



# ***CONNECTED VEHICLE COMMUNICATIONS IN A RURAL SETTING***

**Ira Pray, Fleet Manager  
Idaho National Laboratory**

**NRITS October 2016  
Chattanooga, TN**

[www.inl.gov](http://www.inl.gov)



# 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
    - Mackay

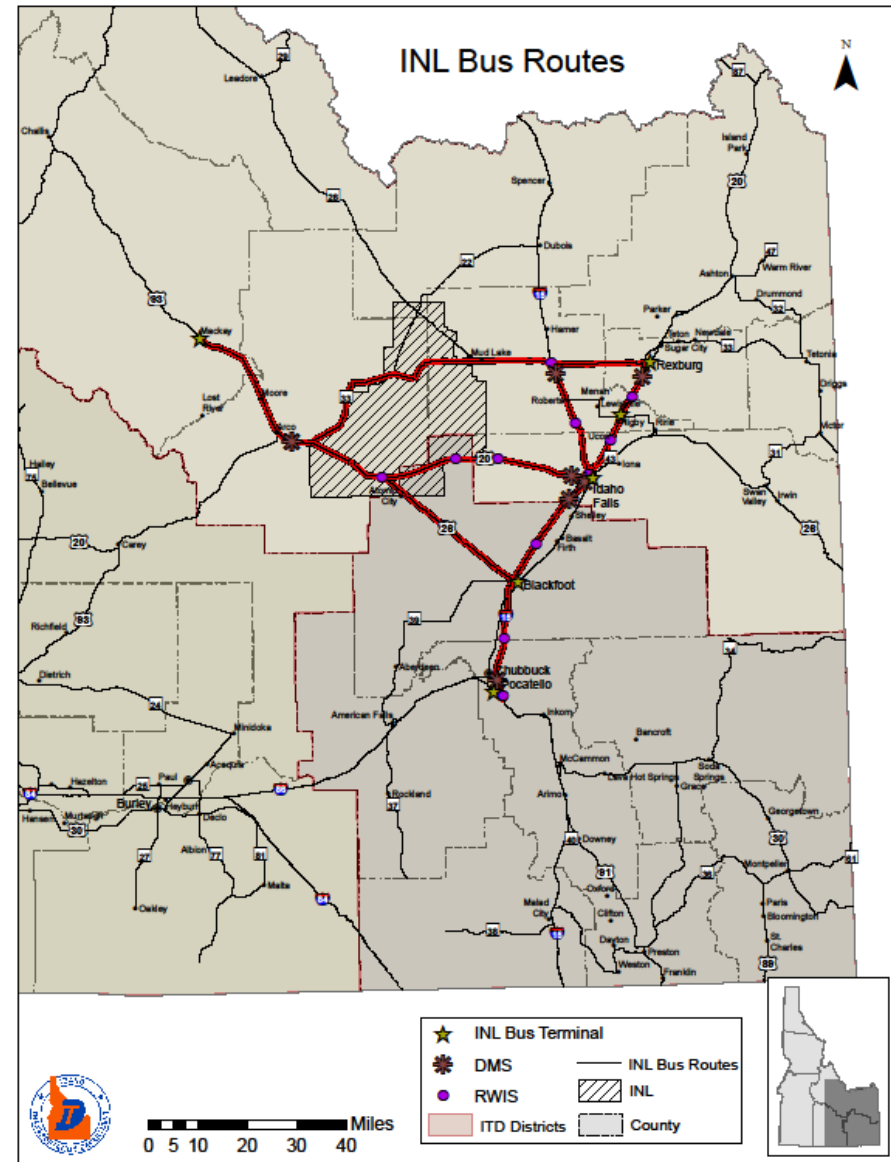
## ***Background cont.***

- 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***

Puzzle: US-20/26, MP 272, Elev 4,954 ft,  
West View

Thu Dec 30 08:47:01 2010



# RWIS Eastern Idaho

Puzzle: US-20/26, MP 272, Elev 4,954 ft,  
East View

Thu Dec 30 08:47:01 2010



## *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)***

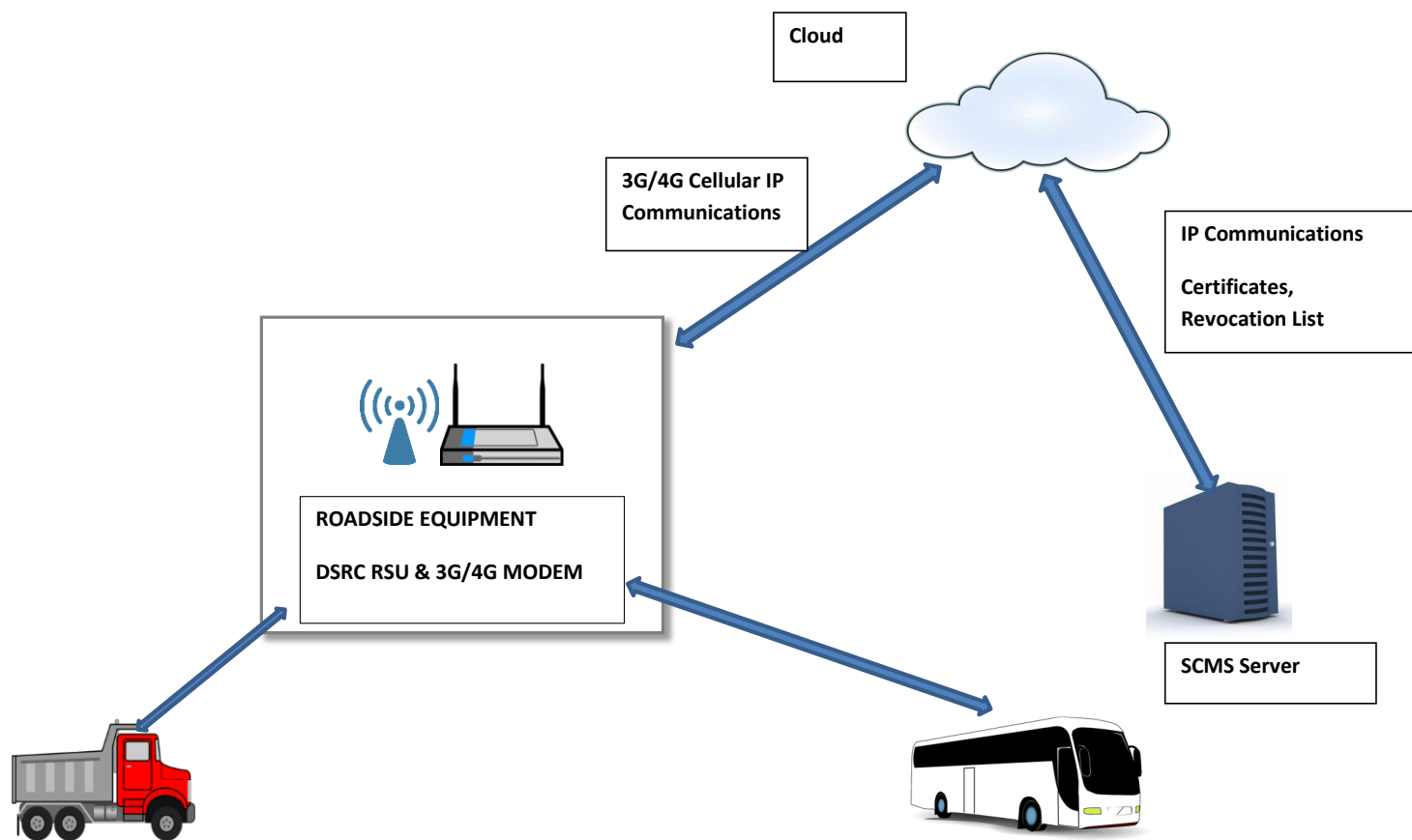
- Two-way short- to medium-range wireless communications
- Up to 1,000 meters; typical is 300 meters
- FCC allocated 75 MHz of spectrum (7 channels) in the 5.9 GHz band for use by ITS for safety and mobility applications
- Fast network acquisition
- Low latency
- High reliability, 100 millisecond transmissions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

## ***DSRC Security Certificates***

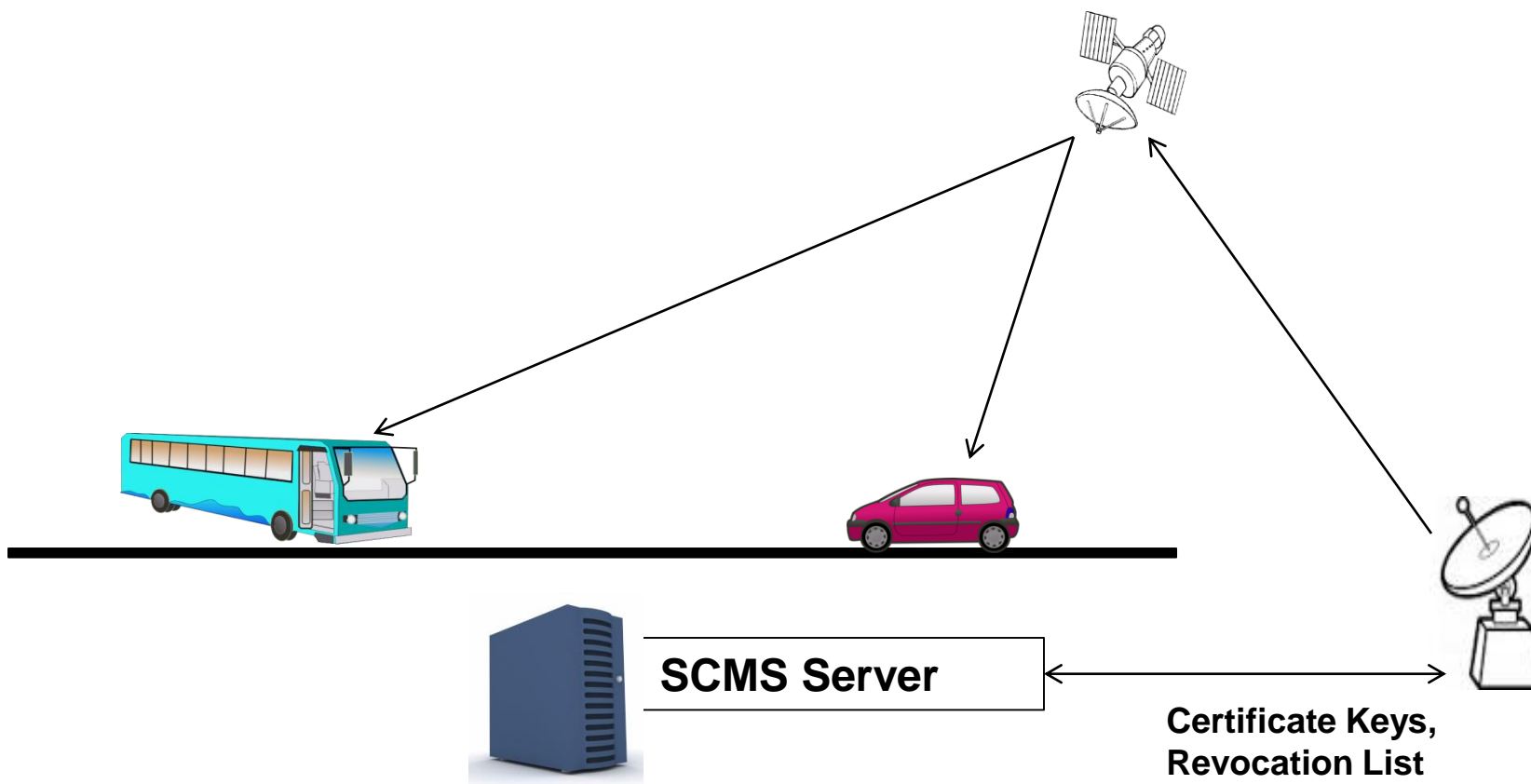
- Security certificates are used to authenticate the sender and receiver of DSRC messages.
- Certificates have short expiration times to promote privacy.
- DSRC radios need a library of certificates.
- Revocation lists of certificates are broadcast triggered by reported malicious behavior.
- SCMS delivery 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



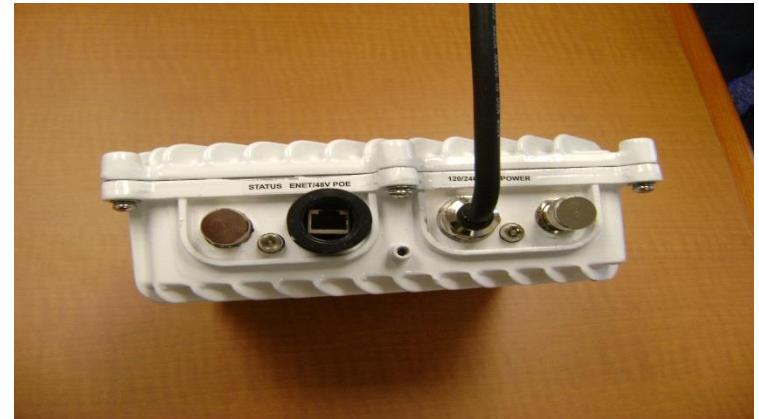
# ***SiriusXM Security Certificate Distribution***



# ***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

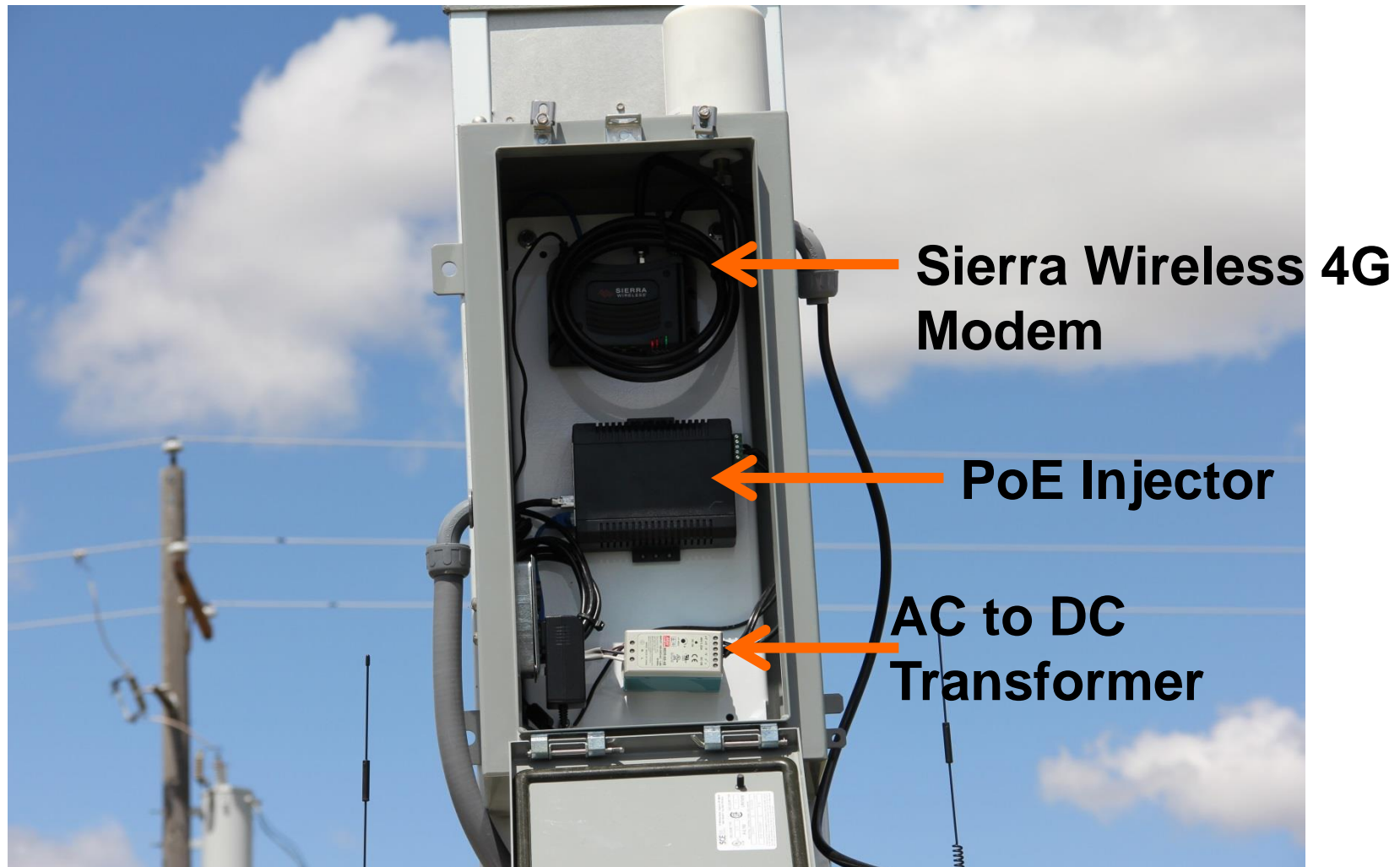


- Raising the tower

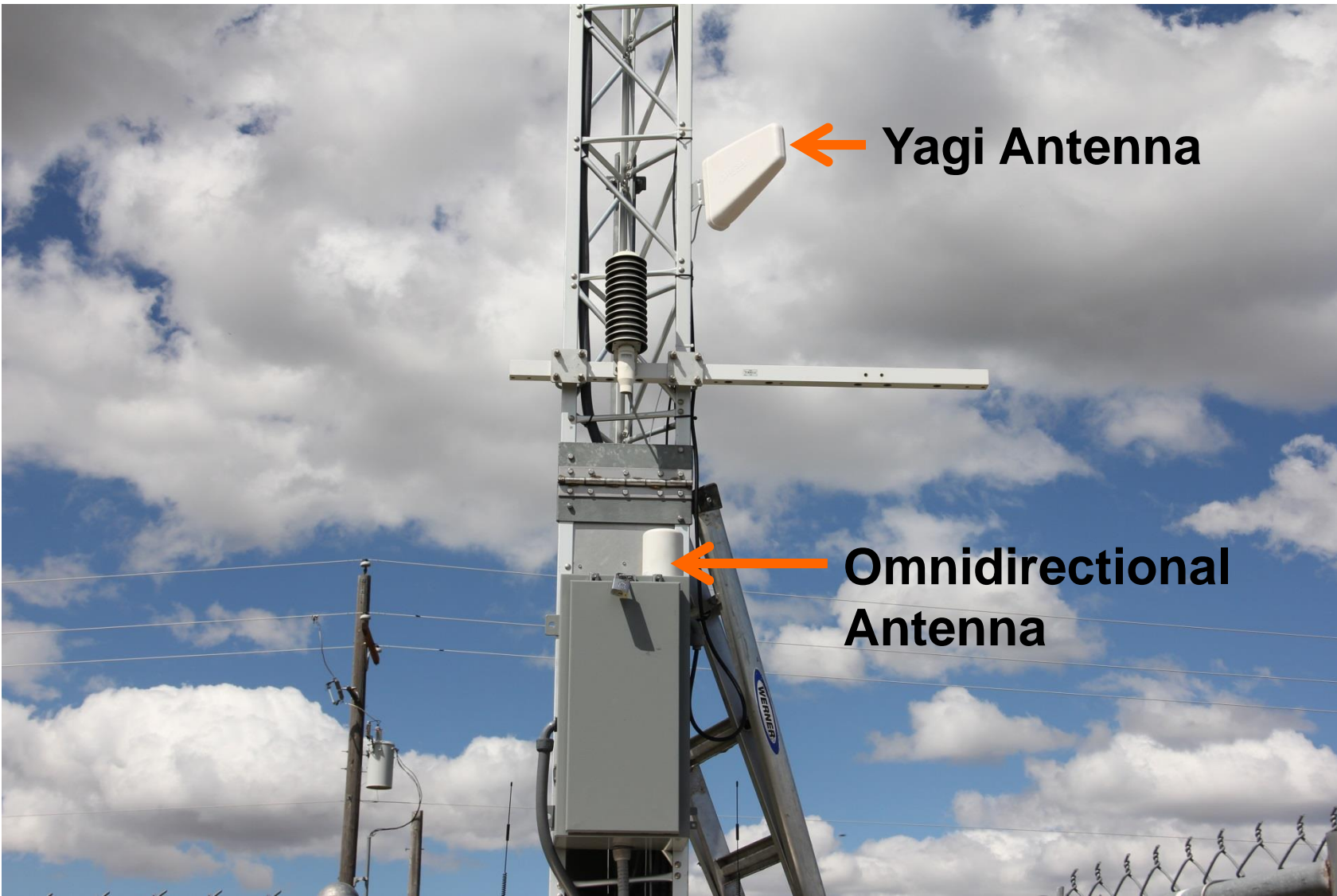




## ***RSU Installation 3***



## ***RSU Installation 4***



## ***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***





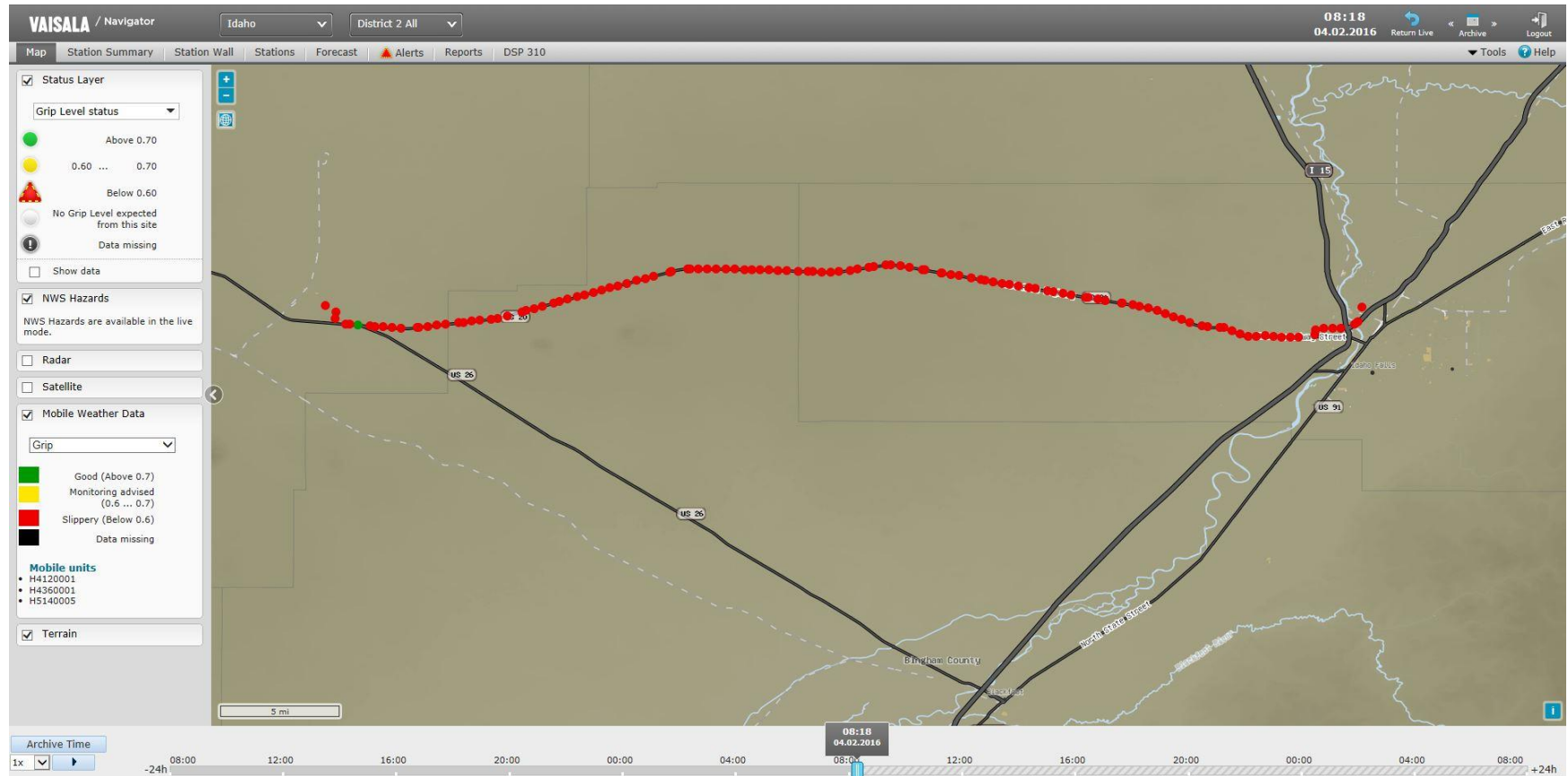
## ***DSP310 Cell Phone Interface***



## ***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





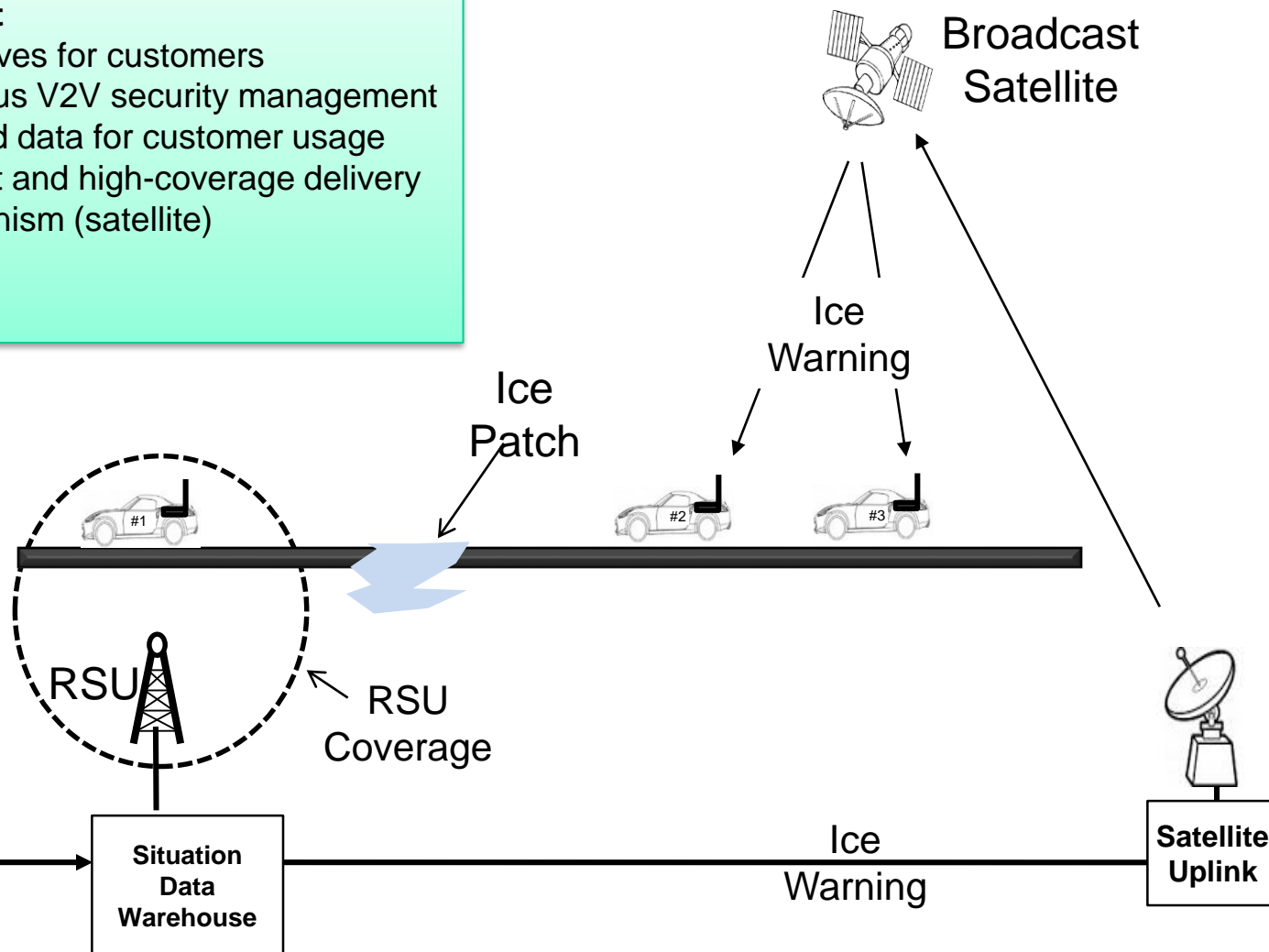


# Wide Area TIM Distribution

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

## **Contact Information**

- **Bob Koeberlein, ITD, HQ Operations Engineer**
  - **[Robert.Koeberlein@itd.idaho.gov](mailto:Robert.Koeberlein@itd.idaho.gov)**
  
- **Ira Pray, Manager, Fleet Management Services**
  - **[Ira.Pray@inl.gov](mailto:Ira.Pray@inl.gov)**
  
- **Scott Wold, Director, Mission Support Services**
  - **[Scott.Wold@inl.gov](mailto:Scott.Wold@inl.gov)**



# Questions??



Thanks for your attention.