Multi-Modal Intelligent Traffic Signal System — Safer and More Efficient Intersections Through a Connected Vehicle Environment

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Multi-Modal Intelligent Traffic Signal System — Safer and More Efficient Intersections Through a Connected Vehicle Environment

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Introduction

While the transportation industry has seen technological advancements in computerized systems, traditional traffic signal control has remained largely unchanged over the past five decades. In the case of signal priority for multiple modes of transportation type (emergency vehicles, public transit, trucks, pedestrians, and vehicles, etc.), traffic signal control logic and control strategies (actuated phases and coordination) currently address special or desired priority service on an independent or first-come, first-served basis when requested. Unfortunately, on April 16, 2014 in Monterey Park, CA, a fire engine and ladder truck from neighboring fire departments collided at an intersection while responding to an emergency call. This accident clearly demonstrates there is a distinct need to simultaneously and safely address multiple priority requests at intersections.

The Multi-Modal Intelligent Traffic Signal System (MMITSS) demonstration featured at the 2014 World Congress on ITS Technology Showcase (on Belle Isle in Detroit, MI), presented an intelligent traffic priority signal system that operates in a connected vehicle environment (vehicle-to-vehicle — V2V; and vehicle-to-infrastructure — V2I). Econolite Group, Inc., in cooperation with the University of Arizona, Savari, Inc., and the University of California, Berkeley PATH program, demonstrated a multi-modal intelligent traffic signal system. MMITSS is a project supported by the CTS Pooled Fund project as well as Maricopa County Department of Transportation, Arizona Department of Transportation, and California Department of Transportation. The MMITSS Technology Showcase demonstration featured a National Electronics Manufacturers Association (NEMA) traffic cabinet outfitted with an Econolite Cobalt™ ATC traffic signal controller, and traffic signal control capabilities with the system-wide software foundation to support a connected vehicle environment. With recent advances in wireless communications and protocols, such as the dedicated short-range communications (DSRC) SAE J2735 Message Set Dictionary standard, the critical wireless communication required for an effective V2I system is available. Controlling the intersection requires a powerful traffic signal controller that supports signal phase and timing (SPaT) status information from DSRC-based roadside devices. ATMS and DSRC combined can provide groundbreaking intersection and traffic control capabilities when combined with MMITSS algorithms and features that are more powerful than each of the individual components to provide enhanced safety and mobility within a Connected Vehicle environment. Together, these proven Intelligent Transportation System (ITS) components can fuel an MMITSS that offers the first real opportunity for significant advancements in traffic signal control, particularly for simultaneous multi-modal signal priority.

The Demonstration

The MMITSS system demonstration represents a market-feasible solution for prioritizing intersection signal requests for service within an integrated connected — V2V and V2I — environment. It did so with transportation management solutions currently available:

- **Econolite** — Traffic Cabinet, Controller, Signals, and ATMS software products
- **University of Arizona** — MMITSS Signal Priority Application
- **Savari, Inc.** — Roadside Equipment (RSE), On Board Equipment (OBE) that comprises Vehicle Awareness Device (VAD) and Aftermarket Safety Device (ASD). Android applications such as SPaT Listener and SmartCross pedestrian application.

The MMITSS Technology Showcase demonstration featured a National Electronics Manufacturers Association (NEMA) traffic cabinet outfitted with an Econolite Cobalt™ ATC traffic signal controller, and traffic signal control.
and pedestrian heads. Savari provided its OBE and RSE family of products. The Savari OBE products are designed as a flexible open platform based on Linux for deploying the technologies needed to support a connected vehicle environment. The OBE features DSRC and WiFi radios and a GPS receiver. The OBE is powered via the automotive 12V power outlet. The magnetic mount DSRC and GPS antenna is attached to the exterior of the vehicle for better reception. Savari’s RSE was a fixed wireless gateway mounted on a roadside portable tripod. The RSE is built according to the USDOT RSE 3.2 specification, contains an embedded platform with two DSRC radios, and wirelessly communicates with the Savari OBE. It communicates via

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the NTCIP protocol over Ethernet to the Econolite controller. Designed as a flexible platform, the Savari RSE hardware facilitated the V2I communications. This hardware and communications connectivity enabled the University of Arizona MMITSS traffic control algorithm application to safely and efficiently manage and implement a multiple requests-based priority signal control strategy.

During the demonstration participants boarded a vehicle that represented the “Transit” vehicle (bus, light rail, etc.), and were driven in a northerly direction toward a four-way signalized intersection. As the “Transit” vehicle approached the intersection, two vehicles, representing “Emergency” vehicles traveling from east and west directions approached the intersection at the same time. The participants witnessed how the connected vehicle systems enabled the signalized intersection to safely prioritize and simultaneously accommodate all of the vehicles approaching the intersection. After safely passing through the intersection, passengers disembarked the “Transit” vehicle and participated in the SmartCross portion of the demonstration. The participants, as pedestrians, walked toward the same intersection, and were able to request a pedestrian crossing signal via a mobile device with SmartCross, the Savari pedestrian walk request Android application.

**Conclusion**

As a result of combining the available transportation management and wireless technologies, MMITSS has the potential to provide detailed information required for intelligent traffic signal control, multi-modal priority, and performance observation. It can provide real-time knowledge of vehicle class (passenger, transit, emergency, commercial), position, speed, and acceleration on each approach. In addition, the ubiquitous use of other wireless devices, including DSRC, WiFi, 3G/4G, and Bluetooth-enabled phones and tablets, it can also provide coverage for other travelers such as pedestrians and bicyclists. The potential for safer and more efficient multi-modal traffic signal operations in a connected vehicle environment is easier to acquire than most people think.

**Figures 3 and 4:** Intersection signal prioritization is especially critical for first responders, including fire department and other emergency vehicles. It can also play an integral part in keeping public transit and traffic flow moving efficiently.