CONNECTED VEHICLE COMMUNICATIONS IN A RURAL SETTING

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Topics

• Background
• Project Needs and Objectives
• Dedicated Short Range Communications (DSRC)
• Mobile Road Weather Data Collection (Cellular)
• Communications Architecture (IP, Cellular, DSRC, Satellite)
• Hurdles and Issues
• What’s Next
• Q & A
Background

- Idaho National Laboratory (DOE)
  - Operates large nuclear research facility in eastern Idaho, 870 square miles
  - Transit fleet of over 90 motor coaches and 400 other vehicles
  - Over 6,000 employees: 4,000 at site, 2,000 in Idaho Falls

- Idaho Transportation Department (ITD)
  - Operates and maintains state highway system, including the INL bus routes that originate from six cities:
    - Idaho Falls
    - Pocatello
    - Blackfoot
    - Rigby
    - Rexburg
    - Mackey
**Background cont.**

- Bus route network consists of some rural interstate segments and predominately two-lane rural highway segments.
- Speed limits range from 65 mph to 80 mph.
- This region experiences environmental challenges year round:
  - Winter storms, snow, and ice
  - High winds, blowing snow/dust
  - Range fires, smoke.
- Elevations range between 4,000 and 5,000 feet.
- Bus routes are patrolled by scout vehicles in advance of bus schedules to report road conditions to dispatch and management.
Rural Two-Lane Route to INL
Project Partners

- Idaho National Laboratory (INL)
- Idaho Transportation Department (ITD)
- Idaho Health and Welfare (EMS Bureau)
- Vaisala
- Castle Rock Associates
- Savari
- SiriusXM
- University of Idaho
- Virginia Commonwealth University
Project Needs and Objectives

• Idaho National Laboratory (INL)
  – Improve vehicle safety
  – Improve operations
  – Executive Order 13693
    • Reduce emissions
    • Reduce fuel consumption
    • Federal agencies to take a leadership role

• Idaho Transportation Department (ITD)
  – Improve winter maintenance efficiency and effectiveness
  – Improve safety and mobility
    • Additional data for CARS 511
RWIS Eastern Idaho
When things Go Wrong…
Deciphering the Acronyms

- DSRC – Dedicated Short-Range Communications (5.9 GHz, 7 channels)
- V2V – Vehicle to Vehicle
- V2I – Vehicle to Infrastructure
- V2X – Vehicle to Device
- OBU – On-Board Unit (DSRC)
- RSU – Roadside Unit (DSRC)
- SCMS – Security Certificate Management System
- DMS – Dynamic Message Signs
- HAR – Highway Advisory Radio
- TIM – Traveler Information Message
- C2C – Center to Center Communications
- HFE – Human Factors Engineering
Dedicated Short-Range Communications (DSRC)

- Two-way short- to medium-range wireless communications
- Up to 1,000 meters; typical is 300 meters
- FCC allocated 75 MHz of spectrum (7 channels) in the 5.9 GHz band for use by ITS for safety and mobility applications
- Fast network acquisition
- Low latency
- High reliability, 100 millisecond transmissions
- Priority for safety messages
- Security Certificate Management System
- Interoperability, SAE J2735 standard for messages
  - Basic Safety Message
  - Traveler Information Message
**DSRC Security Certificates**

- Security certificates are used to authenticate the sender and receiver of DSRC messages.
- Certificates have short expiration times to promote privacy.
- DSRC radios need a library of certificates.
- Revocation lists of certificates are broadcast triggered by reported malicious behavior.
- SCMS delivery mechanisms for new certificates and revocation lists include:
  - Network communications to RSUs
  - V2I communications to update OBU when in proximity of RSU
  - Satellite radio communications to SiriusXM receiver equipped vehicles.
DSRC Security Certificate Distribution
SiriusXM Security Certificate Distribution
**Connected Vehicle Applications**

- **Phase 1 2015-2016**
  - Mobile road weather data collection
    - First installation: INL scout vehicle, May 2015
    - 3 additional units installed 2016
  - Snow plow controller data uploads to Vaisala Navigator website
  - Scout vehicle V2V safety (DSRC)
    - Forward collision warning
    - Electronic brake light warnings
    - Intersection movement assist
    - Blind spot and lane change warning

- **Phase 2 2016-2017 (pending funding)**
  - Signal phase and timing broadcasts along US 20, 14 intersections
  - Bus and snow plow V2I
  - Dashboard camera images
  - 511 Connected Vehicle modules
  - Two animal detection zones
RSU
RSU Installation 1

Before installation

Tilt down lowering of the tower
RSU Installation 2

• Bolting the RSU to the tower

• Raising the tower
RSU Installation 3

Sierra Wireless 4G Modem
PoE Injector
AC to DC Transformer
RSU Installation 4

Yagi Antenna

Omnidirectional Antenna
Current Status

• Mobile road and weather data collection
  – Four units installed

• Mobile road weather data archived on Vaisala Navigator website

• Dashboard cameras
  – iPhone versus Android being discussed

• V2V safety applications
  – Loaded into Savari DSRC OBUs

• 511 website enhancements
  – Work scope finalization underway, pending funding
Project Schedule

• 2015-2016
  – Mobile data collection
  – Snowplow data uploads, integration with Vaisala Navigator
  – DSRC radio installation and testing
  – SiriusXM security certificate and TIM broadcast underway

• 2016-2017
  – V2V applications (scout vehicle, bus, and snowplow)
  – Signal phase and timing – US 20 in Idaho Falls
  – SiriusXM broadcasting
  – Additional V2V testing in simulator, Human Factors Engineering design optimization
  – Evaluation
INL Scout Vehicle With DSP310
DSP310 Pavement Temperature Sensor
DSP310 Controller Case
DSP310 Pavement Condition Sensor
DSP310 Pavement Condition Sensor
DSP310 Cell Phone Interface
**DSP310 Data Collection Parameters**

- Surface temperature
- Surface state
  - Dry
  - Moist
  - Wet
  - Snow
  - Ice
  - Slush
- Grip (friction coefficient)
- Dew point temperature
- Air temperature
- Relative humidity
Mobile Data on Vaisala Navigator Website
INL Bus
OBU to Be Installed on INL Scout Vehicles
Scout Vehicle DSRC Installation

DSRC Antenna

OBU
DSRC Communications Overview

- V2V and V2I Communications
- DSRC OBU
- Roadside Equipment
  - DSRC RSE & 3G/4G Modem
- 3G/4G Cellular IP Communications
- Cloud
- IP Communications
- Back Office Server
Example: A V2V system leveraging satellite distribution may warn vehicles approaching icy conditions before passing through a RSU coverage area.

**OEM Benefit**
- Safer drives for customers
- Ubiquitous V2V security management
- Improved data for customer usage
- Low-cost and high-coverage delivery mechanism (satellite)
Hurdles and Challenges

- Traveler Information Message (TIM) development (FEU to SAE J2735)
- Configuration of DSRC radio sets (first cellular backhaul)
- Human-machine interface on vehicles
- Integration of SiriusXM data on INL Android Zonar tablet
- Funding for expansion of project (ATCMTD proposal has been submitted)
What’s Next (Pending Funding)

- Add dash cameras on snowplows, buses, and scout vehicles
- Add thermal and grip mapping to 511 website
- Add mobile road weather data and dashboard camera images to 511 website, apps, and subscription service
- Interface 511 with SiriusXM
- SiriusXM broadcasting of critical events with geofencing
- Expand DSRC deployment, OBUs, and RSUs.
- Upgrade signalized intersections on US 20 with new controllers, detectors, and DSRC radios
- Deploy two large animal warning systems on bus routes
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Questions??

Thanks for your attention.