Utilizing Mobile Ad Hoc Networks to Enhance Road Safety

Exploratory Advanced Research . . . Next Generation Transportation Solutions

According to analyses by the National Highway Traffic Safety Administration (NHTSA), connected vehicle innovations could reduce crashes, injuries, and fatalities by 50 percent. There are places and times, however, where there will be a need to supplement connected vehicle systems–for example, in rural areas where there may not be enough traffic for connected vehicle systems to be viable or during events when crowds may overwhelm systems that work well during normal operations.

The Federal Highway Administration's (FHWA) Exploratory Advanced Research (EAR) Program supports research that investigates the use of mobile ad hoc networks (MANETs) to enhance road safety for all users. MANETs are a way to communicate on the fly with the hardware and software that is avaible. MANETs require minimal infrastructure and can be created autonomously as desired. They have been used primarily in military applications and in disaster relief efforts but have not yet been utilized for transportation safety.

Researchers at the University of Virginia are exploring how to deploy MANETs in areas and scenarios with less infrastructure, such as when pedestrians and bicyclists cross at the mid-block and in more rural or remote settings. At the University of Wisconsin–Madison, researchers look to harness MANETs to alert vehicles to pedestrian and bicyclist crossings at intersections through a mobile application.

Exploring MANETs to Enable Connected Transportation Services

EAR Program-supported researchers at the University of Virginia have been exploring two specific scenarios where deploying MANETs could be useful for expanding road safety: pedestrians and cyclists crossing in large groups (e.g., people leaving a sporting event or concert) and at the mid-block and improving communication in low-volume areas such as rural areas and national parks. At mid-block and on low-volume roads, drivers may not anticipate pedestrians crossing the road and be as prepared to stop.

For the first scenario, MANET algorithms would use a location-based routing protocol involving global positioning systems, enabling a wider reach for messaging. The smartphones from nonmotorized travelers would automatically send messages with location and speed information via a mobile application to connected vehicles with dedicated short-range communication (DRSC), alerting them of their presence. A vehicle would store this information, and, as it approaches an intersection, it would ping a query to other vehicles about the location of the nonmotorized travelers. Based on the responses a vehicle receives, it can determine how often to query the location of pedestrians, as well as factor in the area speed limit, the vehicle's current speed, and the distance between other vehicles and nonmotorized travelers. By having this consistent communication between vehicles, pedestrians, and bicyclists, a vehicle could receive enough information in time to stop and prevent a crash.

Another method involves smartphones from nonmotorized travelers directly sending automatic, periodic geographical broadcast messages via a mobile application to nearby vehicles, which, in turn, will send that information to following vehicles. This method eliminates the need to ping other vehicles about the nonmotorized traveler's location and alerts vehicles to their location more quickly.

For the second scenario, which the research team intends to demonstrate in a national or state park for use in rural or low-density areas, MANETs created by pedestrians and vehicles would use various delay-tolerant networking routing protocols, which are employed in places that lack a steady data connection or accessible infrastructure. Using MANETs in this way would also keep park visitors informed—via their smartphones—of schedules, trips, and other announcements, as well as create an on-demand shuttle service, using both autonomous and traditional vehicles.

The researchers will deploy both scenarios in simulation and in real-world conditions. Currently, the researchers are developing a mobile phone prototype application for nonmotorized travelers with an application prototype for vehicles with DRSC slated for deployment. Future research will focus on developing and using MANETs where traditional physical infrastructure-dependent networks cannot reach.

U.S. Department of Transportation
Federal Highway Administration

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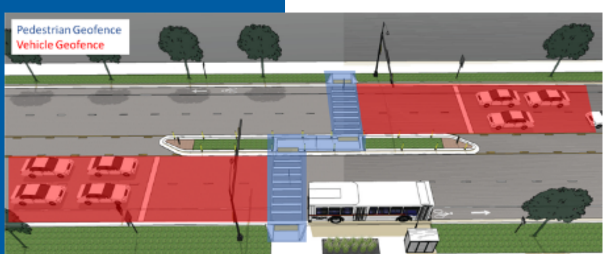
Harnessing MANETs to Improve Vulnerable Road User Safety

The act of stepping off of the sidewalk to cross the street at an intersection is an everyday occurrence that comes with the risk of collision—especially for distracted pedestrians. Previously, transportation researchers have focused on several ways to enhance road safety for pedestrians and bicyclists at intersections—through wireless protocols, using intersection cameras, or infrastructure changes (e.g., creating a pedestrian bridge), where there are costs for every application at each intersection.



Transportation researchers are exploring methods of implementing MANETs to enhance communication between vehicles and nonmotorized travelers. © *University of Virginia.*

Another barrier to increasing pedestrian safety at intersections is limited communication ability—specifically, nonmotorized travelers cannot communicate with oncoming vehicles like connected vehicles can communicate with each other.

Researchers at the University of Wisconsin–Madison have been working on a solution using an Android smartphone application that both vehicle drivers and pedestrians would use to alert drivers of nonmotorized travelers crossing an intersection. This research project has four main thrusts:

- To anticipate pedestrian road crossings by creating a predictive model to allow time for vehicles to stop.
- To communicate safety messages using wireless mediums, from pedestrians to drivers.
- To communicate this information securely in a database.
- To relay this information to human drivers via smartphones, with Wi-Fi.

The EAR Program-supported researchers plan to create a MANET to facilitate multi-hop communication between pedestrians and vehicles without delays or the need for a large infrastructure. This system would alert a driver's smartphone by a message sent from the smartphone of a pedestrian who is about to cross the street. By receiving this virtual heads-up, a car can slow down or change course more safely in time to avoid a collision.

EXPLORATORY ADVANCED **RESEARCH**

What Is the Exploratory Advanced Research Program?

The EAR Program addresses the need for longer term, higher risk research with the potential for transformative improvements to transportation systems—improvements in planning, building, renewing, and operating safe, congestion-free, and environmentally sound transportation facilities. The EAR Program seeks to leverage advances in science and engineering that could lead to breakthroughs for critical, current, and emerging issues in highway transportation—where there is a community of experts from different disciplines who likely have the talent and interest in researching solutions and who likely would not do so without EAR Program funding.

To learn more about the EAR Program, visit www.fhwa.dot.gov/advancedresearch. The Web site features information on research solicitations, updates on ongoing research, links to published materials, summaries of past EAR Program events, and details on upcoming events.

After creating a MANET framework, predictive model, and app, the researchers will focus on data collection and analysis. Future research could also involve identifying distracted or impaired pedestrians.

Learn More

For more information about the University of Virginia project, contact Mohammed Yousuf at 202-493-3199 (email: mohammed.yousuf@dot.gov); for the University of Wisconsin–Madison project, contact Volker Fessmann at 202-493-3322 (email: Volker.Fessmann@dot.gov).

Photo credit, page 1: Researchers at University of Wisconsin-Madison are studying ways to use MANETs to improve pedestrian safety on roadways. © *University of Wisconsin-Madison.*

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