser and ultrasonic technologies, will provide critical positioning information for driver assist systems and advanced automated control systems. Furthermore, communication systems, such as the wireless technologies discussed earlier, will allow information to be shared between vehicles and with the road itself. Sophisticated control systems will utilize this information to make the "intelligent decisions" necessary in automated systems. Finally, these decisions will be implemented with electromechanical actuation systems physically manipulating the vehicle.

Example - California PATH (Shladover, 1992)

The PATH program has conducted research in automated vehicle systems for four years. In the first half of 1992, three critical automation functions (steering, speed, and spacing) were successfully tested.

The lateral (steering) control system utilizes magnets imbedded in the roadway to provide vehicles with a reference system. The magnets contain coded information describing their position and upcoming roadway geometry. These magnets are sensed with magnetometer probes mounted on the vehicles. The information is transmitted to a control system that commands actuators to position the front wheels to a specified angle. The system has demonstrated excellent accuracy (generally within 15 centimeters) and smooth handling.

Longitudinal control experiments have utilized platoons of four vehicles that function as one integrated unit. Radar sensors are utilized to determine longitudinal spacing, and two-way radio communications allow vehicles to "warn" others of accelerations or decelerations. This information is fed to control software, that commands a throttle actuator. Test results have been quite promising: vehicle spacings have varied less than one meter.

ADVANCED PUBLIC TRANSPORTATION SYSTEMS

Functional Description

APTS can best be described as IVHS applied to public transportation. As such, many of APTS's functions are similar or even identical to those of ATMS or ATIS. The promise of APTS lies in improving the management of public transportation, and in making public transportation more appealing to travelers.

APTS focuses on efficiently operating public transportation fleets. APTS will route vehicles efficiently, thereby allowing for demand-responsive public transportation. In addition, APTS will coordinate traffic control strategies to provide preference to high-occupant vehicles. Finally, APTS will manage fare collection using automatic identification/debiting systems, thereby replacing hard currency.

The other major function of APTS is to provide travelers with accurate, timely information in order to make the use of public transportation more attractive. This includes information systems that provide travelers with accurate scheduling information and descriptions of the system's status. Furthermore, APTS will provide the capability for real-time ride-share matching.

Enabling Technology

As in other functional areas, APTS relies primarily on communications and software. Many of the communication technologies described earlier will be required to transmit information for APTS. In addition, computer software will play an important role through data fusion, routing determination, and management assistance. AVI technology will be utilized in advanced fare collection systems. Personal AVI devices, which are commonly referred to as "Smart Cards," are expected to be widely used. Finally, vehicle location technology will allow for efficient fleet management. Systems such as GPS will provide accurate location information.

Example - Baltimore Smart Vehicle (Labell, Schweiger, and Kihl, 1992)

This project is focused on improving the operations of the Baltimore public transportation system. Loran-C, which is a ground-based triangulation location system similar to GPS, is used to locate vehicles. In addition, 800 MHz radio communications are used to provide a two-way communications link between the vehicles and control center. The center monitors and manages the system based on these sources of information.

In upcoming phases of this project, the information collected at the control center will be disseminated to travelers. Schedule adherence and estimated arrival times will be provided to travelers at kiosks and computer terminals. Finally, the project will provide a control center with the capability to preempt traffic signals in order to allow buses behind schedule to catch up.

COMMERCIAL VEHICLE OPERATIONS

Functional Description

CVO is similar to APTS in that it represents the application of IVHS to a subset of transportation operations. The objective of CVO is to improve the efficiency of commercial vehicle operations. This is accomplished primarily through improvements in fleet management and the regulation of commercial vehicle operations.

The management functions of CVO are similar to APTS. By monitoring vehicle positions, traffic conditions, and demand, CVO can optimize fleet movements. Fleet operations can be further enhanced by utilizing information technology to increase the efficiency of commercial vehicle regulation. Functions such as weigh-in-motion and electronic border transactions will reduce the delay imposed on commercial vehicles. Furthermore, more effective enforcement of regulations can be expected.

Enabling Technology

As in other areas, communications and software technology play the critical role in CVO. Some of the more unique applications of technology involve the regulatory function of CVO. For example, weigh-in-motion can accurately weigh and classify vehicles as they travel at highway speeds. This eliminates the long, time-consuming lines often found at weigh stations using static scales only. Another example is the use of AVI and databases to create transparent borders. Vehicles may register once, enter into a multi-state database, and gain approval to pass through state borders once identified by an AVI system. This cuts down on paperwork and delays to commercial vehicles. Finally, it is expected that this technology will also increase the effectiveness of commercial vehicle regulations, thereby increasing a state's ability to identify offenders.

Example - CRESCENT Demonstration (Walton, 1992)

The CRESCENT project is the demonstration phase of the Heavy Vehicle Electronic License Plate (H.E.L.P.) Program. H.E.L.P. is dedicated to investigating methods to utilize technology to create integrated systems for managing large trucks on the highway network. The CRESCENT project is located along Interstate 5, Interstate 10, and Interstate 20 in the states of Texas, New Mexico, Arizona, California, Oregon, Washington, and the Province of British Columbia. In general, CRESCENT locations consist of weigh-in-motion stations, main line monitoring, and ports-of-entry stations.

A unique feature of CRESCENT is the utilization of a centralized data management system. This system is operated by a private third party. This has allowed many problems with privacy issues to be favorably resolved. Finally, CRESCENT is proving successful in increasing the operational efficiency of commercial vehicles.

CONCLUSION

Clearly, IVHS is not science fiction. It is the application of existing information technology to make the operation of the multi-modal transportation system safer and more efficient. An individual system in one of the functional areas only scratches the surface of the potential of IVHS. IVHS requires ATMS, ATIS, AVCS, APTS, and CVO to function together. Together, these functional areas form a well-integrated transportation/information infrastructure.

CHAPTER 3

STRATEGIC PLAN

MISSION

Virginia PROGRESS's mission is to develop and deploy Intelligent Vehicle-Highway Systems to assist in meeting the Virginia Department of Transportation's primary objective: "To provide safe, efficient, effective, and environmentally sound highway and surface transportation systems now and into the Twenty-first Century."

FOCUS

The focus of Virginia PROGRESS is to implement well integrated, comprehensive IVHS systems that will improve Virginia's multi-modal transportation system. Virginia PROGRESS will focus primarily on IVHS applications that increase transportation safety. Furthermore, the program will seek to utilize IVHS to improve the operational efficiency of the entire multi-modal transportation system.

Virginia PROGRESS is designed to expedite the deployment of IVHS through a commitment to IVHS research and development. Furthermore, Virginia PROGRESS will concentrate on IVHS operations and maintenance, which are components that play as significant a role as advanced technology hardware.

Specific areas of focus for Virginia PROGRESS are:

- The development of Advanced Traveler Information Systems (ATIS), which will ultimately result in the deployment of a statewide traveler information network.
- The continued development of Advanced Traffic Management Systems (ATMS).
- The research and development of automated highway systems (AHS), particularly through the "Smart Road" project in Southwest Virginia.
- The application of IVHS to improve Commercial Vehicle Operations (CVO).
- The application of IVHS to encourage the efficient utilization of Virginia's multi-modal transportation system.

COURSE OF ACTION

In order to rapidly deploy well-integrated IVHS in Virginia, Virginia PROGRESS will follow an ambitious course of action. The 20-year program will be structured in three phases, as defined in the national *Strategic Plan for IVHS in the United States*:

- Near Term (1992-1996)
- Middle Term (1997-2001)
- Long Term (2002-2011)

In the near-term phase, Virginia PROGRESS will emphasize IVHS development through upgrading current systems and implementing individual systems as operational tests. The program will concentrate on wide-scale deployment of independent, "stand-alone" systems during the middle-term phase. Finally, in the long-term phase, the focus will be on interfacing systems to achieve well integrated "seamless" IVHS in the Commonwealth.

The fundamental objective of Virginia PROGRESS is to deploy IVHS throughout the Commonwealth in order to help meet Virginia's growing multi-modal transportation needs. Four areas of concentration have been identified in Virginia PROGRESS as critical to meeting this objective:

- Advanced Traveler Information Systems
- Advanced Traffic Management Systems
- Automated Highway Systems
- Commercial Vehicle Operations

These areas are in no way mutually exclusive. Furthermore, their order does not signify any prioritization. In fact, it is clear that the success of Virginia PROGRESS is directly dependent on success in each individual area and the ultimate integration of all IVHS components.

This course of action does *not* detail complete project specifications for Virginia PROGRESS. Rather, it presents a general description of VDOT's objectives in each area and goals for each of the program's phases. As such, the course of action provides the IVHS Steering Committee, which is VDOT's IVHS policy body, with a general direction. Furthermore, Virginia PROGRESS will remain flexible and responsive in order to meet the dynamic multi-modal transportation needs of the Commonwealth.

Advanced Traveler Information Systems

The focus of ATIS is to apply information technology in order to provide complete multi-modal transportation information to travelers. In other words, the program will utilize IVHS to create smart travelers, which will enhance the overall safety and efficiency of the transportation system. Smart travelers will make decisions based on real-time information concerning route selection, public transportation schedules and costs, and road and traffic conditions.

It is important to note that traffic surveillance systems will play a critical role in providing accurate information for ATIS. However, given that surveillance systems are considered the backbone of ATMS, they will be discussed in the ATMS concentration area. This example of "shared" components illustrates the importance of developing well integrated IVHS.

Near-Term Goals

- Deploy regional highway advisory radio systems in Northern Virginia and Hampton Roads. These systems will provide real-time traffic/incident information, work zone information, weather information, public transportation schedules, and other services.
- Investigate and implement the use of private companies to disseminate information.
- Encourage and facilitate the development of complete digital maps of Virginia's transportation system. This effort should be coordinated with VDOT's activities in geographic information systems (GIS).
- Study and test rural applications of ATIS, such as emergency response systems.

Middle-Term Goals

- Deploy multi-modal "mobility managers" in urban areas that will provide real-time information via telephone and cable television. Real-time condition information and scheduling information will be presented to allow for trip planning.
- Participate in an operational test of an in-vehicle navigation/route-guidance system.
- Participate in an operational test of ATIS utilizing advanced in-vehicle communication devices such as radio data systems.
- Participate in an operational test of a coordinated ATIS/ATMS in an urban area.

Long-Term Goals

- Deploy a statewide ATIS that conforms with all accepted national standards.

- Deploy coordinated ATIS/ATMS in urban areas.

Advanced Traffic Management Systems

The primary functions of ATMS are to collect and synthesize real-time multi-modal transportation information and to use this information to enhance operational control over the system. Traffic management will have primary emphasis in urbanized areas through applications such as active traffic signal control and incident detection. Again, it is important to note that although ATIS and ATMS are discussed separately, the ultimate goal of Virginia PROGRESS is to create comprehensive ATIS/ATMS coordinated systems.

Near-Term Goals

- Conduct "early deployment" studies for ATMS in Northern Virginia, Hampton Roads, and Richmond in order to determine needed upgrades in present traffic management systems.

- Adopt a state standard for electronic toll and traffic management (ETTM) and move to convert all Commonwealth toll facilities.

- Participate in the development of methods to coordinate traffic management activities along major interstate transportation corridors through the I-95 Priority Corridor Coalition.

- Examine alternative surveillance technologies and encourage their testing in Virginia.

- Develop enhancements for ATMS operations, particularly in the area of operator decision support systems.

Middle-Term Goals

- Deploy a fully adaptive traffic signal control system and evaluate its effectiveness.

- Initiate an operational test to examine preferential treatment of high-occupancy vehicles (HOVs) by traffic control devices.

- Deploy an ATMS that integrates the control of freeway and surface street networks.

- Coordinate ATMS along major interstate transportation corridors.
- Participate in an operational test of a coordinated ATIS/ATMS in an urban area.

Long-Term Goals

- Deploy a statewide surveillance system.
- Adopt the national ETTM standard for Virginia toll facilities.
- Deploy coordinated ATIS/ATMS in urban areas.

Automated Highway Systems

Automated highway systems (AHS) promise significant benefits to the surface transportation system. Particularly, AHS will improve safety through advanced control of vehicles. Furthermore, AHS will lead to even more efficient utilization of existing facility capacity than will either ATMS or ATIS.

VDOT's efforts in AHS will be focused on the "Smart Road" project. The smart road will be a new facility which directly connects Blacksburg to Roanoke. The road will be constructed as an IVHS facility from the ground up. Furthermore, the phased construction plan will allow portions of the facility to serve as a closed "test-bed" for AHS systems under development. The expectation is that private industry will be able to use both closed and open sections to examine systems under differing travel conditions.

VDOT is participating in the smart road project with the Virginia Polytechnic Institute and State University, as well as private industry.

Near-Term Goals

- Perform a thorough systems analysis of the smart road, considering factors such as functional requirements, human factors issues, and communications needs.
- Develop industry support and participation in the project.
- Develop engineering requirements and specifications for the facility.
- Begin construction of the smart road.

Middle-Term Goals

- Test AHS on "closed" road sections, concentrating on warning and assistance systems.
- Examine and test full AHS issues, such as transition from automatic to manual control.

Long-Term Goals

- Test fully automated control on closed road sections.
- Implement warning and assistance systems on all sections of the facility.

Commercial Vehicle Operations

The use of Virginia's surface transportation system by commercial vehicles has led to a number of safety concerns. Virginia PROGRESS will seek to improve safety through the application of CVO technology. Furthermore, it is commonly acknowledged that the efficiency of commercial vehicles plays a critical role in the economy of the Commonwealth. CVO technology will also be used to improve operational efficiency.

Near-Term Goals

- Participate in CVO institutional issues studies with surrounding states.
- Participate in an operational test of large-truck safety systems by developing the necessary infrastructure for such systems.
- Examine applications of CVO technology to hazardous material transportation.

Middle-Term Goals

- Deploy weigh-in-motion (WIM) devices for commercial vehicle main-line screening, thereby improving the efficiency of enforcement.
- Pursue the institutional arrangements and deploy the infrastructure necessary to ensure "transparent" regulatory borders for commercial vehicles.

Long-Term Goal

- Coordinate ATIS/ATMS with commercial vehicle fleets.

IVHS ORGANIZATIONAL STRUCTURE

In order to carry out Virginia PROGRESS's ambitious course of action, the Department must establish a sound IVHS organizational structure. In addition, the successful application of IVHS will require a staff with knowledge, skills, and abilities currently not found within VDOT. The Department must commit to recruiting highly qualified individuals and providing advanced technology training to present personnel.

The Assistant Commissioner for Operations will lead the IVHS program within VDOT. In this role, this person will be called upon to champion Virginia PROGRESS within the Department, state government, and national government. For example, the Assistant Commissioner for Operations should ensure that IVHS solutions are considered as viable alternatives to traditional facility construction in VDOT's planning process. Finally, the Assistant Commissioner for Operations will provide managerial oversight for Virginia PROGRESS by monitoring the program and modifying resources as the program matures.

Advanced Transportation Systems Division

An Advanced Transportation Systems Unit will be formed to administer Virginia PROGRESS. In the Near-Term Phase (1992-1996), this unit will function as a section within the Traffic Engineering Division. Given that the unit will be acquiring and developing staff during this phase, it will be necessary to utilize Traffic Engineering resources, especially administrative, on an *interim* basis. However, the unit must maintain an independent identity during this interim period; it is important to allow it to work directly with other VDOT divisions as well as the districts.

At, or before, the opening of the Middle-Term Phase (1997), the Advanced Transportation Systems unit will become a Division. It will report directly to the Assistant Commissioner for Operations. The Division will have two key objectives: to design and deploy integrated systems and to support operations and maintenance of these systems. In order to accomplish this, the following are considered to be critical functions for the Advanced Transportation Systems Division (ATSD).

System Deployment

The ATSD will have primary responsibility for deploying IVHS. This includes both operational test projects and integrated systems. ATSD will accomplish this utilizing both contractors and in-house expertise.

1. Contractor Projects

- ATSD will develop requests for proposals (RFPs) for advertisement.

- ATSD will select from and negotiate with interested organizations.
- ATSD will manage contractor projects by monitoring progress and ensuring that all agreements are met.
- ATSD will evaluate completed projects.

2. In-House Projects

It is expected that as Virginia PROGRESS matures, ATSD will develop the staff required to accomplish design and deployment of basic systems. In addition, the division will be called upon to upgrade and enhance existing systems. ATSD in-house projects will consist primarily of basic communication systems, surveillance systems, ATMS software, and systems integration.

Specifications/Standards

In order to achieve truly integrated systems throughout the Commonwealth, specifications and standards will be critical. ATSD will work to ensure that IVHS projects meet national standards and conform to strict statewide specifications. As Virginia PROGRESS matures, this function will take on greater significance.

Planning

The deployment of well integrated IVHS will require a comprehensive planning effort. Different elements of critical components such as communication systems and management systems must be deployed in a well planned order. ATSD will be responsible for IVHS project planning to ensure that IVHS is deployed in the proper manner.

In addition, IVHS must be considered as a viable alternative to other, more traditional, transportation improvements. Therefore, ATSD must work very closely with the Transportation Planning Division to provide technical support.

Maintenance and Operations

Once deployed, IVHS will be distinctly different from other transportation facilities. Systems must be actively operated in order to achieve any benefit. In addition, the maintenance needs are different from traditional maintenance within VDOT. ATSD will actively monitor and evaluate the system's operation to develop standard procedures and operating principles. In addition, the division will support system maintenance in areas such as electronic systems, communication systems, and software.

District personnel will be directly responsible for the system's operation and maintenance. It will be critical to ensure that district personnel possess the necessary IVHS knowledge, skills, and abilities. Furthermore, it will be important for ATSD to have a close relationship with the districts to provide strong support in IVHS activities.

Administrative Functions

All administrative functions necessary for Virginia PROGRESS will be the responsibility of ATSD. For example, ATSD will develop contracts with other organizations, such as universities, to conduct IVHS research. Furthermore, the division will be responsible for overseeing federal funds for IVHS research and development.

Other administrative duties include maintaining memberships with important organizations such as IVHS America and responding to inquiries about Virginia PROGRESS.

Finally, staffing will be a critical concern of ATSD. As stated earlier, ATSD will require a staff with knowledge, skills, and abilities new to the Department. Training programs will be developed to allow present personnel to learn about IVHS technologies. It will also be critical to recruit new personnel, particularly in the following areas:

- Transportation Systems Engineering
- Electrical/Electronic Engineering
- Communication Systems Engineering
- Computer Science.

Virginia Transportation Research Council

The Virginia Transportation Research Council (VTRC) will have primary responsibility for IVHS research and development. The position of IVHS Research and Development Coordinator will be established at VTRC to manage this activity. The coordinator will identify IVHS development opportunities and define projects to meet the research and development objectives of the Strategic Plan. Furthermore, the IVHS Research and Development Coordinator will work with national organizations, such as IVHS America, to represent the Department in national development efforts.

Virginia PROGRESS has access to a number of high-quality resources for IVHS research and development. First, staff at VTRC are currently involved in a variety of IVHS research projects, and it is expected that this involvement will grow. The Transportation Safety Team and the Socioeconomic and Transportation Systems Team will both be involved in IVHS. Furthermore, many of Virginia's public universities are active in IVHS research and development, including Virginia Tech, the University of Virginia, and George Mason University. The IVHS Research and Development Coordinator will work to utilize these resources fully in Virginia PROGRESS.

Another valuable resource for Virginia PROGRESS is the Virginia Technology Transfer (T^2) Center. The IVHS Research and Development Coordinator will work with the T^2 Center to develop IVHS training programs for the Department. In keeping with the Center's practice, resources from VTRC, the Department as a whole, and Virginia state universities will be used to develop courses in different aspects of IVHS.

VDOT IVHS Steering Committee

A VDOT IVHS Steering Committee will be formed to serve as the policy body for Virginia PROGRESS. The committee will be chaired by the Assistant Commissioner for Operations and will include the ATSD Administrator, the IVHS Research and Development Coordinator, and key top-level personnel from other VDOT divisions and the Federal Highway Administration. The IVHS Steering Committee will approve IVHS projects for the six-year plan, operational tests, and research projects. In addition, the committee will monitor Virginia PROGRESS and take steps to modify the program if needed.

Although the IVHS Steering Committee is the formal mechanism for cooperation within VDOT on Virginia PROGRESS, it is critical that individuals in the Department work together on a "day-to-day" basis in order to achieve success. For example, personnel in ATSD need to work closely with VTRC to exchange ideas on a regular basis.

IVHS Virginia

VDOT alone cannot achieve success in Virginia PROGRESS. In fact, it is widely accepted that the success of IVHS depends upon the development of strong public-private partnerships. For example, the Intelligent Vehicle-Highway Society of America (IVHS America) has been established on a national level to foster such partnerships. IVHS America is proving to be quite successful in guiding IVHS development in the United States.

The focal point in Virginia PROGRESS for developing IVHS partnerships is the formation of the Intelligent Vehicle-Highway Society of Virginia (IVHS Virginia). Membership in IVHS Virginia will be available to all state agencies, local agencies, academic organizations, private companies, public transportation agencies, and other interested organizations. A committee structure similar to IVHS America's will be developed to allow IVHS Virginia to produce substantive results. Finally, IVHS Virginia will be a utilized advisory organization to VDOT.

Figure 1 portrays the overall IVHS organizational structure discussed in this section.

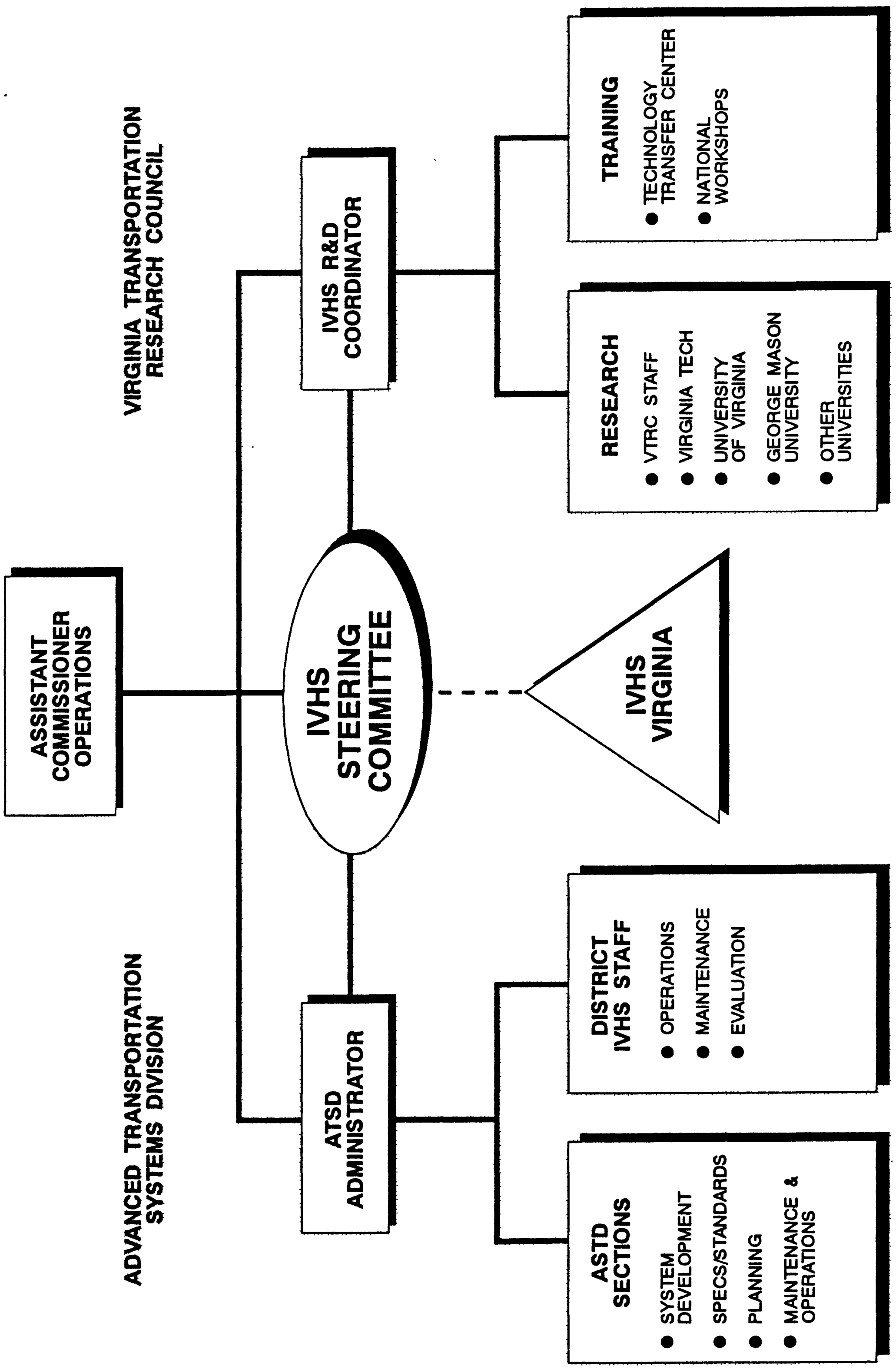

Figure 1. VDOT IVHS Organizational Structure

IVHS FUNDING

The continuous development and deployment of IVHS within the Commonwealth of Virginia will require substantial funding. Virginia PROGRESS will utilize a variety of resources to secure these funds. The program will make every effort to develop public-private partnerships in order to access more resources.

A critical element of Virginia PROGRESS will be to include IVHS deployment within VDOT's standard project programming framework, the 6-year plan. This will involve the IVHS Steering Committee identifying critical deployment projects and bringing them to the attention of the Programming and Scheduling Division, the Commonwealth Transportation Commissioner, and the Commonwealth Transportation Board. To ensure the success of IVHS, deployment must be considered comparable to any other highway construction project.

Virginia PROGRESS will seek to utilize all sources of federal IVHS funding. The 1991 ISTEA legislation initiated a substantial national IVHS development effort. IVHS development funding is available in a number of programs. First, Virginia is fortunate in that the I-95 corridor from Washington, D.C., to Richmond is part of the federally recognized I-95 priority corridor. Operational tests within this corridor will receive priority in obtaining federal funds through the Corridors Program. In addition, VDOT will seek funds for operational tests in other regions of the Commonwealth through the standard Operational Tests Program. Finally, VDOT will take advantage of the early deployment funding available to plan IVHS in urban areas.

All of these federal IVHS programs *require* matching funds from VDOT. Therefore, the Department must be in a position to match federal funds in order to even compete for funding. Given the fast-paced, competitive environment of IVHS, VDOT must be able to respond quickly to opportunities to join partnerships competing for federal funds. A significant element of this is the ability to quickly commit matching funds. Therefore, there is a need to establish a VDOT IVHS project fund.

Furthermore, an IVHS project fund is needed to support VDOT's involvement with national IVHS organizations. In order to participate actively in the national IVHS development effort, VDOT must maintain membership in organizations such as IVHS America and the I-95 Priority Corridor Coalition. Generally, organizations such as these require substantial yearly membership fees. Again, an IVHS project fund will be used to cover these fees.

In addition, Virginia PROGRESS will not be fully successful without some level of state sponsored development. For example, some projects may be of high priority to the Department, but of low interest to the U.S. Department of Transportation. In order to pursue such projects, VDOT must provide full funding. Again, the IVHS project fund will give VDOT the flexibility to pursue such projects.

Finally, given the reality of the congressional appropriations process, VDOT must work to promote Virginia PROGRESS to Virginia's representatives in the United States Congress. The representatives' interest in the program, particularly in key projects, will help to ensure adequate federal support.

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