National Automated Highway System Consortium

Formation

The National Automated Highway System Consortium (NAHSC) was formed in response to a U.S. Department of Transportation (USDOT) request for applications to conduct systems design, feasibility, definition, demonstrations and prototyping of a safe, reliable, cost-effective automated highway system (AHS), capable of substantially improving vehicle throughput, safety and air quality along high-demand urban and rural traffic corridors. The NAHSC represents a unique public-private partnership among governments, industry and academic leaders — all working to develop a prototype automated highway system to enhance transportation in the United States.

Mission Statement

NAHSC's mission is to specify, develop and demonstrate a prototype automated highway system by the year 2002. The prototype AHS will provide fully automated vehicle operation on highway lanes to make travel safer and more efficient, improve the mobility of people and goods, increase the productivity of surface transportation and contribute to a better quality of life. It will facilitate intermodal travel while accommodating transit, commercial and private vehicles, and contribute to a better environment. The NAHSC is committed to achieving a national consensus on major AHS decisions by engaging public and private stakeholders in the definition, development and evaluation of an automated highway system that is technically, economically and socially viable.

NAHSC Core Participants

- Bechtel
- California Department of Transportation (Caltrans)
- Carnegie Mellon University
- Delco Electronics
- General Motors
- Hughes
- Lockheed Martin
- Parsons Brinckerhoff
- University of California Partners for Advanced Transit and Highways (PATH) Program
- U.S. Department of Transportation's Federal Highway Administration

Associate Participants

There are more than 100 Associate Participants to date. These participants enhance the breadth of the Consortium by providing their expertise.

Goals

The NAHSC will define, demonstrate and develop a prototype AHS. During this process, NAHSC will seek national consensus on AHS design and deployment, incorporating stakeholder feedback so the "best" plan — the one that offers the greatest measure of benefits for the greatest number of people, with a minimum of investment dollars spent — will result.

Vision

AHS is the next major upgrade to the nation's transportation system. The AHS vision includes increased efficiency and better utilization of existing transportation infrastructure through automation. Highway transportation systems can be viewed as arteries through which the lifeblood of a nation flows. Similarly, America's economic prosperity can be viewed as an intricate tapestry largely woven around a network of interstate arteries completed during the last half of this century. Increased traffic demand now routinely causes severe congestion along many of these vital urban routes. The resulting congestion reduces safety and affects air quality. These conditions are expected to worsen unless substantial improvement is made in the nation's surface transportation system.

Program Milestones

- establishment of performance and design objectives
- The National AHS Consortium Technical Feasibility Demonstration
- identification and description of feasible AHS concepts
- selection of the preferred AHS configuration
- completion of prototype testing
- completion of both system and supporting documentation

Completion Date

The projected date for the AHS prototype completion is 2002.

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Automated Highway System Projected Benefits

The promise of automated highway system technologies to automatically operate a vehicle's steering, braking and speed in coordination with the roadway will allow the traveler to spend travel time more productively or leisurely. This revolutionary program offers a multitude of benefits:

Economic

- provides favorable return on investment for state and regional transportation agencies compared to transportation alternatives
- improves productivity of commercial users "just-in-time" delivery, enhancing competitiveness and growth
- enhances the use of freight vehicles
- reduces need for new construction
- improves vehicle efficiency, and facilitates intermodal and multimodal movements
- enables transit to become more cost and time competitive to other modes of transportation
- reduces insurance rates due to reduced number/severity of crashes
- reduces need for law enforcement funding required to deter speeding and unsafe driving
- improves fuel economy

Environmental

- reduces emissions and fossil fuel consumption (per vehicle kilometer traveled)
- improves air quality in support of community air pollution policies
- reduces congested interstate, urban and intercity highways
- reduces congestion without devoting more land to highways
- enhances operation of alternative vehicle propulsion systems

Social and Institutional

- improves and predicts transit trip times and travel efficiency
- provides for a smoother flow of traffic and possible higher speeds to increase the throughput of highways
- reduces driver related stress and fatigue caused by congested and long distance commutes
- enhances driving abilities (e.g., elderly, handicapped, inexperienced drivers, enforcement and emergency services)
- supports sustainable transportation policies
- supports diverse interstate, intercity, urban, suburban, and rural roadways
- contains user friendly displays, controls, and operations
- allows users to have more leisure time pursuits

Technical

- integrates advanced GPS, adaptive cruise control, collision avoidance, and object detection features
- supports wide range of vehicle types
- incorporates fail-soft and fail-safe designs to manage any faults, safeguarding against system failure
- supports travel demand management and travel system management policies

Safety

- improves driving abilities during inclement weather
- responds to intrusions by animals, pedestrians and vehicles
- reduces driver errors and incidents
- provides complete analysis of vehicle system status
- reduces the frequency of collisions
- avoids collisions in the absence of operator, or in case of any vehicle or AHS malfunctions
- reduces vehicle crashes (per highway kilometer) by as much as 50 to 80 percent
- reduces accidents on non-AHS roadways through the use of AHS-enabling technology (e.g., collision warning and avoidance and intelligent cruise control)
- reduces fatal and major injury crashes by at least one half the current rate
- prevents unauthorized access and interference
- reduces driver errors caused by fatigue, inattentiveness, drowsiness and delayed reaction times

Mobility

- reduces congestion and travel trip times
- accurately predicts travel times
- ensures on-time performance
- allows vehicles to operate at higher average speeds safely
- increases throughput
- enhances mobility of vehicle users with special needs

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The Technical Feasibility Demonstration

The National AHS Consortium Technical Feasibility Demonstration includes a full-scale, multi-vehicle highway demonstration of automated highway system (AHS) technologies and an exposition center. The AHS lanes and the vehicles that operate on them will have special sensors, computers and communications devices to enable automated control.

When and Where

The National AHS Consortium Technical Feasibility Demonstration is planned for August 1997 in the express lanes on Interstate 15 in San Diego, California. The exposition will be held at Miramar Community College, also in San Diego.

Project Team

The National AHS Consortium Technical Feasibility Demonstration project team is comprised of the NAHSC Core Participants, other stakeholders and special interest representatives.

Contact

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Goal

The National AHS Consortium Technical Feasibility Demonstration will reveal that the necessary technologies either exist or are in development, and that an automated highway system will be a viable alternative in meeting travel demands and enhancing mobility.

Demonstration Summary

The National AHS Consortium Technical Feasibility Demonstration will contain applications of technologies, systems and subsystems that will be building blocks leading to a full AHS prototype. The demonstration will be conducted using contemporary cars, buses and light trucks on a segment of real roadway, employing currently available and emerging automated vehicle technologies and concepts.

Exposition Summary

The Exposition Center will feature stand-alone demonstrations of systems and technology applications, vehicles, equipment displays, computer simulations, small-scale demonstrations, presentations and literature.

Demonstration Test Facility

The Demonstration will take place on a 7.6-mile segment of I-15 that has two operational reversible highway lanes. A total of 92,778 guidance magnets will be installed on I-15 for the Demonstration.

Demonstration Scenarios

Free-Agent Check-in Evaluation

The scenario will start with four Buick passenger sedan vehicles in the south yard. Each vehicle will be manually driven from the staging area onto the entrance ramp and pass through a check-in station that verifies each vehicle's mechanical soundness and equipment status. The sedan without passengers will be redirected to the manual lanes.

Free-Agent Checkout Evaluation

At the south end of the lanes, one of the vehicles will exit the Highway 163 off-ramp and be subjected to a driver checkout evaluation.

Free-Agent Exit Evaluation

The driver will pass the test prior to returning to manual control. The other two vehicles will return to manual control and exit the left ramp toward the south yard.

Platooning Entry Evaluation

Ten Buick full-size, four-door sedans will drive north on the entrance ramp under manual control, enter the right express lane of I-15 and transfer to automated control.

Platooning Lateral and Longitudinal Control Evaluation

Platoon vehicles will proceed along the lanes where an additional vehicle will catch up and join the back of the platoon. At the north end, the vehicles will return to manual control, stop, turn around, and regroup. Once repositioned heading south, they will accelerate in unison, transfer back to fully automated control, and return to the entrance point.

Maintenance and Construction

The maintenance vehicle will travel north and south on the lanes, verifying the presence of functioning magnetic markers. A faulty or missing marker will be part of the script. The van will identify the location of the marker, notify the observing passengers on-board and relay the information to the Traffic Management Center at the Exposition Center. While a free agent demonstration is in progress, a manually-operated vehicle will enter a different segment of the express lanes where a crew will "place" an obstacle. The free agent vehicle(s) will detect it and notify the TMC while the avoidance maneuver is in progress. The obstacle removal vehicle will be dispatched to the obstacle immediately from a convenient staging point. It will retrieve the obstacle and exit.

Automated Highway System Technical Information

Objective

The automated highway system (AHS) will reduce congestion by using existing highways more effectively. A specially equipped AHS lane can double or triple the flow rate (in vehicles per hour) of a manual lane, even in adverse weather conditions. The increased flow rate is possible because the AHS promises to: provide uniform driving performance by eliminating the accordion effect of acceleration, decceleration and weaving typical on today's highways; eliminate traffic flow variances caused by human distractions; safely increase traffic density in the lane because of the tighter operating tolerances possible with fully automated control; and manage entries and exits so that AHS lanes maintain optimum speed and spacing in heavy traffic.

System Operations

To travel on an AHS, a driver of an AHS-equipped vehicle will pull into special, designated lanes — perhaps similar to some of today's high occupancy vehicle express lanes — at which point control of the vehicle's movement will be assumed by the system. Control of the vehicle's braking system will ensure the vehicle remains a safe distance from the AHS vehicle in front, and control of the vehicle's steering will ensure that the vehicle remains in its lane. When the vehicle reaches the exit selected by the driver, it will be moved into a transition area where the driver will resume control and continue driving on the trip. AHS lanes and the vehicles that operate on them will need special equipment. Systems will need to control spacing between vehicles and keep vehicles within the lane boundaries. The vehicles will be equipped with sensors, computers and communications devices to be able to sense and maneuver around obstacles in time to avoid them and to communicate and exchange information with other intelligent transportation systems (ITS) services.

Changes to Existing Highways

Adding an AHS lane to existing highway rights-of-way should be easier and less costly than constructing new highways. In several areas of the country, converting an existing lane to AHS could mean:

- adding roadside electronics
- inserting markers in the pavement to electronically mark the lane
- adding some separators and shoulders to ensure safe AHS operation
- adding entries and exits to the lane

AHS Phases

The U.S. Department of Transportation's (USDOT's) AHS Program, part of the broader intelligent transportation systems (ITS) Program, is structured in the following three phases.

Analysis Phase Systems Development

The analysis phase occurred from 1993 to 1994 and provided:

- Precursor Systems Analyses by 15 contractor teams in 16 areas of analysis addressing AHS requirements and issues
- AHS human factors design handbook
- collision avoidance analyses necessary to investigate avoidance-oriented vehicle warning and control services that may evolve into an automated highway system

Systems Definition Phase

The National Automated Highway System Consortium is currently carrying out the second phase until 2002. This phase will determine and demonstrate the feasibility of an automated highway system and select and test a prototype system for future deployment.

Operational Test and Evaluation Phase

The final phase will continue from 2002 until approximately 2007 and will include:

- integrating the preferred AHS system configuration into the existing institutional, technological and regulatory environment
- evaluating this configuration in a number of operational settings
- establishing guidelines by which USDOT will support AHS deployment

Highlights of the Kickoff Event

National Automated Highway System Consortium Demonstration '97

On June 28, 1996, the transformation of the I-15 High-Occupancy Vehicle (HOV) lanes into the nation's first demonstration of Automated Highway System (AHS) technologies began with a kickoff ceremony in San Diego. The Automated Highway System, technology that enables cars to drive themselves, is a visionary concept that promises to revolutionize transportation as we know it today.

"Buick's XP2000 concept car includes a conceptual guidance system that would allow the car to travel at high speed locked on sensors buried in the road. Today we're headed from concept to reality."

Edward R. Mertz
General Manager, Buick Motor Division

"Advanced transportation technologies, applied correctly, can enhance the personal mobility that Californians value so highly."

Robert H. Nida
Vice President,
General Counsel
Automobile Club of California

"The AHS is a cost-effective solution focused on existing infrastructure."

Julie A. Cirillo
Regional Administrator, FHWA

"Caltrans will spend the next year readying the express lanes for the test."

Gary Gallegos
Director, Caltrans

"These advancements potentially promise to make the driving experience safe, easier, more convenient and less time consuming."

Jan Goldsmith
Assemblyman,
State of California

"The average human takes half a second or more to react to (conditions on the road). Sensors can react in milliseconds."

William Stevens
Technical Director, NAHSC

"Ninety percent of crashes are caused by human error... inattentiveness, under the influence, or other factors."

Bill Gouse
Parsons Brinckerhoff/PB Farradyne Inc.

"This would allow us to drive well beyond the capabilities of the car and driver. [The cars] are in a ballet together. They're synchronized."

Will Recker
UC Irvine, Transportation Expert

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Demonstrations
Concepts
Societal & Institutional Issues
Tools
Stakeholder Relations
Technologies
Prototype
NAHSC Task Team Responsibilities

National Automated Highway System Consortium

"The AHS is no longer a fantastic device for futurists, dreamers and science fiction writers. The technology exists and we will see it in action...."

--Public Roads, 1994.

...the Future of Transportation

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Prototype: Preparing a Glimpse of the Future of Transportation

In 2002, America will glimpse the future of transportation. The world's first prototype AHS will be constructed based on all of the foregoing work of the AHS program.

The prototype will be based on concluding activities of the Concepts task. The role of the Prototype Task Team will be to create all elements of the chosen AHS concept, including hardware, software and infrastructure. These elements will be integrated into a complete functioning system utilizing a fleet of 25 test vehicles. The prototype will allow for a thorough evaluation of the chosen AHS concept, functioning in all types of weather and test conditions.

To make the prototype AHS happen, the Prototype Task Team will tackle a number of difficult activities including: development of control algorithms; preparation of the roadway and embedded instruments; development of software components; procurement of required electronic components for vehicles; integration of vehicles with infrastructure; preparation of a test plan; and prototype testing and evaluation.

All of these activities will occur with maximum involvement of stakeholders through workshops and public forums. The prototype will be a highly publicized event designed to pave the way for operational testing of an AHS.

Technologies: Compiling a Symphony of Advanced Applications

The automated highway system (AHS) will feature existing technologies in diverse fields, working in concert to create a fully integrated system for moving vehicles.

An initial step in creating this system is to determine those "enabling" technologies that will become components of the system. Technologies in areas such as sensors, guidance systems, traffic control software, vehicle electronics, communications and a host of others will mesh in a prototype automated highway system.

The purpose of this task is to get an early start on honing those technologies that will support a range of AHS system concepts. Accordingly, technology assessment is conducted in parallel with development of AHS concepts and specifications. In essence, this task is a bridge between conceptual design and the practical application of that design. The work of the Technologies Task Team will position the NAHSC to physically build selected concepts, the National AHS Consortium Technical Feasibility Demonstration, and the 2002 Prototype.

Specifically, the role of this task is to review and assess the state of the art in each technology area necessary to develop a functioning system. The technologies that most closely fit with AHS system requirements are selected, and a plan for further development and tailoring of those technologies is prepared. Following this plan, technologies critical to AHS will be either custom-designed or procured.

Demonstrations
Concepts
Societal & Institutional Issues
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Stakeholder Relations

Stakeholder Relations and Public Affairs: Bringing Everyone to the Table

The Stakeholder Relations and Public Affairs Task Team offers the general public and transportation stakeholders the unique opportunity to discuss and relay comments, issues, and concerns to the NAHSC table of decision-makers. Accordingly, to the NAHSC, creating public awareness and achieving national consensus for the AHS Program is justifiably as important as AHS is to the efficiency and safety of future transportation. Therefore, the SRPA Task Team actively works within the AHS program and throughout the transportation community to ensure every necessary communication and distribution channel is formed and nurtured to its fullest potential.

Over the life of the AHS program, the SRPA Task Team will use channeled information to prepare internal and external communication materials, quarterly updates, stakeholder relations information, public affairs information, NAHSC summary and progress reports, and will coordinate focus groups, workshops, and forums. Specifically, the SRPA Task Team is an extension of the AHS program to the general public, and creates bridges among transportation stakeholders to the Technologies, Tools, Concepts, S&I, Demonstration, and Prototype Task Teams. As a result, the SRPA Task Team ensures the AHS program will not be directed by core participants alone, but by hundreds of organizations and companies working together toward the efficiency and safety of future transportation.

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Tools: Building the "House of AHS"

Like any new project in the building environment, builders of the automated highway system (AHS) will utilize a number of tools in constructing the infrastructure or "house" of AHS.

Building the house of AHS requires facilities, vehicles, and tools to conduct analysis and simulation. These tools will support design and evaluation of alternative system concepts. Among the key issues to address in conducting this evaluation are: operations and maintenance; liability and legal issues; human interface with an automated system; and environmental concerns.

Initially, the Tools Task Team will determine which tools already exist and are available for use by the NAHSC, and which tools are not available and therefore must be created under the auspices of the NAHSC. The tools will then be acquired or developed, as appropriate.

To accomplish this, the Tools Task Team will monitor public- and private-sector research and development programs, as well as commercially available analytical software and methodologies. In addition, this team will identify facilities to meet a variety of special needs throughout the life of the AHS program. Facilities decisions will include site surveys, cost/benefit analysis and lease/buy analysis, with an objective of efficiently managing program resources. Finally, the Tools Task Team will determine which vehicles to use in the program's numerous test scenarios. This will be accomplished by matching test purposes and information needs to vehicle models that will most easily meet those purposes and yield information.

Societal and Institutional Issues: Ensuring AHS Technology is Planned for "Real World" Use

The value of fundamental changes and advancements, whether introduced via government program or private-sector undertaking, is measured by a simple, common yardstick: does the change or advancement benefit society?

Understanding this, the NAHSC pays special attention to the impact of societal and institutional issues on the AHS program. The Societal and Institutional Task Team addresses desires, risks and concerns of the full range of AHS stakeholders. Many of these issues were identified during a series of precursor studies prior to initiation of the AHS program. Some require additional study and research. This task team is charged with infusing every level of AHS planning, design and development with a sensitivity and responsiveness to societal and institutional issues.

Specifically, this task team has provided an inventory of key S&I issues and has developed a set of S&I benefits criteria for system concepts. The team now works with each of the AHS program tasks to integrate responses to S&I issues, and provides ongoing monitoring and feedback regarding newly emerging issues and developments with existing issues.

Environmental concerns are a good example of a key S&I issue. Through the work of the S&I Task Team, the NAHSC understands that, for AHS to be widely accepted, it must demonstrate positive environmental impacts. Accordingly, criteria have been created for AHS system concepts to reduce amounts of air and noise pollution as compared to a conventional highway. The Technologies, Tools, Concepts and Demonstration Task Teams are working to address these very important environmental concerns.

Through the work of the S&I Task Team, the AHS program is kept on target to reach one simple measure of success: AHS will benefit society.

Concepts: Providing a Launching Pad of Ideas

The journey into the future of transportation begins from a launching pad of ideas. For the AHS program, these ideas come in the form of various system concepts.

In a nutshell, an AHS system concept broadly describes how the system will function. While there is a shared vision of the attributes and benefits of an AHS, there are many schools of thought on how to structure an AHS to achieve those attributes and benefits. The role of the Concepts Task Team is to more clearly define the scope of system concepts, and to select for further action those with the highest probability of success.

The work of this task team is presented to stakeholders for further refinement through a series of workshops that introduce a range of potential system configurations. The additional insights gained at the workshops aid in selecting promising concepts for further development, then developing, testing and analyzing results in a laboratory setting.

Specifically, the work of this team involves evaluating concepts against established AHS requirements and criteria. A system description document is prepared for each concept, then presented in a workshop format. With significant input from all AHS stakeholders, the three best concepts are chosen. Each of these concepts will then be developed, evaluated and tested. This does not entail actual construction of a concept test-track. Rather, the process is one of conceptual planning, detailed design, review, then simulations and analysis to compare expected performance to AHS system criteria. Finally, a deployment plan is prepared for each concept. After design and development of the three alternative concepts is completed, they will each undergo intensive evaluation studies.

Building on the knowledge gained from design, analysis and experimental work, a single AHS concept will be selected for intensive development and testing. This could be one of the three alternative concepts, or the synthesis of two or all three concepts. A system description and supporting documents will be prepared that will guide prototype activity. Completion of this task is a major milestone in the AHS program.

Demonstration: Proving AHS Works

In August 1997, a "live-track" demonstration near San Diego will show that the dream of an automated highway system (AHS) can be made a practical reality. Dubbed The National AHS Consortium Technical Feasibility Demonstration, this public and media event will prove the technical feasibility of the AHS concept.

The National AHS Consortium Technical Feasibility Demonstration will show that the necessary technologies either exist or are in development, and that an automated highway system (AHS) will be a viable alternative in meeting travel demands and enhancing mobility. Activities include live vehicle demonstrations on a 7.6 mile stretch of express lanes on I-15 near San Diego, an exposition located in a conference center and nearby Miramar Community College, in-vehicle rides for selected individuals, and viewing stands to accommodate 200 people per day in strategic locations. The exposition contains stand-alone demonstrations of individual systems and technology applications, equipment displays, computer simulations and literature. While the demonstration and exposition will not directly represent the AHS prototype to be completed in 2002, it will contain applications of technologies, systems and subsystems that will be building blocks leading to a full AHS prototype.

The National AHS Consortium Technical Feasibility Demonstration will feature several scenarios through which the feasibility and practicality of AHS can be evaluated. Individual or "free agent" passenger vehicles will "check in," "check out" and "exit" the automated systems. Free agent vehicles will demonstrate obstacle detection as they move through the automated system. A platoon of several vehicles will undergo an "entry" scenario, then lateral and longitudinal control will be evaluated as they move through the system. Finally, a "maintenance and construction" scenario will be enacted wherein an AHS maintenance vehicle verifies system function and detects breakdowns.

Specific functions of the Demonstration Task Team include: identifying demonstration and exposition content and preparing a plan for conducting the demonstration; functional testing of all systems and subsystems to be demonstrated; marketing of The National AHS Consortium Technical Feasibility Demonstration, including public and media relations; and finalizing the execution and documentation of the event itself. In addition, this task team is responsible for preparing related exhibits and demonstrations.