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Intelligent Transportation Systems

Real World Benefits

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16. Abstract

This report is an adaptation of FHWA's reference report "ITS Benefits: Continuing Successes and Operational Test Results," October 1997, FHWA-JPO-98-002.

It is a compilation of findings from ITS deployments across the United States. Four types of applications are described: Metropolitan, Rural, Commercial Vehicles, and Intelligent Vehicles. The systems deployed within each area reduce congestion, enhance transportation safety, improve access to traveler information, reduce operating costs, and reduce the environmental impacts of transportation.

This report is intended as an introductory resource for the lay reader. It provides an overviewof the benefits of ITS in a single, easy to understand, source. The interested reader is encouraged to explore the online resources, bibliography, and government contacts at the end of this report to gain a further appreciation of the benefits and uses of ITS.

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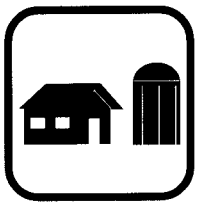

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Introduction

Intelligent Transportation Systems—Real World Benefits

The surface transportation system of the United States—3.7 million miles of roads and 503 public transit systems—accommodates 4 trillion passenger miles and 3 trillion ton miles of freight per year. Demands on the system are growing rapidly.

Now, information and communications technologies are helping states, cities, and towns nationwide meet these demands. Collectively called Intelligent Transportation Systems (ITS), these technologies are combined to form transportation management systems that allow us to actively manage our transportation networks for efficiency.

Investment in ITS will permit us to build fewer new miles of roads, reducing the cost of holding down congestion by 35 percent nationwide [38]. A recent study conducted for the US DOT and ITS America found that these systems produce a benefit/cost ratio of more than 8:1 for the nation's 75 largest metropolitan areas [5].

The four sections of this report summarize the benefits seen in real-world applications of ITS in:

- Metropolitan areas;
- Rural areas;
- Commercial trucking; and
- Intelligent vehicle systems.

For the lay reader, this report brings together information on the real-world benefits of ITS in a single source. In general, the benefits of ITS include:

- Enhanced public safety;
- Reduced congestion;
- Improved access to travel and transit information;
- Cost savings to motor carriers, transit operators, toll authorities, and government agencies; and
- Reduced environmental impacts.

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by Mitretek Systems [38]. The Mitretek report builds on a series of more detailed evaluations that will continue as ITS is applied in more cities, towns, and rural areas across the nation.

Metropolitan

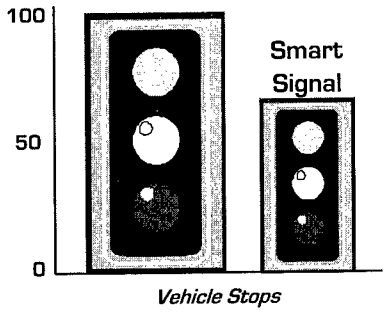
In cities and suburbs across the country, governments are using ITS to get the most out of existing infrastructure and deliver more efficient and effective transportation services. ITS can reduce traffic congestion, but it is also preventing crashes and speeding emergency response, improving the quality of public transportation and helping to clean the environment.

ITS Reduces Rush Hour Congestion & Delay

Anyone who lives or works in an American city can tell you that traffic congestion is getting worse. A third of the nation's urban Interstate highways are rated poor or mediocre for congestion, and the number of miles traveled is expected to grow by 30 percent during the next decade [38].

Increasing highway capacity by one-third would require $15 billion per year in new roadway expenditures [48]. However, ITS permits more efficient use of the roads we already have for far less money. The US Department of Transportation estimates that a combination of ITS and new physical capacity could cut the cost of the infrastructure expansion needed to address future congestion by half [34]. In some places, it's already happening.

Meters at freeway entrance ramps and traffic signals that adjust to current conditions help ensure smooth traffic flow even during the rush-hour period. New monitoring technologies alert authorities of traffic incidents so they can be cleared quickly. Smart signs warn drivers of accidents and other incidents that cause big backups and suggest alternative routes. Electronic toll collection eliminates long lines at tollbooths.

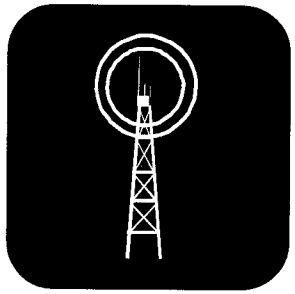


Smart traffic signals have helped reduce vehicle stops in Los Angeles by 41%

Seattle, Washington—Ramp meters along Interstate 5 have increased capacity at rush hour by 10 to 100 percent, while increasing highway speeds [24]. Other cities have reported handling 8 to 22 percent more traffic while increasing or maintaining travel speeds [53].

Los Angeles, California—Traffic signals now adjust for current traffic conditions, even when incidents divert traffic from the freeways. The result, 41 percent fewer vehicle stops at red lights [9].

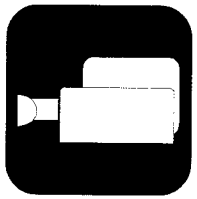
How Can ITS Be Used to Help Traffic Congestion?



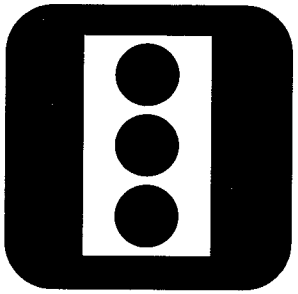
Advanced communications technologies are able to send traffic information to management centers, travelers, and public-access cable television stations.

Special detectors embedded in the road or installed in personal vehicles measure the flow of traffic.

Ramp meters measure and regulate how much traffic is entering and leaving major freeways.

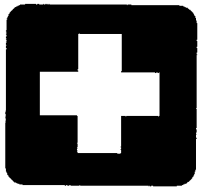


Strategically-placed video cameras monitor traffic to determine traffic flow and to detect incidents.



Traffic Signals can be controlled to speed the flow of traffic and give emergency and transit vehicles priority in special cases.

Incidents can be detected quickly with advanced technologies. Faster detection of incidents decreases response times and speeds the flow of traffic.



Emergency medical teams can monitor traffic and detect incidents from a central dispatch center. With advanced location and dispatch systems, response teams can reach incidents faster and aid those injured very quickly.

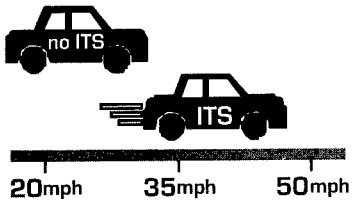
Tow trucks and courtesy patrols can be strategically placed in congested areas and can respond quickly to clear incidents off of throughways.

Information gathered with these advanced technologies can be relayed to Information Systems. Travelers can choose their routes based on congestion levels, incidents, and the availability of public transportation.

Advanced technologies allow travelers to pay tolls electronically rather than with cash. This rids travelers of backups and hassles and improves the efficiency of the toll collection for operators.

And that is just the beginning. In the future, in-vehicle systems will help navigate drivers around congested locations, allowing for faster and safer travel.

According to the Institute of Transportation Engineers, severe traffic congestion is most frequently caused by incidents—crashes, breakdowns, road maintenance, or other irregular or unpredictable events. In some American cities, nearly all of the traffic congestion can be blamed on incidents. Video cameras and sensors in the road help detect incidents quickly. Computer aided dispatch speeds emergency services to the scene. Changeable message signs alert drivers of backups and direct them to alternative routes. These technologies can cut travel time by 10 percent to 45 percent during congested times [35].



INFORM increases rush hour speeds

Long Island, New York—The Information for Motorists (INFORM) program is an integrated system using changeable message signs, ramp meters, in-road traffic detectors, and signal coordination on parallel streets. INFORM has increased rush hour speeds on Long Island from 34 mph to 46 mph. Drivers will divert to an alternate route 5 percent to 10 percent of the time when passive messages are displayed on electronic signs, and will divert even more frequently when the message recommends an alternate route [58].

Maryland—The state uses roving tow trucks and lane sensors to manage congestion on the busy I-95 system. The program yields a 2 million vehicle-hours per year decrease in delay associated with crashes and other unpredictable incidents [11].

Minneapolis-St. Paul, Minnesota—A similar program in Minnesota called Highway Helper has cut by 8 minutes the amount of time stalled or stopped cars are in the roadway blocking traffic. Breakdowns account for 84 percent of traffic incidents. Annual benefits through reduced delay in Minnesota totaled $1.4 million for a program that costs only $600,000 per year to operate [36].

Houston, Texas—The TranStar program was implemented to reduce delays caused by incidents. It is estimated that this incident management program saves the city $8.4 million annually through reduced delay [45].

ITS Gives Travelers Choices through Information

Minneapolis–St. Paul, Minnesota—The Genesis operational test, conducted in 1995, sent up-to-the-minute traffic information to motorists via pagers. Sixty-five percent of those with the service said they used it daily. Motorists found over 50 percent of the incidents affecting their travel via the pager compared with 15 percent for radio or television. And motorists said they changed their travel plans nearly half the time that the system alerted them to a problem on the highway [66].

Atlanta, Georgia and Los Angeles, California—Downtown kiosks provide highway and transit information and alert travelers of unusual conditions. Electronic map displays pinpoint the locations of congestion or incidents and offer alternate route choices. These systems are also linked with public transportation systems to help travelers alter their form of transportation if necessary.

Seattle, Washington—The Smart Trek program for the Puget Sound Region features downtown information kiosks, cable TV broadcasts, and customized internet messages. Traffic flows, congestion levels, and highway speeds are all available via the internet, and visits to the site now number 100,000 a day. Soon, the program will utilize personal hand-held computers and wristwatch messages for traveler information on the street [25].

And for transit, many systems now use telephone hot lines, information kiosks, and the internet to deliver real-time schedule information and assistance.

New Jersey—New Jersey Transit uses an automated transit information system. This system reduced caller wait time from an average of 85 seconds with the old system to 27 seconds, while the total number of callers actually increased [43].

Rochester, New York—After the Rochester-Genesee Regional Transportation Authority in upstate New York implemented a automated transit information system calls from transit riders increased 80 [64].

Minnesota—In the Minneapolis–St. Paul downtown areas, video kiosks provided transit routes and schedules as well as roadway incident and construction information. The information was also available on a computer bulletin board through a dial-in service.

During the study period in 1995, two-thirds of those who accessed the system requested bus route or scheduling information [50].

ITS Speeds Drivers through Toll Plazas

Nobody likes tolls, but now motorists like toll plazas a lot more because electronic toll collection is being used across the country to create stopless, cashless tolling. A roadside sensor recognizes a transponder in the car as it approaches a toll plaza, bills the corresponding account, and permits the car to pass unabated. An estimated 70 percent of toll lanes in the US now feature an electronic tolling option [28].

Oklahoma—As part of the Pike Pass program, electronic toll collection on the Oklahoma Turnpike has cut the costs of operating a toll lane by 91 percent [47].

Westchester County, New York—On the Tappan Zee Bridge over the Hudson River, a manual toll lane can accommodate 450 vehicles per hour while an electronic lane peaks at 1000 [32].

ITS Saves Lives through Emergency Response

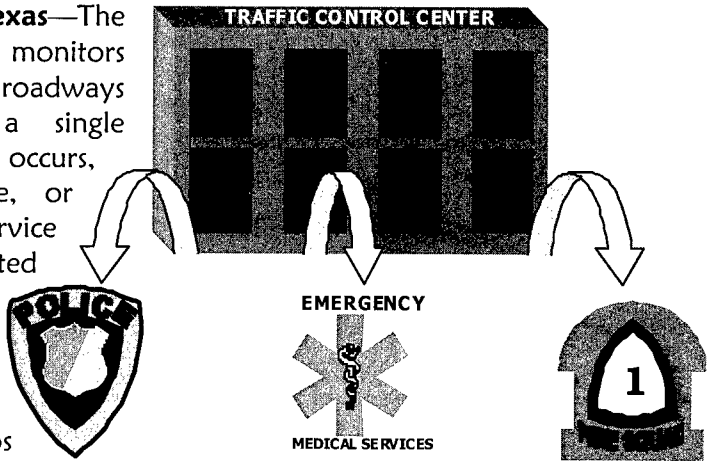
The Fatal Accident Reporting System estimates that if the first report of a crash were hastened from the current 5.2 minutes to 2 minutes, urban interstate fatalities would be reduced 15 percent—that is 365 lives saved nationwide [18]. Emergency services throughout the country are adopting technologies that detect incidents early and aid dispatchers in getting authorities to the scene quickly.

Atlanta, Georgia—In preparation for the 1996 Olympic Games, Atlanta added several ITS capabilities to assist in moving visitors and vehicles in an extremely crowded area. These involve an emergency response program that includes automated incident response and incident verification. The delay between the report of a crash and dispatch of emergency services has been cut in half, and accidents are cleared from the roadway 38 percent faster [7].

Orange County, California—The two communities of Redondo Beach and Hermosa Beach, California have outfitted police vehicles with a satellite-based location system and expect to cut police and emergency response time by 25 percent [62].

Fulton County, Georgia—Atlanta's fire department has consolidated its operations with neighboring fire departments to centrally coordinate their activities. This has cut their response time from an average 7.5 minutes to 4.5 minutes [56].

San Antonio, Texas—The TransGuide Center monitors conditions on all major roadways continuously through a single center. When an incident occurs, the nearest police, fire, or other emergency service vehicle is located electronically and then dispatched to the scene. Highway managers alert other drivers of impending backups through changeable message signs along the roadway. Forty-five percent to 71 percent of motorists surveyed said they save time with TransGuide. Eighty-eight percent said that the changeable message signs are "very easy" to understand [23].



ITS Reduces the Number of Crashes

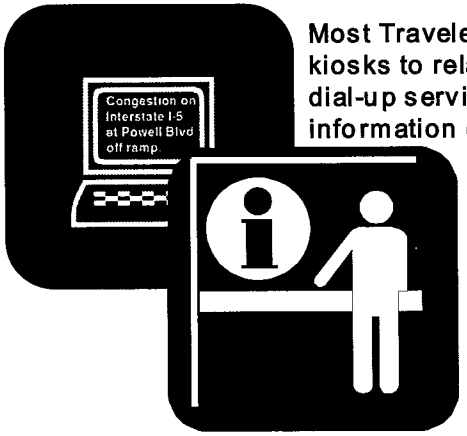
ITS that improves traffic flow also prevents accidents from happening. A nation-wide survey of ramp metering reported that accidents on freeway systems with ramp meters were reduced by 15 percent to 50 percent [53].

Seattle, Washington—On Interstate 5, crash rates have fallen by 38 percent since ramp metering was installed six years ago [24].

Minneapolis, St. Paul—On Interstate 35, crash rates fell by 27 percent—from 421 per year to 308 per year—following the installation of ramp meters [37].

States and cities are also using video cameras and other monitoring techniques to enforce traffic safety laws.

How do Travelers & Commuters Use ITS?



Most Traveler Information Systems utilize internet access, radio, changeable message signs and travel information kiosks to relay transportation activities in a given area. However, information can also be obtained through dial-up services, public-access cable television, or personal pagers. These systems supply a wide variety of information concerning congestion, alternate route-choices, car/vanpooling, alternate modes of transportation, and incidents. This information can then lead to improved traffic flow, reduced vehicle emissions, faster emergency response, and improved productivity.

Changeable message signs alert travelers to delays and incidents along their routes and provide information on alternate routes of travel.

Travelers can be alerted to congestion before they begin their trips in order to alter their route-choice or mode of transportation.

En route and pre-trip information can be accessed through on-board computers that can both navigate and show alternate routes to a destination.

Travelers can receive information to best plan their trips in areas with limited or restricted-access parking.

Travelers can access information about all modes of public transportation and ridesharing available in their area.

Travelers can learn more about emissionless forms of transportation and find the fastest, safest routes to their destinations.

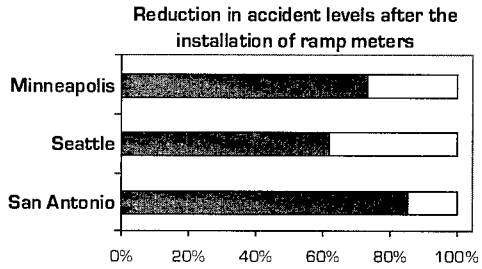
Travelers can be aware of incidents along their travel route. Travelers can then alter their planned route either before or during travel or change their mode of transportation.

Emergency medical teams can learn of incidents and plan the fastest route to the scene of an incident.

With environmental pollutants reaching dangerous levels in many cities, travelers can find out if they have an environmental advisory in their area and alter their mode of transportation accordingly.

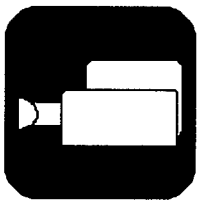
Persons with disabilities and senior citizens can learn about mobility opportunities in their area. Often they can use demand-response services to efficiently manage their trip plans.

San Antonio, Texas—The TransGuide system utilizes changeable message signs, lane-signal controls, video cameras, and loop detectors to measure traffic flows and detect incidents. Since the program began, the frequency of injury-related crashes has dropped by 15 percent, total crashes have dropped by 35 percent, and secondary crashes—those caused during backups created by other incidents—have dropped by 30 percent [23]. This system also helped police and fire crews when an industrial plant fire erupted within view of a freeway video surveillance camera.



San Francisco, California—Use of video cameras on highways and at traffic signals for law enforcement has reduced violations by 30 percent [21].

Howard County, Maryland, Jackson, Michigan, and New York City—Similar systems have reduced red-light violations by 23 percent in suburban Howard County, 67 percent in Jackson, and 20 percent in New York City [21].



Florida—Fort Meade reports a 50 percent reduction in violations at railroad grade crossings since the installation of photo-enforcement equipment [46].

ITS Helps Transit Work Better

Public transit systems use ITS technologies to more effectively and more efficiently manage their fleets. With computer-aided dispatch and automatic vehicle location, they are able to cut costs and improve service.

Winston-Salem, North Carolina—The Winston-Salem Transit Authority uses computer-aided dispatch and scheduling for its 17-bus fleet. The system allows buses to go where the people are, instead of the other way around. Transit riders make same-day reservations and dispatchers maneuver the fleet to maximize utilization and minimize wait time. The system's client list grew from 1,000 to 2,000 in the first six months of the service and wait time dropped by 50 percent, while operating expenditures fell by 2 percent [59].

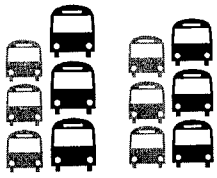
Northern Virginia—The Potomac and Rappahannock Transportation Commission estimates that its demand-responsive transit service

reduced total costs by 40 percent as compared to fixed-route and paratransit services while improving overall customer service [19].

ITS Improves On-Time Transit Performance

Automatic vehicle identification and computer-aided dispatch systems are helping transit systems set new standards for on-time performance.

Automatic vehicle identification and computer-aided dispatch have greatly improved on-time performance in these transit systems



Baltimore: 23% *performance improvement*

Kansas City: 12% *performance improvement*

Kansas City, Missouri—During the first year of operations with automatic vehicle identification, the bus system has improved on-time performance by 12 percent. At the same time, Kansas City cut the number of buses needed for its routes by 9 percent. Kansas City was able to recoup its investment in location systems in two years by eliminating seven of its 200-bus fleet [26].

Baltimore, Maryland—Buses equipped with automatic vehicle identification have a 23 percent better record of on-time performance [26].

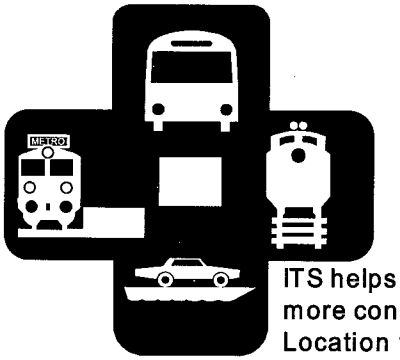
Milwaukee, Wisconsin—The number of buses more than one minute behind schedule declined by 28 percent [26].

Other transit systems have reported reductions in fleet-size of 4 percent to 9 percent due to greater efficiency in bus utilization [26].

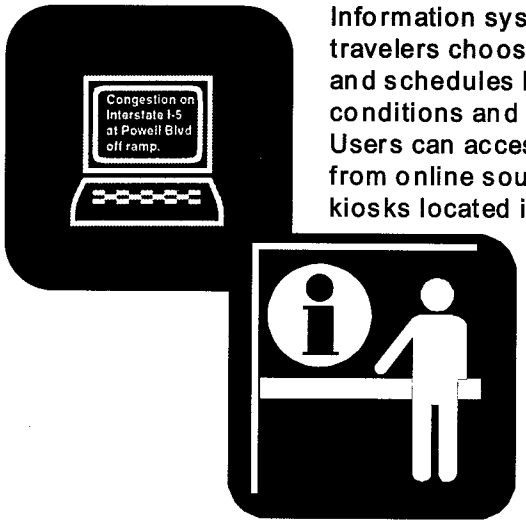
Florida—Medicaid transportation costs could be reduced statewide by an estimated $11 million annually through increased trip coordination made possible by a dispatch system using automatic vehicle location [52].

Portland, Oregon—Using a traffic signal prioritization system the City has integrated the bus system with a traffic signal system at key intersections to help keep buses on schedule. By extending green lights along these routes only few seconds, buses have cut travel time by 5 to 8 percent. Now, fewer vehicles are needed to serve these routes [29].

How is ITS Used with Public Transportation?



ITS helps make public transportation more convenient and easier to use. Location technologies and computer-aided dispatch systems help transit operators keep their fleets on schedule. Coordinated route-management helps integrate the different forms of public transportation.

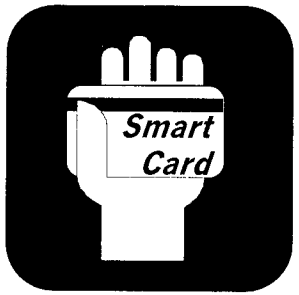


Information systems help travelers choose their best routes and schedules based on roadway conditions and public transit information. Users can access this information from online sources and from information kiosks located in hotels, shopping centers, and on the street.

Travelers are more likely to utilize public transportation if they are aware of parking facilities and parking availability. Real-time parking and travel information gives travelers more options and increases the likelihood of using public transportation.

ITS enhances demand responsive systems and allows people with disabilities and senior citizens to better access public transportation systems and increase their mobility.

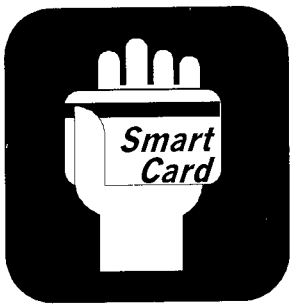
Electronic fare payment allows travelers to pay all of their transit and parking expenses with a single magnetic card rather than with cash.



ITS Improves Financial Transactions for Transit Agencies & Customers Alike

Electronic fare payment systems are helping transit systems work more efficiently and serve their customers better.

Phoenix, Arizona—The City uses electronically-encoded plastic fare cards on its bus system to cut processing fees. During a four-month study period in 1995, an impressive 90 percent of express bus riders in Phoenix used the fare cards improving customer convenience and allowing the transit agency to save money [55].

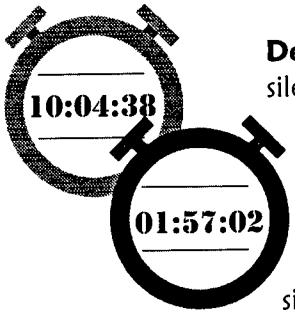


Southern California—An electronic transit fare payment system in Ventura County has reduced data-collection costs by $5 million and improved data accuracy [15].

New York and New Jersey—New York City estimates that electronic fare payment has increased transit ridership and revenue by $49 million. New Jersey Transit estimates that electronic fare payment has reduced annual cash-handling costs by $2.7 million [26].

ITS Makes Public Transit Safer

For the transit riding public, security is a crucial issue. People are more apt to use transit when their confidence in security is high.



Silent emergency alarms installed in buses in Denver have decreased police response time from over 10 minutes to less than 2 minutes

Denver, Colorado—Denver's buses now have a driver activated silent alarm to warn the dispatch center of a problem. The dispatchers can activate a covert microphone on the bus and alert the appropriate emergency service. These systems have reduced average police response time to crime on buses from over ten minutes to less than two minutes and saved the lives of passengers. A dispatcher who listened to crime in progress and described the situation to police arriving at the scene needs no more proof that the city's security system saved lives [26].

Los Angeles, California—Video enforcement at points where the light-rail transit system crosses surface streets also saves lives. A 1993 study at urban Compton Boulevard showed that video enforcement reduced grade crossing violations by 92 percent [46].

ITS Reduces the Environmental Impacts of Transportation

ITS is also being used to help protect our environment. New technologies encourage travelers to use transit, reduce idling pollution at toll plazas and traffic signals, and enable exciting new ways to cost-effectively reduce the environmental impacts of the automobile.

Boston, Massachusetts—Traveler information systems have helped travelers switch from driving to transit. On a daily basis, this adjustment of travel behavior nets an estimated 25-percent reduction of volatile organic compounds, 1.5-percent reduction of oxides of nitrogen, and a 33-percent reduction of carbon monoxide [61].

Washington, DC—Traveler information systems warn drivers on Ozone Alert Days—when climatic conditions are ripe for unhealthy air—and suggest public transit and other transportation alternatives.

A report by the Clean Air Action Corporation projects that electronic toll collection on the Muskogee Turnpike in Oklahoma, the Garden State Parkway in New Jersey, and the Massachusetts Turnpike will reduce emissions of carbon monoxide at toll plazas by 72 percent, hydrocarbon by 83 percent, and nitrogen oxides by 45 percent [10].

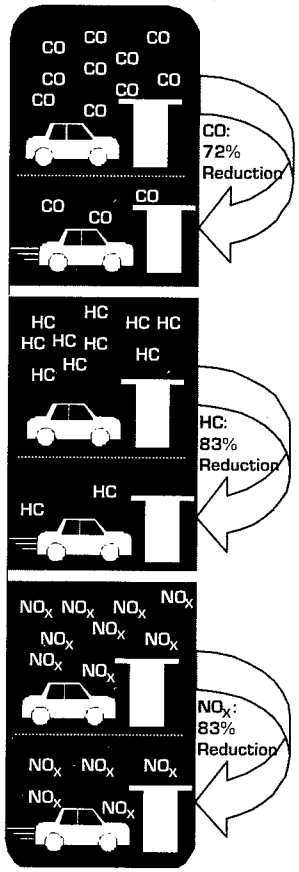
Los Angeles, California—The City has documented a 13 percent decrease in fuel consumption and a 14 percent decrease in emissions as a result of improved traffic signal systems [9].

Abilene, Texas—Traffic control system improvements have led to a 6 percent decrease in fuel consumption, a 10 percent decrease in hydrocarbons, and a 13 percent decrease in carbon monoxide, while nitrogen oxides increased by 4 percent due to increased vehicle speeds [44].

Detroit, Michigan—An expansion of the freeway management system is expected to reduce delays from incidents by about 40 percent. This would lead to an annual reduction of 41.3 million gallons of fuel used, a reduction of 122,000 tons of carbon monoxide, 1,400 tons hydrocarbon, and 1,200 tons of nitrogen oxides [54].

Denver, Colorado and Boise, Idaho—Operational tests in Denver and Boise successfully identified gross polluters using roadside sensors that can detect tailpipe emissions. While the impact of this new technology is uncertain, it is one of many examples of how ITS is being used in the service of environmental protection.

Electronic Toll Collection has significantly reduced emissions at toll facilities in Oklahoma & New Jersey



Rural

In rural areas, ITS systems can avert high-speed collisions. And, when accidents do happen, ITS has the potential to signal emergency response quickly. ITS also helps tourists and travelers. In-vehicle systems use navigation and roadside communication systems to provide travelers with directions and weather information.

ITS Improves Safety in Rural Areas

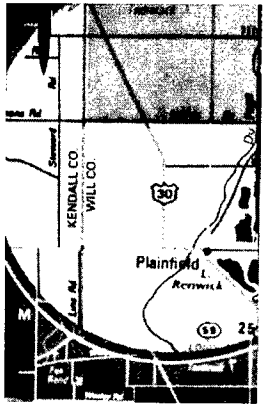
Mayday systems help drivers or their vehicles immediately notify police and emergency response crews of accidents or hazardous conditions. Some systems can transmit a distress signal and vehicle location to a central command center even without action by the driver or passenger(s).

Suppose, for example, a driver encounters an icy patch on a remote, fairly deserted mountain pass and runs off the road into a ditch. The driver is badly injured and cannot leave the vehicle. The probability that another driver will pass by is slim—even if one does, the injured person may not be visible in the ditch. The injured driver may be fortunate enough to be in a hiker's route, but even if the hiker walks by, a distress call to an emergency response team is difficult...

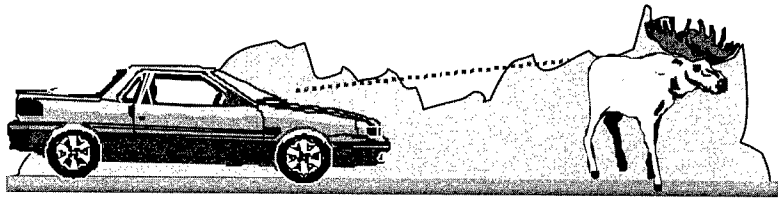
But what if the car is equipped with a "panic button" or a cellular phone capable of determining longitude and latitude? The driver is then only an arm's length away from getting help, even in a remote location—the driver doesn't have to rely on another driver or hope for a hiker to come by. And these systems can be used if a car overheats, blows out a tire, hits an animal, or is stranded by severe weather—any emergency in a rural area.

The practical applications of the systems have made them very popular with consumers. Mayday systems are now available from several auto manufacturers. The OnStar System from GM and the RESCU system available from Ford are two examples. Over half of factory orders for Lincoln Continentals in 1996 requested a package including RESCU [16].

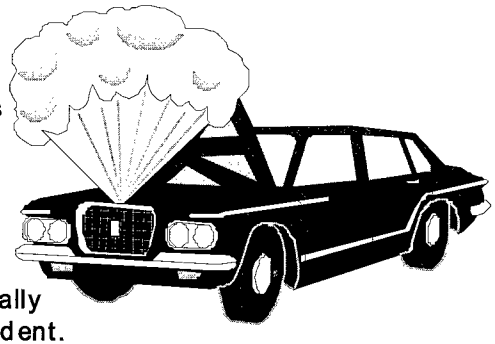
What Are Rural ITS Systems?



Route Guidance and Navigation Systems in personal vehicles can be used to aid drivers in unfamiliar rural areas where directions are often hard to come by. Locational devices can also pinpoint the location of a stolen vehicle.



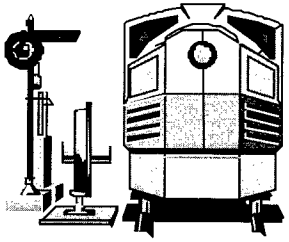
Many rural collisions are animal or tree hits. Vehicle Control and Detection Systems will help drivers avoid incidents by alerting drivers to potential hazards or by taking control of steering or braking functions in the car.

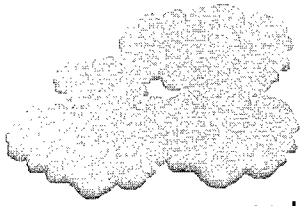


When an incident occurs or a car breaks down in a rural area, Mayday and other Cellular-based systems alert authorities of the driver's location and condition.

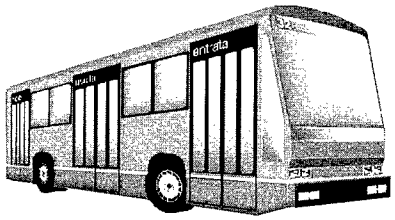
Devices in the vehicle may be operated by the driver or may automatically call for assistance in the event of an incident.

Crashes between cars and trains can be avoided using Railgrade Crossing Systems that alert drivers to approaching crossings and oncoming trains.

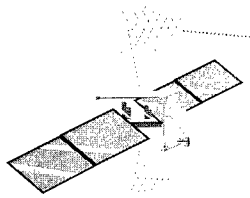




Weather Information Systems can warn rural drivers of bad storms and dangerous roadways. These systems also help authorities clear roadways more efficiently and close fewer roads.



Traveler information systems and transit services are key aspects of rural ITS. Many different transit modes, including light-rail transit and environmentally-friendly buses and vans are being explored in an effort to minimize impacts on environmentally sensitive areas and provide traffic relief in tourist-congested areas.



ITS Enhances Emergency Response

Emergency services use satellites and advanced communications systems to notify medical teams—even in remote locations under adverse conditions.

Muskogee, Oklahoma—When a car and school bus collided, emergency medical teams were delayed by heavy fog. A patrol officer who was able to reach the scene of the crash transmitted his position to a medical helicopter through locational technologies. The helicopter quickly located the crash site and completed the rescue [13].

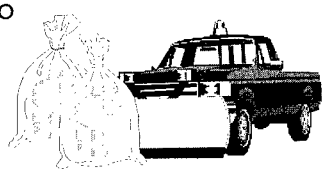
Blue Earth County, Minnesota—Improved mapping systems aid authorities in locating remote addresses in the county. The locations of 9-1-1 callers now appear on a digital map at the dispatch center and emergency teams can reach the caller faster. The database created for this program may also be used by the postal system and utility companies to locate remote addresses and improve customer service [14].

ITS Makes Rural Public Transit More Accessible

Sweetwater County, Wyoming—The bus system in Sweetwater County has doubled its monthly ridership using a computer-aided dispatch system. Five years after its installation, transit-operating costs have decreased 50 percent and ridership has increased by 5 times. The transit center now provides dispatching services for approximately 20 agencies in the region [8].

ITS Takes on Mother Nature

ITS is helping to disseminate information concerning inclement weather and road conditions. This information helps authorities clear snow-covered roads faster using fewer chemicals and helps travelers make better and, more importantly, safer travel decisions. The National Oceanic and Atmospheric Administration currently broadcasts site-specific information over the radio to approximately 80 percent of the US population [14].

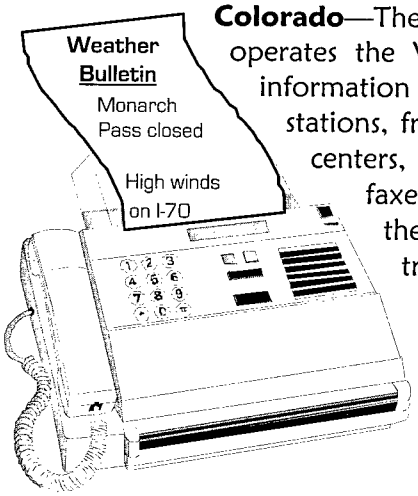


CAD for snowplows has saved Indiana $14 million in operating costs and equipment

Indiana—A computer-aided dispatch system has helped authorities redesign snowplow routes in 80 percent of the state. The total number of routes needed have been reduced

by 10 percent and $14 million in operating and equipment costs have been saved since implementation of the system [14].

Vermont—Infrared sensors installed on maintenance-patrol trucks enables state and county authorities to concentrate snow removal in critical areas. These mobile weather sensors help authorities pinpoint where de-icing chemicals need to be applied most quickly—increasing roadway safety, saving money, and reducing the environmental impact from chemicals [14].



Colorado—The Colorado Department of Transportation operates the Weather by Fax program that provides information to over 200 users, including weigh stations, freight-hauling companies, ski areas, visitor centers, and TV networks. Regular bulletins are faxed to users up to five times a day during the winter months, and special faxes are transmitted to relay information on mountain-pass closures and avalanches. Interstate 70 and Interstate 80 agencies in Wyoming and Utah also receive information from the Colorado program [14].

ITS Brings the World to You

Busy cities are not the only areas benefiting from online information. Traveler and tourist information for regions around the country is becoming increasingly available via the internet. Tourists can find out about activities, special events, shopping and dining, and lodging—even in rural areas. Counties are coordinating their websites to offer tourists a wide geographic range of interesting places to visit and enjoy. Additionally, counties are using the internet to better inform their residents by bringing them all types of information, including road and travel conditions.

Kalamazoo County, Michigan—The County developed a website to promote interaction between residents and the Road Commission. Commission goals, budget information, public hearings, road closures and detours, and news releases are all available on the Kalamazoo site.

Galena, Illinois and Decorah, Iowa—These small cities have developed websites to promote local attractions and provide traveler information. Tourists can access information on historic and natural attractions, local businesses, and seasonal festivals. In the first year the Galena website was operational, the local visitors bureau reported a 60 percent reduction in printed material mailed to inquirers. The website experienced a 10 percent monthly increase in users—that's 1,500 new visitors every month [14].

Commercial Vehicles

Commercial vehicle operations rely upon interaction between public agencies and motor carriers for the maintenance and improvement of highway safety, motor carrier productivity, and related goals.

Commercial Vehicle ITS links state, carrier and national information networks to facilitate simple, cost-effective, and seamless exchange of safety and administrative data. These networks enhance processes for vehicle registration, fuel-tax collection, roadside safety inspections, roadside credential checks, and hazardous materials transport. Federal funding and assistance for developing and delivering these systems is provided mainly through the Commercial Vehicle Information Systems and Networks (CVISN) program.

ITS for commercial vehicles consists of four primary program areas:

- **Safety Assurance**—which gives state safety inspectors access to driver, vehicle, and carrier safety information; automates safety inspections and reviews; and features safety devices inside commercial vehicles.

- **Credential Administration**—which allows trucks and motor coaches to file their necessary credentialing and permit information electronically through a single transaction; and enables state agencies to share and exchange motor carrier information both in and outside the state.

- **Electronic Screening**—which automates weight, safety, and credential screening at roadside weigh stations and facilitates electronic international border clearance.

- **Carrier Operations**—which helps carriers manage their fleets and vehicles more efficiently; provides drivers with traveler information to optimize performance; and helps identify carriers transporting hazardous materials to enhance emergency response in the event of an incident.

ITS Enhances Safety through Better Information

State regulators now use information and advanced communications technology at truck safety stations to target safety inspections.

These advanced technologies are expected to increase motor carrier compliance with safety regulations, provide timely information on

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drivers or vehicles that have been placed out of service due to safety violations, and help state inspectors make better decisions on which vehicles to inspect. Additionally, these systems will help reduce delays at roadside safety stations, reduce the number of crashes involving commercial vehicles, and help state inspectors access safety information from other states.

Across the country, these systems are already experiencing the benefits.

Midwest—In a recent study of 40,000 inspections in ten states, the Upper Great Plains Transportation Institute found that safety inspectors were able to remove 50 percent more unsafe drivers and vehicles than inspectors using conventional processes using safety information systems to identify high-risk carriers [63].

The ATA Foundation—has estimated that portable diagnostic equipment can reduce a safety inspection (typically about a half hour) by 10 minutes [2].

Oregon—The State has implemented a broad-based information network for commercial vehicle regulation. Over a nine-year period, this system allowed the state to increase the number of safety inspections performed on trucks by 428 percent while staffing grew by only 23 percent [30].

Also, ITS technologies allow state regulators to identify those truckers with poor safety records for more frequent inspection and allow compliant trucks to proceed on the highway.

ITS Helps Credentialing Agencies Operate More Efficiently

State administrative agencies use ITS to allow motor carriers to electronically obtain necessary credentials and hauling permits. These systems are expected to help agencies process carrier applications faster, help different agencies exchange necessary information, and improve data accuracy and completeness.

National Governors' Association—A forthcoming analysis of 8 states has estimated that state agencies have a benefit/cost ratio of 1:1 to 7:1 for electronic credentialing implementation [4].

The COVE Study—found that state agencies responsible for administering credentials and permits could save 33 percent to 40

percent in administrative costs through electronic credentialing services [6].

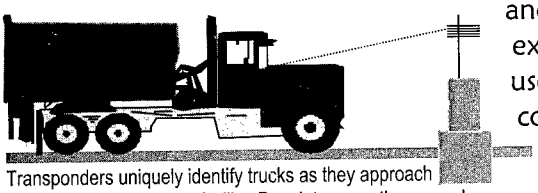
In addition to the benefits states realize through electronic credentialing, motor carriers also save time and money.

Massachusetts—a study from the Massachusetts Metro Transportation Association finds that motor carriers in the Commonwealth could reduce the cost of administrative compliance by $2.4 million annually through adoption of ITS [27].

The ATA Foundation—has estimated benefits of electronic credentialing of 4:1 for carriers with 11–99 vehicles and 20:1 for carriers with 100 or more vehicles [2].

ITS Enhances Clearance Activities at the Roadside

ITS is used at weigh stations to screen commercial vehicles faster. Weigh station personnel use electronic screening to check credentials and make safety-inspection decisions. These systems are expected to help roadside officials target high-risk carriers, use their safety inspectors more efficiently, weigh more commercial vehicles, and improve traffic flow both through the weigh station and on the highway. And the benefits are already emerging.



Transponders uniquely identify trucks as they approach roadside weigh or safety facility. Regulators can then spend more weighing and inspecting vehicles with records of

Colorado—The State estimates that the use of weigh-in-motion and automatic vehicle identification at weigh stations produces a benefit/cost ratio of 7:1. Additionally, the study estimates that electronic clearance technologies at weigh stations would yield an annual benefit/cost ratio of 10:1 for motor carriers [6].

Heavy-Vehicle Electronic License Plate (HELP) Crescent—Under this program, trucking companies and state agencies from Texas to British Columbia are implementing ITS solutions for interstate trucking. HELP permits pre-clearance at weigh stations and other inspection facilities. A 1994 study of the HELP Crescent project estimated that full implementation could reduce tax evasion by $1.8 million annually per state. Overweight loads could be reduced by 5 percent leading to savings of $5.6 million annually. The study also estimated that the operating cost savings of weigh stations of up to $169,000, and savings for credential checking of up to $8.6 million [12].

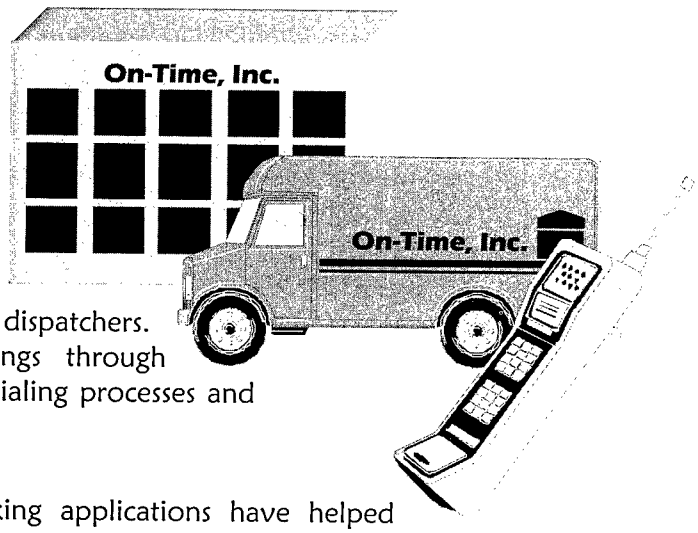
The ATA Foundation—has estimated that expedited clearance activities result in benefit/cost ratios between 2:1 and 7:1 for motor carriers [2].

But states aren't the only ones realizing the benefits of electronic screening—motor carriers save valuable time and money since, if they are in compliance with regulations, they can make fewer stops at weigh stations.

Detroit, Michigan—The Detroit/Windsor area has recently implemented automated vehicle identification and toll collection at the border crossing between the US and Canada. Commercial vehicles accessing this facility are expected to experience a benefit/cost ratio of 4:1 after a single year due to reduced delay[67].

ITS Makes Truck Fleets More Efficient

Truckers are rapidly adopting fleet management and other ITS technologies in an effort to reduce costs in this highly competitive industry.



The ATA Foundation—A survey conducted in 1992 found that those carriers using ITS experienced productivity gains from 5 percent to 25 percent as a result of increased pickups and deliveries per truck per day. Drivers saved 30 minutes per day in reduced communications with dispatchers. Companies also generated big savings through streamlined administrative and credentialing processes and roadside safety inspections [3].

Schneider of Green Bay—ITS trucking applications have helped increase loaded miles by 20 percent. The company has eliminated driver check-in telephone calls, saving two hours per day, which permits increased driver salaries and improved customer service [20].

Best Line of Minneapolis—estimates that 300 drivers gain approximately 15 minutes per day in travel time due to less radio communication with dispatchers. This translates into a $10,000 per month saving for the company [20].

Trans-Western Ltd. of Lerner, Colorado—credits a fleet management system for improved driver relations, noting that drivers

are able to drive 50 to 100 additional miles per day. Driver turnover has dropped from nearly 100 percent to 30 percent annually [20].

United Van Lines—expects advanced tracking systems to reduce theft insurance premiums [20].

North American Van Lines—reports 17 percent more shipments, 6 percent fewer deadhead miles, and 4 percent fewer cancellations as a result of advanced vehicle monitoring and communications technologies [20].

And ITS also eases regulatory compliance for carriers. Drivers are required to log their travel and report their fuel usage to state authorities. ITS allows drivers to create electronic logs that are easy to access and easy to update.

Automated Mileage and Stateline Crossing Operational Test—estimated that trucking companies using advanced communications technologies could reduce their costs by 33 to 50 percent for fuel-tax and registration reporting [33].

ITS Averts Truck Rollovers & Collisions

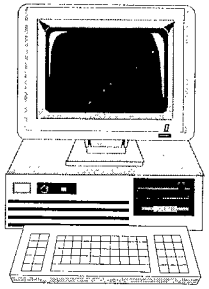
ITS systems enhance driver safety by warning of potential collisions and rollovers before they happen. One analysis estimates that extensive implementation of ITS would reduce trucking-related fatalities by 6 to 27 percent [17].

Washington, DC—On the Capital Beltway, a system warns truck drivers to slow down when they exceed safe speeds at exit ramps. There were 10 rollover truck accidents between 1985 and 1990 on these ramps. Since the system was installed on three ramps in 1993, there have been no accidents at these sites. And average truck speed has declined by 6 miles-per-hour [60].

Glenwood Canyon, Colorado—A truck speed warning system was installed on a narrow curve on Interstate 70. The design speed for the curve is 45mph. Prior to the installation of the warning system, the average truck speed around this curve was 66 mph. This has now been reduced to 48mph [14].

Transport Besner Trucking Co.—has installed collision-warning devices on all of its 170 trucks. Company studies show the combination of these devices and safety-training programs have cut the frequency of accidents by one-third [31].

How is ITS Used in Trucking Operations?



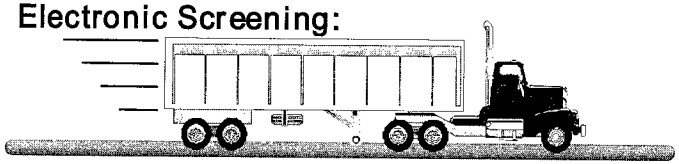
Motor carriers and coaches use ITS in many different ways.

Companies will be able to register their trucks and buses to obtain the proper credentials and operating authority with a single electronic transaction.

Private companies can increase productivity and improve customer satisfaction, since ITS allows companies to schedule, locate, and dispatch their vehicles quickly and efficiently.

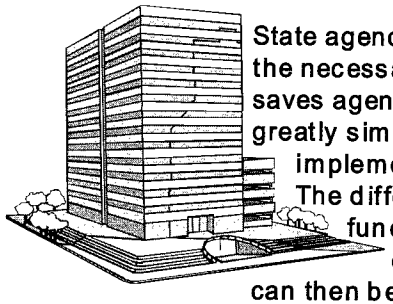
Drivers use advanced technologies in their trucks to communicate with the dispatchers. This saves the driver from locating telephones on the road.

Electronic Screening:



Trucks that are compliant with state and Federal regulations should not have to stop at every weigh or inspection facility along a route. Electronic transponders can identify the vehicle and carrier to check relevant information. Vehicles that have been cleared in one weigh station can bypass the next station, even after crossing state lines.

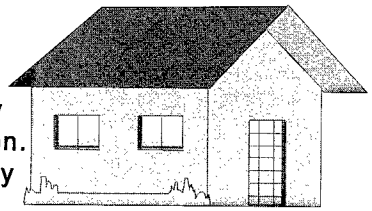
Credential Administration:

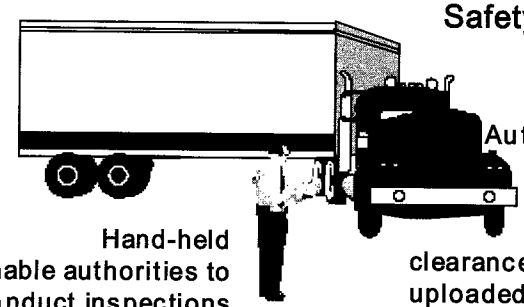


State agencies can register trucks and drivers and issue the necessary permits and credentials electronically. This saves agencies a great deal of time and money. ITS greatly simplifies legal requirements, such as the implementation of fuel and mileage taxes, for state agencies. The different agencies responsible for commercial trucking functions in a state can coordinate their activities efficiently and share information. This information can then be passed on to different states.

Safety Assurance:

State-of-the-art technologies are able to weigh and classify trucks while they are in motion. Since trucks can move quickly through weigh sites, they can save time and avoid dangerous back-ups on the ramps to the stations.





Hand-held devices enable authorities to conduct inspections accurately and efficiently.

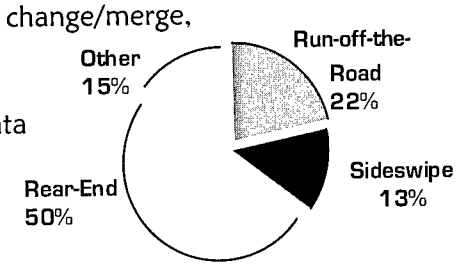
Authorities at the weigh station can access truck information stored in databases via computer. Information they collect during clearance and inspection can be uploaded into the database to be accessed from other stations.

Intelligent Vehicles

In-vehicle systems are driver aids. Just as radios and air conditioning are features drivers have come to expect in a car, advanced technologies will soon be standard features for most vehicles. Collision avoidance systems use radar or sonar technology to detect objects that the vehicle may strike and warn the driver of the hazard. Small monitors in the dashboard display travel maps and provide directions. "Intelligent" cruise control adapts vehicle speed to maintain a safe driving distance.

ITS Averts Crashes & Saves Lives through Collision Avoidance & Warning

ITS has the potential to avert accidents. A working group, convened by the National Highway and Traffic Safety Administration (NHSTA), is examining the number of crashes that can be avoided using in-vehicle devices to aid in avoiding lane change/merge, read end, and single-vehicle roadway departures crashes. Based on the experimental data available, use of these devices could reduce accidents by 17 percent annually—that's a total of 1.1 million crashes annually [49].

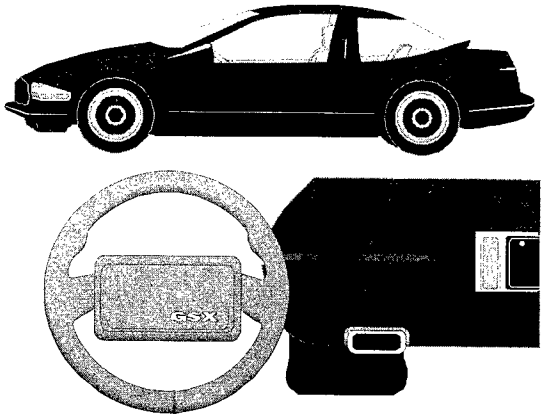


35% reduction in these accidents could lead to
- 52,000 fewer collisions
- 100 fewer fatal accidents

Transport Besner Trucking Co. has installed collision-warning devices on its 170-truck fleet. Internal studies find that the combination of these devices and a safety-training program has cut the frequency of accidents by a third [31]. During a trial of warning systems, Greyhound Bus equipped half its fleet with warning systems and reported a 20 percent accident reduction [51].

The most common accidents are rear end (50 percent), run-off-the-road (22 percent), and sideswipe (13 percent) [1]. Assuming a reduction of 35 percent of these accidents, 52,000 fewer collisions could be expected to occur on a national basis, including 100 fewer fatal accidents.

What Will ITS Do Inside the Vehicle?



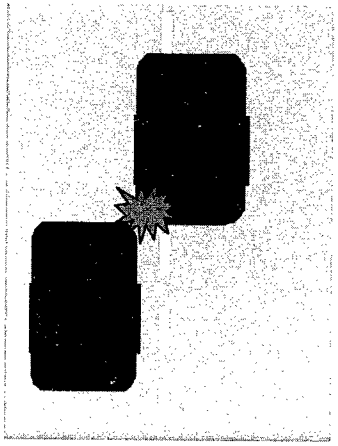
In-vehicle ITS will help the individual driver in numerous ways.

Besides route and navigation aid, on-board computers and sensors detect obstacles, issue warnings, and assume control of certain vehicle functions, such as steering and braking.

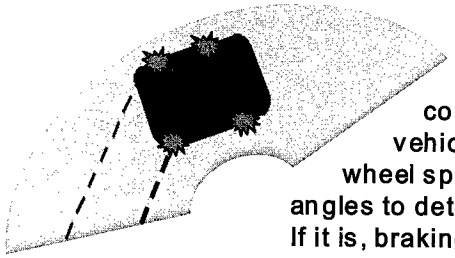
While these technologies are not yet commercially available, their future is not far away.

Advanced sensing systems can assess the condition of drivers and issue audible and visual warnings to alert drivers if they are drowsy.

Visibility can be limited in bad-weather conditions or at night. On-board sensors warn drivers of obstacles in front of vehicles and emit warning signals to help drivers avoid hitting objects.

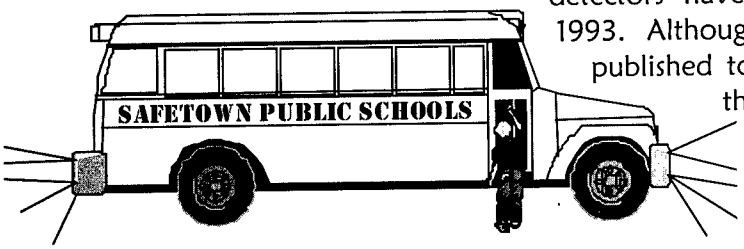


Many incidents are the result of improper lane changes or at highway entrances. Sensors in vehicles warn drivers if they are about to collide with other vehicles.



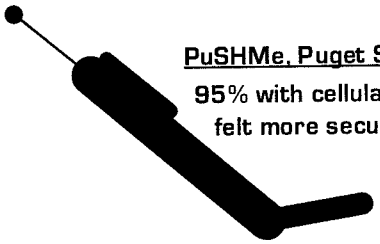
Vehicles tend to spin when driven too fast around curves, especially if conditions are slippery. Advanced vehicle and brake systems measure wheel speeds and steering wheel angles to determine if a spin is imminent. If it is, braking is automatically applied to the appropriate wheels, and the vehicle can balance out of the spin.

Twenty-five to forty-five school-age children are killed annually by school buses. Two-thirds are pedestrians and many others had just exited the bus or were waiting to board it [39, 40, 41, 42]. Blind-spot detectors have been used in school buses since 1993. Although no evaluation data have been published to date, these types of systems have the potential to significantly reduce the number of children killed annually by school buses.



ITS Speeds Emergency Response through In-Vehicle Mayday Systems

Cellular telephones and other mayday systems help drivers or their vehicles immediately notify police and emergency response centers of crashes or hazardous conditions. Some systems permit the vehicle to transmit a distress signal and approximate location to a central command center even without action by the driver or passenger(s). Mayday systems are just beginning to appear in new passenger vehicles.



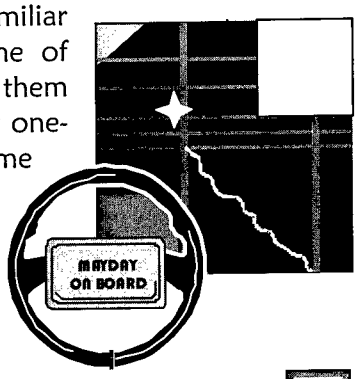
PuSHMe, Puget Sound
95% with cellular felt more secure

Puget Sound, Washington—The Puget Sound Help Me (PuSHMe) Mayday system allows drivers to immediately send a notification and location of an incident to a response center via cellular phone. Of those drivers equipped with cellular telephones, 95 percent said that they were more secure knowing the PuSHMe system was in place [22].

ITS Helps Motorists Find Their Way through In-Vehicle Navigation Systems

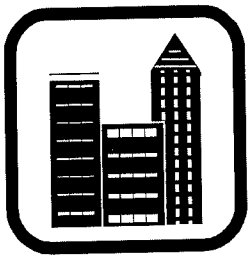
In-vehicle navigation systems help travelers get directions and plan routes while accounting for current traffic conditions.

Orlando, Florida—Both tourists unfamiliar with the city and local drivers tested one of these systems in the city in 1993 and found them to their liking. Motorists made wrong turns one-third less often and reduced their travel time by 20 percent. Travel planning time was slashed by 80 percent, and drivers felt safer, less confused, more confident and attentive to road conditions. Users were



no more likely to be involved in close calls or crashes than were people who didn't have the system in their cars [65].

Los Angeles, California—The Pathfinder project used an in-vehicle navigation and information system, which gave motorists access to real-time traffic information. Travelers perceived that trips were faster and less stressful.



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On-Line Resources

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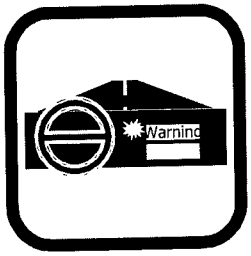

Bibliography & Other Useful References

Glossary

Automated Vehicle Identification (AVI)	a system that combines an on-board transponder with roadside receivers to automate identification of vehicles for purposes such as electronic toll collection and stolen vehicle recovery.
Automated Vehicle Location (AVL)	a computerized system that tracks the current location of vehicles in a fleet. It is used to assist in applications such as dispatching.
Changeable Message Signs	electronic sign on a highway that can change the message it displays. Used to warn and redirect traffic.
Computer-Aided Dispatch (CAD)	uses advanced communications to coordinate and relay information efficiently to vehicle fleets, such as transit buses, patrol cars, emergency-response vehicles, and private carriers.
Commercial Vehicle Information Systems and Networks (CVISN)	the Federally-initiated collection of information systems and communications networks that provide support to trucking operations.
Commercial Vehicle Operations (CVO)	assist the safe and efficient movement of trucks and buses. These systems use electronic screening and vehicle identification systems, advances in administrative functions automation, automated inspections and reporting, hazardous materials response, and on-board monitoring.
Demand Response	segment of public transit designed to efficiently move persons not able to access regular, fixed transit routes. This form of transit is utilized especially for persons with disabilities and senior citizens.
Electronic Toll Collection (ETC)	scanners at toll plazas read transponders on vehicles entering the facility and allow traffic to flow without stopping to pay toll fees.
Federal Highway Administration (FHWA)	agency of the US Department of Transportation that funds highway planning and deployment programs.
Federal Transit Administration (FTA)	agency of the US Department of Transportation that funds transit planning and deployment programs.

Federal Railroad Administration (FRA)	agency of the US Department of Transportation that funds rail planning and deployment programs
HELP/Crescent	a multi-state research effort to design and test an integrated truck-monitoring systems using AVI, AVC, and WIM technologies.
Intermodal Surface Transportation Efficiency Act (ISTEA)	provides the primary federal funding for highway programs in the US. ISTEA authorized increased levels of highway and transportation funding and an increased role for regional planning commissions/MPOs in funding decisions. The Act required comprehensive regional and Statewide transportation plans. [Public Law 102-240, 18 December 1991]. This law expired 30 September 1997.
Intelligent Transportation Systems (ITS)	use of advanced technologies designed to improve the efficiency and safety of urban and rural transportation systems.
ITS Infrastructure	computer, communications, and control systems required to support a variety of ITS products and services in urban and rural areas.
Joint Program Office (JPO)	office of the US Department of Transportation established to oversee and guide the multi-modal National ITS program.
Kiosk	interactive computer center for traffic or travel-related information. Located in shopping centers, hotels, airports, businesses, transit terminals. Provide both recorded and real-time information using text, sound, graphics, and video clips.
Loop Detectors	sensors embedded below the surface of roads and highways that monitor the flow of vehicles and help authorities manage traffic and incidents.
Metropolitan Planning Organization (MPO)	designated with lead responsibility for developing transportation plans and programs for urbanized areas with population of 50,000 or more.
National Highway Traffic Safety Administration (NHTSA)	agency of the US Department of Transportation that whose charge is safety.

National ITS Architecture	establishment of nationally compatible systems linking all modes of transportation. Discourages local or regional areas from developing incompatible ITS implementations.
Ramp Metering	regulation of vehicle entry to a freeway via sensor-controlled freeway-ramp signals.
Smart Card	electronic information systems that uses plastic cards (similar to credit or debit cards) to store and process information. Used in fare-payment and parking applications.
Transponder	electronic device designed to store information. Electronic readers access the information stored on these devices for such functions as toll collection and trucking activities.
Transportation Research Board	serves to disseminate findings of transportation research. Under the direction of the National Research Council.
US Department of Transportation	principal direct Federal funding agency for transportation facilities and programs.
Weigh-in-Motion (WIM)	technology that determines a vehicle's weight without requiring it to stop on a scale.

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Online Resources for ITS

http://www.itsa.org

The ITS America homepage allows members to access a wide variety of ITS-related information. Services include access to a publication library, current news headlines, recent articles, and ITS newsletters. The navigator within the ITS America homepage allows the user to browse other useful sites.

http://www.jhuapl.edu/cvo/frames.html

One of the most comprehensive ITS sites on the web, the Johns Hopkins Applied Physics Lab site provides the latest ITS-related news, provides many ITS links to other websites, and offers a host of papers, reports, and presentation to those interested in learning about all aspects of ITS.

http://www.odetics.com/itsarch

A website contained within the Odetics homepage that deals specifically with the National ITS Architecture. The site includes information on the goals and objectives of the program and detailed information concerning the architecture itself (logical, physical architecture and traceability matrix), analyses and deployment documents, and standards development and requirements documents.

http://nahsc.volpe.dot.gov

This website of the National Automated Highway System Consortium (NAHSC) provides a list of technology demonstrations and workshops available throughout the country as well as dates and exhibit information.

http://www.dot.gov/dotinfo/fhwa/its

A DOT website that provides a comprehensive description of core infrastructure features and information on ITS deployment issues in metro areas.

http://www.its.dot.gov/read

A DOT website that provides a reading room that will become a repository for ITS documents, reports, meeting minutes, past newsletters and updates, brochures, and other ITS material.

http://itsdeployment.ed.ornl.gov

This site contains the FHWA Intelligent Transportation Infrastructure (ITI) deployment databases for 75 metro areas. The site provides detailed information on infrastructure deployments in each of the 75 metro areas, including specific information for five of nine infrastructure components. Cost information is provided in some instances, along with specific ITS technologies used.

http://www.its.dot.gov/links

A DOT website that provides access to results of research, information about ongoing studies and programs, and links to other organizations involved in ITS.

Governmental & Institutional Contacts

American Association of State Highway and Transportation Officials (AASHTO)	Washington, DC 202.624.5880
Federal Highway Administration	Washington, DC 202.366.0660
Federal Transit Administration	Washington, DC 202.366.4052
Institute of Transportation Engineers (ITE)	Washington, DC 202.554.8050
ITS America	Washington, DC 202.484.4847
ITS Joint Program Office	Washington, DC 202.366.9536
National Highway Transportation Safety Administration (NHTSA)	Washington, DC 202.366.9550
Office of Research, Technology Analysis—USDOT	Washington, DC 202.366.4434
Transportation Research Board, National Research Council	Washington, DC 202.334.2936
Turner-Fairbank Highway Research Center (Federal Highway Administration)	McLean, Virginia 703.285.2021

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