Technology Implementations for Rural Road Safety Data Collection, Analysis & Visualization

Portia Shields, Assistant Manager, Yakama Nation
Kameron Greene, MBA, Channel Marketing Manager, AIWaysion

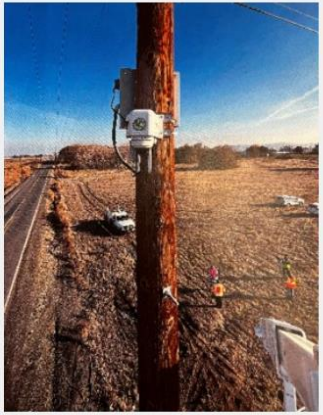
December 2023

FHWA Build a Better Mousetrap Awards

- 2023 Innovative Project Award
- 2023 Best All Around Award

Build a Better MOUSETRAP
National Recognition Program for Transportation Innovation

U.S. Department of Transportation
Federal Highway Administration



Innovative Project Award:

Confederated Tribes and Bands of the Yakama Nation for the Mobile Unit Sensing Traffic (MUST) Devices to improve rural road safety. For more information

https://www.fhwa.dot.gov/clas/babm/babm_winners.aspx#innovative

FHWA Build a Better Mousetrap Awards

2023

Build a Better MOUSETRAP

WINNERS

Without further ado,

Build a Better MOUSETRAP

Innovative Project Award

Confederated Tribes and Bands of the Yakama Nation

Innovation Solution: Mobile Unit Sensing Traffic (MUST) Devices.

mobile unit sensing
traffic (MUST) devices.

Build a Better MOUSETRAP

Innovative Project Award

- Monitors traffic and detects dangerous events
- Provides real-time warning messages
- Specifically designed for rural roads
- Supports traffic planning
- Offers a comprehensive approach to enhancing transportation and infrastructure within Tribal and rural communities.

specifically designed for rural roads.

Team Members

Yakama Nation DNR Engineering

- Portia Shields, Assistant Manager
- Dwayne Valentine, Tribal Transportation Program Engineering Lead

University of Washington (UW) STAR Lab

- Dr. Yinhai Wang, Professor
  - Director, Northwestern Tribal Technical Assistance Program (NWTTAP)
  - Director, Pacific Northwest Transportation Consortium (PacTrans)
- HollyAnna Littlebull, Assistant Director of NWTTAP
- Ollie Wiesner, Research Assistant

AIWaysion (UW Spin-Off)

- Dr. Wei Sun, Chief Executive Officer
- Kameron Greene, Channel Marketing Manager
- Dr. Hung-Min Hsu, Senior Research Scientist
- George Ma, Software Development Engineer

Results Sharing & Peer Exchange

- ❑ 2023 NTICC
- ❑ 2023 ITE Annual Meeting
- ❑ 2023 BIA NWR Tribal Transportation Symposium
- ❑ 2023 ITS America Conference & Expo
- ❑ Yakama Nation Traffic Safety Committee Meetings
- ❑ 2021 Highway Safety Information System (HSIS) Annual Liaison Meeting
- ❑ 2022 TRB Annual Meeting
- ❑ 2022 ITA Annual Meeting

2023 NTICC

TRB TRANSPORTATION RESEARCH BOARD

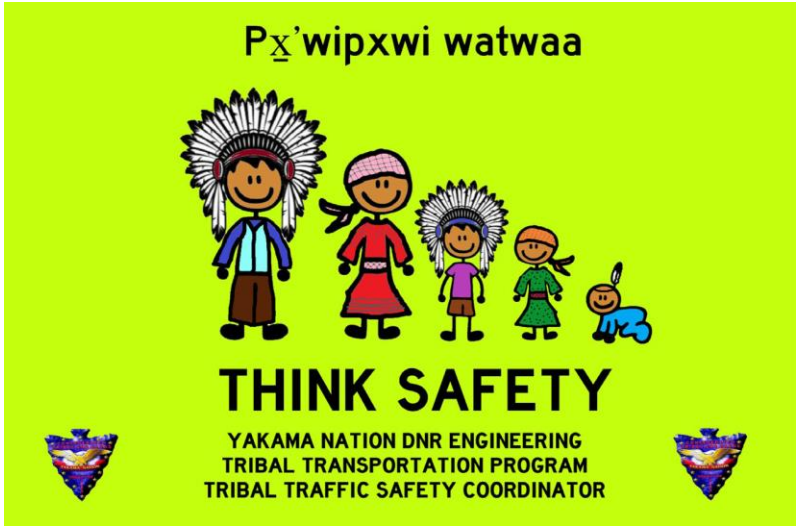
HSIS HIGHWAY SAFETY INFORMATION SYSTEM

2023 NTICC SEPTEMBER 24 - 28 ANCHORAGE ALASKA

Yakama Nation

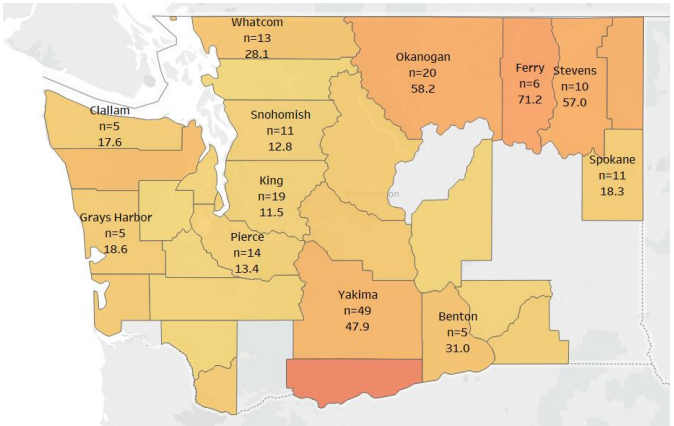
Confederated Tribes and Bands of the Yakama Nation

- Federally recognized tribe in Washington state
- Over one million acres, 1,200 miles of public roads, most are in rural areas

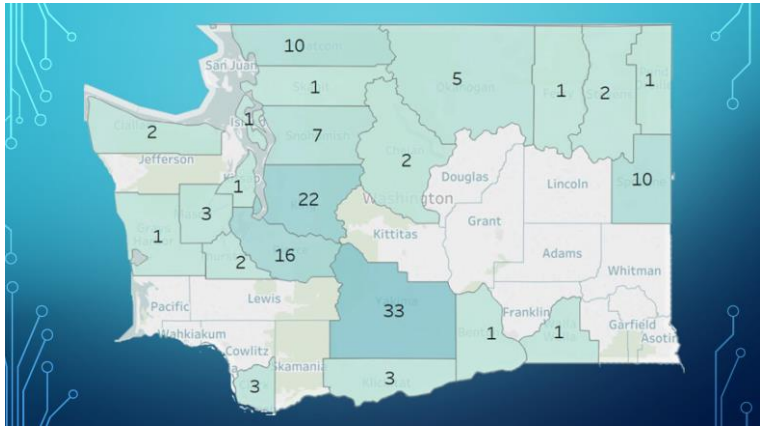


Prevailing Safety Issues

Yakima County has the **highest rates of motor vehicle and pedestrian fatalities** for Native American and Alaskan Native (NA/AN) Populations in Washington



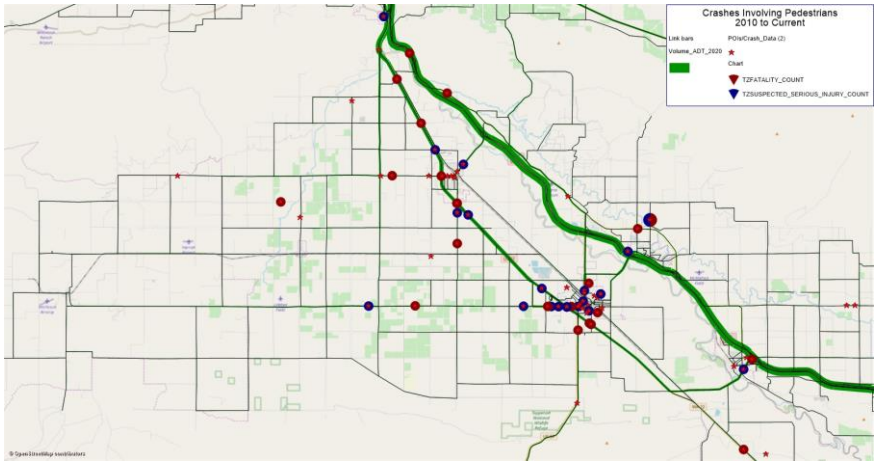
AI/AN Motor Vehicle Fatality Counts and Rates per 100,000 Population by County of Residence, 2011-2016. (Source: Washington State death certificates linked to the Northwest Tribal Registry to identify AI/AN race)



Count of AI/AN pedestrians killed by motor vehicles by residential county of descendent. Yakima County: 33 in Yakima County as opposed to 91 total in Washington State. (Data source: Washington State death certificates linked to the NW Tribal Registry, 1999-2016.)

Prevailing Safety Issues

A large portion of these collisions occur on the **Yakama Nation reservation and ceded territory**



Prevailing Safety Issues

- Roadway geometry
  - Rural roads with sharp corners, steep grades, and often inadequate shoulders and lack of ped/bike facilities, lack of signs, pavement markings, and traffic control devices.
- Adverse weather conditions
  - Heavy fog/low visibility, snow and ice-covered roads, wildfires, etc.
- Human behavior
  - Speeding, not wearing a seat belt, driving under the influence, distracted driving, failed to stop at stop signs, etc.
  - Illegal crossing, walking on highway, etc.

US 97 Corridor

US 97 – Toppenish to Union Gap - Corridor

- A history of severe and fatal collisions
- Over the last 10 years: 350 serious injury crashes and 22 fatal crashes

US 97 CRASH HISTORY

2001 - 2021

	Lateral A	2nd Avenue	Jones Road	W. Wapato Road	S. Wapato Road	McDonald Becker	Buster	Fort Road	SR 22	Larue Road	SR 22 SR 223
Fatalities	1	1	3	3	2	2	1	2	2	7	0
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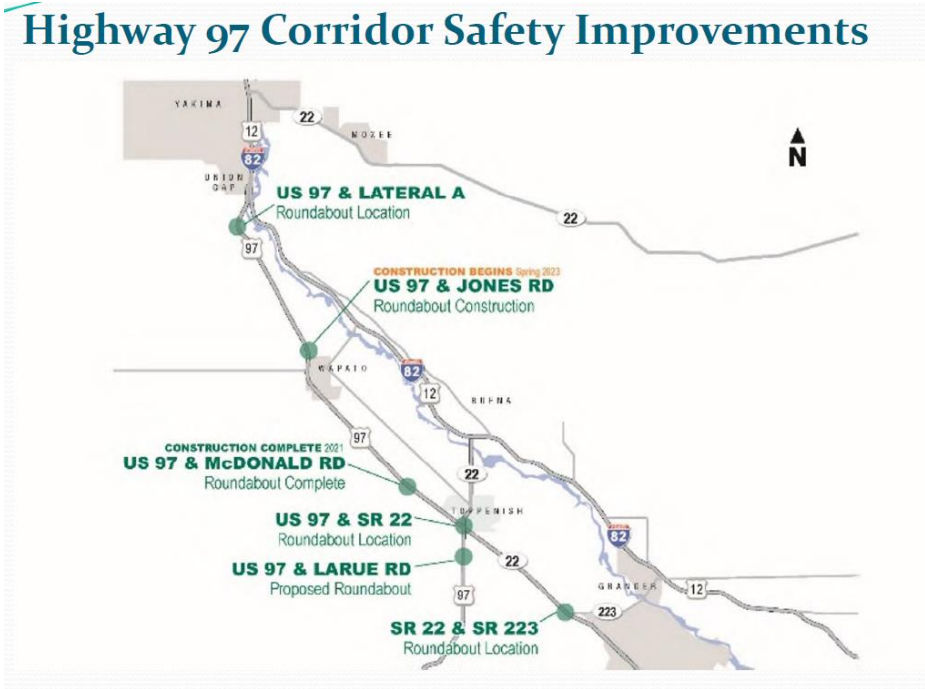
Collisions	89	36	52	163	58	59	29	113	101	33	24

US 97 Corridor

US 97 – Toppenish to Union Gap - Corridor

- In the last 3 years, with approximately $10 million federal and state funding, WSDOT has constructed one roundabout on US 97 at McDonald Road & Becker Road and planning on another roundabout on US 97 at Jones Road.



Rural road safety projects

Safety Data Tool

- Comprehensive Roadway Safety Data Visualization and Evaluation Platform for Yakama Nation
  - USDOT Safety Data Initiative
  - Development of a web-based comprehensive roadway safety tool
  - Establish access and better management of multi-source traffic safety related data

Edge AI Sensing Technology

- Edge Computing and Sensor Fusion System for Comprehensive Monitoring of Traffic and Road Conditions
  - FY23 USDOT Small Business Innovation Research (SBIR) Phase I Project
  - Monitor traffic and road conditions
  - Real-time detection of hazardous events and warning

SBIR
America's Seed Fund
POWERED BY DOT

Comprehensive Roadway Safety Data Visualization Evaluation Platform - USDOT Safety Data Initiative

Objectives

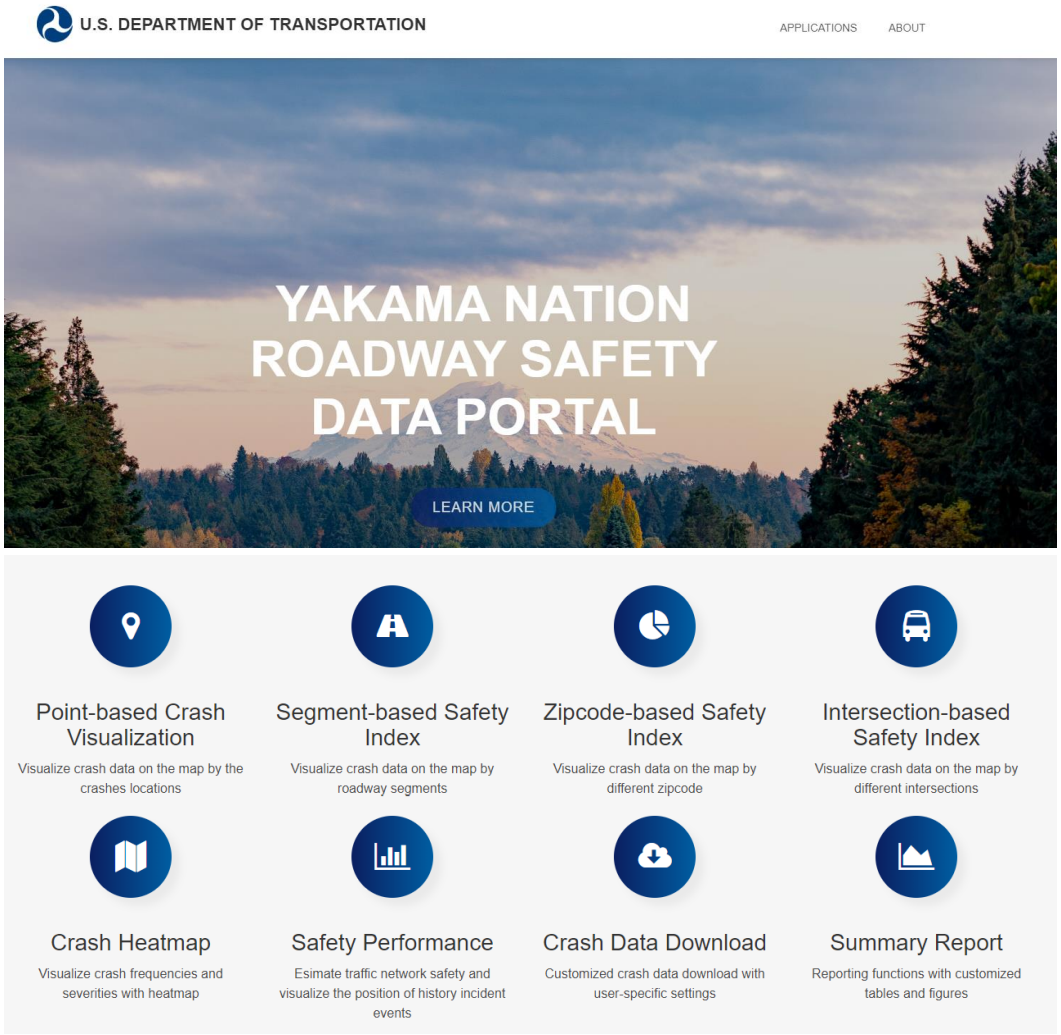
- Address the traffic safety issues through the development of a web-based comprehensive roadway safety tool
- Establish access and better management of multi-source traffic safety related data, both the public available state and county data and local datasets
- Target users: traffic planners and engineers of Yakama Nation DNR Engineering

United State Department of Transportation

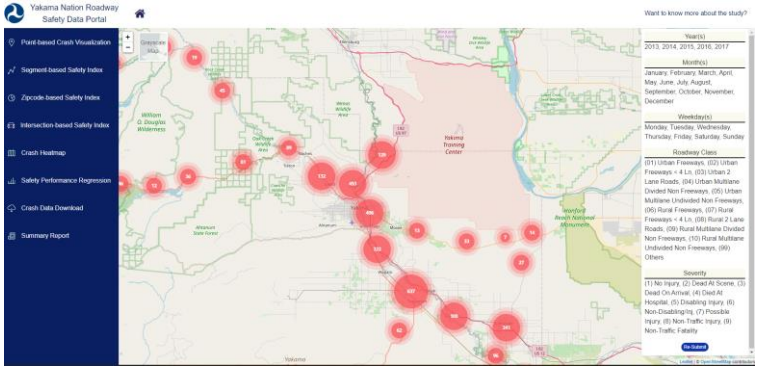
- Paul Teicher, Senior Policy Analyst
- Tom Bragan, Traffic Records Division, NHTSA

Yakama Nation Safety Data Portal

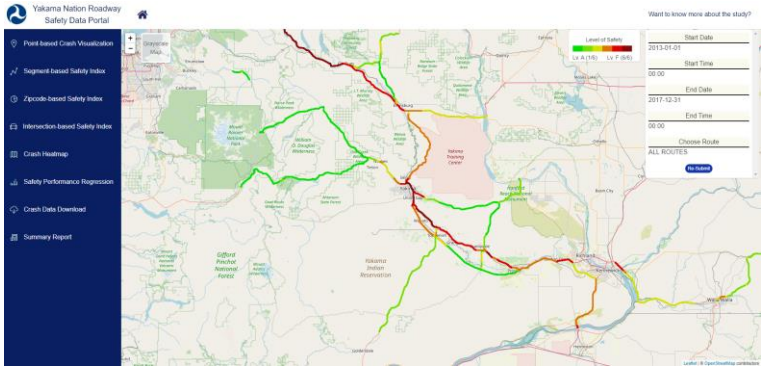
- GitHub repository: (https://github.com/AI-Group-STAR-Lab-UW/yakama-nation-roadway-safety-data-portal)
- Training to Yakama Nation Employees on “Safety Data Collection, Management, and Analytics Technologies”
  - May 19th, 2022 at the UW STAR Lab



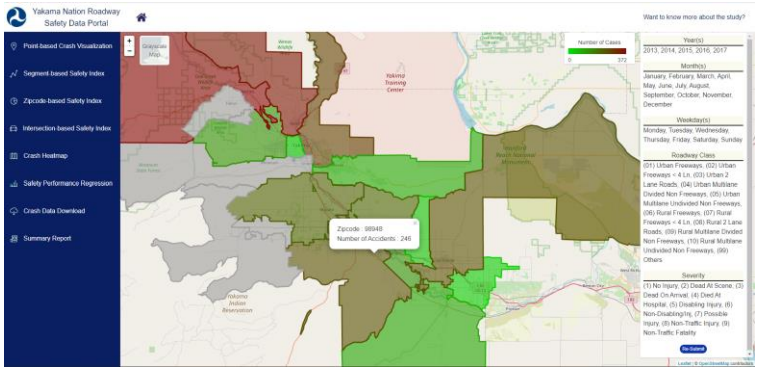
Yakama Nation Safety Data Portal



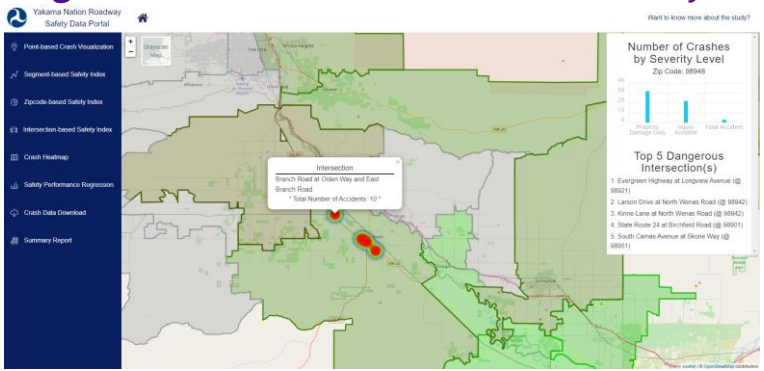
Point-Based Crash Visualization



Segment-Based Crash Visualization & Safety Performance



Area-Based Crash Visualization



Intersection-Based Crash Visualization

Lack of Data in Rural Roads

- Lack of funding and infrastructure support for deploying conventional data collection equipment
  - Limited internet connection
  - Low-volume rural roads
- Lack the technical personnel and technologies
  - To manage, visualize, and analyze the data collected
- Specific data collection needs
  - For example, agricultural vehicles, heavy fog/low visibility, animals, wildfires, etc.
- Tribal sovereignty and privacy over the data collected
  - Data processing within the device, protecting the privacy of communities
  - Data owned by tribe, and tribe should have control over how the data is used, shared, and stored.

AIWaysion

- University of Washington Spin-Off
- USDOT Small Business Innovation Research (SBIR) Awards
  - FY 2023 Phase 1 Funded on “Edge Computing and Sensor Fusion System for Comprehensive Monitoring of Traffic and Road Conditions”
  - FY 2022 Phase 1 & 2 Funded on “Edge Server-Based AI Application for Dilemma Zone and Traffic Conflict Events Detection”

Mobile Unit for Sensing Traffic (MUST)

Computer Vision

MAC Address Detection

Environmental Sensing

Sensor Fusion

Artificial Intelligence

Edge Computing

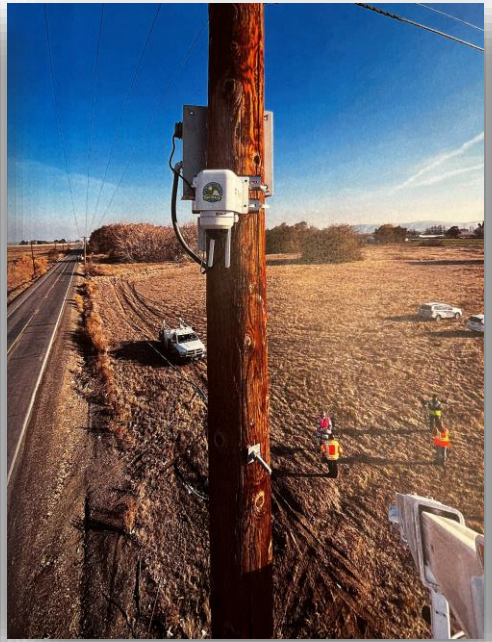
Communication & Control

Perception & Computing & Communication All-In-One Unit

AIWAYSION

Easy Installation Plug-and-Play

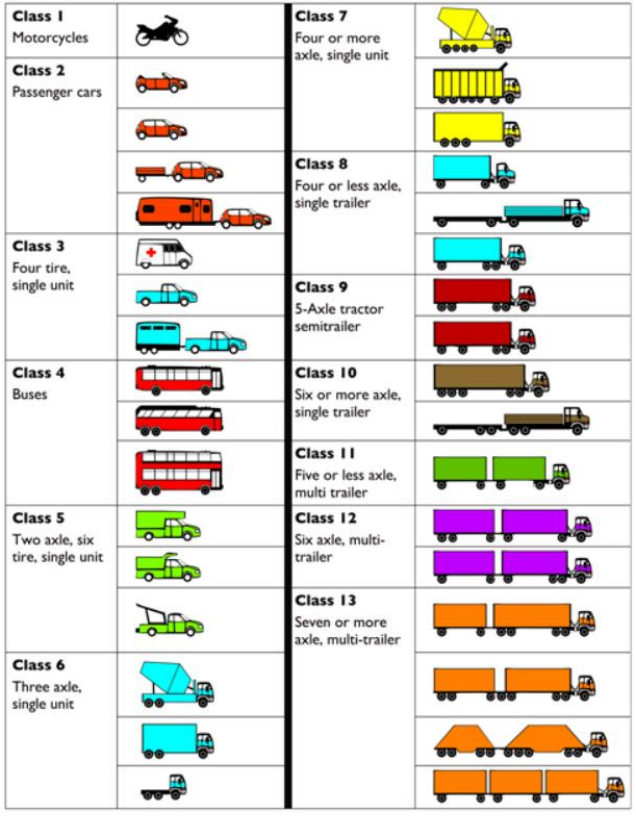
Bellevue, WA



Toppenish, Yakama Nation

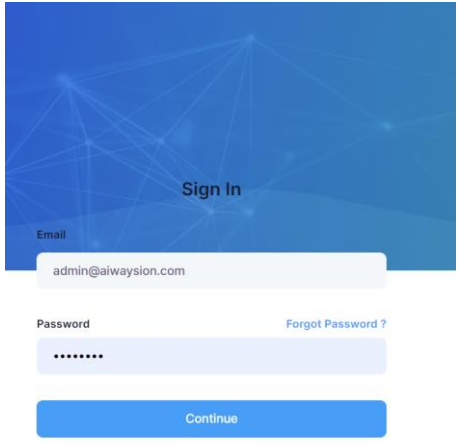
Lynnwood, WA

Data Collection: FHWA 13-Class

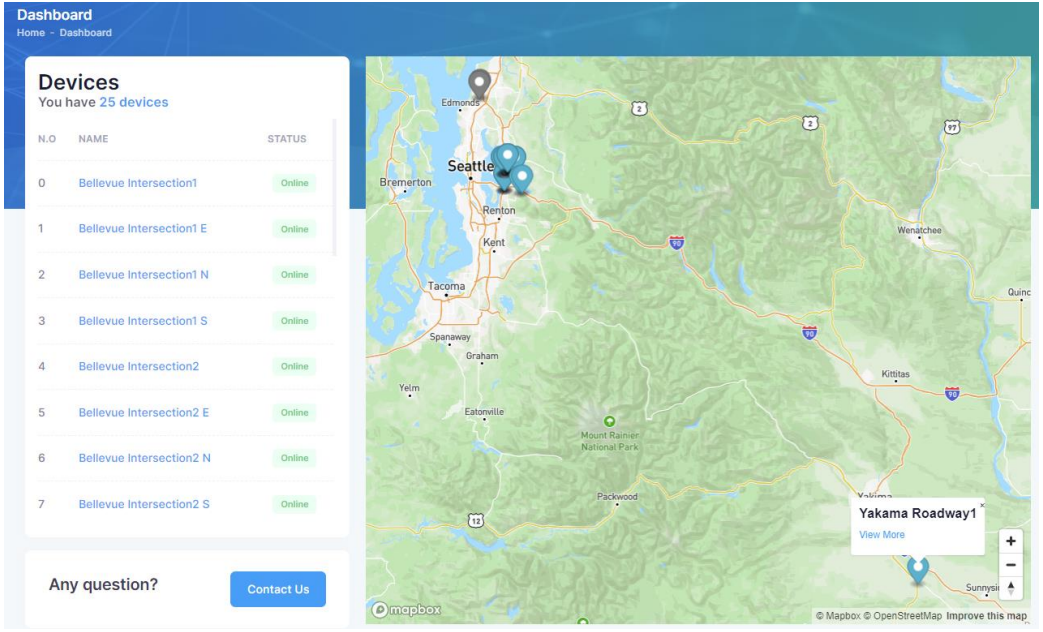


Software: Dashboard

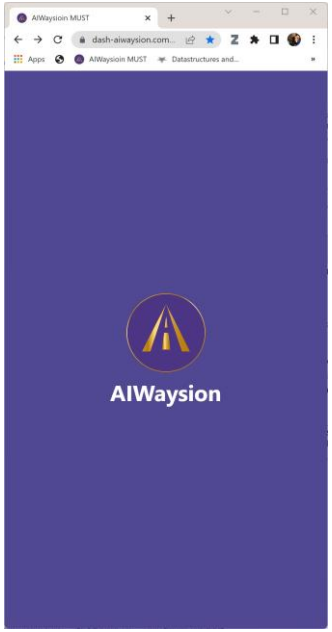
Device Management



Login



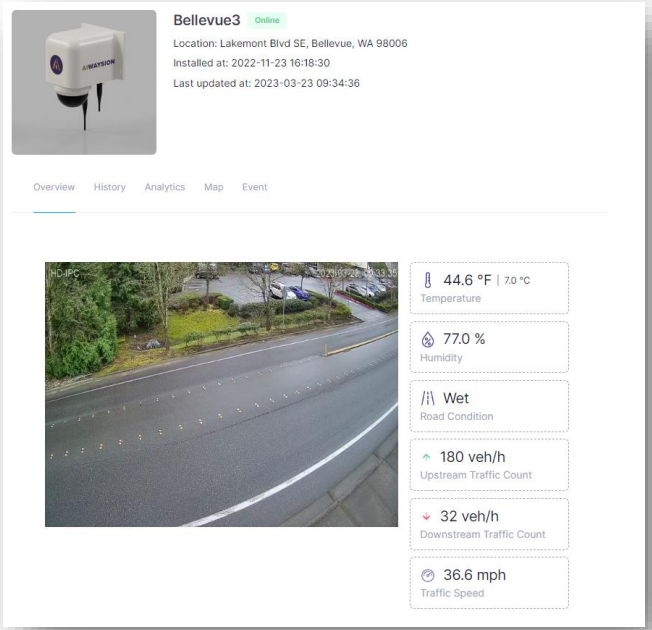
Device list & map



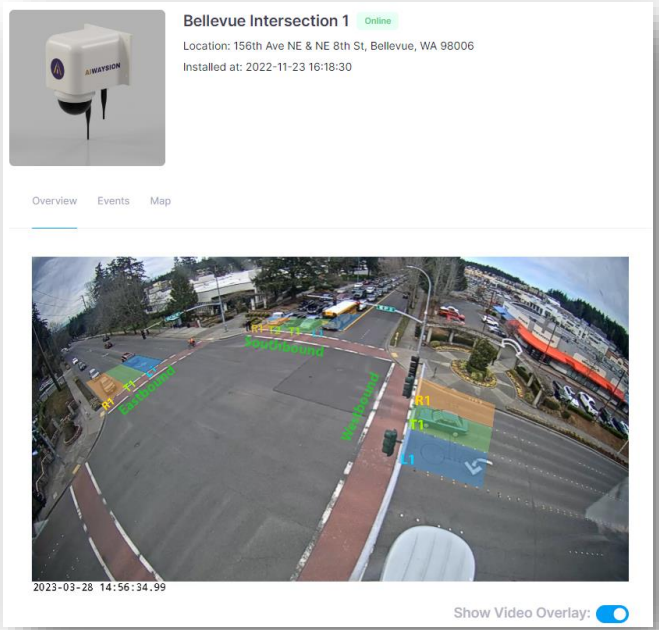
Mobile APP

Software: Dashboard

Data Management, Visualization & Insights



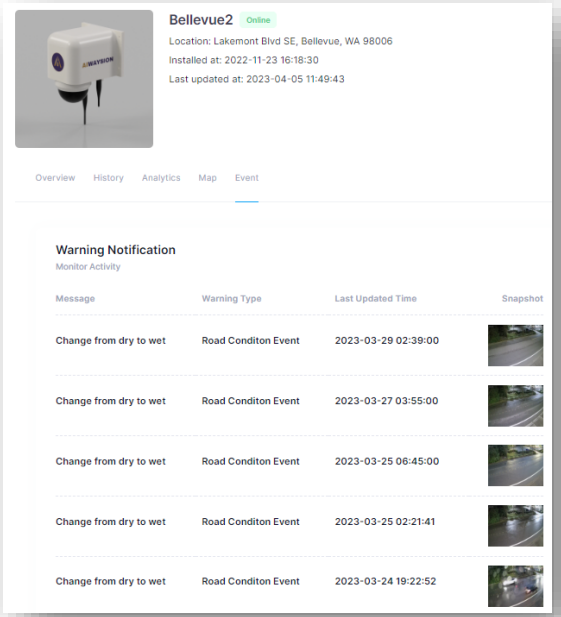
Road



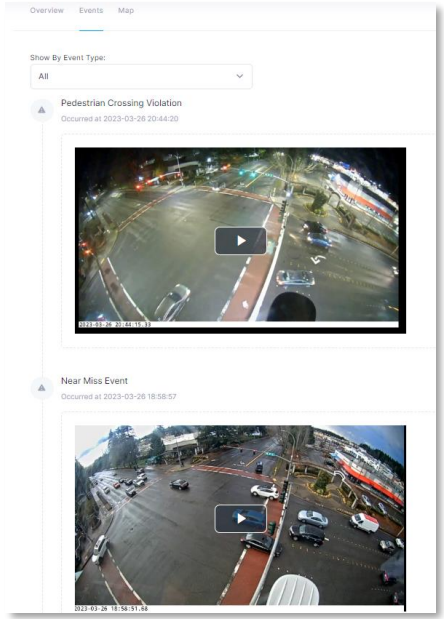
Intersection

Software: Dashboard

Hazardous Events Detection with Snapshots/Video Clips



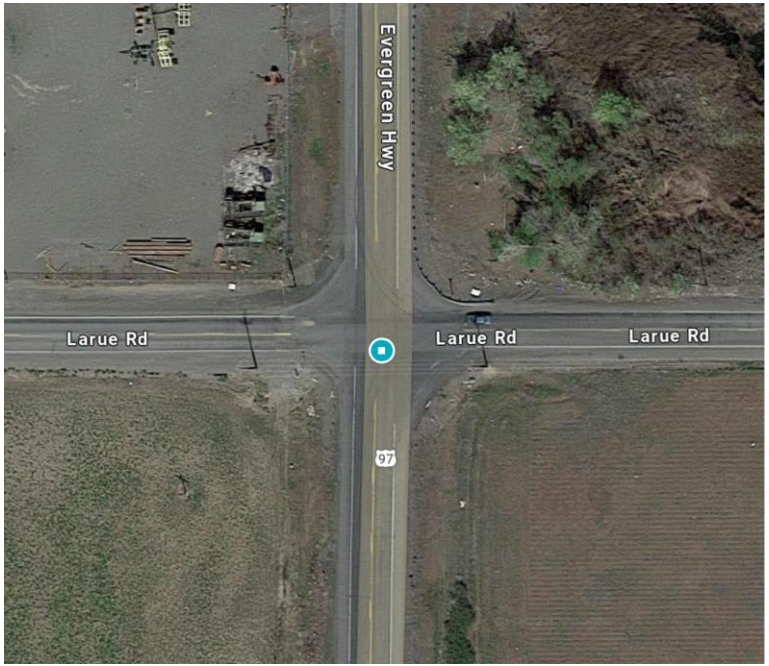
Snapshots



Video clips

Hazardous events (collision/near-miss, speeding, adverse weather and road surface conditions, dilemma zone, wrong way, lane compliance, illegal crossing, pothole, debris, crack, etc.)

Larue Rd & Hwy 97 Intersection



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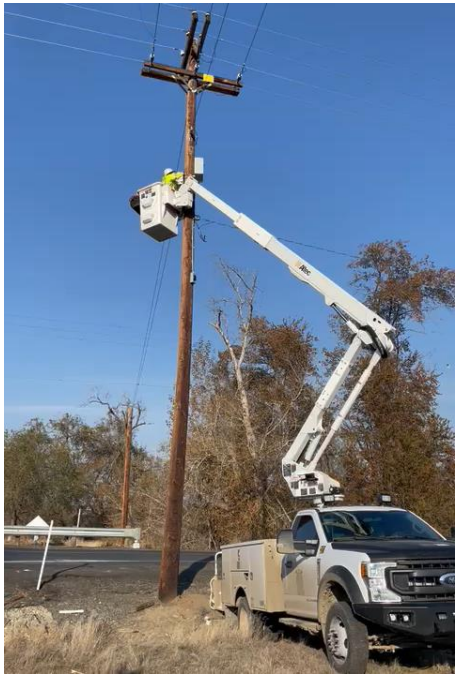
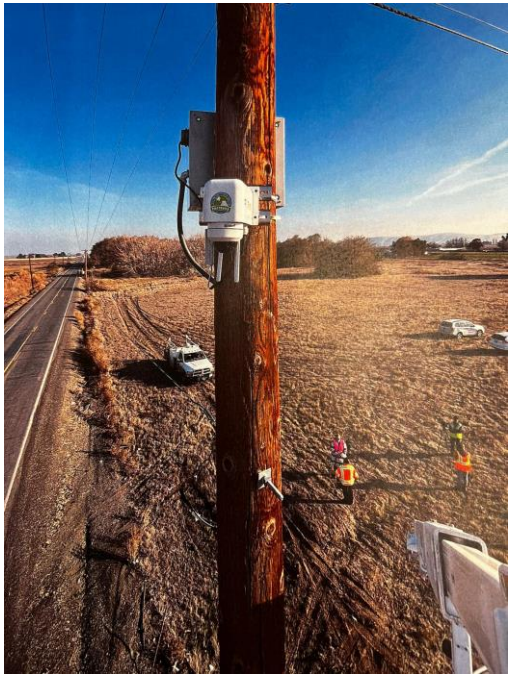
Larue Rd and Highway 97, Toppenish, Yakama Nation

Smart Roadside Device Installation

Mobile Unit for Sensing Traffic (MUST)

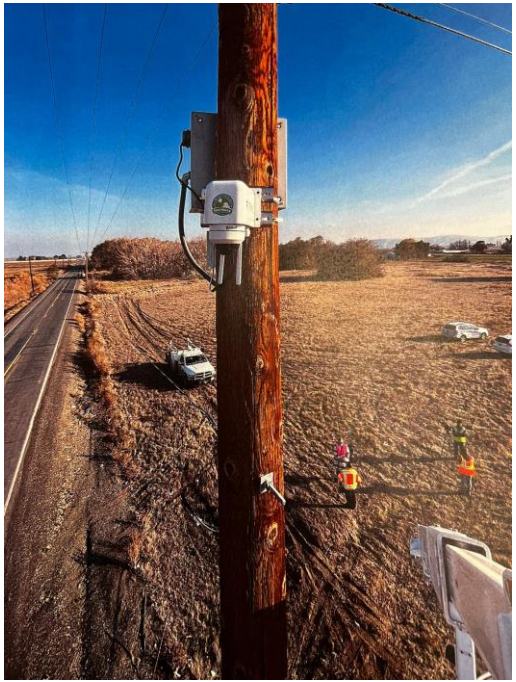




Larue Rd and Highway 97, Toppenish, Yakama Nation

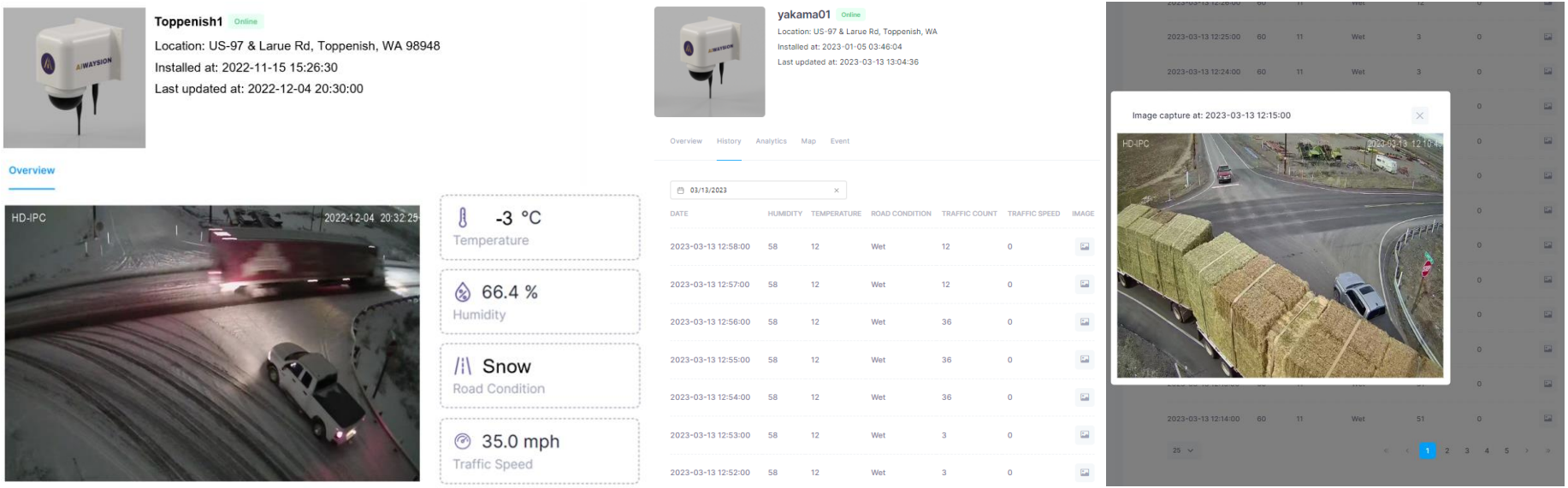
Highway 97 Corridor Safety Improvement

- **Monitor** traffic, vulnerable road users (pedestrian, cyclists), roadway surface conditions (e.g., snow, ice, wet, and dry), environmental conditions (temperature and humidity), visibility conditions, etc.
- **Detect hazardous events** such as stopped vehicles, speeding, heavy fog/low visibility, adverse roadway surface conditions, collision, etc.
- **Communicate** with TMC or traffic control devices (e.g., variable message signs) for real-time countermeasures.



Traffic and Road Conditions Monitoring

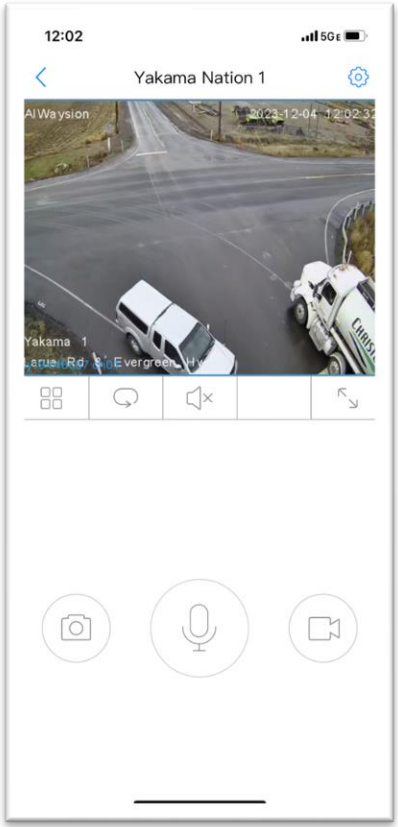
Web dashboard



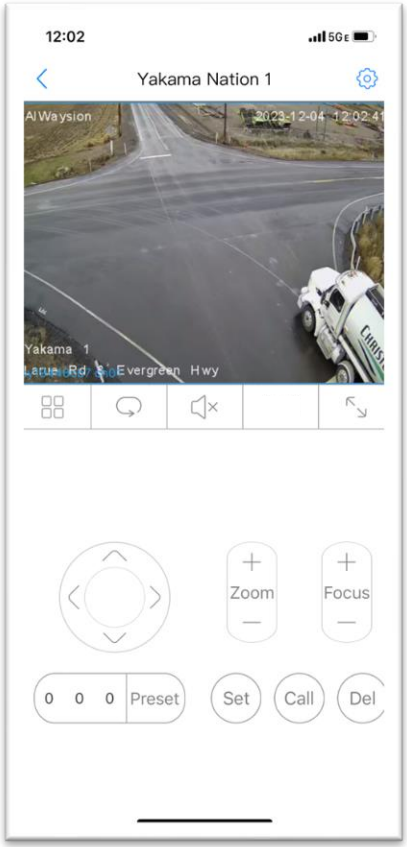
Traffic and Road Conditions Monitoring

Mobile App

- Real-Time Monitoring
- Screenshot
- Video recording



- Pan
- Tilt
- Zoom



Safety Data Collection & Analysis

- Movements of semi-trucks, agricultural vehicles

Safety Data Collection & Analysis

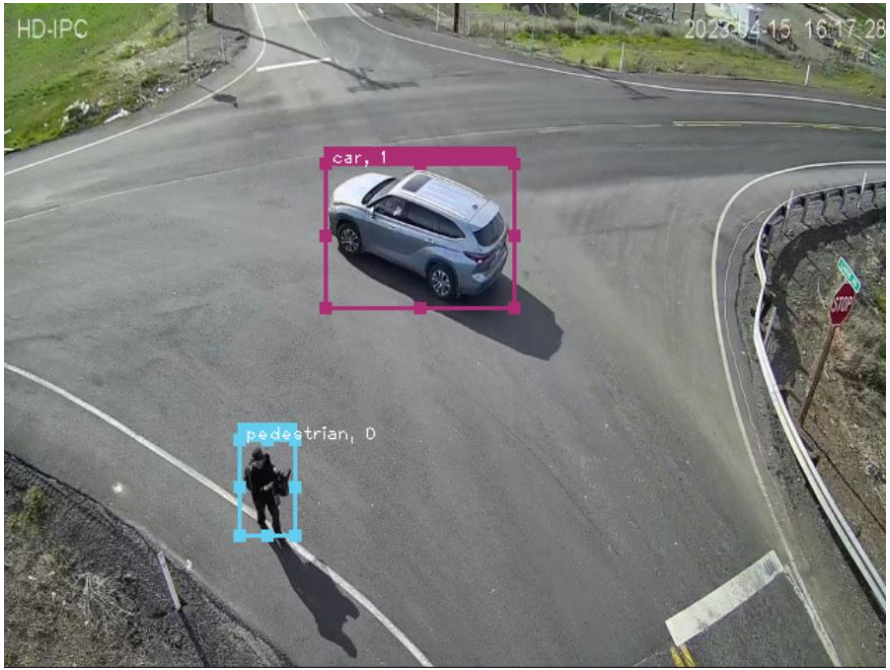
- Movements of semi-trucks, agricultural vehicles

Safety Data Collection & Analysis

- Interactions (collision/near-miss events)

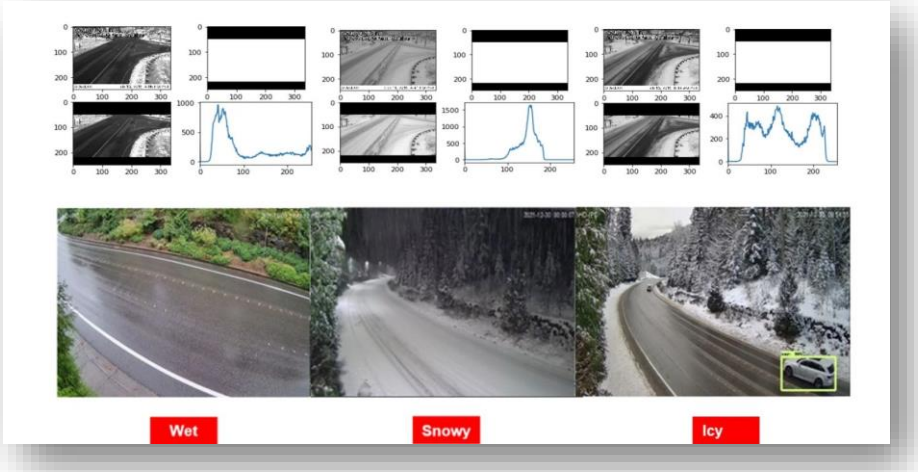
Safety Data Collection & Analysis

- Pedestrian safety (near-miss events)



Roadway Conditions Monitoring

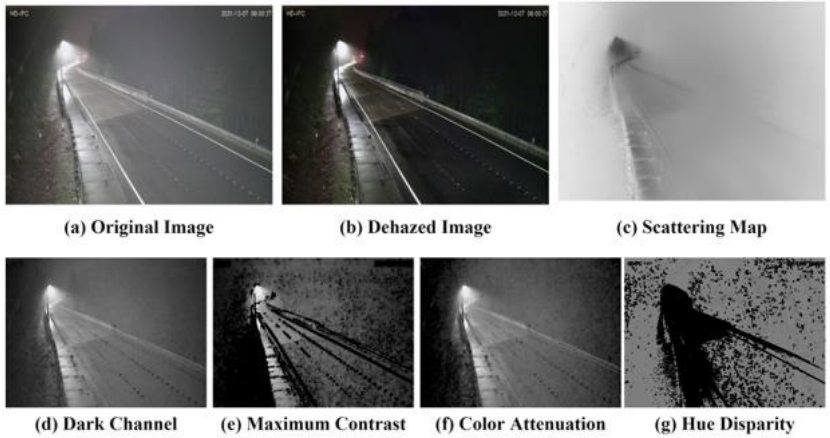
Road Surface Conditions (Snow, Ice, Wet, Dry)



Sensor-fusion ML algorithm with 95% accuracy in detecting road surface conditions

Visibility Conditions Monitoring

Heavy Fog/Visibility Conditions



Visibility \ Threshold	$\pm 5\%$	$\pm 10\%$	$\pm 20\%$
$V_s < 500$ m	85.29%	89.14%	93.18%
$500\text{m} \leq V_s < 1000$ m	88.17%	90.25%	95.42%
$1000\text{m} \leq V_s < 2000$ m	90.36%	93.22%	97.03%
$V_s \geq 2000$ m	91.23%	95.78%	98.75%
Overall	89.27%	92.15%	96.61%

Real-time visibility estimation based on computer vision (i.e., dark channel prior)

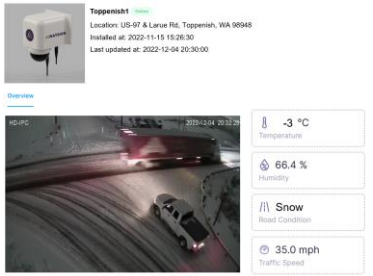
Safety Data Collection & Analysis

- Heavy fog/low visibility, road surface conditions, visibility/fog, wildfire
- Human behaviors: speeding, illegal crossing, fail to stop at stop sign

Snow and ice-covered road surface conditions

Information Dissemination

- Cellular communication
  - Road users: mobile APP/text messages via Mobile App
  - Traffic management center (TMC): web dashboard
- Connected traffic control system
  - Variable message signs
  - Variable speed limits
  - Adaptive traffic-responsive streetlights
  - Smart work zone
  - Adaptive signal control



Next Step: Corridor Safety Enhanceme

US 97 – Toppenish to Union Gap – Corridor

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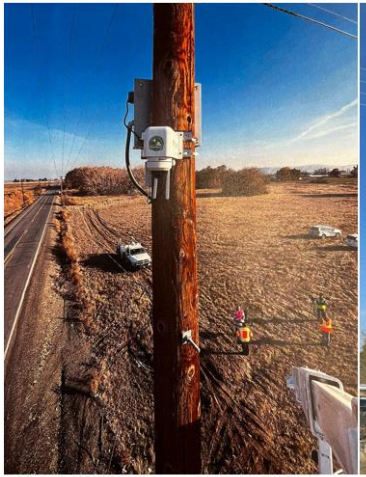
US 97 Corridor Safety Enhancement

Strengthening Mobility and Revolutionizing Transportation (SMART) Grant

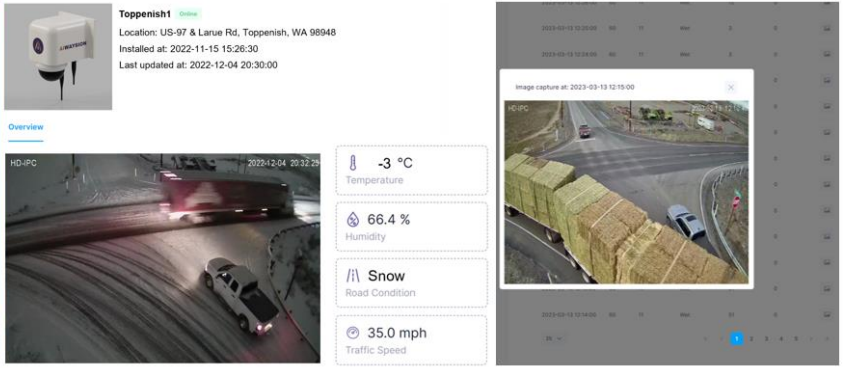
- Deployment of the Cost-Effective Sensing and Alerting System for roadway and intersection safety improvement;
- Conduct safety data analysis to identify high-risk locations and contributing factors; and
- Update Yakama Nation's existing Safety Management Plan.

US 97 – Toppenish to Union Gap - Corridor

US 97 Corridor Safety Enhancement



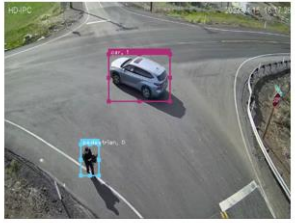
Edge AI Device for Traffic & Road Conditions Monitoring and Hazardous Events Detection



Road Safety Information System

Trucks & Tractors

Road Conditions



Pedestrian Safety

Private 5G Communication

VMS Sign

Thanks!
Questions?

Feel free to reach out with any other questions you may have!

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Ollie Wiesner – olw8@uw.edu