

Vehicle-to-Vehicle Communication (survey)



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V2V communication

The logo consists of the letters 'V2V' in a bold, black, sans-serif font, centered within a rounded square. The square has a vertical gradient from orange at the top to a darker orange at the bottom.

Vehicle to vehicle

or

The logo consists of the letters 'C2C' in a bold, black, sans-serif font, centered within a rounded square. The square has a vertical gradient from orange at the top to a darker orange at the bottom.

Car to Car

- ◆ V2V is an automobile technology designed to allow automobiles to "talk" to each other.
- ◆ V2V is currently in active development by General Motors, which demonstrated the system in 2006 using Cadillac vehicles. Other automakers working on V2V include BMW, Daimler, Honda, Audi, Volvo and the Car-to-Car communication consortium.
- ◆ In April 2014 it was reported that U.S. regulators were close to approving V2V standards for the U.S. market, and that officials were planning for the technology to become mandatory by 2017.

NTSB 'V2V' mandate



- ◆ The NTSB (National Transportation Safety Board) called on NHTSA (National Highway Traffic Safety Administration) to “develop minimum performance standards for connected vehicle technology for all highway vehicles.”
- ◆ Once those standards are established, the NTSB recommends that manufacturers be required to install V2V in all new vehicles.

<http://www.digitaltrends.com/cars/car-hive-mind-will-an-ntsb-v2v-mandate-make-roads-safer/#!96gYM>

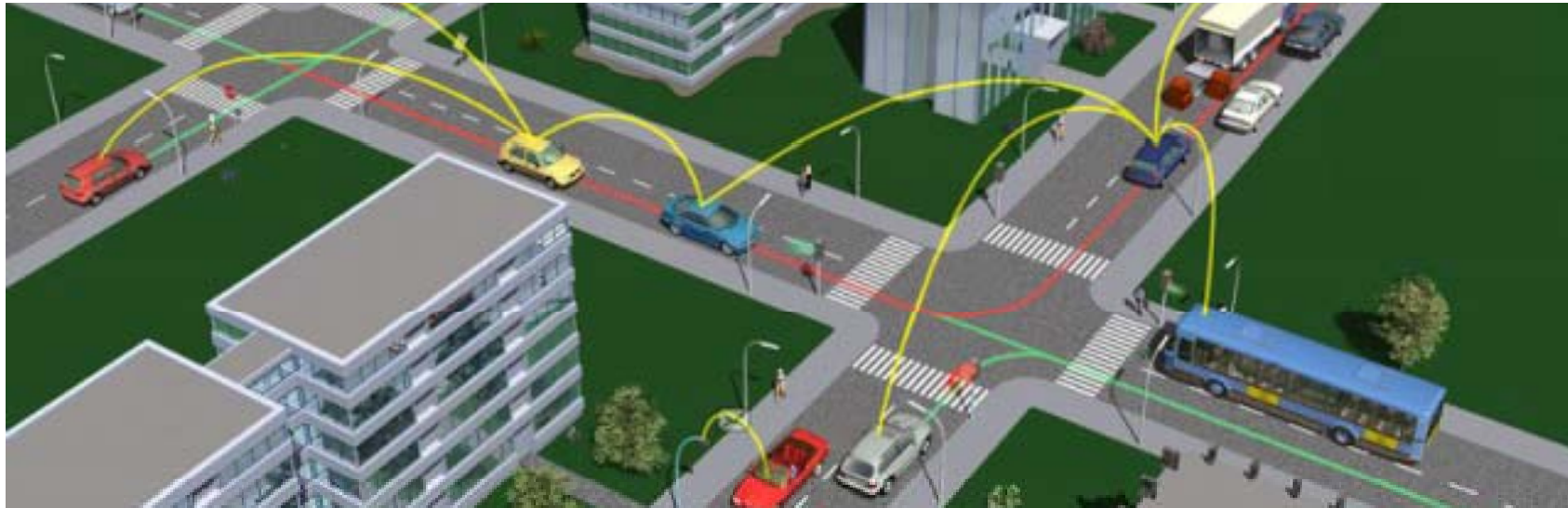
What is V2V?



- ◆ V2V allows vehicles to communicate with their surroundings and each other.
- ◆ Vehicles send messages to each other with information about what they're doing. Data will include information about speed, location, direction of travel, braking, and loss of stability.
- ◆ The NHTSA believes V2V can prevent 80 percent of crashes where driver impairment isn't a factor.

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How V2V works?



- ◆ Current V2V systems use Dedicated Short Range Communication (DSRC)
- ◆ One of the possible frequencies is 5.9GHz, which is used by WiFi
- ◆ The range is up to 300 meters or 1000 feet or about 10 seconds at highway speeds (not 3 seconds as some reports say)
- ◆ Unlike radar, it can be transmitted through solid objects like buildings.
- ◆ If an obstacle is detected, the vehicles alert their drivers with beeps, flashes, or steering wheel and seat vibrations.

<http://www.digitaltrends.com/cars/car-hive-mind-will-an-ntsb-v2v-mandate-make-roads-safer/#!96gYM>

V2V is not the self-driving car - yet

- ◆ Vehicle-to-vehicle communications would make self-driving car even smarter.
- ◆ Self-driving car as of 2014 is a collection of features
 - Adaptive cruise control to pace itself to the speed of the car ahead
 - Lane keep assist to keep the car centered between clearly marked pavement lines
 - Blind spot detection to warn if cars are alongside or just behind



- ◆ Even the best radar only sees a couple 5 or so seconds down the road. V2V extends the reach of what the autonomous car can do so the car and driver don't have to react in a fraction of a second.

<http://www.extremetech.com/extreme/176093-v2v-what-are-vehicle-to-vehicle-communications-and-how-does-it-work>

V2V development

- ◆ Eight automakers are taking part in a University of Michigan V2V project that placed instrumentation along 73 lane-miles of roadway in Ann Arbor to test the concept.



- ◆ Almost all other automakers are investigating and developing this technology themselves
- ◆ It's 2014 now. If NHTSA gets a solid proposal out by 2017 and the first V2V cars reach the roads in 2020, if V2V is as effective as backers claim, we should see safer roads and a steeper downward slope in fatalities around 2025.

<http://www.extremetech.com/extreme/176093-v2v-what-are-vehicle-to-vehicle-communications-and-how-does-it-work>

V2V Saved lives

- ◆ The NHTSA department claims that when fully implemented, V2V could prevent roughly 5.1 million accidents a year and save 18,000 lives.
- ◆ It's also possible V2V will save few of the lives of pedestrians, motorcycles and bicyclists. So the savings might be more on the order of 6000-8000 lives saved.
- ◆ Regardless, even 5000 lives saved, if it happens, is a huge amount.



<http://www.extremetech.com/extreme/176093-v2v-what-are-vehicle-to-vehicle-communications-and-how-does-it-work>

V2V analysis

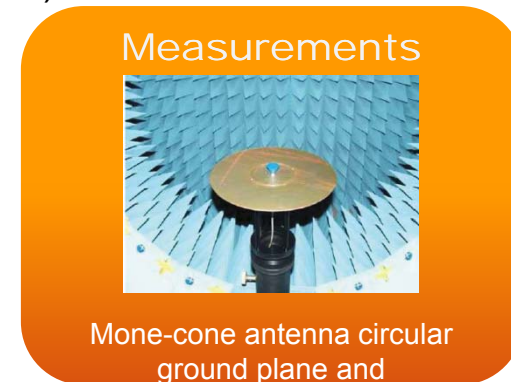
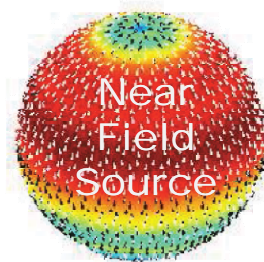
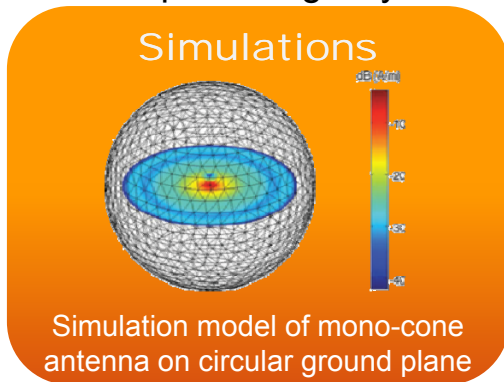
- ◆ All new technologies like V2V requires testing, analysis and design, before they are finally become mandatory.
- ◆ Currently V2V technology is in the phase of active developing.
- ◆ There are lot of hot topics to analyze using computational electrodynamics. For example roof mounted antenna pattern, current distribution near antenna, influence of surrounding objects to the radiation pattern and etc.

V2V simulation using MoM

- ◆ To perform vehicle-to-vehicle system analysis, calculation of radiation from antenna mounted on car is required.
- ◆ For complex antennas mounted on the car it is extremely inefficient to simulate radiation pattern.

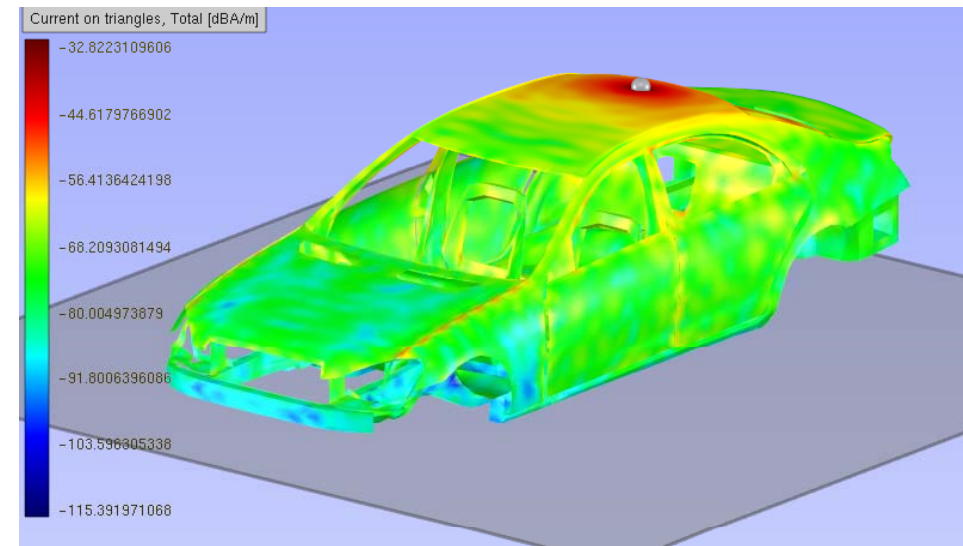
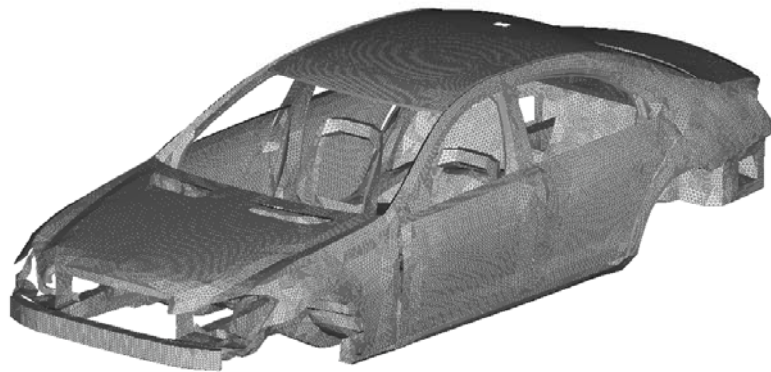


- ◆ It is more practical to obtain antenna pattern without car by simulation or by measurement, and then find a way how to excite the car with such source correctly
- ◆ One of the promising ways is usage of so called near-field source (NFS)



V2V simulation using MoM

- ◆ Accurate MoM simulation of automobile geometry at 5.9GHz requires large number of integration triangles. Direct solution of MoM matrix is non-practical, since N^3 dependence of calculation time on number of unknowns.
- ◆ One of the ways to avoid long calculations is usage of fast iterative solvers.



Model with $\lambda/3$ triangulation at 5.9GHz, consisting of 111,164 triangles.

Number of unknowns for MoM solution is 164,578

RAM required **413,301 MB**

MoM calculation of this model requires more than 19 hours on 48 core cluster (Intel 2GHz, 256GB RAM)



Thank you for your
attention