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

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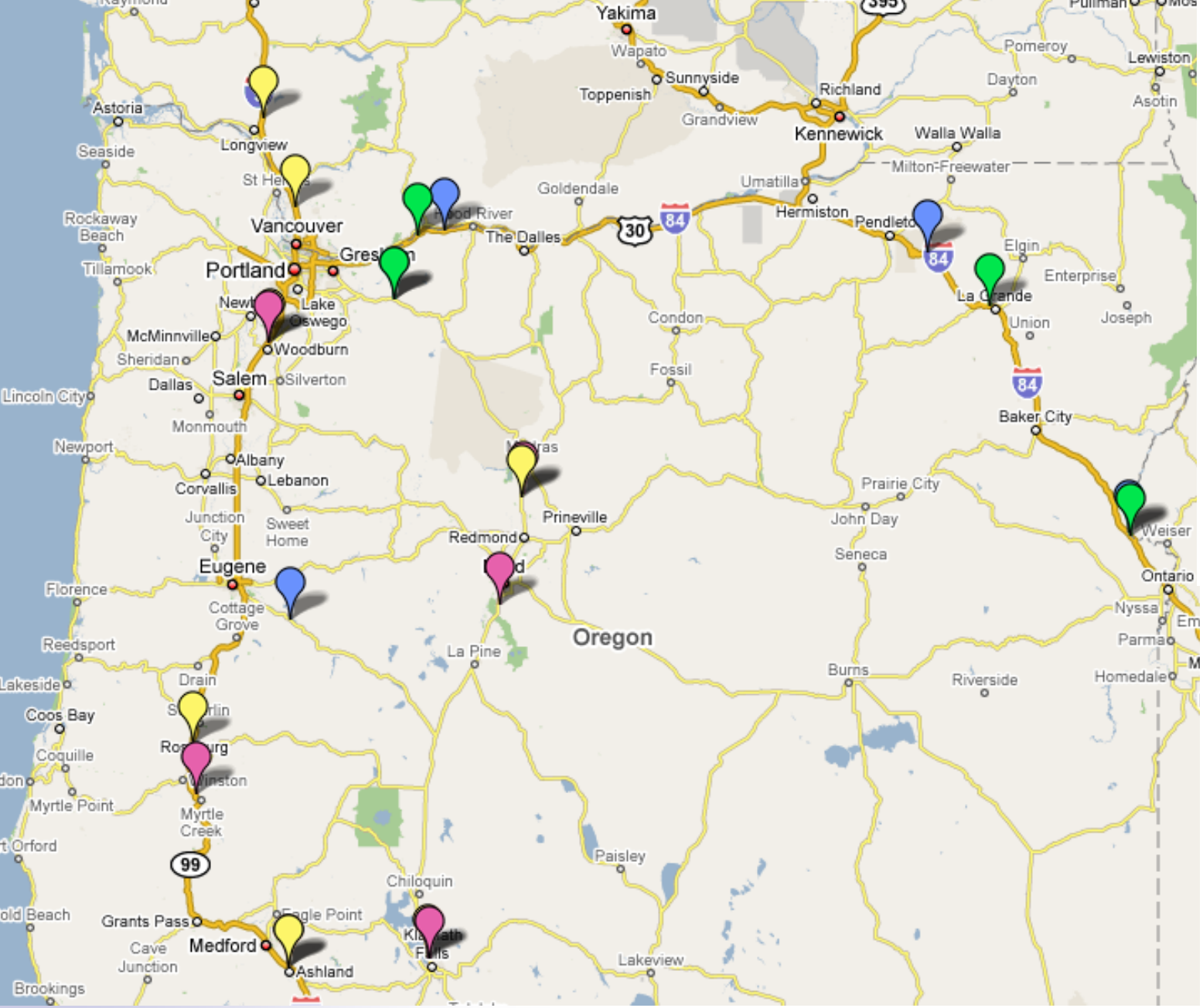
Outline

- 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, Emigrant 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

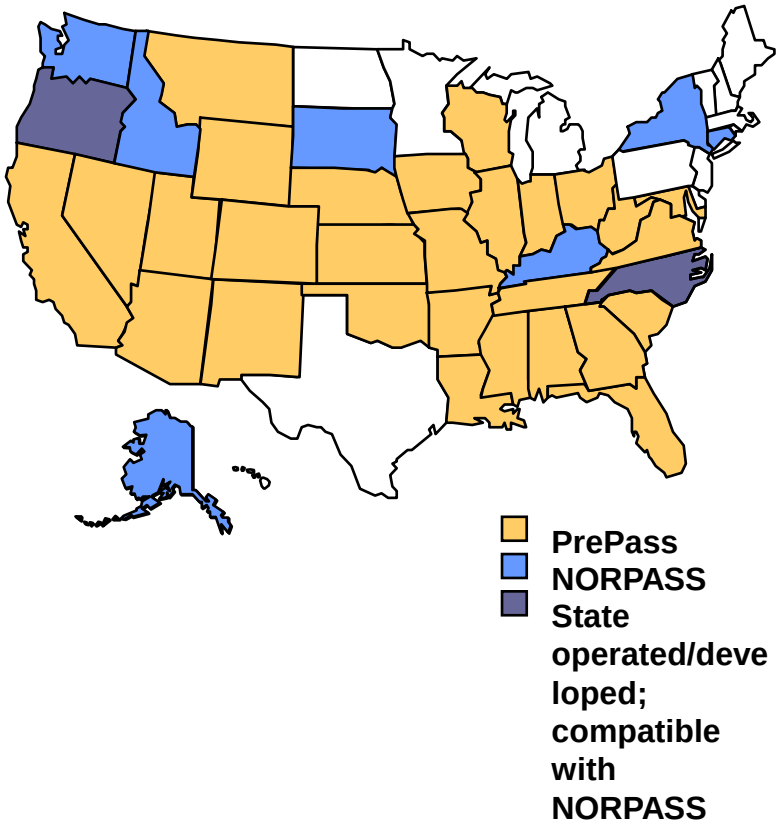
Kelso SB, WA
WIM Station

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

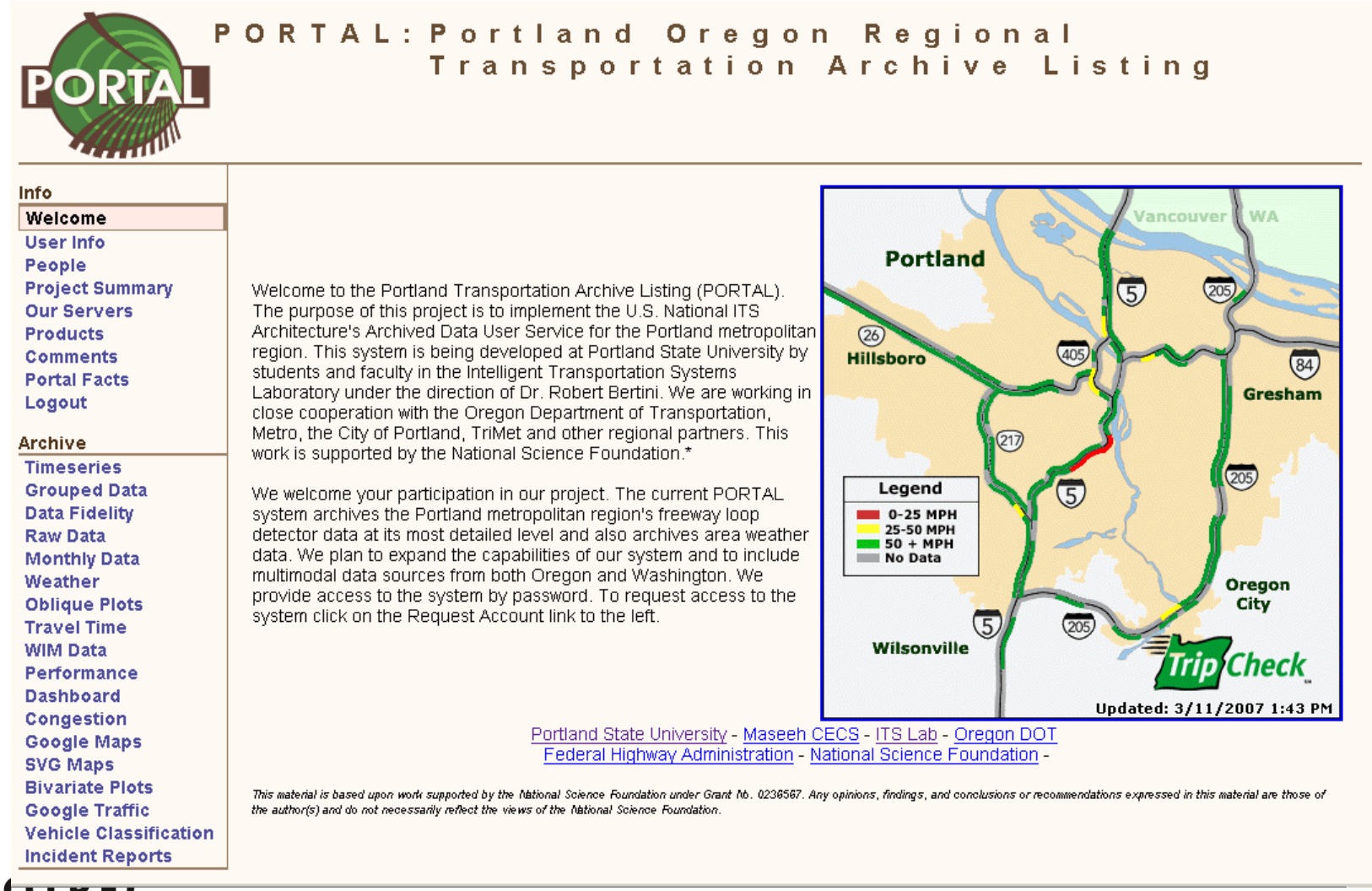
- Single load cells
- Sensors weigh vehicles traveling at normal highway speeds
- Weight measurement affected by many factors
  - Site characteristics
  - Environmental factors
  - Truck dynamics

Primary Users

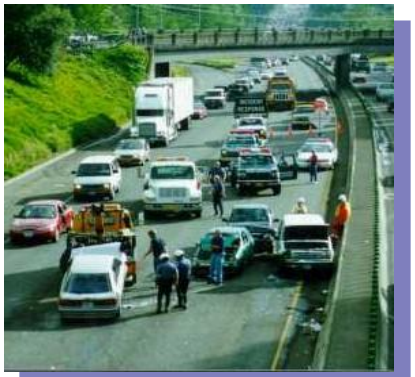
- ODOT Motor Carrier
  - Weight enforcement
    - Workload and screening
  - Weight-mile tax enforcement
- Others want to use but
  - Not sure of quality / accuracy
  - Not equipped to deal with large data sets

PORTAL

PORTAL -- Region's ADUS



What's in the PORTAL Database?



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

Incident Data
140,000 since 1999

Bus Data
1 year stop level data
140,000,000 rows

Weather Data
Every day since 2004

001497

Days
Since July 2004
About 300 GB
4.2 Million
Detector Intervals

VMS Data
19 VMS since 1999

WIM Data
22 stations since 2005
30,026,606 trucks

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

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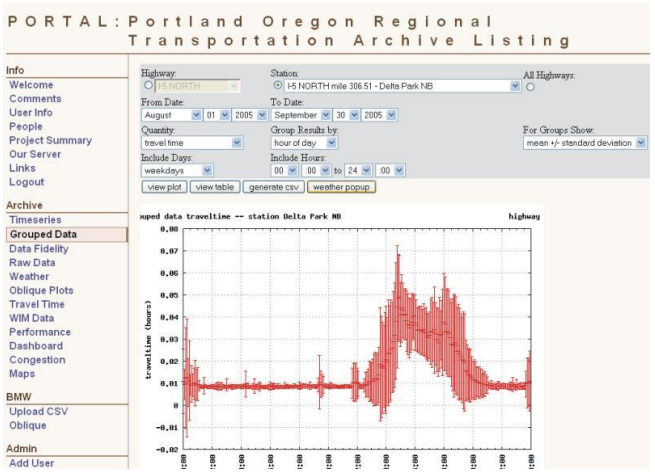
What's Behind the Scenes?

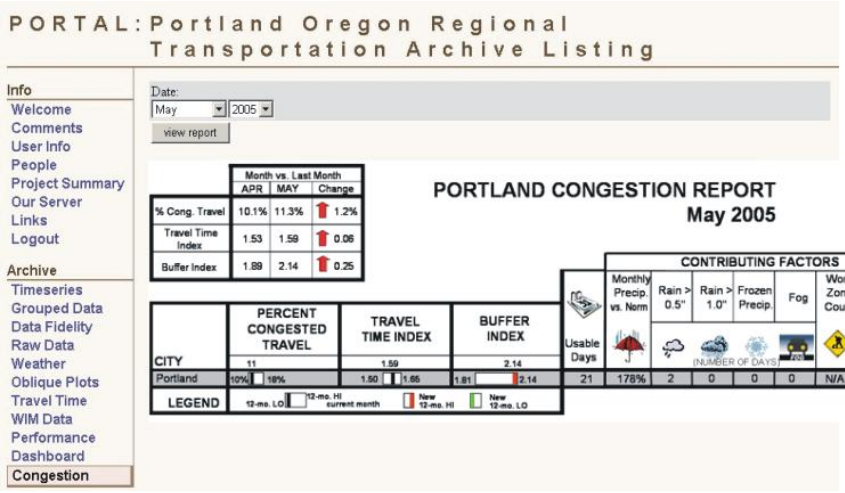
Database Server

PostgreSQL Relational Database Management System (RDBMS)

Storage

2 Terabyte Redundant Array of Independent Disks (RAID)





Web Interface

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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

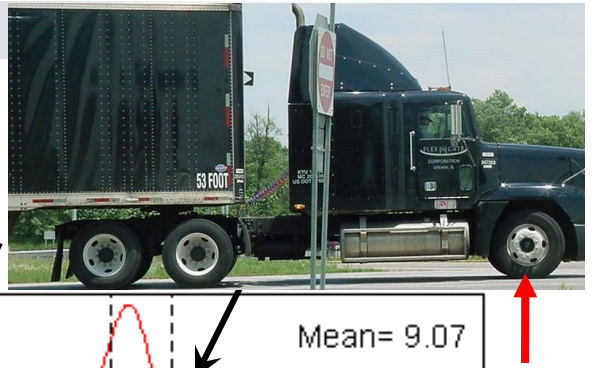
- Sensor Health and Calibration
- Bridge and Pavement Design
- System Performance and Planning Data

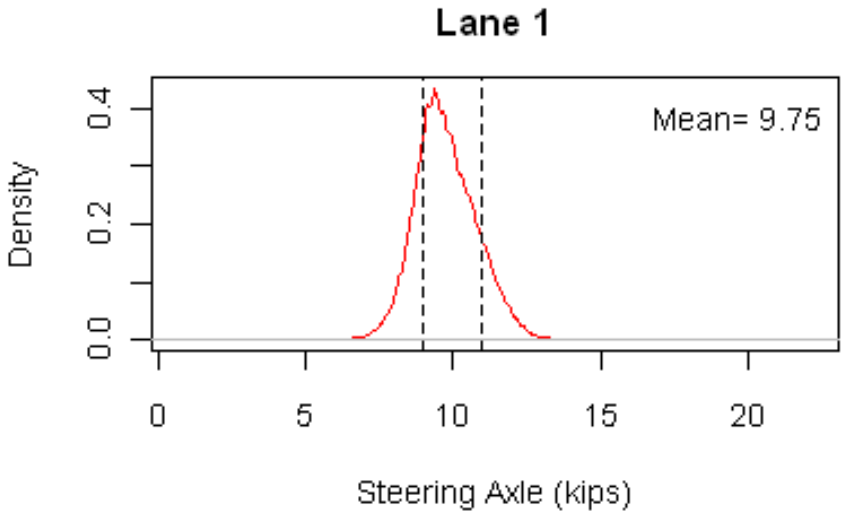
SENSOR HEALTH AND CALIBRATION

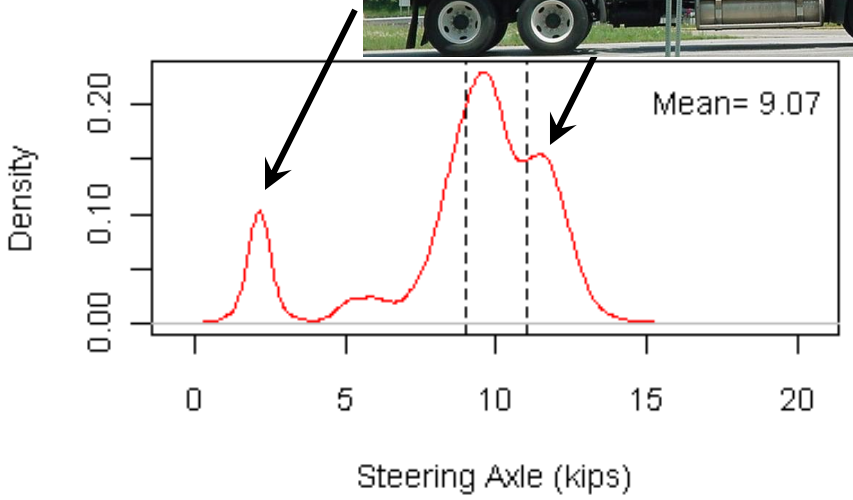
Sensor Health and Calibration

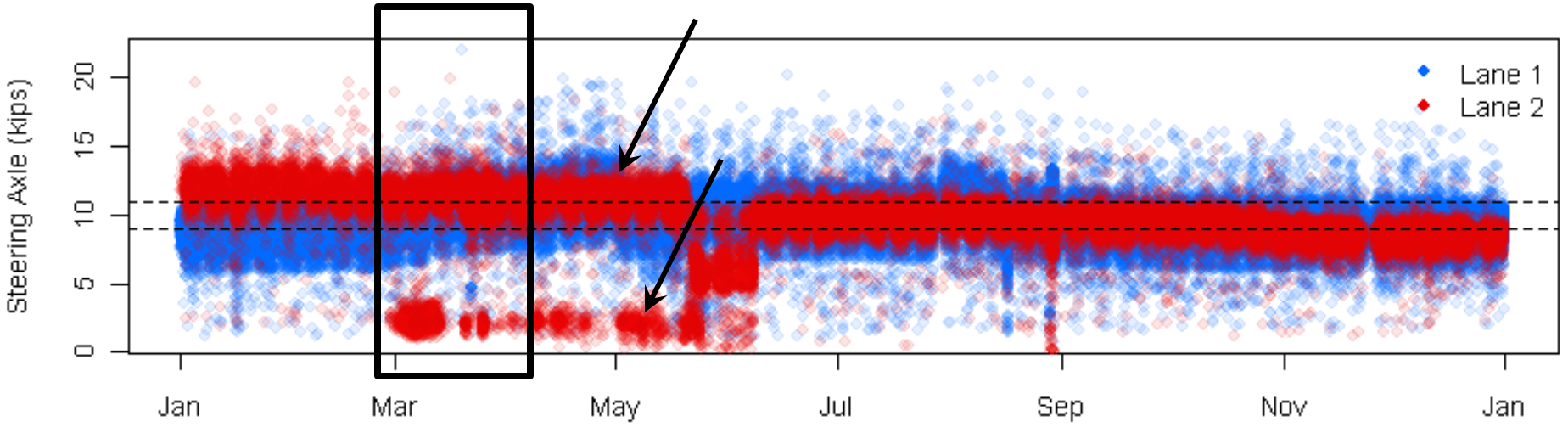
- Current ODOT Practice:
  - Calibrate every 6 months
  - or when scale operators notice “error”
  - Use ~10 trucks (~consecutive)
  - Not really monitoring WIM data, kept for weight-mile tax purposes
- Why not use the data to monitor sensor health and calibration?

Class 9 Steer Axle Weight









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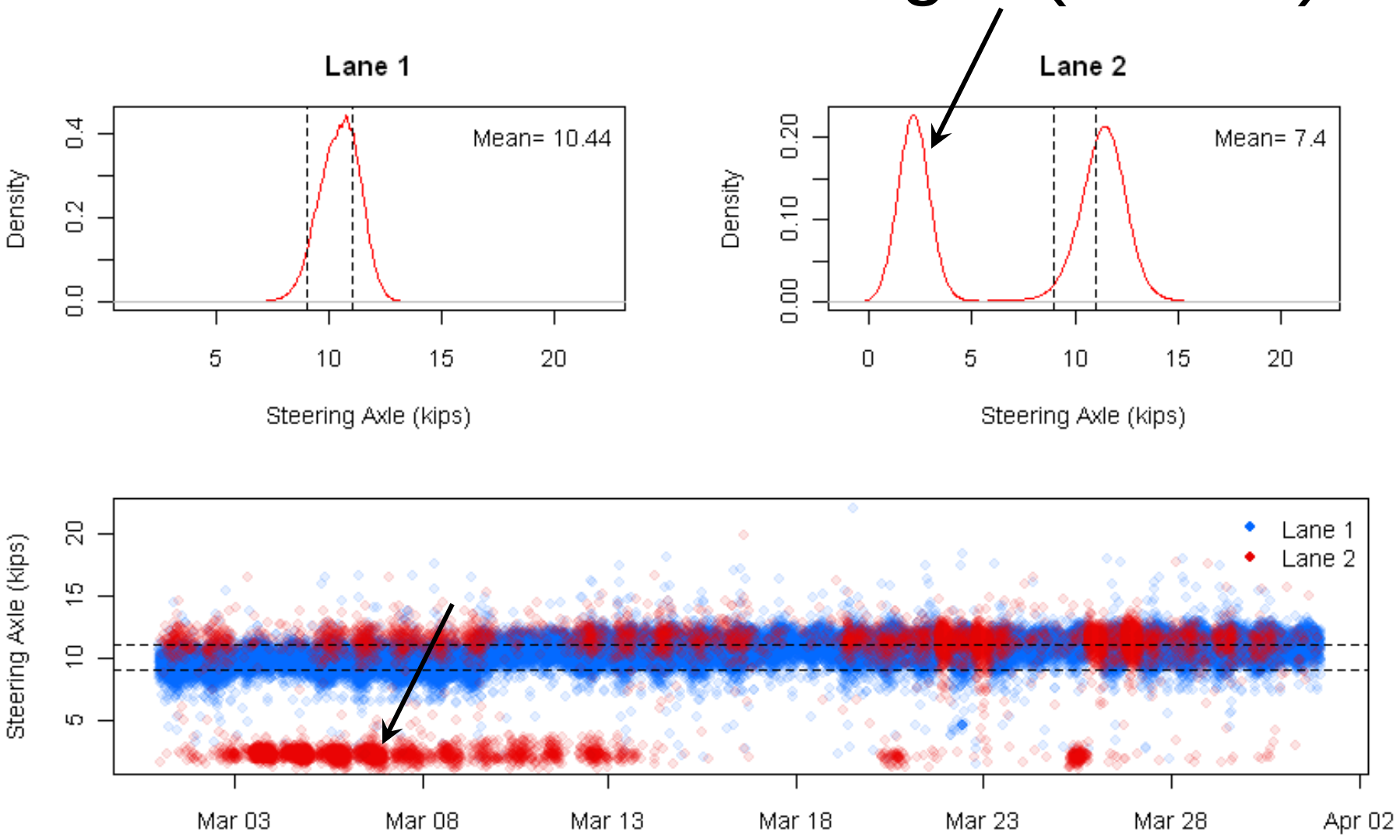
Class 9 Steer Axle Weight (March)



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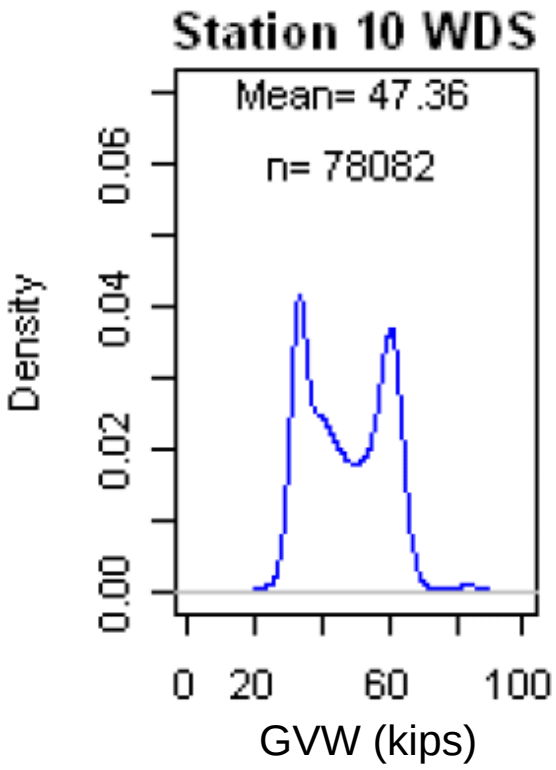
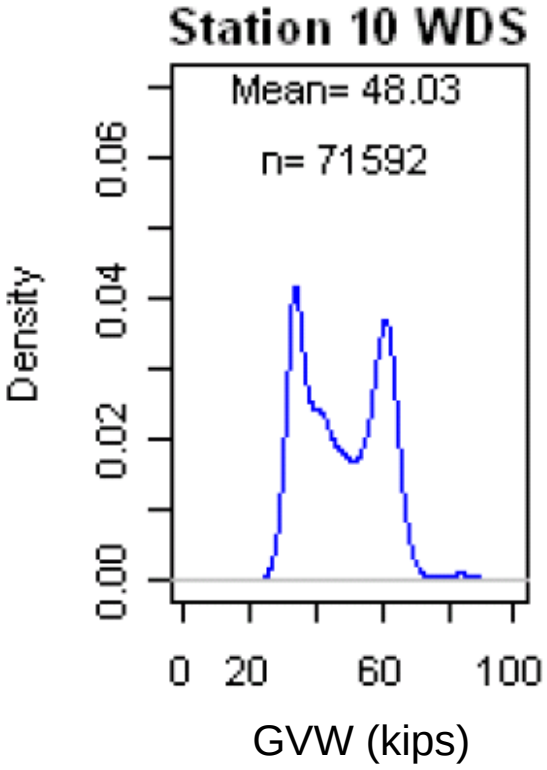
Class 9 Gross Vehicle Weight

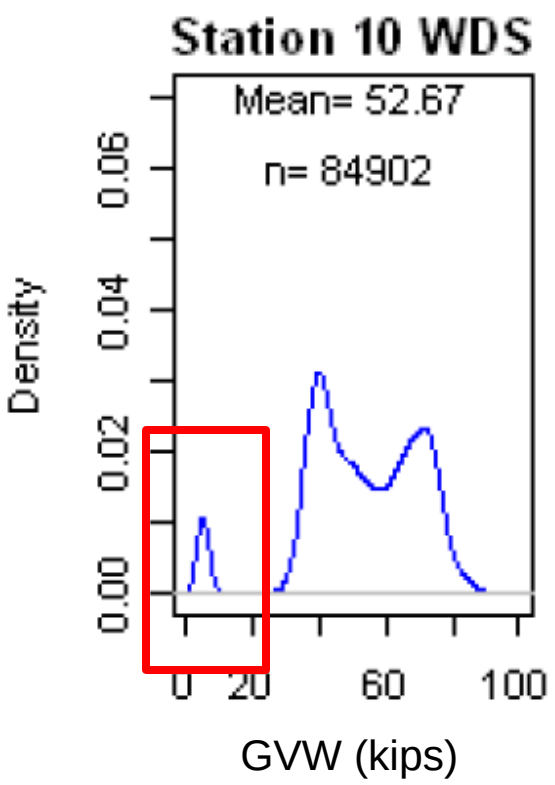
January



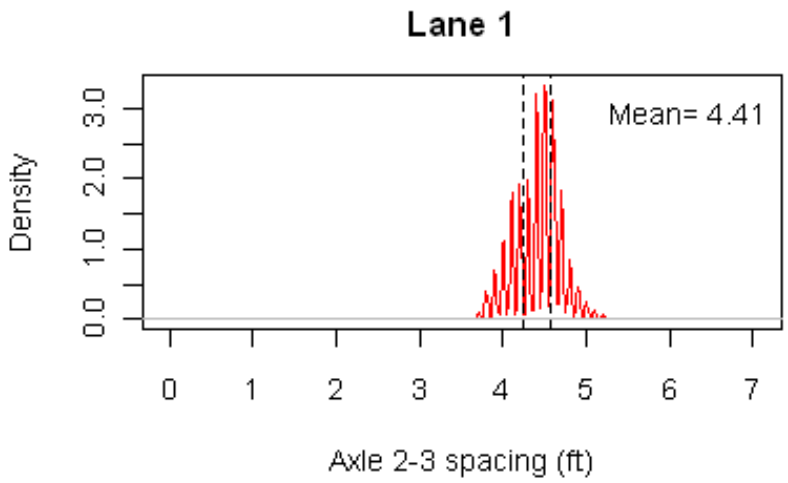
February

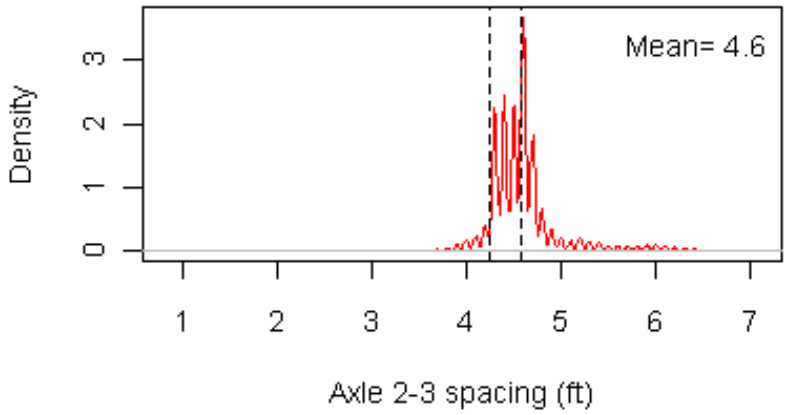


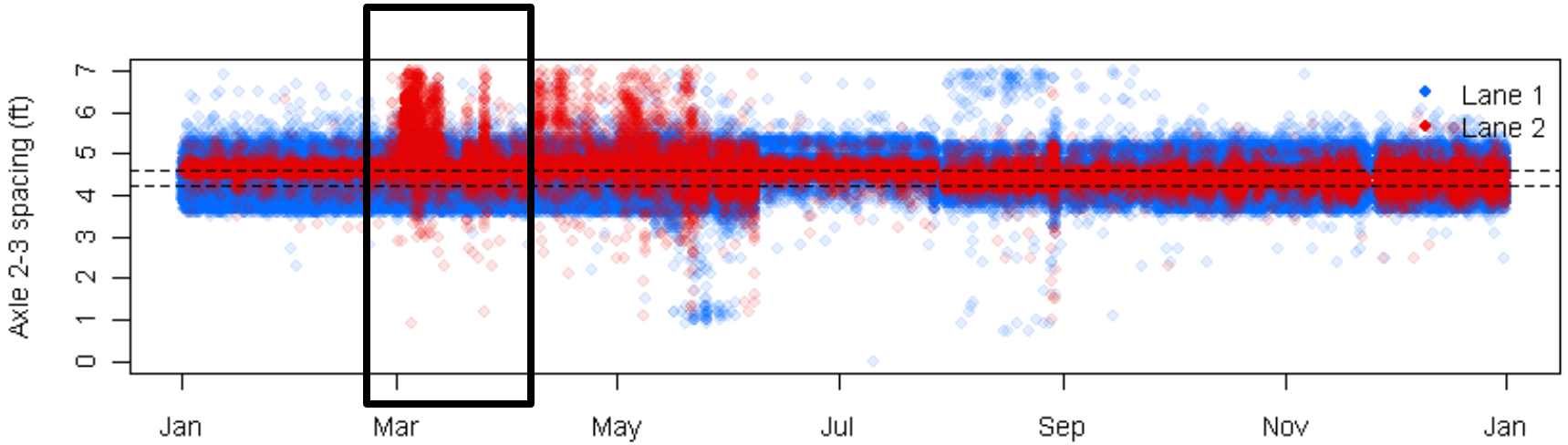
March



Class 9 Axle 2-3 Spacing







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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

Goal 1: Improve Travel Safety in Oregon *

- 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)

Goal 2: Move People and Goods Efficiently

- 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)

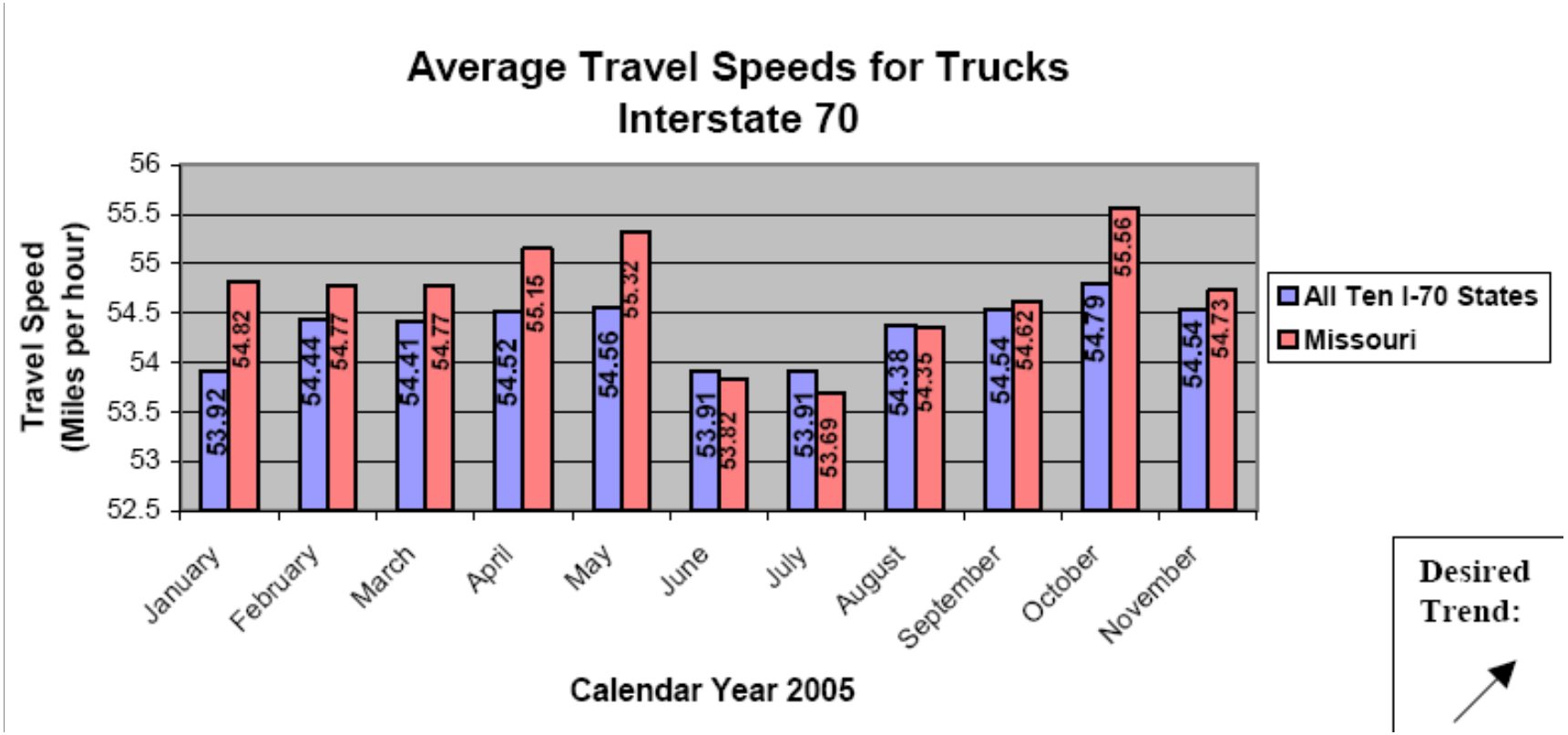
Goal 3: Provide a Transportation System that Supports Livability and Economic Prosperity

- 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)

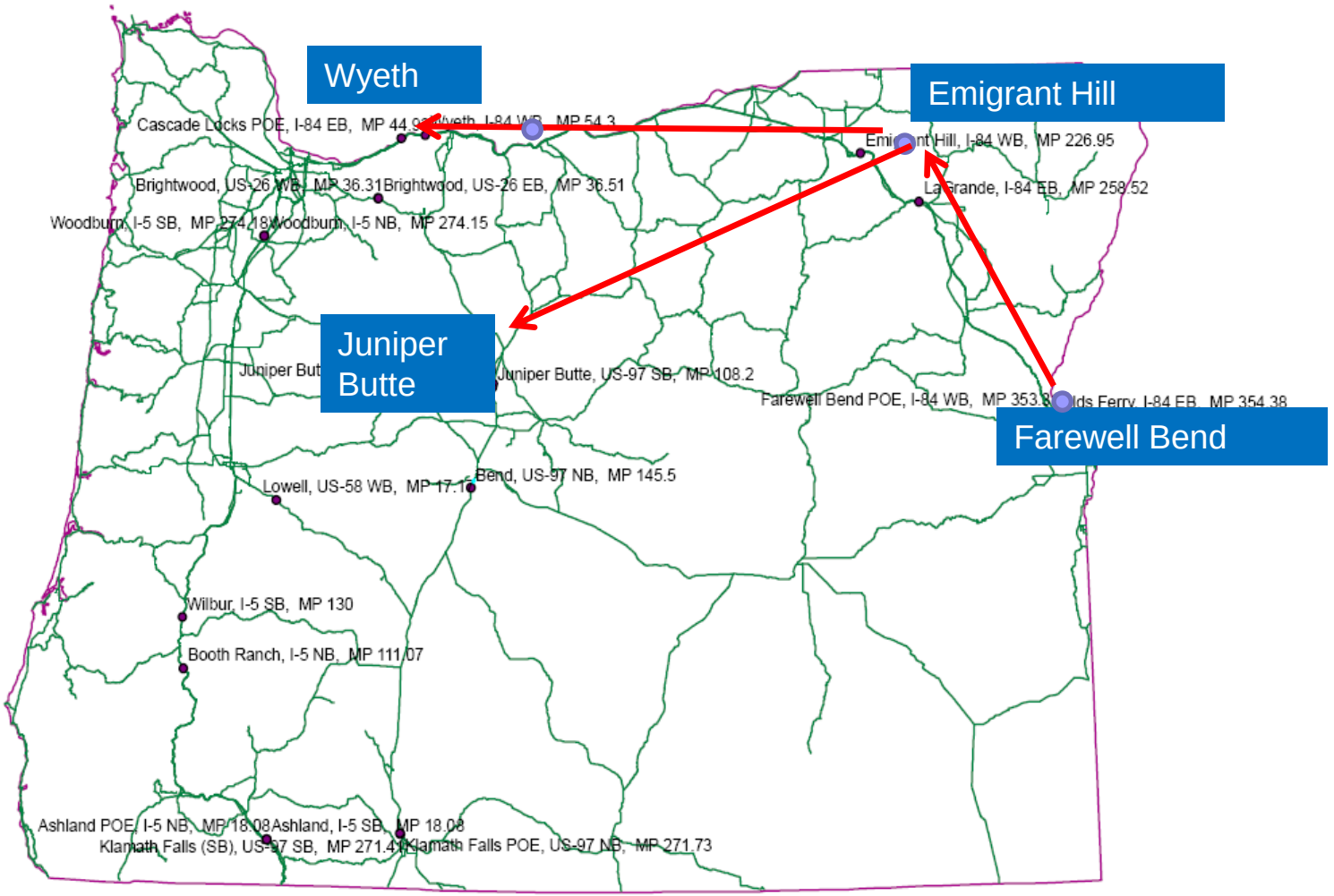
Goal 4: Provide Excellent Customer Services

- 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.



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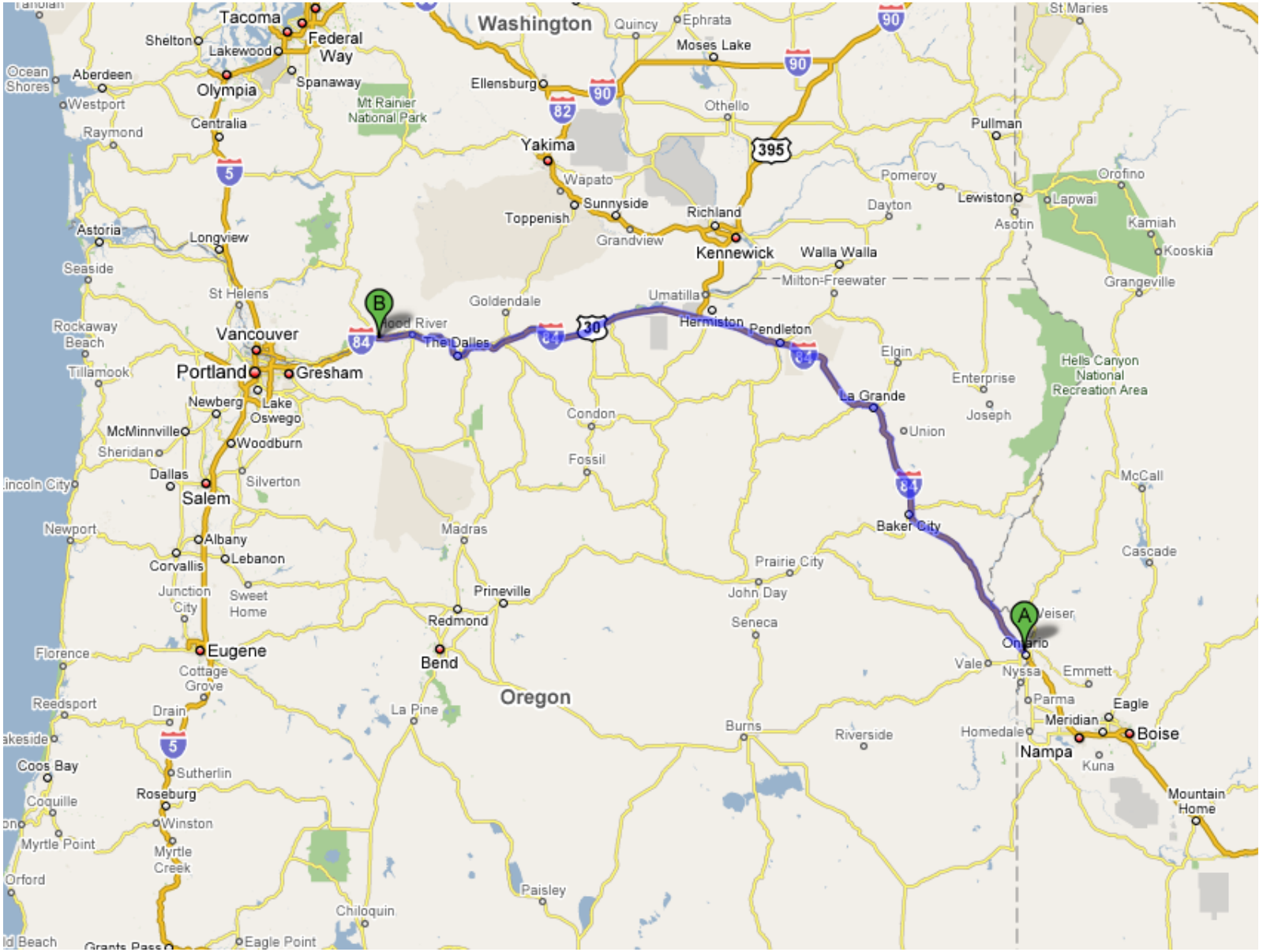

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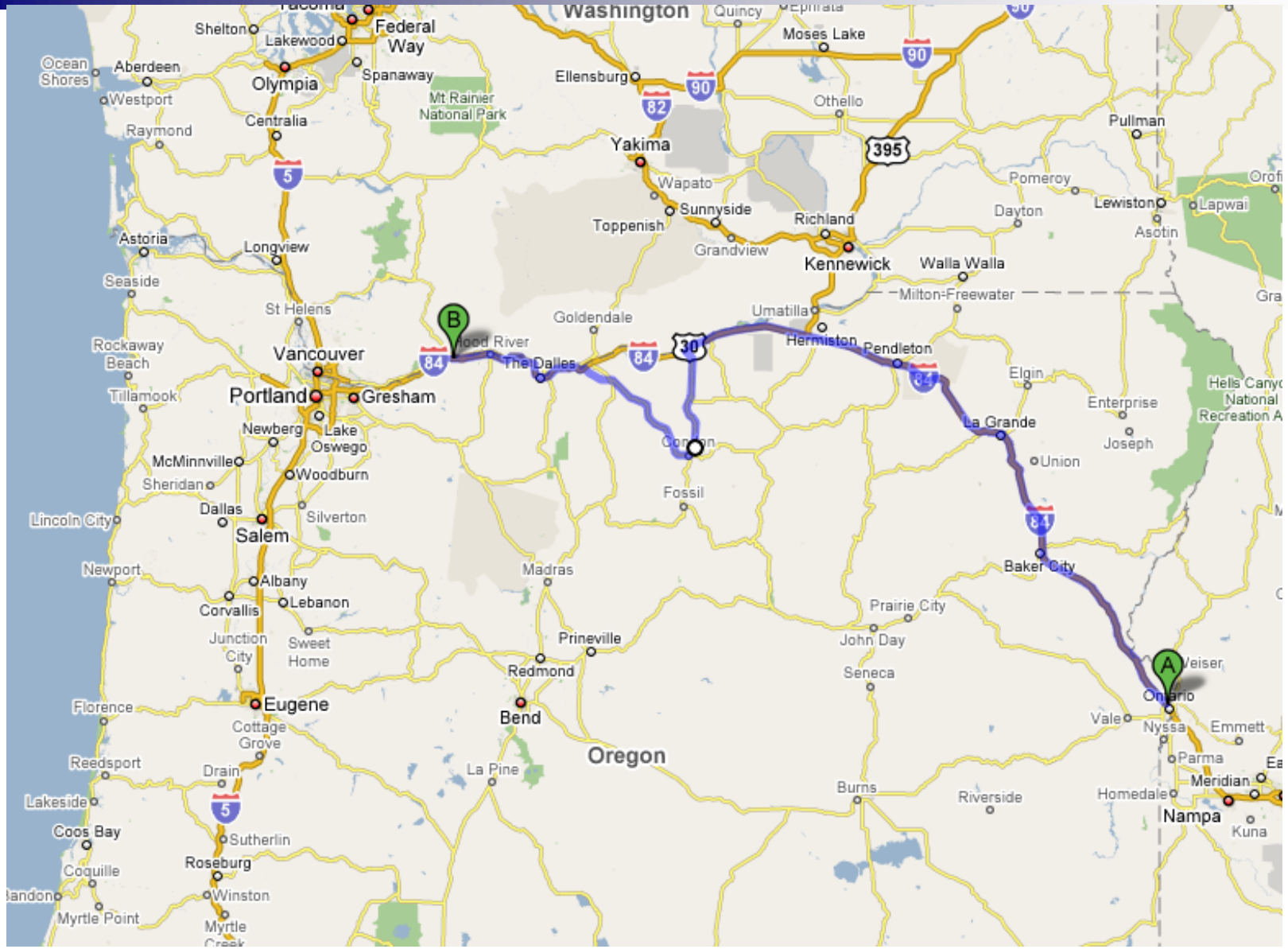

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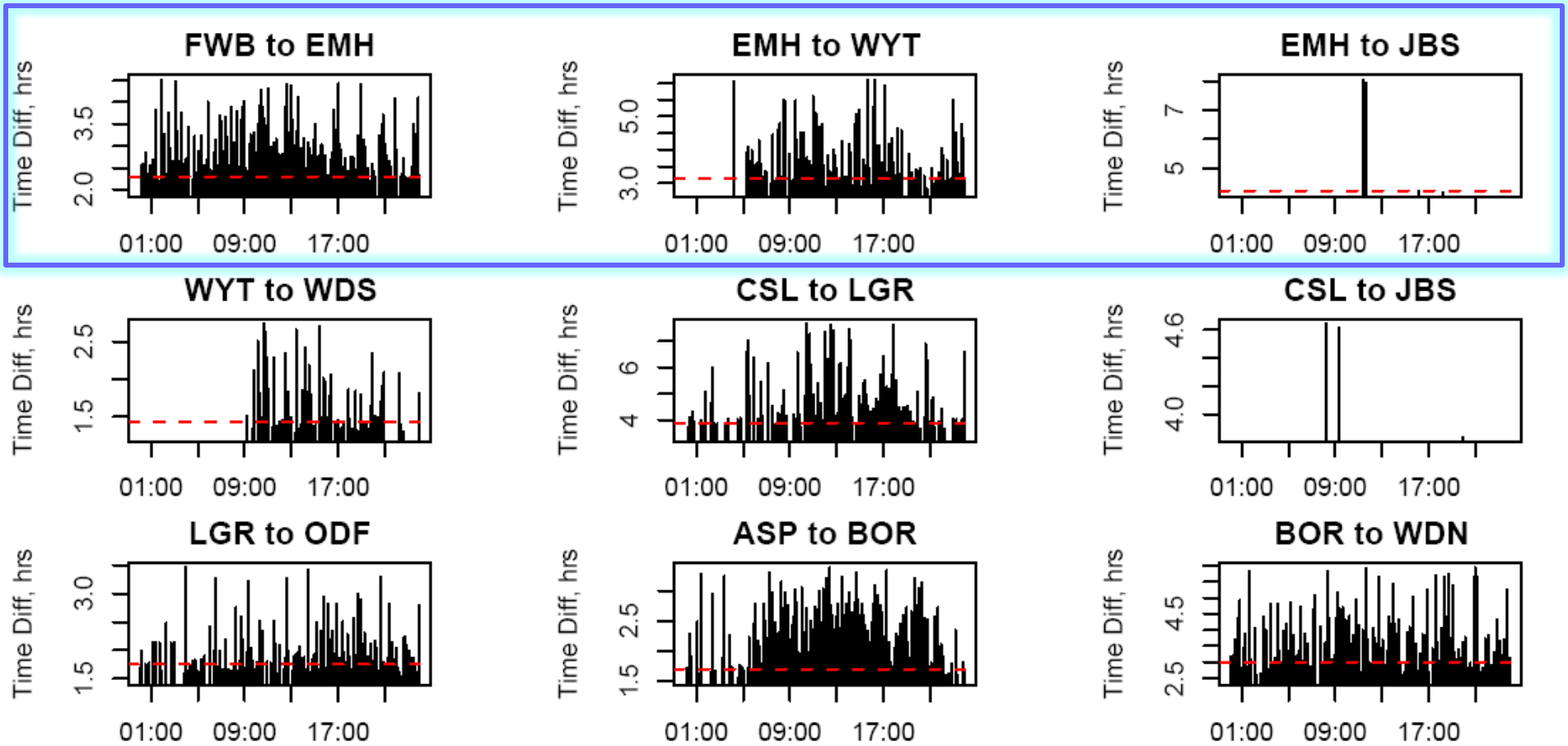
Travel Time, Oct 1 2007



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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















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WIM Classification Algorithm

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

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