Optimizing the system

saving lives saving time

American Association of State Highway and Transportation Officials


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Know the road...
Call or log on.
SERVICES
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Incident
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Conditions
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Optimizing the system

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Foreword

Optimizing is defined as "improving or developing to the greatest extent possible." Optimizing the system describes the mission embraced by most state departments of transportation as they seek the ultimate in the safe and efficient operation of the transportation network we have today.

The need to optimize our transportation system springs from the recognition that growth in demand has far outstripped our ability to provide adequate new capacity. Between 1980 and 1999, the number of vehicle miles traveled on America's roads and highways increased by 76 percent, while capacity grew by only 1.5 percent. Expert analysis estimates that less than half of the new roadway that was needed to handle even current levels of traffic was added in that time.

Our goal must be to make the system work better, safer, and smarter, to both save lives and save time for our citizens. There is no single solution to this challenge, there are many, from the rapid clearing of traffic accidents, to advising motorists of traffic tie-ups or weather delays, to improving highway work zones for the safety of both drivers and workers. There is a tremendous amount of technology that can be deployed, and models that can be used. This AASHTO report showcases examples of what is working well in states across the country.

There are also exciting opportunities within our reach in the next decade. AASHTO is working with the nation's auto industry and the federal government to create a new capability in which vehicles collect and communicate traffic and roadway information to other drivers and to transportation operators. The potential payoffs—in lives saved and delays avoided—are dramatic. The technology is achievable, the incentives are high, and all that is needed is the commitment to work cooperatively to achieve this quantum leap forward.

John Njord

President

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Preface

There is a changing dynamic underway in state departments of transportation across America—a new paradigm in which the agencies that were responsible for building the world's greatest transportation system are now focusing on operating it at its maximum capacity.

That shift has been reflected within the American Association of State Highway and Transportation Officials (AASHTO). The Standing Committee on Highways, which has set the standards for highway construction world wide, has further evolved, creating a new Highway Subcommittee on Systems Operation and Management. A key responsibility of the subcommittee is advancing the deployment of Intelligent Transportation Systems (ITS) and other new technologies, some of which are highlighted in this report. Important leadership is also being provided by the Federal Highway Administration (FHWA), ITS America, and other industry organizations.

As this report reflects, there are many approaches to maximizing the efficiency and safety of our transportation network. The techniques described here benefit the operations of automobiles, trucks and transit vehicles that use the highway system. Other techniques that add to that efficient operation are traffic demand management and shifting traffic from single occupancy vehicles to transit and van pools to ease the demands on our highway system. Those important topics are to be addressed in other AASHTO reports.

The many successful examples depicted in Optimizing the System: Saving Lives; Saving Time are a credit to state DOTs who are making the most of their transportation resources, on behalf of their customers—the public.

John Horsley,

John Horsley

Executive Director

this page, left to right: photos courtesy of Caltrans and VDOT.   opposite page, left to right: photos courtesy of Caltrans and VDOT.

Contents

Argh! Stuck in traffic again

Three lanes of gridlock. You drum your fingers anxiously on the steering wheel, hoping you'll get to the office on time. Tomorrow, you vow to leave the house earlier. But for now, you're going nowhere fast.

Sound familiar? Millions of American motorists battle traffic congestion every day. Some 39,000 miles of highways were routinely congested in 2001, according to the Federal Highway Administration (FHWA).[1] That's enough gridlock to stretch back and forth between New York and Los Angeles nearly 16 times.

Arterial roads (major surface streets) aren't any better. Sixty-one percent of the arterial "lane-miles" in America's 75 largest urban areas were routinely congested in 2001, according to the Texas Transportation Institute (TTI), a research agency based at Texas A&M University.[2]

What causes all this gridlock? About half is "recurring" in nature, meaning it stems from factors that exist daily. Chief among these is a shortage of roadway "capacity," meaning there is simply not enough pavement to handle the traffic volume.

The other half of congestion is "nonrecurring;" it stems from temporary disruptions such as traffic accidents, construction zones and inclement weather. This type is especially aggravating because it can't be anticipated: A minor fender-bender that's not immediately cleared to the shoulder, for example, might turn your normal 20-minute commute into a two-hour ordeal.

But whatever the cause, traffic congestion is more than just exasperating—it's also tremendously costly. In America's 75 largest urban areas, an astronomical 3.5 billion hours of people's time and 5.7 billion gallons of fuel were wasted in 2001 because of congestion, TTI estimates. The cost of these squandered resources? A staggering $69.5 billion, the group estimates.

But as bad as this is, there's an immeasurably more costly and tragic measure of the system's performance: the human toll. Every year, more than 43,000 people are killed and more than three million others are injured in crashes on our nation's roads and highways. Many of these deaths and injuries are directly related to traffic congestion. The economic cost of vehicle crashes annually is over $230 billion dollars.

What's being done to address the situation? Plenty. First and foremost, the federal government and the states are adding new capacity to the system whenever practicable. But this approach is both costly and politically difficult, and it's clearly not keeping pace with the demands being placed on the system. According to the FHWA, the number of "vehicle miles" traveled on America's roads and highways increased 76 percent between 1980 and 1999, while capacity grew only 1.5 percent.[3] TTI estimates that less than half (49 percent) of the new roadway that was needed to maintain even the current congestion level was actually added during the period.

So, in addition to adding whatever capacity they can, many transportation agencies are working to "optimize" the roadway system as it exists today. The goal of this approach is simple: revamp the existing infrastructure so that it can handle more traffic in a safer manner.

introduction

"Travel in this country is growing so fast that we can't keep up with it," says John Njord, director of the Utah Department of Transportation and the current president of AASHTO. "Part of the solution is to build more capacity, but we don't have the resources to solve the problem with new capacity alone. That's why it's critical that we optimize what we've already got."

While transportation agencies are playing a central role in this effort, they are by no means alone. The Optimize-the-System campaign is really a team effort involving many different players—including elected officials, law-enforcement and fire departments, emergency-services providers, private towing and construction companies, and even the automobile industry.

So what exactly, are these groups doing to optimize the system? Currently, much of the focus is on developing and deploying "intelligent transportation systems" technologies, or ITS. These utilize the latest in computer and communications technologies to improve traffic flow and reduce the incidence of crashes and disabled vehicles.

Some ITS technologies are easy to spot. Those closed-circuit television cameras you see along the highway, for example, are ITS components. Also true for dynamic message signs that warn you about hazards up the road. But there's plenty about ITS that you don't see: high-tech sensors embedded in the highway, for example. Computers that run mathematical algorithms to pinpoint traffic tie-ups. And a rapidly expanding wireless communications network that disseminates critical traffic and weather information among transportation officials, emergency responders and the general public alike. ITS technologies such as these are being deployed around the country, and they're doing much to reduce congestion and save lives. Here are few examples:[4]

In Colorado, the installation of a downhill speed-warning system along a mountainous stretch of Interstate 70 led to a 13 percent drop in tractor-trailer accidents.

In Arizona, the synchronization of traffic signals along a major commuting corridor in the Phoenix area boosted travel speeds and decreased crash risk by nearly seven percent.

In California, signal-synchronization projects undertaken along 76 travel corridors across the state decreased the number of "vehicle-hours" of delay by 25 percent.

In Texas, the deployment of dynamic message signs, closed-circuit television cameras and other ITS technologies along 29 miles of highways near San Antonio eased congestion and reduced the number of traffic accidents by nearly three percent.

In New Jersey, the implementation of the E-ZPass electronic toll-collection system reduced delay at toll plazas by 85 percent, saving motorists an estimated $19 million in otherwise lost productivity time and $1.5 million in fuel costs every year.

In New Mexico, the deployment of variable message signs, automated traffic sensors and other ITS technologies at a freeway construction project in Albuquerque reduced the average clearance time for traffic incidents by 44 percent.

Three of the most widely-used ITS technologies—traffic-signal coordination, ramp metering, and incident-management programs—together reduced delay by some 206 million person-hours in 2001, according to TTI.

Most of the ITS technologies described are integrated into the transportation infrastructure; others are incorporated into vehicles themselves. General Motors' OnStar system—available on some vehicles—is of this type. OnStar-enabled vehicles are linked to a customer service center via cellular phone and Global Positioning System (GPS) satellite technology. Motorists stuck in traffic can contact an OnStar advisor to get turn-by-turn directions to an alternate route. Drivers involved in accidents can touch a button to have an advisor alert the nearest emergency-services provider. If a vehicle's air bag deploys, a signal is automatically sent to the OnStar Center, where an advisor will dispatch emergency responders to the scene.

Systems like OnStar are just the beginning. "Intelligent" vehicle technologies now under development can do far more, such as warn drivers when the roadway they're driving on is frozen (and thus hazardous). New technologies can also warn drivers when they're about to rear-end or sideswipe someone, or drive off the road. Some systems will even automatically apply the brakes when onboard sensors determine that a crash is imminent. Early versions of this automated braking technology have been used by the intercity bus industry for buses following too closely.

A Virginia motorist uses OnStar to call for help

Cindy Ensinger was lucky. Cindy, her two daughters, and their dog were on their way home to Virginia Beach, Virginia, one evening two years ago when Cindy decided to pass a vehicle that seemed to be swerving. But as she was passing, the other vehicle inched toward her sedan and forced her off the road, causing her car to roll over three times.

Fortunately, Cindy's car was equipped with General Motors' OnStar system. With the touch of a button, Cindy was able to immediately contact an OnStar advisor, who asked if there was an emergency in the vehicle. "Yes, I need the ambulance! I have three people in the car. I went off the side of the road. Please hurry!" Cindy said.

Using information from the vehicle's embedded Global Positioning System receiver, the advisor was able to pinpoint Cindy's exact location, which he passed along to the local emergency dispatcher. "I probably would have been sitting out in that field unless someone had seen me go off the side of the road," Cindy says. "But since I had OnStar, I was able to push the emergency button and get help for me and my family."

That's not all. Recently, the automobile industry, the U.S. Department of Transportation (U.S.DOT) and AASHTO joined forces to explore the feasibility of a far more ambitious vision: equipping all new cars and trucks with mobility- and safety-enhancing "intelligent vehicle" technologies, while at the same time outfitting roadways and intersections throughout America with ITS technologies. All of the "smart" vehicles, then, would be linked to the "smart" highway infrastructure (as well as each other) via a nationwide, wireless communications network.

The project—still in the exploratory stage—is known as the Vehicle/Infrastructure Integration initiative, or VII. It has "enormous potential" for reducing crashes and enhancing the mobility of the roadway system, says Bill Jones, Technical Director of the U.S.DOT's Intelligent Transportation Systems Joint Project Office.

"The purpose behind VII is to examine the feasibility of establishing a communications link between vehicles and the transportation infrastructure," Jones says. "If every car in the country had this communications link and we had it all over the roadways, we [transportation professionals] could do some things that we have only dreamt about for decades."

The federal government, the 50 state departments of transportation, ITS America, the automobile industry, and other industries are working cooperatively to develop and deploy ITS technologies. That work is vital. More than 43,000 people are killed on the nation's roadways every year. Traffic congestion and delay on rural and urban roads costs the nation hundreds of billions of dollars annually. States can't combat these problems with new capacity alone. They have got to optimize the system. This report takes a closer look at what transportation agencies and their partners are doing towards that end.

Endnotes

1. Dale Thompson, congestion expert, FHWA, interviewed May 26, 2004. The number for the year 2000 (42,500 miles) is cited online at http://fhwa.dot.gov/congestion.tidbits.htm
2. Texas Transportation Institute 2003 Urban Mobility Study, Exhibit A-11, p. 73. Available online at http://mobility.tamu.edu/ums/
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4. Mitretek Systems, "Intelligent Transportation Systems Benefits and Costs: 2003 Update," (Report No. FHWA-OP-03-075), May 2003. Available online at http://www.mitretek.org/its/benecost/BC_Update_2003/index.html

Reducing delay

Unless you live in the hinterlands far off the beaten path, you probably can't hop in your car and drive somewhere without being delayed somewhat along the way. Many things slow us down in our daily pursuits: traffic accidents; construction zones; bad weather; tollbooths; and good-old-fashioned "volume" delays.

Whatever the cause, these delays really add up. According to TTI, drivers and passengers were delayed an incredible 3.546 billion hours—that's 404,794 years—on roads and highways in the nation's 75 largest urban areas in 2001. The average delay was 26 hours per person. The longest was in Los Angeles, where the average road-system user was delayed 52 hours over the course of the year.

About 45 percent of all delay-causing congestion stems from problems that exist every day—the principal ones being too little roadway, poorly timed traffic signals, and lack of fully deployed ITS technologies. The other 55 percent of congestion is caused by "non-recurring," or temporary, disruptions in the traffic flow. About one-quarter of total congestion is caused by traffic incidents, a category that includes everything from disabled vehicles (due to flat tires, overheated engines, etc.), to fender-benders, to overturned tanker trucks. Other non-recurring disruptions include weather (15 percent), work zones (10 percent), and things such as special events (five percent).

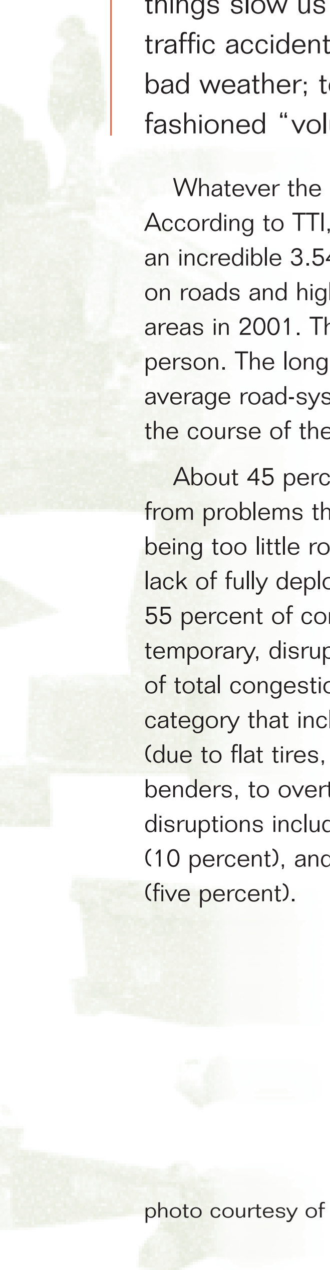


photo courtesy of NJDOT

Traffic incidents

Any sort of incident that blocks a travel lane—from an overheated car to a minor fender-bender to an overturned tanker truck—can cause a lengthy delay if not dealt with immediately. A crash that blocks one lane of a two-lane, two-mile section of freeway for example, could cause congestion to mushroom 250 percent over the "normal" level if the vehicle(s) involved are not moved to the shoulder within 10 minutes.[1] Such an incident would likely delay motorists for hours.

The task of clearing traffic incidents from highways typically involves many different actors, including transportation agencies; law-enforcement agencies; fire and rescue departments; hazardous material (HAZMAT) teams; and private towing companies. State legislators, governors, and other elected officials often help out "behind the scene" by passing laws that expedite the incident-clearance process.

Coordinating the response

Clearing traffic incidents quickly requires coordination, cooperation and communication.

At least 25 states have established "traffic management centers" (TMCs) or "traffic operations centers" (TOCs) as the central hub for managing traffic incidents. Technicians at these centers monitor roadway cameras, evaluate sensor data, and field motorists' calls about incidents. They relay this information as needed to police and fire departments, tow-truck companies, and any other agencies whose presence is needed at an accident scene.

In addition to dealing with traffic accidents, TMCs also perform other system-related tasks, such as timing traffic signals; managing freeway on-ramps and work zones; handling weather-related situations; and disseminating information about these and other matters to the general public so that motorists can make travel decisions.

Inside a traffic management nerve center

Walking into the Statewide Operations Center (SOC) of the Maryland CHART program is not unlike walking into the control room of a nuclear power plant—or at least the Hollywood version of one. More than 24 television monitors of various sizes—including one that measures 16 feet across—cast an electronic glow across the windowless room. Most are mounted in a 40-foot-long, two-story-high "video wall" that forms the back wall of the SOC. The monitors display real-time pictures and video taken by some 60 cameras mounted along various roads throughout the state. Technicians can toggle back and forth between cameras and project different various roadway locations on the monitors as needed. Work-station consoles, each housing a computer monitor, telephone and comfortable swivel chair for the technician, stretch out in front of the video wall. To the rear, behind a wall of smoked-glass windows, is a battery of powerful computers. They run specially designed software that allows technicians to view a host of information on their computer screens, including real-time travel speeds and the location of emergency-response vehicles. With the click of a mouse, a technician can even check the salinity level of a stretch of road on the other side of the state. With this information, the technician can determine if a salt truck needs to revisit an ice-prone area.

Maryland CHARTing the Coarse

The state of Maryland's incident-management program is among the most advanced in the nation. It is part of a larger organization known as the Coordinated Highways Action Response Team, or CHART. In addition to managing traffic incidents, CHART also deals with weather-related emergencies, construction-related road closures, and other issues.

CHART is headquartered near Baltimore/Washington International Airport in a 17,000-square-foot facility known as the Statewide Operations Center, or SOC. Like the traffic it monitors, the SOC operates 24 hours a day, 365 days a year. The facility works in conjunction with several smaller, regional TOCs located throughout the state. The complete CHART program is a joint effort of the Maryland State Highway Administration; the Maryland Transportation Authority; and the Maryland State Police.

To be sure, CHART stays busy. In 2001, program personnel dealt with 4,599 "serious" incidents that blocked one or more freeway travel lanes, according to an analysis conducted by experts at the University of Maryland.[2] CHART also handled 16,555 "minor" incidents involving disabled or abandoned vehicles on freeway shoulders, researchers found. Most of the incidents occurred on freeways in the heavily traveled Baltimore/Washington, D.C. area.

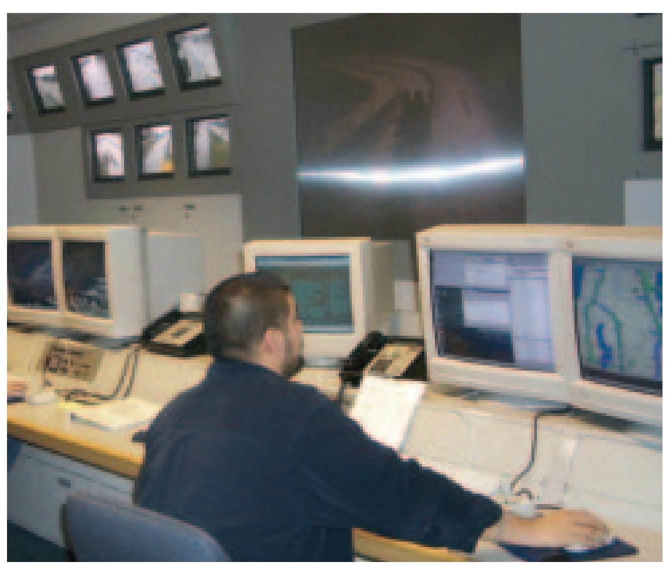


photo courtesy of WSDOT

Clearing major incidents: policy matters

A tractor-trailer rig that overturns on a highway can easily block all available travel lanes, either because of spilled cargo, fuel, or the wreckage of the vehicle itself. Wrecks involving tanker trucks or vehicles transporting other kinds of hazardous materials can be even more devastating. Technically, accidents with an expected duration of more than two hours are classified as "major" incidents. Naturally, these require more responder resources and take longer to clear than do minor fender-benders. And for motorists, that can mean more congestion and longer delays.

Clearing such incidents can require serious hardware, such as cranes, front-end loaders, heavy-duty tow-trucks, highway sweepers, and recovery trucks equipped with "rotators" (for righting overturned trucks). Due to budget constraints, few transportation agencies own outright every piece of heavy equipment they need, so many contract out certain jobs—such as heavy-duty crane work—to private companies. The logistics of these arrangements are usually worked out well in advance.

Clearing incidents quickly requires not only the right equipment, but trained personnel as well. Seventy percent of the agencies surveyed last year by a panel of the Transportation Research Board (TRB) said they provide some form of incident-clearance training to staff members (surveyed agencies include state DOTs, police and fire departments, emergency medical units, and private towing companies).[3] Most of these—82 percent—said they trained jointly with other agencies.

An 18-wheeler rolls over on the highway. The road is littered with smashed-up furniture. The driver is injured and can't talk. Traffic is backing up. What does the response team do? The answer is: It depends.

Different locales have different policies for clearing debris from the road. Fifty-seven percent of jurisdictions in the TRB survey can relocate non-hazardous cargo (such as furniture) from travel lanes without driver consent if necessary. Another 25 percent said they act without permission only if the vehicle operator is not present. Eighteen percent said they require the approval of the vehicle owner and/or a law-enforcement agency before moving spilled cargo. Obviously, this type of policy can result in the lengthiest delays.

Similar differences exist with respect to hazardous materials. To be sure, all jurisdictions commit high levels of resources—hazmat teams, environmental specialists, etc.—to a catastrophic incident such as a completely ruptured tanker truck. But is the same response necessary if a truck leaks just a few gallons of fuel? Some jurisdictions say no—and this policy choice can reduce delays. Roughly 57 percent of the jurisdictions in the TRB survey don't call out hazmat teams to incidents involving "incidental" amounts of spilled fuel. And what agencies define as incidental varies from five gallons in the most restrictive cases, up to 150 gallons.

But any type of incident involving a big-rig can be costly, and some states have stopped picking up the tab. Nearly 40 percent of the agencies surveyed in the TRB report said they have policies or state laws on the books requiring commercial carriers or cargo owners to reimburse them for costs incurred during clearance activities.

Treating traffic fatalities with care

Sadly, people die in traffic accidents—more than 43,000 annually in recent years. Agencies of all types are working hard to reduce this terrible toll, as well as the especially long delays fatal accidents can cause. Such delays can be deadly themselves, due to the increased risk of secondary accidents.

Why can it take so long to clear fatal accidents? One reason is that most jurisdictions—73 percent of the TRB survey respondents—require medical examiners or coroners to respond to crash sites before bodies can be removed. And therein lies the dilemma: medical examiners can be slowed in responding to crash scenes by the traffic congestion the accidents themselves create.

Some locales have decided that the risk of secondary crashes outweighs the practice of allowing only medical examiners to move bodies. Connecticut, Maryland, Virginia, and some parts of Texas and Florida, for example, have policies allowing responders other than medical examiners—such as police or fire fighters—to move bodies in order to expedite the clearance process.

Minor incidents: If you can steer it, clear it!

Policy can also do much to reduce delays caused by "minor" incidents: those not involving serious injury or death, and which can be cleared in 30 minutes or less. These include "fender-benders" and incidents where vehicles become disabled due to flat tires, overheated engines and the like.

States are taking several policy-related steps to expedite the clearance of such incidents. The most common approach is by enacting measures known as "quick clearance" laws. While these take different forms, they are all designed to get vehicles involved in minor incidents out of roadway travel lanes as soon as possible.

At least 14 states have laws on the books requiring motorists to remove their vehicles from travel lanes—even before officials arrive on the scene, if possible—if their vehicles are drivable and no one was seriously injured or killed as a result of the incident.[4] These are generally known as "driver removal" laws. States usually publicize them with catchy names: "Move It," "Steer-Clear," "Steer It and Clear It," and "If You Can Steer It, Clear It," among others.

Closely related are "authority removal" laws. These allow designated responders, such as police and highway-helper teams, to move damaged or disabled vehicles before a tow truck arrives on the scene (and even if the driver objects or is absent). Likewise, some states have "authority tow" laws, which allow pre-designated towing companies to move vehicles before the police show up.

Quick-clearance laws can be extremely effective in reducing delays caused by minor incidents. Their biggest weakness? Motorists don't know about them—especially those requiring drivers to move their vehicles before the "officials" arrive.

That's where education comes in. Many agencies are making some kind of effort to educate motorists about existing quick clearance laws. These include the use of highway signs, billboards, and web sites, and by emphasizing the laws in driver's license testing manuals and high school driver-education courses. Agencies are also reaching out to the media. Some have gotten TV or radio "traffic" reporters to remind their audiences about the laws. Others develop relationships with print reporters. The New Jersey State Patrol and New Jersey DOT, hold special media-education workshops.

Freeway service patrols: the proactive approach

You're driving along the freeway at rush hour when you suddenly get a flat tire. Or your engine overheats. Or embarrassingly, you run out of gas. You manage to get your car to the shoulder, but you're backing up traffic anyway. Stranded on the side of the road, you fear you may be in for a long ordeal.

But then, out of the blue, a tow-truck pulls up behind you. The driver changes your flat tire, or fills your radiator with water, or gives you a gallon of gas. And amazingly, the service is free! The crisis averted, you continue on your way.

Fairy tale? Urban legend? No. Stuff like this happens every day. Many transportation agencies have programs for assisting motorists who run out of gas, suffer flat tires, or encounter other minor problems. Known generally as "service patrols," these programs are designed to get disabled vehicles back on the road as quickly as possible so they won't cause traffic back-ups. If a disabled vehicle can't be repaired on the spot, a service patrol operator will typically offer to tow it to a safe location off the highway—

sometimes even to a nearby service center. Service patrols almost never charge for their services, and operators are usually prohibited from accepting tips.

The Illinois DOT has operated its "Minuteman Service Patrol" program in the Chicago area for decades. The program utilizes medium-duty tow trucks outfitted with a wide variety of tools and supplies, allowing operators to deal with many different kinds of incidents. Minuteman "Emergency Patrol Vehicles," as they are called, are designed so their operators can "grab" stalled or wrecked cars without exiting the cab. This enhances both the safety of the operator as well as the efficiency of the clearance procedure. As the program's name implies, Minuteman operators strive to—and frequently do—relocate disabled vehicles from travel lanes in 60 seconds or less.

The Ohio DOT operates a "Freeway Service Patrol"(FSP) program over some 88 miles of highway in the Cincinnati region. In 2001, the FSP responded to 21,004 traffic-related incidents.

The Tennessee DOT (TDOT) operates its "Freeway Service Patrol" program over about 365 miles of highway in four metropolitan areas: Knoxville, Chattanooga, Memphis, and Nashville. The program has a staff of 89 full-time operators and supervisors. It utilizes some 46 medium-duty patrol vehicles equipped with changeable message boards and other tools needed to respond to different types of incidents. In 2001, TDOT FSP units responded to 12,662 crashes blocking travel lanes or shoulders; 5,910 incidents involving debris; and 5,726 disabled/abandoned vehicles.

Caltrans and the California Highway Patrol (CHP) operate Freeway Service Patrols in several parts of the Golden State. The largest, in Los Angeles County, patrols more than 400 miles of freeways with about 350 tow trucks during peak hours. Last year, the patrol assisted more than 350,000 motorists. Public feedback for the program has been overwhelmingly positive. "We get lots of letters; people absolutely love the program," says Lt. Joe Vizcarra of the CHP, who runs the patrol. "It keeps traffic flowing, and it cuts down on secondary accidents, which prevents injuries and saves lives."

Not surprisingly, these programs are wildly popular with motorists, and the source of many letters of thanks to the agencies that operate them. Here's what one grateful motorist had to say in a letter to the Florida DOT.

Dear FDOT:

I want you to know how much I appreciate your wonderful road rangers. Yesterday my car broke down on I-275 northbound just north of the I-4 overpass. I could not get my car off the road so I was blocking part of the far left lane. I have rarely been as frightened. I didn't even dare unbuckle my seatbelt, because I was certain the next car flying by might be the one that hit me. Your Road Rangers came to my rescue!!! Two Road Rangers stopped. One offered me his cell phone to call for a tow, while they hooked up my car and towed me to safety. Both were kind, courteous, and reassuring. I truly feel that they saved my life. Previous to yesterday, I didn't even know there were Road Rangers, now I thank God for them. I don't know their names, but I want all the Road Rangers to know how much I appreciate the job they do.

Sincerely,
Tracie Patel

Tampa, Florida
Oct. 10, 2003

photo courtesy of MoDOT

Service patrol helps motorists in the mile-high city

In her 25 years of driving, Anne Radecky had never had a flat tire. So Radecky, a resident of Greeley, Colorado, was unprepared when she suffered one while driving on Interstate 25 through Denver a couple of years ago. Fortunately, Radecky managed to maneuver her 1994 Ford Explorer to the shoulder of the busy highway. But as morning rush-hour traffic screamed by just a few feet away, Radecky was sure she was in for a long ordeal.

Joanne McCarthy had a similarly bad experience when one of her tires blew out near the "Mousetrap," the busy interchange between Interstates 25 and 70 in Denver. McCarthy, of Evergreen, Colorado said she felt "vulnerable" as she was stranded on the side of the road during the evening rush hour.

Fortunately for both women—as well as myriad other motorists in the Denver area—the Mile High Courtesy Patrol quickly came to the rescue. A component of the Colorado Department of Transportation (CDOT), the patrol helps motorists whose vehicles run out of gas or become disabled due to flat tires, overheated radiators or various other conditions. As is the case with service patrols in other parts of the country, many Denver-area motorists aren't even aware that the Courtesy Patrol exists until a truck pulls up to help them. Then, stranded motorists are almost always grateful—especially when they learn that the patrol's services are free.

It was such a nice experience," Joanne McCarthy said of the technician who came to her aid on I-25. "I went from feeling vulnerable to uncertain to being very well taken care of."

At present, CDOT's Courtesy Patrol consists of about 14 flat-bed tow-trucks that traverse about 69 miles of highways (as well as a stretch of a major arterial road) in the Denver area. Its primary purpose is to clear disabled vehicles and minor accidents before they cause major traffic tie-ups. The patrol operates weekdays during both morning and evening rush hours. Between rush hours, most of the patrol's 14 drivers work for private towing companies that contract with CDOT for other incident-response functions.

The Courtesy Patrol responds to about 1,000 incidents a month, according to CDOT. Joseph Vialpando, a former deputy sheriff who has worked for the patrol for about two years, says the job is never boring. "The people that you deal with are as different as night and day," Vialpando says. "You never really know what you're going to come up on."

Vialpando's normal "beat" is an eight-mile stretch of I-25 north of downtown Denver. He stays in constant radio contact with a dispatcher at CDOT's Traffic Operations Center, who directs him to some incidents. But frequently, he just comes upon incidents during his routine patrol. What he does then depends on the circumstances: Maybe he adds a little gasoline to an empty tank. Maybe he changes a tire. If he can't fix a disabled vehicle on the spot, he'll offer to tow it to a spot off the highway where the driver can come back for it. That's often the best solution. Vialpando says, because many stranded motorists are in no condition to wait for a private wrecker. "Some people actually have anxiety attacks," he says. "It just scares them to death to be on the side of the highway with other vehicles flying by. So I say, 'let me take you off the highway where it's quieter and calmer, where you won't get killed."

Vialpando has had close calls himself. Earlier this year, a car came careening towards him as he was working on the shoulder. "The guy was over the line, coming right at me," Vialpando says. "He couldn't have missed me by more than a few inches."

Vialpando is especially wary of "secondary" accidents—those caused by "rubberneckers" or people who don't slow down sufficiently for a primary incident. "While you're on one accident, it's not unusual to have another one right next to you, or a few lanes over, or just ahead or behind you," he says. "People drive too fast and crash, or they slow down to take a better look and somebody runs into them."

Despite the constant dangers and challenges of his job, Vialpando finds working on the Courtesy Patrol very rewarding. "A lot of people out there are so pleasantly surprised and happy to find out that we're there to help them," he says. "To me, it's fun. I like helping people."

And the results show…traffic incident management pays off

Reducing delay

Service patrols and specialized incident-management programs can greatly reduce the duration of delays caused by accidents and disabled vehicles. Maryland's CHART program, for example, slashed the time needed to clear traffic incidents by some 43 percent in 2001, from an average of 50.7 minutes per incident to just 28.8 minutes,— saving travelers an estimated 26 million hours of delay.[5]

Enhancing safety

Reducing the time it takes to clear disabled or wrecked vehicles from roadways has a host of spin-off benefits. Among them: reducing the likelihood of "secondary" accidents caused by things such as drivers making sudden lane changes in order to avoid the "primary" accident; drivers plowing into the back of the traffic queue caused by the first accident; and rubberneckers who crash while

above and below: photos courtesy of VDOT and ILDOT

trying to catch a glimpse of the primary accident scene. One study found that the likelihood of a secondary crash increases by 2.8 percent for each minute the "primary" accident continues to be a hazard.[6]

In addition to simply causing further delays, secondary crashes pose especially grave risks for police officers, firefighters and other officials who respond to primary accidents. In 2001, 28 law-enforcement officers, firefighters, and emergency medical technicians were killed in secondary crashes.[7]

Well-designed incident-management programs can reduce these risks. Maryland's CHART program, for example, may have prevented as many as 766 secondary incidents in 2001 through its prompt clearing of primary incidents, according to experts at the University of Maryland.

Saving money

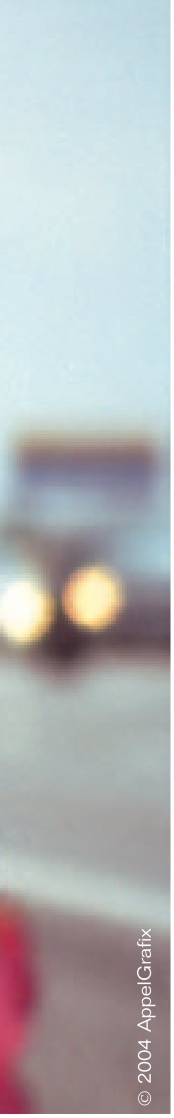
Reducing incident-related delay time has other benefits as well. It saves fuel and reduces the level of emissions vehicles pump into the air. Again, Maryland's CHART program illustrates this point. Researchers estimate that the 25.80 million vehicle-hours of delay "eliminated" by the program in 2001 saved 4.35 million gallons of fuel and kept 4,027 tons of vehicular emissions (carbon dioxide, HC and NO) out of the air.

By affixing per-unit costs to each hour of delay, each gallon of fuel and each ton of emissions, researchers estimate that the CHART program saved Marylanders a whopping $378 million in 2000 and nearly $403 million in 2001!

AASHTO in action

AASHTO is also taking action to improve the way traffic incidents are managed on the nation's roadways. In June 2004, AASHTO convened the inaugural meeting of the National Traffic Incident Management Coalition.

Led by AASHTO and including representatives from the fire, police, emergency medical services, emergency communications, insurance, trucking, towing and recovery, and traffic safety communities. The Coalition's purpose is to advance practices that promote the safe and efficient management of incidents affecting traffic on our nation's roadways. "Although there are some outstanding models



out there, there is much more we can and should be doing nationwide to improve the way we manage traffic incidents," says Coalition Chair John Corbin of the Wisconsin DOT.

The Coalition was formed after an AASHTO Traffic Incident Management Summit in 2002 indicated the need for sustained and focused attention on reducing deaths and traffic congestion resulting from traffic incidents. The Coalition plans to carry out its mission through the development and support of guidance, best practices, technical exchange, and research, and through coordinated public and professional outreach.

Endnotes

1. This hypothetical example is cited by the Transportation Research Board of the National Academies in "NCHRP Synthesis 318: Safe and Quick Clearance of Traffic Incidents,"2003, p. 11. The report is available online at http://gulliver.trb.org/publications/nchrp/nchrp_syn_318.pdf
2. Gang-Len Chang, Pei-Wei Lin, Nan Zou and Ying Liu, "CHART: Real-Time Incident-Management System Year 2001 Final Report," The University of Maryland at College Park, March 2003. Available online at: http://www.chart.state.md.us/downloads/readingroom/CHART_II_Documents/_Toc33869199
3. Transportation Research Board NCHRP report, p. 53.
4. Florida's law is an exception to this rule: it requires drivers to move vehicles even if serious injury or death is involved.
5. CHART: Real-Time Incident-Management System Year 2001 Final Report," op. cit.
6. Karlaftis, M.G., S.P. Latoski, N.J. Richards, and K.C. Sinha, "ITS Impacts on Safety and Traffic Management: An Investigation of Secondary Crashes," *ITS Journal*, Vol. 7, No. 1, 1999, pp. 39–52.
7. Sullivan, J., "Highway Incident Safety for Emergency Responders," Presented at the 2002 Fire-Rescue International, Kansas City, Mo., August 23–26, 2002.

The dreaded orange cones: work zones

You're cruising down the highway, making good time, when you spy the dreaded, blaze-orange sign "Work Zone Ahead." Maybe you knew there was a "cone zone" on your route, or maybe it takes you by surprise. Either way, it's likely to slow you down.

Work zones cause lots of delay on the nation's roadways—a whopping 482 million vehicle-hours of it in 2002, according to the FHWA.[1] And it's no wonder. A full one-fifth of the nation's highway system comes under construction in the summer, the peak road-building season. There are typically more than 6,400 highway work-zone projects every summer, temporarily closing off more than 6,100 lane-miles of roadway to motorists. Why so much construction? To resurface roadways and, ironically, to widen or otherwise improve existing roads in order to reduce—you guessed it—congestion and delay.

But work zones not only cause delay, they are also inherently dangerous. This is the case for numerous reasons: motorists don't slow down enough; they make reckless lane-changes; or they start rubbernecking at the construction scene and rear-end somebody. Indeed, the most common work-zone crash is the rear-end collision. Whatever the cause, work zones are dangerous places for both motorists and construction workers alike. More than 8,000 people have been killed in work-zone crashes in the past decade, and more than 40,000 people per year, on average, are injured.[2]

The best work zones are traffic free: full road closure approaches

Transportation agencies are doing a variety of things to make work zones safer and shorter in duration. One strategy is known as the "full road closure" approach: completely shutting down a section of road while working on it instead of snaking traffic through on one lane, or on the shoulder, or in some other makeshift fashion.

Full road closure is not feasible in every situation. Some locales may simply lack suitable alternate routes, while others may reject the approach due to jurisdictional complications or the impacts full-closure would have on local businesses, among other reasons.

But transportation agencies that have used the full-closure method say it can greatly reduce the time needed to complete a construction project. It can also be safer than the traditional partial-closure approach, advocates say, because it doesn't cause congestion that can lead to accidents. There are other potential benefits as well. Because construction crews can operate more efficiently in a traffic-free environment, full-closure projects can be both less expensive and of a higher quality than those undertaken with a partial-closure approach.

Indiana's "Hyperfix"

Tie up traffic for 180 to 200 days? Over the course of two summers? At a cost of $1 million per day in lost productivity time? That's what the Indiana Department of Transportation (INDOT) calculated it would take to refurbish a dilapidated section of the I-65/70 corridor through downtown Indianapolis using conventional, partial-closure construction methods.

For many in Indiana, that was totally unacceptable. So INDOT devised a full-closure plan, which it provocatively dubbed "Hyperfix 65/70." The plan was bold and risky: it called for 3-1/2 miles of interstate highway in downtown Indianapolis to be completely closed off to motorists for 85 days. Crews working around-the-clock would rehabilitate 33 bridge decks and 35 lane-miles of pavement, as well as

build additional travel lanes in some areas. Under the terms of the deal, the contractor would be paid an additional $100,000 for each day the project came in ahead of schedule. Likewise, the company would be charged $100,000 per day for each day beyond 85. Such incentive/disincentive arrangements are common with highway projects.

INDOT launched the project last May 26. There were plenty of skeptics, including the *Indianapolis Star* newspaper, which warned commuters to brace themselves for what could be the "worst construction season ever."

It didn't turn out that way. On the contrary, the project was completed in only 55 days, a full 30 days ahead of schedule. INDOT Commissioner J. Bryan Nicol hailed Hyperfix as a "huge success." "It was an unusual and risky plan, but it has paid off," Nichol says. "Hyperfix is an innovative model for repairing metropolitan interstates."

Oregon shifts gears

The Oregon Department of Transportation (ODOT) faced a similar situation a few years ago when it concluded that it needed to repave about 33 lane-miles of Interstate 84 in the Portland metropolitan area. ODOT's original plan was to do the repaving at night while keeping the road open with partial closures. ODOT estimated that the project would take 32 nights to complete.

Believing it could do better, ODOT shifted gears and devised a full-closure plan, which it carried out in August 2002. ODOT completed the project in 4.7 days—an 85 percent reduction in duration over the original plan.

Other states have had similarly good experiences using the full-closure approach. Some have saved millions of dollars due to increased contractor efficiency and reduced traffic-management costs. A few examples:

photos courtesy of Caltrans

I-65 Louisville, Kentucky 2 weekends, directional closures	Reduced a 90-day project to 107 hours. Achieved a safer working environment for the contractors and increased productivity. Resulted in a higher-quality end product.
M-10 Detroit, Michigan 2 months, bi-directional closure	Reduced project duration by 71 percent. Reduced maintenance of traffic cost by 75–90 percent. Cited a safer environment for workers and travelers.
I-670 Columbus, Ohio Expected duration of 18 months, bi-directional closure	Expected to reduce project time from four years to 18 months. Estimated cost savings of $8 to $10 million. Expected to increase productivity due to increased workspace.
3 intersections on SR 35 Kennewick, Washington 2 weekends; 2 intersections on 1 weekend and 1 on the second weekend	Reduced project duration by 70 percent on average for each intersection. Eliminated the need for confusing traffic patterns that would have resulted from maintaining traffic through the intersections. Achieved positive public sentiment and support for the use of full closure.
I-95 Wilmington, Delaware 7 months, directional closure	Reduced project duration by 75 percent. Believed to increase the safety of both workers and travelers. Improved public appreciation for DelDOT services.

Other approaches

Besides full closure, states are employing a number of other strategies in work zones in an effort to reduce delays. These include:

Night/Off-Peak Closures: Transportation agencies often seek to limit delays by working construction projects only during "off-peak" hours, usually at night. About one-third of all highway work zones every year are active primarily at night. Some of these are full-road closures; others allow some traffic to pass through.

Limited Capacity Closures: These bar certain types of vehicles but allow others to pass through (e.g., allowing tractor-trailer rigs but not passenger vehicles). This can reduce congestion for motorists on designated alternate routes (because trucks are absent) while allowing commercial truckers to use the regular roadway.

Coordination and planning are key

The key to successfully managing any type of work zone—full closure, partial closure or otherwise—is coordination and planning. Highway projects typically involve many players, including federal, state, and local transportation agencies, private contractors, and police and fire departments. Work zones impact not only motorists, but businesses, schools and neighborhoods as well. Projects go smoother if all of these stakeholders are involved in the process.

In Indiana, stakeholders began planning the Hyperfix project more than a year before the first jackhammer ripped into concrete. This allowed stakeholders to identify and fix problems with the plan early on. One big change involved adding significant capacity to a city arterial street that was to be used as an alternate route. One of the stakeholders, the city of Indianapolis, called for the change after a team of engineering consultants determined that the arterial would not be able to handle the increased traffic volume.

In another cooperative effort, a group of city, state and federal agencies collaborated with IndyGo, the local transit agency, to create a park-and-ride program to shuttle commuters downtown during the closure period. Two shopping centers and another private organization helped out by allowing commuters to use their parking facilities.

Managing traffic during the closure period was a collaborative, coordinated effort as well. The primary players here were the state of Indiana's Traffic Management Center, the Indiana State Police and INDOT's service patrol, known as the "Hoosier Helpers."

Informing the public

If you're going to rip up the road, you've got to tell the public early, often, and in an effective manner. Ideally, people should understand not only how to avoid the

"cone zone," but also why a construction project is necessary in the first place. Transportation agencies commonly do this with mailers, radio ads, TV commercials, news stories, flyers, newsletters, and the internet.

In Indiana, INDOT worked with a public-relations firm to "brand" what became known as the Hyperfix project. In addition to the name, the firm helped INDOT develop a logo—a running construction worker—and other easily identifiable markings to use on highway signs, public transit and printed materials.

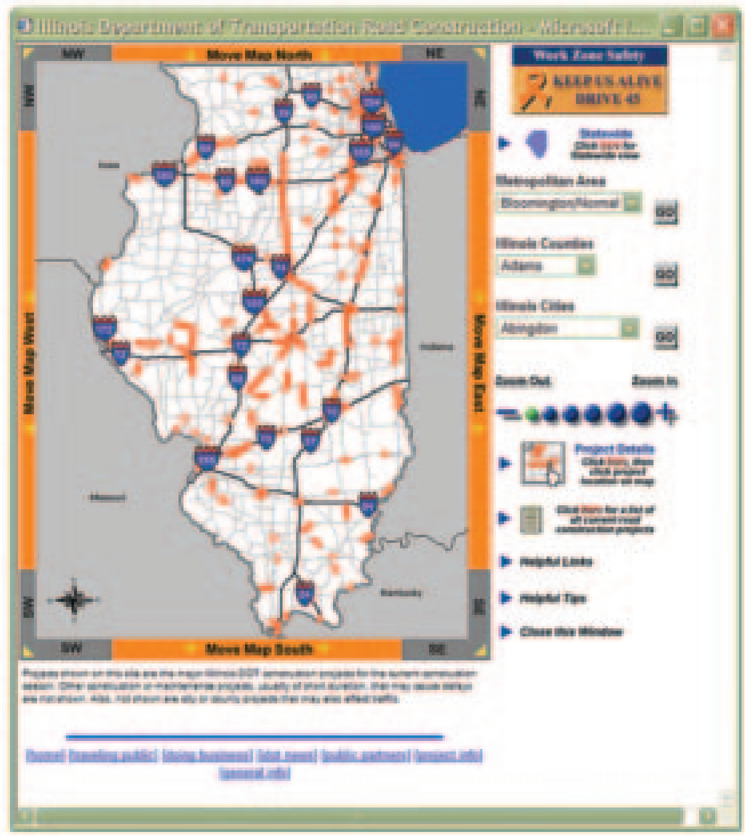
Four months before construction began, INDOT and the public relations firm launched a community-outreach campaign to inform the public (and the media) about the project: why it was necessary; how it was going to be done; and what motorists needed to know to minimize construction-related delays. A quarter of a million maps detailing the project and recommending alternate routes were distributed to the public.

As the construction date drew nearer, INDOT posted its distinctive Hyperfix signs in and around the city. These gave information about the project and recommended alternate routes. Additionally, INDOT used overhead dynamic message signs and portable message signs to convey real-time project-related information to the public. The city of Indianapolis helped out by posting 600 new Hyperfix-related signs downtown and along heavily traveled arterial corridors.

Work zones and ITS

There is widespread agreement among transportation and law-enforcement officials that the most effective way to get motorists to slow down in work zones is to station state troopers—with their vehicle lights flashing—at their entrances. Many locales take this approach when they can, but few have the resources to do it all the time. The same is true of laws that double fines for speeding in work

left and right photos courtesy of WSDOT and MNDOT



zones. While these have some deterrent effect, they cannot be enforced unless additional resources (police or photo-radar systems) are deployed on the scene. A similar problem exists with the "full-closure" approach to road construction. While it can do much to enhance safety, it is simply not feasible for many communities.

Increasingly, transportation agencies are using Intelligent Transportation Systems technologies in work zones. A primary reason for this is to bolster work-zone safety. But ITS technologies also help officials expedite the flow of traffic through work zones, as well as provide real-time information about construction closures to the traveling public.

Credibility Gap

You're driving down the highway when you come upon a fixed, orange sign: "WORK ZONE AHEAD," it says. Then another: "SLOW." Soon, you're proceeding through a narrow aisle of orange cones. But then you notice there aren't any construction workers around. All the machinery is idle. You think, "What am I slowing down for?" So you step on the gas—as you do in the next similarly signed "work zone" as well. Unfortunately, such behavior is quite common: motorists frequently give little "credibility" to "generic" work zone signs, studies have found. Obviously, this can have tragic results.

Safer, "Smarter" Work Zones

Using ITS technologies to advise and control motorists in work zones is a good way to address the "credibility" problem, which, by extension, makes the zones safer, many experts say. The reason is simple. ITS systems can provide motorists with accurate, real-time information—something fixed signs and traffic cones cannot do.

The typical ITS approach utilizes some combination of automated traffic sensors, dynamic message signs, and/or variable speed limit signs to communicate real-time work zone conditions to motorists. One such system is known as ADAPTIR (which stands for Automated Data Acquisition and Processing of Traffic Information in Real-Time).

left photo courtesy of MoDOT

ITS in Work Zones: Providing Real-Time Information To Travelers and Transportation Officials Alike

The Illinois Department of Transportation (IDOT) utilized various ITS technologies as part of a bridge-reconstruction and pavement-resurfacing project along 40 miles of Interstate 55 south of Springfield. The system consisted four portable closed circuit television (CCTV) cameras, eight portable traffic sensors, and 17 remote-controlled portable dynamic message signs (DMSs). Real-time information about the congestion level in the work zone was conveyed to motorists via the DMSs as well as a web site designed for trip-planning purposes. The web site updated congestion levels in the workzone every five minutes.

The Michigan Department of Transportation (MDOT) employed ITS technologies to rebuild 32 bridges and rehabilitate/widen eight miles of Interstate 496 through downtown Lancing. MDOT decided to use a full-closure approach coupled with ITS technologies after determining that it would have taken two full construction seasons to complete the project using conventional, partial-closure methods. Using the full closure/ITS approach, MDOT completed the project about half that time.

MDOT's ITS system consisted of 17 cameras, 12 dynamic message signs, six queue detectors, and a special software package called ITSworkzone that processed and disseminated critical construction-related data to technicians and the general public. The devices were all linked via wireless communications to a computer at MDOT's Construction Traffic Management Center (CTMC).

Real-time traffic information was conveyed to motorists via the dynamic message signs. In addition, MDOT created a public, trip-planning Web site that featured a map displaying real-time average roadway speeds in around the construction area. The site also allowed the public to view camera images of several roadways in the area.

"During construction projects, it is important to provide the most up-to-date information to motorists. By allowing the average citizen to access ITS technology through a video network, roadside kiosks, and on the internet, Michigan is allowing the daily commuter to make informed, educated choices regarding their travel plans." says Terry L. Anderson, Manager, Lansing Transportation Service Center

The New Mexico Department of Transportation used ITS technologies in rebuilding the interchange between Interstates 25 and 40 in Albuquerque. The so-called "Big I" interchange was originally designed to handle 40,000 vehicles a day, but was jammed with some 300,000 daily prior to the redesign that began in 2000. Crews added 111 lane-miles of new capacity and built 45 new bridges over the course of the project, boosting the interchange's capacity to 400,000 vehicles per day.

NMDOT technicians monitored camera images continuously from 5 a.m. to 8 p.m. When a crash or other incident occurred, technicians dispatched a service patrol vehicle to the location. Information from the cameras images and patrol vehicle staff helped emergency response teams to gauge what vehicles they needed to send for the incident, which prevented excessive responses that could have tied up traffic even further.

Real-time traffic information was disseminated to motorists through the dynamic message signs and highway advisory radio, as well as a web site. In addition, people could put their names on a distribution list to have closure updates sent to them daily via email, fax or pager.

The Nebraska Department of Roads (NDOR) is using ITS technologies to improve safety and efficiency in a work-zone project along I-80 in the Omaha area. System components include nine electronic traffic detectors, two mobile camera units, 21 variable message signs and a central computer system. The system informs motorists approaching the construction zone of real-time delays, instructs them to slow down, and advises them to take alternate routes if necessary.

NDOR also posts this information on traveler-information web site. Users can simply click on the color-coded, interactive site to find real-time traffic speeds and other information.[3]

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ADAPTIR uses Doppler radar and/or road-embedded sensors to measure traffic speeds and congestion levels at several points "upstream" and within work zones. Computers analyze the data and post messages reflecting real-time traffic conditions on dynamic message signs. The system can calculate exactly how long a delay will last based on current conditions and advise motorists accordingly. If delays get too long, the signs can be programmed to suggest alternate routes. ADAPTIR comes packaged with prerecorded messages, but traffic managers can also create their own.

To date, more than a dozen states have used the ADAPTIR system in work zones. The Illinois DOT used the system on a bridge-rehabilitation project in Peoria, and the Ohio DOT used it while rehabilitating a stretch of Interstate 75 north of Toledo.

Increasingly, agencies are using ADAPTIR (or similar systems) in conjunction with other ITS technologies to inform the public of real-time conditions in work zones. These include Web sites, voice-activated telephone systems and highway advisory radio, as well as systems that distribute information via email, fax, or pager.

Incoming!

Another type of ITS system is the "intrusion alarm," which is designed to protect work-zone personnel from out-of-control vehicles. Intrusion alarms employ various technologies, such as infrared, ultrasonic, microwaves, or pneumatic tubes, to detect intruding vehicles. When the system detects an intrusion, it sounds a loud siren to warn workers in the area. Workers typically have between four and seven seconds to get out of the way—not long, but better than no warning at all. With some systems, the warning sirens are routed to small devices worn by individual workers. These devices can also warn workers when they venture outside of "safe" zones, as well as activate dynamic message signs notifying motorists that workers are in the travel lanes.

The Pennsylvania Department of Transportation (PennDOT) used an infrared intrusion-alarm system to protect workers on a project on Route 22. The alarms were used in combination with a traffic monitoring and management system that informed motorists about the work zone.

AASHTO Boosts Work Zone Safety

How do you portray the dangers of work zones? How about setting up 868 orange traffic cones topped with black memorial ribbons on the National Mall in Washington, D.C.? That's what AASHTO and several other transportation organizations did a few years ago to commemorate the 868 people who died in work zone crashes in 1999. The event was part of National Work Zone Awareness Week, which is held every April to increase public awareness of work-zone safety. Last year's event was held at a work zone on Interstate 95 near Springfield, Va. John Njord, AASHTO's president and director of the Utah DOT, was one of several transportation officials who spoke at the event. "Drivers, so strongly represented in the work-zone fatality numbers, clearly have a great deal at stake personally. But they can also take steps to keep themselves, and

others, out of such danger. Slowing down and increasing alertness is crucial," Njord said.

National Work Zone Awareness Week is co-sponsored by AASHTO, FHWA, and the American Traffic Safety Services Association (ATSSA), with the cooperation of the American Road and Transportation Builders Association (ARTBA) and the Associated General Contractors (AGC). More information is available online at http://safety.fhwa.dot.gov/programs/wzs.htm

AASHTO, through voluntary contributions of the states, has helped fund a national clearinghouse on work zone innovations housed at ARTBA. Also, AASHTO has launched a marketing of ITS smart work zone approaches through its Technology Implementation Group program and formed a high-level Task Force to advise states and U.S.DOT about setting work zone safety policies and practices.

Endnotes

1. http://www.fhwa.dot.gov/rnt4u/ti/its_wz.htm
2. Federal Highway Administration, "Reducing Congestion and Crashes Through Full Road Closure for Maintenance and Construction," August 2003.
3. http://www.dor.state.ne.us/roadrunner/docs/june-july-04.pdf

Anticipating the weather

Snow may be a boon for kids hoping to duck school, but it can be a headache—a hazard, even—for motorists. The same goes for rain, sleet, fog and other "adverse" weather conditions. Bad weather, in a nutshell, can cause major traffic delays. Nearly a quarter (23 percent) of all non-recurring highway delay is caused by snow, ice or fog, researchers estimate.[1]

Worse, bad weather either causes, or contributes to the occurrence of myriad traffic accidents that kill or injure thousands of motorists every year. In 2001, the latest year for which data are available, nearly 7,000 people were killed and more than 615,000 were injured in weather-related traffic accidents. The FHWA defines "weather-related" crashes as those that occur either in "adverse" weather conditions—i.e., rain, sleet, snow or fog—or on "slick pavement"—that is, roadway rendered wet, slushy or icy by a weather event that may or may not be active when a crash occurs.

For transportation agencies—or taxpayers, really—bad weather comes with a great cost. This is especially true during the winter months. State and local transportation agencies together spend more than $2.3 billion a year on snow and ice removal, and more than $5 billion annually repairing roads and bridges damaged by snow and ice. Trucking companies, too, pay a high price for weather-related delays. Truckers lose an estimated 32.6 billion vehicle hours per year to weather-related congestion, which costs the industry between $2.2 and $3.5 billion annually, researchers estimate.

Different approaches

Transportation agencies may not be able to control the weather, but they are doing a number of things to mitigate its detrimental effects. These efforts fall into three general categories: advisory strategies, control strategies, and treatment strategies. Typically, agencies employ some combination of the three to minimize the effects of bad weather in their jurisdictions. A brief description of each:

Advisory strategies warn people about current and predicted weather conditions. Examples include posting fog warnings on dynamic message signs, and Web sites that provide weather information for trip-planning purposes.

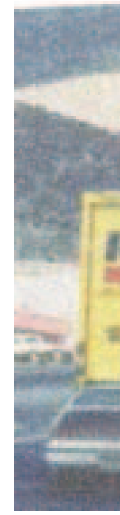
Control strategies limit motorists' actions on roads made dangerous by ice, fog or other weather events. Examples include posting variable speed-limit signs to slow motorists down on certain sections of roadway.

Treatment strategies involve applying materials or services to roads in order to minimize or eliminate their weather-related hazards. Examples include applying sand, salt, or chemical compounds to icy roads.

A high-tech finger in the wind

Just how, exactly, do transportation agencies know when to issue a weather advisory, or close a road, or send out a sand truck? By peering out the window? Hardly. In addition to getting reports from sources such as the National Weather Service or officials (such as police officers) "in the field," many agencies employ their own, sophisticated, high-tech devices to gather weather data. These are known generally as "environmental sensor stations," or ESS. Agencies place them at fixed spots along roadways and equip them with sensors to measure any number of atmospheric conditions, including air temperature and humidity; wind speed and direction; precipitation type and rate; and the location and direction of any storm cells in the vicinity.

ESS systems can also be equipped to monitor "surface" conditions of roadways, such as the temperature of a stretch of pavement and whether it is wet, icy, or flooded. Sensors can even determine the salinity level or concentration of de-icing chemicals on roadways, which allows technicians to determine if more treatment is needed. Still other ESS systems can monitor "hydrologic" conditions, such as the water level of rivers or lakes near flood-prone roadways.



There are currently more than 2,000 ESS devices throughout the country. Most are components of larger, weather/traffic-management programs operated by state DOTs. These systems have one overarching goal: to distribute critical weather data to motorists as well as to agencies responsible for responding to weather-related events. Here are a few examples.

Bucking high winds in Montana

The wind can blow pretty hard in parts of Montana—hard enough to knock over motor homes and other high-profile vehicles. These conditions are especially prevalent along a 27-mile stretch of Interstate 90 in the Bozeman/Livingston area.

The Montana Department of Transportation (MDOT) uses an environmental sensor station (ESS) to monitor for high winds in the area. The ESS is linked to dynamic message signs posted at both ends and in the middle of the 27-mile segment. These components are part of a larger, statewide Road Weather Information System (RWIS), which collects and transmits a wide range of environmental data to transportation offices around the state.

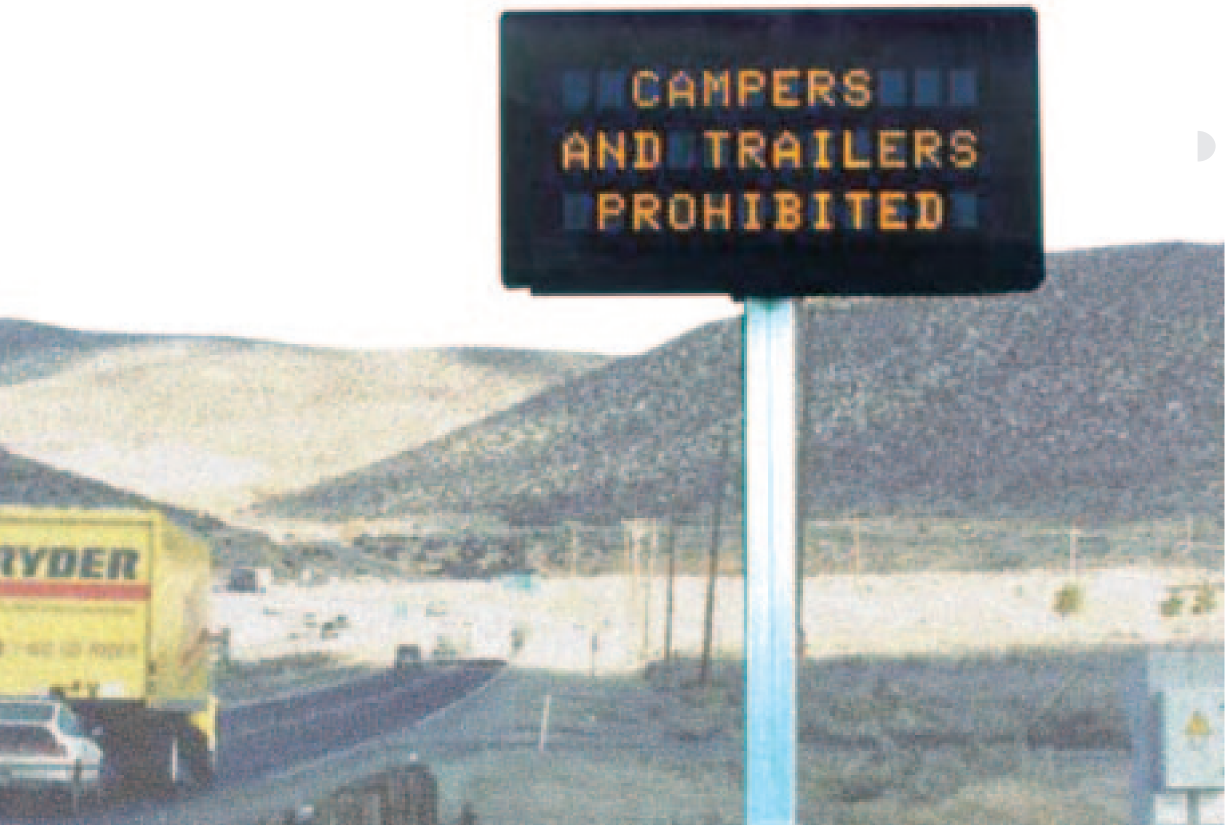
The high-wind warning system is both an advisory and a control strategy. When the ESS detects wind speeds higher than 20 miles per hour, the system automatically posts an advisory message —"CAUTION: WATCH FOR SEVERE CROSSWINDS"—on the dynamic message signs. It also alerts MDOT officials of the conditions in the area. When winds reach 39 miles per hour, a "control"-type message appears on the signs instructing high-profile vehicles to exit or avoid the highway. MDOT also uses the signs to warn motorists of other hazards as well, such as icy conditions.

New Jersey: from plywood signs to high-tech sensors

In the 1950s, when driving on the New Jersey Turnpike was rendered hazardous by snow, fog, or other adverse weather conditions, state troopers would nail up plywood signs along the freeway instructing motorists to slow down.

Times have changed. Today, the New Jersey Turnpike Authority (NJTA) uses about 30 environmental sensor stations (ESS) to monitor weather conditions along 148 miles of the turnpike, one of the nation's most heavily traveled freeways. The sensors monitor various types of atmospheric and surface conditions, including wind speed and direction, precipitation type and rate, barometric pressure, air temperature and humidity, visibility distance and pavement temperature.

Data from the stations is transmitted via a wireless communications system to the turnpike's Traffic Operations Center (TOC) in New Brunswick. The TOC also monitors traffic volume, speed and incidents on the turnpike via sensors embedded in the roadway and closed-circuit television cameras. TOC technicians use this data to warn motorists of hazardous conditions via 113 dynamic message signs and a low-frequency highway advisory radio signal. TOC can also slow traffic speeds on the turnpike as needed (a "control strategy") through the more than 120 variable speed limit signs located along the freeway at two-mile intervals. Both the variable speed-limit signs and the



dynamic message signs can be programmed to inform motorists of the reason for the speed reductions (i.e., "FOG," "SNOW," or "ICE"). Officials say the approach has significantly reduced the frequency of weather-related crashes and the corresponding delays on the turnpike.

Florida: sensors at the beach

There aren't many ways off Clearwater Beach Island, a narrow strip of land in the Gulf of Mexico just offshore from Clearwater, Florida. So when an afternoon thunderstorm rolls through and sends beachgoers scurrying for the mainland, there's a high potential for major traffic back-ups on the Memorial Causeway, the main route off of the island.

The city of Clearwater mitigates this problem with a system that utilizes an environmental sensor station (ESS) that measures rainfall (both amount and rate) at the beach. Other system components include sensors mounted along the causeway that measure the length of the traffic queues on the roadway's inbound lanes. All of the devices are linked to the city's traffic operations center, specifically to the computer that controls all of Clearwater's 145 traffic signals.

The rain gauge at the beach is programmed to alert the traffic-signal computers after a certain amount of rain has fallen. The traffic-queue sensors operate in a similar manner. Once these thresholds are met, the signal-control computer automatically "retimes" the city's traffic signals so that vehicles exiting the island get longer green cycles, thus mitigating congestion and delays. The computer selects the appropriate timing plan based upon traffic volumes. When the volume returns to normal levels, the computer restores normal signal-timing cycles.

How are the roads? Check the web

Currently, at least 39 states operate web sites where the public can view statewide weather data, usually in both "real time" and forecast form. This information can come from a variety of sources, including state-owned ESS systems, the National Weather Service and/or other federal agencies; and university-affiliated or private meteorological service providers. Most of these web sites also provide real-time information about non-weather-related events, such as traffic back-ups caused by accidents or work zones. All the state sites can be reached from www.fhwa.dot.gov/trafficinfo/index.htm.

In Washington State, where highway travel can be impacted by a wide range of weather conditions, the Washington State Department of Transportation (WDOT) operates a traveler-information web site in conjunction with the University of Washington's Department of Atmospheric Sciences.

To make travel decisions, the public may access the site to view state, regional, and local maps featuring real-time weather data, video from roadside cameras, information on road maintenance operations, and travel restrictions on mountain passes (e.g., reduced speed limits, prohibited vehicle types). Information posted on the site is compiled

photo courtesy of NVDOT

from more than 450 environmental sensor stations; 350 closed-circuit television cameras; and other sources such as the National Weather Service. Both WDOT and the university's department of atmospheric sciences participate in formatting the data with sophisticated computer-modeling programs. Much of the information available on the web site can also be accessed through a voice-interactive telephone service.

To be sure, these services are popular: An audit found that the web site had more than 3,700 user sessions a day, on average, in February 2001. Site usage swelled to nearly 13,000 sessions during a snowstorm that month. The interactive telephone service typically receives one million calls each winter (i.e., an average of 8,000 calls per day), with call volumes increasing during inclement conditions or major incidents.

Better approaches to snow and ice

Automated de-icing systems. Proactive anti-icing strategies. Sophisticated snow-removal programs. To be sure, transportation agencies know a lot about keeping roads free of snow and ice. But are there other, better ways that remain untested or undiscovered? An AASHTO initiative known as the Snow and Ice Pooled Fund Cooperative Program (SICOP) is designed to find out. A component of AASHTO's Winter Maintenance Program, SICOP's mission is to discover, test and implement systems and technologies for snow and ice removal that are not yet in use. AASHTO's partners in the venture include local, state and federal transportation agencies, the National Association of County Engineers, and the American Public Works Association, among others. SICOP projects are reviewed at the biannual meetings of AASHTO's Winter Maintenance Policy Coordinating Committee. More information is available online at www.sicop.net

Advanced maintenance vehicles

Snowplows are just big, lumbering dump trucks with blades on the front and sand or salt in the back, right? Not anymore. Modern snowplows—winter maintenance vehicles, more accurately—employ a host of sophisticated technologies to boost their performance and make them more cost-effective.

Long gone are the days when plow operators used CB radios to inform dispatchers of their locations and which roads they had treated. Today, several states track their trucks' movements with global positioning system (GPS) satellite technology, which allows dispatchers to view on computer screens exactly which routes have been serviced and which require attention.

Modern maintenance vehicles can also take the guesswork out of applying de-icing (or preventative anti-icing) materials to roadways. Trucks can be outfitted to carry several types of liquid or granular materials suitable

photo courtesy of MNDOT

for different conditions, as well as on-board sensors and computers to determine the best type and the optimum amount to apply. This information can be stored in trucks' on-board computers for later download, or transmitted directly to traffic-management centers.

Advanced maintenance vehicles also pose fewer risks to motorists. Some have collision-warning systems with 360-degree radar to inform operators of approaching obstacles. If other vehicles get too close, the radar activates strobe lights to alert the encroaching motorists.

The Minnesota DOT has experimented with an even more advanced technology to minimize crashes between plows and cars, as well as between plows and guardrails, and signposts. It involves marking roadway lane stripes with a special magnetic tape. Truck-mounted sensors then "read" the tape and project a video-game-like display on the windshield, allowing operators to see a "virtual" version of the roadway, even if it is covered with snow.

Endnote

1. FHWA web site: http://ops.fhwa.dot.gov/Weather/q1_roadimpact.htm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Rural, but still risky

Increasingly, transportation agencies and local governments are deploying ITS in rural areas — locales with populations less than 5,000 people. There is certainly a pressing need. In 2002, nearly 26,000 people were killed in traffic accidents on rural roads. That's a full 60 percent of all U.S. traffic fatalities for the year—a remarkably high fraction considering that rural roads accounted for less than 40 percent of all vehicle miles traveled that year.[1]

Saving lives in rural areas

Rural roads can be dangerous for a variety of reasons. Some have sharp, unmarked curves, obscured intersections or other design flaws, such as narrow lanes, no shoulders and no edge stripes. Some have poorly maintained surfaces, whether gravel or pavement. Most lack road lights to illuminate these and other hazards, such as animals, at night. In mountainous areas, fast-moving storms can quickly make roads slick and impede visibility. In many cases, people who travel these roads are tourists who are not familiar with them. And when crashes do occur in rural areas, response times can be much longer because (1) they may go unreported for some length of time, or (2) the distances involved. On average, it takes twice as long in rural than urban areas for crashes to be reported and for victims to be transported to hospitals, according to the FHWA.[2]

ITS technologies can help mitigate these rural driving dangers. Automated collision notification (ACN) systems, for example, can dramatically reduce emergency response times. These are vehicle-based systems that use on-board sensors to detect crashes. When a vehicle crashes, its ACN system automatically sends an electronic message to a system or 911 operator. Most ACN systems use global positioning system (GPS) technology to pinpoint the exact location of a crash.

Other ITS applications well-suited for rural areas include "traveler information" systems that provide people with real-time and forecast weather information for trip-planning purposes. Such systems commonly disseminate information via Web sites or voice-activated telephone services, and some allow people to sign up to receive information via email, fax, or pager.

Other ITS application suitable for rural areas include road sensors that detect dangerous weather and/or pavement conditions and display this information on variable message boards; radar-like systems that help motorists avoid collisions with animals; and systems that use transponders and other devices to warn motorists of trains approaching unsignaled railroad crossings.

Of course, rural roads can also be optimized for safety through low-tech means such as improving signage and lighting, or installing shoulder and centerline rumble strips. The Pennsylvania DOT recently installed 300 miles of centerline rumble strips on rural roadways, and state officials estimate that the approach could reduce vehicle run-off-the-road crashes by 25 percent.[3]

AASHTO's "Lead States" effort has a number of strategic guides designed to reduce fatalities along rural roads. Currently 31 states are participating in the first wave of deploying the new safety guides. For further information see safety.transportation.org.

Endnotes

1. U.S. General Accounting Office, "Highway Safety: Federal and State Efforts to Address Rural Road Safety Challenges (GAO 04-663), May 2004. Available online at http://www.gao.gov.new.items/d04663.pdf
2. http://www.nawgits.com/fhwa/sheet4.pdf

A green light for intersection safety

Green means go, red means stop. Those red, eight-sided signs mean stop, too. Yield to oncoming traffic when turning left. With rules as simple as these, intersections should be pretty safe places—right? The statistics say otherwise.

There were more than 2.8 million intersection-related crashes in 2000, which constituted about 44 percent of all crashes for the year. These crashes killed roughly 8,500 people and injured nearly 1 million.[1] Put differently, this amounts to:

One intersection-related crash every 12 seconds;

One intersection-related injury every 30 seconds; and

One intersection-related fatality every hour.

Transportation and safety agencies are doing a number of things to reduce this terrible toll and make intersections safer. Intelligent Transportation System technologies figure prominently in this campaign. Here are just a few examples.

Coordinating traffic signals

Better traffic flow—i.e., fewer stops for red lights—means fewer opportunities for intersection-related crashes, studies have found. Most traffic signals in the United States operate in "time of day" mode, meaning they run a different, predetermined timing pattern depending on the time of day (e.g., morning rush hour, evening rush hour, or off-peak hours).

Coordinating these signals involves tweaking some aspect of their patterns (e.g., light length or sequence), or incorporating other signals—including those in different jurisdictions—into an existing pattern. A cross-jurisdictional effort of this type was conducted along a major commuting corridor in the Phoenix area several years ago. The result was a 6.7 percent reduction in crash risk due to improved traffic flow and fewer stops, studies found.[2]

Other traffic signals function according to real-time traffic conditions. Signals of this type use sensors to measure traffic speeds, queue lengths and other factors. This data is transmitted to computers that cycle the lights in the manner that best minimizes delay and reduces the number of stops motorists must make.

While some transportation officials argue that these types of systems are no better than well-designed time-of-day plans, locales that use them say they make intersections safer because motorists don't have to stop as often. In Oakland County, Michigan, the number of red-light stops decreased by 33 percent after officials outfitted more than 350 intersections with an Australian-designed system known as SCATS (officially, the Sydney Coordinated Adaptive Traffic System). In Los Angeles, some 1,170 intersections utilize a system known as the Automated Traffic Surveillance and Control program, or ATSC. Officials there estimate that the program has reduced red-light stops by 41 percent.

Emergency vehicle preemption

This technology allows fire trucks, ambulances, and other emergency vehicles to take control of traffic signals as they approach intersections. These systems consist of special control devices mounted atop traffic signals that approaching emergency vehicles can trigger with onboard radio transponders, light, or sound. By giving themselves green lights and vehicles on cross streets red lights, emergency vehicles can both avoid accidents and improve response times.

Collision-warning systems

A car is stopped at a red light. The light turns green. The driver, sensing no danger, proceeds into the intersection. Suddenly—she's broadsided by a red-light runner.

Such accidents would be less common if people took extra caution to look before proceeding. But what if our cars—or even intersections themselves—could watch out for red-light-runners for us? They will. Even now, researchers are developing such intersection "collision-warning systems," as they are known. These systems utilize various types of sensors and computer technologies to identify vehicles that are traveling too fast to stop for red lights or stop signs. Some are entirely "infrastructure based," meaning their components are incorporated into the confines of individual intersections. When they detect potential red-light runners or other dangerous vehicles, they warn motorists waiting on cross streets by preempting traffic signals, or by triggering some type of warning device—a strobe light or a siren, for example—mounted in the intersection.

Other systems now being tested are of the "infrastructure-to-vehicle" variety, meaning devices located in an intersection detect potentially dangerous vehicles and transmit warning messages directly into vehicles waiting on cross streets. Still other collision-warning systems are entirely vehicle-based.

Last year, the FHWA opened an "intelligent intersection testing facility" in McLean, Virginia, to develop and test these technologies. One system under development there is the brainchild of the California DOT and researchers from the University of California. It uses road-embedded sensors, a roadside computer to warn drivers when it is unsafe to make a left turn. Researchers from the University of Minnesota and Virginia Tech University are also testing systems at the center, which is a component of the FHWA's "Intelligent Vehicle Initiative," (IVI).

Endnotes

1. http://safety.fhwa.dot.gov/fourthlevel/intersafagenda.htm#intro
2. Zimmerman, C., et al., Phoenix Metropolitan Model Deployment Initiative Evaluation Report, FHWA OP-00-15, Washington, DC, 2000.

Making the existing system work better

This much is clear: traffic congestion causes delay. It also makes driving more dangerous. To be sure, both of these problems can be addressed by adding more roadway capacity. But this approach alone isn't enough. In a report released last year, TTI concluded that it would be almost impossible to attempt to maintain a constant congestion level [today] with road construction only.

This is why states are also focusing on how to make the existing system work better. Here's what transportation agencies are doing to "optimize" America's freeways and arterial roads, the two biggest components of the system.

Freeway management

Many locales have specialized "freeway management" programs to keep highway traffic moving as efficiently as possible. These programs overlap with initiatives designed to handle traffic incidents, bad weather, and work zones, since these are all causes of freeway congestion. Thus, freeway-management programs typically operate out of traffic-management centers (TMCs), where technicians monitor highway conditions via closed-circuit television cameras and road-embedded traffic sensors. Some TMCs gauge traffic speeds with sensors that track vehicles outfitted with electronic toll-collection tags or other technologies—maintaining anonymity for drivers of course! TMCs also monitor traffic conditions by fielding 911 calls from motorists, as well as reports from police, service patrols and media helicopters, among other sources.

Understanding conditions on the roadways enables operators to take timely and appropriate actions to maintain the best possible traffic conditions. These actions may include identifying and clearing incidents quickly, opening or closing traffic lanes, adjusting signal timings, or simply providing good information to motorists about what to expect during their commute.

Ramp metering

One tool in the freeway management arsenal is "ramp metering," or regulating the flow of traffic onto freeways from entrance ramps. This is done with traffic signals on the ramps that allow vehicles to enter only at certain intervals; e.g., one every two seconds or every two minutes. The goal is to create more space between entering vehicles so they do not disrupt the mainline traffic flow. Metering also makes it easier—and thus safer—for vehicles to merge onto busy freeways. Automated traffic sensors or, sometimes, technicians monitoring cameras in TMCs control the rate at which vehicles enter a highway.

The benefits of ramp metering can be significant, according to agencies that use it. Studies have found that ramp-metering can:

- Reduce crashes by 15 to 50 percent;
- Increase freeway travel speeds by 8 to 60 percent; and
- Increase vehicle throughput by 8 to 22 percent.

Study: ramp-metering works in the Twin Cities

How do you know if freeway ramp meters really work? Turn them off and see what happens. That's what the Minnesota Department of Transportation (MnDOT) did—or rather, was ordered to do—a few years ago with more than 430 meters in the Minneapolis-St. Paul area. The results were very interesting.

MnDOT had long used the ramps as part of its freeway-management program in the Twin Cities region, and the transportation agency believed they were effective.

photo courtesy of MNDOT

But in the late 1990s and into 2000, some motorists—and politicians—believed otherwise. These critics argued that the meters did more harm than good because they forced motorists to wait too long on entrance ramps before allowing them to merge onto highways. Motorists were indeed kept idling on ramps for a seemingly long time: The average meter-related delay during morning and evening rush hours was 6 minutes, and delays of 15 minutes or more were not unheard of, surveys found.[1] Critics argued that the cumulative impact of the ramp delays far outweighed any benefits that the meters brought to mainline freeway traffic. In a survey taken in mid-2000, 21 percent of the respondents voiced support for a complete shutdown of the ramp-metering system.

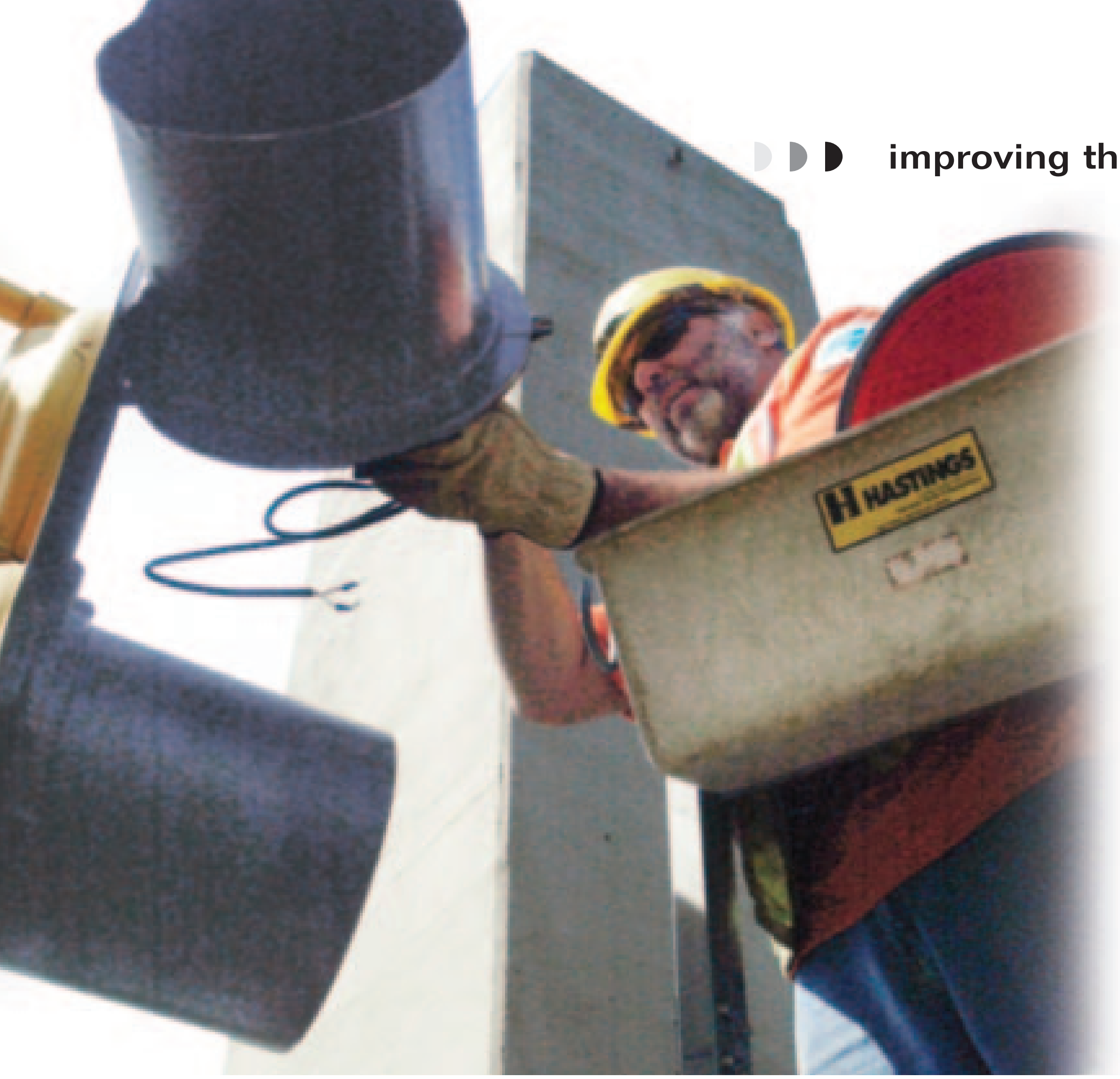
Prompted by these concerns, the Minnesota state legislature passed a law in 2000 requiring MnDOT to study the ramp-metering program to see if its benefits really outweighed its costs. Supporters of the measure suspected that the opposite was true.

MnDot first profiled traffic conditions with the meters "on" by quantifying average traffic speeds, travel times, hours of motorist delay, and the number of freeway accidents, among other factors. Then, as mandated by the law, the agency turned the meters off and measured the same factors so comparisons could be made.

The meters were shut down in October 2000 and stayed closed for more two months. To be sure, some motorists welcomed the meter-reprieve. "I'm so happy they're off [and] I hope they stay off," said commuter Mary Wiersum of Shorewood, Minn., on the second day of the shutdown. "I just can't stand them—they are way too controlling."

But others felt differently. Brian Peters of the Minneapolis suburb of Champlin said his morning work commute took 10 to 20 minutes longer without the meters. Peters said he'd have to pack up and move closer to the city if the meter program was shelved for good. "I can't wait until they turn them back on, personally," Peters said during the first week of the shutdown. "If I hit 45 minutes every day each way to work, I'm heading back to the city because that's taking away from my personal time."

The meters were eventually turned back on. The study comparing traffic conditions "with" and "without" the meters was released in February 2001, with some interesting results.



Travel speeds/delay: Turning the meters off reduced mainline highway travel speeds by 8 to 26 percent. Because of these slower travel speeds, highway users were delayed approximately 25,121 hours more than they would have been had the meters been operating during the test period.

Traffic volume/throughput: Turning the meters off reduced the volume of traffic that highways could handle by an average of 9 percent, and by 14 percent during peak travel hours.

Safety: Turing the meters off resulted in 26 percent more crashes on freeway ramps than would have occurred had the meters been operating. Put differently, the study found that ramp metering prevents 1,041 crashes per year, or about four per day.

Emissions: Keeping the meters on results in a net annual reduction of 1,160 tons of emissions.

Fuel consumption: Keeping the meters on causes fuel consumption to rise by 5.5 million gallons per year. This was the only criteria category which was worsened by MnDOT's ramp-metering program.

The bottom line: All things considered, ramp metering saves the Twin Cities' traveling public approximately $40 million annually, the study found.

Since many motorists (and politicians) found the 10-15 minute meter delays unacceptable—MnDOT has modified the program so that drivers will wait no longer than four minutes to enter a freeway, and no longer than two minutes at freeway-to-freeway meters. To make the modification, MnDOT installed more than 4,000 new pavement-embedded sensors on entrance ramps. When the sensors determine that ramp waiting times are getting too long, they tell the traffic-control computers to speed up the cycling of the meter signals.

Lane-use management

Some transportation agencies use high-occupancy vehicle (HOV) lanes to facilitate the flow of freeway traffic. This approach is most commonly used in major metropolitan areas where freeway congestion is severe. HOV lanes, or "carpool" lanes as they are sometimes called, are reserved for buses and passenger vehicles occupied by more than one person. Most agencies set the lower

left to right: photos courtesy of WSDOT and Caltrans

limit at two or three people, but this can vary according to local traffic conditions.

HOV lanes have a number of benefits. Since most people drive alone, these lanes are seldom congested, which makes travel easier for people who share the ride. But HOV lanes benefit solo drivers as well by encouraging carpooling and public transit, which reduces the overall number of vehicles on the road. This, in turn, can have the added benefit of reducing exhaust emissions.

HOV lanes are typically located next to regular, "unrestricted" freeway lanes. There are various types. Some, called "concurrent flow" lanes, route traffic in the same direction as adjacent, unrestricted lanes. Others, called "contraflow" lanes, route vehicles down the "wrong" side of the highway behind concrete barriers separating them from oncoming traffic. "Reversible" HOV lanes, usually located in the highway median, flow in one direction in the morning, then in the opposite direction in the afternoon—getting maximum use for minimum roadway space.

Some states operate their HOV lanes only during rush hours, when they are most likely to save time for car-poolers. During off-peak hours, these states either open the lanes to all traffic, or simply close them until the next scheduled opening. Other states operate their HOV lanes around the clock.

There are currently about 100 HOV projects nationwide, representing more than 1,100 route-miles. While results vary, nearly all states with HOV lanes say they increase the efficiency of their freeway systems.

Pre-trip traveler information

Planning a long trip? Wondering what route to take? You could consult your two-year-old road atlas, or that old map you bought at the gas station five or six years ago. Or, you could go online and see how work zones, weather, traffic accidents, and other factors are affecting travel on your intended route right now. You can get information about future road closures and weather forecasts, too.

Many state DOTs operate such web sites. They function as freeway-management tools because they help motorists to make more informed travel plans. Many feature interactive maps that display information such as:

- **Real-time** travel speeds;
- **Travel times** between various locales (based on current roadway conditions);
- **Real-time weather** conditions and weather forecasts;
- **Work zone information**, including lane and/or total road closures; and
- **Location and status** of disabled vehicles and traffic accidents.

Special event in town? Check ahead for traffic information

Driving in the Washington, D.C., area can be challenging even under "normal" circumstances. Special events—presidential inaugurations, the Fourth of July, etc.—can ratchet up this challenge exponentially. Such was the case during the summer of 2004, as the nation's capital prepared to host the state funeral for former President Ronald Reagan.

Transportation agencies throughout the region used the media, dynamic message signs, the Internet and other means to keep motorists apprised of funeral-related road closures, which occurred—and changed—with little or no warning. While the roads were congested, officials said the situation would have been a lot worse had it not been for the traveler-information campaign. "The evidence from this week is that when people have good information, they will respond," said Dan Tangherlini, director of the D.C. Department of Transportation.[2]

Some traveler-information sites are cooperative efforts between multiple transportation agencies. An example is the Gary-Chicago-Milwaukee (GCM) Priority Corridor initiative—a joint effort between the Illinois, Indiana, and Wisconsin departments of transportation—as well as several transit, tollway, and metropolitan planning organizations. People who log on to the coalition's web site (www.gmctravel.com) can check travel conditions on 2,500 miles of roadway throughout a 16-county region encompassing the Gary, Chicago, and Milwaukee metropolitan areas. Information on the site is collected via traffic sensors, cameras and other means, and is updated once a minute.

511: the only number you need to know

No computer? No problem! Traveler information is readily available via America's most popular means of communication—the telephone. State DOTs and other agencies have established more than 300 telephone numbers in the past decade that people can call to get traffic and weather information. Like traveler-information web sites, these systems disseminate both real-time and forecast weather and traffic information. Most organize data into sections that callers can access using their telephone keypads. Some systems are voice-activated and can recognize certain words spoken by callers, such as the names of freeways in their coverage areas.

Over the years, perhaps the biggest shortcoming of these systems was that people didn't know what number(s) to call—especially when traveling through several systems' coverage areas. Fortunately, this has been getting easier in recent years thanks to the so-called "511" program, which is an effort to replace the hundreds of traveler-information telephone numbers with a single, nationwide, easy-to-remember three-digit dialing code: 5-1-1. The program was launched in 1999 at the behest of the U.S.DOT, 17 state DOTs, and a host of transit and city-planning agencies.

511 service is currently being deployed across the country. As of April 30, 2004, it was available in 21 locations in 20 states. Many of the now-active systems are statewide, while a few cover only metropolitan areas or Interstate Highway travel corridors. All told, these areas are home to more than 56 million Americans, or about 19 percent of the nation's population.

The "basic" function of 511 systems is to provide the public with information on road and weather conditions. But increasingly, states are "enhancing" their systems so callers can get other types of data—such as point-to-point travel times, or information about local tourist attractions or public transit (e.g., bus and/or train

schedules). States are also enhancing their systems to broadcast "Amber Alerts" about missing children. Here's a sampling of what states are currently doing with 511.

In the San Francisco Bay Area, 511 callers can obtain estimated, real-time travel times between cities or major landmarks, as well as information about crashes or disabled vehicles along the way. The system is voice-activated, so callers need only ask for "Driving Times" and then say their starting and destination points (e.g., "Oakland" to "PacBell Park." The system will then provide the current driving time between the two points.

Vermont's state-wide 511 service, launched in early 2003, offers information on traffic, road and weather conditions, tourism, public transit, and ferry schedules. Vermont has formed a coalition with its neighboring states of Maine and New Hampshire to provide region-wide travel information via 511 or the Internet.

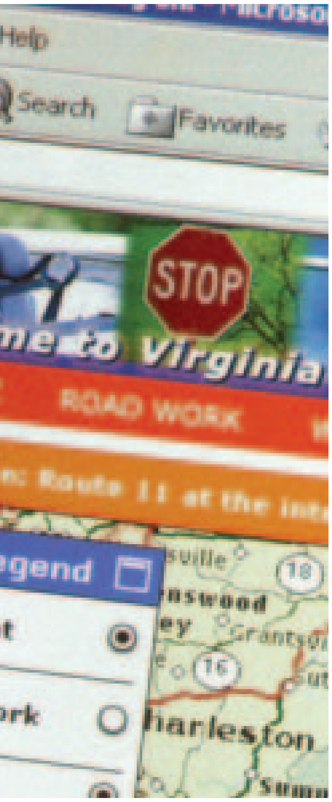
Washington's state-wide 511 service currently serves more than six million residents. It provides information on traffic conditions, mountain pass and road weather conditions, and public transit, including ferries.

Maine's state-wide 511 service provides information on weather-related road conditions, traffic incidents and public transportation, including real-time transit information for the Acadia National Park Region.

New Hampshire's state-wide 511 service offers information on traffic incidents, weather, and road and bridge construction

Utah's state-wide 511 service provides a host of information on public transportation. During the 2002 Olympics in Salt Lake City, 37 percent of the calls to the 511 system were transit-related. The state is planning to add real-time light rail information to its 511 system. Last year, Utah recently enhanced service to broadcast AMBER alerts.

Kentucky's 511 service provides information about tourism as well as basic road and weather conditions. The state's service may soon offer live operators who can suggest alternate routes around major accidents. Kentucky is also working to form a travel-information coalition with its neighbors Indiana and Illinois.



Kansas's state-wide 511 system, launched in early 2004, provides information on routes, current and forecasted weather, and construction and detour information. The system also broadcasts AMBER Alerts, Homeland Security Alerts, and general transportation alerts.

511 is clearly very popular. To date, more than 16 million calls have been placed to 511 systems around the country. By switching from their old traveler-information numbers to 511, agencies have seen their call volumes increase by as much as 600 percent. Moreover, surveys show that people are finding 511 systems very useful. In Southeast Florida, for example, more than 97 percent of people surveyed reported changing a driving route at least once based on information from 511.

AASHTO spearheads 511 deployment

The responsibility for deploying 511 systems where they do not yet exist rests mainly with the states. AASHTO and a host of other transportation organizations have created an organization called the 511 Deployment Coalition to provide leadership on a national level. The Coalition has developed voluntary guidelines for states to follow when planning and deploying 511 services in their states or regions. The coalition has established a number of deployment goals, such as:

By 2005:

511 will be operating in 25 or more of the states.

At least 30 of the top 60 major metropolitan areas and more than 50 percent of the nation's population will have access to 511.

More than 25 percent of the nation's population will be aware of 511.

More than 90 percent of 511 users will be satisfied with the service provided.

By 2010:

511 will be operating throughout the United States.

Over 90 percent of the nation's population will be aware of 511.

All of the users will be satisfied with the service provided.

left and right photos courtesy of VDOT

En-route traveler information

While many people call 511 or consult traveler-information web sites before leaving home, motorists can of course use these services "en-route" with cell phones and wireless communications devices. But a more common way for motorists to get real-time travel information en-route is by simply reading variable message signs (VMS) along the roadway. Also known as dynamic or changeable message signs, these devices can be operated automatically by road-embedded sensors, or manually by technicians in traffic management centers. Either way, the signs are used to communicate a host of real-time travel information to motorists. Common types of messages include:

Incident messages that inform travelers of accidents, disabled vehicles, work zones, slippery pavement, and other issues that may cause delay on the roadway. The signs often specify exactly where a problem is located and which lanes are affected.

Travel-time messages that inform motorists of how long it takes, under current conditions, to drive between major points along the highway system.

AMBER alerts for missing children, emergency information, and public safety notices, such as the "Click It or Ticket" seat-belt campaign.

Arterial/corridor management

Arterial roads (major surface streets) aren't any better than freeways when it comes to traffic congestion. Nationally, 61 percent of the arterial "lane-miles" in America's 75 largest urban areas were routinely congested in 2001, according to TTI. Not surprisingly, very large urban areas—those over three million in population—generally beat this average. The New York and Los Angeles metropolitan areas both registered 65 percent, while the Boston, Chicago, and Washington, D.C. regions all registered 75 percent. A somewhat smaller metropolitan area—Denver—led the nation in arterial congestion with 80 percent. And notably, even small urban areas—those with fewer than 500,000 people—ranked high in arterial congestion. The Eugene/Springfield, Oregon area, for example, registered 75 percent in 2001—double the figure from 1982. Transportation agencies are doing a number of things to address these problems. Among them:

Traffic signal systems

Traffic signals have a lot to do with how well traffic flows on arterial roads. Much (though not all) of the delay that motorists experience on arterial roads stems from red lights at signalized intersections. But it's not just the time that motorists sit waiting at red lights that constitutes this delay—it's also the rear-end collisions and other crashes that occur when drivers have to stop for red lights.

Transportation agencies commonly address this situation by "coordinating" or "synchronizing" traffic signals along major arterial corridors so that motorists don't have to stop as often. This is accomplished in different ways, depending on whether the signals to be coordinated are "pre-timed" or "actuated." But in any event, coordinating signals can be an effective way to reduce delay:

A 2001 study found that signal-coordination projects undertaken along 76 corridors in California cities reduced vehicle delay in the corridors by 25 percent.[3]

An study sponsored by the Minnesota DOT found that coordinating traffic signals along an arterial corridor to accommodate adverse winter weather conditions yielded an eight percent reduction in delay.[4]

Transportation agencies in all 75 of the nation's largest urban areas coordinated their traffic signals to at least some degree in 2001, according to TTI. In sum, these coordination efforts reduced delay by approximately 16 million person-hours, the group estimates.

Integration is key

To be sure, coordinating traffic signals can be technologically challenging. But frequently, the most important determinant of success is jurisdictional cooperation. This is because arterial corridors commonly pass through multiple jurisdictions, so all must synchronize their signals together

Illinois: fighting arterial congestion with teamwork

Traffic can get pretty bad in Lake County, Illinois, a fast-growing county of about 645,000 people just north of Chicago. So the county is partnering with both the U.S.DOT and the Illinois Department of Transportation (IDOT) to implement a multi-pronged Intelligent Transportation Systems program. One aspect of the initiative, dubbed the "Lake County Passage" program, entails synchronizing a host of state-and county-owned traffic signals along several busy arterial corridors. The signals' timing patters will be adjusted according to real-time information in order to maximize traffic flow and improve travel times through the entire corridor. Future plans call for the addition of municipally-owned traffic signals into the synchronized network.

The county is also building a new Traffic Management Center (TMC) to serve as a headquarters for its new ITS technologies. The center, which will also handle dispatch and incident-response efforts, is being built in the town of Libertyville with funds and assistance from the U.S.DOT. Ultimately, officials plan to add dynamic message signs, highway advisory radio, a traveler-information web site and other features to the program.

"We [will] be able to determine where the congestion is [and decide if] we need to re-route traffic, re-time the traffic signals, that sort of thing," says Marty Buehler, Lake County's director of transportation. Eventually [we'll] put this [information] out on the web so people can look it up themselves."[5]

if traffic flow is to be improved. A city public-works department, for example, may agree to work with a state DOT to synchronize traffic signals they operate at different points along an arterial road. Sometimes these are formal, written agreements; sometimes they are not. Such as:

In Pennsylvania, the city of Philadelphia has several informal agreements with neighboring townships to provide arterial signal coordination. In general, the agreements allow the city to synchronize some of the townships' traffic signals with its own in order to improve traffic flow on arterial roads that pass through both jurisdictions.

In Colorado, a multi-jurisdictional agency called the Denver Regional Council of Governments (DRCOG) led an effort to synchronize 49 traffic signals along four major arterials in suburban Denver. The project synchronized signals in three different jurisdictions: the city of Greenwood Village, Colorado; Arapahoe County, Colorado; and the Colorado DOT. The project resulted in a 13 percent reduction in travel time and a 17 percent improvement in travel speeds in the area, according to DRCOG.

Clearly, true integration must include cooperation on arterial and freeway systems, transit systems, public safety, and emergency management. The key is agencies exchanging data and working together to make regional networks function as a single system.

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PAY TOLL – 1 MILE
E-ZPass
LEFT LANE
CASH
TICKETS

ITS: keeping America truckin'

All those tractor-trailer rigs motoring to and fro on America's streets and highways are enormously important to the nation's economy. Trucks transported some 10.8 billion tons of goods worth an estimated $7.4 trillion in 1998, and experts say the trucking industry will play an even bigger role in the future due to population growth and increasing international trade. [1]

That's the good news. The bad news is that all this growth and prosperity is putting tremendous strains on the nation's freight-transportation network. This is affecting all freight-transport modalities, including the shipping, railroad and air-freight industries. But it is especially problematic for the trucking industry, which must share its infrastructure—the highway system—with a large and ever-increasing number of passenger vehicles. And to make matters worse, the number of vehicle miles traveled on America's roadways is increasing much faster than we are adding new roadway capacity.

Weight not

Truckers get delayed for many of the same reasons other motorists do: traffic accidents, bad weather, work zones, and good-old-fashioned volume delays, among others. They also lose time for other, unique reasons, such as mandatory weigh-station and records-inspection stops.

But this is changing, as many states are employing electronic clearance and other capabilities to speed up the inspection process and help officials target unsafe vehicles.

Electronic clearance systems generally work this way: truckers first submit their credentials and truck records so that they (and their vehicles) can be identified by the program. Participating trucks are then equipped with transponders that communicate electronically with roadside readers installed in advance of participating inspection stations. The readers are connected to a computer system inside the inspection station that verifies the vehicle's credentials and indicates any potential problems. If a truck's credentials are in line, the in-cab transponder picks up a green "go ahead" signal from a second roadside reader meaning it does not have to stop at the station. Many inspection stations today are also outfitted with "weigh-in-motion" (WIM) scales, and officers are equipped with hand-held computer technologies that significantly speed the inspection processes within stations as well. Such technologies save time and fuel for truckers and reduce the safety hazards of trucks leaving and entering the roadway. They also allow scarce inspection resources to be used to target the most dangerous trucks.

PrePass and NORPASS—saving time, fuel, and big money

One such electronic clearance system, PrePass, is a partnership between a number of private trucking companies and various state governments. In June 2004, PrePass was operational in 242 locations in 24 states, with more than a quarter of a million trucks enrolled in the program. On average, truckers save at least five minutes and a half-gallon of fuel with each weigh-station bypass, according to Heavy Vehicle Electronic License Plate, Inc. (HELP), the Phoenix-based organization that operates the program. That means at its present level of implementation, PrePass is saving the trucking industry 200,000 hours of productive time and nearly one million gallons of fuel every month, notes HELP president Dick Landis.

"These PrePass-equipped trucks are bypassing weigh stations more than 2.4 million times each month, and the industry's time and fuel savings associated with these bypasses are staggering," said Landis says.

A similar system, The North American Preclearance and Safety System (NORPASS), has about 67,000 registered trucks and is operational in five states.

Commercial vehicle information systems and network (CVISN)

ITS applications aren't limited to weigh stations—they can be used to facilitate a wide variety of procedures for commercial vehicles of all types. ITS may help with border-crossing procedures, licensing and registration requirements, and regulatory processing, among other things. What these activities have in common is that each requires a great deal of paperwork—and in many states the term paperwork applies literally, fully electronic processes are not yet available. In other states these "backroom processes" may be electronic, but are spread across multiple systems that are not integrated.

Many in the commercial-vehicle sector believe these applications will work better if they are all part of an integrated package. To that end, the FHWA and the Federal Motor Carrier Safety Administration is spearheading an initiative known as the Commercial Vehicle Information Systems and Networks program, or CVISN. The goal of the initiative is to link the many disparate government systems now impacting the sector under a single operating umbrella. This will speed backroom processes for the industry and government and enable inspectors and regulators to access more robust data. More information about the initiative is available online at http://www.jhuapl.edu/cvisn/.

Electronic toll collection

One ITS application that reduces delay for commercial vehicles and passenger cars alike is electronic toll collection, or ETC. These systems allow motorists to pay tolls and fees electronically, often at mainline highway speeds.

The most sophisticated systems designed for highway toll collection enable motorists to pass through fee stations without slowing down. New York and New Jersey

photo courtesy of Caltrans

implemented such a system—known as E-ZPass—a number of years ago. The system utilizes radio frequency identification tags attached to cars and trucks. Electronic equipment located in toll plazas can read these tags as vehicles pass through at highway speeds. The equipment automatically deducts a toll from debit or credit-card accounts set up in advance by drivers. Toll amounts vary according to vehicle type (e.g., passenger cars or semi-trailer trucks). The system recognizes these differences and charges accordingly.

A study of the E-Zpass system published in 2001 found that the technology reduced toll-plaza delay on the turnpike by 85 percent. For passenger vehicles, that translates into a savings of $19 million in productivity time and $1.5 million in fuel costs annually, the study found.[2] Over time, the E-ZPAss system has expanded to other states. Today, five states—New Jersey, New York, Pennsylvania, Delaware, and Maryland—have partnerships that recognize each other's EZ-Pass tags. The long-term goal of the I-95 corridor coalition is to allow motorists to travel from Maine to Florida with one common electronic pass.

Some highway and transit fare collection systems are employing new "smart tags." These tags can be used for multiple purposes from paying transit fares, to parking fees, and even to commercial applications.

Endnotes

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Preparing for tomorrow's solutions

The transportation community isn't standing still in finding new ways to optimize the nation's transportation systems. State DOT's and their partners are actively engaged in developing tools and techniques that will enable a whole new realm of traffic management and life-saving capabilities. Here's what's in store.

E-911

So you're driving down the highway when you spot a traffic accident across the median. Being a responsible citizen, you whip out your trusty cell phone and dial 911. Do you know exactly where you are? And how far back the accident was that you sped by at 60 miles per hour? You'd better—because the 911 operator probably won't. That's because unlike calls placed over regular "land lines," calls made to 911 on wireless cell phones frequently can't be traced to specific locations.

While cell phones can be great to have in emergencies, they do cause problems for this reason. In scenarios like the one described above, 911 operators may have no choice but to dispatch multiple units to search for an incident scene, which ties up valuable resources that may be needed elsewhere. A related problem is that because cell phones are now so ubiquitous, 911 operators may receive scores (or even hundreds) of calls reporting the same incident. This can prevent other emergency calls from getting through, as well as make it difficult for officials to determine which calls are referring to the same incident.

Fortunately this is changing, thanks to an initiative known as Wireless Enhanced 911, or E911 for short. In essence, E911 is an effort to upgrade standard 911 services so that operators can ascertain callers' locations. The Federal Communications Commission (FCC) adopted rules in 1996 requiring wireless telecommunications companies to provide wireless E911 service by Dec. 31, 2005. The deployment, which is ongoing, is based on both new technologies and coordination among public safety agencies, wireless carriers, technology vendors, equipment manufacturers, and other players. The U.S.DOT, the National Emergency Number Association (NENA) and the Association of Public Safety Communications Officials International (APCO) are providing leadership and technical assistance on a national level. AASHTO is part of the policy group providing guidance and encouragement to state DOTs to be involved in the effort.

"Smart" vehicles

What if your car could warn you when you're about to collide with something, or run off the road? Or what if an onboard device could automatically take control of your vehicle and steer you clear of the danger?

Science fiction? No. Technologies like these are becoming reality. Known as "intelligent vehicle" technologies—they're designed to reduce the number and severity of traffic accidents by helping drivers avoid hazardous mistakes. There is much to be gained by these technologies, as driver error is responsible for the vast majority of the 41,000-plus deaths and 3.4 million-plus injuries caused by the six million-plus crashes on America's roads and highways every year.

IVI technologies are being developed primarily by the motor vehicle industry, other private-sector companies and university researchers. State and local transportation agencies are also involved. The U.S.DOT is facilitating the effort at the federal level through a program called the Intelligent Vehicle Initiative, or IVI technologies. The program focuses its efforts on four types of vehicles: "light" (cars, pick-up trucks, and SUVs); "commercial" (i.e., tractor-trailer rigs); "transit" (i.e., buses); and "specialty" vehicles, such as snowplows and ambulances.

photo courtesy of VDOT

Intelligent vehicle technologies are now in various stages of development, and they are designed to do many different things.

Crash-avoidance technologies

These monitor vehicles' surroundings and warn drivers when they're about to hit something or run off the road. Some systems go even further by automatically applying the brakes when a vehicle is imminent danger of crashing.

These technologies promise to be especially useful in preventing rear-end collisions, which account for more than 1.5 million crashes every year. In March 2003, General Motors and a group of partners field-tested several technologies designed to prevent such collisions in passenger cars (the test vehicles were Buick LaSabre sedans). One technology, called a forward collision warning system, uses electronic sensors, global positioning system technology and radar to warn drivers when they are approaching slowed or stopped objects too rapidly, or when they are following vehicles in front of them too closely. The system alerts drivers in two ways: with an audio warning telling them they may need to brake quickly, and with a visual warning projected on the windshield, a technology used in fighter planes.

An enhanced version of this system incorporates an additional technology known as adaptive cruise control. Like conventional cruise control, this technology is designed to keep a vehicle traveling at a constant speed. Vehicles equipped with adaptive cruise control look for vehicles in the same lane in front of them. If the lane is clear, the system maintains the speed set by the driver. But if another vehicle is in the lane ahead, the system automatically adjusts the equipped vehicle's speed so that it remains at a "following" distance specified by the driver.

Crash-avoidance systems can also project warning signals backwards to heed off tailgating motorists, or sideways to warn motorists in adjacent lanes that they are getting too close. These technologies, known respectively, as rear-impact and lane-change avoidance systems, typically use sensors or radar to detecting encroaching vehicles, and bright, flashing lights to warn their drivers to back off.

In addition to passenger vehicles, these technologies have also been tested (and deployed) in trucks, buses, and other types of vehicles:

Volvo trucks and US Xpress, a motor carrier, field-tested a rear-end collision warning system in 2003 that included adaptive cruise control and advanced braking technologies. Most drivers who tried the system thought it could be useful.

In Michigan, the Ann Arbor Transportation Authority partnered with a private-sector firm, Veridian Engineering in 2002 to field-test a rear-impact collision warning system for transit buses. The system uses radar to sense when a bus is about to be hit from behind by another vehicle. It then flashes bright lights in an attempt to stave off the impending collision.

In San Mateo, California, the local transit authority (SamTrans) partnered with the California Department of Transportation (Caltrans) and a private-sector firm, the Gillig Corporation, on a system that warns transit bus drivers of impending collision with vehicles in front of them. The system uses radar and other sensors to detect obstacles, and a sophisticated software program to determine the threat level.

A side-collision warning system utilizing ultrasonic sensors was tested on 100 transit buses in Pittsburgh, Pennsylvania, in May 2002. Seventy percent of the drivers who participated in the field test responded favorably to the technology. Participating agencies included the Port Authority of Allegheny County, Carnegie Mellon University, the Pennsylvania DOT and Collision Avoidance Systems, a private-sector company.

Road departure

A related intelligent-vehicle technology warns motorists when they are likely to run off the road, either due to excessive speeds or inattention. These systems use radar or other sensors to track the edge of the road (or lane) and suggest safe speeds for drivers to travel. The DOT recently partnered with three private-sector companies to field-test a system designed to warn drivers when they are about to drift off the road and crash into an obstacle, or when they are traveling too fast for an upcoming curve. The system uses a vision- and radar-based "lateral drift warning system" and a map-based "curve-speed" warning system.

In the future, more advances systems of this type may automatically apply the brakes on vehicles that are traveling too fast to negotiate a curve in the road. Other systems, similarly, may use vehicle-based sensors to determine if the road is wet, icy, or otherwise hazardous and automatically slow vehicles down as needed.

Intersection collision-avoidance

Approximately 30 percent of all traffic accidents every year occur in or near intersections. Researchers are developing technologies designed to warn motorists when the potential for such collisions exists. These systems monitor a vehicle's speed and position relative to an intersection, as well as the speeds and positions of other vehicles in the vicinity, and warn drivers when a collision is imminent. Some of the systems now under development are entirely vehicle-based, while others require vehicles to communicate with sensors or other devices incorporated into the roadway system itself.

Vehicle stability

Researchers are also working on technologies to prevent tractor-trailer rigs and other large trucks from rolling over. There is much to be gained from such technologies, since truck rollovers frequently result in deaths, injuries, property damage, and long traffic tie-ups. One system developed by the Freightliner truck company uses sensors and in-cab display devices to warn drivers when their vehicles are at risk of rolling over. Freightliner is currently working to integrate the system with roadway geometry mapping to make it more effective as a proactive crash warning/crash avoidance system.

Vision enhancement

Many things can impair our vision while driving—such as rain, sleet, snow, fog, and darkness. Obviously, it's dangerous to drive when conditions make it difficult to see. According to the U.S.DOT, reduced visibility is a factor in 42 percent of all vehicle crashes.

Researchers are developing technologies that make it easier for drivers to see what rain, darkness, and other environmental conditions sometimes obscure. One system, already available on some General Motors' vehicles, works by detecting infrared radiation emitted from pedestrians, animals, and various roadside objects. The system transfers the images to video and projects them on the windshield, as is done in some military aircraft, so drivers can see an enhanced picture of what lies ahead without taking their eyes off the road.

Some agencies use similar systems in snowplows, police cars, ambulances, and other vehicles that must operate during inclement weather conditions. Some of these systems are not entirely vehicle-based, but instead work in conjunction with magnetic tape or other sensors mounted along roadways. The Minnesota DOT uses such a system on a stretch of highway in the Minneapolis area. The highway's edges and lane stripes are marked with special magnetic tape that can be read by equipment carried aboard winter-maintenance vehicles. This allows operators to see a "virtual" picture of the roadway even when it is covered with ice or snow.

Fatigue warning systems

As a general rule, it's not dangerous to fall asleep while watching TV on the couch. But doze off behind the wheel and you're likely to run off the road and/or crash into something, and injure or kill yourself or others.

Researchers are developing technologies to prevent crashes caused by driver fatigue. Such technologies are especially useful for over-the-road truck drivers, who must drive long hours, frequently at night. One technology already available utilizes a computerized, camera-like device mounted above the windshield and trained on a driver's eyes. When the device detects that a driver's eyelids are covering his or her pupils more than a specified amount—an indicator that the driver is nodding off—the system sounds an alarm to wake the driver up.

Vehicle-infrastructure integration

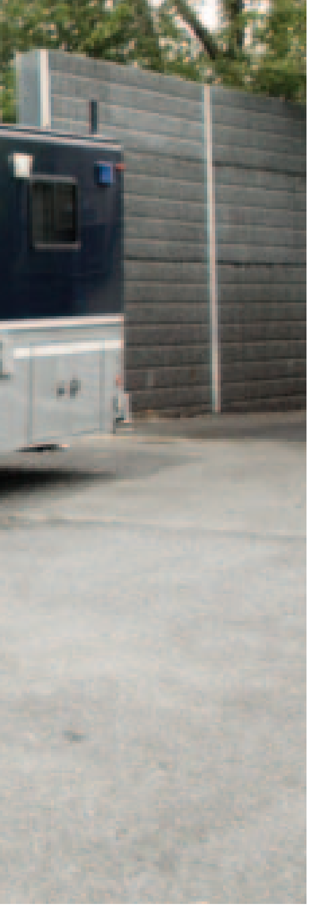
Sure, “intelligent” vehicles make driving safer and more efficient—at least for motorists who have them. But what if every car and truck on the road was equipped with mobility and safety-enhancing technologies? Moreover, what if all of these vehicles could communicate with the roadway system so they could operate according to real-time traffic and weather conditions?

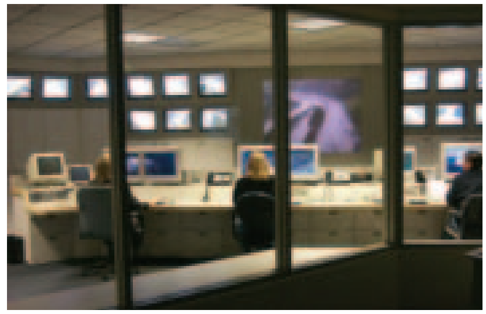
The U.S.DOT, the automobile industry and AASHTO believe this could benefit the highway system in enormous ways. These three groups have formed a partnership, known as the Vehicle/Infrastructure Integration Initiative, or VII, to study the concept further. The VII vision is a bold and ambitious one: equipping all new cars and trucks with mobility- and safety-enhancing “intelligent vehicle” technologies, while at the same time outfitting roads and intersections throughout America with ITS technologies. All of the “smart” vehicles, then, would be linked to the “smart” highway infrastructure via a nationwide, wireless communications network.

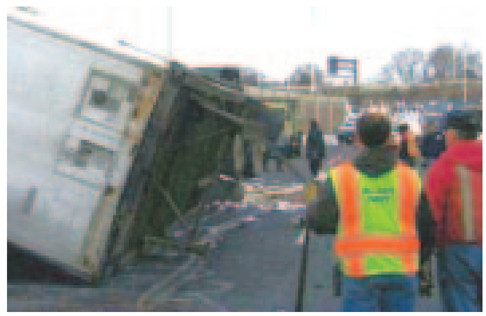
Information would flow over this network in several different directions. Sensor-equipped vehicles, for example, would collect and transmit real-time traffic and weather information to transportation agencies via roadside ITS devices. Transportation agencies, conversely, would use the network to alert motorists about a wide variety of roadway and weather conditions. Ultimately, the system might even be configured to automatically prevent vehicles from engaging in dangerous activities, such as tailgating or running red lights. Here are some other possibilities.

Intersection safety

Motorists could be warned, either by their own vehicles or field-mounted devices, when it is unsafe to enter an intersection. Such warnings might be given, for example, when a car is approaching an intersection too fast to stop for a red light. VII could make this determination by analyzing certain data transmitted by the speeding car—e.g., its speed, location, and the condition of the roadway on which it is traveling, as well as data mined from the “smart” intersection—e.g., the phase and timing of the traffic signal. This information could be processed either inside individual vehicles, or in computers located inside traffic-signal cabinets.







Intersection safety, part 2

Similarly, VII could warn drivers when it is unsafe to make left turns in intersections. This would be especially useful in intersections with poor sight lines, or where oncoming traffic is traveling at high speeds.

Taming dangerous curves

VII could also warn drivers when they are traveling too fast to safely negotiate upcoming curves in the road, or freeway entrance/exit ramps. As a vehicle approached a curve or ramp, infrastructure or in-vehicle sensors would determine if it needs to slow down—and by exactly how much—by analyzing a host of factors: speed, vehicle type (e.g., low-profile sedan or high-profile sport-utility vehicle), and road conditions (e.g. dry, wet, or icy pavement). Again, drivers could be warned by alarms in their own vehicles, or by roadside devices. More advanced VII systems might even slow down speeding vehicles automatically.

Traffic incidents

VII could also help officials deal with traffic incidents in a faster, more effective manner. When a vehicle becomes disabled or crashes, onboard sensors could automatically alert a 911 or traffic-management center. Technicians could then dispatch the appropriate resources to the scene. More advanced systems could even give responders clues as to the nature and severity of incident by telling them, for example, that the vehicle was hit from behind, or that its passenger-side airbag was deployed.

Weather

Similarly, VII could improve agencies' abilities to respond to weather events, since so many vehicles would be transmitting real-time weather and road-condition information to traffic-management centers. This wealth of information would allow transportation officials to make better, more cost-effective decisions regarding road treatments and crew deployments.

clockwise from left: photos courtesy of VDOT, WSDOT, and NJDOT

AASHTO, U.S.DOT, and the auto industry are currently holding talks and exploring options to determine what form of VII is most feasible and, how it would be designed, paid for and deployed. No final decisions on these matters are expected until at least 2008.

In the meantime, researchers are testing various applications and technologies that could potentially be used in the system. The Ford Motor Company, for example, is partnering with the Minnesota Department of Transportation (MnDOT) on a VII-type test project in the Minneapolis area. The test calls for more than 50 state-owned police cars, ambulances, and other vehicles to be outfitted with sensing devices that will collect data such as speed, location, and heading. Sensors will also collect weather-related data, such as temperature, precipitation, and the condition of the pavement.

All of this data will be transmitted wirelessly to a traffic management center, where it will be analyzed and broadcast back to the motoring public via highway message signs, 511 telephone services and traveler-information web sites. The data may also be used to deploy emergency assistance and/or road maintenance crews.

"These vehicles will become sensors on the roadway, gathering instantaneous roadway conditions and sharing this information with each other and the infrastructure," says Jim Kranig, MnDOT's assistant traffic engineer for operations. "This is truly a breakthrough for the state of Minnesota, allowing the average driver to envision and know what the roadway ahead is like."

Dr. Charles Wu, director of manufacturing and vehicle design at Ford Research and Advanced Engineering, is equally optimistic. "What has been lacking in the past is a holistic integration of vehicles with roadway infrastructure," Wu says. "Through the combination of intelligent vehicle technology and ITS, we hope this program...will contribute to the development of the next generation in transportation and driver information systems."

Many transportation and auto-industry experts say the biggest challenges to getting VII up and running will be institutional—not technological—in nature.

"The technology is here to do this," says Christopher Wilson, Vice President of ITS Strategy and Programs at DaimlerChrysler, Inc. "What is lacking is the institutional will to go ahead and make this sort of system possible. "We [the auto industry and transportation agencies] have not had a discussion like this in 6,000 years, since the wheel was invented. Since that initial discussion, there's

photo courtesy of VDOT

been very little communication between our communities, and we need to change that."

David Acton, Director of Global Telematics Portfolio Planning at General Motors, agrees. "This has never been done before," Acton says. "Success will depend on visionary, dynamic leadership. How many times in a lifetime do you actually get to create a new industry and have such an impact as this? I'm just excited to be part of it."

John Njord, Director of the Utah DOT, is leading the discussions between the transportation and auto industries. And Njord sees great things down the road. "VII is not going to be easy to accomplish because we come from very different worlds," says Njord. "But the opportunities to save people's lives and to enhance their travel experience is so enormous that I think there's enough momentum behind it to make it happen."

Conclusion

The examples shown in this report are only a small part of the work being done across the country to optimize the use of the nation's transportation system. No one solution is a panacea—but taken as a whole, these techniques offer promise of a better future—with less congestion, greater efficiency, and dramatic improvements in highway safety. Optimizing the system is not just a buzz phrase, it's a better way of moving America.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