Wyoming CV Pilot Team
I-80 Corridor

- 402-mile corridor along Wyoming’s southern border
- >32 million tons of freight per year
- Truck volume 30-55% of total traffic stream on an annual basis
  - Seasonal peaks as high as 70%
I-80 Corridor
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
Connected Vehicle Pilot
Wyoming Connected Vehicle Pilot

DSRC BASED

FREIGHT FOCUSED

INTEGRATED WITH TMC

INTEGRATED WITH WYDOT Fleets

FORWARD LOOKING
CV PILOT APPLICATIONS

- I2V SITUATIONAL AWARENESS
- WORK ZONE WARNING
- SPOT WEATHER IMPACT WARNING
- DISTRESS NOTIFICATION
- FORWARD COLLISION WARNING
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
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
The Pikalert® System – Environmental Logs

<table>
<thead>
<tr>
<th>WEATHERCLOUD-EQUIPPED</th>
<th>BASIC SAFETY MESSAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Wiper Frequency</td>
<td>➢ GPS Coordinates/Timestamp</td>
</tr>
<tr>
<td>➢ GPS Coordinates/Timestamp</td>
<td>➢ Ambient Air Temperature</td>
</tr>
<tr>
<td>➢ Ground Temperature</td>
<td>➢ Exterior Light</td>
</tr>
<tr>
<td>➢ Ambient Temperature</td>
<td>➢ Wiper Status and Rate</td>
</tr>
<tr>
<td>➢ Barometeric Pressure</td>
<td>➢ Brake Status</td>
</tr>
<tr>
<td>➢ Relative Humidity</td>
<td>➢ Coefficient of Friction</td>
</tr>
<tr>
<td></td>
<td>➢ ABS/Traction/Stability Control Status</td>
</tr>
<tr>
<td></td>
<td>➢ As Available</td>
</tr>
</tbody>
</table>
Vehicle Data Translator

- Environmental logs assigned to WYDOT road segments
  - Updates every one mile and five minutes on I-80
  - Assignment based on location and time of observation

- Both WeatherCloud observations and BSM used as available
Vehicle Data Translator

- Ancillary (traditional) weather observations also matched to road segments
  - Update as available
  - Radius used for non-gridded products

- Data include:
  - Road Weather Information System (RWIS) stations
  - Automated Surface Observing System (ASOS) stations
  - Weather radar
  - Background model analysis
Road Weather Hazard Module

- Road segment statistics are used to assess for precipitation, pavement condition, visibility, and blowover hazards.
- Assessments can run without mobile data, but are greatly enhanced by mobile observations.
Human-Machine Interface (HMI)

E-Training
In-Cab Display Unit Layout

- Critical Warnings
- Advisory Warnings
- Speed Limit
- Distress Notification Button
- Settings Button
- Vehicle Speed
- Forward Collision Warning

Note: The notifications will remain on the display until the event is over.
Road Weather Hazard Modules

- Precipitation type
  - Snow, rain, icy mix, or none
- Intensity
  - None, light, moderate, heavy, road splash

- Dry, wet, snowy, icy, hydroplaning risk
- Yes/No Slickness flag

- Reduced or impacted visibility
  - Precipitation impacts (Heavy rain, heavy snow, blowing snow)
  - Fog

- Risk based on four vehicle types
  - High profile, heavy vehicles
  - High profile, light vehicles,
  - Pickups with attached trailers
  - Passenger Cars

Precipitation  
Pavement Condition  
Visibility  
Blowover
Meteorology Behind Wyoming’s High Winds

- Air flows through lower elevations along I-80
- This passageway narrows from 110km wide to 45km

- The confluence of air causes increased wind speeds
- Flow around the mountains cause increased crosswinds frequency

Source: Martner, et al., 1981
The Pikalert System and the Blowover Algorithm

The Pikalert System:
- The system is used for collecting and quality controlling data
- Alerts are produced for connected vehicles
- Lacked a high wind algorithm

General idea behind the implementation of the algorithm

Input Parameters:
- Wind Speed
- Wind Gust
- Road Condition
- Road Orientation
- Wind Direction

Blowover Algorithm:
- Output
  - Passenger Risk
  - Heavy Truck Risk
  - Light Truck Risk

Driver Alert

Source: Brittany Welch
Blowover Algorithm: Fuzzy Logic

An interest level between 0 and 1 for each vehicle classification

Determines the type of advisory or warning each vehicle class receives

Why these parameters?
• These parameters were chosen based on their significance in vehicle stability in previous research.

What were the initial values?
• Initial weights and functions were based on previous research by Young et al. (2007).

Source: McNeil et al., 1993
Refining the Algorithm – WYDOT Feedback

Suggested Updates

- Algorithm was run in real time during the 2017-2018 winter season in the WYDOT Pikalert
- User feedback indicated that overalerting was an issue
- WYDOT forecasters and personnel proposed updates to the wind differential, wind direction, weights, and functions.

Methods of Refining the Algorithm

- Preformed Sensitivity testing various combinations function thresholds and weights for each category
- Missed crash analysis
- Evaluation of changes in Probability of Detection (Hit/Total) for each test version
- One year evaluation of algorithm performance
Results: Algorithm Adjustments

Possible Probability of Detection for Differing Algorithm Versions

- Passenger POD
- Loaded POD
- Light POD
- Pickup POD
- Severe Data Frame POD

Algorithm Version Number

Version 1: 2017 Blowover Algorithm
Version 2
Version 3
Version 4
Version 5
Version 6: 2018 Blowover Algorithm
Wyoming I-80 Drivers
- Safe and swift travel on I-80
- Increased amount, timeliness, and quality of information

Fleet Managers
- Increased efficiency and safety for fleet drivers

WYDOT
- Reducing crash-induced road closure
- Enhanced data collection
- Efficiency in emergency management procedures
- Continued support for the advancement of CV technologies. Project is open source and available for other DOTs and the public.

US DOT
Connected Vehicle Pilot

WYOMING DOT CONNECTED VEHICLE PILOT
IMPROVING SAFETY AND TRAVEL RELIABILITY ON I-80 IN WYOMING

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