



WYOMING DOT CONNECTED VEHICLE PILOT

IMPROVING SAFETY AND TRAVEL
RELIABILITY ON I-80 IN WYOMING

GENERATING WEATHER ALERTS
INCLUDING HIGH WIND BLOWOVER
HAZARDS USING PIKALERT® FOR THE
WYOMING CONNECTED VEHICLE
PILOT PROJECT



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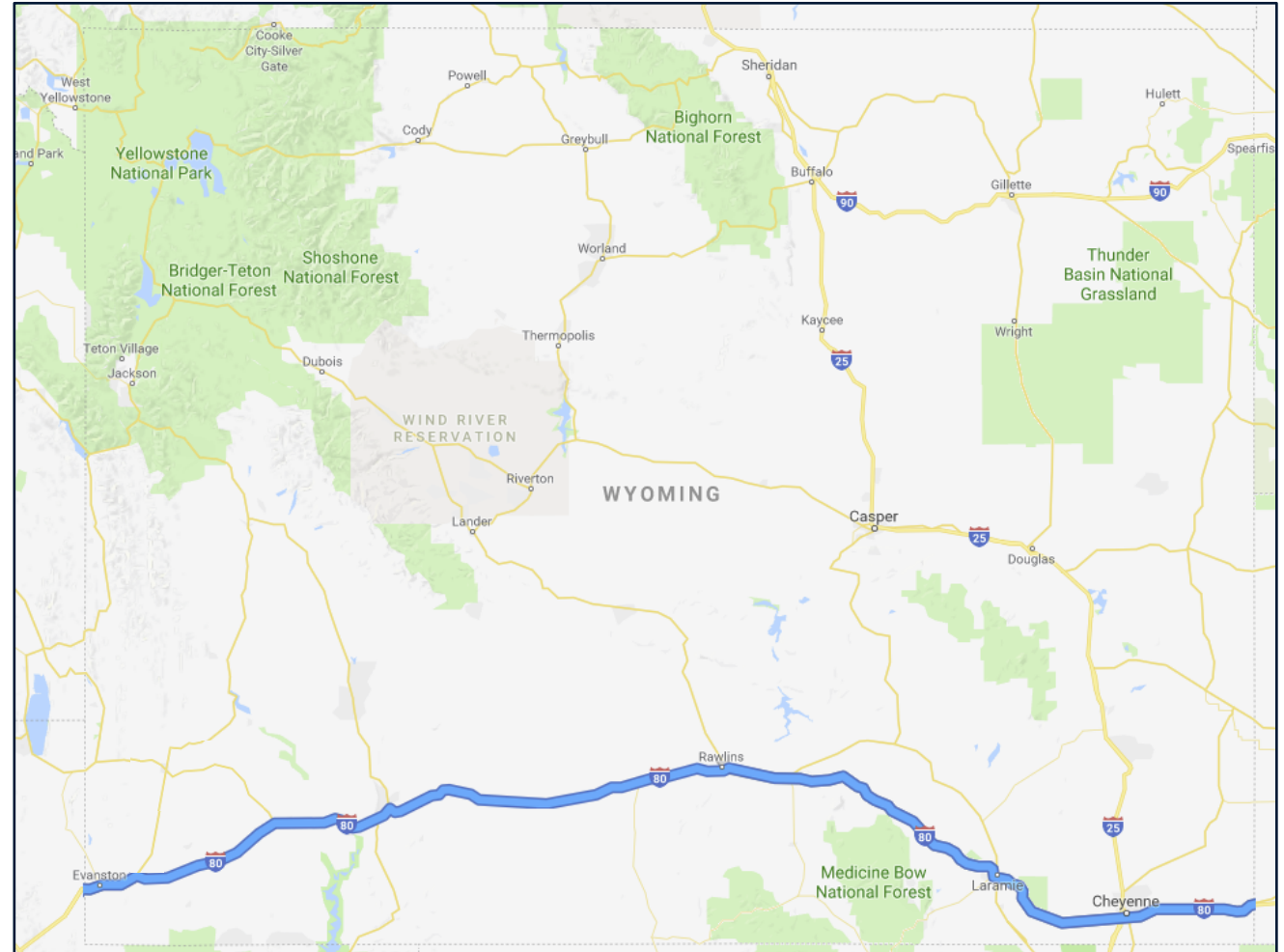
Wyoming CV Pilot Team



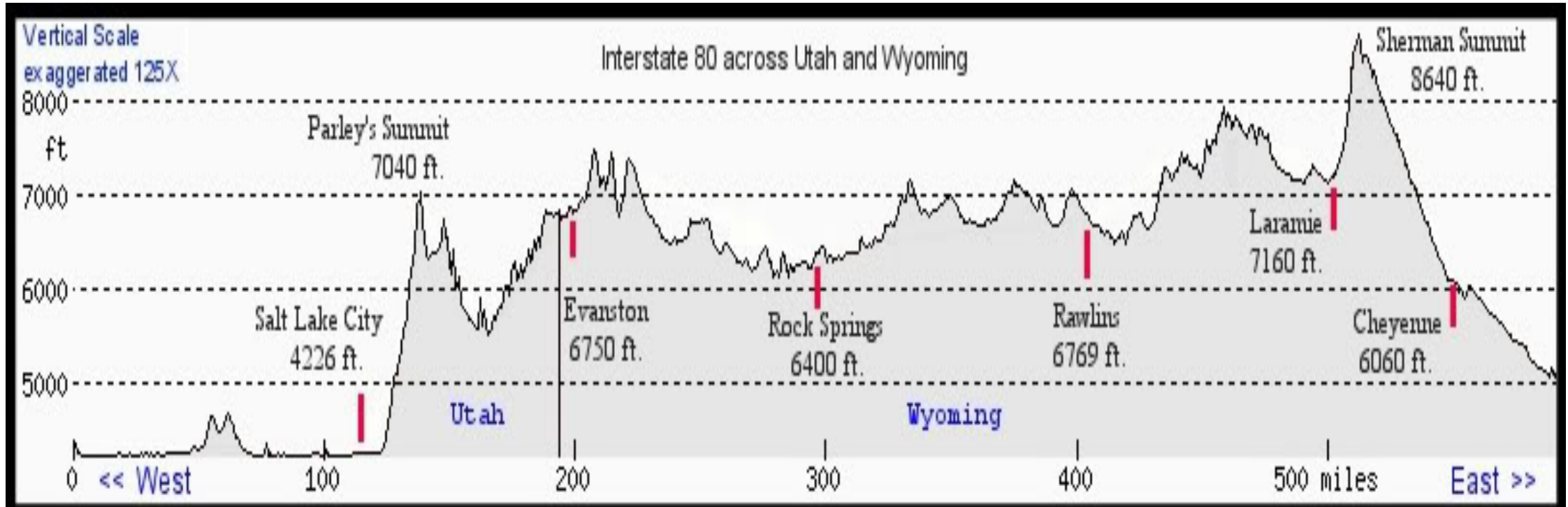
I-80 Corridor



- 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



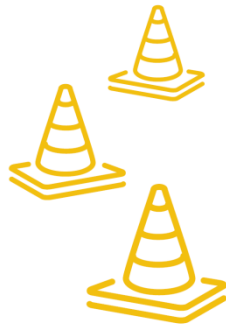
FORWARD
LOOKING



CV PILOT APPLICATIONS



**12V
SITUATIONAL
AWARENESS**



**WORK ZONE
WARNING**



**SPOT WEATHER
IMPACT
WARNING**



**DISTRESS
NOTIFICATION**



**FORWARD
COLLISION
WARNING**

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



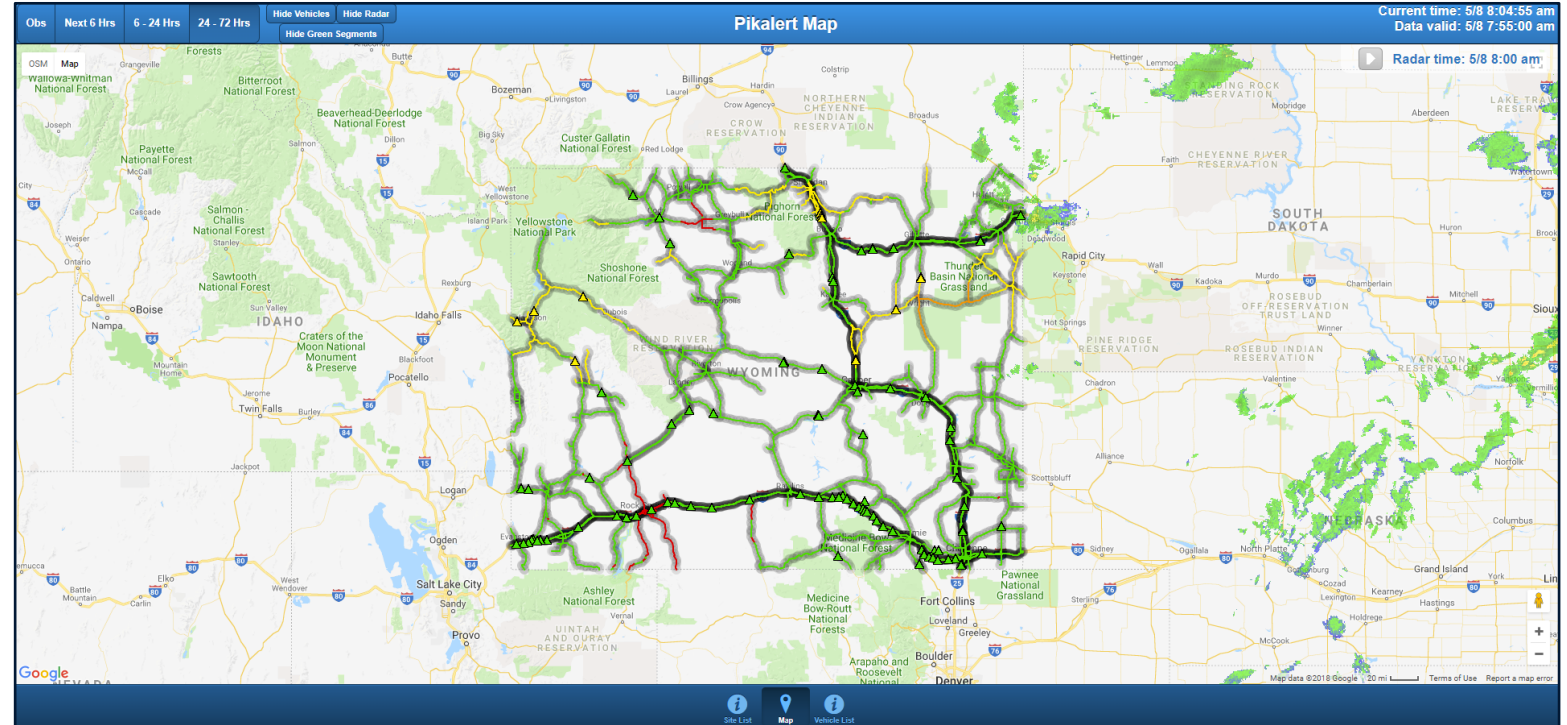
- CVOP Users (800 firms)
- Wyoming Trucking Association
- Third Party Intermediaries

Freight
Partners



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

WEATHERCLOUD-EQUIPPED

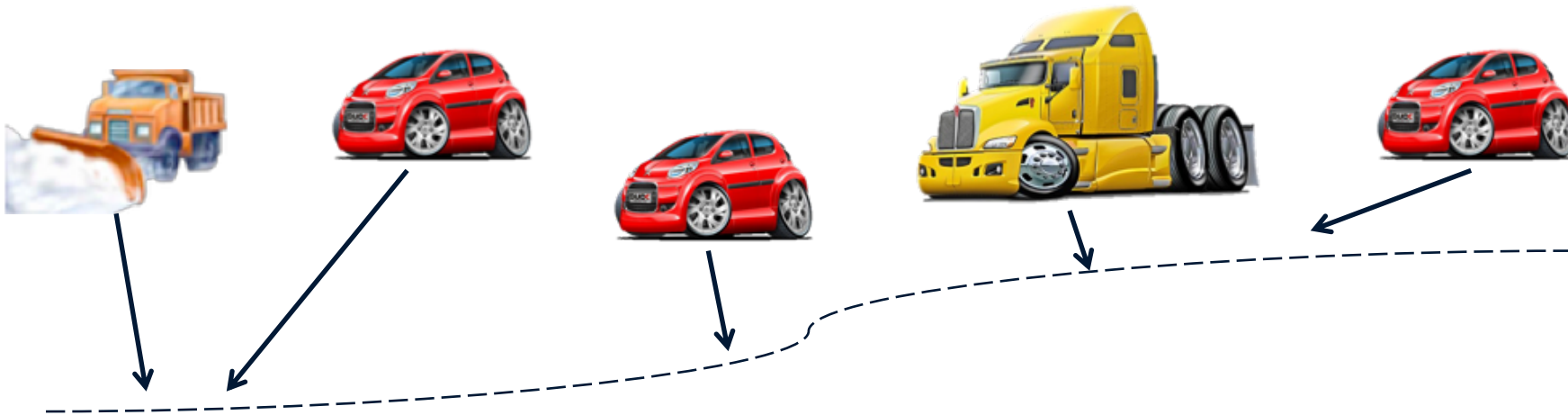
- Wiper Frequency
- GPS Coordinates/Timestamp
- Ground Temperature
- Ambient Temperature
- Barometric Pressure
- Relative Humidity

BASIC SAFETY MESSAGE

- GPS Coordinates/Timestamp
- Ambient Air Temperature
- Exterior Light
- Wiper Status and Rate
- Brake Status
- Coefficient of Friction
- ABS/Traction/Stability Control Status
- As Available

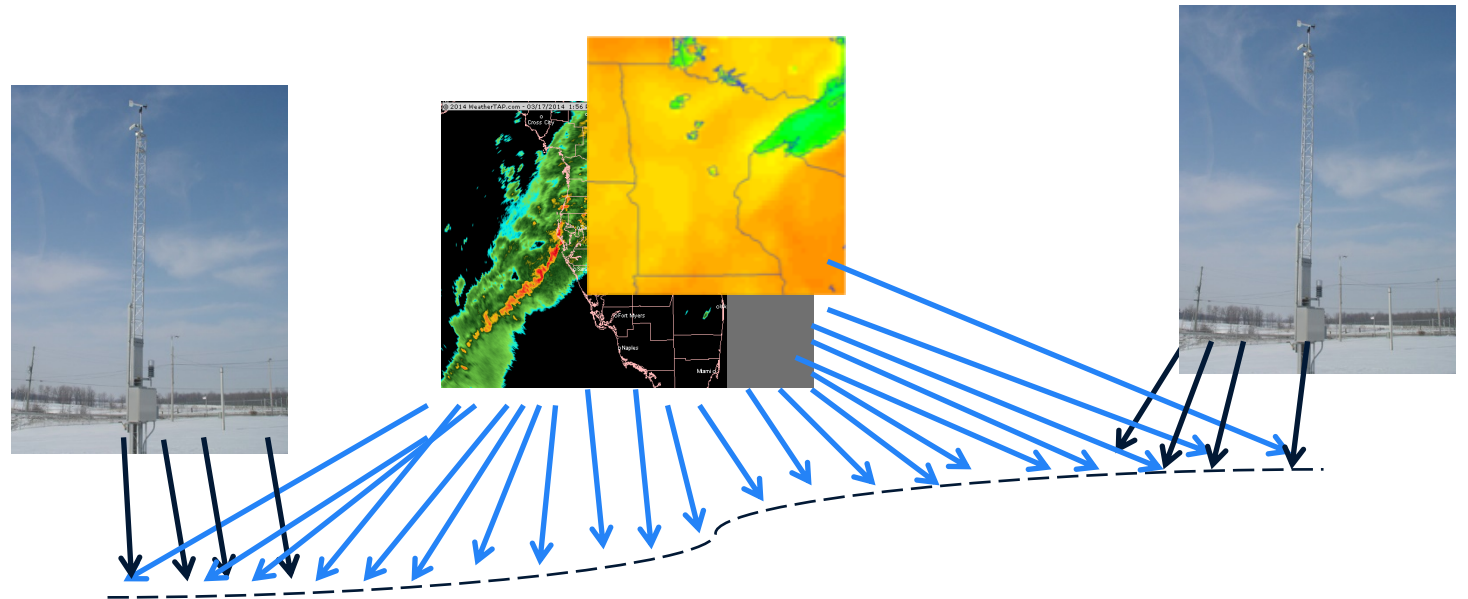
Vehicle Data Translator

- 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



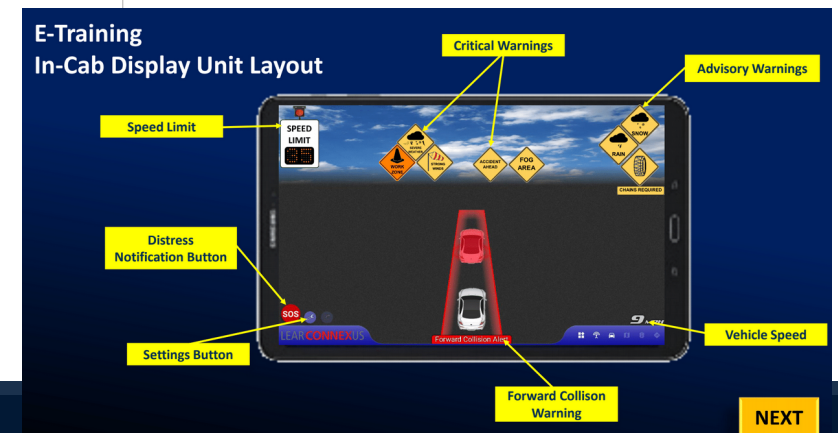
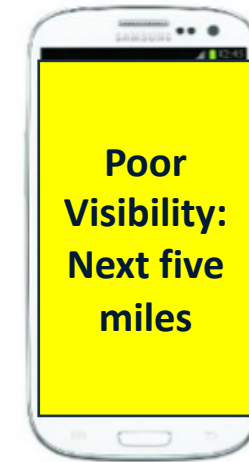
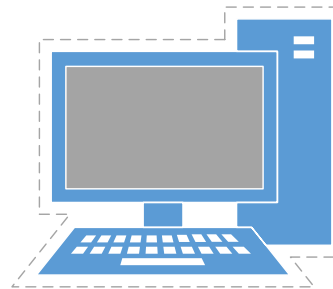
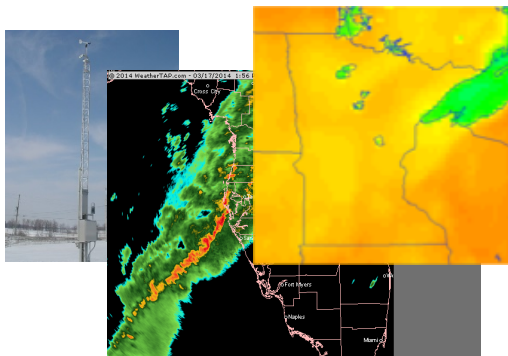
Vehicle Data Translator

- 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

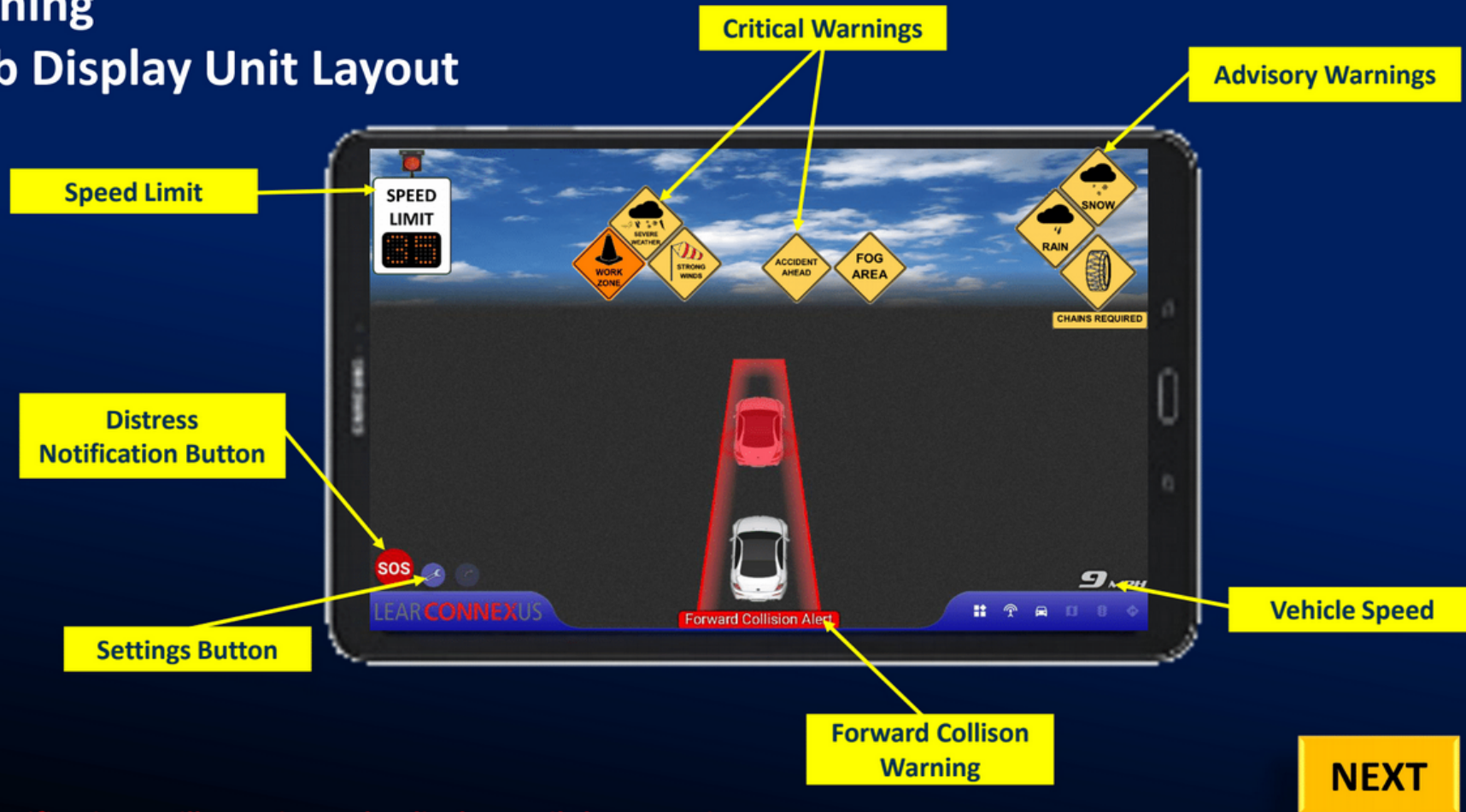
- Road segment statistics are used to assess for precipitation, pavement condition, visibility, and blowover hazards
- Assessments can run without mobile data, but are greatly enhanced by mobile observations



Note: The notifications will remain on the display until the event is over

Human-Machine Interface (HMI)

E-Training In-Cab Display Unit Layout



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

Precipitation

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

Pavement Condition



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

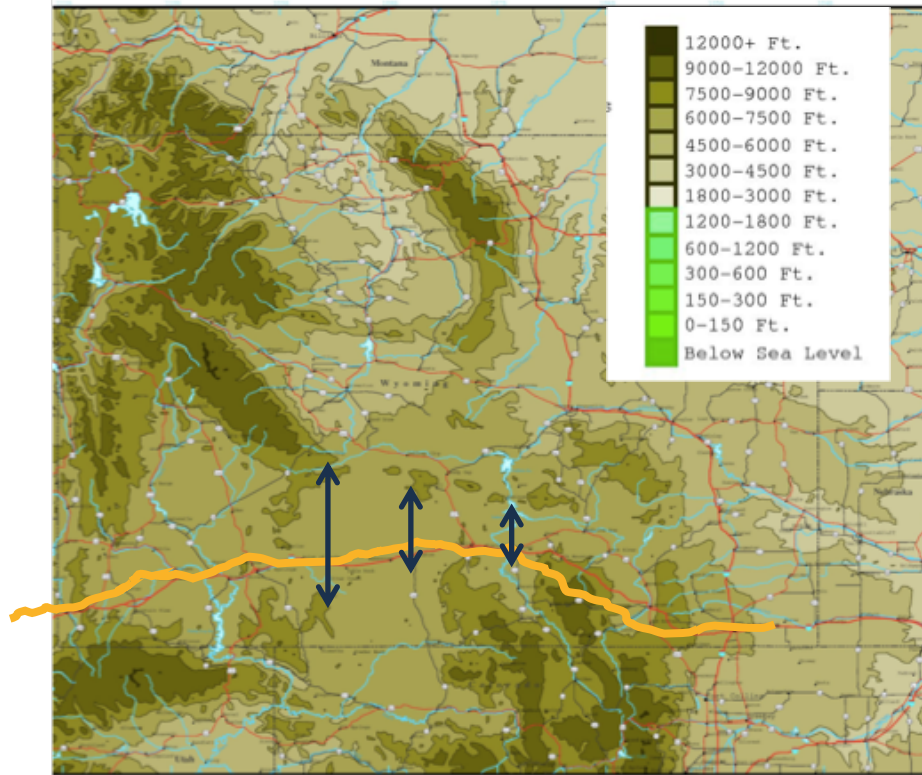
Visibility



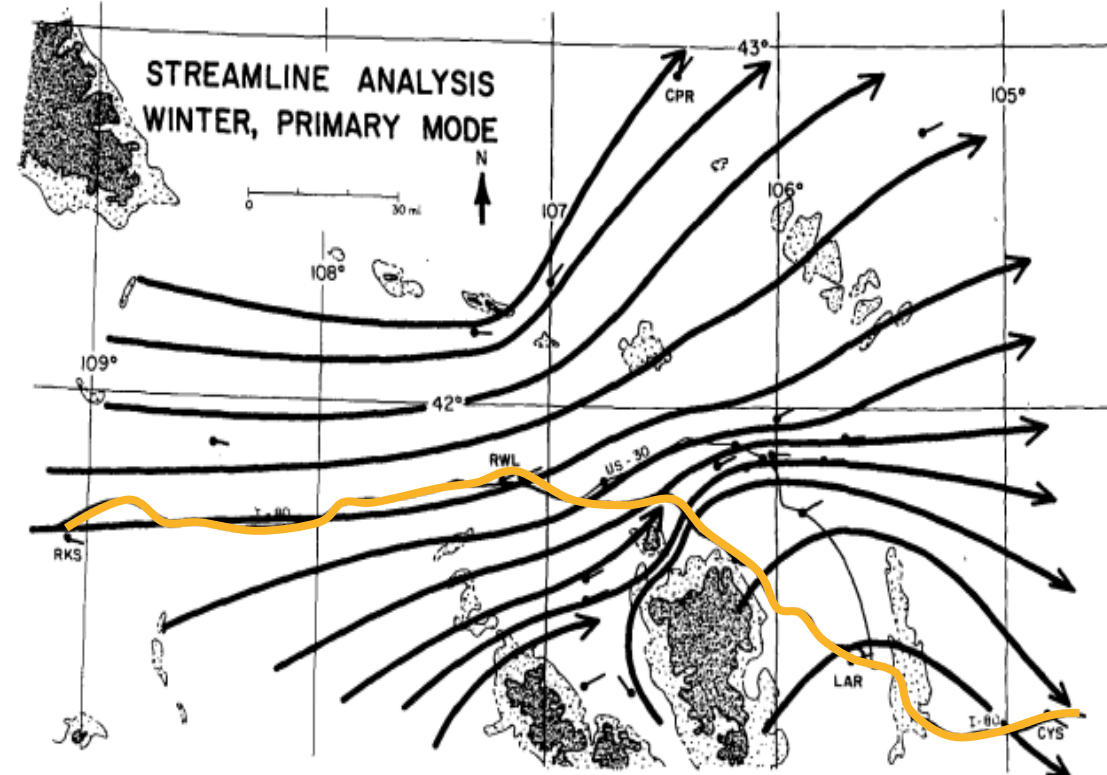
- Risk based on four vehicle types
 - High profile, heavy vehicles
 - High profile, light vehicles,
 - Pickups with attached trailers
 - Passenger Cars

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

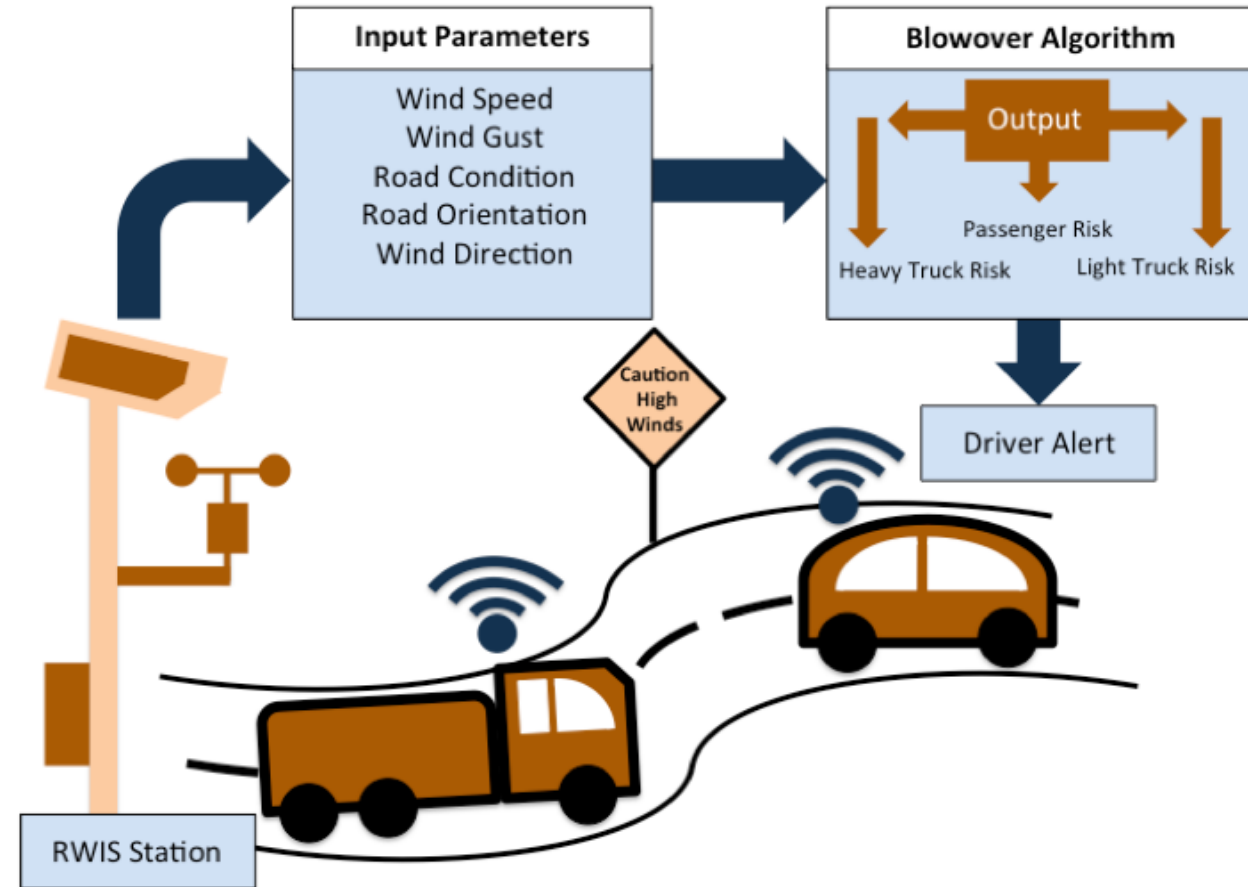
The Pikalert System and the Blower Algorithm

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

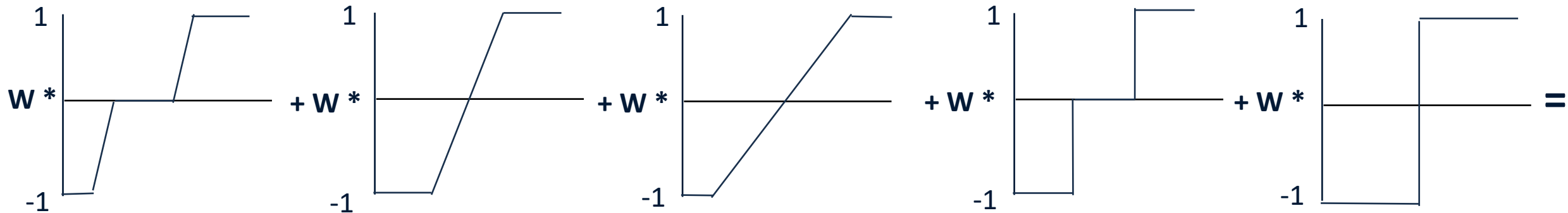
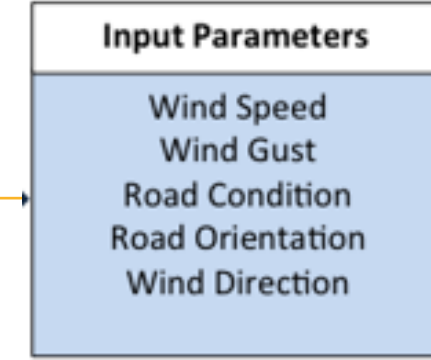


Source: Brittany Welch



Blowover Algorithm: Fuzzy Logic

Visual Representation of 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

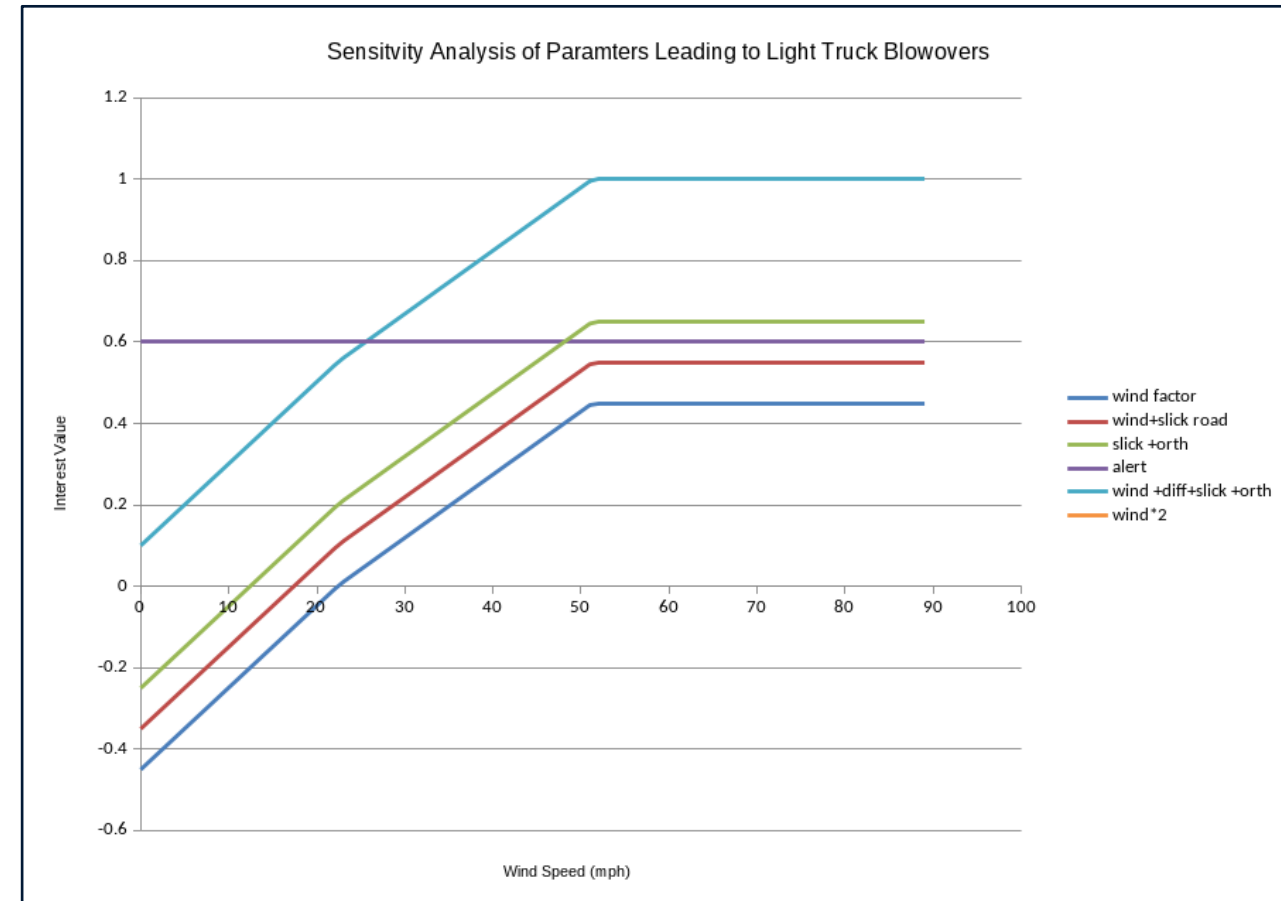
Refining the Algorithm – WYDOT Feedback

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.

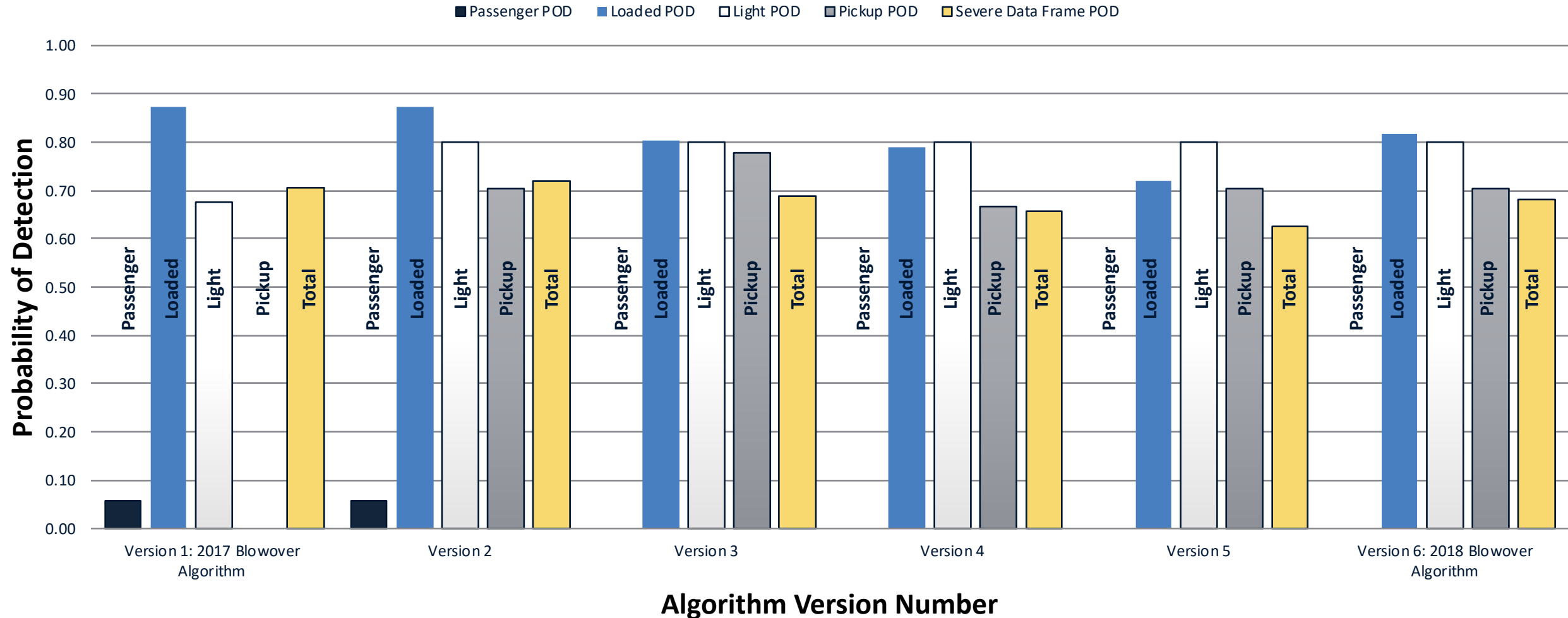
Methods of Refining the Algorithm

- 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

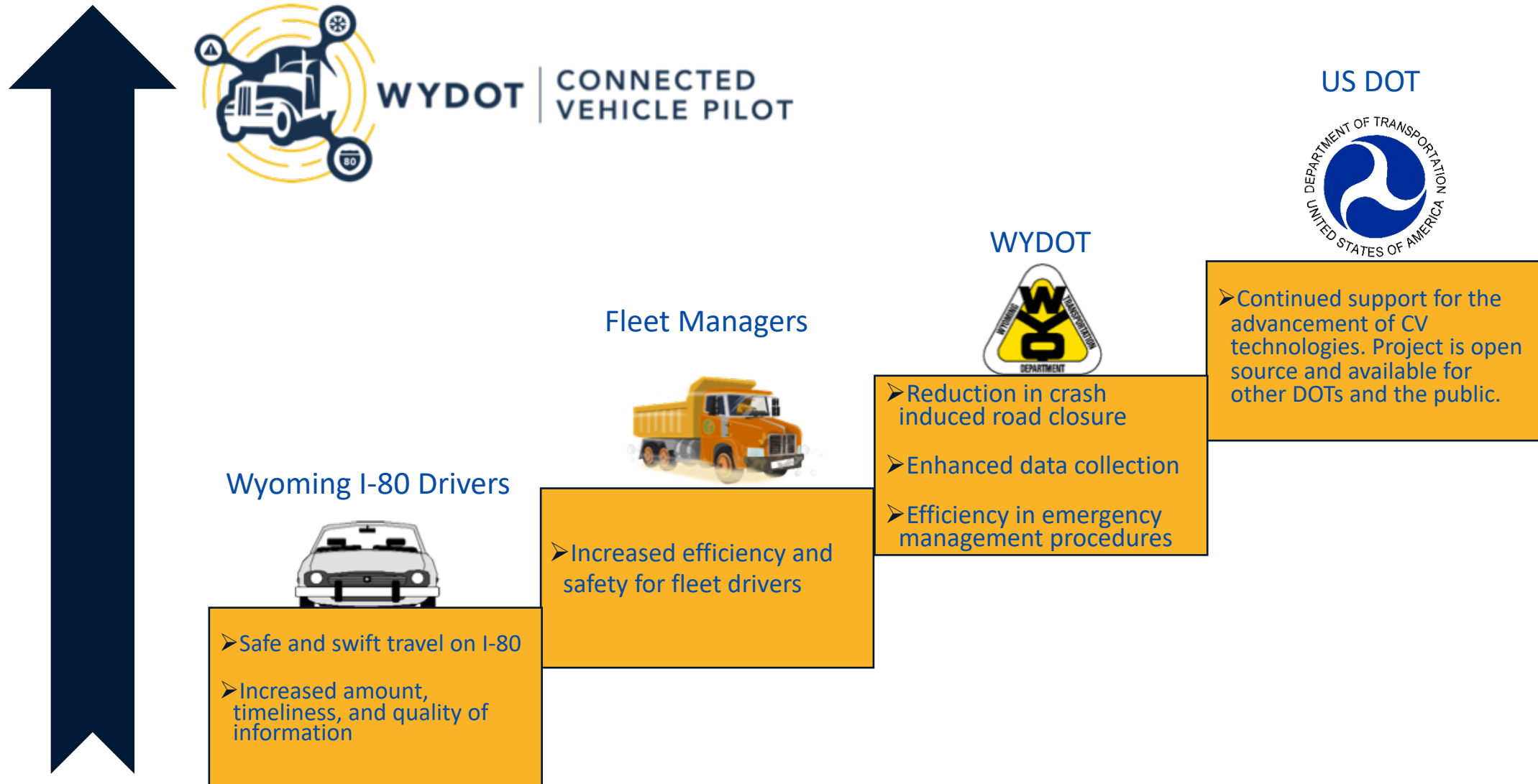


Results: Algorithm Adjustments

Probability of Detection for Differing Algorithm Versions



Pikalert: Real World Impact



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

email
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