Highway End-of-Queue in-Vehicle Alerting System Based on Probe Vehicle Data

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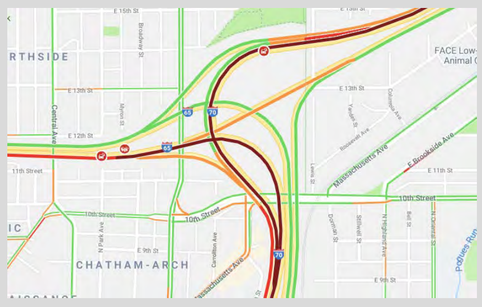
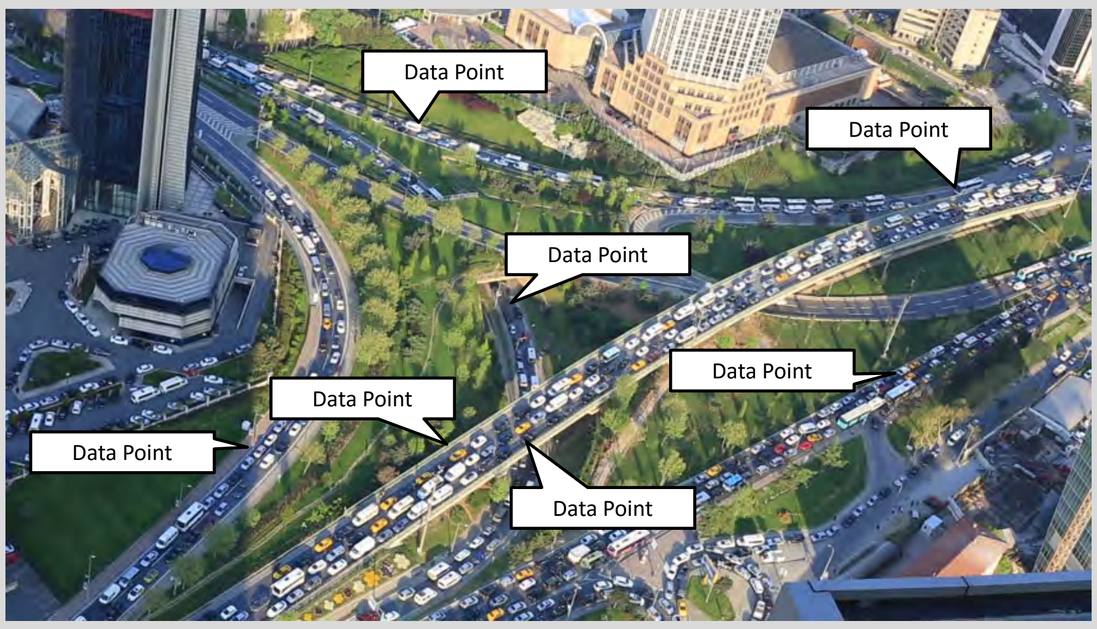
Problem Statement

- Highway congestions cause a much higher crash rate compared to uncongested driving conditions. Advanced driver assistance systems (ADAS) may cause increased driver inattention that delays driver response during highway cruising. Published studies show that end-of-queue alerting systems can potentially improve safety in this scenario.
- Using probe vehicle data, INDOT is able to monitor highway congestions, estimate queue locations, and queue length. However, there is no method available now to inform on-road drivers approaching highway queues.

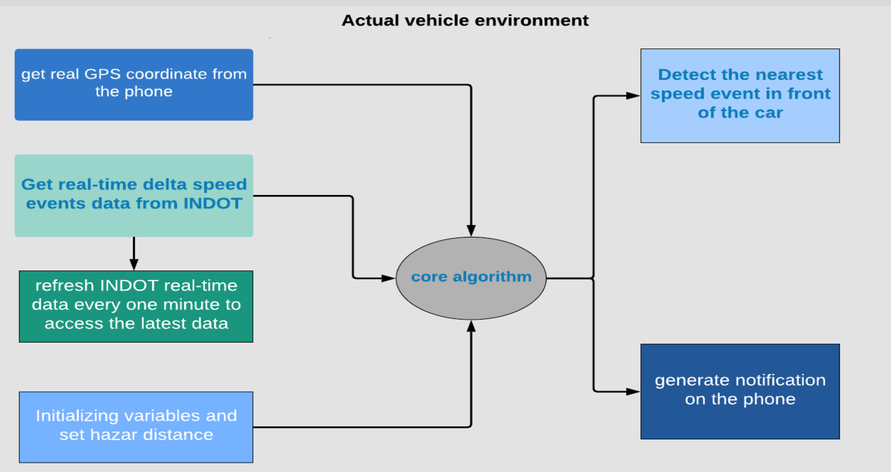




Research Objectives

- Investigate feasible solutions for deploying end-of-queue alerts through smartphone Apps
- Optimize human-machine interface for better user experience
- Develop a prototype end-of-queue alerting system based on probe vehicle data
- Evaluate the benefits via driving simulator and limited on-road driving tests

Overall Project Plan



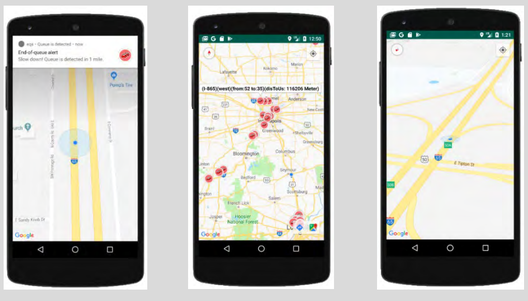
Tasks Accomplished

Task 1 Probe Vehicle Queue Data Acquisition

- Fetched real-time probe vehicle data from INDOT
- Used Google API for visualization and road name detection
- Developed related software programs and algorithms

Task 2 Investigation of Feasible End-of Queue Alerting Solutions

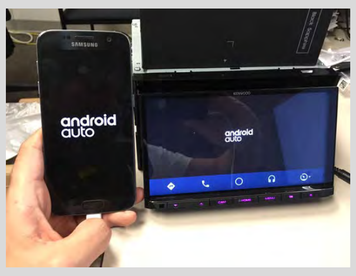
- On-board alerting device (e.g., Android Auto)
- Android App: Developed in PC in simulated Android environment
- Message carrier: 4G/LTE network
- Smartphone GPS data are used to obtain real vehicle GPS locations



Tasks Accomplished

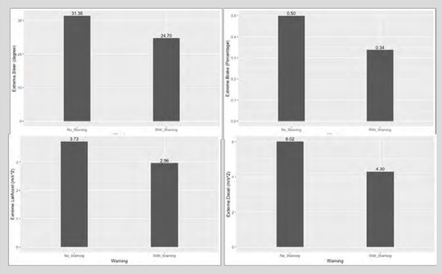
Task 3 Hardware/Software Implementation for Pilot Alerting Systems

- Set up Android Auto device
- Established connections between Android phone and Android Auto device
- Implemented alerting functions on Android Auto device
- Integrated functions on Android app with Android Auto device



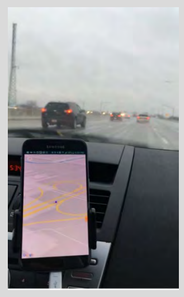
Task 4 Evaluation of the Pilot Alerting System in Driving Simulator

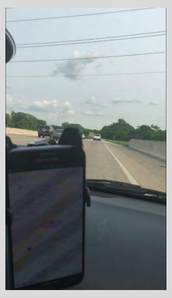
- Built Modules for Connection and Communication.
- Built the test scenarios using the driving simulator.
- Designed of the procedure of data collection.
- The result indicates that this alert system can overall reduce intensive driving behavior.

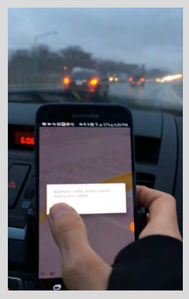


Task 5 Evaluation of Refined Pilot Alerting Systems with Limited Road Testing

- Tested the app in different highways where a delta-speed events were detected.
- In 80% cases, the alerts were delivered successfully.

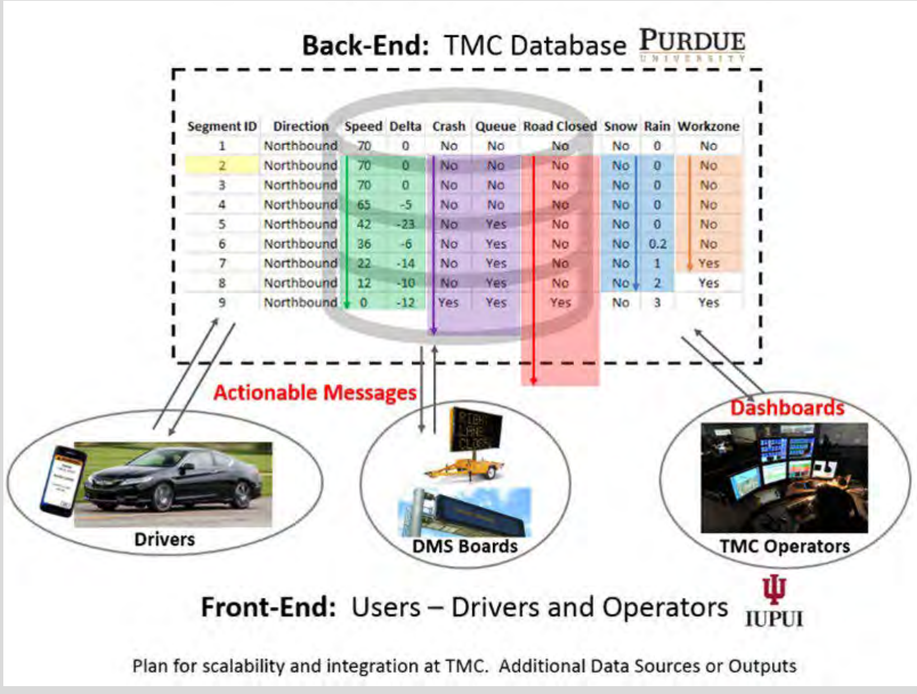






Detailed Future Plan

- Develop a statewide baseline milepost geodatabase along with tools, protocols, and interfaces that allow other data sources to be efficiently referenced.
- Integrate a variety of data sources (e.g., probe vehicle data, CARS 511, weather, ARIES, etc.) to identify different traffic hazards (e.g., incidents, queues, work zones, etc.), preferably in real-time.
- Develop algorithms to generate all possible alerting messages based on the integrated data, given the location of the end-user on highway.
- Prioritize alerting messages based on the severity, temporal/spatial distance, and the safety impact.
- Devise message delivery schemes to optimize the delivery means (e.g., Overhead DMS boards, Portable DMS Boards, and Smartphone Apps) and info (e.g., prioritized message types, number of messages, etc.) to end-users.
- Improve android-based smartphone App and develop iOS-based smartphone App for issuing the end-of-queue alerts.
- Evaluate the performance of the integrated platform via the driving simulator study and a limited scope of road tests.



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