Using Commercial GPS Data to Quantify Truck Performance on Rural Roads

Edward McCormack

University of Washington

NRITS

August 30, 2011

Public Transportation Agencies Need Truck Data

- Most of North America's freight is moved on trucks.
- Beyond a few roadside volume counts, public agencies have minimal truck data.
- The private sector has GPS truck fleet data. How should public agencies acquire and use this data?

Commercial Fleet Management GPS

- Numerous vendors sell GPS services to trucking companies. Used to track and dispatch trucks, monitor driver performance.
- Report using a cellular connection.
- One estimate is 25% of trucks have these GPS.
- Data is a “waste” product of the trucking industry.

We Buy this Truck GPS Data from Vendors

- GPS vendors realize selling data is a new revenue stream.
- One-stop shopping – one GPS vendor includes a large number of trucking businesses.
- Good technical support from the vendors for pushing out the data.
- Relatively inexpensive (compared to a research-oriented data collection program).
  - Less than a $0.01 a truck per day.

Partners

- Washington Trucking Associations: Initiated and supported the project
- Washington State DOT: Owns the data and will respond with construction projects to remove bottlenecks
- University of Washington: Provides technical staff, build databases, developing truck data tools

WTA

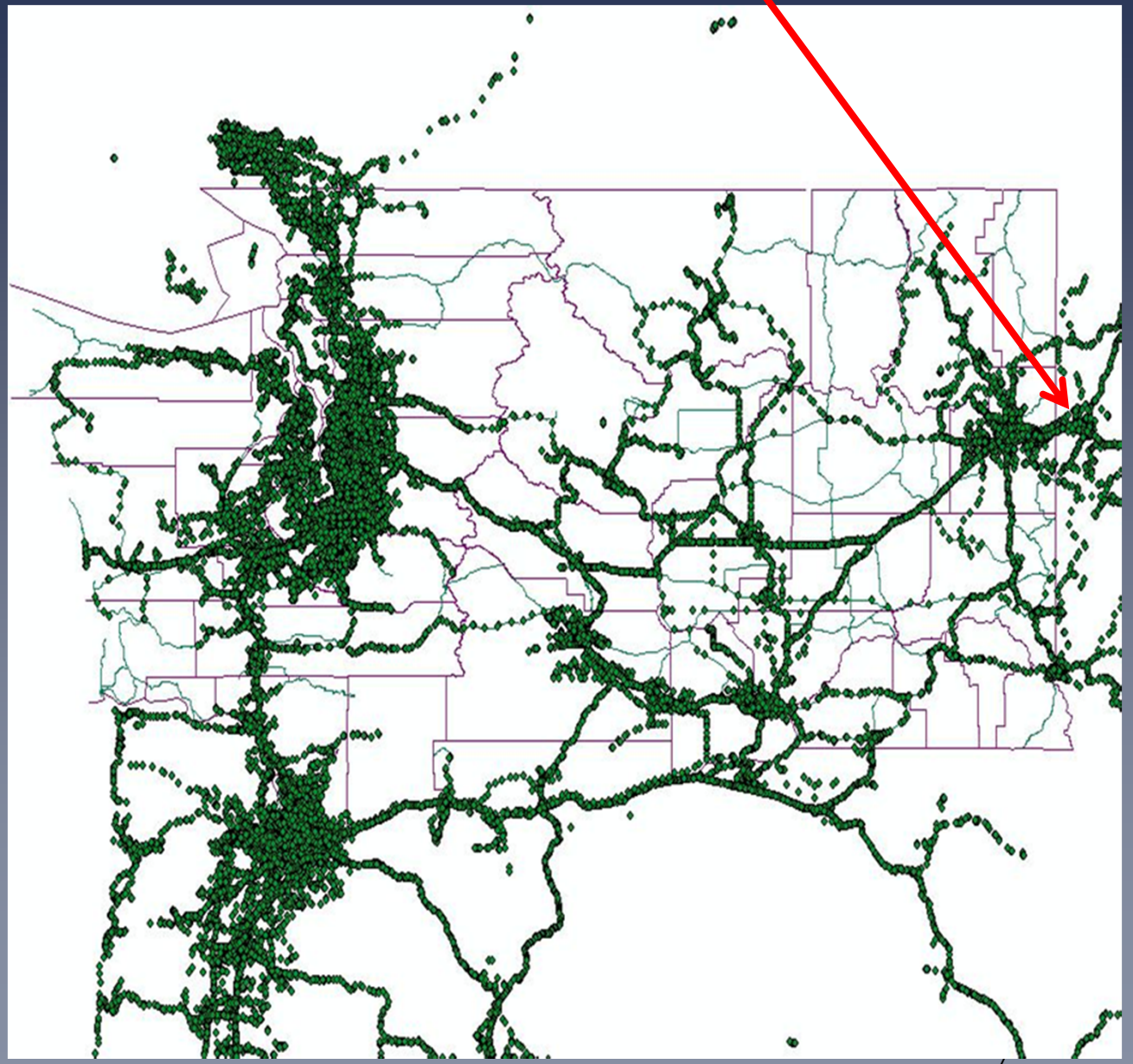
Washington State Department of Transportation

UNIVERSITY of WASHINGTON

The Commercial GPS Data

- Includes at least: lat/long, time/date stamp, travel direction, spot speed, truck ID.
- The data is collected for trucking company business needs and not for public sector use.
  - Due to cellular cost, the truck's location report are often infrequent (every 10 to 15 minutes when moving).
- One vendor can provide many probe trucks.

Data Acquisition - One Day of Data



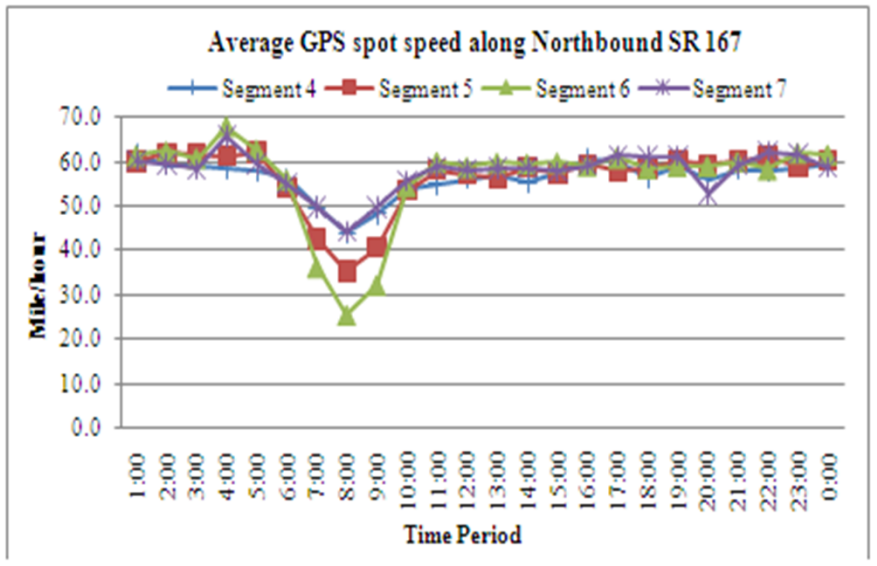
Data Issues

- Setting up a automated processing mechanism is necessary since the database includes millions of points.
- Due to privacy protection - you do not know the truck's size, class, or cargo.
- The raw data requires considerable processing:
  - Error checking.
  - Fixing GPS signal problems.
  - Geo-locating (snapping) in a GIS to roadway.
  - Locating trip origins and destinations.

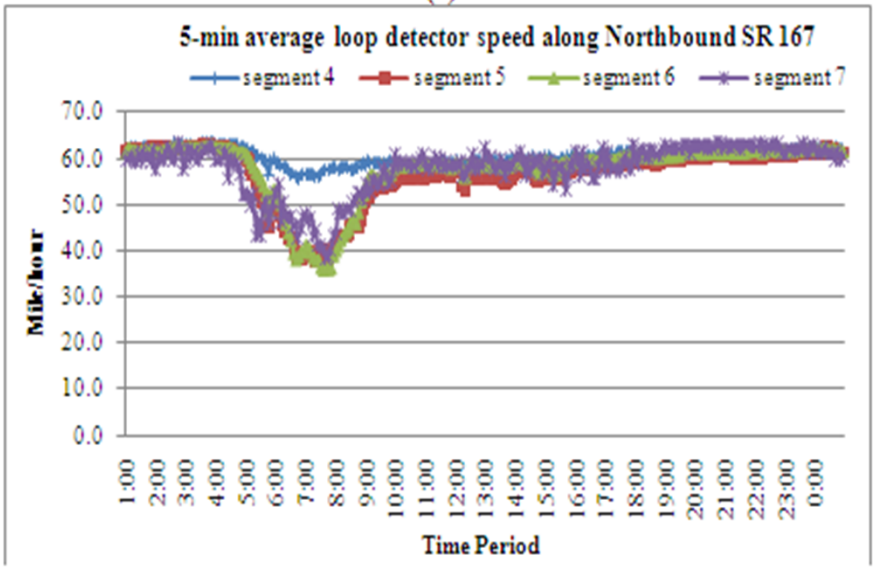
How do we do with this data?

- We have (for WSDOT):
  - developed methodology to identify and rank statewide truck highway bottlenecks
  - looked at freight mobility both before and after construction projects
  - provided truck network travel times for truck forecasting models
- We plan to:
  - explore truck travel patterns by time of day and season
  - look at drivers' trip linking behavior
  - support air quality monitoring

Verify GPS Spot Speeds with Roadway Loop Data



(a)

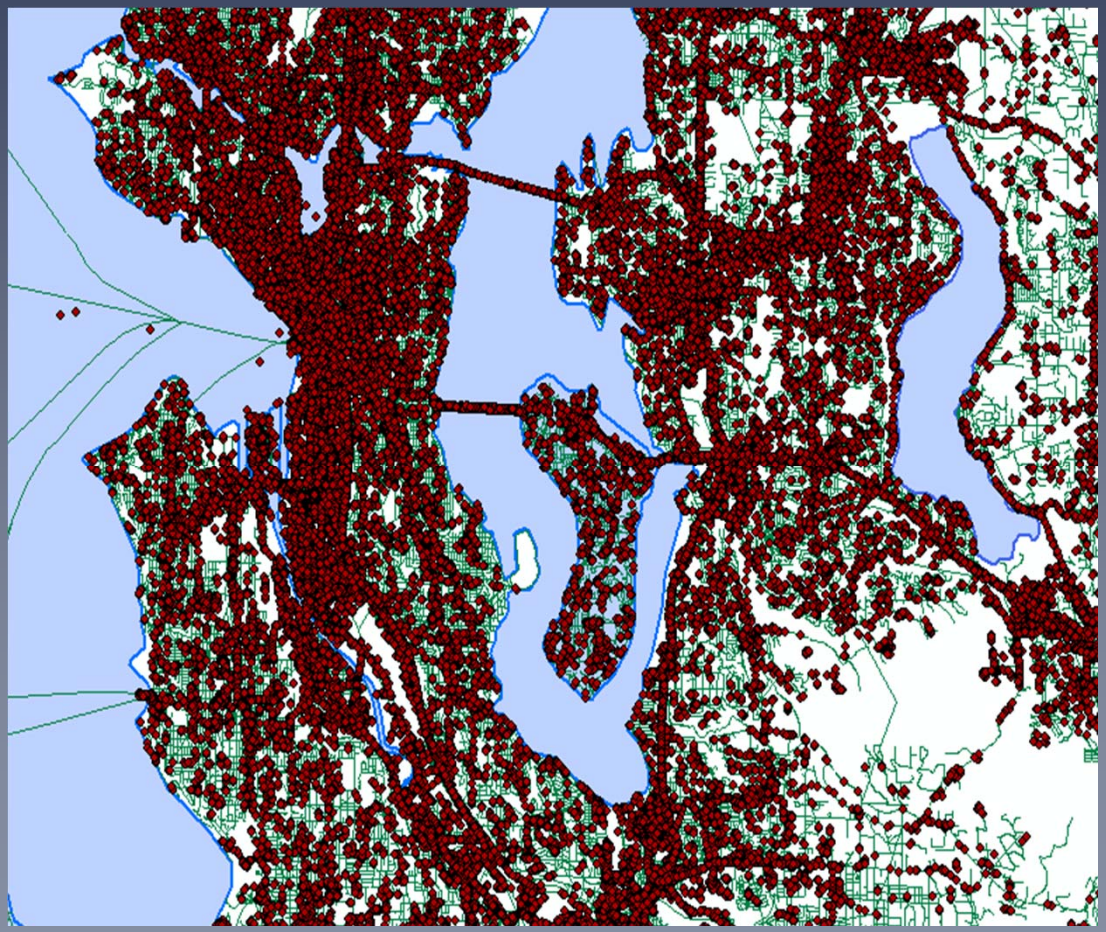


(b)

Identifying truck bottlenecks

Step 1 - Code truck Global Positioning System (GPS) data to Washington State's freight corridors.

We have data from 6,000 trucks each day



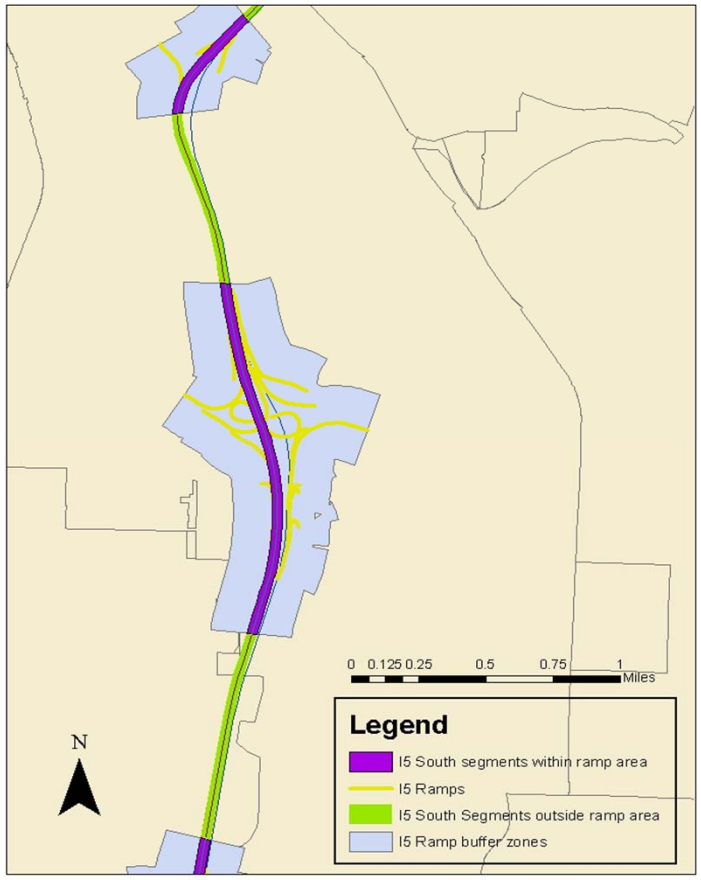
Identifying truck bottlenecks

Step 2 – Pre-determine segments to analyze on the state's major truck corridors

We divided the state highway system into segments according to:

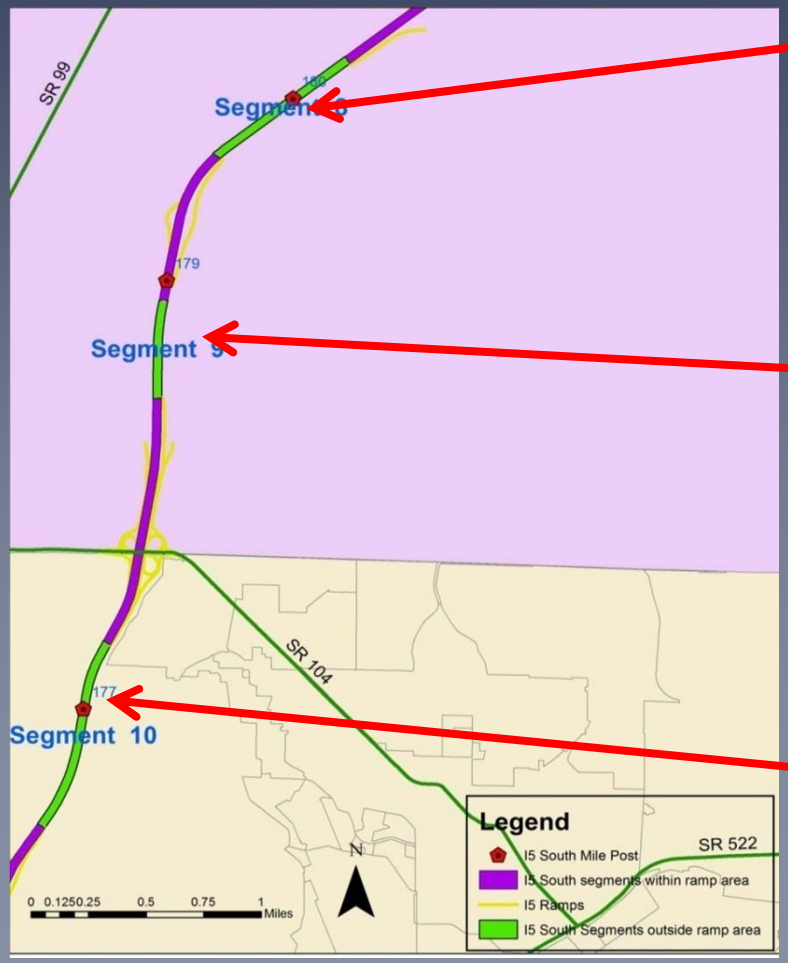
The location of ramps and major (signalized) intersection and in some rural areas by distance.

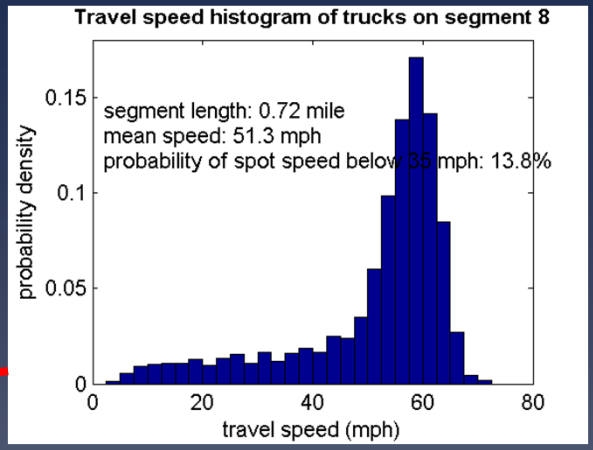
22,000 segment in Washington

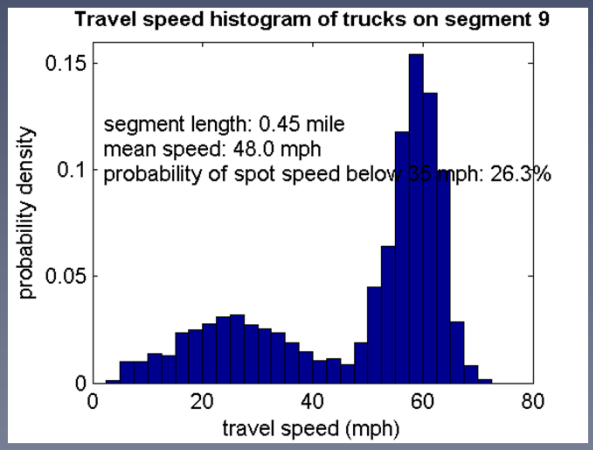


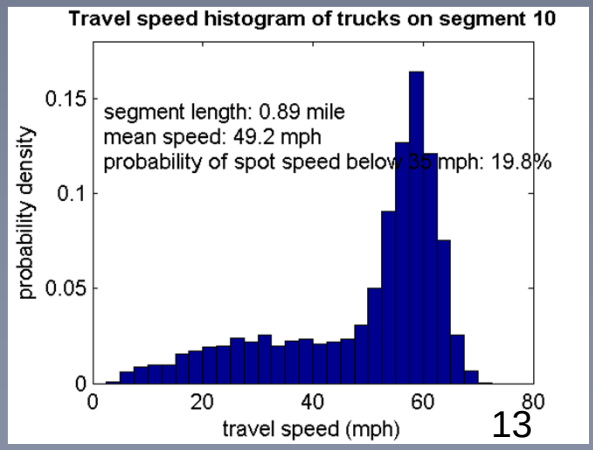
Identifying truck bottlenecks

Step 3 – Automatically pull GPS data from trucks traveling on the predetermined corridor segments.







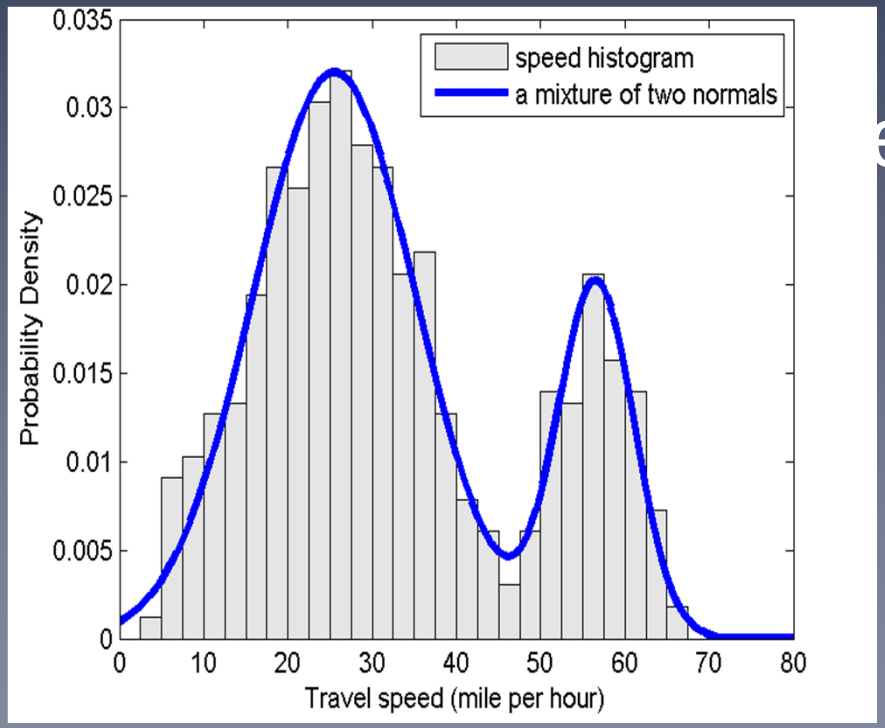


Identifying truck bottlenecks

Step 4 – Determine each segment's reliability by analyzing truck speed data by time-of-day

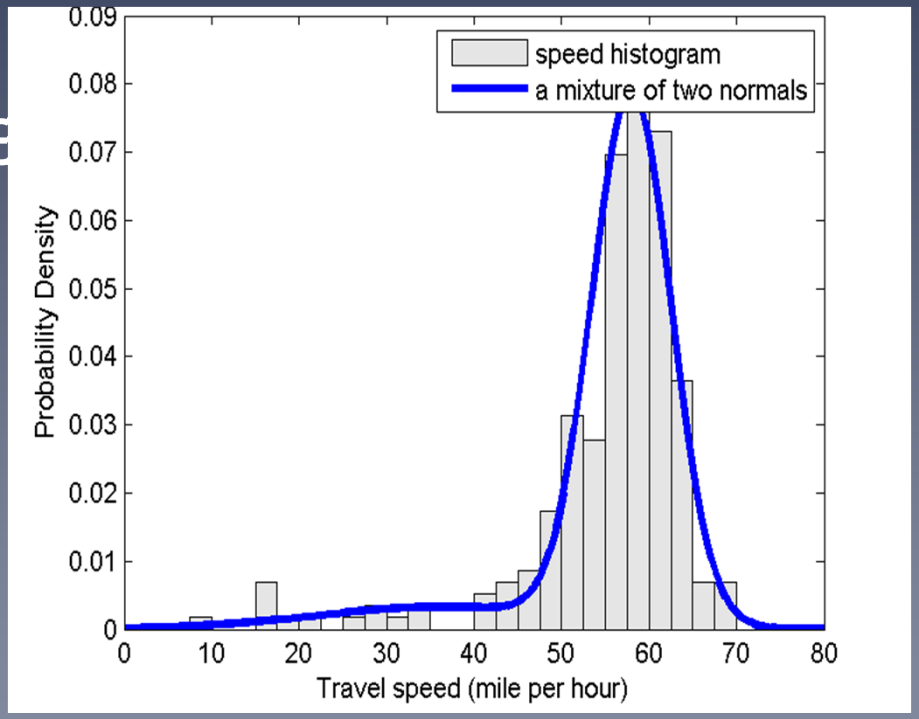
AM Peak

Speed distribution for SB I-5 (Snohomish County between 220th SW and 236th SW)



PM Peak

Speed distribution for SB I-5 (Snohomish County between 220th SW and 236th SW



The diagram on the left shows a highway segment that is unreliable in the AM peak. The diagram on the right shows that trucks reliably travel at 50 to 65 miles per hour in the PM peak on the same segment.

Identifying truck bottlenecks

Step 5 – Define and apply criteria to rank the highway bottlenecks

We developed four criteria to identify and rank truck bottlenecks:

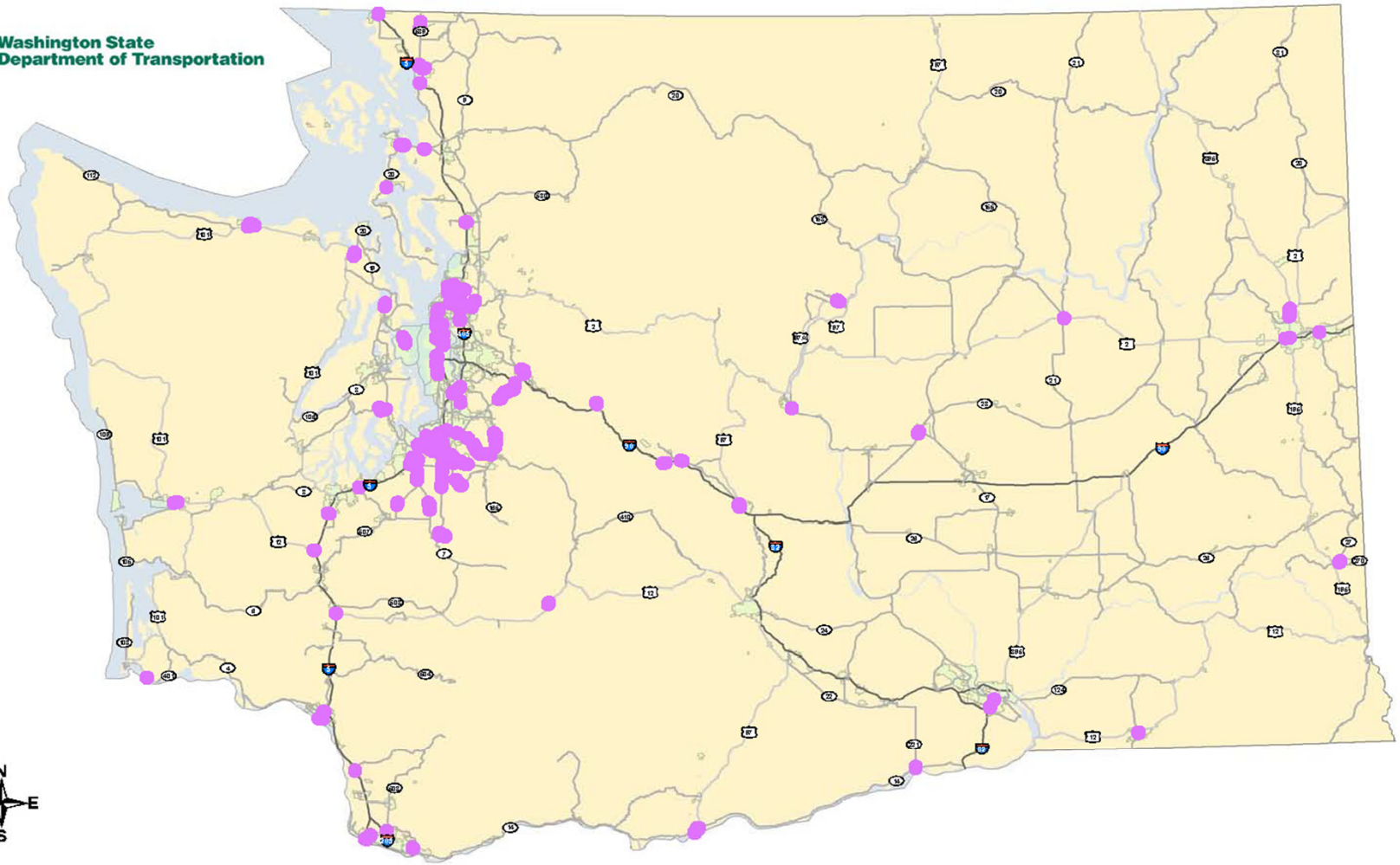
1. Truck speed below severe congestion threshold, which WSDOT has defined as 60 percent of posted speed (35 miles per hour on urban freeways),
2. Average speed,
3. Speed distribution (reliability), and
4. Truck volume.

Percentage of truck speeds falling below severe congestion threshold on southbound I-5

Segment Location	6AM-9AM	9AM-3PM	3PM-7PM	7PM-6AM	Average
NE 63rd St and NE Pacific Ave E	53.9%	51.7%	80.1%	6.9%	48.2%
NE Pacific St and Eastlake Ave E	39.9%	41.8%	78.3%	7.7%	41.9%
NE 75th St and NE 63rd St	43.2%	43.9%	69.4%	8.1%	41.2%
NE 80th St and NE 75th St	37.4%	41.1%	66.6%	7.1%	38.0%
NE 90th St and NE 79th St	29.1%	39.2%	56.3%	2.0%	31.7%
Eastlake Ave E and SR 520	13.7%	26.0%	82.8%	4.1%	31.6%
SR 520 and I-90	20.2%	22.4%	66.4%	5.0%	28.5%
NE 95th St and NE 90th St	19.1%	35.1%	57.0%	1.7%	28.2%
NE Pacific St and Eastlake Ave E	7.6%	38.4%	57.9%	3.5%	26.8%
NE 123rd St and NE 117th St	14.9%	19.7%	34.3%	2.8%	17.9%

Truck Bottlenecks on the Strategic Freight & Goods Transportation System

Washington State Department of Transportation



Truck Bottleneck
City Limits

Filters:
Truck speed less than 60 percent of Posted Speed Limit (Top 40 segments in Puget Sound and the rest of the state for a total of 80)
Length of grade greater than 1.00 mile where grade is 3.5 percent or greater
Truck AADT less than 250

cpe/freight_final.mxd

Severe statewide truck bottleneck:

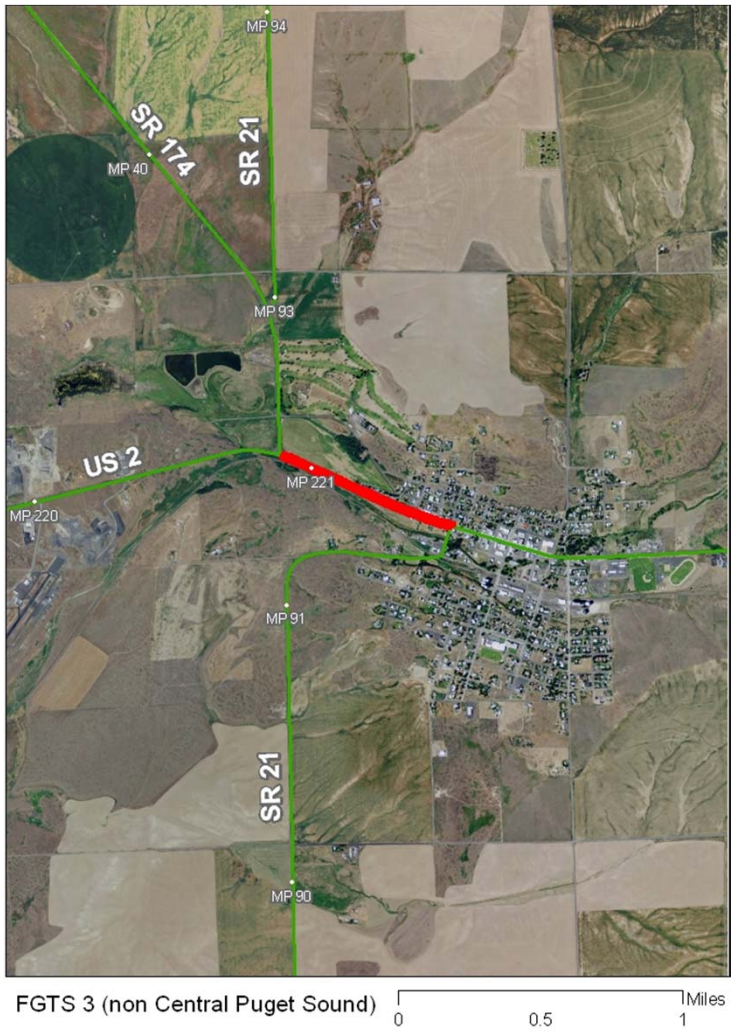
IS 82 eastbound

- Location: IS 82 eastbound, south of IS 90, Ellensburg, WA
- Length: 2.00 miles
- Daily Truck Volume: 4,400

- Average truck travel speed: 46 mph
- Percentage of travel speed below 60% of posted speed limit: 47%
- Travel Reliability: Unreliable

Severe statewide truck bottleneck:

SR 2 westbound



- Location: SR 2 westbound, east of SR-21, Wilbur, WA
- Length: 0.65 mile
- Daily Truck Volume: 480

- Average truck travel speed: 21 mph
- Percentage of travel speed below 60% of posted speed limit: 85%
- Travel Reliability: Unreliable

Severe statewide truck bottleneck:

SR 221 westbound

- Location: SR 221 westbound, east of SR-22, Prosser, WA
- Length: 1.46 mile
- Daily Truck Volume: 980

- Average truck travel speed: 31 mph
- Percentage of travel speed below 60% of posted speed limit: 86%
- Travel Reliability: Unreliable

Results Plugged in WSDOT's Planning Process

1. Capital Program Development and Management Office
2. WSDOT's regional offices for comments
3. Eventually root cause analysis (is infrastructure or congestion the root of the problem)
4. Hopefully infrastructure improvements

Extending the Value of the Data

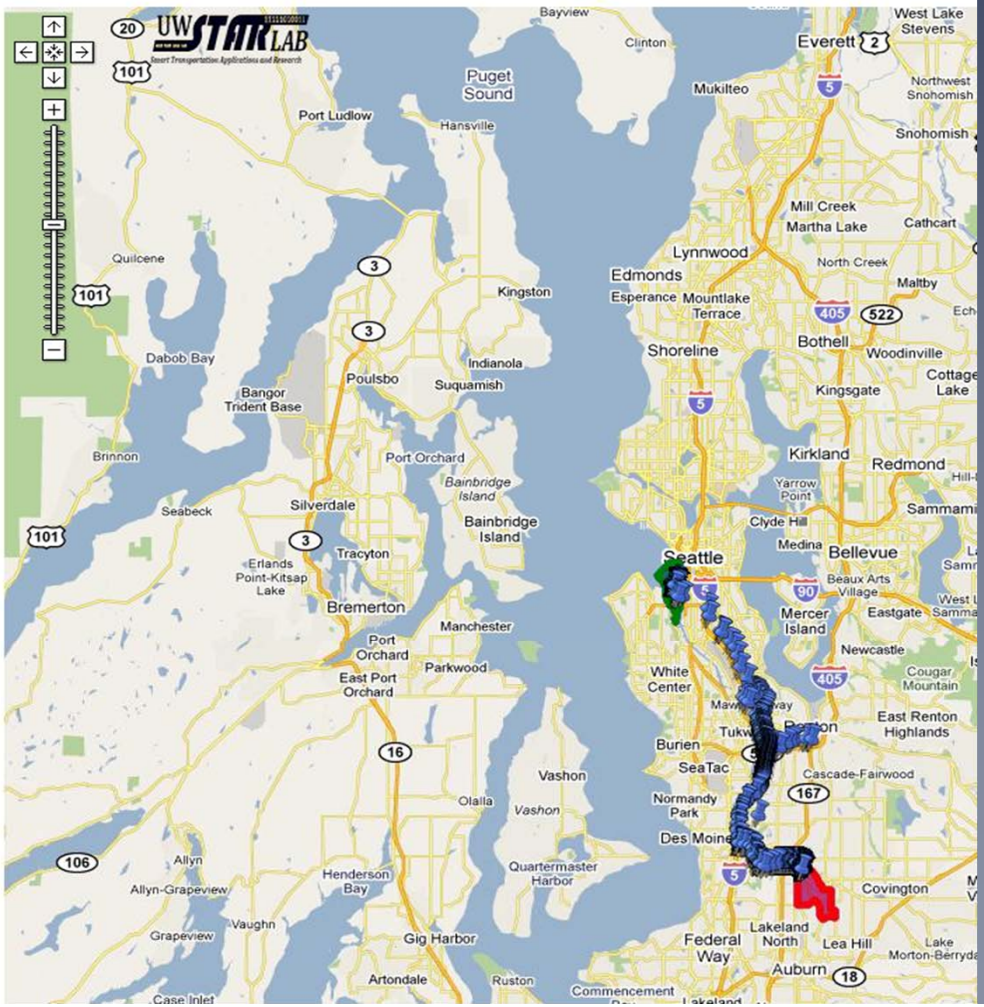
Interactive Database

DRIVE Net | *Digital Roadway Interactive Visualization and Evaluation Network*

Freight Performance Measures(Back)

Total Access Trips: 469
Average Travel Time: 33.2 min.
Travel Time Variance: 4.8 min.
95 percentile Travel Time: 42.5 min.
Average Travel Speed: 36.2 mph
Travel Speed Variance: 4.2 mph
Average Travel Distance: 19.7 mile
Planning Time Index: 1.4
Travel Time Index: 1.1
Buffer Time Index: 1.3
Free-Flow Travel Time: 31.3 min.
Free-Flow Travel Speed: 37.7 mph
Minimum Sample Size: 6
Total AM Trips: 54
Average AM Travel Time: 32.7 min.
Average AM Travel Speed: 36.3 mph
Total Mid Trips: 125
Average Mid Travel Time: 37.1 min.
Average Mid Travel Speed: 32.6 mph
Total PM Trips: 123
Average PM Travel Time: 33.4 min.
Average PM Travel Speed: 35.9 mph
Total Evening Trips: 75
Average Evening Travel Time: 30.8 min.
Average Evening Travel Speed: 38.5 mph
Total Overnight Trips: 81
Average Overnight Travel Time: 30.1 min.
Average Overnight Travel Speed: 39.5 mph
Total Weekend Trips: 10
Average Weekend Travel Time: 30.3 min.
Average Weekend Travel Speed: 39.5 mph.

Show GPS Points

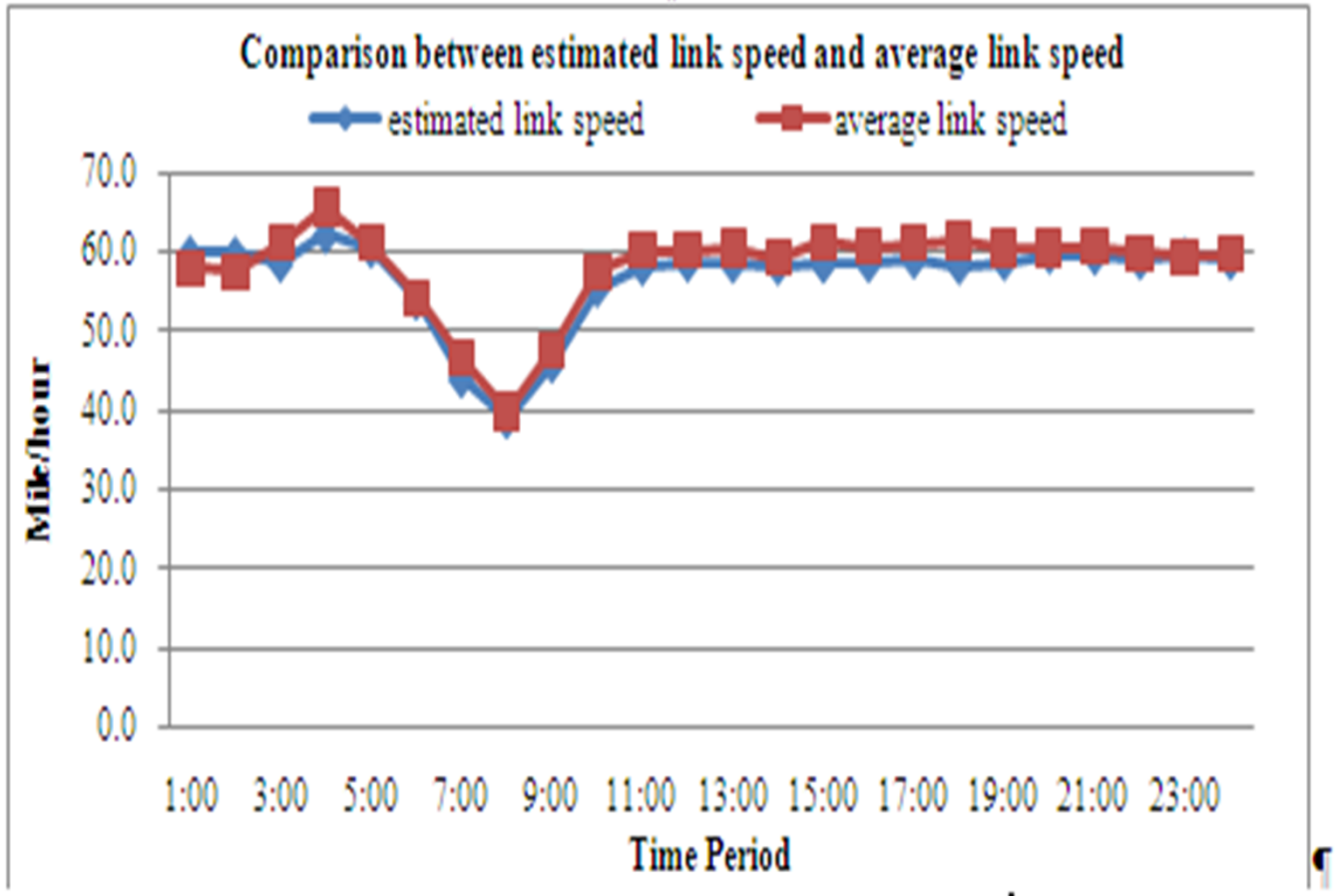


Questions?

Ed McCormack
University of Washington
(206) 543-3348
edm@uw.edu

Extend the Value of the Data

- Look at border delay?
- Inform the cross-border travel demand model
- Recognize there will be better data as more truckers install GPS devices and as location read rates improve.
- We have a relationship with the GPS vendors and are working with them to develop more value – they are willing.
- This data supports other such as developing freight models.
  - Better network assignment.
  - Trip generation for models.
  - Quantifying zone to zone freight movements.
  - Air quality modeling.



·link·composition·on·southbound·SR·167.

Summary – Use of GPS Data

It's efficient to contract with vendors for truck GPS data

There are advantages:

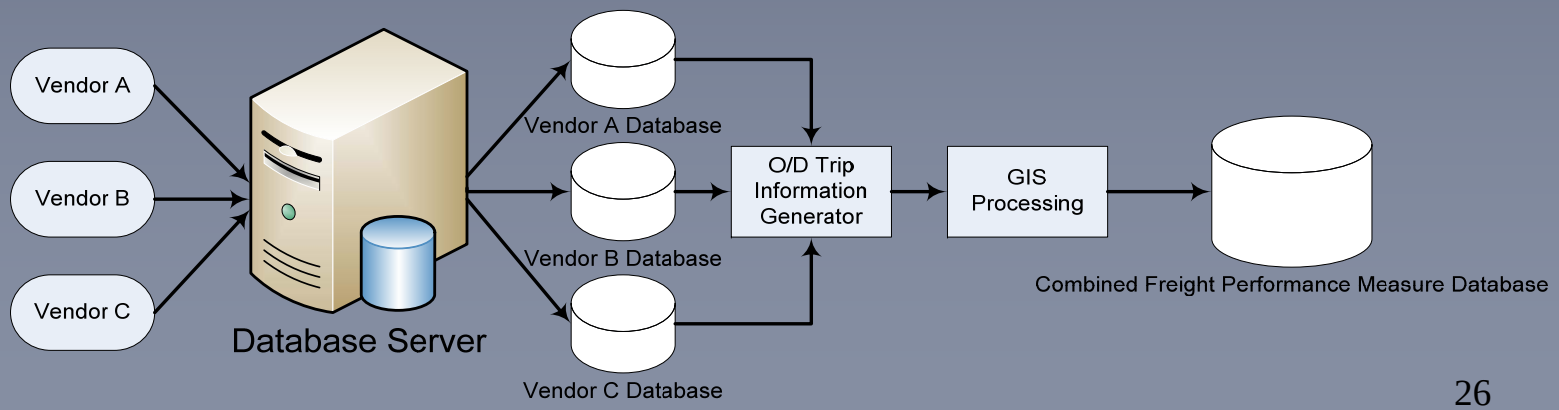
- Each vendor collects data from many trucking companies.
- Technical support is available.
- You pay for the data so have a business relationship.
- The data will be improving with more trucks and better GPS devices.

And disadvantages to working with vendors:

- You have to pay for the data and protect privacy.
- Contracts and non-disclosure agreements are required, so attorneys are involved.
- Each source requires a different technical connection.
- The output data satisfy the trucking companies' needs - not the public sector's needs.

WSDOT- Data Collection Process

- Each dataset required a custom connection developed in cooperation with the GPS vendor's technical staff.
- The automated database handles large quantities of data – we have been collecting data for more than a year.



Buying Truck GPS Data from Individual Businesses

- In the Seattle area, trucking and freight firms agreed to provide their daily GPS data at no cost.
- It did not work because:
  - Sharing data low priority for a business.
  - Lack of technical support.
  - Many different data formats and data feeds required.
  - Multiple types of data agreements would be needed.

Partners

- Washington Trucking Associations: Initiated and supported the project
- Washington State DOT: Owns the data and will respond with construction projects to remove bottlenecks
- University of Washington: Provides technical staff, build databases, developing truck data tools

WTA

Washington State Department of Transportation

TRANSNOW

But Buying Truck GPS Data

- Requires contracts which can be complicated and time consuming.
- Privacy of the truckers is a major concern.
  - Requires non-disclosure agreements.
  - Limits your ability to distribute disaggregated results and to share data.
- You need a budget.