DSRC Live Vehicular Safety Demonstrations

Introduction

During SAE Convergence 2008 in Detroit, USA, Cohda Wireless & ST Microelectronics demonstrated the ability of the Cohda radio to enable reliable vehicle-to-vehicle safety applications. The following live vehicular safety demonstrations were performed:

- *Intersection Collision Warning*: Warning drivers of potential side impact when entering an intersection. This application was demonstrated in an open intersection and in a closed intersection;
- *Electronic Brake Light*: Warning following driver of a braking leading vehicle; and
- *Rear Collision Warning*: Warning of potential rear impact from a following vehicle.

The demonstrations were conducted on public roads, providing a real world urban environment and traffic conditions.

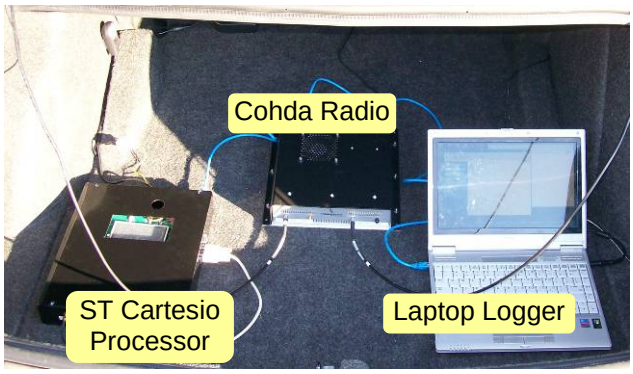
Current DSRC onboard and roadside units use WiFi radio chipsets that have been adapted for 802.11p. Buildings, vehicles and other objects can cause non-line-of-sight conditions and multipath signal reflections. These WiFi chipsets are designed for indoor stationary use and are unable to provide reliable connectivity in the presence of vehicular mobility and multipath. Radio failure in these conditions is highly undesirable, as the highest potential danger arises when drivers are traveling at speed and cannot see each other.

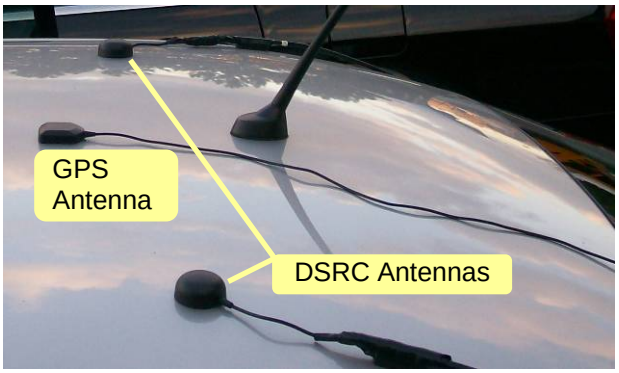
Cohda Wireless has performed more than 500 trials comparing DSRC radios from multiple manufacturers, covering over 5,500 miles on three continents. Results from these trials consistently show that WiFi chipset based DSRC radios are severely challenged by non line-of-sight environments such as blind corners and closed intersections, and by other traffic. In contrast, the Cohda Radio provides robust connectivity under identical conditions.

Unlike WiFi based systems, the Cohda Radio has been designed from the ground up to provide robust wireless communications in mobile outdoor urban environments. This is achieved using advanced receive-side signal processing, while remaining 100% compliant to the IEEE 802.11p standard. This design makes the Cohda Radio a unique and robust foundation for DSRC applications, as demonstrated at SAE Convergence.

Demonstration DSRC System

The trunks of two cars were fitted with identical DSRC demonstration systems, and antennas were mounted at the rear of the roof, as shown in the following figures. The laptop was used only to log data and did not play an active role in the system.





The ST Cartesio Processor includes a high quality embedded GPS receiver to provide current location and time. This information is used to build SAE J2735 Basic Safety Messages, which are then broadcast via the Cohda 802.11p Radio, at a rate of 10 messages per second.

The Cohda Radio receives Basic Safety Messages from the remote vehicle. It forwards these messages to the Processor, which extracts time-stamped positions. Combining knowledge of the local and remote vehicles, the Processor then geometrically assesses potential danger, and issues a warning if appropriate.

The Processor uses an FM radio transmitter to provide an audio Human Machine Interface (HMI) via the car stereo. The following audio was used for demonstration purposes:

- Spoken “1” Driver should take regular action, e.g. slowing down, to avoid collision;
- Spoken “2” Driver must take more extreme action, e.g. heavy braking, to avoid collision;
- Spoken “Brake” Driver of vehicle in front has applied brake heavily; and
- Ping Tone Radio connectivity – indicating that remote vehicle data is available.

Demonstrated Applications

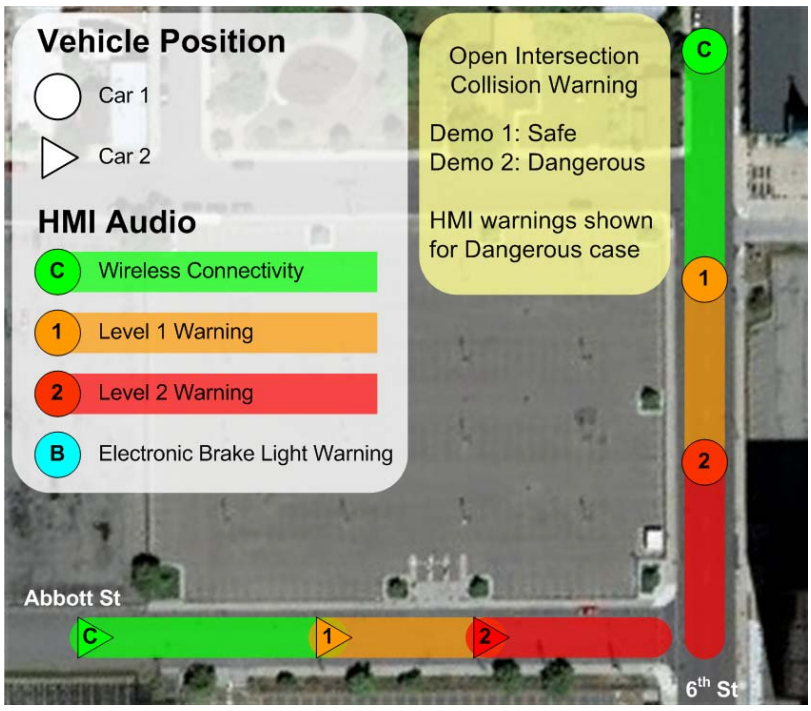
The demonstrations were performed in an urban area around the intersection of Sixth Street and Porter Street, approximately one half mile northwest of the Cobo Exhibition Centre. The overview provided here has been constructed using real data that was logged during the demonstrations. Motion replays of the trials have also been generated, and are available at www.cohdawireless.com/reports/DSRCApp/dsrcapp.asp.

Intersection Collision Warning – Open Intersection

In this demonstration the cars approached an open intersection on the corner of Sixth Street and Abbott Street. The demonstration was executed twice.

Demo 1 – Safe
Car 1 approached at the speed limit and Car 2 approached slowly. No false alarms were sounded in either vehicle.

Demo 2 – Dangerous
Both cars approached at the speed limit. Concurrent, and hence potentially dangerous, arrivals were coordinated. The HMI in each car sounded Level 1 and then Level 2 alarms, as shown in the figure, before Car 2 came to a halt at a stop sign.

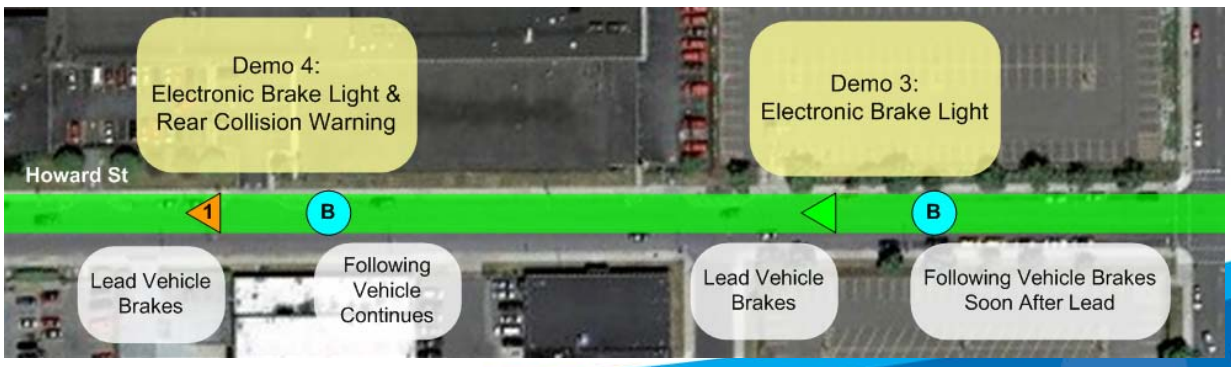


Prior to the warnings, the availability of reliable wireless connectivity is highlighted in green. Note that the Cohda Radio established a robust link well before any potential danger, allowing the safety system maximum opportunity to take action.

Electronic Brake Light and Rear Collision Warning

In Demo 3, The Electronic Brake Light (EBL) application was demonstrated on Howard Street, one block south of Abbott Street. Car 2 was leading and the driver applied the brake heavily, causing an audible Brake Warning in Car 1, as shown in the following figure. The driver of Car 1 then applied the brake. It is worth noting that this application has also been successfully demonstrated when the vehicles were separated by a large truck.

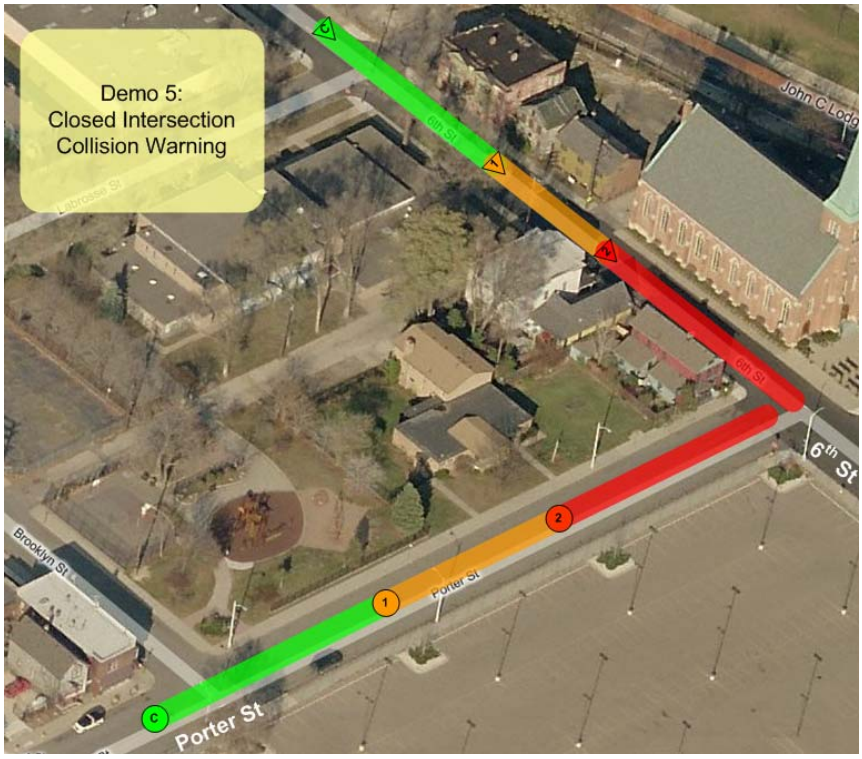
In Demo 4, the scenario was repeated, although in this case the driver of Car 1 continued without immediately applying the brake. This caused the leading Car 2 to sense a potential rear collision and sound a Level 1 alarm. An integrated safety system could use such an alarm to prepare for the collision, e.g. by pre-tensioning seatbelts.



Intersection Collision Warning – Closed Intersection

In the final demonstration the cars approached a closed intersection on the corner of Sixth Street and Porter Street. Similarly to Demo 2, the two cars approached the intersection at the speed limit. However in this demonstration a blind corner separated the two vehicles and removed line-of-sight. This increases the potential danger, as the drivers can no longer see each other approach. It also makes the radio environment significantly more challenging. To provide a reliable wireless link the receiver must be robust to the combination of mobility and multipath reflections – a feature that is unique to the Cohda Radio.

Despite the harsh radio environment, the Cohda Radio again established a robust connection well before the situation became dangerous, as shown in the following figure. As the potential for collision escalated, the HMI in each car sounded Level 1 and then Level 2 alarms, before Car 1 came to a halt at a stop sign.



The blind corner increases potential danger and creates a challenging radio environment.

Conclusions

Cohda Wireless has developed a DSRC radio from the ground up, with unparalleled performance and a unique ability to perform at high mobility in harsh real world environments.

The value of the Cohda Radio was clearly demonstrated through vehicle-to-vehicle safety applications at SAE Convergence in Detroit 2008. The Cohda Radio will allow DSRC to work in more places, more of the time, and will result in more lives saved.