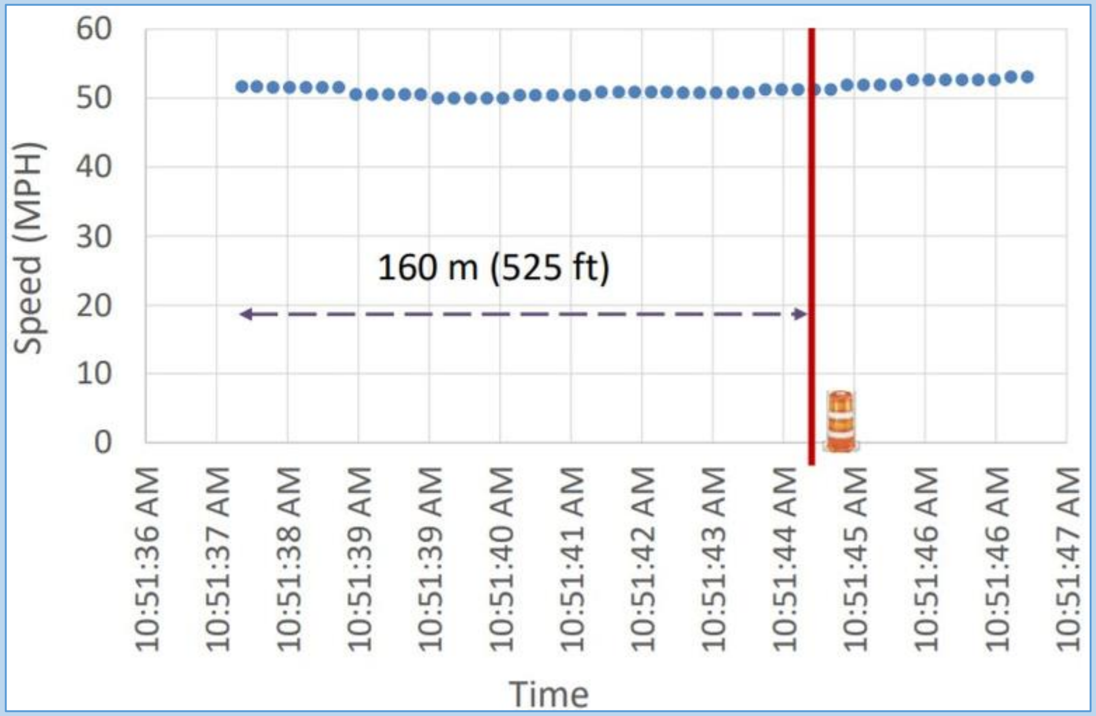
Minnesota Work Zone Alerts

CASE STUDY

Using Bluetooth transmitters and smartphone applications to inform drivers of upcoming construction.

Freight Challenges	Congestion, Last Mile Access
Data Sources Used	Wireless Address Matching, Global Positioning System
Analytical Approaches	Speed, Location, Classification



Visualization of Work Zone Detection Events

Source: Chen-Fu Liao and Max Donath, Using Bluetooth Low Energy (BLE) Technology to Trigger In-Vehicle Messages at Work Zones, 2017, University of Minnesota.

WHAT ARE THE FREIGHT CHALLENGES?

Construction and work zones are a major source of congestion on both highways and “last mile” surface streets in cities, and this traffic congestion can impede the movement of freight. In addition to congestion problems, larger or wider trucks may have difficulty safely navigating work zones with narrow lanes or no shoulders. Providing drivers advance with notice of work zones is important for the safety of trucks, personal vehicles, and construction workers.

WHAT WAS THE GOAL OF THE PROJECT?

The Minnesota Department of Transportation sought to evaluate if Bluetooth transmitters placed on the side of the road could deliver information to drivers traveling at highway speeds. This evaluation work was done as part of the development of a prototype smartphone application intended to provide drivers with notifications when their vehicle approached and entered a work zone. One long-term goal of the application is to help protect crews working on mobile or short-term road work projects, which may have less warning signage or protection relative to longer-term construction projects.

WHAT DATA SOURCES WERE USED?

The main enabling technology and data source for this project was roadside wireless Bluetooth Low Energy (BLE) transmitters, which could broadcast a signal to Bluetooth-equipped smartphones in vehicles. An example of a transmitter installed on a traffic barrel is shown on the next page. Researchers also used the GPS functionality in smartphones to determine when the vehicle was approaching pre-set geographic work zones, and “wake up” the phone’s Bluetooth sensing ability. This GPS function supplement was used because an “always on” Bluetooth function would drain the phone’s battery quickly, while geolocation using GPS uses less energy.

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Bluetooth Transmitter in a Protective Case
Source: MnDOT "Bluetooth Technology Delivers Work Zone Alerts to Highway Drivers", 2016. Available: http://www.dot.state.mn.us/research/TS/2016/201638TS.pdf

WHAT ANALYTICAL APPROACHES WERE APPLIED?

This project used wireless address matching: the mobile application would pair a smartphone's observations of a specific BLE transmitter's network address with a previously-provided list of messages that were associated with each transmitter's address. To start, two types of information were uploaded to the MnDOT servers that supported the smartphone application: 1) data about the geographic bounds (often referred to as "geofences") of work zones, and 2) a record of the specific notifications that should be displayed when the phone detects specific BLE transmitter addresses. This information was then distributed to the smartphone application via wireless internet. Storing information about work zones on a central server meant that the locations and messages for work zones could be quickly and easily updated, and updates easily pushed out to the smartphone applications. This ease of quick updates is necessary for supporting mobile road repair operations and other "temporary" maintenance work that may not have the same level of warning signage in place as longer-term construction projects.

As the test vehicle approached a work zone, the phone's GPS functionality would recognize entry into the "geofenced" area, and activate the phone's Bluetooth receiver. When the vehicle and smartphone were in close proximity to a BLE transmitter, the phone detected the address associated with the specific BLE transmitter. Finally, the smartphone application matched the observed BLE transmitter's address to the MnDOT server's list of messages associated with specific transmitter addresses, and displayed the correct notification to the driver.

WHAT WERE THE RESULTS?

The project demonstrated that using Bluetooth devices to communicate with drivers is technologically feasible. In the demonstration, BLE tags were capable of delivering messages to drivers traveling at highway speeds. A vehicle traveling at 70 MPH can detect a Bluetooth signal from 125 meters away, and slower speed resulted in a longer detection range. Future steps for research include determining which messages are most effective at alerting drivers. On a more general level, this project demonstrates how the technology that can be used to collect emerging freight data can also be used to communicate directly with system users and control system operations.

HOW WERE THE RESULTS VISUALIZED OR COMMUNICATED?

Results of the study were presented in a written report and a MnDOT research bulletin. Since the study was focused on evaluating technology, not phenomena, visualization of data was limited to conceptual diagrams, and graphs showing the ranges at which BLE transmitters could be detected. The example graph on the previous page illustrates BLE detection events (blue dots) as a vehicle approached a transmitter.

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