

Software Defined Radio and Cognitive Radio for IntelliDriveSM

This white paper suggests Software Defined Radios and Cognitive Radios as emerging technologies to meet the needs of transportation communications. The success of transportation safety, mobility and operational networks is integrally tied to robust wireless communications between vehicles, infrastructure, and remote devices. The rapid development cycle of wireless technologies creates new opportunities for successful implementation but also generates potential hurdles when contrasted to typically slower procurement timelines. Similarly, the combination of available technologies, frequency spectrums, and multi-agency procurements highlights the need for a future-proof platform capable of adapting to changes in technology and enabling interoperability across frequency spectrums and agencies.

The military, public safety and railroads experience similar issues regarding the need for interoperability among multiple users and avoiding technology obsolescence. These sectors are turning to Software Defined Radios (SDR) as a platform of choice to address these needs. SDR is built upon a flexible hardware architecture that defines radio parameters through software code similar to a personal computer supporting many different uses via specific software programs. A single SDR based radio could potentially act as a 5.9GHz DSRC, 2.4GHz Wi-Fi, or 4.9GHz public safety node depending on the needs of the user and availability of services.

The reconfigurable nature of SDR creates the prospective for 'smart' radios that can observe their spectrum and user need environments and adapt to changing conditions. This area of research, known as Cognitive Radio, is leading to situationally aware devices that can be more spectrum efficient, robust to interference/jamming, and have the potential to learn from their experiences. Combining the flexible nature of SDR with spectrum/data sensing techniques and artificial intelligence leads to a Cognitive Radio that can observe, orient, decide, and act based on its location and environment. Cognitive Radio also enables self configuration and long term radio/network management leading to potential cost savings by minimizing system integrator deployment and maintenance labor associated with frequency planning and network initialization.

Additionally, as identified in the final report for the NHTSA Vehicle Safety Communications Project, "channel capacity is an issue that will need to be addressed for large-scale deployment in stressed traffic environments" and suggested that "adaptive protocols for scaled situations should be developed based on the potential for temporarily or intermittently reducing update rate, transmission power, or both while recognizing congested channel conditions." Such adaptive protocols are characteristic of Cognitive Radio algorithms. Because of these algorithms' low-overhead, scalability, prioritization capabilities, rapid adaptation rate, and applicability to a broad range of operating conditions, we believe these algorithms can be successfully applied to vehicle safety communications.

In conclusion, Software Defined Radios and related Cognitive Radio research have significant potential in the transportation arena by providing a flexible open platform that enables interoperability, adaptability, and mitigates against technology obsolescence.