ITS Institute research is centered on safety-critical technologies and systems for efficiently moving people and goods in the following areas:

- human performance and behavior
- technologies for modeling, managing, and operating transportation systems
- computing, sensing, communications, and control systems
- social and economic policy issues related to ITS technologies

The Institute’s research program joins technologists—for example, engineers and computer scientists—with those who study human behavior to ensure that new technologies adapt to human capabilities, rather than requiring drivers to adapt to technology.

The Institute’s geographic location gives it a unique advantage for developing research applicable to transportation in a northern climate and transportation in rural environments in addition to the metropolitan Twin Cities area. The ITS Institute research program includes research projects funded by various partners, including federal funds from SAFETEA-LU legislation, the Federal Highway Administration, the Federal Transit Administration, the National Highway Traffic Safety Administration, the National Park Service, and the Department of Homeland Security. Other funding partners include the Minnesota Department of Transportation (Mn/DOT), Minnesota Local Road Research Board, Metropolitan Council, Hennepin County, Metro Transit, and the Minnesota Valley Transit Authority in addition to local governments, agencies, and private companies that contribute funding and in-kind match.

Activities undertaken by the Institute support all ITS-related research projects, regardless of funding source; all current ITS-related projects are listed in this annual report. The research section comprises two parts. The first highlights in detail a selection of projects under way, while the second briefly describes other Institute projects either recently completed, in progress, or selected to begin this coming year.

Research funding sources for all ITS-related research projects

The total funding for ITS-related research projects was approximately $7.7 million in FY08. Sources for projects receiving funding in FY08 are shown in the chart to the right.

During this period, 50 faculty and research staff and 65 students were involved in ITS-related research.
Motorcycle Riding Impairment at Different BAC Levels

HumanFIRST Program research fellows Janet Creaser and Mick Rakauskas, former HumanFIRST director Nic Ward, consultant Erwin Boer, and Intelligent Vehicle Lab (IV Lab) director Craig Shankwitz collaborated to study the effects of alcohol on motorcyclists, taking advantage of the programs’ access to unique research facilities and expertise in monitoring driver performance.

Motorcycles and scooters are more popular than ever—even in Minnesota, where frigid winters limit riders to a few months a year. But statistics from the National Highway Traffic Safety Administration (NHTSA) show that while motorcycles account for only three percent of motor vehicle registrations, they make up 11 percent of total motor vehicle fatalities. Crash reporting data reveal that alcohol is more likely to be a factor in motorcycle crash fatalities than in fatalities involving automobiles (one in three fatal crashes for motorcycles versus one in four automobile crashes). And, alarmingly, statistics from the Centers for Disease Control indicate that the number of fatalities due to motorcycle crashes each year in the United States is currently rising, reversing a nearly two-decade downward trend.

With these statistics in mind, and given the unique demands of motorcycle operation, safety experts are asking whether the restrictions on blood-alcohol content that govern automobile drivers are appropriate for motorcyclists.

With funding from NHTSA, the study aimed to fill a gap in research on the effects of alcohol consumption on motorcycle operation. While a large body of research has been devoted to detailed analysis of how alcohol interferes with automobile operation, relatively little effort has been made to study the effects of alcohol on the different skills required to operate a motorcycle.

This discrepancy is due in large part to the technical difficulty of research on motorcycle rider impairment. Advanced driving simulators for motorcycles are virtually unknown, and in-vehicle testing is largely impossible due to the hazards of impaired motorcycle operation and strict laws prohibiting motor vehicle operation while intoxicated.

To overcome these obstacles, the IV Lab researchers first created a motorcycle that could be operated safely by a study subject while under the influence of alcohol. They modified a common motorcycle by adding two outriggers that engage if the bike tips during a test ride. (The outriggers prevent the bike from landing completely on its side on the rider.)

The motorcycle was then equipped with an onboard suite of sensors also designed by research engineers from the IV Lab. The Motorcycle Data Acquisition System, or MoDAQ, monitors both the participant and the various control surfaces of the motorcycle. In addition, a set of inertial measurement units were deployed on the motorcycle’s frame and the rider’s helmet to measure acceleration and rotational rate.

Even with added safety features, operating the motorcycle with alcohol-impaired research subjects would...

For their experiments, researchers added two outriggers that engage if the motorcycle tips during a test ride.
still have been prohibited by Minnesota law, which applies to private driving courses and tracks as well as to public roads. Fortunately, one driving course in Minnesota is specifically exempt from the state law: the Minnesota Highway Safety and Research Center in St. Cloud. The facility is one of several closed courses used in HumanFIRST research.

The research team recruited 24 male study participants who had a minimum of five years of motorcycling experience and drank alcohol at least once a week but with no history of alcohol dependence. After training designed to familiarize the riders with the research motorcycle, the riders participated in three day-long test sessions during which they either drank alcohol to reach a blood-alcohol concentration of .02, .05, or .08 g/dL (the legal limit in Minnesota) or were given a placebo (alcohol applied to the rim of a glass containing a non-alcoholic beverage).

After consuming the alcoholic beverage or the placebo, the participants rode through a test course developed in collaboration with motorcycle instructors Bill Shaffer and Jed Duncan from the Minnesota Motorcycle Safety Center. The course included a variety of tasks, ranging from routine riding situations to emergency maneuvers. Data from both baseline (non-alcohol) rides and rides after consuming alcohol were gathered for each participant, enabling the researchers to compare the effects of different amounts of alcohol consumption.

Analysis of data from these tests revealed that some impairment was evident in motorcycle riders at the 0.05 blood-alcohol level, below the 0.08 level that constitutes intoxication in the eyes of the law. And while self-reports by the test subjects indicated that many riders may realize when alcohol is affecting their riding performance, the researchers caution that the evidence does not mean that self-regulation is sufficient to mitigate the increased crash risk due to riding after drinking.

Influence of a Haptic Driver Support System on Informational Processing, Attentional Resource Management, and Driving Performance

Only a few decades ago, catastrophic failure of critical components was a common cause of automobile crashes. Since then, improvements in automotive engineering have greatly reduced the number of crashes caused by mechanical failure while driving. So why are so many people still losing their lives every year in automobile crashes? One explanation for this apparent paradox is that while engineers have been very successful in making vehicles safer, drivers remain largely unchanged. Today, driver error may play as significant a role as mechanical failures in crashes. In addition, the myriad electronic controls and options in current vehicles, not to mention cellular phones and other personal communication devices, mean that the potential impediments to good driving performance may be increasing.

All drivers, no matter how experienced, are subject to natural limits of human behavior, cognition, and perception. But just as technology can help overcome physical limitations, it can also help address the perceptual and cognitive biases that often lead to less-than-optimal driving performance.

The potential solution, says Michael Manser, director of the HumanFIRST Program, is using technologies that support—rather than impede—good driving practices. For the past four years, he has been one of the primary researchers in a collaborative effort with Nissan Motor Company of Japan aimed at evaluating a new driver-assistive system. The Nissan system uses a haptic (touch-based) feedback mechanism attached to the accelerator pedal to provide variable resistance depending on how close a driver’s vehicle is to a lead vehicle. Forward-looking range sensors are able to sense changes in distance much more accurately and quickly than the human eye and relay these changes instantly, even if the driver’s attention is elsewhere.
Although humans are endowed with highly evolved senses of hearing and touch, we rely almost exclusively on vision when we get behind the wheel. In this context, says Manser, haptic feedback systems are interesting because they exploit a relatively underused information channel that may not compete with the many visual cues that drivers already have to process.

Manser first set out to determine whether drivers could effectively process information presented to them through this novel non-visual channel. The HumanFIRST Program’s immersive driving simulator provided an ideal environment for initial testing, allowing the research team to monitor driver reactions and control the parameters of driving situations in which the haptic feedback system would be activated.

Reaction-time data from initial tests revealed that drivers responded to the sudden slowdown by a lead vehicle by moving their feet off the accelerator pedal more quickly when using the haptic feedback system, and that this benefit was present in both high-complexity and low-complexity secondary task scenarios.

A second finding highlights some of the hidden complexity of driver response. The data reveal that the initial reaction times of drivers using the haptic feedback system are better (i.e., lower), but that drivers then take slightly longer to transition from the accelerator pedal to the brake pedal. Manser believes this slight delay may result from drivers performing a visual double-check on the lead vehicle to make sure it is actually slowing. This extended transition time is more than offset by the reduced reaction time, making total response time significantly better with haptic feedback than without.

These results substantiate the hypothesis that the use of a haptic feedback system can result in a significant improvement in driver performance, and that this is the result of the system freeing cognitive resources that are then directed to the primary task of driving. However, an unintended consequence is that drivers could use the cognitive resources it frees up to perform other secondary tasks.

The HumanFIRST researchers devised a second test to investigate this possibility. Like the first test, it involved performing a secondary task while following a lead vehicle, but this time the task required drivers to interact with a touch-screen display rather than adjusting a stereo system. This task was designed to be more demanding perceptually, cognitively, and physically in order to approximate the normal demands of an in-vehicle secondary task (e.g., using a cellular phone) of real-world situations.

The researchers found that using the haptic feedback system improved vehicle controllability (the primary task), and also improved drivers’ performance on the secondary task. These findings suggest that drivers are taking advantage of the newly freed resources from the haptic system to improve driving performance and to improve secondary task productivity. HumanFIRST has received follow-on funding from Nissan to continue researching the implications of the haptic pedal system.
The ability to measure traffic flow rate is crucial to traffic monitoring and control. Ramp meters, which control the number of cars entering the freeway, are set according to current traffic conditions. So are variable messaging signs, which alert drivers to conditions on the road ahead. Accurate traffic flow measurements are also essential to Minnesota’s 511 traveler information service.

One way of measuring traffic flow is by using loop detectors. These widely used devices consist of a large electrically powered wire coil embedded in the roadway. Each passing car triggers a change in the magnetic field of the wire, which is recorded by the detector.

Due to their accuracy, loop detectors have proven popular in the United States and Europe. But now Professor Rajesh Rajamani, research fellow Lee Alexander, and graduate Ph.D. student Krishna Vijayaraghavan, all with the Department of Mechanical Engineering, are developing a new battery-less, wireless traffic sensor that may offer even greater benefits.

Like the loop detector, the new sensor accurately measures traffic volume and vehicle speed, but it also provides new data such as vehicle length and the number of axles. In addition, it costs less than a loop detector, is easier to install, and is more environmentally friendly because it uses no energy.

The sensor consists of two components: a piezoelectric beam embedded in the road and a data processing unit located within a few hundred feet of the road. Cars passing over the beam cause it to vibrate. The vibration creates electric energy that is used to send information to the data processing unit.

Every time a vehicle passes over the beam, the sensor captures and stores energy. The harvested energy is more than enough to power the device and keep it running. Unlike a loop detector, which must be attached to an external power source, the beam is self-powering.

More than 6,000 loop detectors are currently in use in the Twin Cities metro area—one in every lane of every mile of every major highway. Each loop detector must be continually powered, even at times when there is little traffic on the road. Because the new sensors do not depend on an external power source, their use would cut energy consumption.

Researchers estimate that the wireless sensors would cost less than $100 each, compared to more than $700 in hardware costs for a typical loop detector. The wireless sensors are easier to install because there’s no need to connect the beam to a power supply or to other signal lines. The beam is also smaller than the loop, which means that highway crews would need to drill only a small slot in the roadway instead of laying the wire needed for the loop. As a result, there would be no need to close lanes and stop traffic for long periods of time during installation of the beam.

To design the sensor, the team developed several computer models and simulations. Using the data from these studies, the researchers built the prototype. They tested the device by placing it under a wooden ramp in a University parking lot and driving over it. Further testing was done in a vacant lot where the team placed the device in a hole and covered it with mud and gravel.

The researchers are now developing a smaller version of the piezoelectric beam. They are also working on an enhanced sensor that will measure vehicle weight in addition to length and number of axles. Future testing will compare the new sensor to existing sensors in terms of longevity and accuracy.

Ultimately, the team hopes to develop and evaluate a sensor network that can be used for short-term applications such as turn analysis at rural intersections. Rajamani estimates that the battery-less, wireless sensor will be ready for highway use in two to three years.
Unlike metropolitan highways, rural roads lack sensors—usually cameras or loop detectors—to collect traffic data such as average speeds, car counts, and queue lengths. For this reason, engineers have been evaluating the use of miniature airplanes, known as remotely operated vehicles (ROVs) or uninhabited aerial vehicles (UAVs), to help collect some of this data.

Besides playing a useful role in rural areas and other locations where traffic sensors are rare, the vehicles could also be used to inspect roads, bridges, and other infrastructure. In emergencies, they could help with disaster management by transmitting pictures or serving as temporary cell phone towers.

In fact, says Demoz Gebre-Egziabher, assistant professor of aerospace engineering and mechanics, ROVs and UAVs were used in the recovery effort after Hurricane Katrina to look for signs of life in empty buildings and inspect damaged structures before rescuers were allowed to enter. In general, however, the use of ROVs and UAVs is currently banned by the Federal Aviation Administration (FAA). Research is permitted only in very restricted environments and under tightly controlled conditions. Regulators want to be sure that the vehicles will not crash into buildings or other planes and that they will not break up and fall into crowds or onto busy highways. In other words, just like large aircraft, ROVs and UAVs will need to meet safety criteria before they are allowed to fly.

As a first step toward creating safety criteria, Gebre-Egziabher and his research team (students Troy Wigton and Zhiqiang Xing, research scientist Greg Nelson, and research engineer Curt Olson) are identifying hazards associated with ROVs and UAVs and quantifying the likelihood of their occurrence.

The first stage in this research involves determining the reliability of the computer systems in the vehicle. The researchers want to find out, for example, whether the Global Positioning System (GPS) provides sufficiently reliable information all the time. But GPS is just one of many different systems in the vehicle. So during the second stage of their research, Gebre-Egziabher and his colleagues will determine the reliability of the mathematical methods used to combine information from multiple systems. This task resembles the navigational challenge faced by bats, Gebre-Egziabher explains. In the dark, bats rely on their natural sonar to avoid flying into a wall. In the light, they rely on their vision. When placed in a well-lighted room with a large window, bats will sometimes fly into or hit the window because they ignore their sonar and trust their vision.

To avoid a fate similar to the bat’s and assure safe operation of the vehicle, the mathematical methods must determine when each system should be trusted and when it should be ignored. The researchers are focusing on a particular set of data used in these mathematical methods: the location and orientation of the vehicle—that is, where the vehicle is and which way it is pointed.

FAA safety standards are expressed in terms of mathematical odds, such as a one in a million chance of malfunctioning. Because safety standards for ROVs and UAVs have not yet been determined, Gebre-Egziabher and his colleagues are considering various odds. For example, if the standard is one in a million, developers would use a given method. For a standard of one in 100,000, the equations used in the mathematical methods might be slightly different.

The ultimate goal of the researchers is to create a methodology that federal and state agencies can use to develop safety standards for ROVs and UAVs. Such a methodology will also allow designers to develop hardware specifications that include operational requirements such as system reliability, required accuracy of location, and velocity estimation. In addition, operational procedure designers could use the methodology to determine the required qualifications for operators of remotely controlled planes.
Research

Transportable, Low-Cost Traffic Data Collection and Wireless Surveillance Device for Rapid Deployment for Intersections and Arterials

Many commuters spend at least part of their daily round trip on arterial streets as they drive to or from the freeway. And some don’t use the freeway at all because their entire commute takes place on city streets.

Well-timed traffic signals on busy arterials can minimize stops and delays, which improves overall traffic coordination and reduces congestion. Fewer stops and delays also reduce energy consumption and pollution levels since drivers spend less time in intersections with car motors idling and emitting exhaust.

To time signals correctly, traffic engineers need to determine detailed traffic flow characteristics (vehicle counts and type, turnings, and queue size). But this is not easy to do because, despite recent advances in technology, most traffic engineering studies of intersections and arterial streets are done manually. In other words, someone must sit on the side of the road and count cars as they pass by.

Such studies are notoriously inaccurate. They also provide no visual record of traffic characteristics for verification, analysis, or research that could lead to improved safety and control practices. This means that traffic engineers must rely on the Highway Capacity Manual, which is generally inadequate for the advanced applications dictated by current ITS requirements.

Manual studies are costly, time-consuming, and logistically difficult. As a result, these studies are performed only when absolutely necessary—because of reconstruction, congestion, unusually high crash rates, excessive public complaints, or emergency situations.

But this may soon change. University of Minnesota researchers are working on a stand-alone data-collection and video-surveillance system that is inexpensive and nonintrusive. A rapidly deployable and easy-to-use device is being developed by civil engineering professor Panos Michalopoulos, Minnesota Traffic Observatory manager Ted Morris, and civil engineering graduate student Jory Schwach.

Their goal is to create a device that will automatically measure traffic volumes, turning movements, speeds, and other characteristics of traffic operations at intersections and urban arterials. It will also provide a video record, which will allow surveillance and visual verification of traffic data.

To develop the required specifications for the apparatus, Michalopoulos, Morris, and Schwach consulted with a panel of researchers, engineers, and practitioners in the field of traffic data collection. The team determined that the device should:

- Be constructed from off-the-shelf components for less than $5,000;
- Include both video detection and recording capabilities;
- Include a video camera on a self-raising mast at least 30 feet high;
- Require no more than 15 minutes to set up and take down;
- Be portable enough for one person to set up;
- Be weatherproof; and
- Have the ability to record for long periods without its battery needing to be recharged.

In addition, wireless camera control and data acquisition are under development and will be added to the current prototype.

To test the apparatus, researchers are deploying it at five intersections in the Twin Cities metropolitan area. The intersections were chosen because they represent the five most common designs used in American cities. During each deployment, the system will record weekday morning, mid-day, and evening peak-hour travel times over the course of one week—producing about 40 hours of video. Once the test is complete, the research team will manually verify all the automatically extracted traffic data against the video record.
The apparatus will also be deployed in the middle of the block preceding the intersection to measure vehicle speeds and volumes immediately upstream of the intersection site.

In the future, multiple systems could be deployed simultaneously to collect data along critical corridors. Researchers also hope to further develop the apparatus so that it will one day have the capability of automatically extracting left and right turns within a given intersection.

The new device promises to provide traffic engineers with more detailed data and a greater ability to verify its accuracy. This will allow engineers to create better strategies for arterial operations and to improve inner-corridor traffic management.

Access to Destinations: Estimation of Arterial Travel Time

Access—or how long it takes people to reach necessary or desirable destinations such as jobs, stores, or movie theaters—is one of the most important concepts in transportation planning, but to determine accessibility, planners need accurate estimates of travel time. Freeway travel time is easily estimated due to the presence of loop detectors—electrically powered wire coils embedded in roadway that measure traffic flow. Yet not all travel takes place on the freeway. Every automobile trip includes at least some time spent on arterial streets, and some trips take place entirely on arterials. But since detectors are not built into arterials, travel time on these streets is more difficult to measure. For this reason, planners must rely on mathematical models or equations.

Although mathematical models work well for estimating freeway travel time, they are not always accurate for arterial travel time. That’s because traffic flow on arterials is controlled by traffic signals. As a result, accurate estimation needs to take into account factors such as the timing of the red and green lights, how long lights stay green, and what proportion of vehicles pass through the intersection on a green light without stopping.

In a recent study, a component of the larger Access to Destinations Study, civil engineering professor Gary Davis and graduate student Hui Xiong compared travel-time predictions generated by five commonly used models to actual travel-time measurements made in the field. (Access to Destinations is an interdisciplinary research and outreach effort coordinated by the Center for Transportation Studies. The first research component, Understanding Travel Dimensions and Reliability, focuses on improving the understanding of travel within urban transportation systems.)

The goal of Davis and Xiong was to determine which mathematical models produce the most accurate predictions of arterial travel time. Commonly used models can be divided into two kinds: those that include the effect of traffic signal timing and those that don’t. Davis and Xiong wanted to determine whether a model that didn’t take into account signal timing could produce a reasonably
School choice was created as an alternative to forced desegregation. It has proven popular with parents, allowed urban districts to retain white middle-class students, and is encouraged by the “No Child Left Behind” Act of 2001. But it has also had unexpected implications for transportation.

These days, it’s not uncommon for five students who live on the same city block to be bused or driven to five different schools in five different areas of town even though they all live within walking distance of the same neighborhood school.

Elizabeth Wilson became interested in the implications of school choice one morning as she biked near her home in St. Paul’s St. Anthony Park neighborhood. She found herself riding behind five school buses, choking on exhaust fumes, and wondering about the impact of busing on the environment, energy use, and transportation.

Wilson, an assistant professor at the Hubert H. Humphrey Institute of Public Affairs, decided to take a closer look at school travel. The initial analysis was very simple: Wilson, Kevin Krizek, former researcher at the Humphrey Institute, and graduate student Ryan Wilson compared the PTA list from the neighborhood school attended by Wilson’s daughter with the list from a citywide school attended by the child of a friend.

They geocoded the addresses and, using national data, categorized each student as “walk” or “not walk.” For students in the “not walk” category, she created two scenarios: In the first, students took the bus. In the second, they were driven to school.

The researchers determined that compared with the neighborhood school, the citywide school had 6 times fewer walkers. Students traveled 4.5 times as many miles, and this travel created between 3 and 4.5 times the amount of criteria pollutants and greenhouse gases.

In the scenario with bus service, emissions were reduced and the number of miles traveled decreased by 30% accurate forecast of travel time on arterial streets.

To find out, the researchers randomly sampled traffic flow on 50 arterial streets throughout the Twin Cities metro area. To measure actual travel time on a street segment between signals, two observers—one at either end of the segment—entered into a laptop computer the last three license numbers of as many passing cars as possible. The time each car arrived at a signal was also recorded. The license numbers and times were later matched to determine travel time between signals.

Gary Davis

Davis and Xiong then compared the travel times recorded in the field with the estimated times generated by five commonly used mathematical models. To do this, they gathered information needed for each model, such as the length of each link and timing of signals.

And they determined traffic volume by videotaping and counting passing cars on each segment. This information was plugged into each model.

The researchers found that the two models that allowed for the inclusion of signal-timing information produced the most accurate results. The more precise the signal-timing information, the more accurate the prediction. But even when less precise “default” information about signal timing was included in the model, the estimated travel time was still acceptably accurate.

One mathematical model in particular—known as the Skabardonis-Dowling model—produced the best results, using both precise and default information. Davis and Xiong recommend that this model be used in the next phase of the Access to Destinations Study when researchers will analyze changes in travel time and accessibility and begin considering possible future policies.
or 40 percent compared to the scenario in which students were driven to school. No bus service reduced the cost to the school system. But in all scenarios, the neighborhood school came out ahead.

In the next phase of the study, Wilson, Krizek, and Julian Marshall, assistant professor of civil engineering, surveyed parents of grade school children in St. Paul and Roseville. The survey included questions about modes of travel, concerns about travel, and demographic information.

Survey results confirmed the initial analysis: distance from school affects the choice of travel mode. Results also showed that local data are useful. This includes information about actual rates of walking, busing, and driving, as well as the use of different modes of travel to and from school.

The most surprising finding was that white and non-white parents had different attitudes toward school travel. Non-white parents, for example, had more concerns about safety, including children’s safety while waiting at the bus stop and walking home. They were less concerned about long bus rides, however. Researchers learned from school personnel that this was because many non-white parents used bus service as proxy childcare.

These concerns are extremely important in districts such as St. Paul, where the majority of students are non-white. In addition, transportation planners must think about school concerns, including cost, safety, and convenience.

The implications of school choice should also be considered when assessing programs such as Safe Routes to School. Such programs may not be effective if a high percentage of neighborhood children attend magnet or charter schools in other neighborhoods.

Ryan Wilson has continued this examination of school travel issues. He created two statistical models of travel behavior, using the data set created by Marshall, Krizek, and Elizabeth Wilson, along with a full sample of all elementary-age students in the St. Paul School District. Using these models, he analyzed and quantified the transportation effects of various education policies, such as no school choice and school choice on a lesser geographic scale.

Among his findings: total walking and school bus travel is slightly greater from-school than to-school. Magnet schools draw from broader geographic regions than neighborhood schools and students are less likely to walk, not because of parents’ attitudes toward travel, but simply because they live too far away. School district transportation costs are also greater for magnet schools because more magnet students ride the bus.

This research provides planners with a framework for examining different school choice or transportation policies and evaluating their impact on the school district budget, school choice opportunities, and active transportation.

“School choice matters,” Wilson says. “The barriers to the deployment of new transportation technology are real and important. We hope that our work will provide the context needed by researchers who are investigating emerging technologies.”
ITS technologies can give planners and engineers new tools that produce a safer and more efficient transportation system. However, because many of these technologies track and record the movements of individual citizens, scholars and legal advocates have begun to raise privacy concerns. Under the auspices of the TechPlan Program, a research program at the Humphrey Institute of Public Affairs funded by the ITS Institute, a team is investigating the implications of privacy law related to emerging ITS technologies. Thus far, State and Local Policy Program assistant director Frank Douma, along with research assistants Steve Frooman and Jordan Deckenbach, has found that while privacy protections for citizens on the open road are quite sparse, the rapid development of these technologies may require a reconsideration of parts of the legal framework for privacy in America.

The United States does not currently have a comprehensive legal framework for privacy but instead relies on a nebulous web of state and federal constitutional provisions and statutes. The major issue in examining ITS is whether the ability of surveillance technologies to track and record where a specific vehicle has been, as well as predict where it may go, begins to impinge upon some of these protections.

Most broadly, the United States Supreme Court has declared that a right to privacy exists when there is an expectation of privacy and when society is ready to accept that expectation of privacy as reasonable. Though current jurisprudence and statutory regulations do not directly attempt to regulate ITS technology designs, a number of state legislatures and courts have begun to write and interpret laws concerning data practices, vicarious criminal liability, and privacy tort actions in ways that may affect the use of ITS.

One ITS technology application with potential legal implications is automated enforcement of traffic laws. Red-light intersection cameras, license plate recognition systems, and photo-radar technologies have begun to be tested and used in a number of jurisdictions around the United States. Proponents of these technologies cite increased road safety and needed relief for understaffed law enforcement agencies. Although these technologies have not been found to violate any stated privacy regulation, legal challenges centered on the issue of vicarious criminal liability have succeeded.

In a 2006 challenge to Minneapolis red-light enforcement cameras, the Minnesota Supreme Court ruled a Minneapolis ordinance—which held owners responsible when their vehicles were caught on camera running a red light—invalid, as it conflicted with state statutes that made the driver the liable party. Because the law held...
owners responsible for infractions committed in their vehicles, it deprived them of due process through the automatic assignment of guilt. Proponents of automated enforcement technologies have countered that the issue of due process under criminal procedure requirements need not apply, as only civil penalties are levied on owners of a vehicle for red-light violations. Though this rationale has been accepted in Ohio and Washington, D.C., district court, the Minnesota Supreme Court rejected that argument, claiming petty misdemeanors, though not crimes, still fall under the rules of criminal procedure that demand a presumption of innocence.

Other legal issues with ITS technologies center on questions of the kind of data that are collected and who has access to that information. As much as ITS can be used to create safer and more efficient transitways, law enforcement agencies could also use ITS in fighting crime and advancing homeland security. ITS technologies might allow law enforcement officials to backtrack the activities of a suspect's vehicle or discover what vehicles were in a particular location at a certain time. Though at first consideration these uses seem beneficial to society, without proper legal limitations these technologies could be used to invade the private lives of innocent parties.

In The Company v. United States, the United States Court of Appeals for the Ninth Circuit found that the FBI’s tapping of an onboard navigational system with a built-in cell phone in order to listen in on the private conversation of the vehicle’s occupants was inappropriate. However, the court stated that the problem was not due to a potential privacy invasion, but because the tapping disabled the services of the system, most notably, the ability of the system to be continually available to contact emergency services at any moment. Consequently, it appears that should this technical problem be resolved, the knowledge that in-vehicle conversations can be legally tapped may deter people from using or buying this type of ITS technology, despite the opportunity to otherwise obtain significant safety benefits from them.

Although the current privacy regulations do not pose a direct challenge to successful development and implementation of new ITS technologies, the current legal landscape still contains barriers that must be considered. Consequently, as ITS planners and engineers continue to develop new technologies, they may also find it useful to advocate for continued development of privacy and related protections that facilitate and support efforts to produce safer and more efficient transportation systems while also respecting the expectations of the users.