

Intelligent Systems at an Intelligent **Price**

The benefits of high-tech transportation may be surprisingly affordable today

The move toward intelligent trafficways has only just begun, and there is no end to the high-end applications that are being installed or are planned for the future.

Last year, *RoadScience* covered how, after nearly two decades of development, intelligent transportation system (ITS) technologies were finally going mainstream. This included the outlook for self-controlling “autonomous” vehicles that respond to environmental and vehicle cues, and the use of ITS to track vehicle movements to manage traffic volume and impose congestion pricing, both goals of *IntelliDrive*, a service mark of the U.S. Department of Transportation (see “ITS Finally Here!,” July 2010, pp 12–21).

But there also are relatively low-cost methods of increasing traffic volumes, and moving traffic faster via intelligent systems, that are available to agencies from coast to coast. The following is an overview of some of these accessible technologies for state, city and county road agencies.

The payoff can be quite good for low-cost applications, like **synchronized traffic signals**. “Transportation agencies that have invested in ITS have found that every \$1 spent on technologies like synchronized and **adaptive traffic signals** returns nearly \$40 or more to the public in time and fuel savings,” says Scott Belcher, president and CEO, ITS America, the public/private sector organization that advocates for and coordinates intelligent transportation technologies.

Variable message signs, video cameras and loop detectors are

among the more popular means where state agencies are implementing intelligent transportation technologies.

Loop detectors are electrical voltage sensor wires buried in the driving course. They determine that a vehicle has passed via changes in electrical voltage caused by the metallic body of the passing vehicles. When linked to a regional transportation center’s computer, software can determine the speed and volume of vehicles on a pavement by analyzing how much time elapses between activation of two sets of wires.

If the traffic center computers detect congestion, video cameras can look for the cause of the congestion and this information can be displayed on variable message boards to advise motorists and to suggest alternate routes.

In the Canton/Akron region, the Ohio DOT is developing an ITS that will use variable message signs, and it will be integrated into the statewide ITS website at www.buckeyetraffic.org. The site lists lane closures and restrictions, road weather

At a March press conference at the Las Vegas-area *FAST Traffic Management Center* of the Regional Transportation Commission of Southern Nevada, Rudy Malfabon, deputy director, Nevada Department of Transportation, discusses the highway funding needs of the state, flanked by Jacob Snow, RTCSN general manager, and Frank Moretti, director of policy and research for TRIP, The Road Information Program.



PHOTO CREDIT: Tom Kuennen

In the Canton/Akron, Ohio area, new variable message signs give traffic times and will be tied into statewide ITS, where current messages can be displayed in real time.

conditions, webcams, relative traffic speeds, what each variable message sign says in real time, and much more.

By the end of September, webcams and variable message signs on major routes in the area will be connected to the system. In the Canton/Akron metro area, some 64 web cameras have been installed, with 18 variable message signs on the way, primarily on Interstate routes. This summer, 18 electronic message signs on those same routes are being installed.

Mobile Phones and More

One way agencies are using existing infrastructure to leverage intelligent transportation is enhanced use of **smart phones**.

For example, in June, ITS America recognized the New Jersey Department of Transportation and Turnpike Authority with its Smart Solution Spotlight award for the agency's use of a smart phone "app" to provide New Jersey commuters with more accurate and timely information about traffic conditions, weather situations and safety advisories.

Drivers on New Jersey's most heavily traveled highways may download a free smart phone application called *Trumpit*, developed by ITS America member HNTB, to receive audio-based traffic, weather and public safety alerts customized to their commute.

The free Trumpit app for iPhones, Androids or BlackBerrys allows drivers to hear audio alerts that can be tailored to their commutes through the My511 feature at the www.511nj.org website. When an alert tone sounds on a driver's phone, the driver can listen to it by pressing a single button.

NJDOT plans to use global positioning systems in smart phones to deliver traffic alerts for any roadway on which drivers are traveling without having to sign up for that specific road through the app, anticipated for later in 2011.

Smart phones may also offer more than just an outreach function; they may also enable intelligent highways or traffic monitoring, analysis and response.

Because digital phones and smart phones emit radio signals that reveal the locations of their owners, future traffic management systems may be able to collect the data and disseminate traffic information more easily and quickly.

Listening posts, in conjunction with cell phone base stations, would permit traffic management personnel to triangulate the location of each vehicle containing mobile phones, and by time-stamping the radio signals, the listening posts could algorithmically determine the speed, direction and location of each mobile device-bearing commuter on a particular highway.

Then, traffic control could send to the mobile devices personalized traffic updates, along with GPS-produced maps advising commuters of alternate routes and traffic information to the affected commuters' phones.

This already is happening in New York City, where the city's Metropolitan Transportation Authority has been using "NEXT



PHOTO CREDIT: Ohio DOT

TRAIN 00 MIN" displays in stations to maintain patron confidence in train arrivals. But in early June 2011, *The New York Times* reported that a web development firm called Densebrain says it can do the same thing at practically no cost, by analyzing how people lose phone service when they head underground.

"Densebrain's project works by taking note of which cell-phone tower a phone is communicating with," *The New York Times* reports. "It then looks for disruptions in service followed by significant changes in location. If a phone located near Times Square suddenly loses service and reconnects at Prince Street and Broadway 15 minutes later, then it has almost certainly traveled there using the N or R trains. This type of data, when taken from large numbers of phones and analyzed algorithmically, could give an accurate look at the performance of the entire subway system in real time.

"Urban planners, technology companies and officials from local governments see potential in projects like these that mine data collected from phones to provide better public services," *The Times* reports.

Can You Hear Me Hit That Pothole Now?

Boston is developing a system that will use sensors in Android-based smart phones to provide a real-time "snapshot" of pavement conditions such as potholes.

The system, called *Street Bump*, uses a smart phone's accelerometer and GPS system to detect when a driver hits a pothole, and then sends that information to city officials. Such a system will have the ability to help government agencies collect data that would have required in-pavement network sensors.

"It is unlikely that we are going to be able to invest in that sensor system," says Chris Osgood, co-chairman of the Mayor's Office of New Urban Mechanics in Boston, which is responsible for establishing Street Bump, as reported in *The New York Times*. "But what we've recognized is that many, many constituents have already invested in a sensor platform," that is, their smart phones.

The Boston Urban Mechanic Profiler (Street Bump) prototype app was developed in partnership with Fabio Carrera, a

Worcester Polytechnic Institute professor who has partnered with the City of Boston on a variety of projects focused on collecting and using data to improve city operations.

Taking advantage of the sensors on Android-system smart phones, Street Bump will provide the city with a near-real-time picture of Boston's road conditions and the location of its potholes. When launched and recording, Street Bump collects information from the phone's sensors to record the time, the phone's location, its orientation, its speed, its bearing and its acceleration. These readings are automatically uploaded to the Street Bump website.

In early 2011, the app was in prototype form, simply recording and uploading data from the sensors. In collaboration with InnoCentive and Liberty Mutual Insurance, Boston was preparing to launch a challenge to design the algorithms needed to convert the data into actionable information.

Adaptive System Cuts Commutes

Adaptive traffic systems coordinate traffic signals along a corridor based on prevailing conditions, yielding smooth, more-balanced traffic flow and enhanced arterial capacities, and can help agencies get extra capacity out of existing roadways.

Reacting to real-time traffic loads, adaptive signal control accelerates travel times, enhances intersection safety, and lowers fuel consumption and exhaust emissions.

In the past year, in San Diego suburb San Marcos, Calif., an adaptive traffic system has reduced delays on San Marcos Blvd. by up to 46 percent, with an average fuel reduction of 8 percent, according to Jack Stack, a traffic consultant who drives the route.

The federally-funded, \$670,000 system – which was completed in early 2010 after three years of installation – links signals at 17 major intersections along a 3.6-mile segment of San Marcos Blvd., and was installed by McCain Inc., of Vista, Calif. McCain's analysis found motorist stops decreased 39 percent

and drive times dropped an average of 20 percent, according to the *San Diego Business Journal*.

Another way to lower the cost of intelligent transportation is to spread its cost over multiple city agencies, providing a unified view of urban needs and providing a coordinated approach toward operations. That's the goal of the new IBM Intelligent Operations Center for Smarter Cities.

The IBM Intelligent Operations Center monitors and manages city services, providing operational insight into daily city operations through centralized intelligence. "Now cities, government agencies and enterprises can optimize operational efficiencies and improve planning," the firm says.

Introduced in June 2011, the IBM Intelligent Operations Center for Smarter Cities is intended to provide cities of all sizes a "holistic" view of information across city departments and agencies. "By infusing analytical insights into municipal operations through one central point of command, cities will be able to better anticipate problems, respond to crises and manage resources," IBM says.

Through a unified operations center, cities will be able to:

- accurately gather, analyze and act on information about city systems and services, including public safety, transportation, water, buildings, social services and agencies;
- analyze real-time information to better model and anticipate problems to minimize the impact of disruptions to citizens; and
- integrate real-time information from across multiple city systems to enable collaborative decision-making for rapid response to events and incidents.

The system can integrate city management of services such as transportation, public safety, water, building and energy management within the Intelligent Operation Center.

The system will use analytical technologies to provide travelers with real-time traffic information across multiple modes of traffic, so that they



PHOTO CREDIT: City of Boston

Boston's *Street Bump* uses a smart phone's accelerometer and GPS system to detect when a driver hits a pothole, and then sends that information to city officials; users activate the app using this icon on their Android-based smart phone.



PHOTO CREDIT: NHTSA

The Integrated Vehicle-Based Safety Systems (IVBSS) project involved light-vehicle and heavy-truck field operational tests of the effects of a prototype-integrated crash warning system on driver behavior and driver acceptance.

can choose the best route for their commute. For example, the Intelligent Operations Center allows analysts to anticipate traffic disruptions and model "what if" scenarios, providing options to minimize traffic congestion. Automated directives can trigger communication and collaboration across the city departments and out to citizen alerts.

Pinpointing No-Pass Zones

Technology can be applied to road safety issues as well. No-passing zones on highways traditionally have been circumscribed using engineering judgment, but in today's legal environment, a new program permits no-passing zones to be determined using line-of-sight equipment.

A no-passing zone study is required for proper striping of two-lane roadways, according to MasterMind Systems. "Changes to roadways and growth of foliage in the right-of-way lends itself to having the study performed every several years," the firm says. "Aside from the protection from lawsuits, proper zoning makes your roads safer for the traveling public."

MasterMind uses a two-vehicle, sight-light method to establish no-passing zones caused by vertical or horizontal curves. All data are collected using the firm's RoadMaster NPZ system. Sight height and zone lengths are set according to a state's *Manual on Uniform Traffic Control Devices*, or MUTCD specs. Zone lengths and intersection approach zones can be customized to specifications.

Then, no-passing zone graphical logs can be created showing the location and parameters of each no-passing zone in the state, and can be accessed publicly from an online GIS map. "Logs normally display 1 mile per page, but can be scaled to 1/4-, 1/2-, 1-, 2- and 3-mile-per-page scales," MasterMind says. "These roadlogs also make T-marking, or indexing, the road a simple procedure. Lineal footage, paint and bead quantities can be easily calculated."

Wireless-Linked Vehicles Tested At Speedway

Even as these technologies appear from coast to coast, the U.S. DOT continues to explore wireless vehicle-to-vehicle communications, using auto race tracks to do so on a safe, controlled basis.

In June 2011, the DOT announced the selection of Michigan International Speedway (MIS) near Detroit as one of only six venues in the country to host testing for wireless

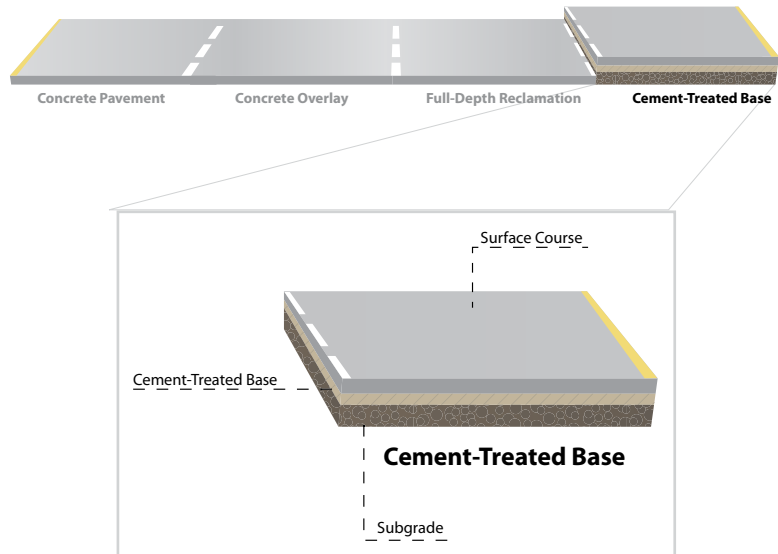
vehicle-to-vehicle safety communication technologies. Other "clinics" will be held in Minneapolis; Orlando; Blacksburg, Va.; Dallas and San Francisco.

In August 2009, the Michigan DOT

and the Center for Automotive Research began to use the MIS road course as a test facility for connected vehicle technology.

"MDOT's partnership with MIS will position Michigan as a leader in the

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The interior of Integrated Vehicle-Based Safety Systems (IVBSS) heavy truck; the vehicle was instrumented to capture detailed data on the driving environment, driver behavior, warning system activity and vehicle kinematics.

development of connected vehicle technology," said Kirk T. Steudle, Michigan transportation director in 2009. "This concept provides a unique opportunity to shape the future of transportation by improving safety and mobility on heavily traveled highways."

Earlier in 2011, RITA – the Research and Innovative Technology

Administration of the U.S. DOT – conducted the *Connected Vehicle Technology Challenge*, a national competition seeking ideas for using wireless connectivity between vehicles to make transportation safer, greener and easier.

RITA is soliciting ideas for products or applications that use *Dedicated Short Range Communications* (DSRC), an advanced

wireless technology similar to WiFi but faster and more secure. DSRC can communicate basic messages – such as alerts about imminent crash situations or roadway hazards – from one vehicle to another in a fraction of a second with minimal interference and without manipulation by the driver. The spectrum used by DSRC technology has been reserved by

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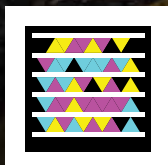
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DSRC will be the basis for a future system of connected vehicles that will communicate with each other as well as the surrounding infrastructure, such as traffic signals, work zones and toll booths. According to a National Highway Traffic Safety Administration report, wireless *Vehicle-to-Vehicle* (V2V) and *Vehicle-to-Infrastructure* (V2I) communications will make for safer driving.

Not Professional Drivers on a Closed Course

This month at Michigan International Speedway, RITA will begin testing of wireless connected vehicle warning devices with ordinary drivers in normal roadway situations.

"Connected vehicle technology has the potential to address 81 percent of all unimpaired driver-related crashes," says RITA administrator Peter Appel. "We must take a serious look at how this

technology will work in the real world to create a safer transportation system."

The *Connected Vehicle Safety Pilot Program* includes six driver clinics, in which motorists will be monitored in a controlled environment, and a model deployment during which drivers will test the safety technology with volunteer drivers in one geographic region without any restrictions.

The two components of the program include:

- **Safety Pilot Driver Clinics:** During these tests, which will take place in six locations in the United States, regular drivers will test cars with built-in wireless safety warning devices in a controlled environment. The goal will be to see how motorists handle various alert messages such as in-car collision warnings, do-not-pass signals and warnings that a car ahead has stopped suddenly.
- **Safety Pilot Model Deployment:**

This trial will include up to 3,000 vehicles fitted with devices that will communicate with other vehicles and the surrounding infrastructure, while operating on everyday streets in a highly-concentrated area where the cars will regularly interact with each other. Motorists will be able to tell when another vehicle fitted with a wireless safety device has moved into their immediate driving area, and they will get warnings if either car is in danger of crashing.

The Connected Vehicle Drive Clinics at Michigan International Speedway are part of a DOT research program held in conjunction with the National Highway Traffic Safety Administration, and the private-sector Crash Avoidance Metrics Partnership Vehicle Safety Communications Consortium, a research effort of eight automobile manufacturers.

The program is aimed at developing technology that will help vehicles avoid crashes by communicating with nearby

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vehicles and with roadway infrastructure such as traffic signals, dangerous road segments and grade crossings. This is achieved by alerting the driver when there is a risk of a crash or other safety driving hazard.

But before real-world testing is undertaken, agencies must test in a safe, controlled environment, and this is where the MIS facility serves this critical role. In Michigan, some 100 local drivers will be recruited for the clinic, which will take place in controlled locations around the racetrack. Each clinic will include about 16 cars equipped with technology applications that drivers will evaluate as they use the vehicles in a controlled environment designed to simulate real roadways and intersections.

The trials will take place along the speedway's road course, some of which will be outfitted with temporary traffic signals to mimic city streets and roads. Movable traffic lights will allow agencies to test anywhere on the track's pavement throughout the 1,400-acre property.

After the driver clinics are completed, the DOT plans to deploy thousands of wirelessly-connected vehicles to test how the technology performs in a real-world driving environment. The model deployment is scheduled to begin in fall of 2012 at a site that will be selected through an open competition.

Previous to the six field tests involving actual drivers off the street, NHTSA completed study of **Integrated Vehicle-Based Safety Systems (IVBSS)**, and in June 2011 released a final report.

The project involved light-vehicle and heavy-truck field operational tests of the effects of a prototype-integrated crash warning system on driver behavior and driver acceptance. Both platforms included three integrated crash-warning subsystems, forward crash, lateral drift and lane-change/merge crash warnings. The light-vehicle platform also included curve-speed warning.

The integrated systems were introduced into two vehicle fleets of 16 light vehicles and 10 Class 8 tractors. The light vehicles were operated by 108 volunteer drivers for six weeks, and the heavy trucks were driven by 18 commercial-truck drivers for a 10-month period.

Each vehicle was instrumented to capture detailed data on the driving environment, driver behavior, warning system activity and vehicle kinematics. Data on driver acceptance are collected through post-drive surveys and debriefings.

The University of Michigan Transportation Research Institute analyzed the data and found that the integrated crash warning system results in improvements in lane-keeping, fewer lane departures and increased turn-signal use.

Both the passenger car and commercial drivers accepted the integrated crash warning system and benefited from improved awareness of vehicles around them. No negative behavioral-adaptation effects of using the integrated system were observed in either driver group.

You may download the report at nhtsa.gov/DOT/NHTSA/NVS/Crash%20Avoidance/Technical%20Publications/2011/811482.pdf ♦

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