Criticality of Communications for Road Vehicle Automation

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IEEE WCNC Panel – March 22, 2017

A bit of history for context…

- National Automated Highway Systems Consortium Demo ’97 (August 1997, San Diego)
- 8 cars, automatic steering and spacing control (5.5 m), lane changing, switching positions
- Demo rides for a thousand visitors
- Each car driven by one Pentium @ 166 MHz

V2V Communication:

- Utilicom/Hughes spread spectrum radios
- 902-928 MHz
- Slotted ALOHA protocol
- 50 Hz update interval

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Wireless Communications to Enable Vehicle Automation

- **Intermediate developments at PATH:**
  - **802.11b WiFi, 20 Hz updates, for merging and truck platooning (2000 - 2003) and cooperative collision warnings (2004-5)**
- **Current work on cooperative adaptive cruise control and intersection safety applications:**
  - **5.9 GHz DSRC, 10 Hz updates (V2V and I2V)**
- **Requirements driven by safety criticality:**
  - **Low connection latency**
  - **High reliability of message receipt**
  - **Security against attacks or interference**

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What are the V2V needs?

- **Frequent enough state updates to not impede vehicle dynamic responses (50 – 100 ms)**
  - **Enough data to represent vehicle motions smoothly and safely for platooning (BSM +)**
  - **Emergency flags and maneuver commands**
- **Additional messages:**
  - **External hazard alerts**
  - **Negotiating cooperative maneuvers**

- **Well-suited to 5.9 GHz DSRC**

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What are the I2V/V2I needs?

- **I2V:**
  - **Traffic signal status (SPaT) – 100 ms period**
  - **Variable speed advisories**
  - **Medium to long-range hazard alerts or traffic condition updates**
  - **Emergency software updates**
- **V2I:**
  - **Traffic and road condition (probe) information**
  - **Signal priority requests**

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Needed advances

- **5.9 GHz DSRC:**
  - **Prove congestion management in high-density traffic environment**
  - **Define BSM extensions to support V2V cooperative control/platooning (and gain access to safety channel for them)**
- **5G cellular:**
  - **Show that it can scale to support these applications in high-density traffic**
  - **Show an acceptable cost/business model for vehicle users**

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