Transportation Research Procedia

Volume 15, 2016, Pages 459–470

ISEHP 2016. International Symposium on Enhancing Highway Performance

Performance Benefits of Connected Vehicles for Implementing Speed Harmonization

Richard Dowling[1] Brandon Nevers[1], Anxi Jia[1], Alexander Skabardonis[1], Cory Krause[2], Meenakshy Vasudevan[2]

[1]*Kittelson & Associates, Inc., Portland, Oregon, USA*

[2]*Noblis, Falls Church, Virginia, USA*

rdowling@kittelson.com, bnevers@kittelson.com, ajia@kittelson.com, askabardonis@kittelson.com, cory.krause@noblis.org, meenakshy.vasudevan@noblis.org

Abstract

This paper reports on a microsimulation and small scale demonstration evaluation of the freeway performance effects of a specific connected vehicle implementation of speed harmonization.

Keywords: Connected Vehicles, Speed Harmonization, Freeway

1 Introduction

The advent of connected vehicle technology has made possible continuous real time monitoring and communication with drivers, which in turn enables the possibility of providing real-time guidance to drivers to promote safer driving. Speed harmonization and advanced queue warning are two examples of the types of real-time guidance that connected vehicle technology would enable agencies to apply in order to promote safer driving.

This paper reports on the results of an impacts assessment of one particular implementation of the dynamic speed harmonization concept with advanced queue warning ("The Prototype"). The Prototype was developed by Kevin Balke, Hassan Charara and Srinivasa Sunkari (Balke, Charara, & Sunkari, 2014) for the United States Federal Highway Administration. This particular implementation of dynamic speed harmonization and advanced queue warning will be abbreviated as SPD-HARM and Q-WARN in this paper. SPD-HARM and Q-WARN are two component applications of FHWA's envisioned Intelligent Network Flow Optimization (INFLO) bundle (Mahmassani, Rakha, Hubbard, & Lukasik, 2012).

This paper:

(i) Assesses the mobility impacts of a SPD-HARM with Q-WARN,

(ii) Indirectly assesses the potential safety implications of SPD-HARM with Q-WARN, and

Selection and peer-review under responsibility of the Scientific Programme Committee of ISEHP 2016

doi:10.1016/j.trpro.2016.06.039

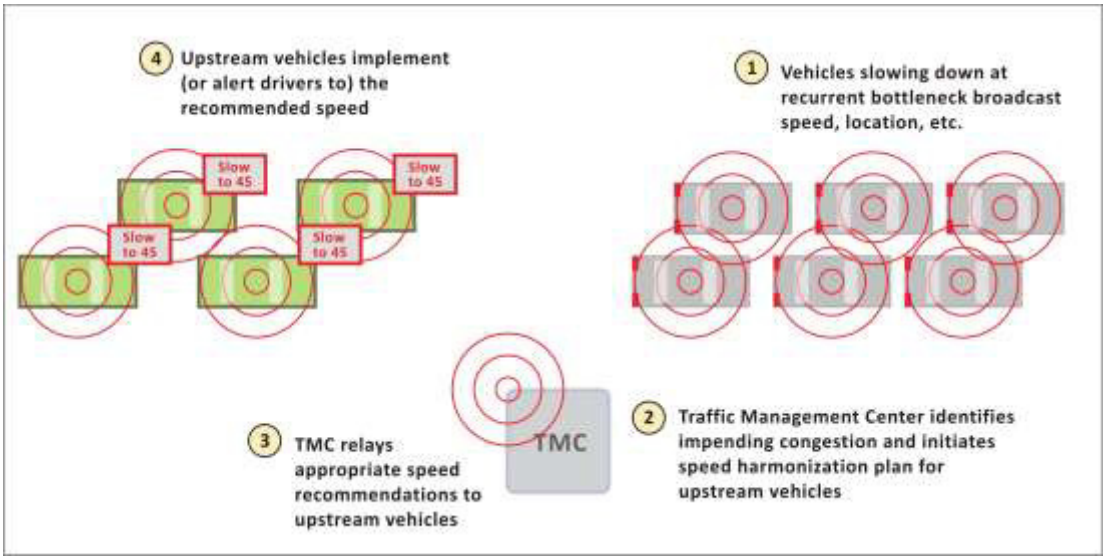
(iii) Investigates how these impacts vary for varying levels of potential future market acceptance for connected vehicle devices.

2 The Speed Harmonization Prototype

The concept of speed harmonization is that reducing the speed differences between vehicles in response to downstream congestion, incidents, and weather or road conditions can greatly help to maximize traffic throughput and reduce crashes. The Intelligent Network Flow Optimization (INFLO) SPD-HARM application concept selected by FHWA aims to realize these benefits by utilizing connected vehicle communication to detect the precipitating roadway or congestion conditions that might necessitate speed harmonization, to generate the appropriate response plans and speed recommendation strategies for upstream traffic, and to broadcast such recommendations to the affected vehicles.

The overall concept for the SPD-HARM application is illustrated in Figure 1. Roadway sensors and connected vehicles transmit information on vehicle speeds, flow rates, and occupancy to the traffic management center (TMC). A road weather information system (RWIS) transmits facility information on visibility, coefficient of pavement-tire friction, temperature (air and road surface), humidity, wind speed, pressure, and precipitation to the connected vehicle and/or the TMC.

The SPD-HARM application detects the presence of a mobility problem or predicts an imminent mobility problem based on heavy flow rates. A response-generating algorithm within the SPD-HARM application (housed at the TMC) recommends speeds for upstream vehicles and other recommended actions on the part of the TMC. This algorithm identifies the timing, location, and recommended speeds for transmission. The speed recommendations are transmitted to the vehicles on the facility.



Source: (Mahmassani, Rakha, Hubbard, & Lukasik, 2012).

Figure 1: Illustration. SPD-HARM concept with connected vehicles

The SPD-HARM prototype developed by Balke et al. implements specific aspects of the speed harmonization concept. In particular, the SPD-HARM prototype does not predict traffic conditions; it only reacts to observed congestion. More specifically, the prototype has the following features: