

WYOMING DOT CONNECTED VEHICLE PILOT

IMPROVING SAFETY AND TRAVEL
RELIABILITY ON I-80 IN WYOMING



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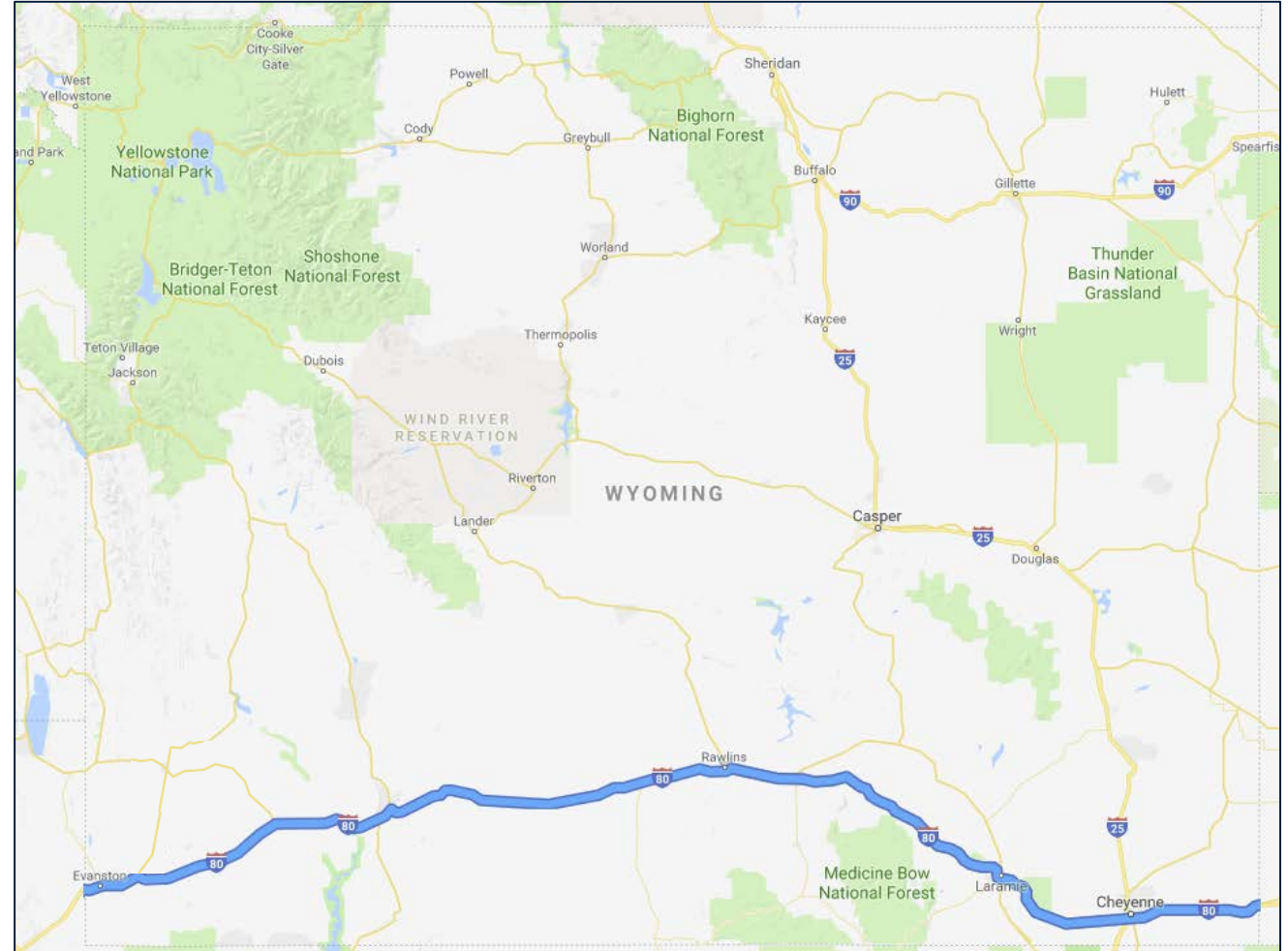


Presentation Overview

- Description of I-80 through Wyoming
- Pilot overview
- Technology discussion and focus on Open Source

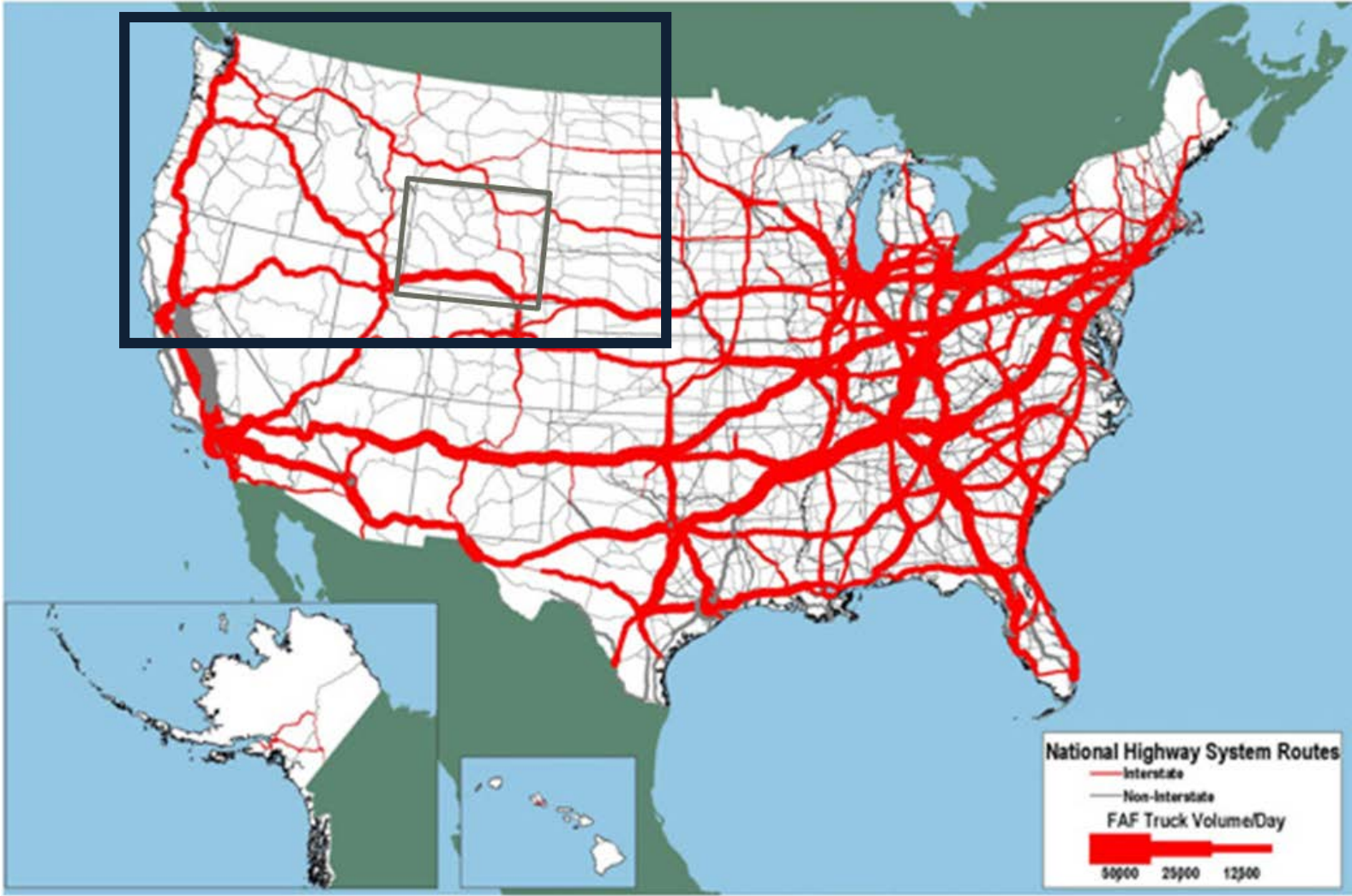
I-80 Corridor

- Runs 402 miles along Wyoming's southern border
- More than 32 million tons of freight per year
- Truck volume is 30-55% of the total traffic stream on an annual basis
 - Seasonal peaks as high as 70%

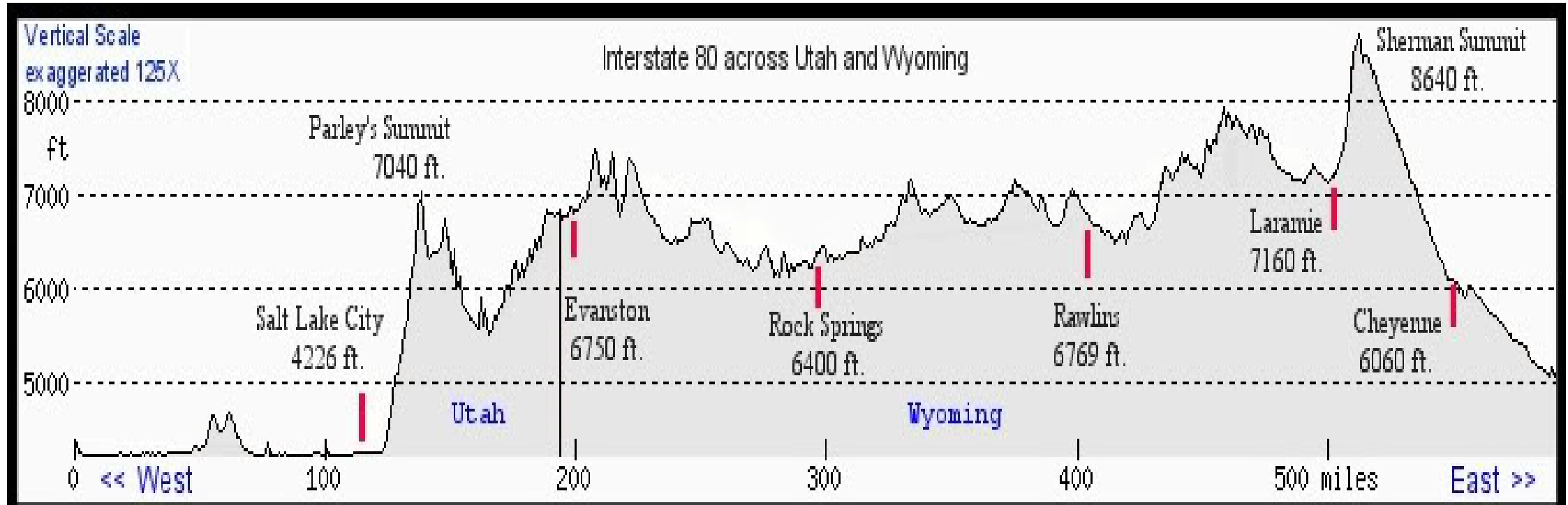




I-80 Corridor



I-80 Corridor



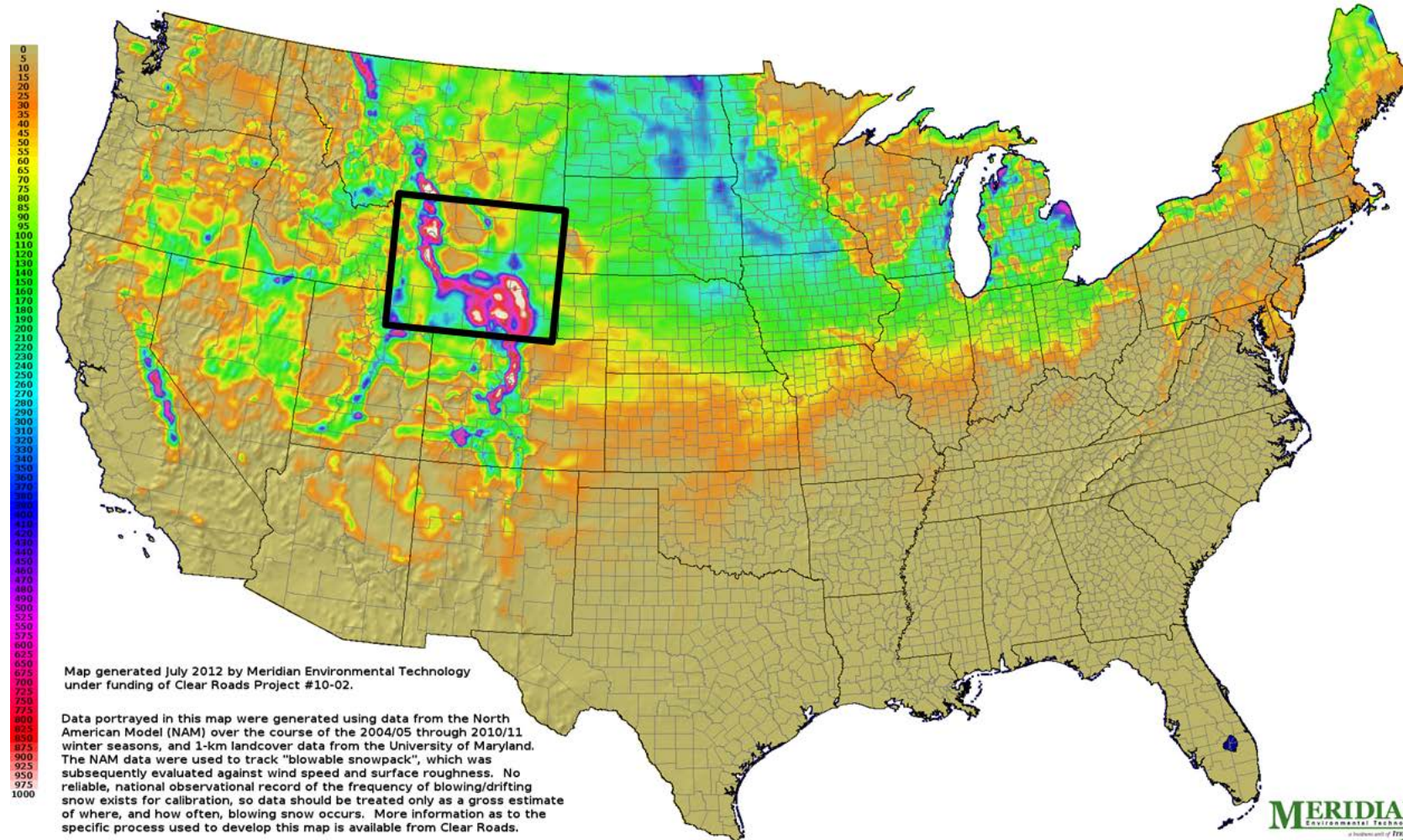


I-80 Corridor



I-80 Corridor

U.S. Annual Hours of Blowing Snow Estimated from Modeled Data





I-80 Corridor





I-80 Corridor

One of the most heavily instrumented rural corridors in the United States

136 Variable Speed Limit Signs

supported by 94 traffic sensors

54 Electronic Message Signs

44 Weather Stations

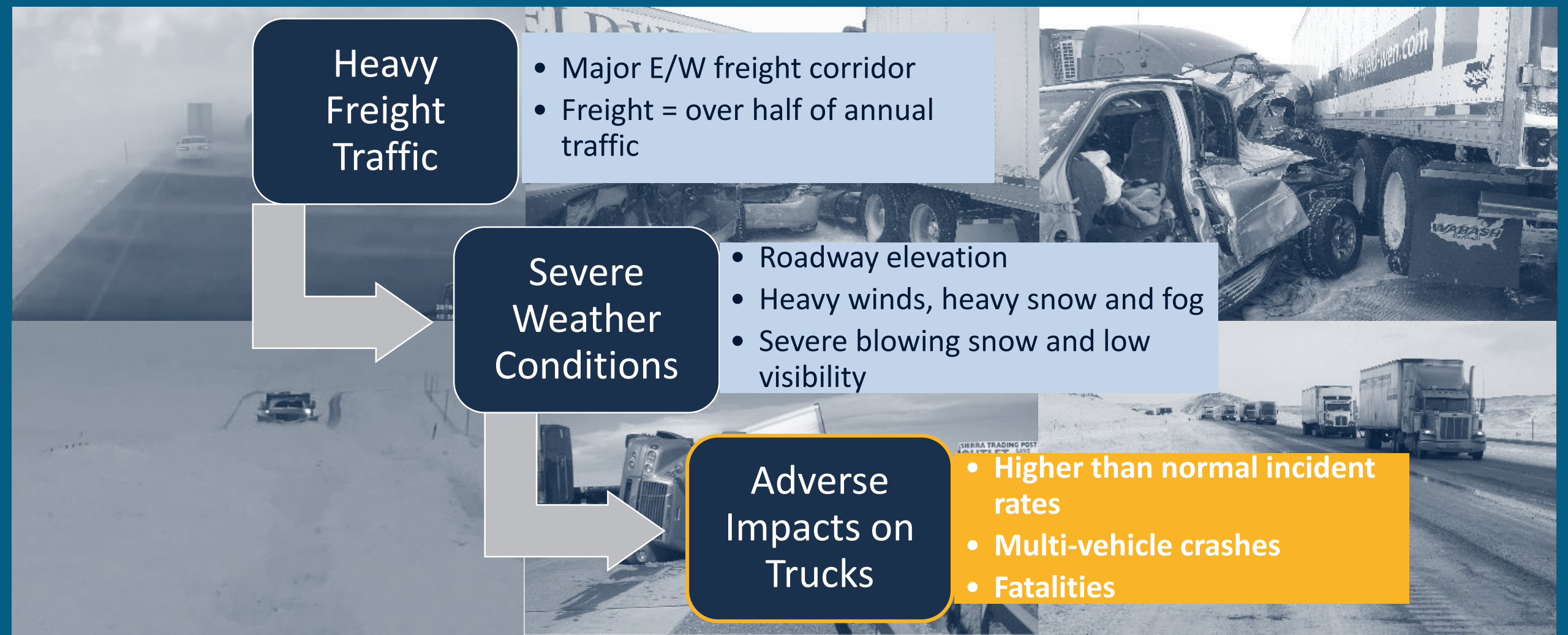
52 Webcams



A problem worth solving



A problem worth solving



Heavy Freight Traffic

- Major E/W freight corridor
- Freight = over half of annual traffic

Severe Weather Conditions

- Roadway elevation
- Heavy winds, heavy snow and fog
- Severe blowing snow and low visibility

Adverse Impacts on Trucks

- Higher than normal incident rates
- Multi-vehicle crashes
- Fatalities

A problem worth solving

Heavy
Freight
Traffic

- Major E/W freight corridor
- Freight volume of 16,000+ trucks per day

1,600+ crashes

1,923 vehicles

\$865.3M

Societal Impact

Trucks

- Fatalities

low and fog
and low

er than normal incident

i-vehicle crashes

Connected Vehicle Pilot



Connected Vehicle Pilot



Wyoming Connected Vehicle Pilot



DSRC BASED



FREIGHT
FOCUSED



INTEGRATED
WITH TMC



INTEGRATED
WITH WYDOT
FLEETS



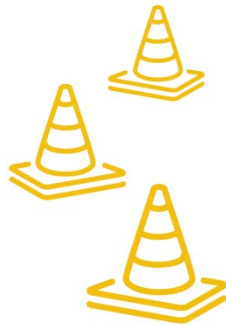
FORWARD
LOOKING



CV PILOT APPLICATIONS



**12V
SITUATIONAL
AWARENESS**



**WORK ZONE
WARNING**



**SPOT WEATHER
IMPACT
WARNING**



**DISTRESS
NOTIFICATION**



**FORWARD
COLLISION
WARNING**

DSRC Connectivity



DSRC BASED

Connectivity

Operates using Dedicated Short-Range Communication (DSRC)
over the 5.9 GHz public safety spectrum

Allows for rapid device connectivity

Information broadcast 10/second

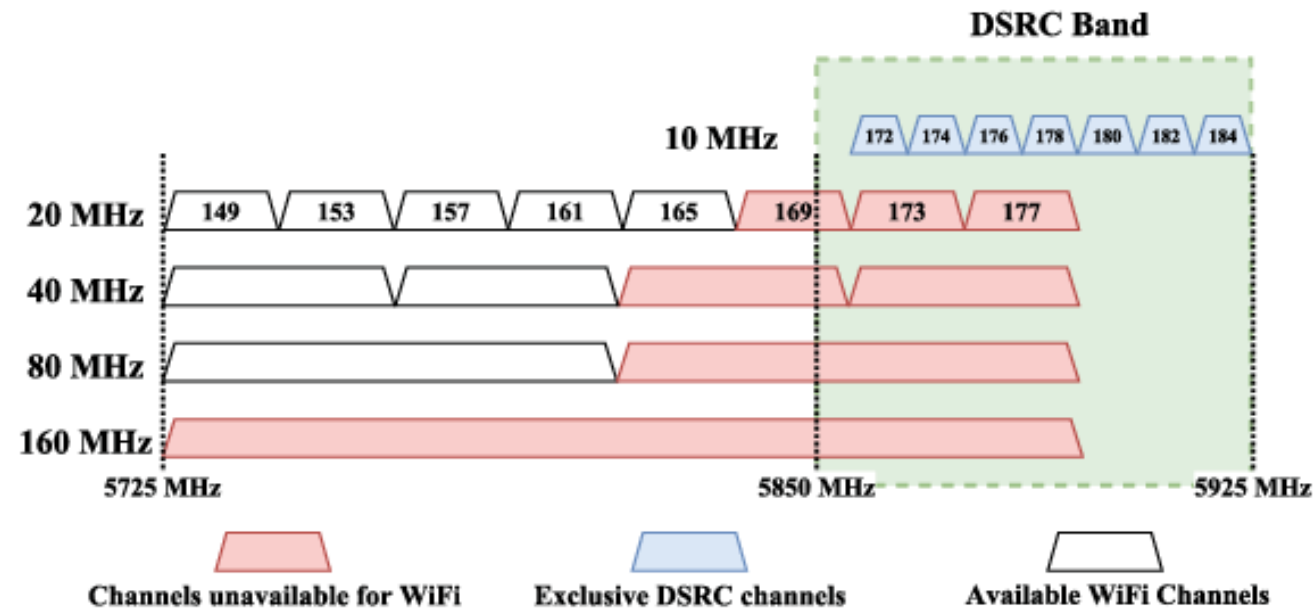


Image: Bin Cheng, Hongsheng Lu, Ali Rostami, Marco Gruteser, John B. Kenney
Published 2017 in 2017 IEEE Vehicular Networking Conference (VNC)

Connected Vehicle Overview



DSRC BASED

➤ Vehicle to Vehicle (V2V)

- Vehicles send basic messages and distress notifications that are received by nearby vehicles.
- This information is processed to give meaningful alerts to drivers for benefits like speed harmonization and crash avoidance.



Connected Vehicle Overview



DSRC BASED

- Vehicle to Infrastructure (V2I)
 - Vehicles send out basic messages or data to roadside infrastructure.
 - This can include basic vehicle metrics, like whether windshield wipers are on. For this purposes of our pilot, it also includes data about interactions with other CVs.
 - Data comes from vehicle sensors, including weather data.
 - Vehicles receive Traveler Information Messages from roadside infrastructure, supplemented by satellite.



Connected Vehicle Overview



DSRC BASED

- Wyoming's telecommunication infrastructure - there's not fiber everywhere
- Worked with ETS to update routers and configured for native IPv4 and IPv6
- Still working to dual route communications from the TMC



Freight-focused



FREIGHT
FOCUSED

- ~150-200 are large trucks
- ~ 100 are small/medium trucks

CV Trucks



- Trucking Companies of various sizes
 - Dooley Oil
 - Double D Distribution
 - Sinclair Oil
 - Others...

Fleet
Partners



- CVOP Users (800 firms)
- Wyoming Trucking Association
- Third Party Intermediaries

Freight
Partners



Integrated with the TMC



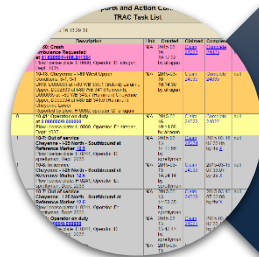
INTEGRATED
WITH TMC



Supports I-80 Traveler Information



Supports VSL and other traffic
management strategies

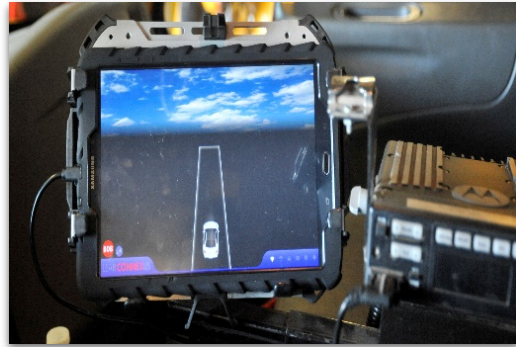


Integrated with TMC Management
Systems

Integrated with WYDOT Fleets



INTEGRATED
WITH WYDOT
FLEETS



~100 DSRC-
enabled snow
plows and
highway patrol
vehicles



Environmental
Probe Data
Collection



Leverage existing
technology

Forward Facing



FORWARD
LOOKING

- Interoperability is a major component of this project
- The project is built to standards, and we've documented everything we've done along the way
- Successful testing with the other two pilot sites shows that systems can work across jurisdictional boundaries and with various vendors' equipment

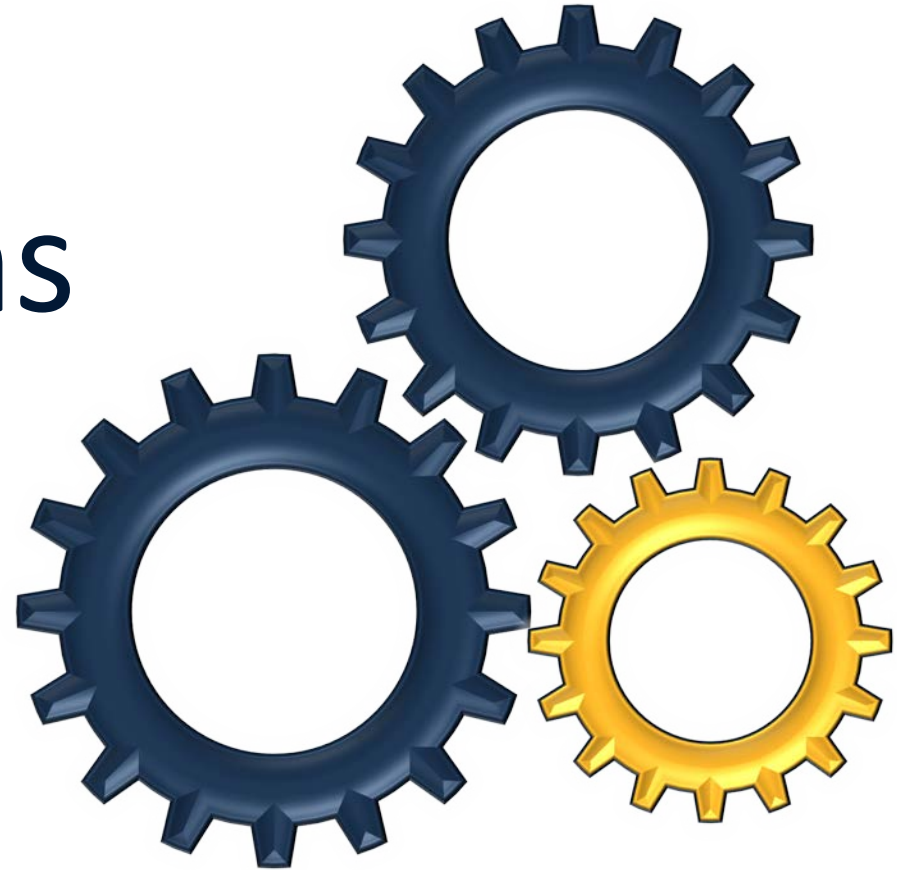


Image: USDOT

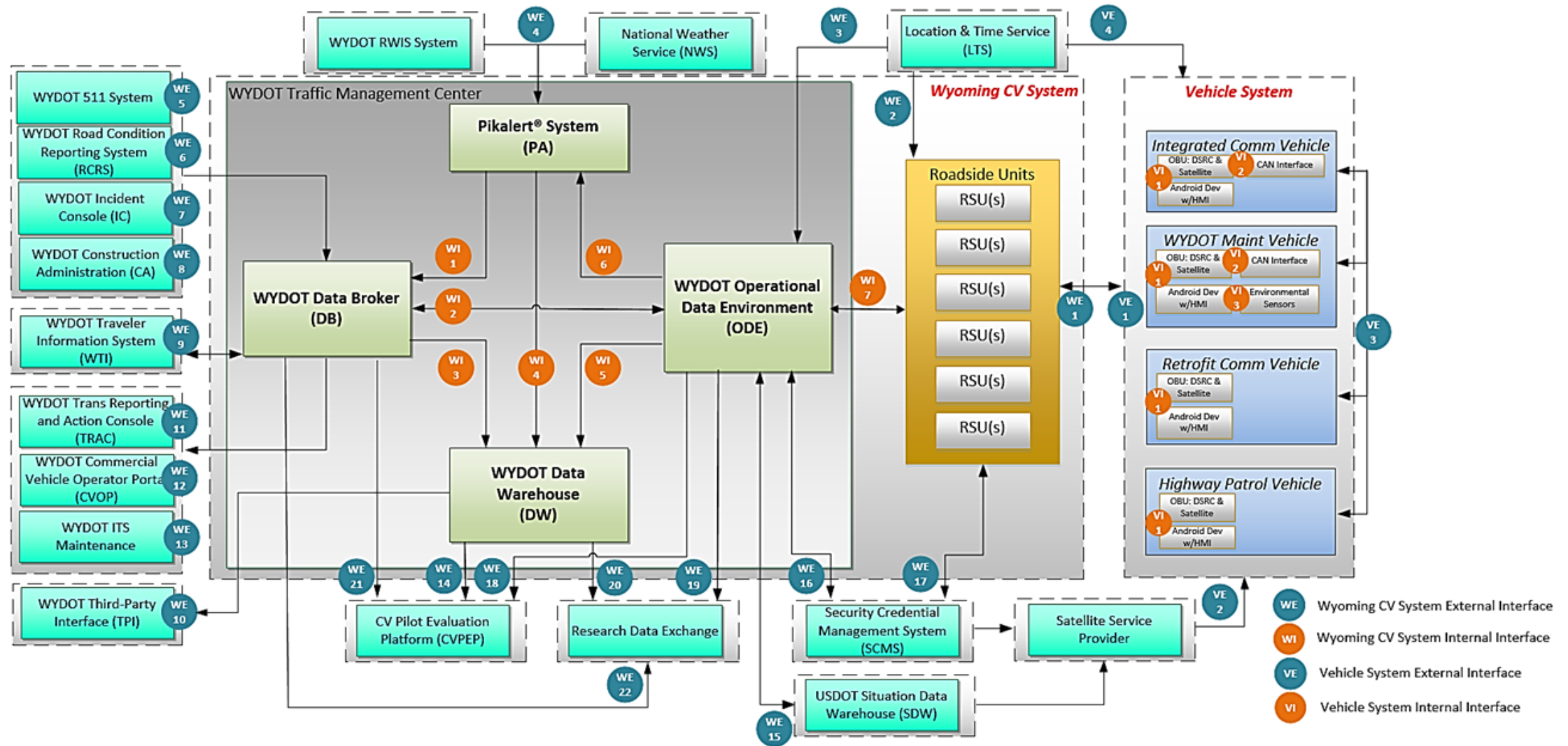
How does it all work?



Back end Systems



Backend Systems





Connected Vehicle Pilot: Security

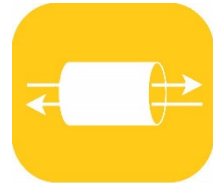
SECURITY BY DESIGN



HSM
On-board
units



HSM
Road-side
units



SSL VPN

VPN
Protect
data in
transit



HSM &
Background
Checks
For TMC



Database
Encryption
Tables w/
Potential
PII

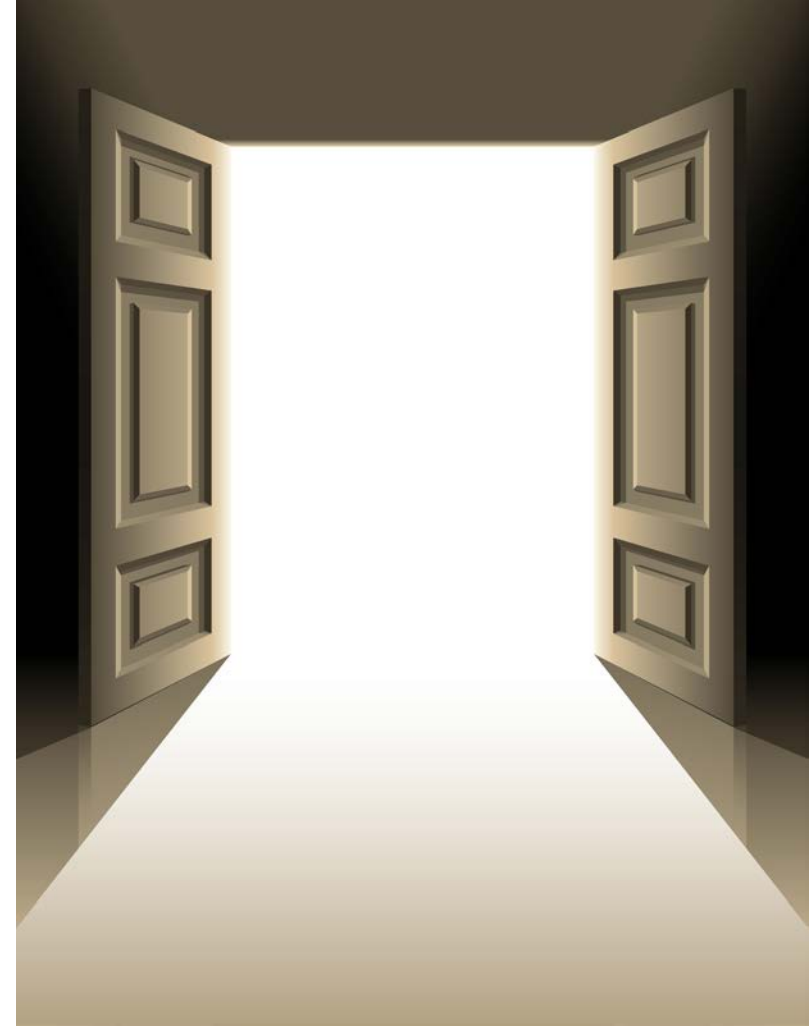


SCMS
Certificates
and
Validation



Firewalls
IPv4 and
IPv6

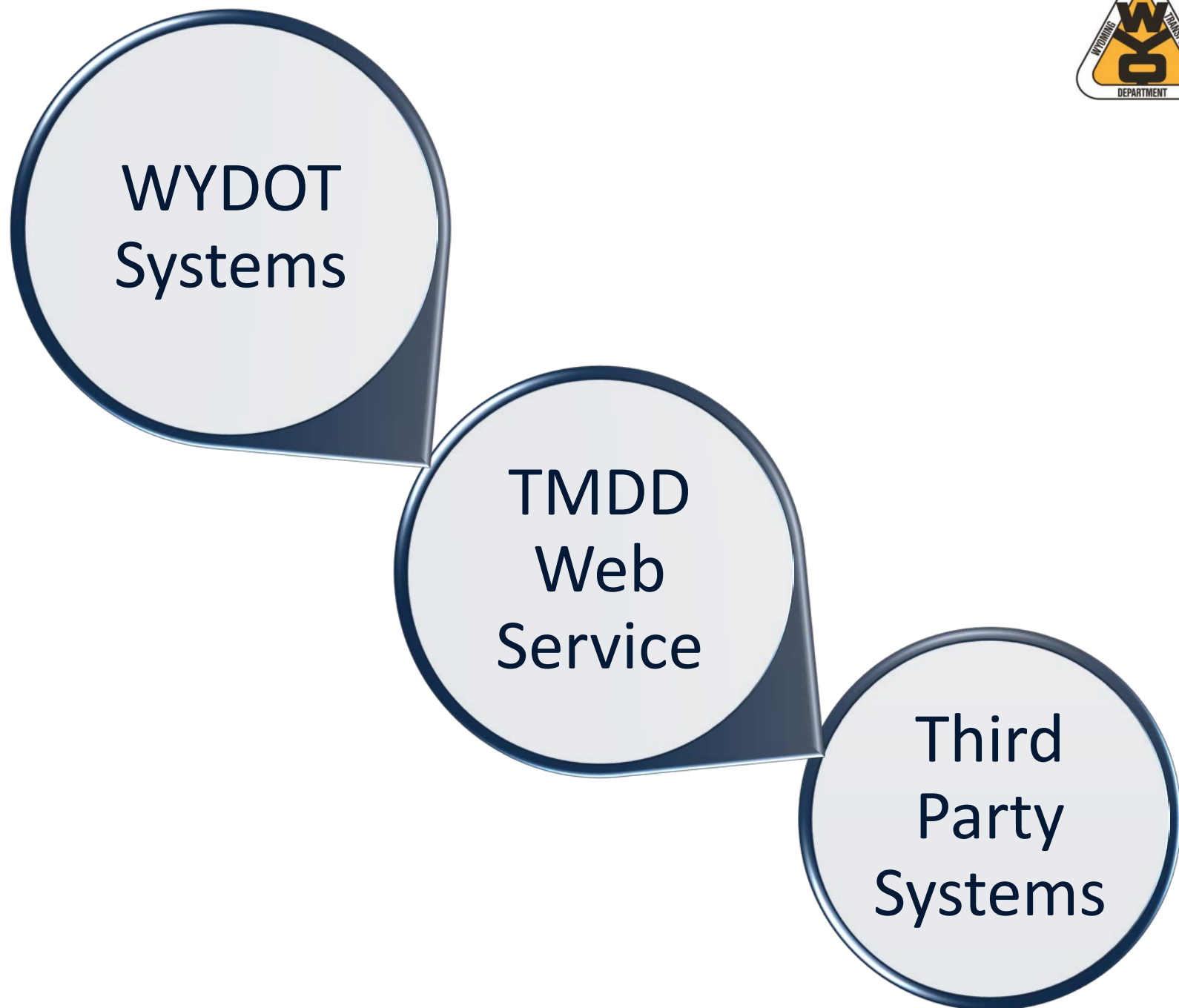
Open Source Software





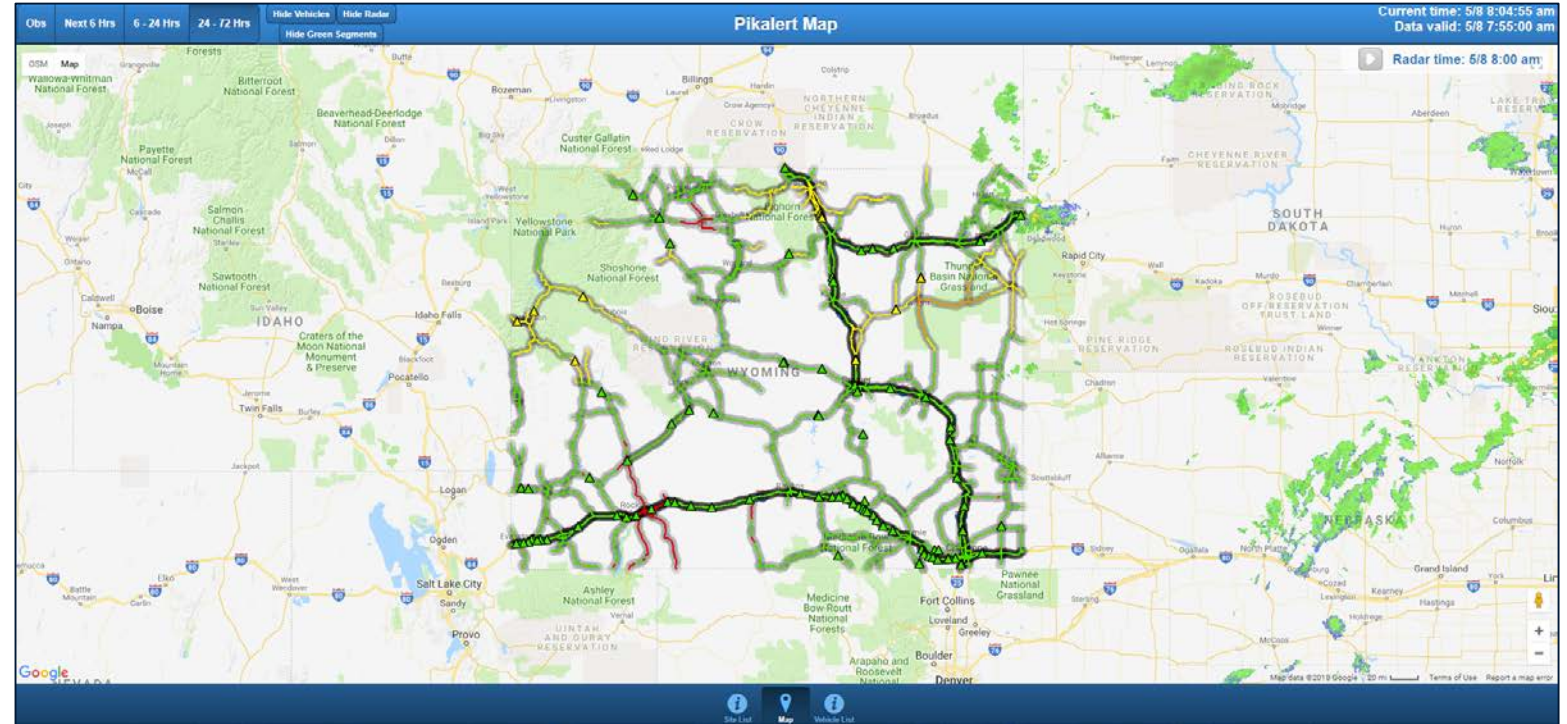
Open Source: TMDD Data Feed

- WYDOT wants all consumers of our information to benefit from improved data



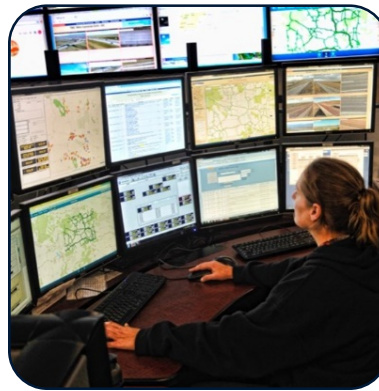
Open Source: Pikalert

- Using the Pikalert system developed by the National Center for Atmospheric Research to process CV data
- Provides actionable alerts to TMC operators
- Provides forecast weather and “now-cast” surface conditions



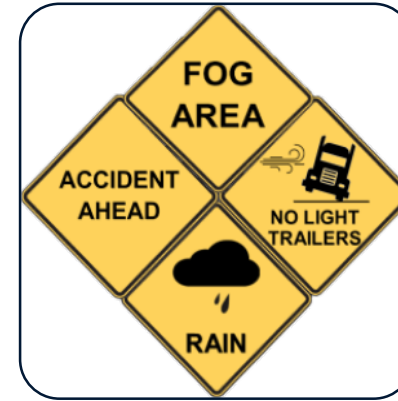
Open Source: TIM Builder

- RSUs will be updated with the same application used for updating WYDOT's website, phone system, text/email alerts and Highway Advisory Radios
- This integration means no additional work for operators



TMC Apps

- Construction
- Road Conditions
- Incidents



TIM Builder

- API
- Builds & Distributes TIM

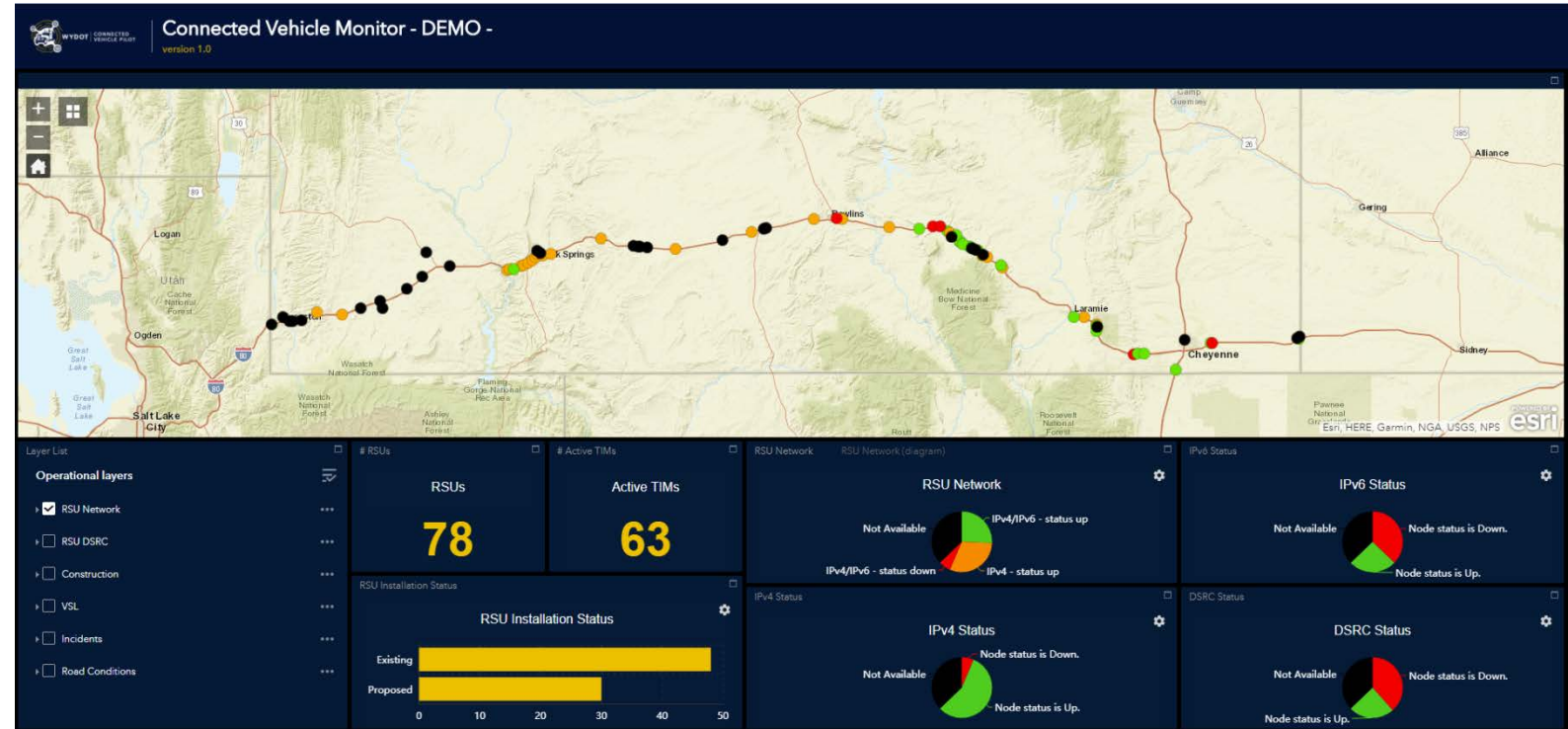


RSU

- Validates incoming TIM
- Broadcasts TIM to OBUs

Open Source: CV Monitor

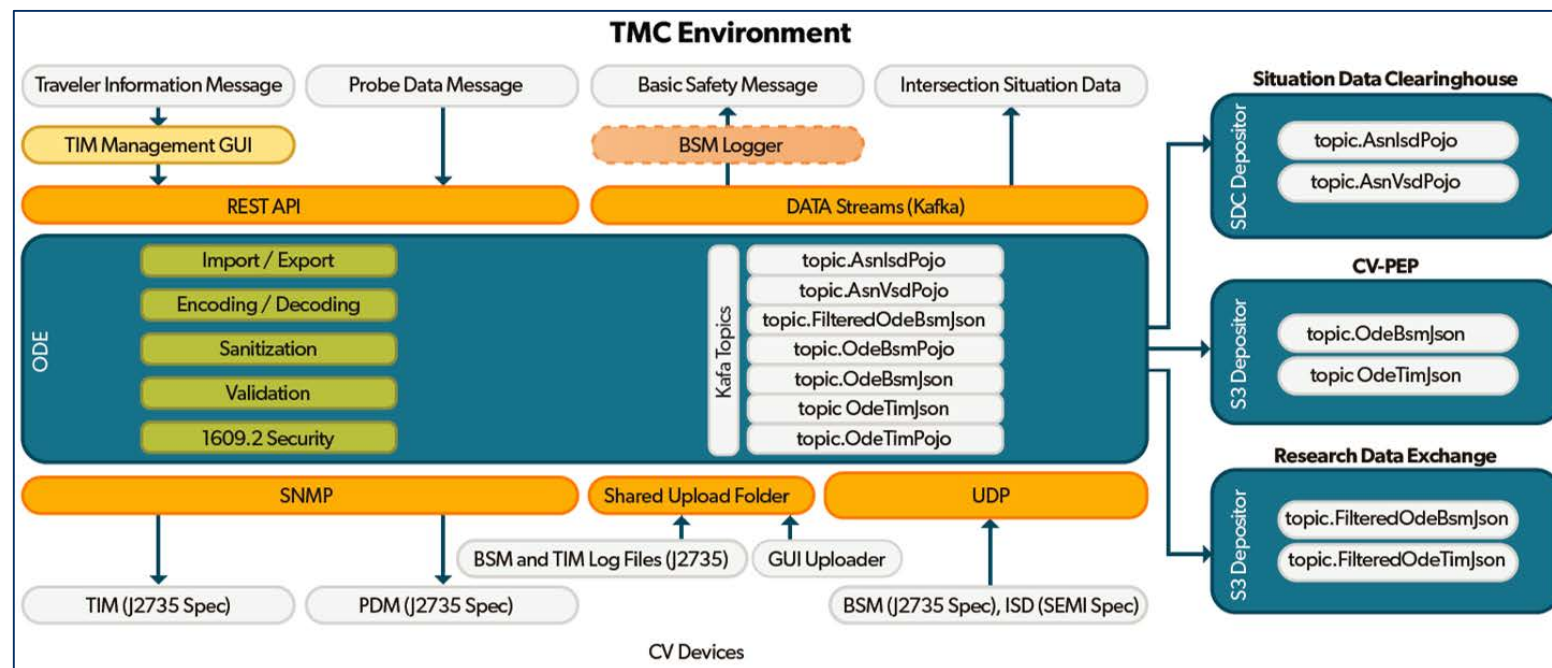
- The CV monitor is used to monitor RSUs in real-time
- Provides the status of communication, vehicle counts, posted TIMs and other information
- A specialized version with an enhancement allows authorized people to apply firmware updates to RSUs



Open Source: ODE

- Through the Operational Data Environment, information is sent from the CV to the TMC and then to a central repository

➤ <https://github.com/usdot-jpo-ode/jpo-ode>



More open source

- Situational Data Warehouse
- Sirius XM is able to pick up messages from the SDW and broadcast them using its satellite network

➤ <https://webapp.cvmvp.com/whtools/>

System Name
SDW 2.3

Dialog ID
156 (travelerInformation)

Start Date
2018-10-11T21:20:52
X
Calendar
>=
Operator

End Date
2018-10-18T21:22:16
X
Calendar
<=
Operator

NW Corner Lat/Lng
42.30270602152241
-108.5349655151367
Globe



Application code sharing: OSADP

- All applications developed as part of this pilot are considered open source and made publicly available
- The repository includes code and release notes

➤ Open Source Application Development Portable

- Public repository for code base and application notes
- Applications like the ODE and SDW are discoverable through the OSADP, but available for pull requests, development in the open integration, documentation, and installation through GitHub

Data sharing: USDOT Public Data Hub

- Data from the pilot is shared via the USDOT



Image: USDOT

Connected Vehicle Pilot



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RELIABILITY ON I-80 IN WYOMING



visit the Wyoming Connected Vehicle Pilot website
<https://wydotcvp.wyoroad.info>

email
dot-cvpilot@wyo.gov