DSRC Industry Consortium (DIC)

DSRC Technology and the DSRC Industry Consortium (DIC) Prototype Team

White Paper

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Revisions

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1 Introduction

*Dedicated Short-Range Communications (*DSRC) is an emerging technology with intriguing performance and benefits that provides a critical communication link for future Intelligent Transportation Systems. DSRC technology will provide secure, reliable communication links between vehicles and infrastructure safety subsystems that can increase highway safety. Improved highway safety is the number one priority of the United States Department of Transportation (DOT). These DSRC-based systems may save lives by providing warnings to drivers of impending dangerous conditions or events, thereby providing drivers more time to take corrective or evasive actions. The 5.9 GHz DSRC link uses *digital radio* techniques to transfer data over short distances between roadside and mobile units, between mobile units themselves and between portable and mobile units. This link enables operations related to the improvement of traffic flow, highway safety, and other ITS applications in a variety of application environments called DSRC/WAVE (Wireless Access in a Vehicular Environment).

5.9 GHz DSRC system requires robust, fast, localized transmissions from vehicle–to-vehicle (V-V) and roadside-to-vehicle (R-V) to serve many public safety and private commercial applications (in-vehicle signage, collision avoidance, fee collection, internet access, etc). The technology draws upon the increasingly popular IEEE 802.11 "Wi-Fi" standard already widely deployed in businesses and homes. However, for high-speed vehicular applications, significant changes were required to provide latency minimization, authorization, prioritization and anonymity without compromising messaging integrity, correctness, privacy, & robustness attributes. This highly efficient system is complementary to existing cellular and satellite communications but does not give "2 Way Voice / Broadcast" or "Tracking" device capabilities.

2 Operation & Parameters

The 5.9 GHz DSRC system contains Roadside Units (RSUs) connected to a land-based infrastructure with ITS application interface and On-board Units (OBUs) integrated into the vehicle's internal network (IVN) and supporting embedded vehicular applications. The DSRC/WAVE system supports communication links in the following parameters:

1) Vehicle speed (up to 120 mph)
2) Communication range (up to 1000 meters for special vehicles; nominal is 300 meters)
3) System Latency (< 50 ms)
4) Data rate (default is 6 Mbps; up to 27 Mbps)
5) Single transaction size (up to 20K bytes)

The system is based on "events and snapshots" in a read zone when an OBU enters the communication zone of an RSU. In this case, the RSU sends messages on the control channel and the OBU listens and then responds with public / private data. In the case of V-V communication, one of the OBUs will start the transaction by taking on many characteristics of an RSU (i.e., sending the initial interrogation). An OBU is a transceiver that is normally mounted in or on a vehicle, but may, in some instances, be a portable unit. An OBU can be operated while a vehicle or person is either in motion or stationary. OBUs receive and contend for time to transmit on one or more radio frequency (RF) channels. An RSU is a transceiver that is mounted

along a road or pedestrian passageway. In some cases, an RSU may also be mounted on a vehicle or can be hand-carried; however, such operations are only permitted when the vehicle or hand-carried unit is stationary. Furthermore, RSU operations are restricted to those locations where it is licensed to operate. An RSU also provides channel change control and operating instructions to OBUs within its communications zone along with exchanging data.

3 Term/Meaning

"DSRC" has different meanings, different technical characteristics and different operating frequencies around the world in the transportation sector. In most parts of the world, DSRC is generally used only for electronic tolling collection (ETC) & access control applications. In the United States, DSRC/WAVE operates at 5.9 GHz and supports a whole new range of vehicle communication uses with two-way high data rate capabilities and larger communication ranges. It offers superior vehicle-to-vehicle communications and will probably be the "Tag of the 2010 Decade" from the tolling perspective.

4 Industry Activities - Participants & Issues / Deployment

In order to deploy a nationwide technology, the U.S. Department of Transportation (DOT), including both NHTSA and FHWA, has been working with many groups to address public safety, regulations/licensing, standards, testing/compliance, certification, interoperability, networking, data security, electronic technology and system performance issues. Figure 1 below shows many of the companies and organizations involved:

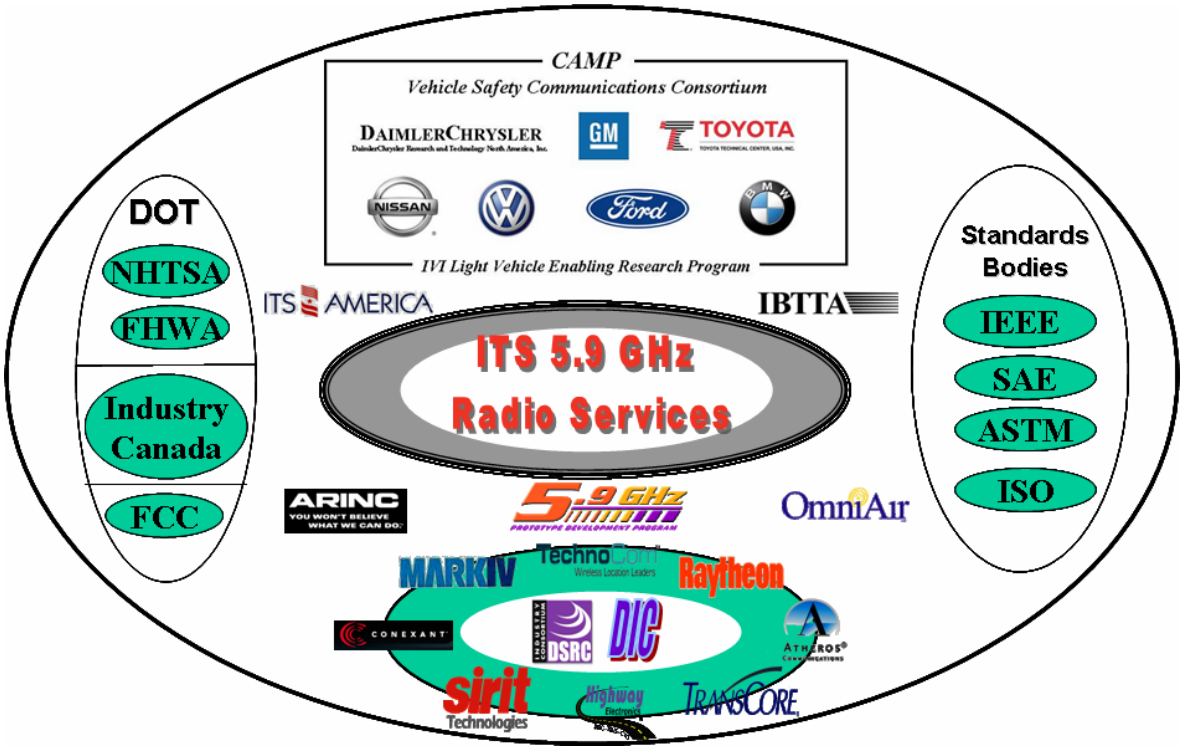

Figure 1 - Industry Activities Participants

The U.S. DOT is planning to make a strategic safety-system deployment decision in the 2008 timeframe. If positive, this decision would result in RSUs (roadside units) being deployed primarily at intersections and OBUs (on-board units) incorporated into new automobiles in the 2010 timeframe. Whether this deployment decision takes the form of a mandate is yet to be determined.

5 Service Categories

DSRC will incorporate a rigid message prioritization scheme to assure that the most important messages are always the first to be transmitted. DOT has dictated "Safety of Life" messages (e.g., messages related to an imminent collision) as top access priority followed by public safety messages (police, fire, ambulance) and then private commercial applications. The following eight service categories have been identified to increase safety and provide more efficiency in the ITS transportation system:

1) Travel and traffic management
2) Public transit management
3) Commercial vehicle operations
4) Advanced vehicle safety systems
5) Maintenance construction operations
6) Electronic payment
7) Emergency management
8) Information management

6 Regulations

The Federal Communication Commission (FCC) has completed the rule making and licensing policies for DSRC. The FCC issued Report & Order "03-324A1" in February 2004 and posted in the Federal Register August 2004 as a final rule. Licensing registration started October 2004 per FCC's public notice DA-04-3165A1. The permanently fixed RSUs are registered and licensed per Part 90 and OBUs are licensed by rule per Part 95. FCC ruling was based on the ASTM standard E2213-03 where the 5.9 GHz (5.850-5.925) band is divided into seven 10 MHz channels (one control & six service) at power levels up to 44.8 dBm (30 Watts) EIRP for RSUs and 33 dBm (2 Watts) EIRP for OBUs. The antennas (omni-directional or directional) connected to RSUs must be mounted between 6 and 15 meters high. Each channel is allocated for specific application types and performance characteristics as depicted in Figure 2.

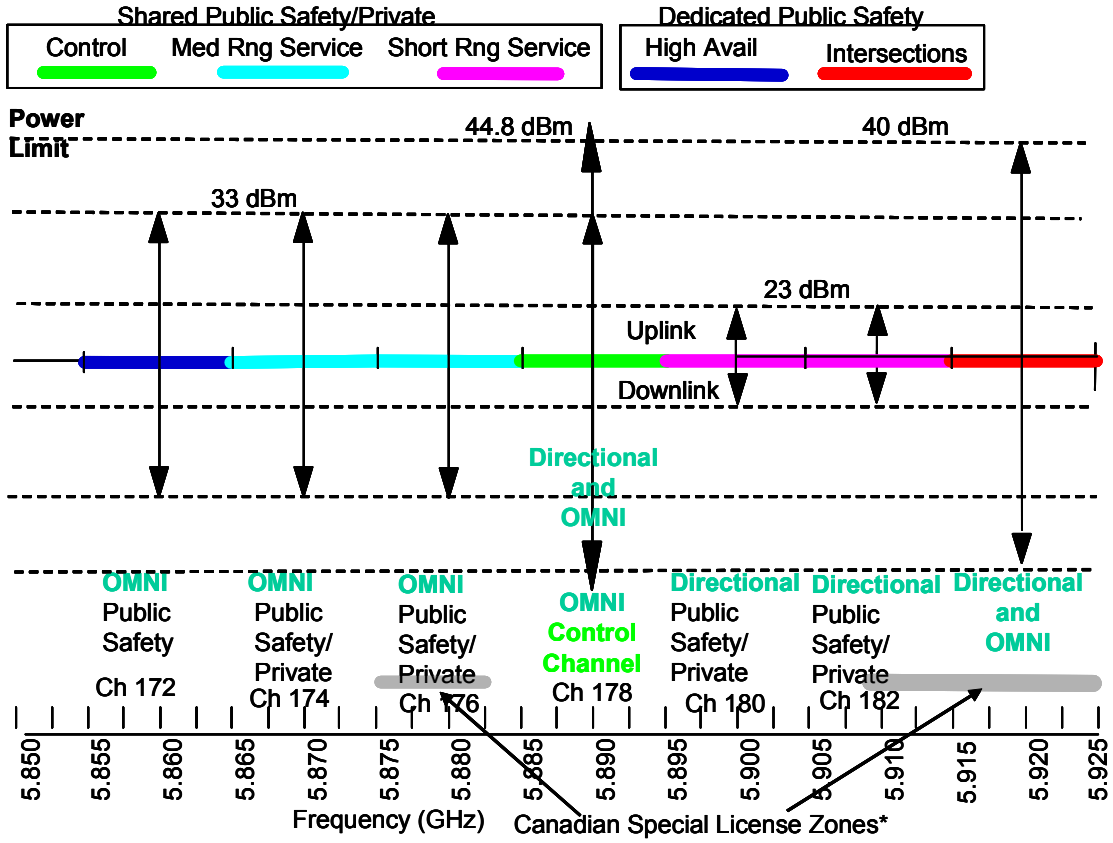

Figure 2 - Frequency Channel / Antenna Plan

7 Standardization

Standardization plays a very important role in the success of any potential large-scale deployment of DSRC technology. A national deployment requires interoperability of equipment and systems coming from many different manufacturers, hardware / software certifications, compliance testing and security. A complete suite of standards is currently under development within IEEE and these are expected to eventually migrate into ISO. IEEE 802.11p addresses the physical layer and medium access control layer (MAC) called 802.11p module. The upper layers (network & data) of the communication stack are being developed within IEEE 1609 (Wave Management, Channel Management, & Resource Manager) and IEEE 1556 (DSRC Security) through the normal IEEE committee process. The vehicle aspects are being developed and evaluated through VSCC / CAMP (represents seven major automotive manufacturers) and SAE is developing the message set, data dictionary and application framework standards. Certification / compliance processes are being worked through the OmniAir consortium.

8 DIC Prototype Team

The *DSRC Industry Consortium (DIC)* prototype team has been created by industry, funded by U.S. DOT and administrated through ARINC to develop / verify the standards and hardware in order to validate the technology & application parameters in its real-world environment. The prototype team includes Mark IV, Raytheon, Sirit Technologies and TransCore. These companies are the technology leaders in ITS systems in the United States and Canada. Prototype program tasks include the development of system architecture, standards,

hardware, software and testing. The first generation of hardware will validate the initial standards and test the prototype units for technical and operational parameters. Once the basic functions are verified, the prototype units may be used in larger pilot trials such as intersection testing model deployments and other robustness / system capacity tests and therefore provide a foundation for larger North American DSRC deployments.

9 Summary

5.9 GHz DSRC is the emerging communication technology that offers standardized ITS products and benefits in national large-scale deployments. U.S. DOT and the automotive OEMs will be the strategic players making deployment decisions in the year 2008 timeframe. 5.9 GHz DSRC systems provide a significant enhancement in communication capabilities over all previous ITS systems. DSRC will support multiple uses in vehicle / public safety and commercial applications that cannot be achieved today. DSRC is a cost-effective communications service, especially when compared with current cellular and satellite systems. The technology can be leveraged for Open Road ETC and mobile 802.11 Wi-Fi deployments, creating nationally interoperable systems and networks. DSRC is the technology for the 2010 decade and beyond.