

Building a WIM Data Archive for Improved Modeling, Design, and Rating



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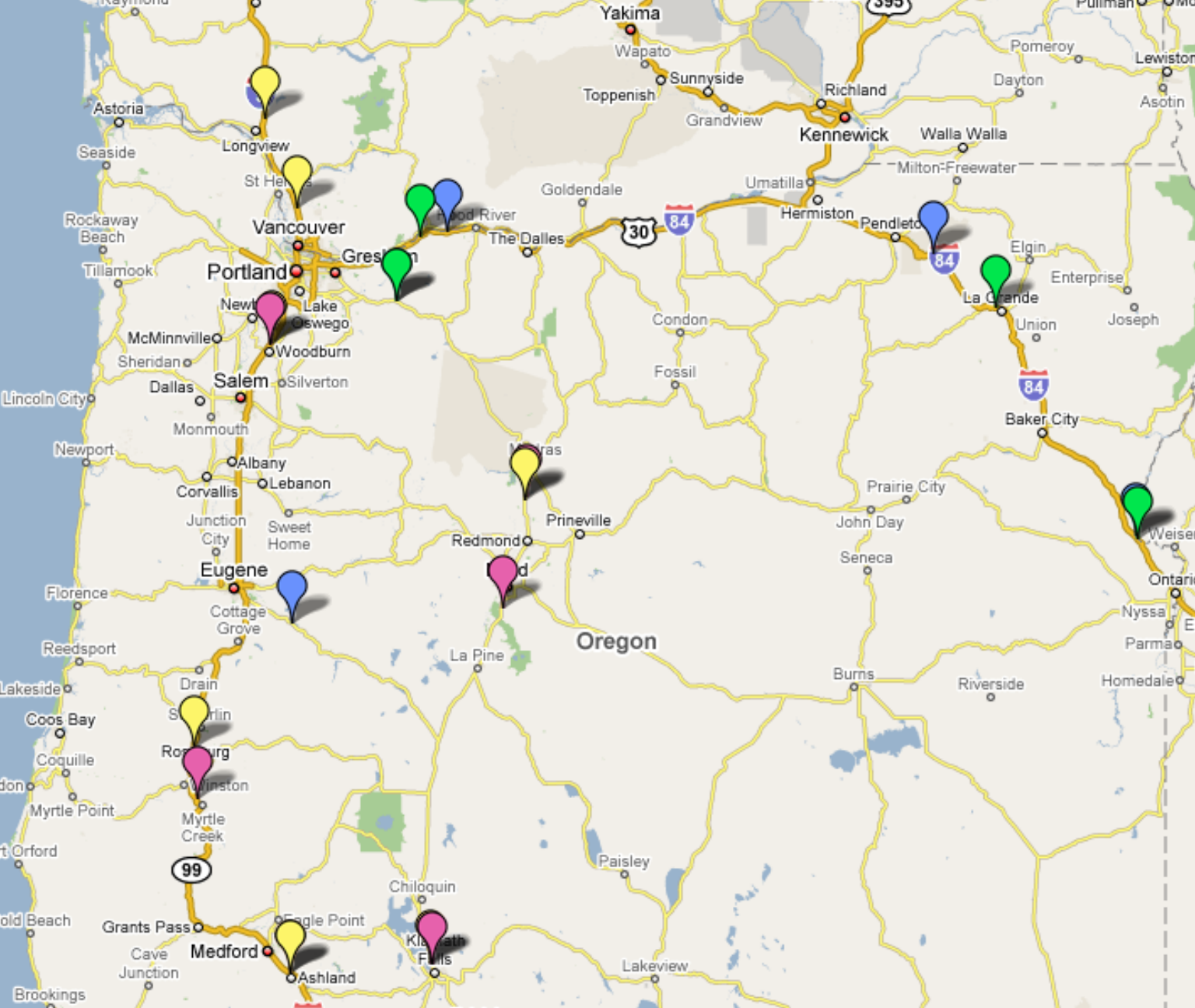
Outline

- Data Almanac
- PORTAL
- WIM Archive Quality Control
- Sample Uses of the WIM Archive
 - Sensor Health and Calibration
 - Bridge and Pavement Design
 - System Performance and Planning

DATA ALMANAC

Data Almanac

- 22 reporting WIM sites
 - All upstream of weigh stations
 - All are CVISN sites
 - April 2005 - March 2008
 - 30,026,606 trucks
 - Intermittent data outages and problems
 - Data quality and accuracy?



- [2, Migrant Hill, WB](#)
WIM station
- [13, Juniper Butte, SB](#)
WIM Station
- [19, Juniper Butte, NB](#)
WIM Station
- [17, Klamath Falls POE, NB](#)
WIM station
- [7, Ashland POE, NB](#)
WIM station
- [8, Booth Ranch, NB](#)
WIM station
- [15, Wilbur, SB](#)
WIM station
- [14, Lowell, WB](#)
WIM station
- [18, Bend, NB](#)
WIM station
- [6, Olds Ferry, EB](#)
WIM station
- [1, Farewell Bend, WB](#)
WIM station
- [10, Woodburn POE, SB](#)
WIM station
- [11, Brightwood, EB](#)
WIM station
- [4, Cascade Locks POE, EB](#)
WIM station
- [3, Wyeth, WB](#)
WIM station
- [5, LaGrande, EB](#)
WIM station
- [16, Ashland, SB](#)
- [20, Klamath Falls, SB](#)
- [9, Woodburn, NB](#)
WIM Station
- [12, Brightwood, WB](#)
WIM Station
- [Ridgefield SB, WA](#)
WIM Station
- [Kelso SB, WA](#)
WIM Station

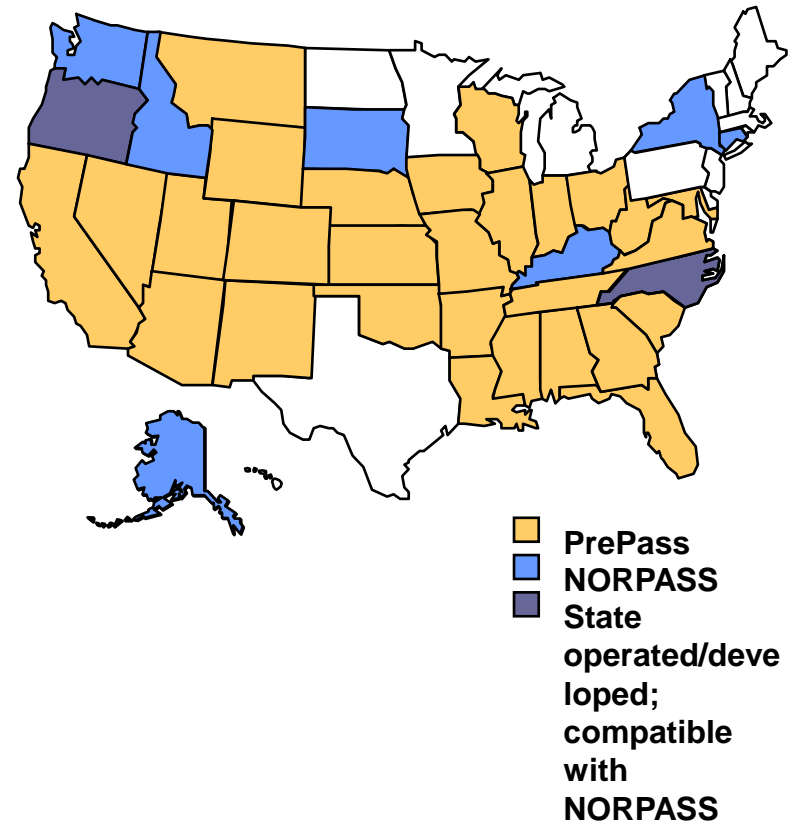
Data Almanac

- These WIM sites provide
 - Axle weights
 - *Gross vehicle weight*
 - Axle spacing
 - *Vehicle class*
 - Bumper-to-bumper length
 - Speed
 - **Unique transponder numbers**

RFID Tags - Transponders

■ Three types of tags

- Heavy Vehicle Electronic License Plate (HELP)'s PrePass program
- North American Pre-clearance and Safety System (NORPASS)
- Oregon Green Light Program



J. Lane, Briefing to American Association of State Highway and Transportation Officials (AASHTO), 22 February 2008

freight.transportation.org/doc/hwy/dc08/scoht_cvisn.ppt

Axle Weight Sensors

- Single load cells
- Sensors weigh vehicles traveling at normal highway speeds
- Weight measurement affected by many factors
 - Site characteristics
 - Environmental factors
 - Truck dynamics



Primary Users

- ODOT Motor Carrier
 - Weight enforcement
 - Workload and screening
 - Weight-mile tax enforcement
- Others want to use but
 - Not sure of quality / accuracy
 - Not equipped to deal with large data sets

PORTAL

PORTAL -- Region's ADUS



PORTAL: Portland Oregon Regional Transportation Archive Listing

Info

Welcome

User Info

People

Project Summary

Our Servers

Products

Comments

Portal Facts

Logout

Archive

Timeseries

Grouped Data

Data Fidelity

Raw Data

Monthly Data

Weather

Oblique Plots

Travel Time

WIM Data

Performance

Dashboard

Congestion

Google Maps

SVG Maps

Bivariate Plots

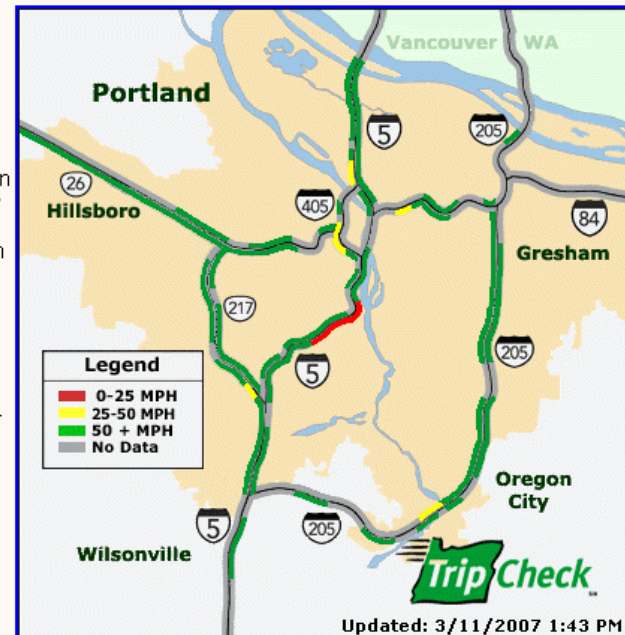
Google Traffic

Vehicle Classification

Incident Reports

Welcome to the Portland Transportation Archive Listing (PORTAL). The purpose of this project is to implement the U.S. National ITS Architecture's Archived Data User Service for the Portland metropolitan region. This system is being developed at Portland State University by students and faculty in the Intelligent Transportation Systems Laboratory under the direction of Dr. Robert Bertini. We are working in close cooperation with the Oregon Department of Transportation, Metro, the City of Portland, TriMet and other regional partners. This work is supported by the National Science Foundation.*

We welcome your participation in our project. The current PORTAL system archives the Portland metropolitan region's freeway loop detector data at its most detailed level and also archives area weather data. We plan to expand the capabilities of our system and to include multimodal data sources from both Oregon and Washington. We provide access to the system by password. To request access to the system click on the Request Account link to the left.



[Portland State University](#) - [Maseeh CECS](#) - [ITS Lab](#) - [Oregon DOT](#)
[Federal Highway Administration](#) - [National Science Foundation](#) -

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What's in the PORTAL Database?



Loop Detector Data

20 s count, lane occupancy,
speed from 500 detectors
(1.2 mi spacing)

001497

Days
Since July 2004
About 300 GB
4.2 Million
Detector Intervals

Incident Data

140,000 since 1999



VMS Data

19 VMS since 1999

Bus Data

1 year stop level data
140,000,000 rows

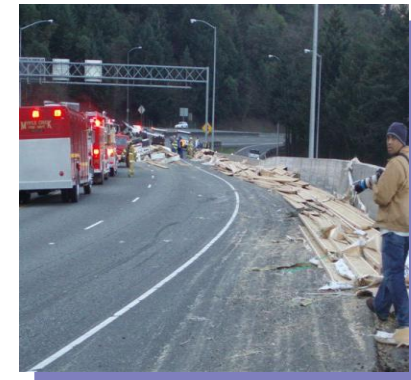


WIM Data

22 stations since 2005
30,026,606 trucks

Weather Data

Every day since 2004



Crash Data

All state-reported crashes
since 1999 - ~580,000

What's Behind the Scenes?



Database Server

PostgreSQL Relational Database Management System (RDBMS)



Storage

2 Terabyte Redundant Array of Independent Disks (RAID)

PORTAL: Portland Oregon Regional Transportation Archive Listing

Info: Welcome, Comments, User Info, People, Project Summary, Our Server, Links, Logout

Archive: Timeseries, Grouped Data, Data Fidelity, Raw Data, Weather, Oblique Plots, Travel Time, WIM Data, Performance, Dashboard, Congestion, Maps, BMW, Upload CSV, Oblique, Admin, Add User

Highway: Station: All Highways:

From Date: To Date:

Quantity: Group Results by: For Groups Show:

Include Days: Include Hours:

speed data traveltime -- station Delta Park NB Highway

PORTAL: Portland Oregon Regional Transportation Archive Listing

Date:

	Month vs. Last Month		
	APR	MAY	Change
% Cong. Travel	10.1%	11.3%	↑ 1.2%
Travel Time Index	1.53	1.59	↑ 0.06
Buffer Index	1.89	2.14	↑ 0.25

PORTLAND CONGESTION REPORT May 2005

CITY	PERCENT CONGESTED TRAVEL	TRAVEL TIME INDEX	BUFFER INDEX	Usable Days	CONTRIBUTING FACTORS						
					Monthly Precip vs. Norm	Rain > 0.5"	Rain > 1.0"	Frozen Precip.	Fog	Work Zone Count	Monthly Incidents vs. Norm
Portland	10%	1.59	1.81	21	178%	2	0	0	0	N/A	N/A

LEGEND: 12-mo. LO, 12-mo. HI, current month, New 12-mo. HI, New 12-mo. LO

Web Interface

QUALITY CONTROL

WIM Archive Quality Control

- Upload all per-vehicle records to database
 - Only records with invalid data excluded
 - Include “error” records
- Want records with inaccurate data
- Plan to incorporate
 - Filters to exclude inaccurate data
 - Ability to adjust data

Uses of the WIM Archive

- Sensor Health and Calibration
- Bridge and Pavement Design
- System Performance and Planning Data

SENSOR HEALTH AND CALIBRATION

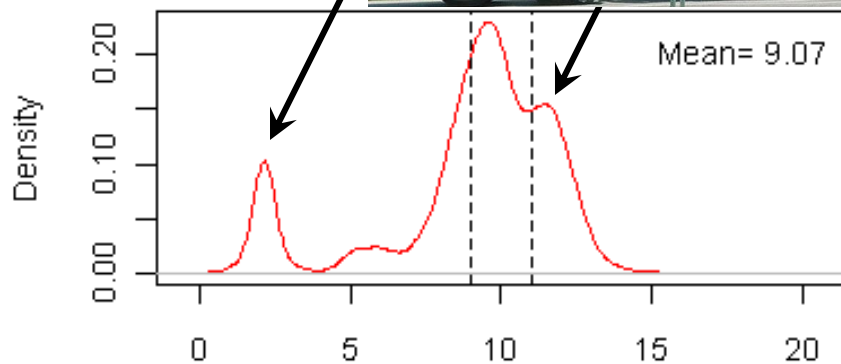
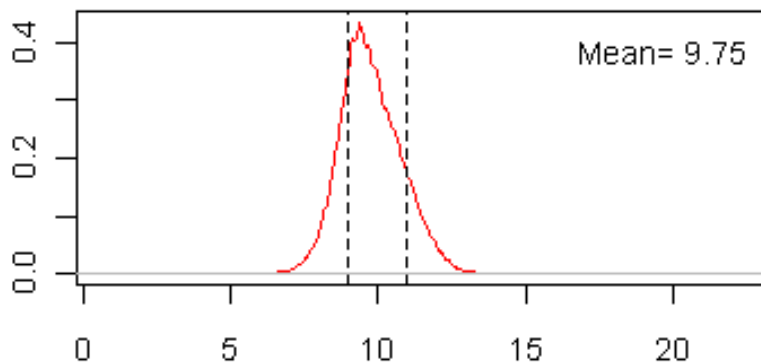
Sensor Health and Calibration

- Current ODOT Practice:
 - Calibrate every 6 months
 - or when scale operators notice “error”
 - Use ~10 trucks (~consecutive)
 - Not really monitoring WIM data, kept for weight-mile tax purposes
- Why not use the data to monitor sensor health and calibration?

Class 9 Steer Axle Weight

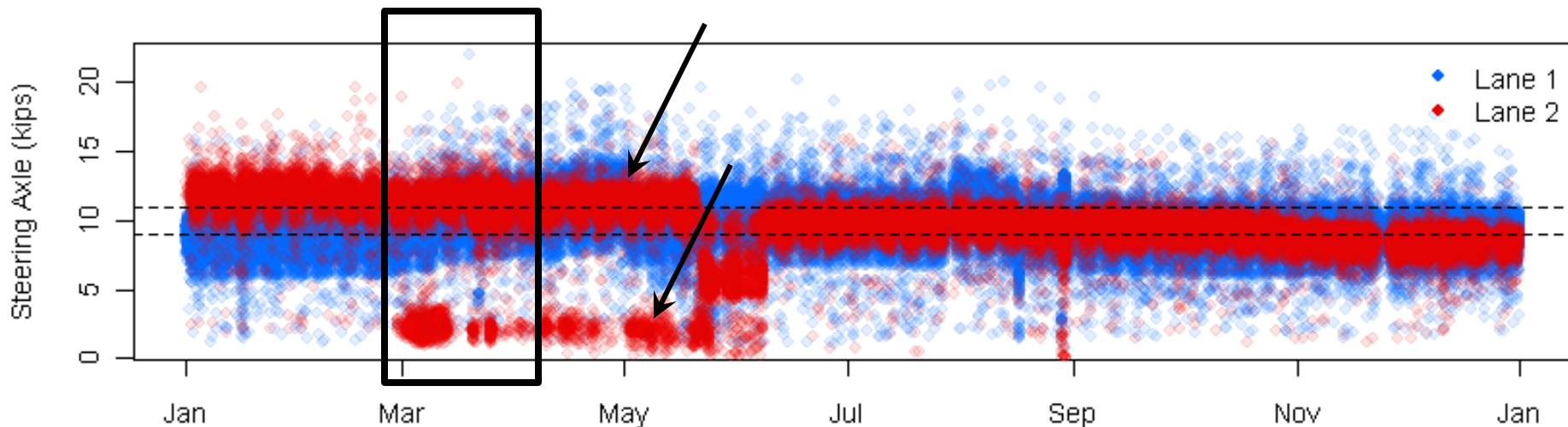


Lane 1

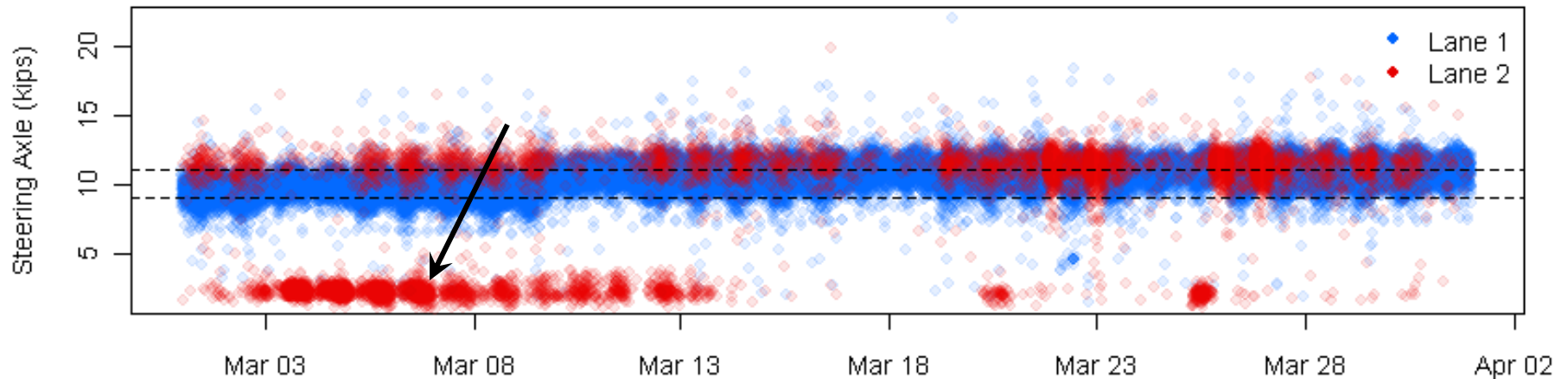
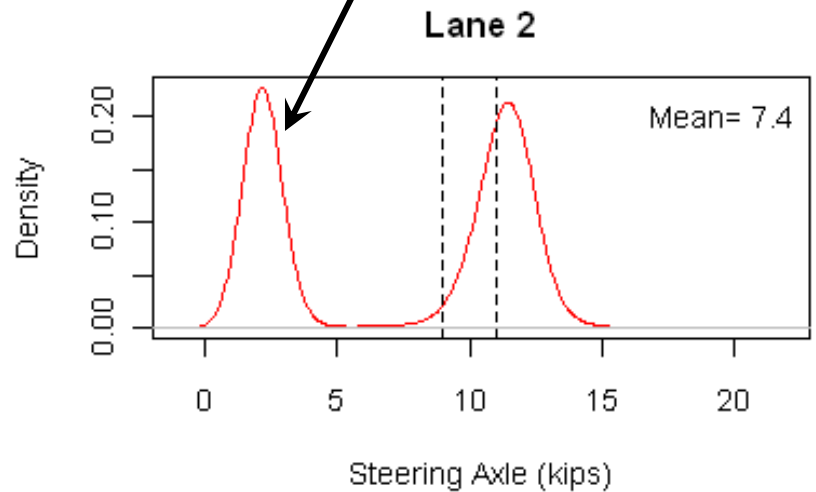
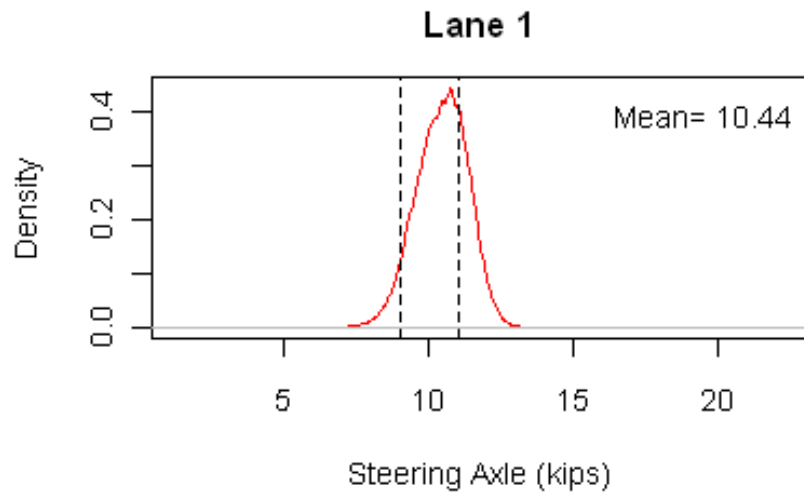


Steering Axle (kips)

Steering Axle (kips)



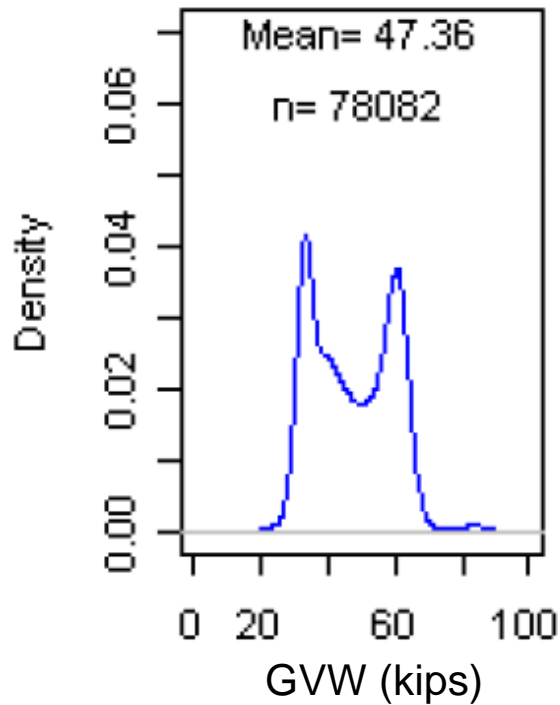
Class 9 Steer Axle Weight (March)



Class 9 Gross Vehicle Weight

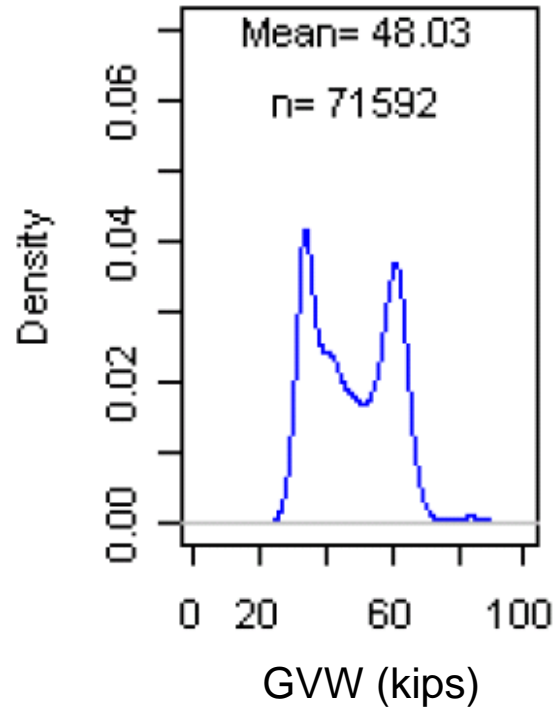
January

Station 10 WDS



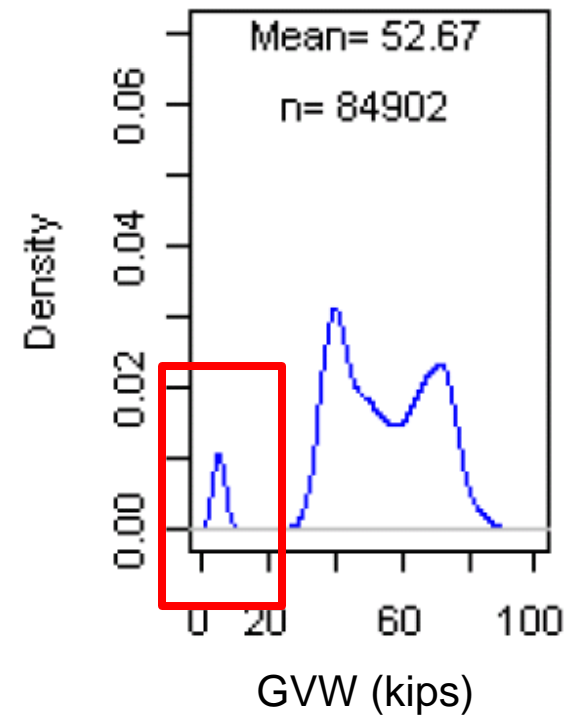
February

Station 10 WDS



March

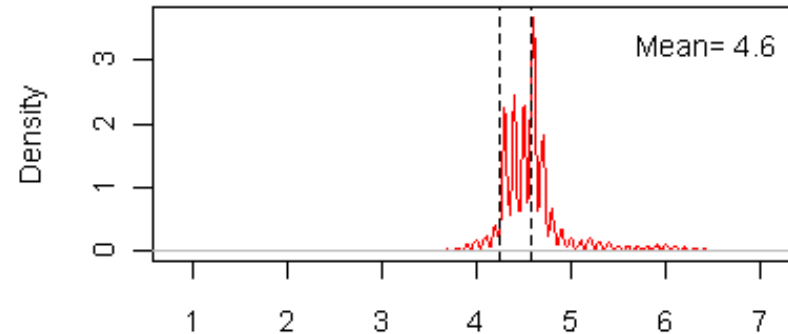
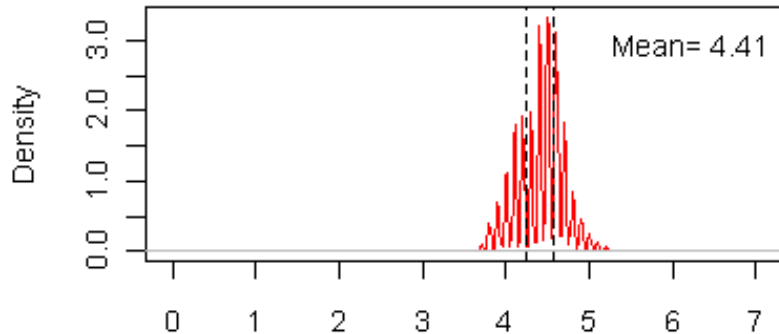
Station 10 WDS



Class 9 Axle 2-3 Spacing

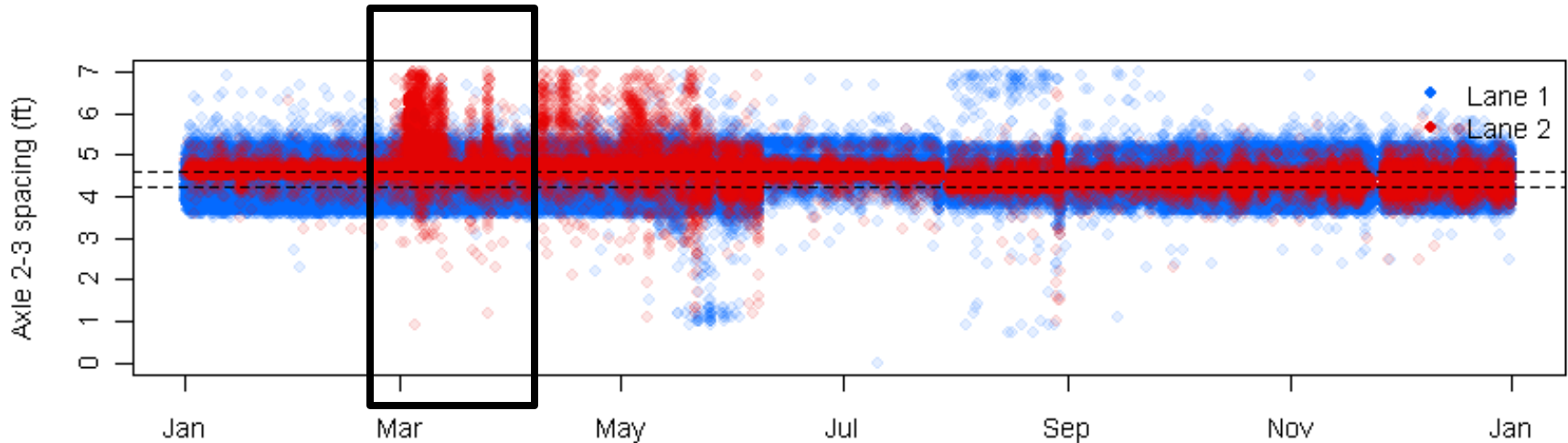


Lane 1



Axle 2-3 spacing (ft)

Axle 2-3 spacing (ft)



Issues

- How to automate “visual” assessment?
- WIM GVW calibration
 - With other WIM sites via matched tags
 - With static scale via sampling
- WIM axle weight/spacing calibration
 - With other WIM sites via matched tags

BRIDGE AND PAVEMENT DESIGN

Oregon-specific Uses

■ Bridge Design

- First state-specific live-load rating factors (LFRs)
- Side-by-side loading criteria
- Need ~2 weeks of CLEAN accurate data
- Promised update every 2 to 5 years

■ Pavement Design

- Facility specific factors for MEPDG

SYSTEM PERFORMANCE AND PLANNING DATA

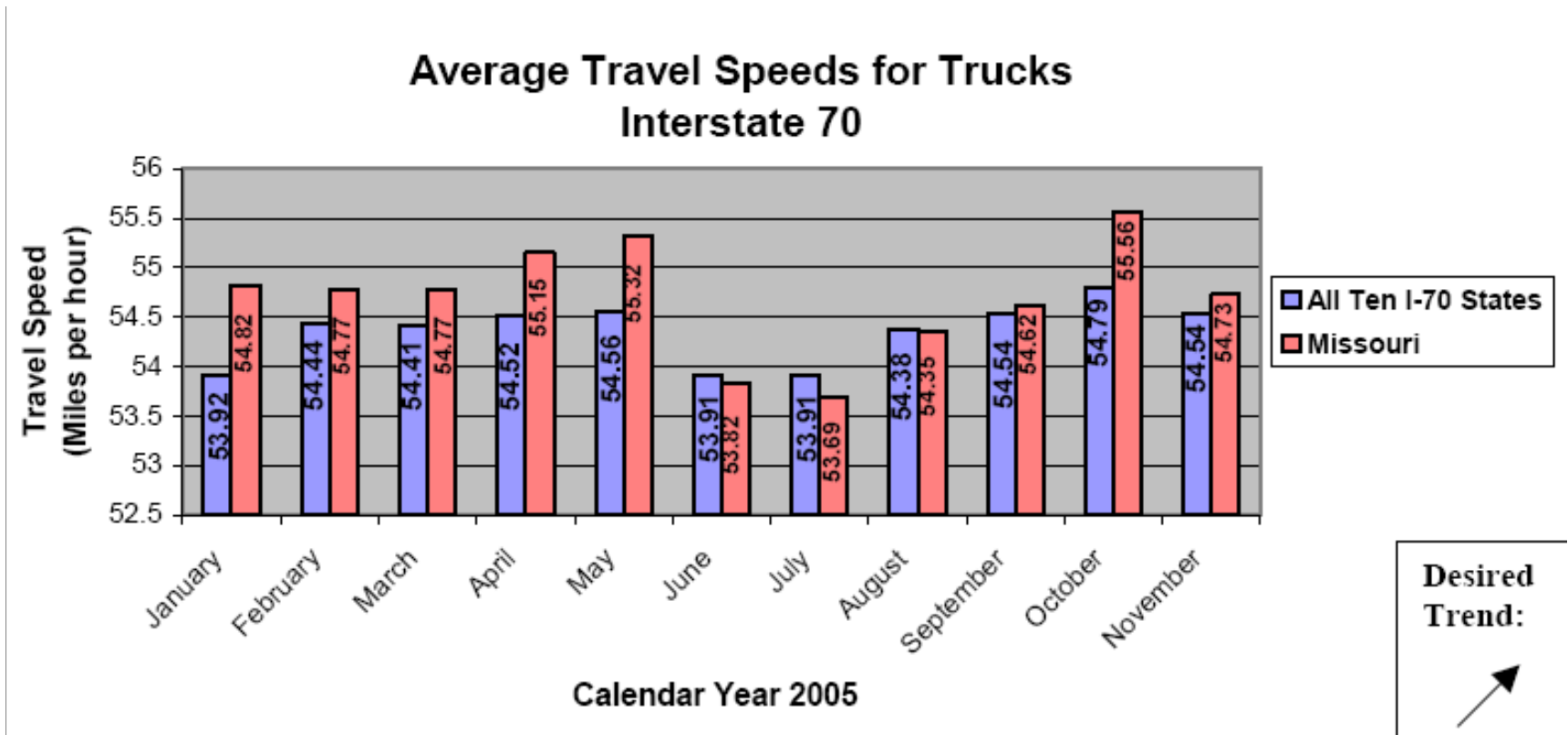
System Performance and Planning

- Transponder data allows unique matches
- Travel times on long-distance corridors
 - ~1 million upstream-downstream pairs in 2007
- Routing
- Planning metrics
 - Ton-miles on each corridor by various temporal considerations
 - Seasonal variability in loading, routes, and volumes

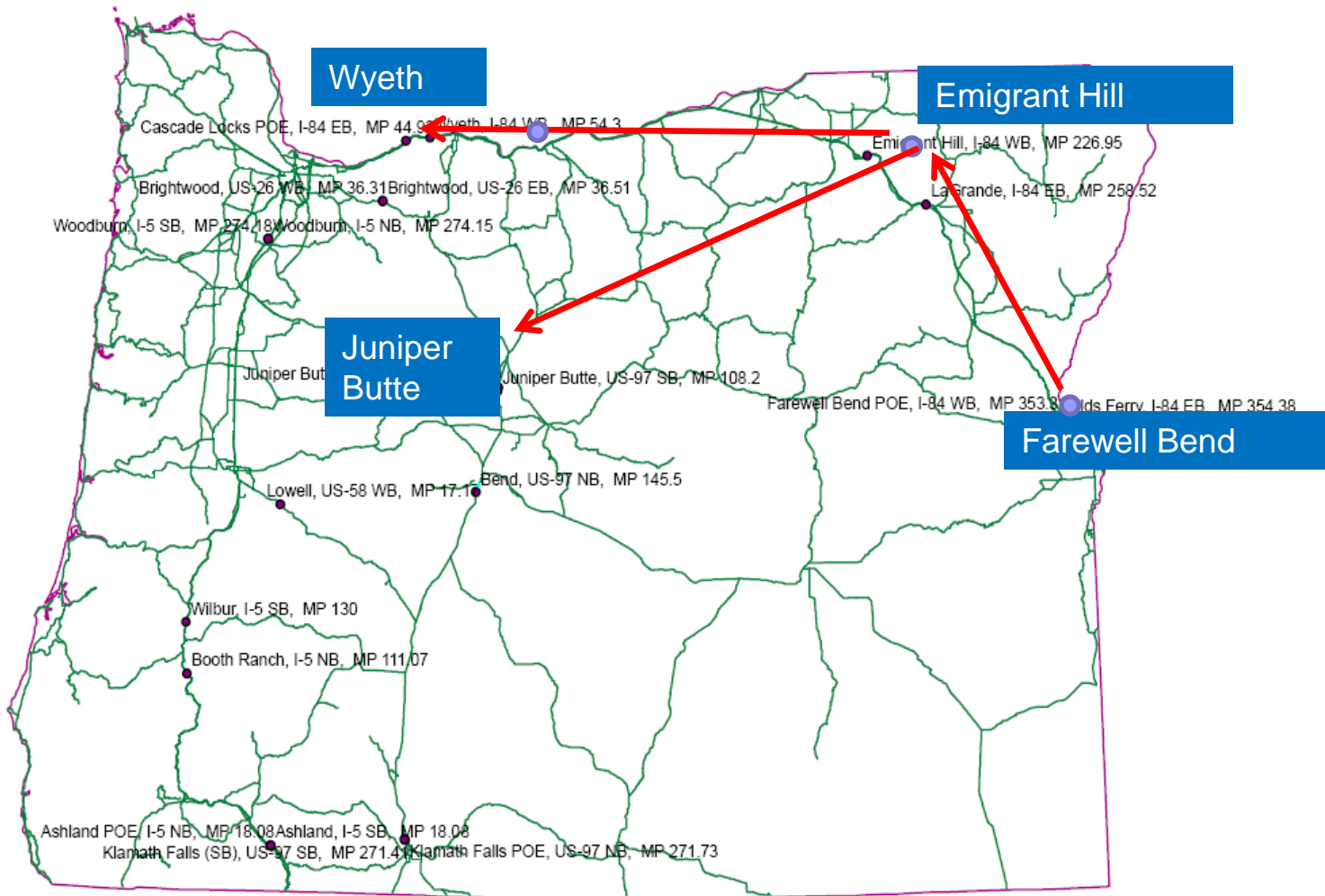
Freight performance metrics

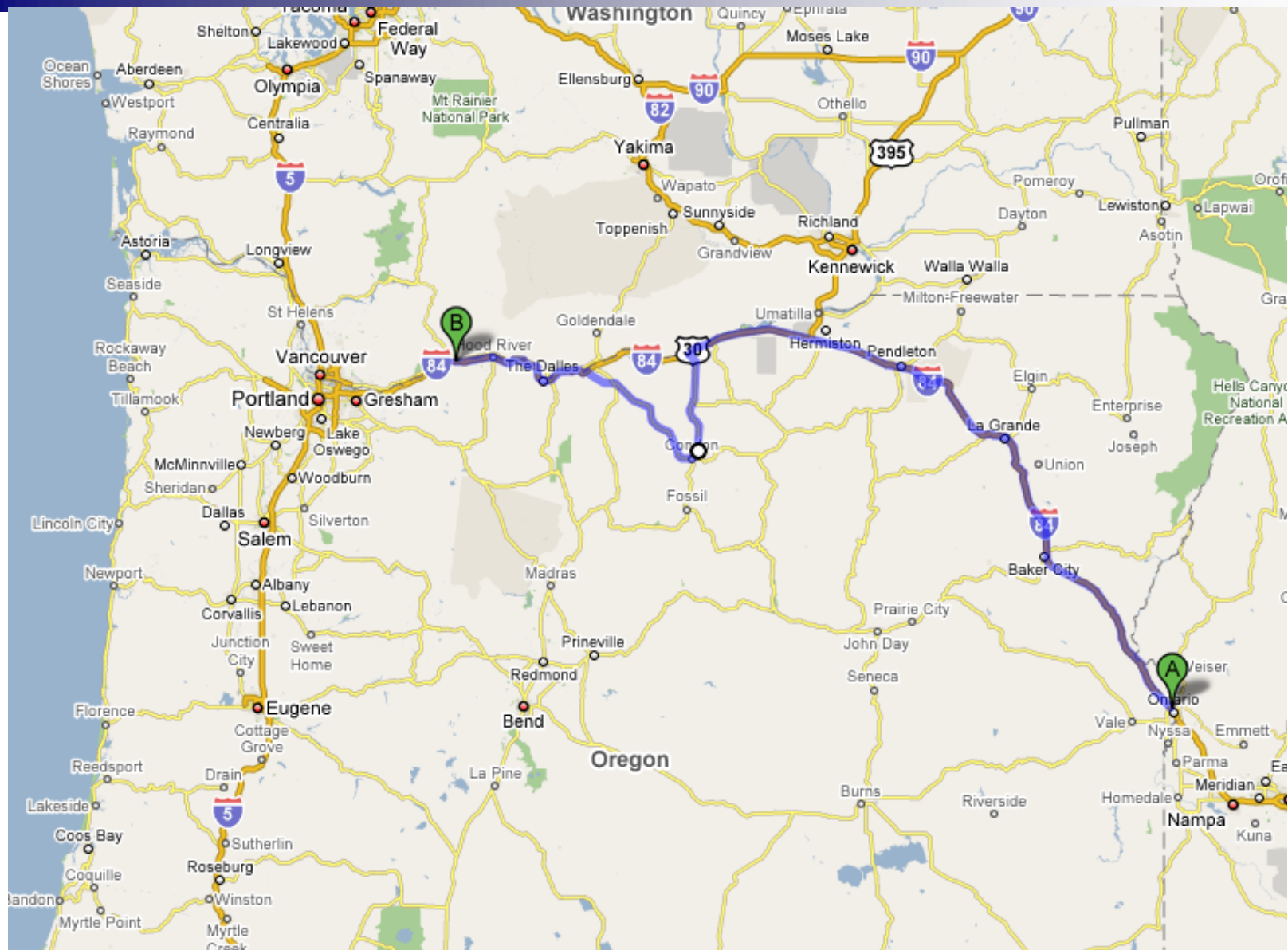
<p>Goal 1: Improve Travel Safety in Oregon *</p> <ul style="list-style-type: none"> ▪ Traffic Fatalities (#1) ▪ Traffic Injuries (#2) ▪ Safe Drivers (#3) ▪ Impaired Driving-Related Traffic Fatalities (#4) ▪ Use of Safety Belts (#5) ▪ Large Truck At-Fault Crashes (#6) ▪ Rail Crossing Incidents (#7) ▪ Derailment Incidents (#8) ▪ Travelers Feel Safe (#9) 	<p>Goal 2: Move People and Goods Efficiently</p> <ul style="list-style-type: none"> ▪ Special Transit Rides (#10) ▪ Travel Delay (#11) ▪ Passenger Rail Ridership (#12) ▪ Alternatives to One-Person Commuting (#13) ▪ Traffic Volume (#14) ▪ Pavement Condition (#15) ▪ Bridge Condition (#16)
<p>Goal 3: Provide a Transportation System that Supports Livability and Economic Prosperity</p> <ul style="list-style-type: none"> ▪ Fish Passage at State Culverts (#17) ▪ Intercity Passenger Service (#18) ▪ Bike Lanes and Sidewalks (#19) ▪ Jobs from Construction Spending (#20) ▪ Timeliness of Projects Going to Construction Phase (#21) ▪ Construction Project Completion Timeliness (#22) ▪ Construction Projects On Budget (#23) ▪ Certified Businesses (DMWESB) (#24) 	<p>Goal 4: Provide Excellent Customer Services</p> <ul style="list-style-type: none"> ▪ Customer Service Satisfaction (#25) ▪ DMV Customer Services (#26) -- DMV Field Office Wait Time (#26a), DMV Phone Wait Time (#26b), and DMV Title Wait Time (#26c) ▪ Economic Recovery Team Customer Satisfaction (#27)

Freight performance metrics



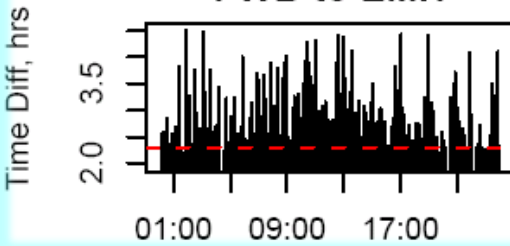
Using Federal Highway Administration (FHWA) / American Transportation Research Institute (ATRI) proprietary truck satellite data.



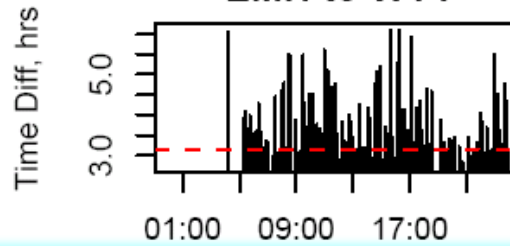


Travel Time, Oct 1 2007

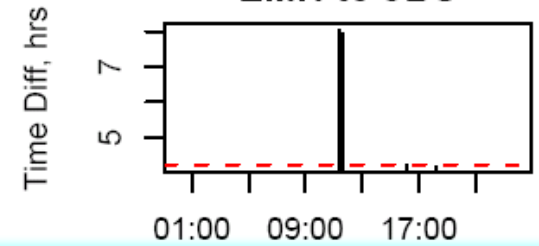
FWB to EMH



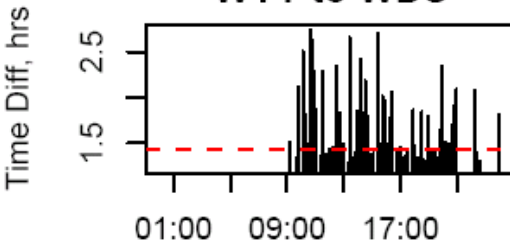
EMH to WYT



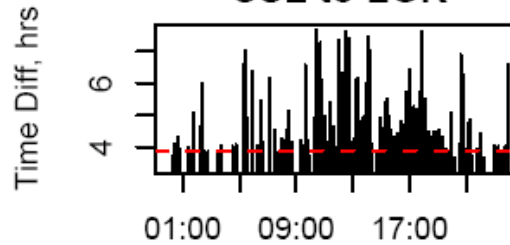
EMH to JBS



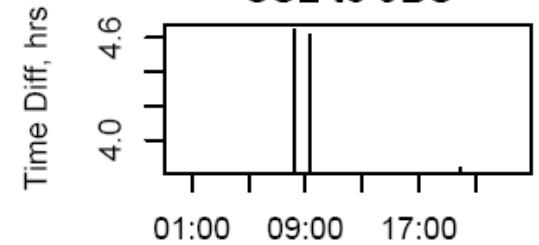
WYT to WDS



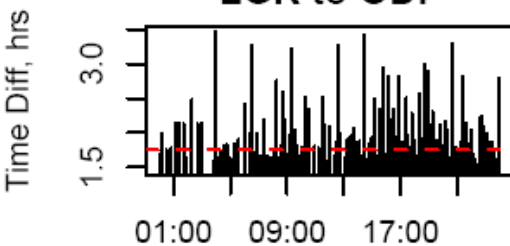
CSL to LGR



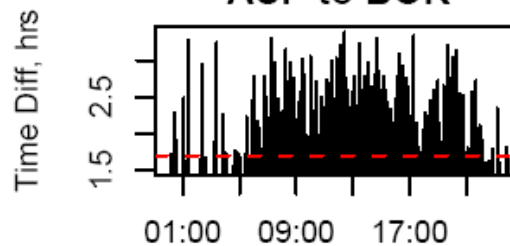
CSL to JBS



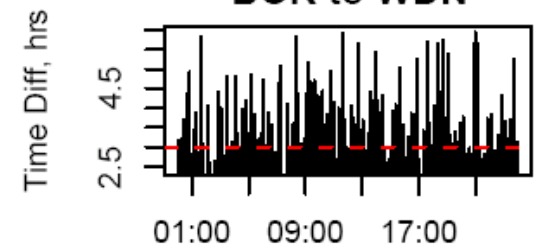
LGR to ODF



ASP to BOR



BOR to WDN



Conclusions

- Oregon's extensive deployment useful
 - Transponders unique in data
- Building on experience with archiving other data (i.e. freeway loops)
 - Data improvement follows use
 - Various users requirements
- Let the data tell the story
 - Quality control helps all users

Acknowledgements

■ Funding

- UTCs: Oregon Transportation Research Education and Consortium & Rahall Transportation Institute
- Oregon DOT and NCHRP
- National Science Foundation (PORTAL)
- Dave McKane and Dave Fifer, ODOT
- Kristin Tufte and Heba Alawakiel, PSU



M MARSHALL UNIVERSITY

OSU Oregon State UNIVERSITY

OTREC OREGON TRANSPORTATION RESEARCH AND EDUCATION CONSORTIUM

WIM Classification Algorithm

- Portion related to 5-axle vehicles shown
- Works like a sieve
- Min/Max thresholds for
 - # of axles
 - axle spacing
 - axle weight
 - gwv
- Primarily configured for axle spacing

	↓	↓	↓	↓	↓
	19	20	21	22	23
Vehicle Type	19	20	21	22	23
Vehicle Class	7	9	9	11	9
# of Axles	5	5	5	5	5
Min GVW	0	0	0	0	0
Max GVW	221	221	221	221	221
1 Min Weight	3	3	3	4	3
1 Max Weight	50	50	50	50	50
1 Axle Marking	s	s	s	x	x
1-2 Min Spacing	0	0	0	0	0
1-2 Max Spacing	40	40	40	14.2	40
2 Min Weight	0	0	0	4	0
2 Max Weight	50	50	50	50	50
2 Axle Marking	x	d	d	x	x
2-3 Min Spacing	0	0	0	0	0
2-3 Max Spacing	5.8	5.8	5.8	40	40
3 Min Weight	0	0	0	4	0
3 Max Weight	50	50	50	50	50
3 Axle Marking	x	d	d	x	x
3-4 Min Spacing	0	0	0	0	0
3-4 Max Spacing	5.8	40	40	40	40
4 Min Weight	0	0	0	4	0
4 Max Weight	50	50	50	50	50
4 Axle Marking	x	d	x	x	x
4-5 Min Spacing	0	0	0	0	0
4-5 Max Spacing	5.8	5.8	11.7	40	40
5 Min Weight	0	0	0	4	0
5 Max Weight	50	50	50	50	50
5 Axle Marking	x	d	x	x	x