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# Advanced Vehicle Collision Safety Systems

***What is the Problem?***

The human loss in traffic crashes is tragic. More than six million motor vehicle collisions occur on the Nation's highways every year, causing approximately 5.2 million injuries and more than 41,000 fatalities, and costing more than $150 billion per year. Approximately three-quarters of these collisions could be prevented if the driver's attention had not been diverted moments before collision. These numbers are unacceptably high.

***What is the Technology Match?***

For several years, the National Highway Traffic Safety Administration has sought to reduce highway accidents through effective and practical in-vehicle electronic driver aids and warning systems. The national ITS program has strengthened the support base for focused research into why collisions occur and how the development of intelligent technologies will prevent them. Dramatic advances in sensing devices and computational power now offer a real possibility to develop in-vehicle systems that can alert drivers to hazardous situations and impending collisions, and could even take temporary control of the vehicle to avoid a collision. Other innovations could monitor the driver's physiological condition, improve the driver's effective vision or otherwise alert the operator to potential hazards.

***What is the Proven Benefit?***

NHTSA estimates that 1.1 million or 17 % crashes could be prevented annually if all vehicles were equipped with just three of the primary ITS crash avoidance systems -- rear-end, roadway departure, and lane change/merge. By avoiding more than a million accidents, these systems could save thousands of lives and $23 billion per year. Specific benefits are outlined in Attachment A -- Benefits Chart

***What is the Federal Program?***

NHTSA's advanced collision avoidance and vehicle safety systems program seeks to deepen understanding of the causes of collisions, identify and evaluate potential solutions, and work in partnership with industry to facilitate the development and deployment of effective collision avoidance products. This approach translates into a five-prong program: (1) Research Tools and Knowledge Base; (2) Identify Promising Crash Avoidance Opportunities; (3) Demonstrate Proof-of-Concept; (4) Facilitating Commercial Development; (5) Accessing the Safety of Other ITS Systems. For detailed descriptions of each of these areas see Attachment B: Advanced Vehicle Collision Safety Systems --Five Prong Program.

In addition, the program's research efforts (administered by NHTSA) are focused on: (1) collision avoidance systems; (2) automatic collision notification systems; (3) vision enhancement systems; (4) driver performance monitoring systems; and (5) research tools and knowledge base. For detailed descriptions of each of these areas see Attachment C: Advanced Crash Avoidance Research.

### *Long- Term Vision*

Collision avoidance systems are a near-term reality with the continued application of knowledge and tools to assess their effectiveness, acceptability, and commercial viability. Although much of the technology is not readily available to the buying public, the next phase of the program aims to make effective systems available to car buyers as standard or optional equipment. As a result, the program will focus on overcoming technical challenges through field tests and other activities.

The program also expects to'expand its focus from single crash avoidance technologies to integrating and combining elements of crash avoidance with broader ITS applications and the wider intelligent transportation infrastructure.

### *For More Information*

Contact: Ray Resendes, Program Manager, 202-366-2182
Dr. Joe Kanianthra, NHTSA, 202-366-5672

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**Attachment A -- Benefits Chart**

| Advanced Crash Avoidance Program/Element | Benefits |
|---|---|
| Rear-end Crash Avoidance Systems | • **ITS countermeasures could address over 1.5 million of the 1.7 million rear-end crashes that occur annually. NHTSA estimates that ITS driver warning systems would be effective in 49% of the rear end crashes, which would prevent 759,000 crashes annually.** |
| Road Departure Collision Avoidance Systems | • **ITS countermeasures apply to about 458,000 of the 1.2 million roadway departure crashes that occur annually. With an overall effectiveness of 65%, the systems could prevent 296,000 crashes annually.** |
| Lane Change/Merge Crash Avoidance Systems | • **ITS countermeasures apply to 192,000 of the approximately 200,000 lane change/merge crashes per year. The estimated effectiveness of the system is about 20% which could prevent about 39,000 accidents per year.** |
| Automatic Collision Notification Systems | • **Tests of on-board crash notification systems, simulated emergency calls have shown a decrease in time for medical help to arrive from 14 minutes to 8 minutes for urban crashes and from 21 minutes for out-of-town crashes. The 43% drop in response time corresponds to a 12% increase in the change of survival for an occupant involved in the crash. U.S. response times for fatal accidents average 10.1 minutes in urban areas and 19.6 minutes in rural areas.** |

**Attachment B:**
**Advanced Vehicle Collision Safety System**
**Five Prong Program**

| Program Prong | Program Scope |
|---|---|
| **Prong 1: Research Tools and Knowledge Base** | The design of ITS crash avoidance systems requires a greatly enhanced and detailed understanding of how individuals drive and the characteristics and causes of accidents. As a result, NHTSA has developed a crash avoidance knowledge database of the major causes of crashes and pre-crash factors from real-world cases. In addition, NHTSA has created a portable on-board vehicle data gathering system -- the Data Acquisition System for Crash Avoidance (DASCAR) -- that can monitor and record vehicle performance and the driver's physical reactions. |
| **Prong 2: Identify Promising Crash Avoidance Opportunities** | Using its knowledge database, NHTSA has determined the factors that precede specific types of accidents. This understanding is being used to develop performance specifications for collision avoidance systems and to determine the benefits of deployed collision avoidance countermeasures. |
| **Prong 3: Demonstrate Proof-of-Concept** | A key program role is to demonstrate that advanced technology can practicably enhance the crash avoidance performance of motor vehicles. NHTSA's program includes the development of performance guidelines for crash avoidance technologies and field testing of prototypes This work builds upon the statistical and casual hardware and human factors needed to ensure that crash avoidance systems are safe and perform as required. The program has developed preliminary performance standards required for rear-end, road-departure, and land change/merge collision avoidance systems. In addition, the program has begun four operational field tests of intelligent cruise control and automated collision notification systems. |
| **Prong 4: Facilitating Commercial Development** | The ultimate objective of the crash avoidance program is to help the industry develop safe and effective products. Six cooperative agreements are now in place with industry for development and testing of systems addressing crash avoidance, applications to heavy commercial vehicles, lane-occupancy detection, and intelligent cruise control. |
| **Prong 5: Accessing the Safety of Other ITS Systems** | Other in-vehicle advanced transportation systems -- such as in-vehicle en-route guidance and information systems -- are coming on the market. NHTSA, working cooperatively with FHWA, is evaluating these systems to ensure that they are safe and do not distract the driver or overload the driver with information. |

**Attachment C:**
**Advanced Crash Avoidance Research Program**

The Advanced Crash Avoidance Research Program focuses on development of the following tools and systems:

- **Rear-end collision avoidance systems:** These systems are primarily located on-vehicle, but could also be enhanced by equipment in the roadside or other vehicles, to prevent or decrease the severity of rear-end crashes.
- **Road-departure collision avoidance systems:** These sensor technologies could detect roadway or lane boundaries to keep vehicles from straying off the road. The systems alert the driver of the need for corrective actions.
- **Lane change/merge collision avoidance systems:** These systems assist drivers in safely carrying out lane change, merging, and back maneuvers.
- **Intersection collision avoidance systems:** These systems are aimed at avoiding collisions at intersections and could be a combination of in-vehicle systems, infrastructure-based, or hybrid vehicle/infrastructure systems.
- **Heavy vehicle collision avoidance systems:** These systems embrace a number of objectives, including a drowsy driver monitor, stabilizing heavy vehicles, collision warning, and improved braking performance.
- **Automatic collision notification systems:** As collisions occur, these systems would automatically notify emergency medical services of the occurrence and location of the collision reducing the time between an accident and the arrival of life-saving support.
- **Vision enhancement systems:** These motor vehicle-based systems could help drivers avoid collisions with other vehicles, pedestrians, and other objects on the road due to reduced visibility conditions (e.g., at night and during inclement weather).
- **Driver performance monitoring:** These vehicle-based devices would unobtrusively monitor driver performance and would alert the driver.
- **Research Tools and Knowledge Base.** NHTSA has developed an advanced driving simulator, called the National Advanced Driving Simulator (NADS), which will allow risk-free controlled studies of operator behavior in crash-imminent situations; it is expected to be completed by 1999. Other key tools being developed include a measurement systems to quantity the movement of vehicles in real traffic -- called the System for Assessing the Vehicle Motion Environment (SAVME) -- and a test vehicle with computer control of throttle, brake and steering -- the Variable-Dynamics Test Vehicle -- that can determine how drivers will react to various proposed ITS crash avoidance designs. NIITSA is also conducting studies of driver workload, special needs of older drivers, human interaction with crash warning systems to provide information necessary to develop safety performance guidelines.

# Advanced Rural Transportation Systems (ARTS)

***What is the Problem?***

Rural areas have significantly different transportation needs than urban area. Although less than 40 percent of annual vehicle-miles traveled is on rural roads, these roads account for about 60 percent of all traffic fatalities because of comparatively slow emergency response.

Furthermore, many rural residents are isolated, without a car or access to public transportation. Presently, 38 percent of rural residents live in areas without any public transit service; another 28 percent live in areas where the level of transit service is negligible. In addition, visitors to rural tourist areas have limited access to directions and other basic travel information.

***What is the Technology Match?***

To advance the strategic application of ITS technologies to address rural transportation issues, the ARTS program has identified seven critical program areas or "clusters." They are: (1) Traveler Safety and Security; (2)Emergency Services; (3) Tourism and Travel Information Services; (4) Public Traveler Services/Public Mobility Services; (5) Infrastructure Operating and Maintenance; (6) Fleet Operating and Maintenance; (7) Commercial Vehicle Operations. Specific action plans for identifying and applying a range of ITS technologies to each cluster are being developed. For some clusters, the technologies being applied are closely related to technologies being used in urban settings; whereas, other clusters require technologies specific to rural settings. Specific technologies and their applications for each cluster are outlined in Attachment A: ARTS Technology Solutions.

***What is the Proven Benefit?***

The rural program is focusing on documenting the benefits of advanced traveler information, collision avoidance, and public transit systems in the rural context. Given the enormous needs of users of rural transportation systems, ARTS services are expected to create significant benefits, such as:

- faster response time to incidents and crashes that will not only save lives, but reduce medical costs
- safety and security systems, in addition to, travel information services that will improve customer satisfaction or "peace of mind
- in-vehicle communications and signing equipment that will improve safety along isolated stretches of road that are prone to hazardous weather conditions
- sensors systems that will provide more accurate, reliable information to travelers and could reduce the occurrence of visibility-related multi-vehicle accidents in rural areas.

- integrated road, traffic, transit, weather, and value-added traveler services that will improve real-time access to information on travel conditions by travelers thereby reducing delays

***What is the Federal Program?***

In 1993, FHWA initiated a comprehensive study of rural applications of advanced traveler information systems (ATIS). The study produced a rural user needs assessment, a technology review, development of rural system concepts, and an activities assessment. Based on this study, the ITS Joint Program Office formed a Rural Action Team in 1995 to develop a vision, strategic plan, and program plan for the ARTS program; the preliminary versions of these were completed in September 1996. Key findings from these efforts are outlined in Attachment B: Key Findings of ARTS Program (1993- 1996).

The program has also launched six operation tests (see Attachment C: ARTS Operational Tests). In addition, the Rural Action Team is assessing the results of other operation tests of systems with rural applications, such as automated collision notification ("Mayday") systems, warnings at rail-highway grade crossing, and demand-responsive paratransit. There are 28 completed or ongoing operational tests which deal with rural issues in ATIS, ATMS, Mayday, and CVO.

In 1997, the ARTS program will focus on developing educational materials and technical assistance tools for implementing rural ITS solutions. Several operational tests will also be conducted to evaluate and test technology solutions and the costs vs. benefits of applying these solutions in a rural setting. See Attachment D: 1997 ARTS Program Plans, which outlines specific 1997 ARTS program plans.

***For More Information***

Contact: Ray Resendes, Program Manager, (202)366-2 182

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**Attachment A:**
**Advanced Rural Transportation Systems**
**Technology Systems Applications**

| Program /Cluster Area | Technology Systems Applications |
|---|---|
| **Traveler Safety and Security** Technologies, such as wide-area nformation dissemination systems containing safety nformation, site specific safety advisories and warnings, and safety surveillance and monitoring, alert drivers to hazardous conditions and dangers. | *Railroad Crossing Warning System* is an active device to warn drivers of an oncoming train at unprotected grade railroad crossings. The train, equipped with a transmitter, sends a signal to vehicles approaching the grade crossing notifying the vehicle driver that a train is approaching.<br>*Vehicle-Based Adaptive Safe Speed System* uses information on vehicle weight, vehicle type, roadway geometry, and road surface conditions to recommend a safe speed. Static and dynamic roadway data will be combined with vehicle data in an on-board processor to compute the safe speed.<br>*Animal Warning System* will emit a high frequency signal or signals, audible to animals but not humans, to alert animals and divert them away from the roadway. The goal of this system is to warn animals which are large enough to cause an accident or damage a vehicle.<br>*Work Zone Delay Advisory System* provides travelers with an active indication that delays actually exist at the work zone. The simplest type of system is a static sign with flashers which can be activated when there are delays. A second type uses speed sensors to determine approximate delay through the work zone and changeable message signs to transmit the information to travelers. A third type uses a passive automatic vehicle identification travel time monitoring system to more accurately determine delay at work zones.<br>*Electronic Flare Warning System* is an in-vehicle device that transmits warning signals of advisory information to surrounding or approaching vehicles. The system is envisioned for use on slow moving construction and maintenance equipment, school buses, and emergency vehicles. The system could be applied to construction sites (e.g., lane closure and flagging operations). The approaching vehicle has an on-board device that receives the signal and issues an appropriate warning to the driver. |
| **Emergency Services** technologies, such as advanced dispatching and vehicle-based response systems, automatically notify emergency response services (ambulances, police, fire) of collisions and other emergencies. | *Mayday Systems* are in-vehicle systems that transmits an emergency "help" signal to an emergency response system. An on-board GPS location device determines the vehicle coordinates and transmits them as part of the mayday signal. Currently, there are two types of mayday systems -- cellular and satellite.<br>*Slow-Scan Video for Emergency Response* to record and transmit a visual record of an accident scene to a dispatch center and associated responder units. Responder vehicles will be equipped with portable video cameras, one-way slow scan communication, and two-way audio communication to the agency dispatch/communications center. The video and audio records transmitted to the dispatch center will enable immediate assessment of conditions to aid in subsequent response agency alerts, actions, and victim trauma control steps. |

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|---|---|
| **Public Traveler Services/Public Mobility Services** improve the efficiency and accessibility of transit services to rural inhabitants. APTS technologies can provide rural operators the benefits of better scheduling capabilities leading to greater operational efficiencies. The technologies used include AVL and improved dispatching, smart card payment/transaction systems, and advanced ride sharing and ride matching systems. | *Transit Fleet Management Systems* use a broad set of ITS technologies e.g., automated vehicle location (AVL), global positioning satellite (GPS), computer-aided dispatching (CAD), etc.] to boost the efficiency of transit systems, reduce operating costs and improve transit services. They enable he integration of route deviation, fixed-route, and demand responsive public transit service types which in-turn address the public transportation needs of .he community more efficiently and effectively.<br>*Smart Card Payment/Transaction Systems* use advanced fare media such as magnetic stripe cards) and employ electronic communication, data processing, and data storage techniques to make fare payment more convenient to travelers while making revenue collection less costly for transit providers. |
| **Infrastructure Operating and Maintenance** technologies improve the ability of transportation personnel to maintain and operate rural roads. They include severe weather information services, early detection of pavement problems, and detection of dangers to work zone crews. | *Winter Road Maintenance Management System* uses advanced roadway and weather data collection technology along with vehicle probe technologies. The system gathers detailed real-time roadway and weather condition information to guide effective scheduling of winter roadway maintenance operations. The primary purpose is to provide more pertinent and accurate data than is currently available to road maintenance personnel. The information collected by the highway agencies could also be disseminated to travelers to assist them in making travel decisions.<br>*Slippery Conditions Warning System* uses ice detection technologies to determine when icy or slippery conditions exist on special segments of the roadway. The system then provides dynamic warning of those conditions to travelers.<br>*Extended Tail Light Warning System* will consist of vehicle detectors and light sources mounted either above ground at the should edge or embedded in the pavement. Passage of a vehicle will activate the lights and cause them to remain lit for a certain length of time, depending on the vehicle speed, grade, and road surface. The illuminated lights will indicate the safe following distance.<br>*Weather/Road Conditions Monitoring System Using Vehicle Probes* will take advantage of vehicles equipped with advanced systems (e.g., friction factor measurement systems) and other vehicles which regularly travel segments of rural roads such as law enforcement and maintenance vehicles. These vehicles will be used to probe the rural roadway network for weather and road conditions. Data collected by these vehicle probes will be downloaded to roadside units, from which the data will be transmitted to travelers via roadside information systems. |
| **Fleet Operating and Maintenance** systems improve the efficiency of rural transit fleets, particularly their scheduling, routing, and maintenance. These systems use advanced dispatching and routing systems, and advanced vehicle tracking systems. | |

| | |
|---|---|
| **Commercial Vehicle Operations** systems manage the movement and logistics of commercial vehicles and include technologies, specifically for rural areas, that monitor vehicle and driver performance and locate vehicles during emergencies and breakdowns. | |
| **Tourism and Travel Information** Services provide travel information to assist travelers unfamiliar with the local rural area. These systems include information services, provided at fixed locations and en route, mobility services, smart card payment/transaction systems, and portable event management systems. | |

**Attachment B:**
**Key Findings of ARTS Program (1993-1996)**

- The needs and user services associated with the ARTS are common to all ITS users, and will best be met by a national ITS that is integrated and interoperable. Developing separate, disconnected, or overly-specialized systems for rural environments would be counterproductive to creating a national ITS.
- Rural transportation issues differ from urban issues as a result of a few uniquely rural activities such as agricultural production, operational characteristics of transportation due to long distances, low population densities, and sparse, unmarked, or rugged environments.
- In general, rural applications emphasize congestion less than urban applications, Rural areas are marked by great diversity, however, so there are exceptions. Traffic control and its integration with regional systems can be important for tourist hot spots, seasonal events, rural places just below the urban threshold, and rural areas on metropolitan fringes. Rural areas need to be able to adapt systems for episodic and part-time or seasonal traffic congestion problems.
- All of the program areas have functions that require good radio propagation for communications and positioning information. ITS often relies on cellular communications in sparsely populated and rugged areas this is currently unavailable and may remain so until the advent of cheap low-orbital satellite systems. In rugged terrain, coverage of satellite positioning signals and communications may be unreliable. Because of these economic and technical issues, it is unclear when and where ITS functions will be available in the rural environment.
- It is vital to define better the cost-effective limits resulting from the sparseness and large dimension of rural applications. Once these limits are defined, explicit decisions can be made as to whether federal resource can reasonably extend the limits. Consequently, the rural demonstrations need careful planning to explore efficiently the economic feasibility of the spectrum of applications.
- Most of the technology needed for the ARTS exist or are being developed for general ITS user services already. While some rural technology R&D may be justified, the major problems are information dissemination, training, and financial resources to deploy what is already available.

## ITS Standards

### *What is the Problem?*

The success of the ITS program relies on the ability to integrate and share information among various users and across institutional boundaries. The national ITS architecture defines how the largest-scale ITS components, such as traffic management systems and traveler information systems, will work together by defining interfaces and consistent data flow requirements.

The establishment of standards for those interfaces is the key to insuring compatibility and interoperability at regional and national levels. We see the benefit of standards every day as we buy software from multiple vendors -- all to work on "IBM" type computer. Or we purchase lightbulbs from multiple manufacturers which fit into the electrical socket at home. On our highways there are standardized lane widths and ramp geometry which we have come to subconsciously expect regardless of the state we are driving in. Likewise ITS standards will insure that tags for the collection of tolls will function in different regions of the country. That transportation information receivers will work for both the commute at home and when visiting another state on vacation.

Normally, the industry process for reaching consensus on standards is quite slow. Two to ten years is not unusual. The majority of the time is spent in developing the detailed specifications of the draft standards because the process is normally carried out by volunteers working on off hours or vacations. The need for ITS standards, however, has taken on a special urgency as implementation of various infrastructure components moves forward. Without standards the risks of incompatibility are high, and the costs of "custom producing" some elements are prohibitive.

### *What is the Proven Benefit?*

Standards create a market by reducing the risk to the manufacturer that what the manufacturer produces will match the buyer's specifications. The buyer benefits by having multiple manufacturers -- all producing to the same specifications. The buyer benefits by having multiple manufacturers --all producing to the same specification -- to choose from. The price is likely to be lower and quality higher. Moreover, technology upgrades are easier thereby extending the life of the overall system.

### *What is the Federal Program?*

The objective of the federal ITS standards program is to support the industry and buyers in achieving consensus on the numerous standards -- faster than would normally be the case. Through the ITS standards development process, innovative cooperative agreements with Standards Development Organizations (SDOs) and professional organizations have created a new model of public/private partnership, one that provides dedicated support to advance standards development for the common benefit of the public sector and private industry.

Through this mechanism, the department is providing funding to support industry experts to devote full time attention to developing draft standards for debate and revision among the volunteer committee. Support has also been provided to bring public sector representatives to the table to insure that the consensus represents their perspective as well.

The standards chosen for the Department funding are typically those needed to implement the infrastructure side of ITS, as called out by the National Architecture. These include primarily, key interface standards such as message sets and data dictionaries, foundation standards such as location referencing and some safety standards, needed to deploy key functions safely and efficiently. In some cases, development of communications standards specific to ITS applications, is required.

To address the multitude of various standards that need to be developed to support the ITS objectives, a strategic plan has been formulated by the Department to target Federal funding towards specific standards development activities, in a prioritized manner. Attachments A and B provide detailed information on both the short-(O-3 years) and long-(3-5 years) term priority areas for the standards program and the complete list of currently funded standards activities.

***Long-Term Vision***

Much of the success of ITS will be determined by how well the various components play together in a synergistic manner. The national architecture is the framework and the standards are the glue to help make this happen.

Implementation, however, won't be easy. Although a major emphasis of the standards effort is geared towards ensuring involvement by the various stakeholders (both public an private), there is still a high probability of inconsistent usage throughout the United States and our partners to the North and South.

In addition, many communities will be focused on short term payback. In deploying major systems, such as ITS, one needs to look at full life cycle costs and not just initial implementation. In addition, there are a range of intangible benefits that standards development will yield, such as risk reduction by having multiple vendors to choose from versus locking into a proprietary environment. Additional incentives (e.g., tying Federal funding to compliance with specific ITS standards) may be necessary to catalyze community buy-in, as a whole.

***For More Information***

Contact: Mike Schagrin, Program Manager, 202-366-2180 (Rev. l/24)

## Attachment A:

## Short- and Long-Term Priority Areas
## for the
## ITS Standards Program

As a general rule, standards activities that fall into the following categories are priority candidates for funding support.

**Tier 1 (0-3 years)**

- **Current activities of SDOs** mesh with the Federal objectives of promoting national interoperability and facilitating the intelligent transportation infrastructure deployment. These activities include message set development, and the development of special ITS communications standards.
- **Foundations standards,** which support the general ITS deployment and cover multiple interfaces in the National Architecture. These interfaces include data dictionaries, location referencing, and safety and human factors standards.
- **CVO standards,** primarily Dedicated Short Range (DSRC) Communications and Electronic Data Interchange activities.
- **Other standards requirements,** as identified by the national architecture that supports the intelligent transportation infrastructure, typically in the form of message set standards.

**Tier 2 (3-5 years)**

- **Requirements outside of the intelligent transportation infrastructure** resulting from the National Architecture as called out in the Standards Requirements Documents. This consists primarily of message set development.
- **Continual collaboration** among the ITS Joint Program Office, SDOs, and ITS America to assure timely development of the standards and protocols. Partial funding will be provided when necessary to assure that the process of funding does not supplant, weaken, or discourage the volunteer consensus process of the SDOs.

**Attachment B:**

**Listing of Currently Funded ITS Standards Activities**

The following table identifies those activities that have been identified as highest priority and currently being funded under the Department standards program.

| ACTIVITY | DESCRIPTION | ORGANIZATION |
|---|---|---|
| NTCIP | Develops physical and data link protocols and application specific object sets. | AASHTO |
| Traffic Management Data Dictionary | Defines specific data elements that make up messages used within an ATMS traffic management center (TMC) and exchanged with other external systems and subsystems. | ITE |
| DSRC Message Set for CVO and ETC | Defines the application specific message sets. | IEEE |
| Location Reference Specification | Evaluates preliminary specification in a test and modifies it as necessary into a draft standard. | SAE |
| Dedicated Short-Range Communications Protocol | Develops physical and data link standards for beacons. | ASTM |
| Message Set for External TMC Communication | Defines the application messages transferred between TMCs and other ITS centers. | **ITE** |
| Spatial Data Interchange | Supports development of an ITS profile to the Spatial Data Transfer Standard. | ORNL Study* |
| Survey of Communications Technologies, Practices, and Standards Relevant to ITS ** | Survey and analysis of existing standards and those under development applicable to the needs of the ITS Short Range and Wide Area Wireless and Wireline Communications. | IEEE |
| High Speed Data Subcarrier Protocol | Defines the FM subcarrier modulation format for ATIS message sets. | SAE |
| Message Set for Incident Management | Prescribes the form and content of the messages for real-time emergency notification from the Emergency Management Subsystem to other centers and providers. | IEEE |
| Umbrella Standard for ITS Data Dictionaries | Defines the format and content standards for ITS data dictionaries. | IEEE |
| Message Set for Commercial Vehicle Safety & Credentials Information | Defines the message structure with which authorized parties can request and obtain information on the safety performance, regulatory compliance, and credential status of commercial motor vehicles. | APL*** |

| | | |
|---|---|---|
| Message Set for Commercial Vehicle Credentials | Defines the message structure with which owners, lessees, and drivers of commercial motor vehicles can electronically apply for and receive credentials necessary to legally operate. | APL*** |
| Commercial Vehicle Operations Data Dictionary | Defines the data elements pertaining to CVO messages and information transfer. | APL*** |
| Traveler Information Data Dictionary & MS | Defines the message set and data dictionary for ATIS applications. | SAE |
| Traffic Controller 2070 (NTCIP) | Develops hardware, software, and user interface standards for the 2070 Advanced Traffic Controller. | ITE |
| Navigation and ATIS MS Evaluation | Implements, tests, evaluates, and validates a message set for two-way, vehicle to infrastructure ITS communications, based upon SAE J2256 and advances the message set to become an accepted standard. | SAE |
| Transit Communication Interface Protocol | Defines the physical, data link, and application layer standards for the Transit Management Center (TrMC) and vehicle and between TrMC, vehicle, and other centers. | ITE |
| In-Vehicle Databus Interface | Develops a set of standards that will permit plug and play integration of multiple ITS electronics devices into a vehicle while ensuring the safety and integrity of the vehicle and on-board systems is maintained. | SAE |
| Message Set for Mayday Alert | Prescribes the form of messages exchanged between and ISP and in-vehicle systems. | SAE |
| Vehicle Navigation/Route Guidance Standards | Defines human factor standards for safe operation of navigation/route guidance equipment in vehicles. | SAE |
| Automatic Vehicle Identification | Defines the messages used to report vehicle identification. | **IEEE** |

*ORNL is providing additional requirements definition to support subsequent standards development activities.
**Although not specifically a standard, this effort cuts across and supports multiple standards development activities.
***APL is supporting the ANSI Xl2 committee for the development of electronic data interchange standards.

# ITS Architecture

***What is the Problem?***

In any system, the architecture defines major components and describes how system elements interact. A home entertainment system architecture, for example, allows a television, video cassette recorder, audio tape deck, compact disk player, radio, headphones, and remote control to function as a unified system, even though individual components are designed and produced by different manufacturers using different technologies. Interface specifications, defined in an architecture and documented in open standards, provide a framework for a range of capabilities and low risk future expansion so that speaker manufacturers can produce speakers that will "go with" products from other manufacturers to produce a system. To be practical, ITS (just as home entertainment systems) need a framework upon which they can be built. The framework is the National ITS Architecture.

***What is the Federal Program?***

*Development*

From September 1993 through 1994, four teams developed four independent concepts for a national ITS architecture. A broad range of technical experts and ITS stakeholders scrutinized the resulting concepts. The Department of Transportation then selected two teams to work together to merge the best concepts from all four teams into the National ITS Architecture. In June 1996, following extensive technical and public review, the two teams delivered over 5,000 pages of documentation in 18 volumes that are collectively titled: *"The National Architecture for ITS: A Framework for Integrated Transportation into the 21st Century."* For an overview of major system architecture findings as a result of the development process see Attachment A.

*Demonstrating and Testing the Architecture*

The development of the National ITS Architecture is an important initial step toward achieving the vision of a nationwide, fully integrated intelligent transportation system. A critical next step is to validate the efficacy of the architecture through actual application in various settings. The architecture will be used to implement Model Deployment Initiatives for the metropolitan Intelligent Transportation Infrastructure in four cities and Commercial Vehicle Information Systems Network (CVISN) in seven prototype states. The lessons learned in these efforts will highlight the need for possible refinement or expansion of the National ITS Architecture as a comprehensive guiding framework.

## ***Guidance***

The U.S. DOT intends to provide technical assistance to the transportation community over the next few years to ensure that the general concepts and technical information generated during the development of the National ITS Architecture are adopted. Toward this end, the U.S. DOT has established an ITS Architecture Task Force to guide, promote, and facilitate effective, efficient, and rapid adoption of the architecture. Key task force goals include: increasing awareness concerning the architecture and its use among highway and transit agencies; mainstreaming the architecture into transportation planning and acquisition processes; and making sure the architecture remains current and relevant to transportation decision makers.

Preliminary guidance has been produced on how to use the architecture to achieve integration of the Intelligent Transportation Infrastructure components. Efforts are underway to include technical guidance in ITS educational initiatives and professional capacity building programs. This includes an in-depth 3-5 day course for transportation engineers and planners on the use of the National ITS Architecture in their efforts to upgrade their local, state, and regional systems. An architecture implementation guide for transit applications has been completed and distributed at the Transportation Research Board's Annual Meeting in January, and four similar guides covering other application areas will be completed this fiscal year.

## *What is the Proven Benefit?*

The National ITS Architecture provides a guiding structure based on open systems concepts and recommended non-proprietary standards. Most significantly, the architecture enables a degree of modal integration and system interoperability that would not otherwise be possible to achieve. Specific benefits are outlined in Attachment B: Benefits of ITS Architecture.

## *What Lies Ahead*

Long-term stewardship of the architecture is an important goal of both U.S. DOT and ITS America. The National ITS Architecture provides a vehicle for embarking on a journey of improvements in surface transportation safety and efficiency. An ongoing architecture "maintenance" effort is planned to keep the architecture up-to-date by incorporating experiences gained through initial deployments. New user services will also be incorporated as the need arises. Importantly, such ongoing efforts will identify the need for and guide the development of new or modified ITS standards and protocols.

## *For More Information*

Contact: Lee Simmons, Program Manager, 202-366-8048

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## Attachment A:

## Key Findings from the Development of a National ITS Architecture

The National ITS Architecture development process determined that many ITS user services can be implemented using proven, commercially available technologies. However, the most ambitious ITS concepts, such as Automated Highway Systems, require further research and technological advances before being ready for deployment Major system architecture findings include:

- Of the 125 ITS architecture interfaces, 44 have been identified by stakeholders as needing to be standardized right away to ensure national compatibility and broad market benefits. Specific ITS standards requirements have been identified and sorted into 11 groups to be addressed by appropriate Standards Development Organizations (SDOs).
- A common and open standard for location reference communication is needed; it is neither cost efficient nor practical to accommodate numerous methods for representing locations within transportation networks. An ITS location reference open standard for communication has been proposed and is supported within the architecture.
- Although dedicated short range communication (DSRC) between vehicles and roadside beacons is proposed for several ITS user services in the architecture, DSRC beacons are not the preferred approach to provide route guidance services; the desired near ubiquitous coverage can be achieved more economically via other approaches.
- Communication networks and services are critical to ITS success. In particular:
  - -- ITS communication needs can be met through a combination of owned (dedicated) facilities and/or leased or pay-for-use (shared) services, including emerging data communication developments associated with the National Information Infrastructure (NlI).
  - -- A common and reliable DSRC spectrum is needed (possibly in the 5850-5925 MHZ band) for electronic toll and other ITS user services.
- Transit schedules and real-time transit information from transit vehicles can be integrated with travel congestion information and made broadly available to travelers over a variety of interfaces. This accurate and reliable information may reduce the uncertainty of the transit travel mode, thus addressing the concerns of potential new passengers currently using personal vehicles, and enabling a new modal shift from single occupancy to transit vehicles.
- Market acceptance, public sector budgetary constraints, and institutional impediments to public/private partnerships pose greater risks to ITS implementation than do technological constraints.

## Attachment B:

## Benefits of ITS National Architecture

The national ITS architecture enables a degree of modal integration and system interoperability that results in the following benefits:

- **Lower costs:** The architecture allows common ITS products and services to be assembled in various ways to address a range of needs across all markets, thus allowing production economies to be achieved; the cost to ITS consumers is affordable and the risk for all producers is reduced.
- **Compatibility:** The architecture ensures that conforming products from competing vendors will be interchangeable and ensures that infrastructure implemented by one jurisdiction will be compatible and able to interface with systems in neighboring jurisdictions.
- **Flexibility:** Because the architecture embraces open standards, a wide range of designs can be tailored to meet specific local needs and applications and can evolve as new technologies or requirements arise. There is no concern about "vendor lock-in" or functional isolation or obsolescence -- all of which can be experienced with proprietary solutions.
- **Synergy:** The architecture allows a range of applications to share common communication and information infrastructure. This makes implementation more affordable as compared with stand-alone systems and enables a wider range of benefits by supporting a cross-section of users.