# CRS Insights

Spectrum Needs of Self-Driving Vehicles
Linda K. Moore, Specialist in Telecommunications Policy (lmoore@crs.loc.gov, 7-5853)
February 12, 2015 (IN10168)

*Baby you can drive my car* (unless it drives itself). Among the technologies that are emerging from laboratory environments to test their wings in the real world, the self-driving vehicle is a noticeable standout. Autonomous vehicles is a class of communications and decision-making technologies that are part of what some describe as the Industrial Internet—the integration of complex machinery with networked software and sensors. By 2020, there are likely to be 50 billion devices in this category—which includes the more familiar Internet of Things. Many of the devices will require wireless communications and converge with commercial rollout of the next generation of communications technologies (fifth-generation, or 5G). Identifying radio frequency spectrum for multiple technologies, uses, and users in a fifth-generation communications environment will likely become a significant policy issue, as demonstrated by the current debate about access to the 5.9 GHz band for vehicle communications for crash avoidance. Bills that address some of the issues raised in the debate have been introduced by Senator Rubio (S. 424) and Representative Latta (H.R. 821).

Vehicular Communications Systems

At least three major types of new communications technology systems are being installed or tested in vehicles. The technologies and terminologies overlap but might be summarized as follows:

Connected cars is a term used most frequently to describe the communications services—that may include safety features—provided to an automobile and its occupants. It might be described as a personal communications system operating over commercial networks, using their spectrum and technologies.

Talking cars has been used by the media to describe the Intelligent Transportation System (ITS) connected car program and refers to vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications. Talking cars might be described as a communications-based safety system operating over customized networks using dedicated spectrum to deliver messages between cars and infrastructure.

Self-driving cars refer to the autonomous and semi-autonomous cars and trucks being developed and tested for eventual use on public roads. Carnegie Mellon University has developed and tested a self-driving car that incorporates existing technologies. Cadillac is to introduce a highly autonomous vehicle by 2017 that would include V2V technology. In Europe, for example, Daimler has introduced a semi-autonomous truck, and BMW a luxury car, that are self-driving on the highway but rely on a driver for off-ramp travel. The Google car is self-contained and fully automated; unlike other self-driving prototypes, it has no steering wheel.

Autonomous vehicles rely on spectrum for high-performance radar, laser, and lidar (light detection and ranging) systems. Radar systems operate in the 70 GHz range; laser operates in the 24 GHz band. All of the vehicles use satellite communications for location mapping but are not reliant on GPS technology. Europeans are using mobile chips to communicate with commercial cellular networks for self-driving and safety features and are also testing IEEE 802.11p, the international standard developed to operate on unlicensed broadband frequencies such as 5.9 GHz.

The Debate over the 5 GHz Spectrum Band

The Spectrum Act (P.L. 112-96, Title VI) requires a review of frequencies at 5 GHz, with the objective of improving future Wi-Fi capacity through shared use. In response to the requirements, the Federal Communications Commission (FCC) opened a proceeding to expand access for new unlicensed devices

in the 5350-5470 MHz band and the National Telecommunications and Information Administration (NTIA) prepared an evaluation of spectrum-sharing technologies for the 5350-5470 MHz and 5850-5925 MHz (5.9 GHz) bands. These actions have led to a ruling from the FCC that might open 100 MHz of spectrum in the 5 GHz band for unlicensed use. The FCC would like to expand the ruling to include frequencies in the 5850-5925 MHz band. This band includes 75 MHz of spectrum at 5.9 GHz assigned on a non-exclusive basis to the United States Department of Transportation (USDOT) for various uses. Notably USDOT is using the radio frequencies for the development of Dedicated Short Range Communications (DSRC) standards and systems for vehicle safety in the ITS connected car program.

With the participation of various consortia representing the automotive industry, the National Highway Traffic Safety Administration (NHTSA) is testing DSRC in a program that currently has 2,800 vehicles equipped with V2V systems. The program primarily tests crash-prevention applications. DSRC transmits messages between vehicles, or between vehicles and road safety equipment (V2I) using assigned channels at 5.9 GHz.

The DSRC standard customized through the ITS program is designed to be interoperable with IEEE 802.11p but includes additional features unique to the American V2V program, intended to operate on dedicated channels at 5.9 GHz. Design decisions for V2V and the need to reconsider them are at the core of the debate about the use of frequencies at 5.9 GHz.

Representatives of the Wi-Fi industry are pressing for shared access to the 5.9 GHz frequencies (with priority access for DSRC), while many supporters of the connected car program are adamant that the proximity of unlicensed devices will cause harmful interference to DSRC messages, jeopardizing the safety of the occupants of connected cars.

An evaluation of the issue of interference to DSRC and its coexistence with Wi-Fi are under study by the "Coexistence Tiger Team," a multi-stakeholder forum created to reach a successful collaboration for use of the 5.9 GHz frequencies.

Deployment

NHTSA has said that it "plans to prepare for the introduction of autonomous vehicles to a connected vehicle environment...." To reach a meaningful mass of equipped vehicles may take 20 or more years, according to NHTSA and ITS statements. However, a number of autonomous vehicle technologies are further along in development, introduction, and acceptance than the NHTSA program. Meanwhile, self-driving cars and 5G communications systems are being promised by their developers for commercial deployment by 2020. If Dedicated Short Range Communications continues as a proprietary technology, it may not be able to evolve with 5G technologies and risks being isolated from the communications environment around it.