Office of Research & National Best Practices

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Communication Between Vehicles and Roadways is Next Step in Safety

Intelligent Transportation Systems and Vehicle Infrastructure Integration are Creating Safer Roadways

Traffic congestion on Michigan's urban highway network is lengthening commuting times and slowing the delivery of products and services. High traffic volumes are also increasing the chances of crashes. Minimizing congestion and improving safety through the application of new technologies is of utmost importance to MDOT. Intelligent Transportation Systems (ITS), such as incident management systems, real-time traffic and weather data, and changeable dynamic message signs, are already helping to manage congestion on Michigan roadways. The development and implementation of Vehicle Infrastructure Integration (VII) will dramatically enhance safety. VII includes technologies that enable real-time, dynamic communication and data exchange among vehicles and between vehicles and the roadway.

"VII technologies are strategically significant for MDOT and for the State of Michigan."

Calvin Roberts, Administrator
MDOT Office of Research and National Best Practices

The research, development, and application of collision avoidance technologies similar to those in the field of VII have enabled the airline industry to realize incredible improvements in safety over the past 80 years. In 1926 one person died for every 26,000 miles traveled by air. Today that ratio is one fatality for every *1.6 billion* miles traveled.

Rep. James Oberstar (D-Minnesota), Ranking Democrat on the Committee on Transportation and Infrastructure in the U.S. House of Representatives, while speaking at the International Transportation Technology Transfer Symposium in early August this year, said, "With the advancements we're seeing in the field of Intelligent Transportation Systems, we should expect roadway safety improvements similar to those we realized in the airline industry." Oberstar's comments reflect a fundamental shift in how we think about roadway safety.

Historically, the players in the roadway safety arena have focused exclusively on passive safety measures and roadway layout to make vehicular travel safer. Anti-lock brakes, improved child restraints, air bags, vehicle impact standards, and seat belt laws all are intended to minimize the effects of crashes. Dr. Jeffrey Runge, M.D., former Administrator of the National Highway Traffic Safety Administration (NHTSA) commented in an address to the 11th ITS World Congress in Nagoya Japan in 2004, "We have traditionally dwelt on passive safety and crash worthiness standards. But things are changing. To drive down the fatality rate further, we need to focus on intelligent systems for active safety and crash avoidance." Dr. Runge went on to describe how VII technologies can help us achieve a world where vehicles do not collide.

The Office of Research and National Best Practices (ORNBP), under the leadership of Calvin Roberts, has responded to this new way of thinking by aligning MDOT's research pro-

gram to take on the challenge of helping to develop VII. In FY 2006, MDOT spent $50,000 on research projects involving VII. For FY 2007, the ORNBP has nearly $3M available for this type of research. "Our purpose is to promote research that supports MDOT's strategic goals," explains Roberts, "VII technologies are strategically significant for MDOT and for the State of Michigan. We're here to help take the next steps."

In addition to a growing emphasis on active measures to improve roadway safety and mobility, the accelerated interest in VII can also be attributed to rapid advancements in wireless communications technologies and the Federal Communication Commission's (FCC) approval of the 5.9 GHz spectrum solely for Dedicated Short Range Communications (DSRC) in transportation applications.

VII research and implementation will not only improve safety and reduce congestion on Michigan roadways, but will also create significant opportunities for new commercial development in Michigan. With a unique combination of auto makers, high tech businesses and cutting edge intelligent transportation researchers within close proximity to one another in the state, Michigan is positioned to become a world leader in the development of VII. The technologies involved with VII, including wireless communication, high-speed computing and other high tech areas, can play a significant part in diversifying and improving Michigan's economy.

MDOT Chief Operations Officer Larry Tibbits articulated a bit of MDOT's vision for ITS development and VII implementation at the ITS Michigan 11th annual Conference in June. "With VII we can save lives and improve the quality of life for Michigan motorists," Tibbits said, "to make it happen, businesses, researchers, and government agencies have to cooperate as partners."

Cooperating and partnering on VII initiatives is already happening among researchers and government agencies. To establish sustainable momentum, private businesses must assume a major role. "Ultimately, we're looking for the business community to invest in the technology and elevate its use and usefulness in our state and in the market," Tibbits said.

Cooperation is Crucial but Complicated

A planned group of VII test beds in southeast Michigan is an encouraging indication that cooperation is growing. The sites are being established by MDOT working with DaimlerChrysler, Ford, General Motors, Motorola and Nissan, and will be located in Warren, Auburn Hills, Southfield, Dearborn and Farmington Hills (see Figure 1). Public partners in the effort include the Road Commissions for Oakland and Macomb Counties and the University of Michigan Transportation Research Institute (UMTRI) in Ann Arbor. The intent of each installation is to support some aspect of the national VII research effort by testing and evaluating communications technologies that link vehicles and the roadway.

MDOT and the California Department of Transportation (Caltrans) are working together to define how VII will ultimately be applied. Caltrans is developing and testing the physical equipment to facilitate DSRC. MDOT, through the VII test beds, is concentrating on the communications system that will someday use the DSRC equipment. Every test installation is designed to incorporate DSRC radio equipment once the standard is stable and the equipment is ready for deployment. "Right now we're concentrating on getting the right players in the right positions," explains Greg Krueger, MDOT's ITS Program Manager, "The test beds are a way for us to identify additional partnering opportunities and define needs for further VII development."

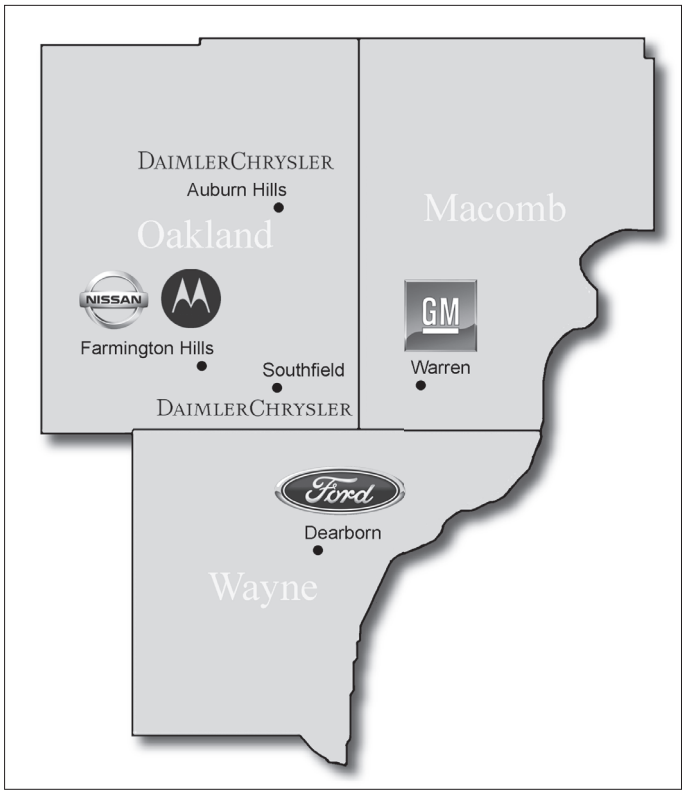


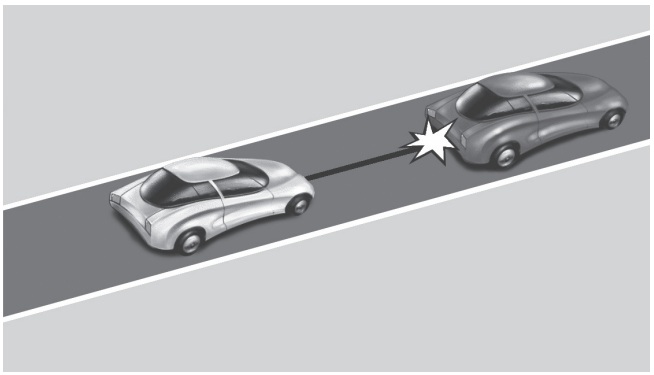
Figure 1. Planned VII Test Beds in Southeast Michigan.

Cooperative relationships in the VII field are complicated because of the proprietary nature of the technologies involved. In order for any VII partnership to have significant impact or value, participants must give up information that in some cases provides competitive advantage. Simply agreeing to work together doesn't accomplish much in the realm of VII development. "To get things done we have to put aside the historically competitive nature of this business and instead adopt an abundance mentality," Krueger explains, "ultimately, when VII takes off, everyone will win."

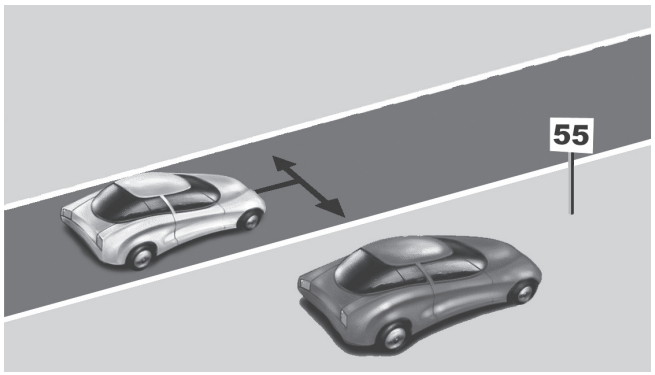
Michigan State University (MSU) is also a key partner with MDOT on VII initiatives. MSU is currently conducting a study to determine the impact of VII on Michigan's economy, including research and development efforts and potential future production, deployment and operations efforts.

VII Concept: Avoid Collisions, Stay on the Road

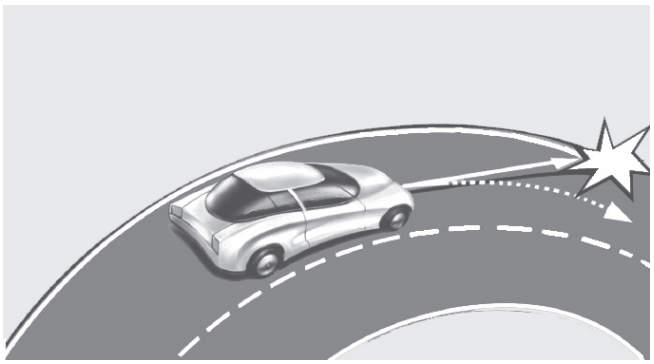
Nearly half of the 43,000 annual deaths on America's roads, are caused by roadway departures and collisions at intersections. For this reason, much of the emphasis in VII development has focused



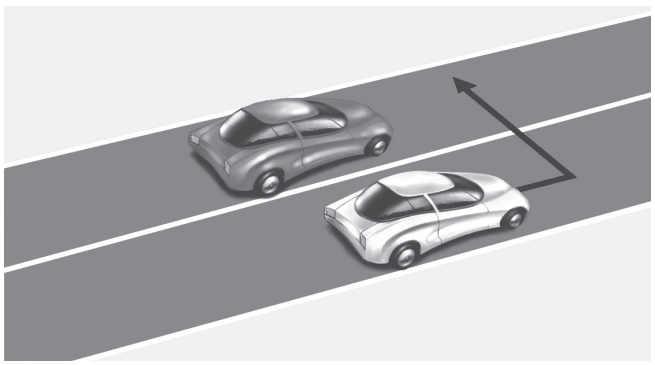
Forward Collision Warning – Uses radar and video inputs to track objects in order to assess collision threats based on vehicle speed, path, deceleration, and all in-path vehicles.



Lateral Drift Warning – Uses video input to track vehicle position and lateral velocity relative to the lane in order to alert driver of lane drift.



Curve Speed Warning – Uses radar and video inputs to track road geometry and vehicle status in order to warn drivers if they are moving too fast for an upcoming curve.



Lane Change/Merge Warning – Uses radar inputs to provide full-time visual vehicle presence indicators and audible warnings triggered by the turn signal if a lane change maneuver if unsafe.

Figure 2. Components of the Integrated Vehicle Based Safety Systems Project.

on lane departure and collision avoidance systems. UMTRI is currently involved in two such efforts: the Cooperative Intersection Collision Avoidance Systems (CICAS) project and the Integrated Vehicle-Based Safety System (IVBSS) project. The objective of the CICAS project is to develop and test a VII-based intersection warning system to alert drivers of stop violations and insufficient gaps when turning across traffic with no protected green signal. The project involves cooperation among several state departments of transportation, automotive manufacturers, university transportation research groups, and various modal administrations of the U.S. DOT. Contributing to the CICAS project, UMTRI is working directly with the University of California-Berkeley, Caltrans, MDOT, and the Road Commission for Oakland County (RCOC) to characterize driver behavior at intersections using data from instrumented vehicle studies. The data used is from past studies and studies specifically designed for the CICAS project.

The IVBSS project includes a suite of four crash warning subsystems designed to help the driver of a vehicle maintain a safe position on the roadway (see Figure 2). The project is funded through a $25 million contract with the U.S. Department of Transportation and $6.6 million from MDOT and several private collaborators including Batelle, Cognex, Eaton, Honda, Kenworth, and Visteon. Phase 1 of the project, which involves developing warning algorithms, building system modules and data acquisition systems, and installing the system in 16 passenger cars and 10 semi tractors, is scheduled for completion in December 2007. Phase 2, from December 2007 until December 2009, will involve field testing the system and collecting data in natural driving conditions.

UMTRI recently completed extensive field testing of a similar but simpler system for warning drivers of potentially dangerous maneuvers. Testing involved recording various vehicle, driver, and system data in real-world driving situations. An onboard computer collected the data in the vehicle for later download into a database at UMTRI. A cellular phone link with the UMTRI lab broadcast summary data – such as vehicle speed distribution, location, and general system health – every time the vehicle was shut off.

"We've tested these vehicles under real-world conditions. They definitely demonstrate safety benefits," Dr. Tim Gordon, Head of the Engineering Research Division at UMTRI, explains, " but driving is a very complex process; it's difficult to measure how it's done most effectively. The challenge is to do the right things with the data we collect."

VII Concept: The Next Step Toward Safer Roadways

Oakland County roads have the lowest fatality rate in the world for a community its size. Brent Bair, managing director of the Road Commission for Oakland County (RCOC) attributes the low rate to a combination of using ITS technologies, improvements in road design, and advancements in passive automobile safety systems such as air bags and anti-lock brakes. However, Bair is quick to point out that fatalities and serious injuries have leveled off recently. "To reduce fatalities and serious injuries further, we have to develop active crash-avoidance technologies. VII is the answer," Bair says. Toward that end, RCOC has teamed up with MDOT and Motorola to test wireless communications between vehicles and the roadway. "The experiment will complement MDOT's test beds in this area," Bair explains, "we're basically testing the communications capabilities; we're not exchanging any data yet."

This is the first test of Motorola's new MOTODRIVE wireless network architecture, which – like MDOT's test beds – acts as a surrogate for the future DSRC standard. The system uses transmitters mounted on traffic signal poles around the RCOC Traffic Operations Center and in several test vehicles. The lessons learned through this effort will one day allow vehicles to share real-time information about traffic conditions and potential roadway hazards such as icy pavement, potholes, or collisions. "This technology, and the ability to connect it to the road infrastructure, is the link that we anticipate will make VII a reality," Bair explained.

Cooperation Leads to Significant Accomplishments

Since the early 1990s the RCOC – in cooperation with several public and private partners – has invested over $100 million in ITS technologies to improve safety and relieve congestion on Oakland County roads. The RCOC was the first agency in the U.S. to provide online real-time traffic congestion display for non-freeway roads. Today they have the largest adaptive signal system in the U.S. and the largest video vehicle detection system in the world. The system, called Faster And Safer Travel Through Routing & Advanced Controls (FAST-TRAC), uses input from over 2000 live digital video cameras mounted at 650 intersections to continuously monitor and adapt to traffic conditions. "Intersections impact traffic flow the most," Bair explains, "when cars move smoothly through intersections, the entire system moves better." According to a study conducted by MSU, the system has decreased the length of the morning rush hour on one major corridor by 20 percent.

The RCOC's Traffic Operations Center in Waterford Township is linked to MDOT's Michigan Intelligent Transportation Systems (MITS) Center in Detroit to facilitate traffic management across jurisdictions. The two centers exchange the following:

- Congestion data
- Construction project data (locations, descriptions, impact)
- Weather data from three remote RCOC weather sensing stations
- Still images from RCOC video cameras; video images from MDOT freeway cameras

State-of-the-Art Ice Control

The Southeast Michigan Snow and Ice Management (SEMSIM) system incorporates several ITS Technologies to track and report road conditions for motorists and those who manage the roads. SEMSIM partners include the RCOC, Wayne County Department of Public Services, the City of Detroit, the Road Commission of Macomb County, and the Suburban Mobility Authority for Regional Transportation (SMART). The effort is funded through approximately $10 million of federal grants plus a 20% match by all partners. When fully deployed during the winter of 2006, the system will be the largest of its kind in the U.S.

The SEMSIM system uses infrared sensors on plow trucks to read pavement and ambient temperatures so operators know when to apply salt. Additional sensors on the plows and spreaders and a global positioning system send data to an on-board computer on each vehicle. Each computer is linked through SMART's 900 MHz radio system to the fleet manager's computer. Through a GIS-based interface the fleet manager can track each plow truck's speed, position, and activity to better manage resources. The vehicle and road information is also shared with SMART to allow transit dispatchers to make more informed routing and scheduling decisions.

Simplifying the Driving Experience

The complexity of the driving experience is perhaps the greatest factor contributing to the number of vehicle crashes on our roadways today. With the continued development and deployment of ITS and VII, transportation by automobile promises to become much less complex and much safer on the roadways of tomorrow. With the help of auto makers, high tech businesses, and cutting edge ITS and VII researchers, and the continued support of MDOT and other public agencies, Michigan will play a significant role in making it happen.

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