

# Michigan VII Update

Designing a better transportation system through Vehicle Infrastructure Integration

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## VII Systems Thinking

by Peter Sweatman, UMTRI Director

Of all the ITS technologies deployed in highways and vehicles, VII is especially innovative because it creates a fully interactive system from the separate elements of vehicles, drivers, roadways, and environmental factors. As researchers, we have thoroughly studied aspects of the driver vehicle system and of the vehicle road system, but have focused less on the entire driver vehicle roadway environment system. Comprehensive wireless communication makes that system a day to day reality, and that system supports our way of life and economy, and offers system solutions to complex problems like safety, traffic congestion, and sustainability.

Systems thinking and systems solutions usually require the ability to describe and even model the entire system at a particular point in time. For VII, it is also necessary to account for changes that occur over time, subject to external influences. For example, automotive consumers need to adopt the new technology and their attitudes will change with experience, competitive behavior, price changes, etc. Such complex systems modeling requires looking for tipping points in markets and consumer behavior.

I believe it is crucial to have a good business model defined prior to completing a full VII deployment plan. We may not need to develop a full simulation yet, but we need to know all the key interactive elements and influences. As VII is deployed,

### VII Mission:

MDOT's VII mission is to partner with public agencies, the automotive industry, and the telecommunications industry to lead the nation in VII research and sustained VII deployment by providing the public foundation for Michigan's new automotive information technology industry and ensuring improvements in transportation systems safety and operational performance.

we need to track the effects of external influences.

What system attributes contribute most to our way of life and economy? So far we are assuming that time saving functions like traffic throughput at intersections, route guidance, and parking advice are important. But what additional mission critical functions would we identify if we focused on higher level attributes like reducing commuting time or goods delivery time? Or providing improved access to services for our aging population?

Technologies are being developed and evaluated to avoid certain vehicle to vehicle crashes, with VII making a huge contribution. But safety research sets a high bar. We rigorously use statistics to identify key problems and apply exacting experimental methods to see whether proposed countermeasures

are effective and to guard against unintended consequences. The development and evaluation of VII safety applications are in a class of their own.

While it is widely assumed that VII will reduce traffic congestion and increase throughput, and that probe data will prove to be the basis of effective VII applications, there has been little systematic investigation of how this will work on a large scale. Modeling is needed to show the way and is appropriate given that the burden of proof is much lower than for safety applications.

It has perhaps been implicit that VII will reduce vehicle fuel use and emissions through avoidance of traffic jams. Meanwhile, the issue of transportation energy in relation to oil dependence, national security, and carbon emissions has risen to the top of the national energy policy agenda. VII needs to connect with this agenda and develop proposals to enhance moves to renewable energy and plug in hybrid electric vehicles.

As we consolidate our VII developments and capabilities in Michigan, and reach out to important collaborations with other countries, it is doubly important that we come together to develop a more explicit framework for the societal value of VII, and a more complete rationale and set of applications to address all major negative side effects of transportation.



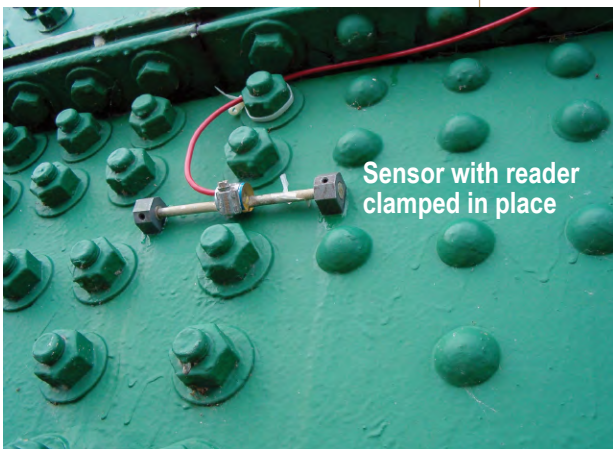
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Peter Sweatman

## VII Communication at the Mackinac Bridge

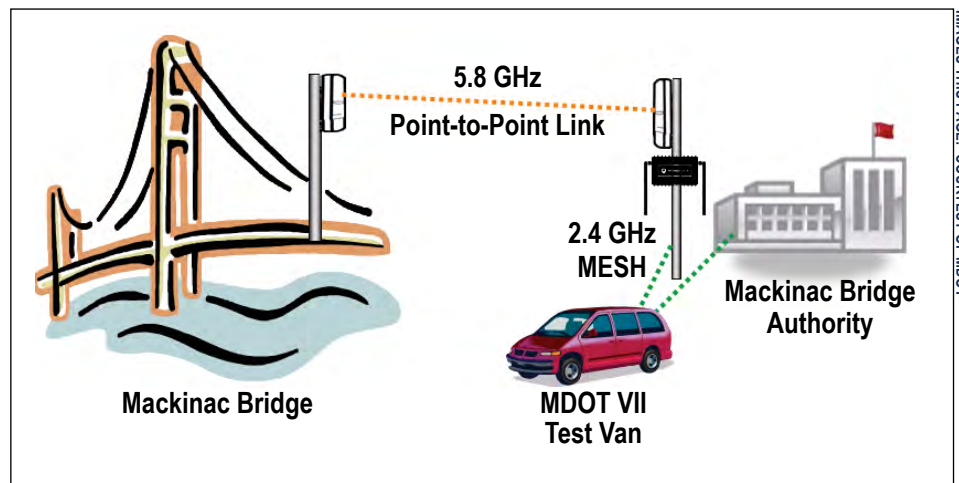
MDOT in partnership with the Michigan Economic Development Council, the Center for Automotive Research and Connected Vehicle Proving Center CVPC, and Motorola Inc. recently installed and operated sensors on the Mackinac Bridge to test and demonstrate a broadband wireless communication system. The installation proved that a temporary application could be deployed quickly and easily, and, more importantly, that the Motorola wireless network would be a highly effective system for expanding wireless communication to cover other MDOT highway bridges throughout the state.

The wireless broadband network was installed during the week of August 27, in time for the annual Labor Day Mackinac Bridge Walk on September 3. Data collection occurred September 14. Sensors installed on the Mackinac Bridge monitored Labor Day traffic conditions and used VII technologies to collect data from specific locations on the bridge. From these locations, data was sent through a wireless communication network for storage



Sensor with reader clamped in place

The bridge sensor contains a vibrating wire inside a small steel tube that acts as a piano string. As the wire stretches, due to increased traffic, the frequency increases. The frequency is converted first to a voltage, then to strain, and then to stress, which is then compared to allowable from the original 1953 design.



A broadband wireless communication system was installed on the Mackinac Bridge to monitor Labor Day traffic. The system collected data from specific bridge locations and sent it to MDOT vehicles (equipped with VII on-board systems) and to laptops at the Mackinac Bridge Authority.

and display, both to MDOT vehicles equipped with a VII on board system and to laptops at the Mackinac Bridge Authority MBA building, away from the bridge see diagram. MDOT and MBA officials monitored this data. The Labor Day test examined the vehicles' ability to collect bridge monitoring data and transmit it through a point to point canopy and mesh communication wireless network. The network conclusively validated its ability to deliver high speed, real time data every eight seconds and allow this data to

be processed for historical asset management monitoring purposes.

Using the Mackinac Bridge as a pilot test case has helped advance the development of wireless bridge monitoring technologies and other potential uses such as homeland security applications, automated toll payment systems, truck weigh in motion monitoring, weather effects, improved operations and maintenance, and general infrastructure data collection for

asset management and planning purposes. The pursuit of these innovative technologies will provide MDOT with important knowledge that can be used to enhance and improve the future of state's transportation network.

MDOT is currently working with Motorola and other industry partners to expand this wireless network beyond the Mackinac Bridge to the Cut River Bridge 24 miles to the west. While the same Motorola canopy and sensors on the Mackinac Bridge will be used for the proposed expansion, new challenges will be recognized, such as data delivery, power sources, system security, and weather related issues.

For more information, contact Steven J. Cook, P.E., MDOT, Operations Engineer, 517 322 5709, [cooksj@michigan.gov](mailto:cooksj@michigan.gov).

## Emerging Intelligent Transportation Systems

MDOT and the State of Michigan are proponents of applying the newest road technologies appropriately and cost effectively. As an early adopter of intelligent transportation systems ITS and vehicle infrastructure integration VII programs, Michigan is playing

a national and international role in researching the design, planning, and deployment of these systems. ITS involves surveillance, traffic control, lane management, parking management, information dissemination, and enforcement. VII is a segment of ITS that seeks to link vehicles to the infrastructure and to each other through wireless connections. Applications of VII systems encompass a variety of on board vehicle safety applications and transportation operations.

VII at its most basic level involves two major components: roadside equipment and on board equipment in specially designed “smart cars.” Roadside units are similar in size and operation to a home wireless network router. They gather information from various infrastructure sources, such as sensors, and relay it to specially equipped intelligent vehicles. Vehicle on board equipment utilizes data received from the roadbed, as well as other intelligent vehicles, to disseminate and receive information from other intelligent transportation systems, such as dynamic messages signs, weather stations, other vehicles, and owners of the infrastructure for asset management data collection purposes. This creates a constant pipeline of information flow between the infrastructure and vehicles. VII technology allows vehicles to serve as “probes” on the roadway, sending back continuous information on traffic, incidents, pavement, weather, and other location specific conditions along the road network. These systems will create economies of scale by integrating multiple in vehicle technologies that will increase the efficiency of the data collection process, while providing near real time information to drivers through in vehicle warning systems and other ITS systems located throughout the infrastructure.

The crossover and synergies that exist among the various initiatives within this ITS network are vast and complex. Transportation is undergoing a significant technological transformation with wireless communication that enables vehicles to communicate with other vehicles and with the infrastructure, thereby improving safety, mobility, vehicle performance, and personal convenience.

One such initiative related to the advancement of these technologies is the Connected Vehicle Proving Center CVPC . The CVPC will test, evaluate, and showcase connected vehicle systems by integrating connected vehicles, smart roadway infrastructure, and a broad range of telecommunication technologies, as well as provide expertise in evaluation design, data storage and analysis, and information sharing. The CVPC also assists with linking its private and public sector partners with appropriate equipment and operational environments for testing connected vehicle products and services.

Collectively ITS, VII, and initiatives like CVPC, Clarus, RWIS, 511, MDSS, Tolling, DUAP, SRIS, VIIC, CAMP, V2V IVBSS, and ATIS will comprise a network of ITS activities that can be leveraged to increase safety and mobility on U.S. roads. Enabled transportation systems of the future will provide value added features and services, resulting in enhanced safety, commerce, and economic growth for the traveling public and businesses dependent on the transportation industry. It is expected these technologies will evolve independently, but operate on a common platform that supports both ITS and VII initiatives, making the whole greater than the sum of its parts.

For more information, contact Steven J. Cook, P.E., MDOT, Operations Engineer, 517 322 5709, [cooksj@michigan.gov](mailto:cooksj@michigan.gov).

## Economic Impacts of VII Program in Michigan

A team at Michigan State University and the Center for Automotive Research is under contract to examine the economic contribution of the VII deployment in Michigan. The team recently completed a draft of a study that is expected to provide policymakers with an estimate of the economic contribution to the state’s economy from the jobs, corresponding wages, and other compensation that will be created through direct employment in the industry. The contribution of indirect employment and the effects on tax revenues have also been estimated. The estimates, which were determined by modeling the regional economy, offer insight into the industrial sectors of Michigan’s economy that will benefit from VII research, development, and deployment.

The study was based upon the industry assumption of a full deployment of VII in Michigan by 2011 and includes forecasts of the impacts of VII on the Michigan economy beginning in 2016, five years after full deployment. The preliminary results of the analysis indicate that there will be growth in jobs as well as in tax and compensation revenues resultant from VII deployment in Michigan.

The significance and magnitude of this growth is dependent upon several factors, such as the efficiency and timeframe of VII deployment relative to states adjacent to Michigan in particular and to the rest of the country in general. In view of the fast pace of technological advances and stiff competition for leadership by auto companies and other states it is imperative that the deployment in Michigan be both focused and consistent.

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## ITS World Congress Debuts VII Tech Demos

With the theme "ITS Connections: Saving Time, Saving Lives," the 15th World Congress on Intelligent Transport Systems and ITS America's 2008 Annual Meeting and Exposition will be the largest event in the world for ITS professionals. Mark your calendar for November 16-20, 2008, in New York City.

Attendees will have access to over 200 policy and technology sessions, technical tours including the New York State DOT's INFORM Center and George Washington Bridge, and the opportunity to connect with industry professionals from around the world.

This event will feature the largest fully integrated demonstration of deployed and marketable ITS technologies, highlighting vehicle to vehicle and vehicle to roadside communication technologies and applications. The demonstrations will include innovative mobility solutions operating on the streets and highways of New York and will build upon the success of the Innovative Mobility Showcase at last year's World Congress.

### VII Test Beds

Three DSRC equipped test beds are being developed in and around New York City to demonstrate applications such as in vehicle signing, warnings, traveler information, and e-commerce. Tour buses will be equipped with video screens that replicate a driver interface so large numbers of delegates can experience these various applications.

### 11th Avenue Theater

Live demonstrations in a narrated, theater like environment in front of the convention center will highlight active safety systems and other dynamic applications that are not practical to conduct in real traffic.

## VII Transportation Management Center of the Future

A video wall will illustrate transportation systems in 2020. Raw probe data will be transmitted from the tour buses and other DSRC equipped vehicles in the New York area. Attendees will be shown how vehicle based sensor data can be used to generate information useful to highway operations such as the generation of travel time data, signal timing, weather forecasting, and road condition warnings.

For more information, see [www.itsworldcongress.org](http://www.itsworldcongress.org).



## VII California Report

California and Michigan share a common vision of reducing fatalities, congestion, global warming, and carbon emissions, and achieving energy independence. This article describes California VII efforts that complement those of Michigan. Caltrans and MTC<sup>1</sup> are leading the VII California Program, working closely with their respective technical partners, the California PATH Program and Telvent Farradyne. Four automotive original equipment manufacturers—VW, BMW, Mercedes, and Toyota—are also key partners in the program.

Building on its experiences from the 2005 ITS World Congress, the VII California team is constructing a VII California Testbed along a 20 mile corridor in Palo Alto. The testbed will be built on three

## Upcoming Events

2008 ITS-Michigan Annual Meeting and Exposition: "Integration of Technology and Services—A World of Innovation," May 13-14, Novi, MI, [www.itsmichigan.org](http://www.itsmichigan.org)

Management Briefing Seminars, August 11-15, Traverse City, MI, [www.cargroup.org](http://www.cargroup.org)

15th World Congress on Intelligent Transportation Systems: "ITS Connections: Saving Time, Saving Lives," November 16-20, New York, NY, [www.itsworldcongress.org](http://www.itsworldcongress.org)

parallel north-south routes: U.S. Highway 101, Interstate 280, and State Route 82. Twelve roadside equipment locations have been installed, and the team is committed to installing a total of 40 sites over the next year.

The U.S. DOT recognizes the testbed as a formal test site for the national VII Program, and it will be used to develop and test VII applications such as traveler information, intersection safety, curve speed warnings, electronic payments, and ramp metering.

The RITA Administrator, Paul Brubaker, and members of the national VII Technical Working Group toured the VII California Testbed in early December.

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