Vehicle Speed Detection at Signalized Intersections Using High-Resolution Data

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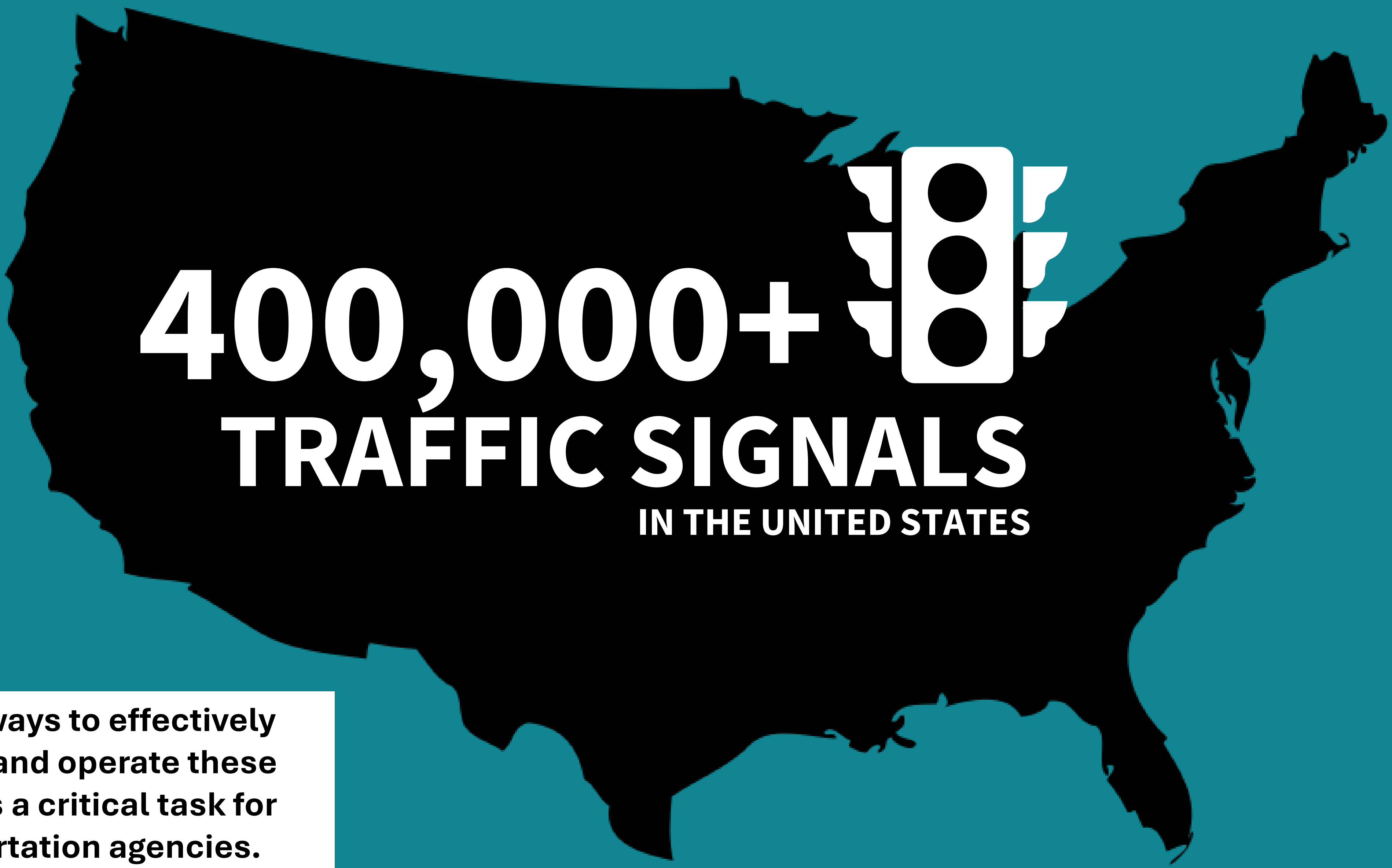
Oregon State University

ITE Western District Annual Meeting
June 28 - July 1, 2026

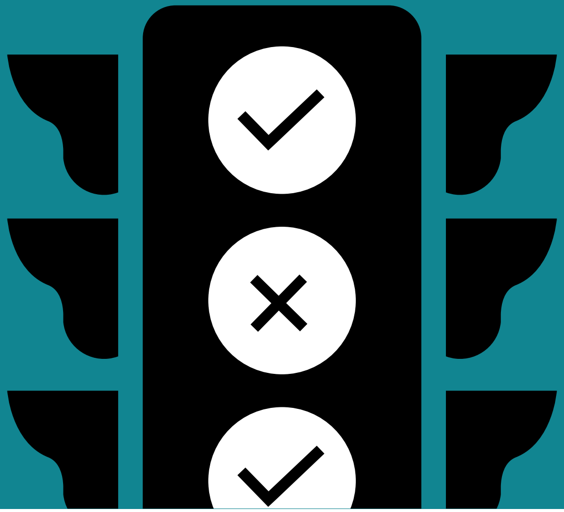
PBOT
PORTLAND BUREAU OF TRANSPORTATION



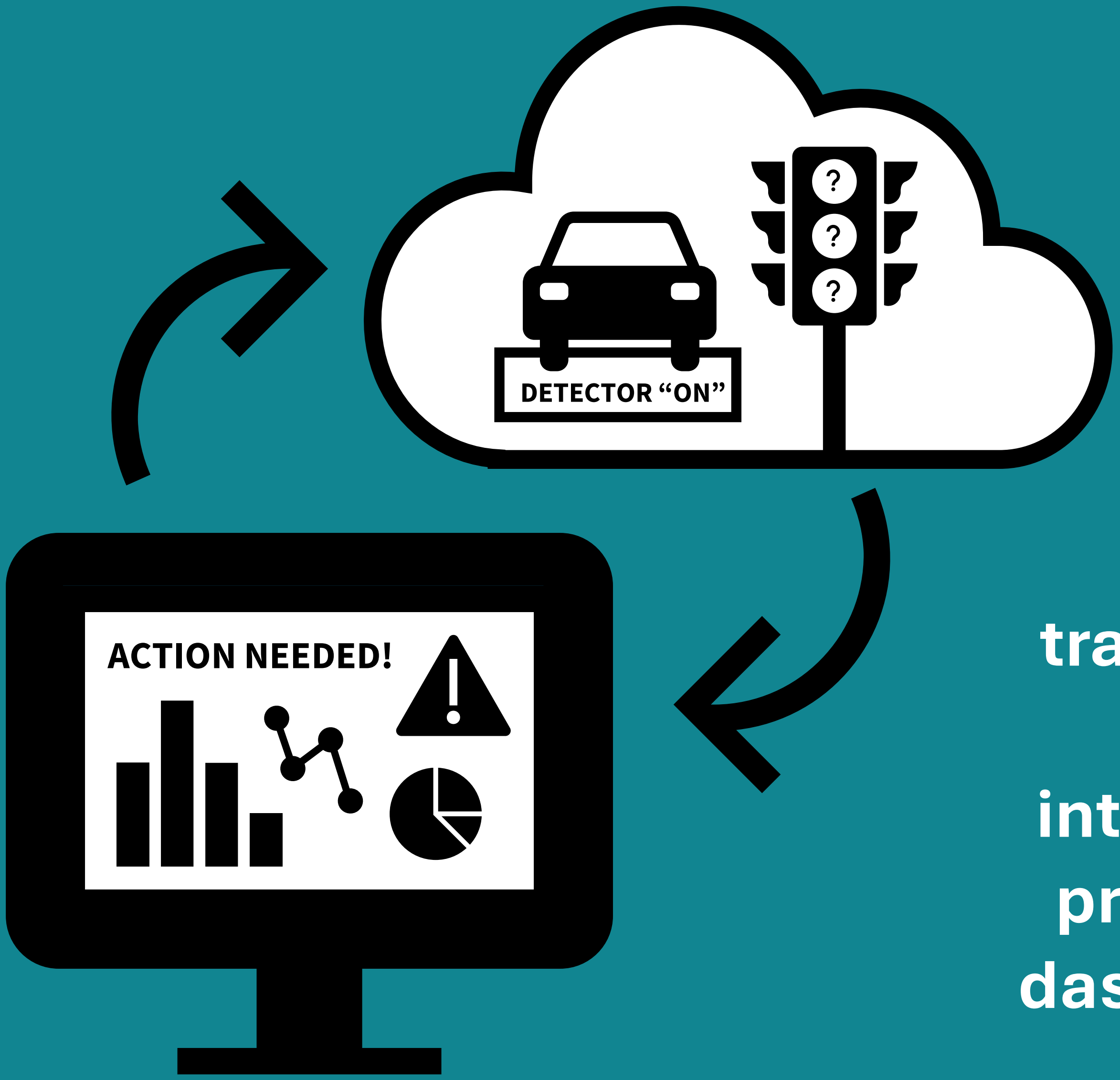
Finding ways to effectively manage and operate these signals is a critical task for transportation agencies.

Source: National Cooperative Highway Research Program (NCHRP) Research Report 954

ATSPM



Automated **T**raffic **S**ignal **P**erformance **M**easures



ATSPM

A framework that allows transportation agencies to collect real-time data from vehicles interacting with traffic signals and processes this data in the form of dashboards and automated alerts.

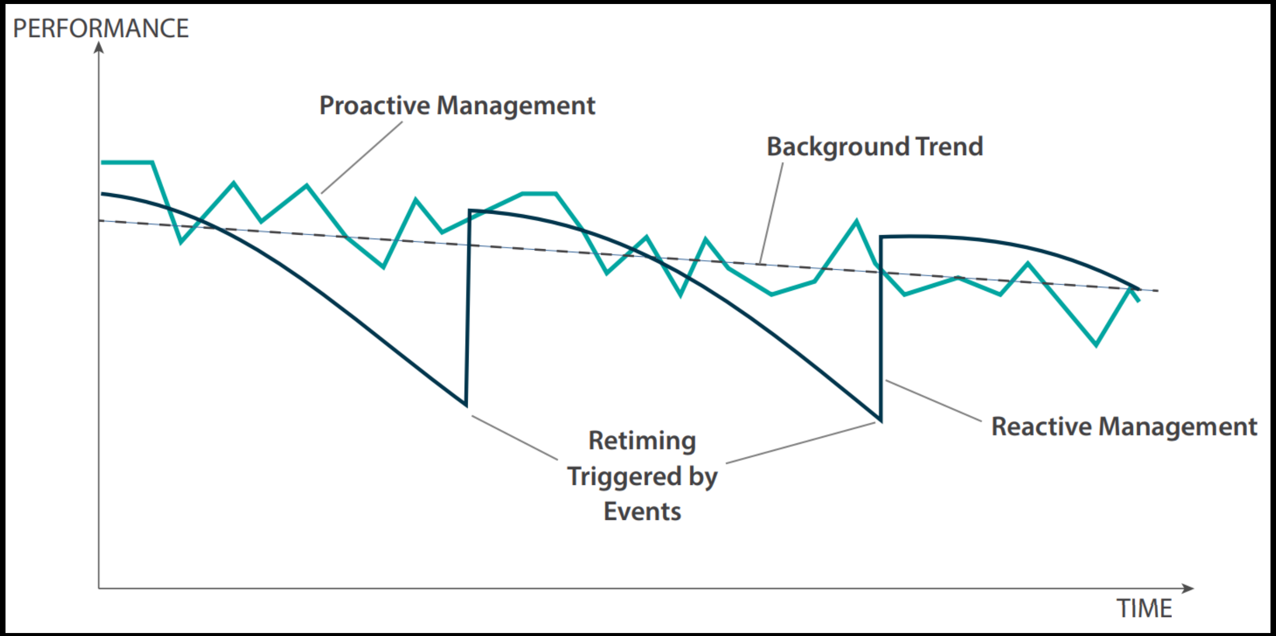
With ATSPM, transportation agencies can quickly identify important issues such as traffic signals that lost power, intersections experiencing excessive delays, or intersections where vehicles are traveling at very high speeds.

REACTIVE VS PROACTIVE MANAGEMENT

One of the most influential benefits of ATSPM is its ability to promote a

CULTURE SHIFT

from **REACTIVE** management to **PROACTIVE** management.



Source: FHWA-HOP-20-003

The incremental changes enabled by PROACTIVE management allow agencies to maintain the performance of traffic signals more consistently over time as compared to REACTIVE management, where performance needs to degrade significantly before it is noticed and addressed.

What if we could leverage **ATSPM** to evaluate vehicle speeds at signalized intersections?

In 2023, there were over 2.4 million people injured in our roads.

Source: NHTSA (2025)

NATIONAL

NATIONAL

From 40,000+ fatalities, over 11,000 occurred in speeding related crashes (2023).

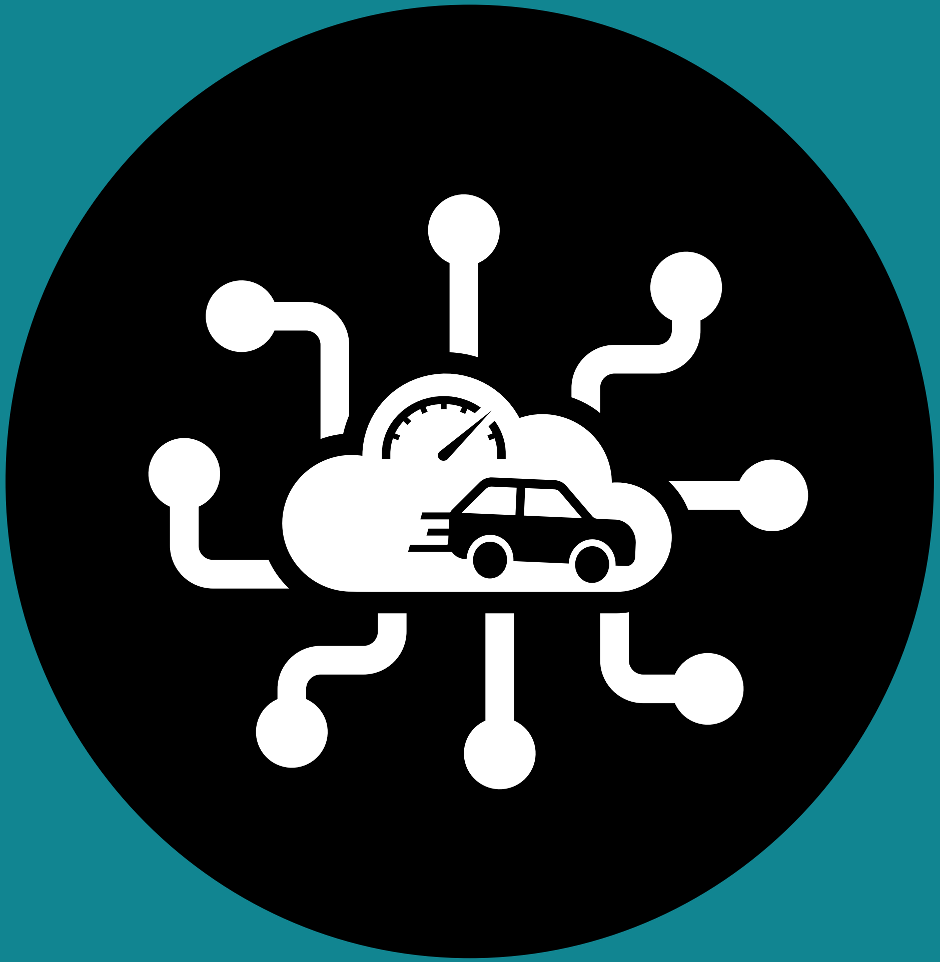
Source: NHTSA (2025)

In 2023, 58% of traffic deaths in Portland, OR involved speeding.

Source: 2023 Portland Deadly Traffic Crash Report

PORTLAND, OR

Speeding is consistently identified as a major factor in traffic fatalities and injuries in Portland, OR and in the United States. Accurate vehicle speed detection at signalized intersections is essential for ensuring traffic safety.



With current advancements in technology, agencies can choose from a variety of speed detection devices.

RADAR SENSORS

Detect vehicles by transmitting radio waves that reflect off vehicles and are received by the device.

PNEUMATIC ROAD TUBES

Detect vehicles by sending a pulse of air pressure along a rubber tube when a vehicle passes over it.

HANDHELD LIDAR

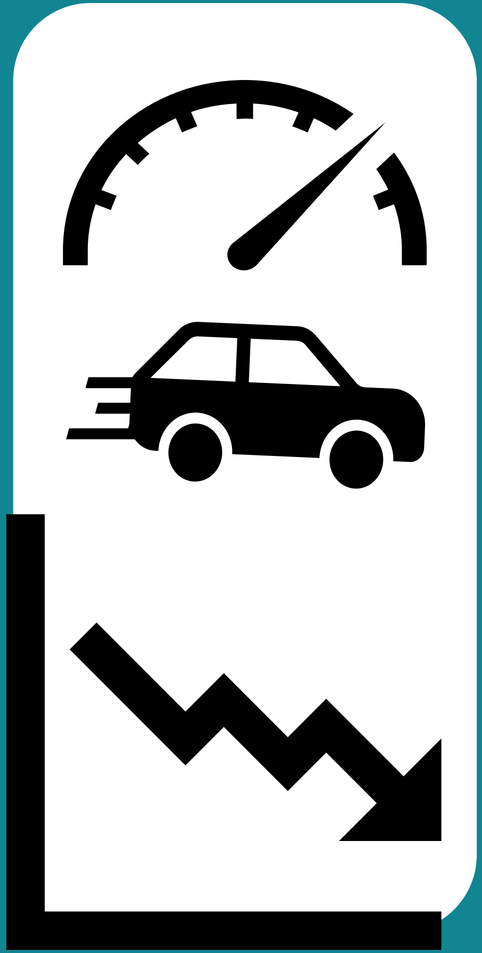
Detect vehicles by transmitting light pulses that reflect off vehicles and are received by the device.

Let’s dive deeper into how we leveraged these technologies during our research collaboration with the Portland Bureau of Transportation (PBOT).

1

RESEARCH OBJECTIVE

VISION ZERO



PBOT’s goal is to eliminate crashes that result in fatal and serious injuries.

- **Determine if technology already installed in the field can be used to evaluate signal timing interventions.**
- **Confirm that the speed data sourced from radar sensors is accurate.**
- **Test signal timing strategies for reducing speeding.**

RESEARCH OBJECTIVE

Validate speed data collected from traffic signal-mounted radar sensors using data collected from pneumatic road tubes (ground truth) and handheld LiDAR.

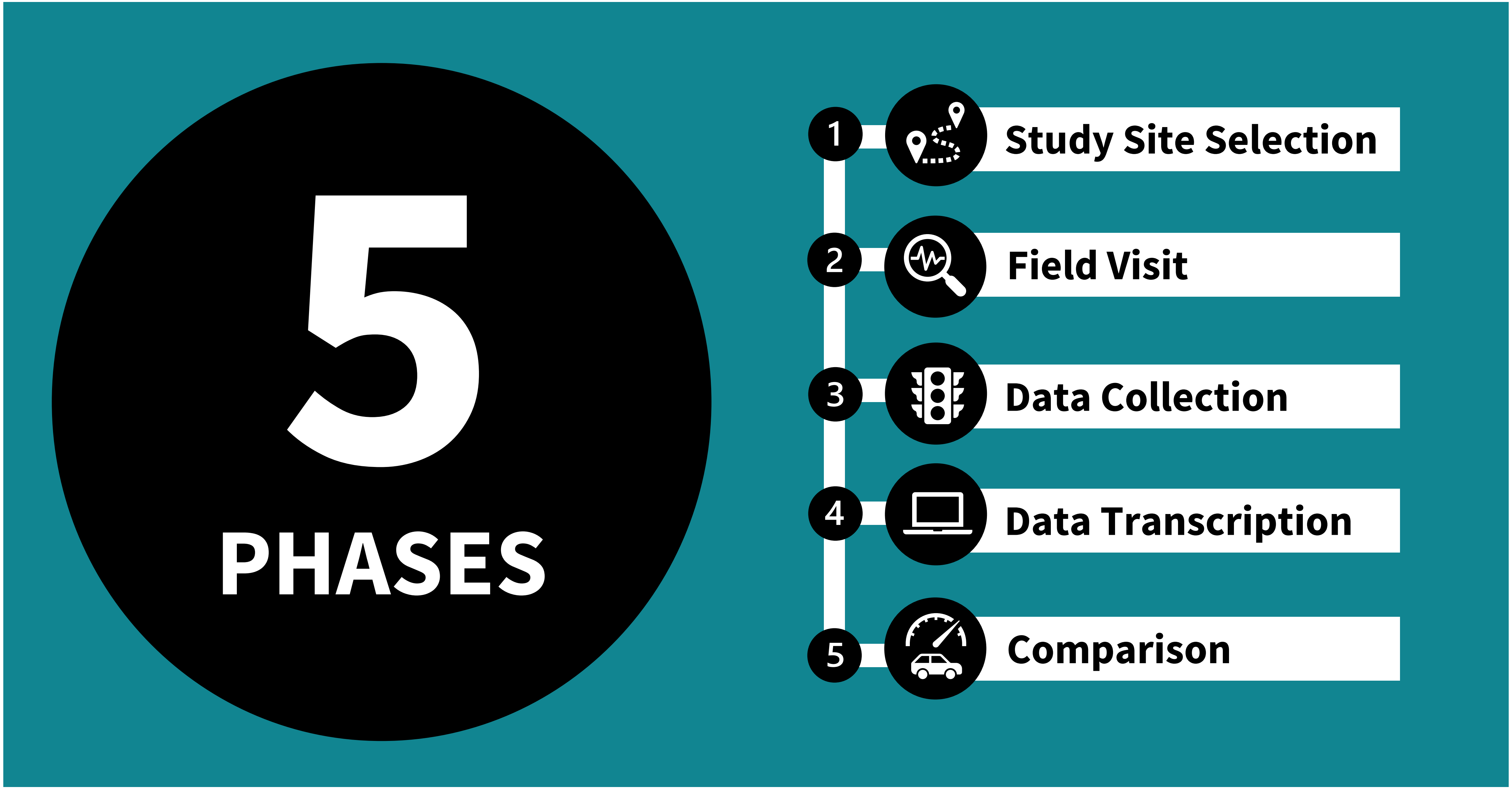
RADAR SENSORS

PNEUMATIC ROAD TUBES

HANDHELD LIDAR

2

METHODOLOGY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PHASES
1 Study Site Selection
2 Field Visit
3 Data Collection
4 Data Transcription
5 Comparison

1

Study Site Selection

2 INTERSECTIONS in Portland, Oregon.

MLK & Tillamook and MLK & Fremont

KEY FEATURES

- Signalized & Coordinated
- Portland's High Crash Network
- Pan-Tilt-Zoom (PTZ) Cameras
- Radar Detection Units (RDU)
- Advanced Transportation Controllers (ATC) with Communication

2 Field Visit

Distance From Each Other

~0.7 mi

Posted Speed Limit

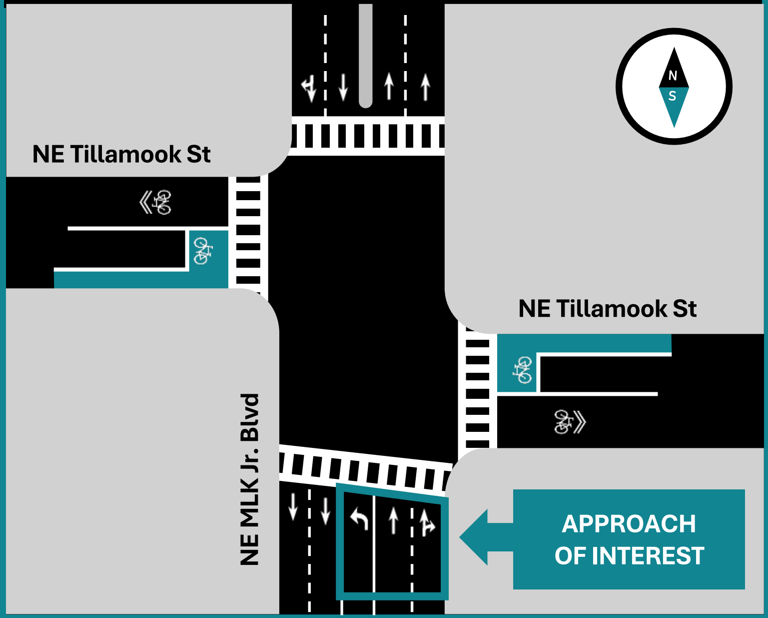
30 mph

Approach of Interest

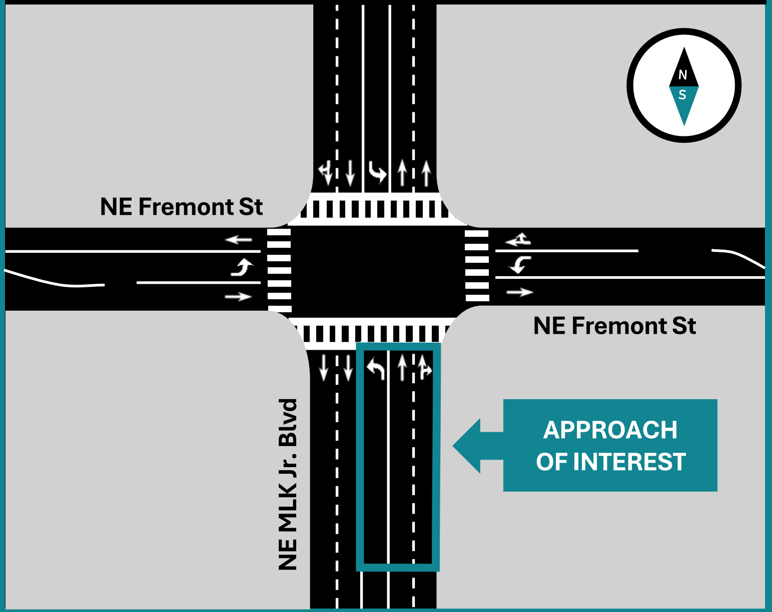
Northbound

SELECTED STUDY SITES IN PORTLAND, OREGON

MLK & TILLAMOOK



MLK & FREMONT



3 **Data Collection** | **Data Collected By PBOT**

- **Pneumatic Road Tube Data.**
- **High-Resolution Data (Radar Sensors).**

24 Hrs. Across 4 Days

+

Saturday thru Tuesday (June 10-13, 2023).

3 Data Collection

Data Collected By OSU

- **Handheld LiDAR Data.**

~2 Hrs. Per Intersection

Saturday (June 10, 2023).

30+ Free-Flow Vehicles

4

Data Transcription

Pneumatic Road Tubes

DATA CLEANING

Raw data was first quality checked and cleaned by removing all observations where tube failures were experienced.

DATA FILTERING

The data was then filtered to include observations of 35 mph and above to match the speed filters from the radar sensors.

DESCRIPTIVE STATISTICS

Descriptive statistics and visualizations were then generated using Excel and R Studio.

4

Data Transcription

Handheld LiDAR

Free-flow speeds at each of the two intersections were recorded using handheld LiDAR guns (ProLaser 4).

DATA CLEANING

Raw data was first quality checked and cleaned by removing all observations marked with “ignore” due to occlusion issues.

DESCRIPTIVE STATISTICS

Descriptive statistics and visualizations were then generated using Excel and R Studio.

4

Data Transcription

Radar Sensors

4 Advance Count detectors with speed filters: 35-39 mph, 40-44 mph, 45-49 mph, 50-100 mph.

R CODE DEVELOPMENT

To transcribe the high-resolution dataset (with 200,000+ data points per intersection), a code was developed in R Studio.

DATA FILTERING

The R code filters the high-resolution data by Event Code 82 (On) and generates a vehicle count for each detector.

DESCRIPTIVE STATISTICS

Using the midpoint speed in each speed filter and the vehicle counts, descriptive statistics and visualizations were then generated.

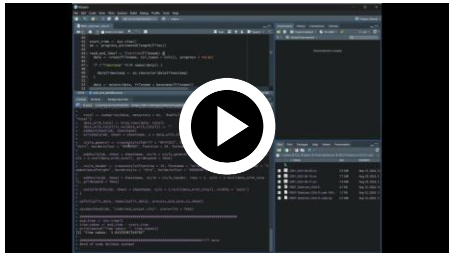
4 Data Transcription

Radar Sensors

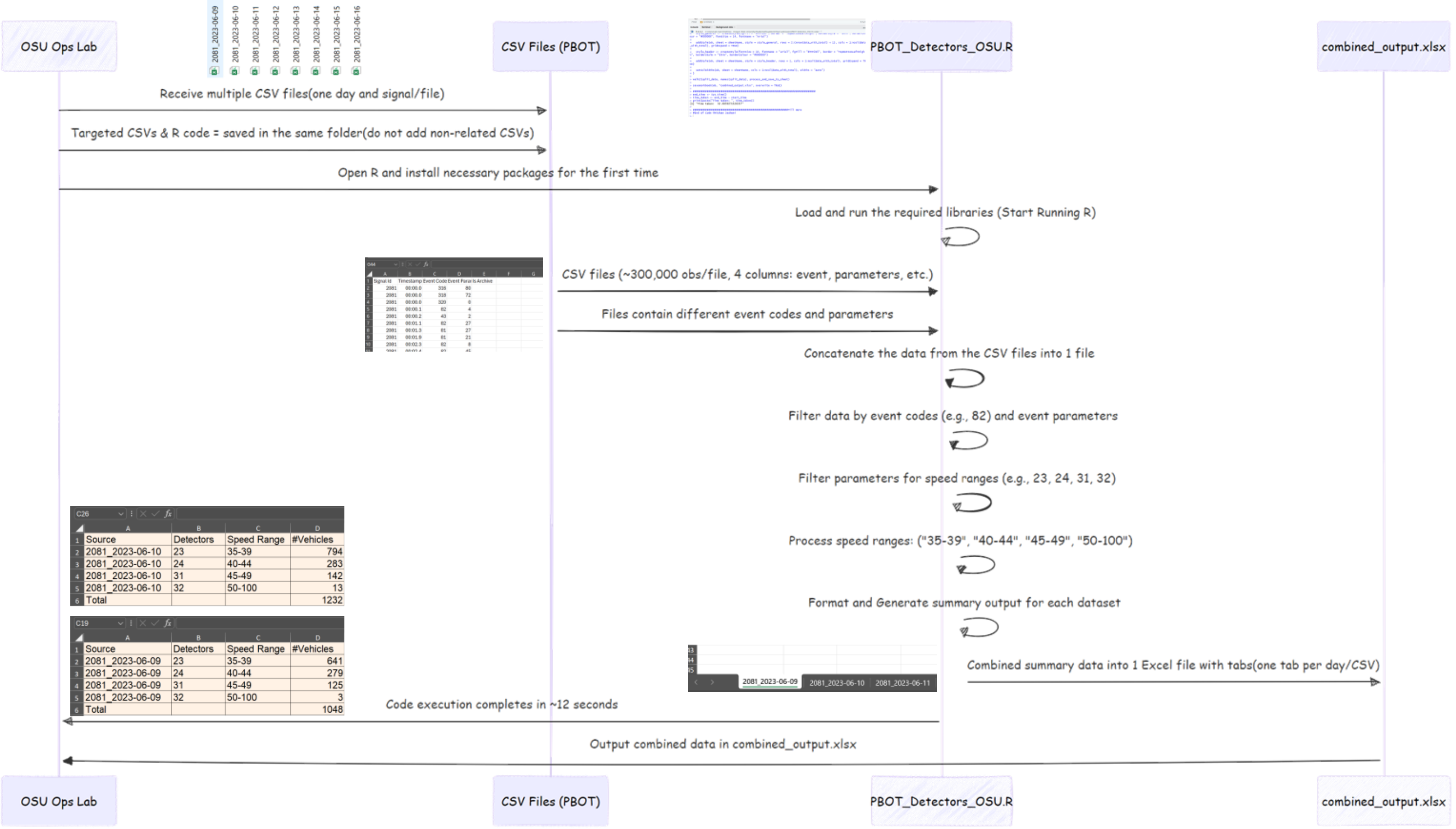
TRANSCRIPTION PROCESS

Data was transcribed using a code developed by Dr. Hisham Jashami.

VIDEO DEMONSTRATION



CODE FLOWCHART



5 Comparison

1st Comparison

VS

RADAR SENSORS

PNEUMATIC TUBES

2nd Comparison

VS

PNEUMATIC TUBES

HANDHELD LIDAR

3

RESULTS

1st Comparison

Mood's Median Test (95%)

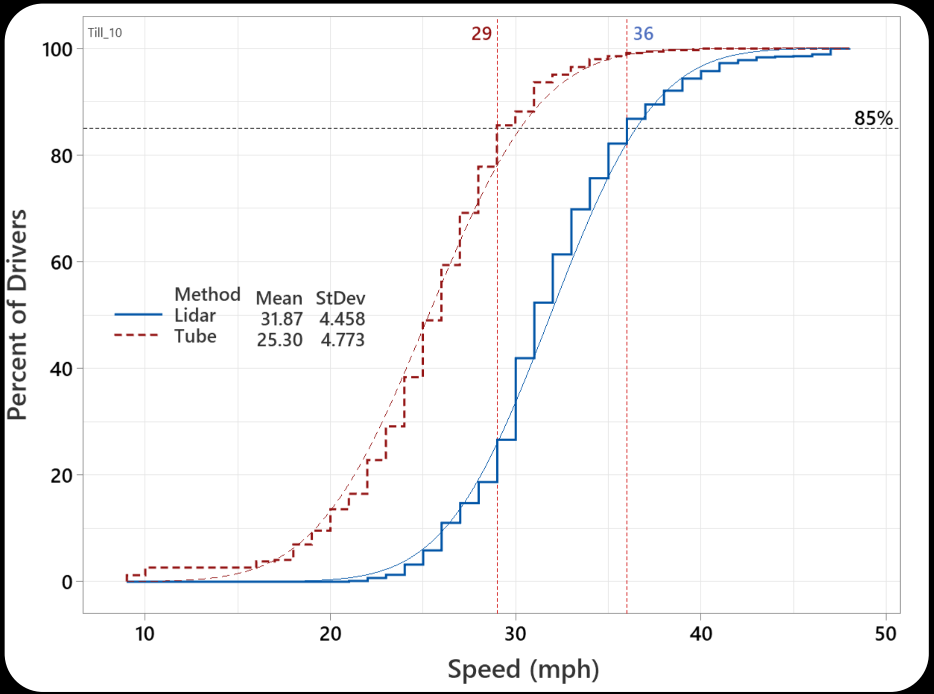
RADAR SENSORS VS PNEUMATIC TUBES

Intersection	Date	Device	Mean	Std	Median	Mode	N	P-Value
MLK & Tillamook	Saturday 6/10/23	Radar	40.60	4.87	37.50	37.50	290	**0.374**
		Tube	37.69	3.79	36.00	35.00	347	
	Sunday 6/11/23	Radar	40.60	4.60	37.50	37.50	326	**0.052**
		Tube	37.40	3.08	36.00	35.00	343	
	Monday 6/12/23	Radar	40.53	4.69	37.50	37.50	457	**0.056**
		Tube	37.25	2.86	36.00	35.00	304	
MLK & Fremont	Saturday 6/10/23	Radar	39.99	3.79	37.50	37.50	1232	**0.012**
		Tube	38.15	3.42	37.00	35.00	578	
	Sunday 6/11/23	Radar	40.08	3.78	37.50	37.50	1353	**0.685**
		Tube	37.71	3.63	37.00	35.00	582	
	Monday 6/12/23	Radar	40.11	3.74	37.50	37.50	1684	**0.649**
		Tube	37.61	3.09	37.00	35.00	504	
	Tuesday 6/13/23	Radar	40.37	3.90	37.50	37.50	1598	**0.468**
		Tube	37.53	2.75	36.00	35.00	317	

2nd Comparison

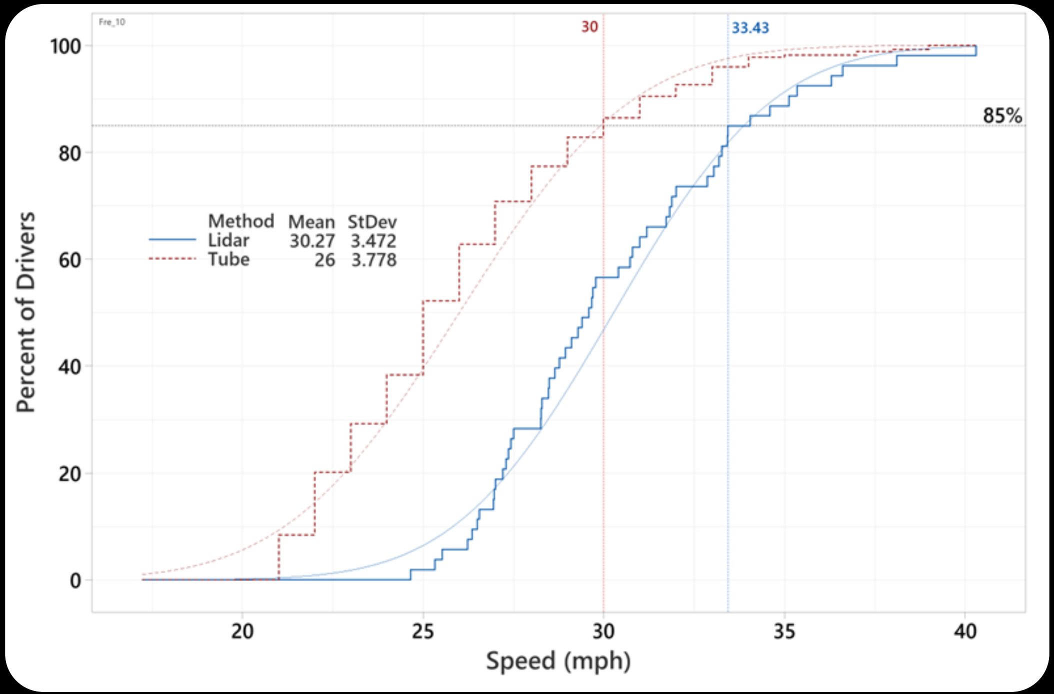
PNEUMATIC TUBES VS HANDHELD LIDAR

MLK & TILLAMOOK (JUNE 10)



At MLK & Tillamook, the average speed collected by LiDAR was 6.6 mph higher than the tubes.

MLK & FREMONT (JUNE 10)

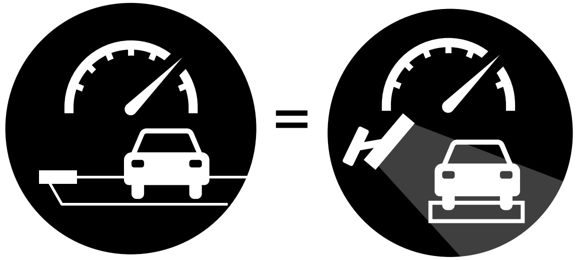


At MLK & Fremont, the average speed collected by LiDAR was 4.3 mph higher than the tubes.

Comparing spot speeds (Tubes) against space speeds (Handheld LiDAR) contributed to the differences in speed observed.

SUMMARY OF STUDY FINDINGS

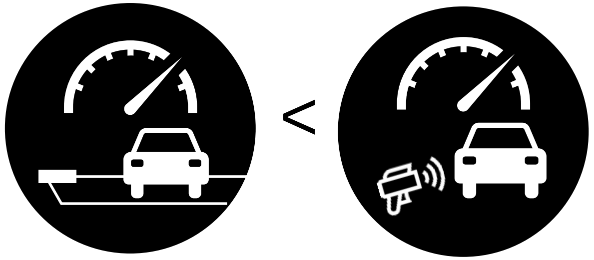
RADAR SENSORS VS PNEUMATIC TUBES



NO STATISTICAL DIFFERENCE BETWEEN SPEEDS COLLECTED.

However, radar sensor speeds can be used to evaluate compliance against a threshold speed limit, but not in absolute terms.

PNEUMATIC TUBES VS HANDHELD LIDAR



LIDAR SPEEDS MODERATELY HIGHER THAN TUBE SPEEDS.

We are comparing spot speeds against space speeds.

4

LIMITATIONS

LIMITATIONS

NUMBER OF STUDY SITES

This study focused on two study sites to develop a proof of concept. Increasing the number of study sites would provide greater variability between sites and would increase the transferability of the results.

LACK OF PER VEHICLE SPEEDS

The radar sensors employed cannot archive individual speeds for each vehicle in each lane.

Thus, mean and median speeds were derived from vehicle counts.

ASYNCHRONOUS ANALYSIS

The code developed in this research is intended for asynchronous analysis, not for real-time monitoring. Future research could further develop code like this for real-time monitoring applications.

5

FUTURE WORK

FUTURE WORK

These validated speed measurements can support ITS applications for monitoring traffic system performance, conducting safety evaluations, and assessing the safety outcomes of signal timing strategies aimed at reducing speeding and red-light violations at signalized intersections.

THANK YOU!

This research was possible thanks to a collaboration with the Portland Bureau of Transportation (PBOT)

Oregon State University

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