Schaffnit Consulting Inc

Vehicle Safety Communications in North America

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Annual United States Crash Statistics

According to the United States National Highway Traffic Safety Administration (NHTSA):

- Over 6 million vehicle crashes annually
- Nearly 3 million persons injured
- Over 42,000 fatalities
- Fatalities increased 1.5% for 2002 over 2001
- Average is over 115 fatalities per day
- Over $230 billion annual economic impact

Reference: http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/Rpts/2003/Assess02.pdf

SAFETEA

- Safe, Accountable, Flexible, and Efficient Transportation Equity Act of 2003 (SAFETEA)
- $247 billion surface transportation reauthorization proposal (follow-on to TEA-21)
- Reauthorization proposal covers fiscal years 2004-2009
- Focus on safety - proposes to more than double funds for highway safety to over $15 billion

Intelligent Vehicle Initiative

- USDOT ITS program authorized under TEA-21
- Program mission is “prevention of highway crashes and the fatalities and injuries they cause”
- Program addresses eight major problem areas:
  - Rear-end collision avoidance
  - Lane change & merge collision avoidance
  - Road departure collision avoidance
  - Vision enhancement
  - Vehicle stability
  - Driver condition warning
  - Safety-impacting services

Reference: http://www.its.dot.gov/ivi/ivi.htm

Crash Avoidance Metrics Partnership (CAMP)

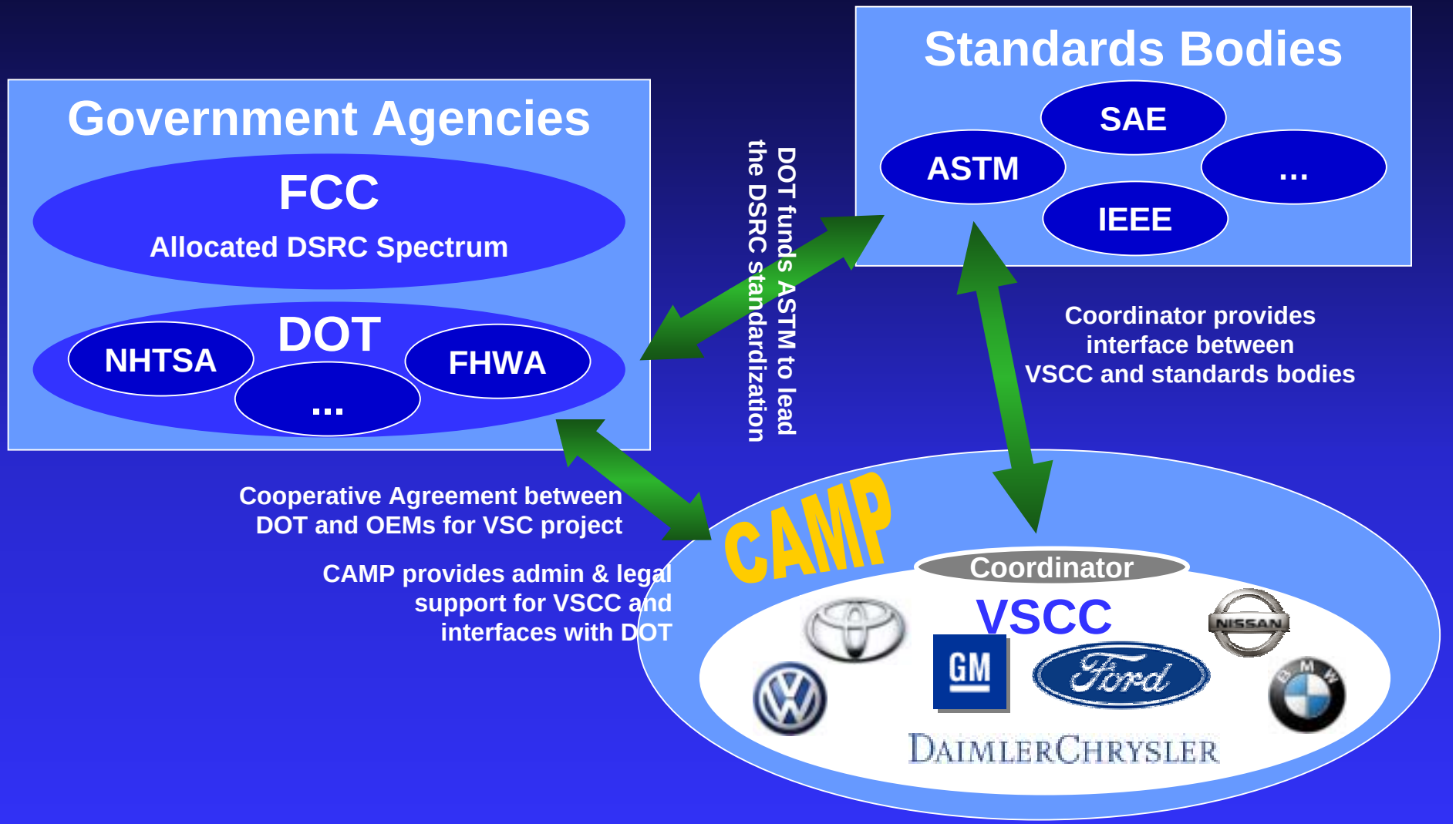
- Ford Motor Company and General Motors Corporation created CAMP in 1995 to:
  - conduct joint pre-competitive projects
  - accelerate the deployment of future crash avoidance measures
  - bring together various combinations of automobile manufacturers
- CAMP Intelligent Vehicle Initiative (IVI) Enabling Research Program:
  - work on a set of key pre-competitive projects
  - enable the successful deployment of emerging crash avoidance and driver information systems

Reference: www.itsdocs.fhwa.dot.gov/jpodocs/rept_mis/99z01!.pdf

Vehicle Safety Communications (VSC) Project

- Two year USDOT project under CAMP, started May 2002
- VSC Consortium Members: BMW, DaimlerChrysler, Ford, GM, Nissan, Toyota, and VW
- Facilitate the advancement of vehicle safety through communication technologies
  - Identify and evaluate the safety benefits of vehicle safety applications enabled or enhanced by communications
  - Assess associated communication requirements including vehicle-vehicle and vehicle-infrastructure communications
  - Contribute to DSRC standards and ensure they effectively support safety

VSC Organization



Vehicle Infrastructure Integration (VII) Plans

- Vision is a “breakthrough” using vehicle communications
- First production deployment plan for October 2005
- Model deployment with exactly the same system in each State – demonstrating nationwide interoperability
- Enable better traffic information for all routes using probe vehicles, allowing dynamic re-routing
- Larger purpose is preventing injuries and death
- Individual companies must have their own valid business plans

Reference: Dave Acton presentation to DSRC Standards Writing Group – 08/18/2003

Automotive Safety Systems Trend

- Trend from passive, toward intelligent, active safety systems
- Passive safety systems include:
  - conventional ABS
  - ABS with traction control
  - passive airbag
  - passive cruise control
- Active safety systems include:
  - adaptive airbag
  - adaptive cruise control
  - electronic stability program

Reference: ITS America News - Vol. 13, No. 8, August 2003, "Vehicle Safety Systems Get Active," by Colin Barnden

Potential for Active Vehicle Safety Enabled by Wireless Communications

- Intelligent on-board systems for active safety application processing
- Coupled with wireless communications for real time access to relevant off-board data
- Enhancing planned active safety applications
- Enabling new safety applications

Current “After Crash” Focus

- Mayday-type crash notification applications use wireless communications to save lives by providing more rapid medical attention
- Automatic crash notification (ACN) upon airbag deployment summons help for unconscious victims
- Enhanced ACN with crash severity, occupant information, supports advanced preparations by emergency medical responders

Future Focus – Prevent/Mitigate Crashes

- Many vehicle safety application scenarios are potentially enabled by wireless communications
- Communications between vehicles, and between vehicles and infrastructure, to warn drivers of dangerous situations and avoid crashes
- Potential for crash severity mitigation, for example:
  - Pre-arming airbags
  - Pre-tensioning seatbelts
- Future developments may possibly allow automated crash avoidance systems, potentially:
  - braking assistance
  - steering assistance

Potential Infrastructure-to-Vehicle Application Scenarios

- Adaptive Drivetrain Management
- Adaptive Headlight Aiming
- Blind Merge Warning
- Cooperative Adaptive Cruise Control
- Cooperative Vehicle-Highway Automation System (Platooning)
- Curve Speed Warning – Rollover Warning
- Enhanced Route Guidance and Navigation
- GPS Correction
- Highway Merge Assistant
- Highway/Rail Collision Warning
- Intersection Collision – Infrastructure-Based Warning
- Intersection Collision – Vehicle-Based Warning
- In-Vehicle Signage
- Just-In-Time Repair Notification
- Left Turn Assistant
- Low Bridge Warning
- Low Parking Structure Warning
- Map Downloads and Updates
- Non-Stop Tolling
- Pedestrian Crossing Information at Designated Intersections
- Point of Interest Notification
- Road Condition Warning
- Safety Recall Notice
- Stop Sign Movement Assistance
- Stop Sign Violation Warning
- Traffic Signal Violation Warning
- Work Zone Warning

Potential Vehicle-to-Infrastructure Application Scenarios

- Blind Merge Warning
- Emergency Vehicle Signal Preemption
- Infrastructure-Based Traffic Management – Probes
- Intelligent On-Ramp Metering
- Intelligent Traffic Lights
- Intersection Collision – Infrastructure-Based Warning
- Intersection Collision – Vehicle-Based Warning
- Just-In-Time Repair Notification
- Non-Stop Tolling
- Post-Crash Warning
- SOS Services
- Stop Sign Movement Assistance

Potential Vehicle-to-Vehicle Application Scenarios

- Approaching Emergency Vehicle Warning
- Blind Merge Warning
- Blind Spot Warning
- Cooperative Adaptive Cruise Control
- Cooperative Collision Warning
- Cooperative Glare Reduction
- Cooperative Vehicle-Highway Automation System (Platooning)
- Electronic Brake Lights
- Highway Merge Assistant
- Highway/Rail Collision Warning
- Instant Messaging
- Intersection Collision – Vehicle-Based Warning
- Lane Change Assistant
- Left Turn Assistant
- Post-Crash Warning
- Pre-Crash Sensing
- SOS Services
- Stop Sign Movement Assistance
- Vehicle-Based Road Condition Warning
- Vehicle-to-Vehicle Road Feature Notification
- Visibility Enhancer
- Wrong-Way Driver Warning

Requirement for Broadband Communications Channel

- Most anticipated safety applications require only very small bandwidth, on an individual basis
- However, many scenarios envision hundreds of vehicles in a particular area, with rapid, periodic repetition of short messages
- In aggregate, this type of message load requires broadband wireless communications capabilities

General Communications Requirements

- Public safety
  - range requirements up to 1 kilometer
  - may require directional and/or omnidirectional coverage
- Vehicle safety communications
  - range requirements up to 300 meters
  - generally omnidirectional coverage requirements

Latency Requirements

- Vehicle safety application scenarios generally require approximately 100 millisecond latency
- Some scenarios may require lower latencies
- 100 millisecond latency is consistent with automotive safety sensor update rates

Addressing Requirements

- Initially, one-way transmissions to all vehicles and all infrastructure in the immediate area
- Likely, future addressing to all vehicles or infrastructure in front of (or back, left, right of) sender
- Longer term, possibly all vehicles in a geographically or relationally defined group
- A few vehicle safety application scenarios require point-to-point communications

Potentially Enabling Wireless Technologies

- Digital Cellular/ PCS / 2.5 - 3G
- Bluetooth
- Infrared (IR)
- Ultra Wideband (UWB)
- 802.11a, b, g, etc. (WiFi +)
- Dedicated Short Range Communications (DSRC)

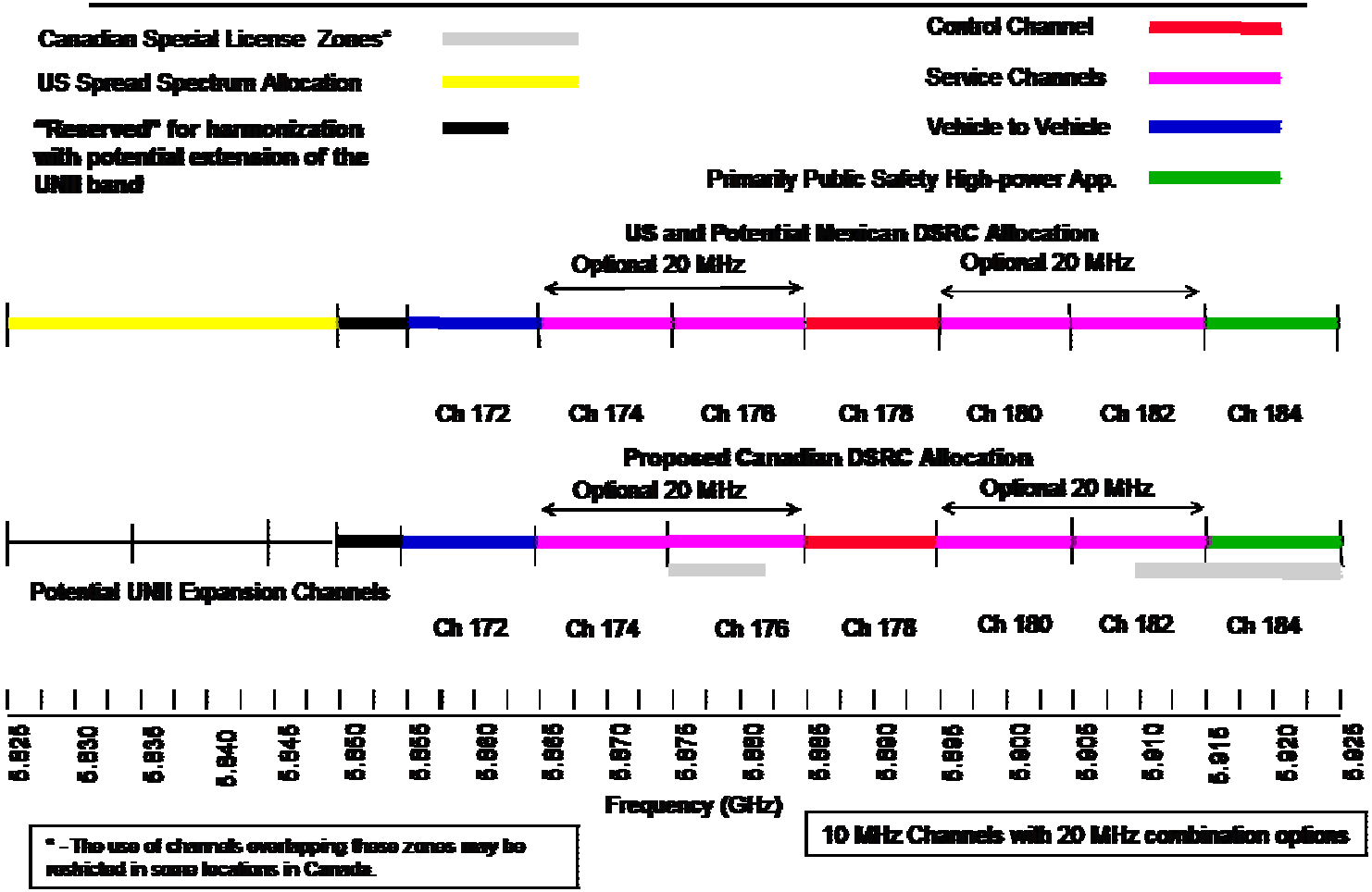
Evaluation of Wireless Technologies

- Digital Cellular/ PCS / 2.5 - 3G – issues with addressing, latency, cost, interoperability
- Bluetooth – issues with range, scalability
- IR – issues with range, interference
- UWB – issues with range, technological maturity
- WiFi + – issues with latency, mobility
- 5.9GHz DSRC – appears to offer the best potential to support vehicle safety applications

5.9 GHz DSRC in North America

- FCC authorized 75 MHz of spectrum for ITS in 1999 “to improve highway safety and efficiency”
- FCC collected public comments on proposed 5.9 GHz DSRC earlier in 2003
- FCC rulemaking expected by the end of 2003
- Likely to incorporate ASTM lower layer standards (based on 802.11a) as recommended by ITS America, Alliance of Automobile Manufacturers, and other significant stakeholders

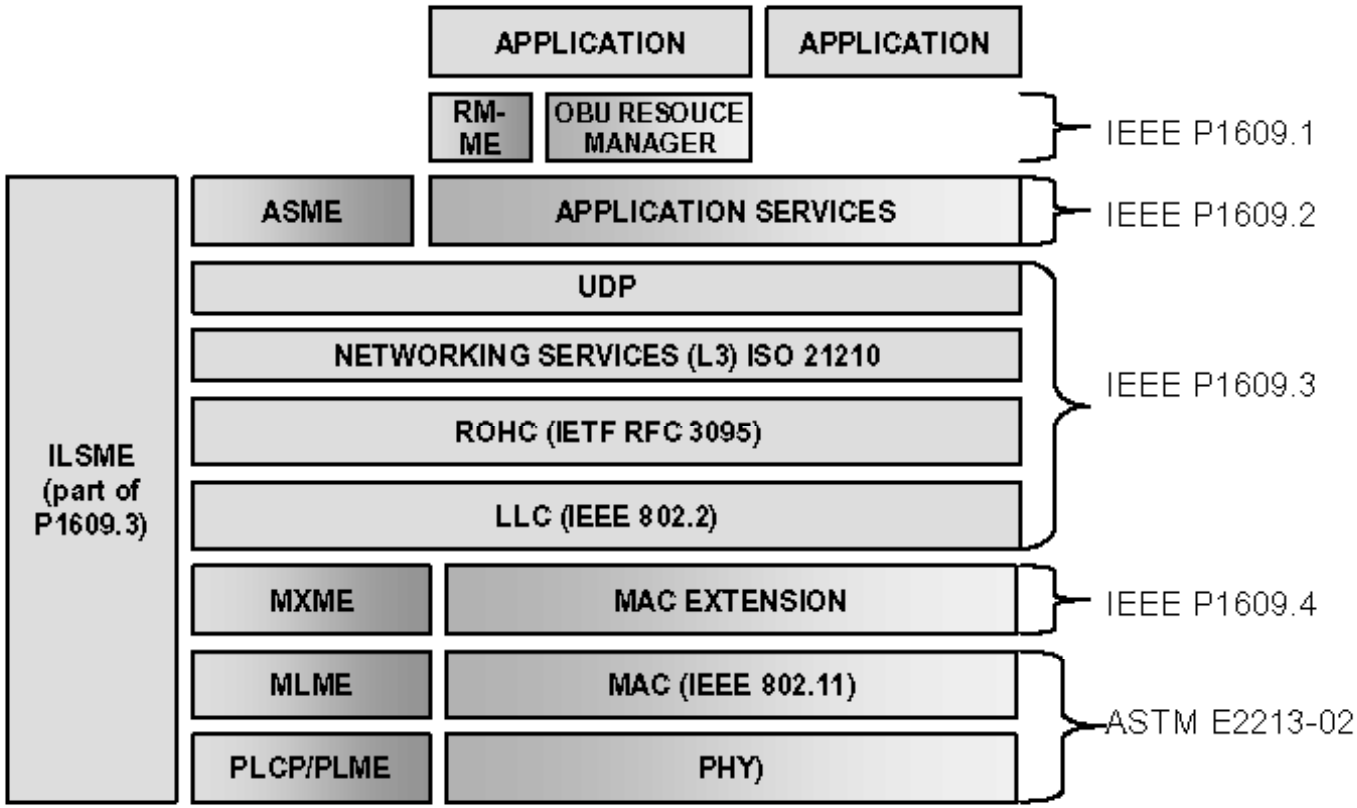
HARMONIZED 5.9 GHz DSRC BAND PLAN



5.9 GHz DSRC Standards Development

- ASTM lower layer standard completed in 2003
- Plan is for integration into IEEE 802.11
- IEEE 802.11 DSRC study group has been formed
- Upper layer standards are being developed in IEEE P1609
- IEEE upper layer standards are to be completed by the end of 2003
- Other related standards are under development or planned

5.9 GHz DSRC Draft Architecture



Benefits of Application Aggregation

- Same hardware supports multiple applications
- Hardware costs spread over multiple applications
- Allows safety applications to enable commercial applications, plus
- Allows commercial applications to subsidize safety applications

Major Challenges

- Interoperability
- Sharing spectrum effectively and efficiently
- Maintaining priority channel access for safety applications
- Economics
  - Minimize costs (communications, on-board equipment, infrastructure)
  - Develop convincing value proposition
  - Coordinate deployment – on-board, infrastructure

Potential Benefits of Global Coordination

- More resources may be focused upon creating consistent solutions
- Potential for creation of economies of scale
- Facilitation of supplier base development
- Possibilities for synergies in planning
- Accelerated deployment potential

Conclusions

- There appear to be significant potential vehicle safety benefits from the use of wireless technologies
- 5.9 GHz DSRC appears to be the most likely wireless technology to meet most vehicle safety communications requirements in the US
- Long-term planning and investment is required to enable large scale deployment in vehicles and infrastructure
- Standards are very important to ensure interoperability and priorities for safety applications

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