Predictive Mobility:
to Increase Safety and Reduce Congestion at Rail Crossings

Kurt Brandt, PhD, CEO
LinqThingz
A Predictive Mobility Company

OUTLINE

Characteristics of Rail, Road, Pedestrian Traffic at Grade Crossings

Safety and Congestion impacts

Measuring Data

Predictive Mobility

Driver Information Systems for Predictive Mobility

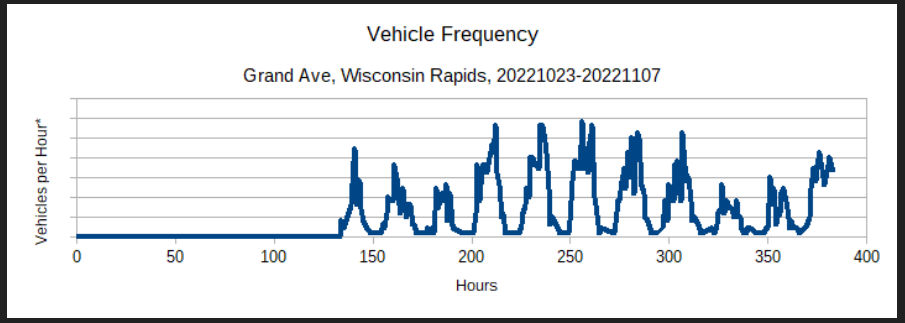
1860s

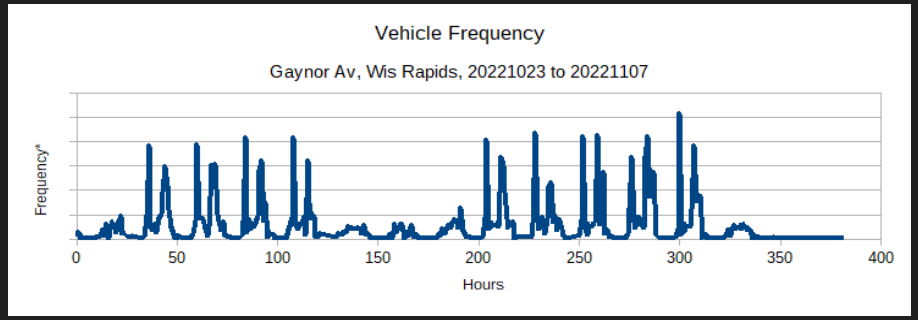
- Roads where Dirt
- Traffic was Horses
- Crossing Speed 4 MPH
- US Population 30M
- Attention Span 20 min
- Transcontinental Rail
- Cross bucks Patented

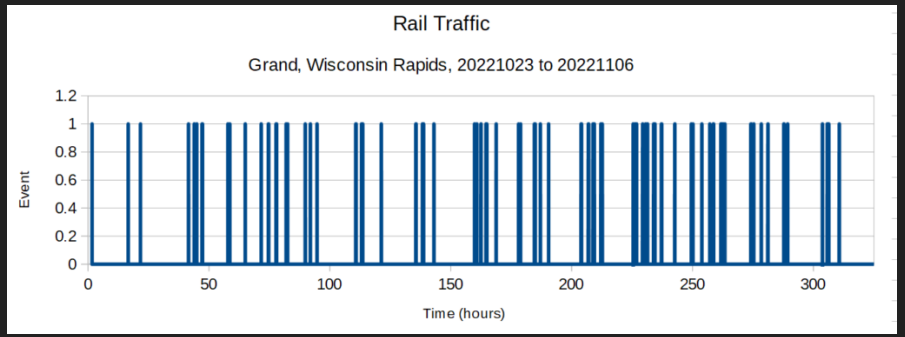
2020s

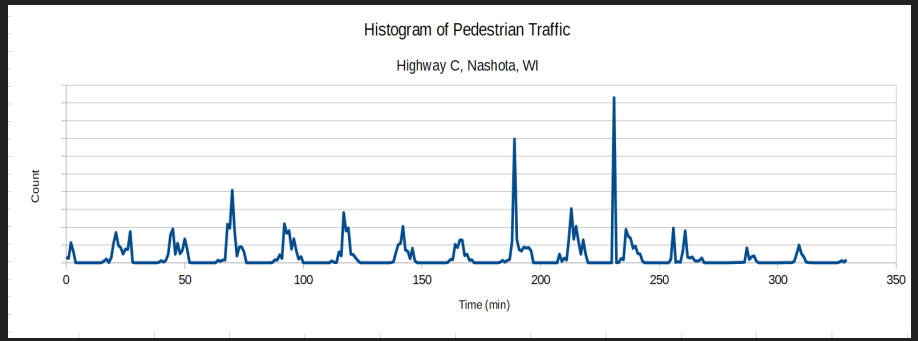
- Roads are Complex
- Fuel/Electric/Autonomous
- US Population 300M
- 250,000 crossings
- Attention Span 9 seconds
- Connected Phones/Cars

Rail Traffic vs Highway Traffic vs Pedestrian Traffic









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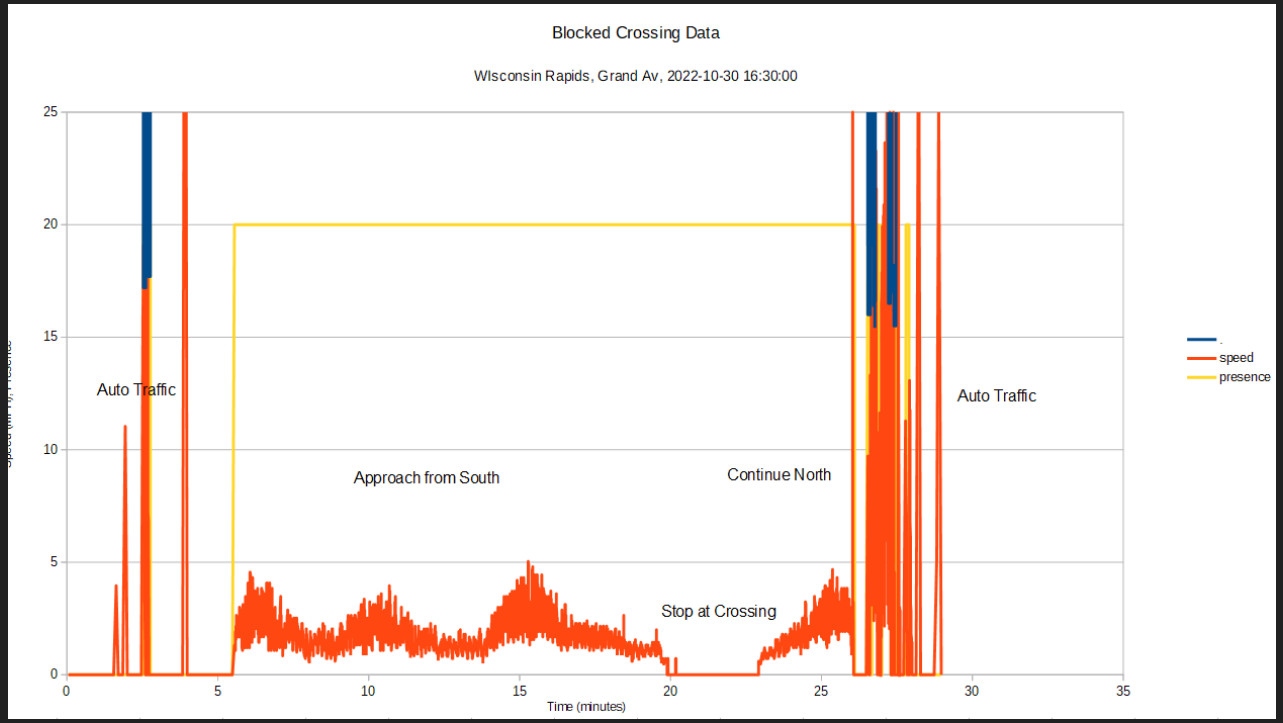
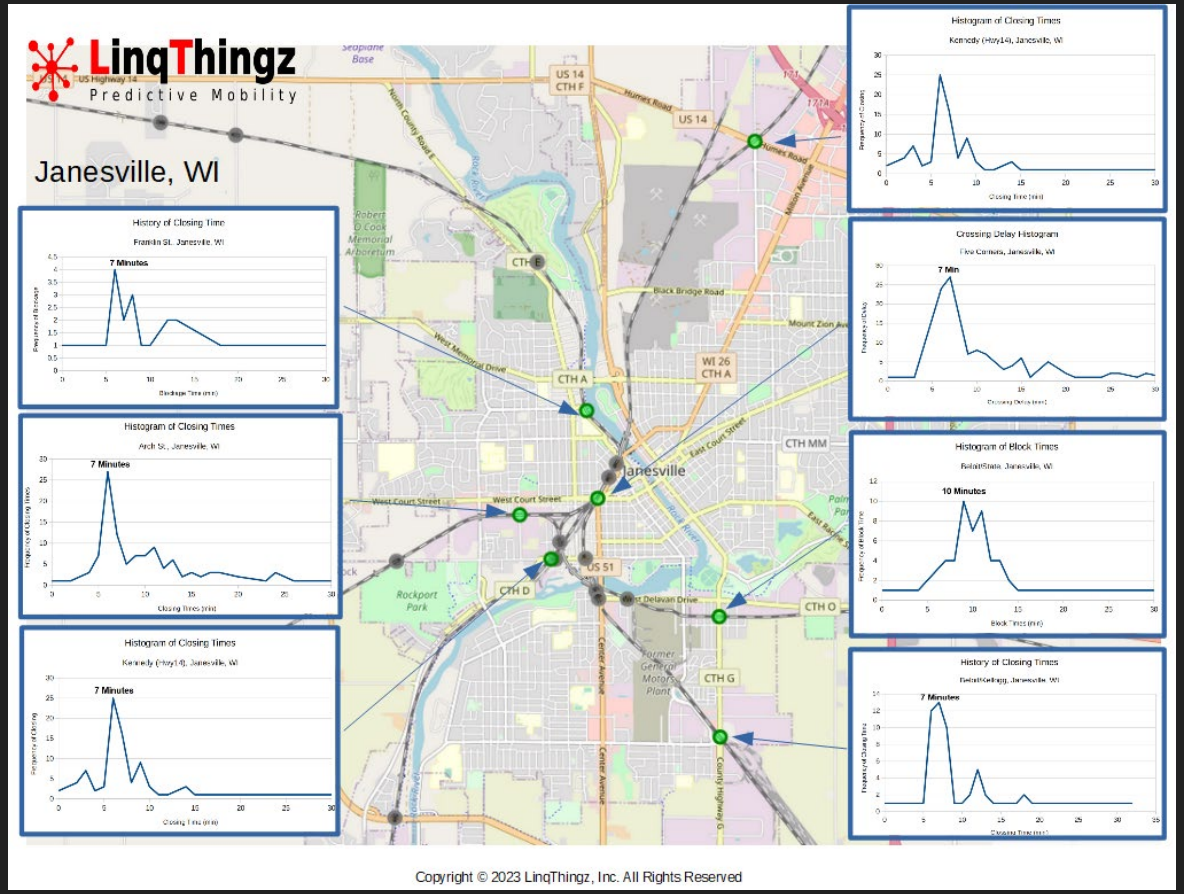
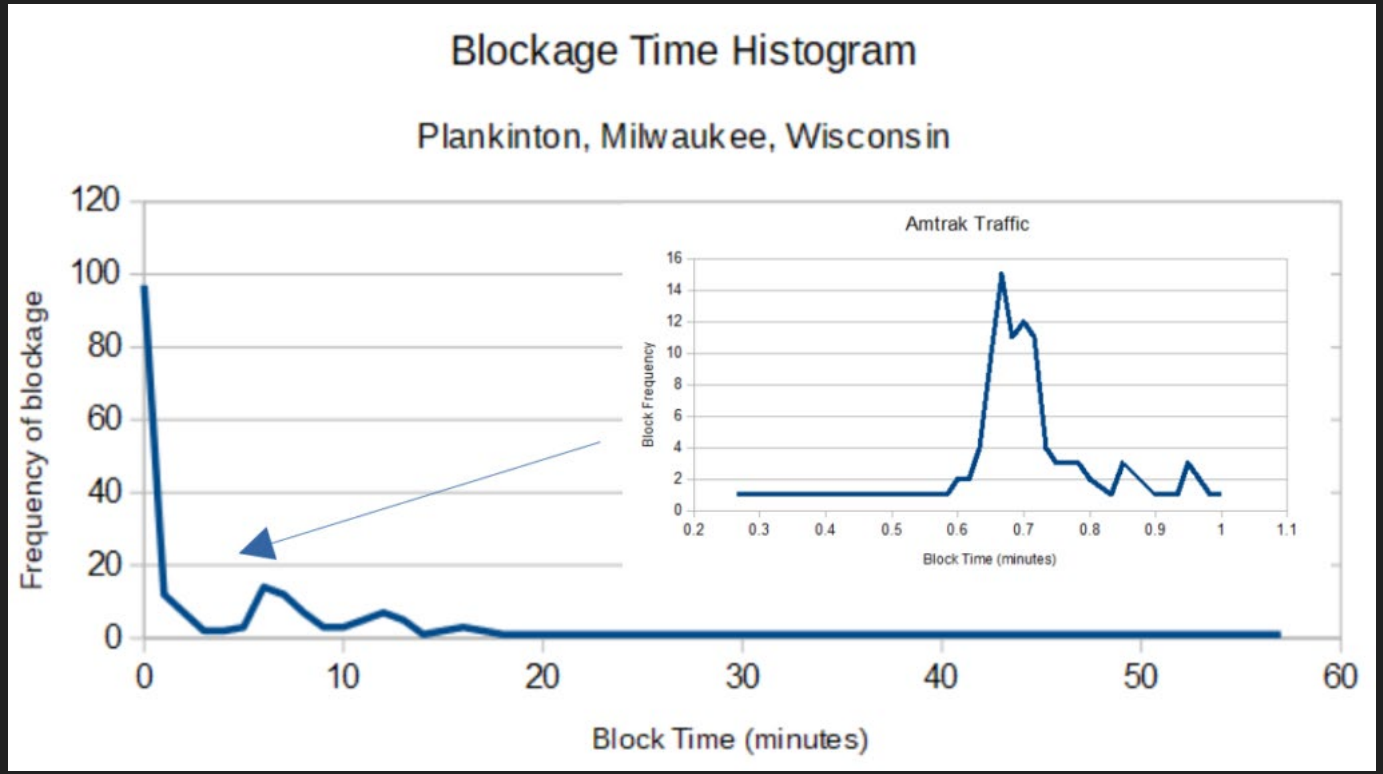
Rail Traffic can be Complex
(Speed data)



Blockage Statistics on Freight Traffic



Blockage Statistics Commuter versus Freight Traffic



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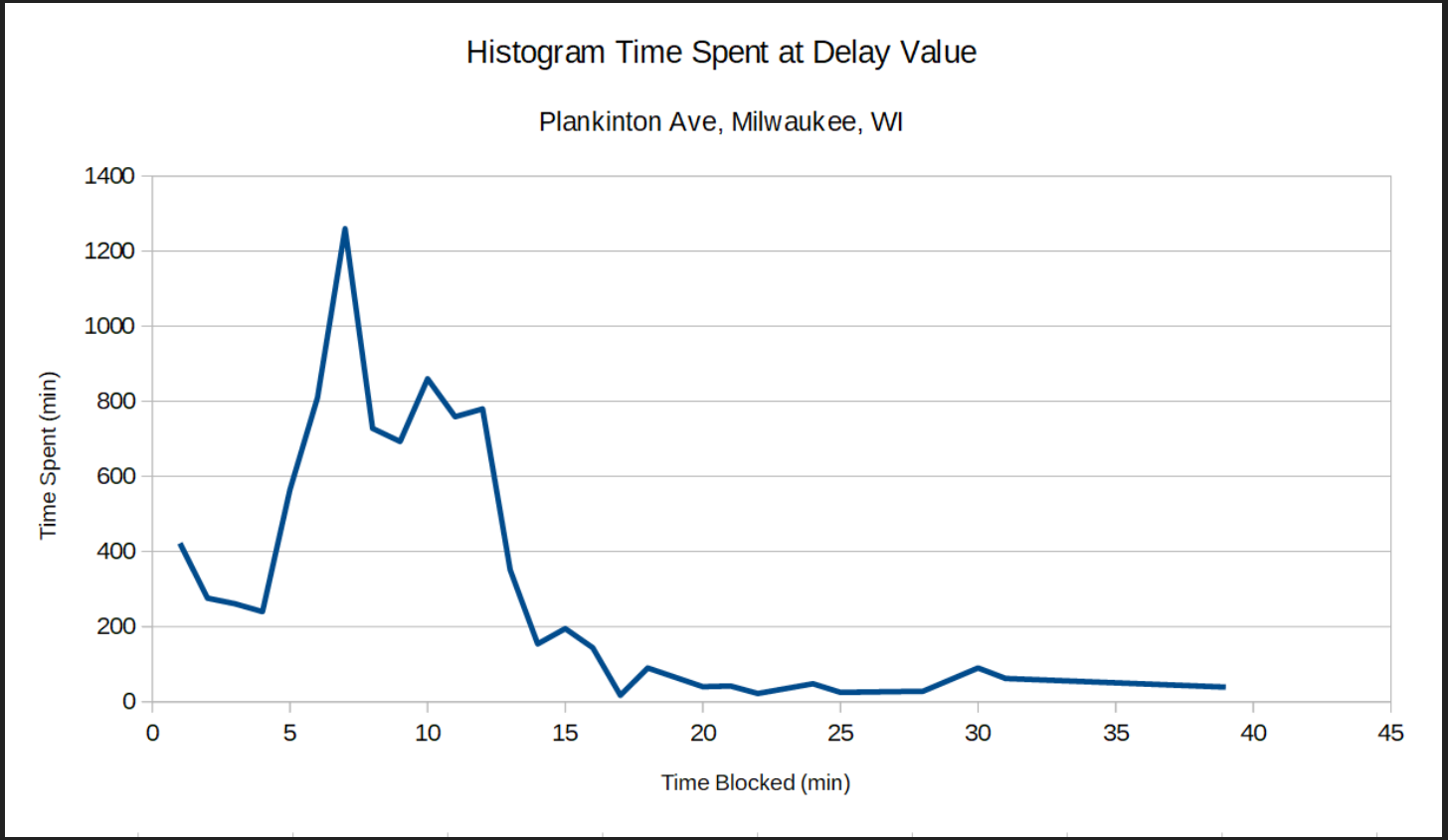
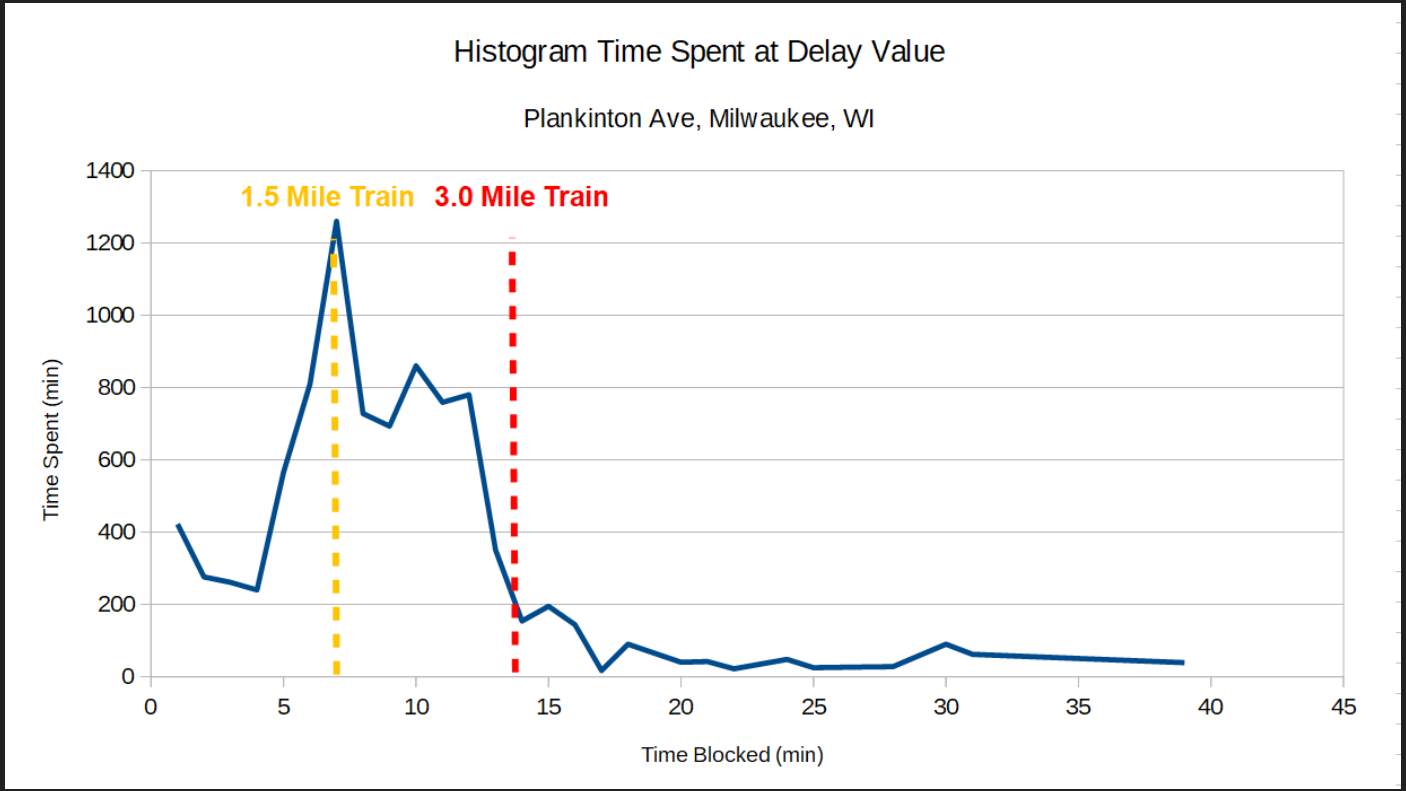
Blockage Time vs Time at Crossing



1.5 mile trains vs 3.0 mile trains



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Beware of Summary Results

SUMMARY Plankinton		
Test Start (UTC)	'2023-01-26 00:00:00'	
Test End (UTC)	'2023-02-04 00:00:00'	
Test Duration	9	days
Total Close Time	848.20	minutes
Average Close Time	4.74	minutes
Maximum Close Time	57.16	minutes
Most Frequent Wait Time	7	minutes
Average Speed at Close	15.54	MPH
Average Speed at Open	10.63	MPH
Close Time per day	94	minutes
Close Time percentage	6.54%	
Trains per day	20	trains
AADT	6600	vehicles
Vehicles blocked per day	432	vehicles
Vehicle blocked hours per year	12447	hours

Commuter ~ 45 sec

Freight ~ 10 min

Daily typical 10 min, 20 min delay once a week, 60 minute delay once a month

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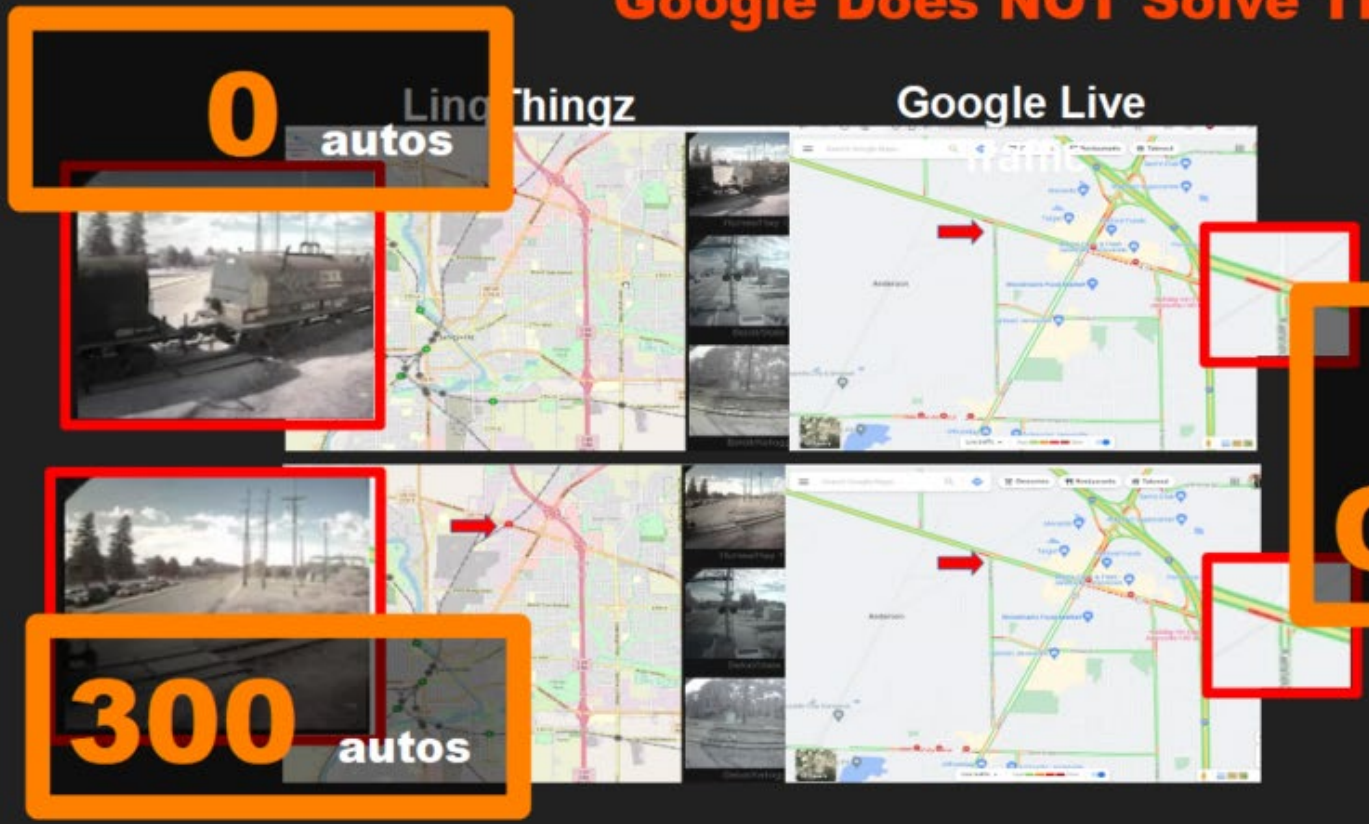
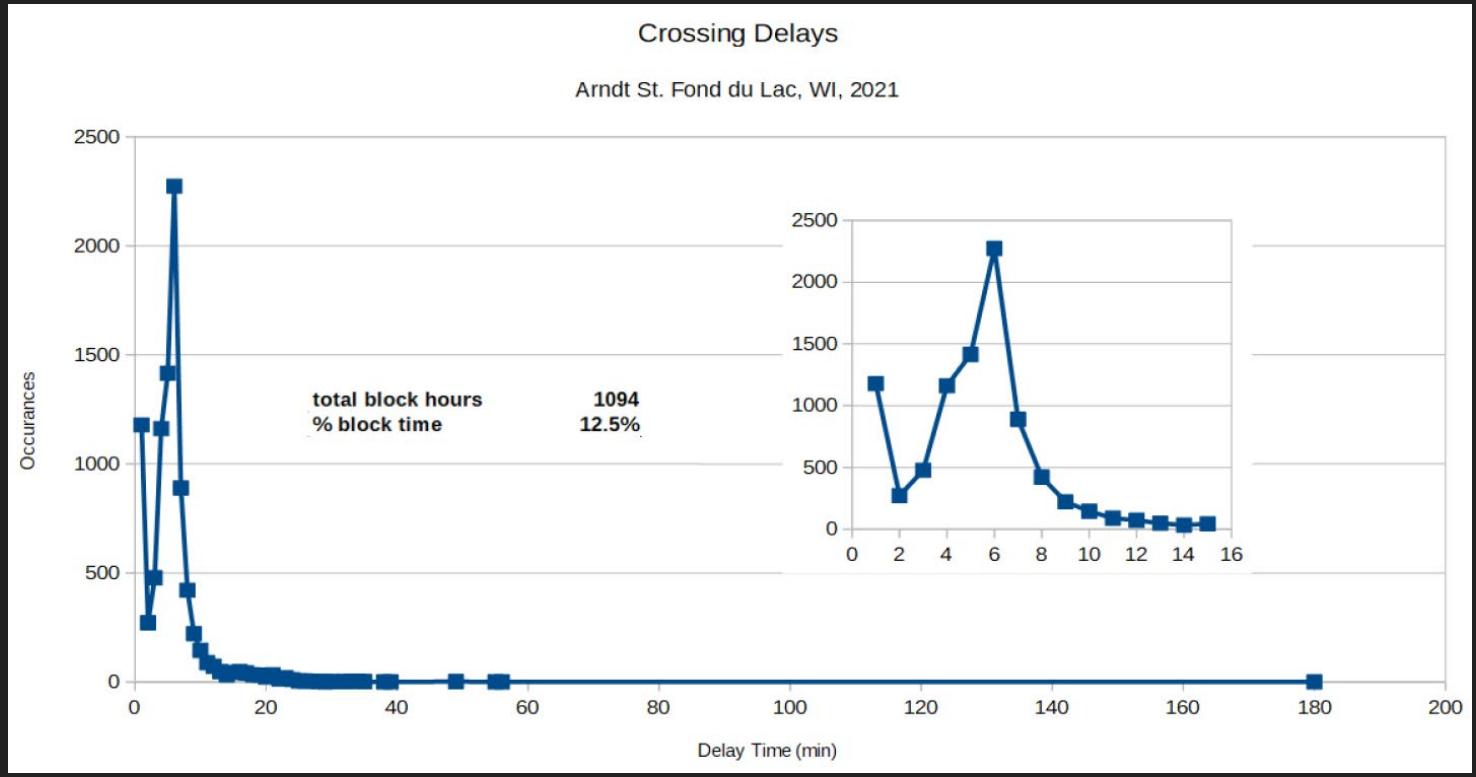
Beware of Social Travel Data

Google Does NOT Solve This!



Blockage can be 3 hours each day!



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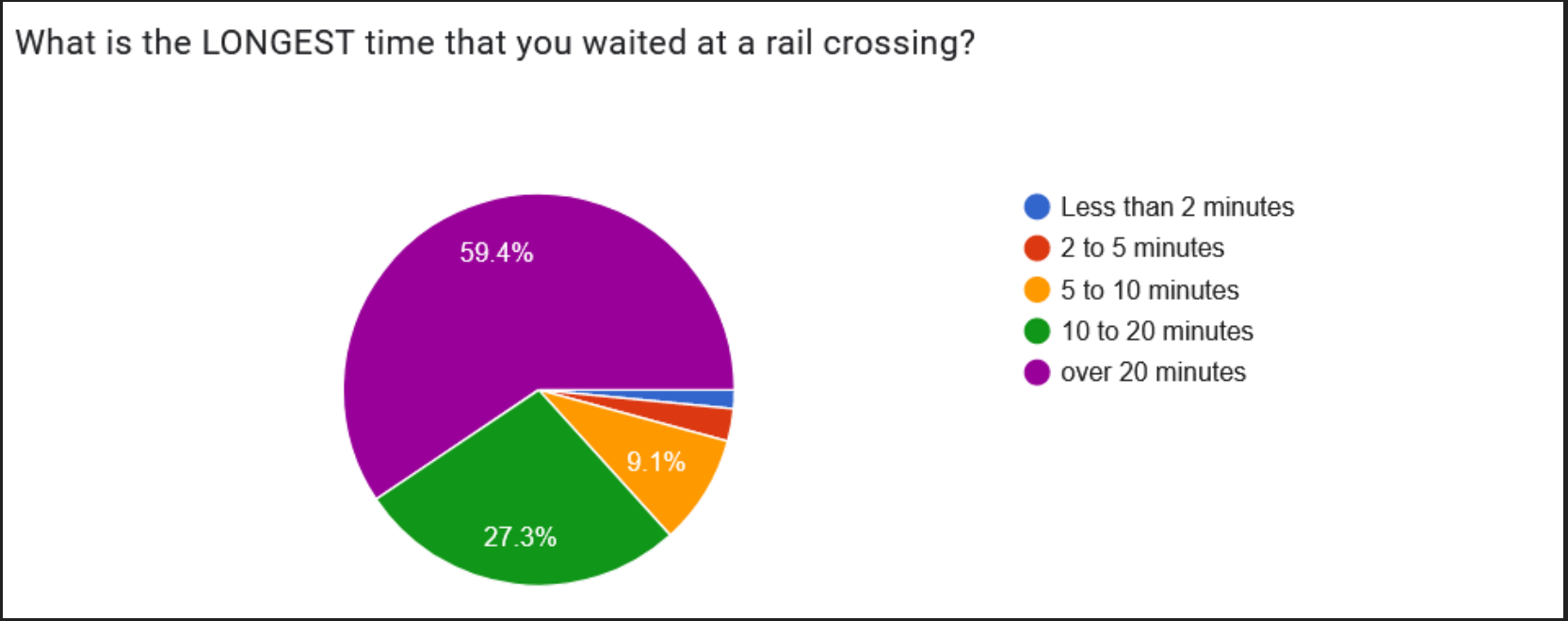
Clarity about Traffic at Highway Rail Grade Crossings

71% of deaths occur at crossings with improved safety measures*

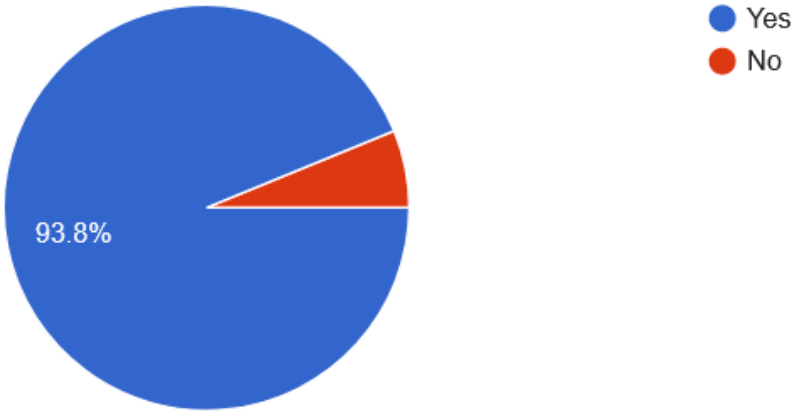
States report little change or decrease in safety after improvement*

Survey Results match Data!



Clarity about Traffic at Highway Rail Grade Crossings

When approaching an intersection blocked by a train, have you turned around, used neighborhood streets or tried to beat the train to an unblocked at-grade crossing to avoid being delayed?



“Congestion Frustration”

Blocked Emergency Response has Consequences

Circumventing Safety is “NORMAL”

Common Behavior

Figure 3.

Examples of Drivers' Behavior Contributing to Crashes at Grade Crossings

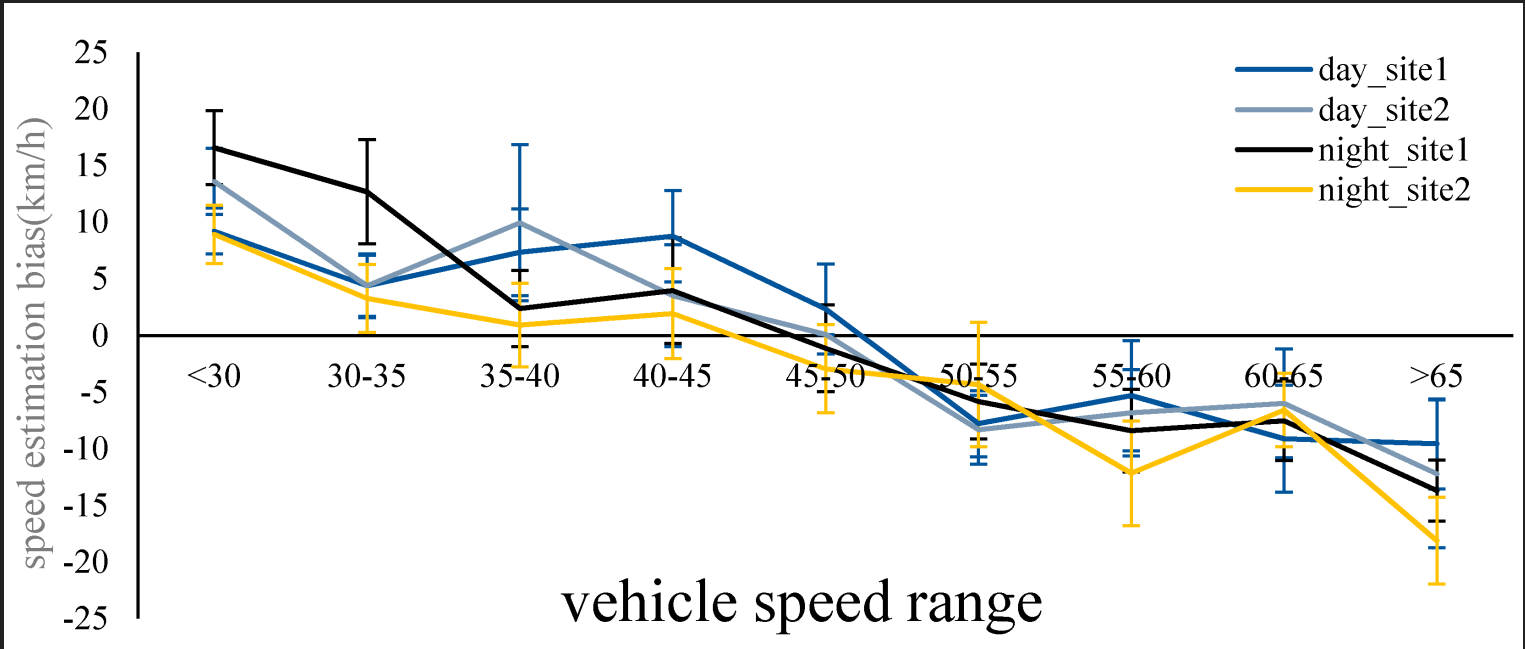
Driver going around gates | Driver queuing on tracks | Driver turning onto right-of-way

Source: GAO. | GAO-19-80

Catastrophic Results

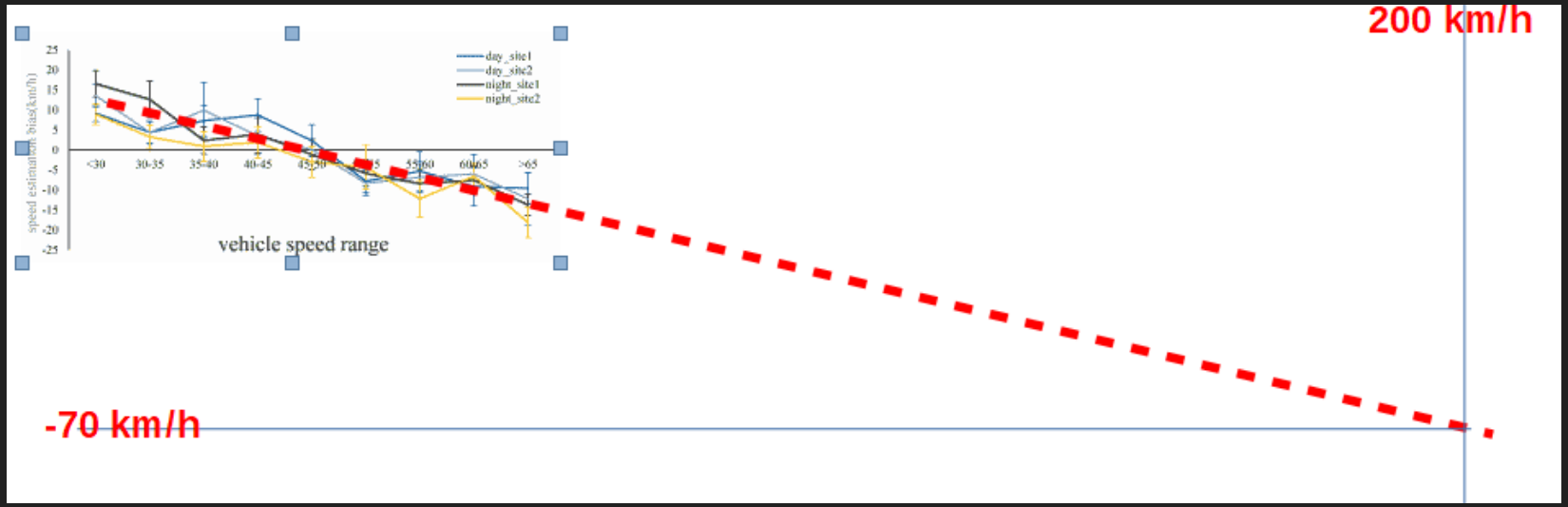
Brightline trains have the highest death rate in the U.S., fatally striking 98 people since Miami-West Palm operations began

Error In Human Speed Estimation



Error In Human Speed Estimation

e.g. extrapolate for High Speed Rail



“Congestion Impact”

Calculated Impact

Congestion Impact at Grade Crossings	
AADT(vehicles)	33,960.00
Carbon Cost ($)	$22,031.58
Fuel ($/yr)	$198,326.40
Citizen Costs ($/yr)	$1,804,770.24
Supply Chain Costs ($/yr)	$3,476,909.70
Total	$5,502,037.92

Small city – 16 Crossings, Population 11,000

Calculated Impact

Railroad Subdivision	Number of Identified Grade Separations	Estimated Cost	Estimated Public Benefit (20-year)	Ratio: Benefit/Cost (20-year)
Austin ML-1	21	$ 267,900,000	$ 290,020,000	1.08
Austin ML-2	10	$ 177,800,000	$ 74,910,000	0.42
Corpus Christi	9	$ 84,200,000	$ 39,980,000	0.47
Del Rio	11	$ 126,300,000	$ 218,800,000	1.73
Glidden	8	$ 165,900,000	$ 103,080,000	0.62
Laredo	7	$ 101,700,000	$ 60,560,000	0.60
Total:	66	$ 923,800,000	$ 787,350,000	0.85

Large City – 66 Crossings

Calculated Impact

County	AADT	Carbon ($/yr)	Citizen Costs ($/yr)	Logistics Costs ($/yr)	Totals
Waukesha	335,900	$453,991	$25,165,898	$71,646,420	$97,266,309
Milwaukee	227,300	$307,211	$36,005,060	$48,482,380	$84,794,650
Racine	80,600	$108,936	$8,923,763	$17,191,728	$26,224,428
Kenosha	25,800	$34,870	$2,856,490	$5,503,059	$8,394,420
Ozaukee	33,100	$44,737	$3,664,722	$7,060,127	$10,769,585
Walworth	26,000	$35,141	$2,878,633	$5,545,719	$8,459,493
Washington	51,700	$69,876	$5,724,052	$11,027,448	[illegible]
Totals	780,400	$1,054,761	$85,218,618	$166,456,881	$252,730,261

Seven Counties – 300 Crossings, Population 2 million

“Data Collection”

Trainable FUSION SENSORS

Feature	Fusion	Audio	RADAR	LIDAR	Magnetic	Video	IR
Train Presence	✔	✔*	✔	✔	✔	✔	✔
Train Speed	✔	✘	✘**	✘**	✘**	✘***	✘***
Train Direction	✔	✘	✘**	✘	✔	✘***	✘***
Train Length	✔	✔*	✔	✔	✔	✘***	✘***
Cross Guard Operation	✔	✘	✘	✔	✘	✘***	✘
Highway Blockage	✔	✘	✘	✘	✘	✘***	✘
Trespassers/Pedestrians	✔	✘	✘	✘	✘	✘***	✔
Multiple Trains	✔	✘	✘	✘	✔	✘	✘

* Roop et.al. Concluded that indicated that the false alarm rate of the system was too high (94.3 percent) even though the system did not make any true negative detections. Roop, S. S., Olson, L. E., Ruback, L. G., Roco, C. E., and Protopapas, A. (2007). *An Analysis of Low-Cost Active Warning Devices for Highway-Rail Grade Crossings. Texas Transportation Institute*, College Station, Texas.

** Can be achieved with multiple sensors

*** Can be achieved with AI software. LinqThingz is the only comprehensive AI provider for all these solutions.

One Box, Sensor Array, ML, Configurable

Trainable Sensor Modules™

- LIDAR
- RADAR
- Camera
- Infrared
- Magnetometer
- Audio
- Power Monitor
- Temperature
- Humidity
- Atmospheric Pressure
- Adhoc external connected data

FUSION SENSOR with a suite of on-board sensors connected through Machine Learning is the most advanced, accurate and reliable solution for identifying rail vehicles, pedestrians, etc.

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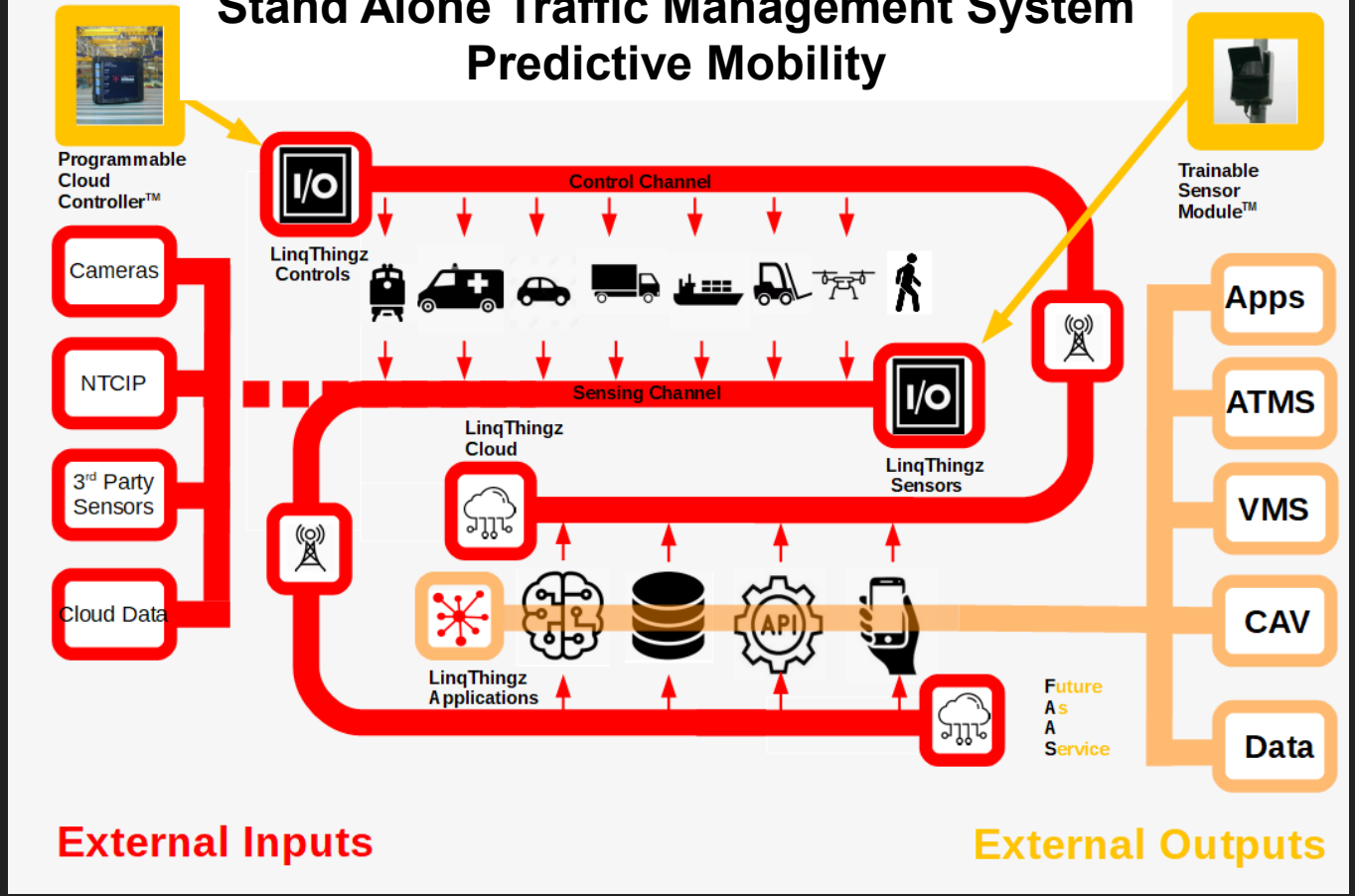
Stand Alone Traffic Management System
Predictive Mobility



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Trainable = Multi Use Cases

Trespassing
Pedestrian Crossing Intent
Vehicle Crossing Intent
ROW Blockage
Guard Circumvent
Stalled Vehicle
Anomalous Rail Truck Noise
Anomalous Rail Truck Heat
GPS correction messages
Local Environmental Info

Solution! Predictive Mobility:

1. Provides advanced notification
2. Alternative routes capability
3. Improves Safety by keeping traffic away from RR occupied ROW
4. Reduces cost/time for Commerce
5. Improves congestion/quality of life
6. Reduces Pollution

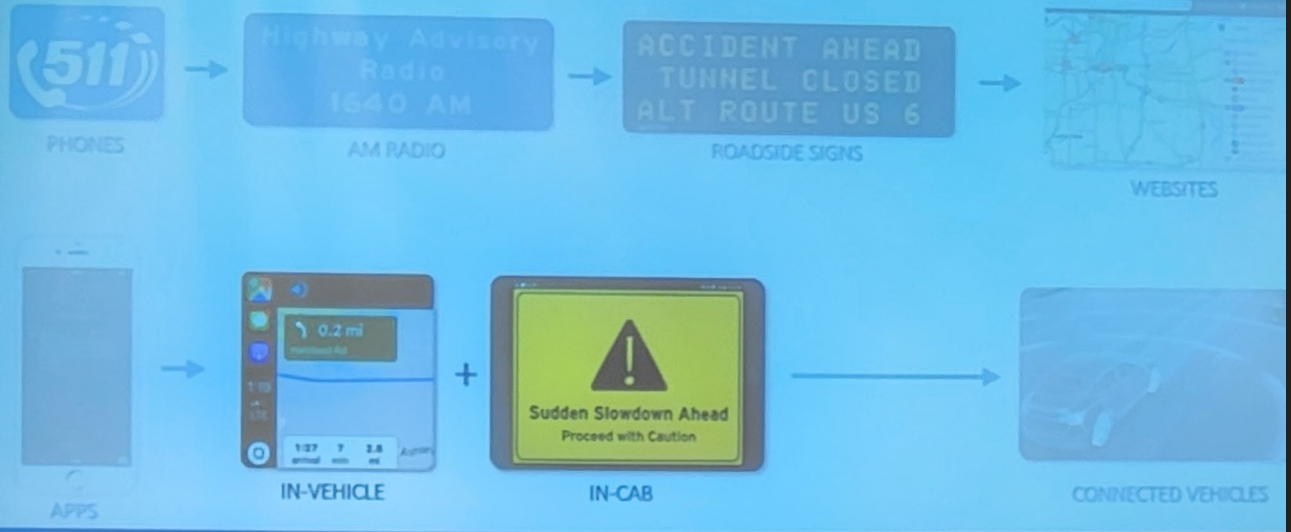
Value Comparison

	12-year Carbon Tons	12-year cost	Cost/Ton	Cost/Ton/Crossing
Electric Bus	1380	$1,000,000.00	$724.64	
Predictive Mobility	5280	$458,000.00	$86.74	$7.23

	12-year AADT	12-year cost	Cost/Usage	
Bridge 1 Crossing	142,800.00	$35,000,000.00	$245.098	
Predictive Mobility	1,480,701.00	$458,000.00	$0.309	$0.300

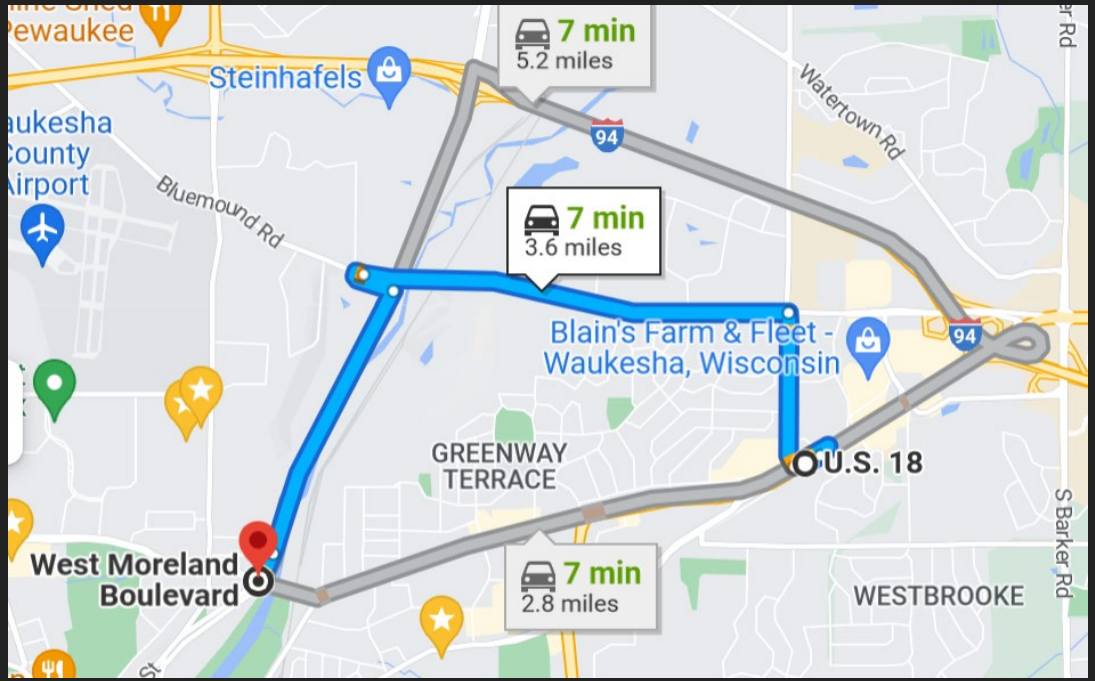
*Predictive Mobility Calculation is for 12 Crossings

History of Traveler Information Systems



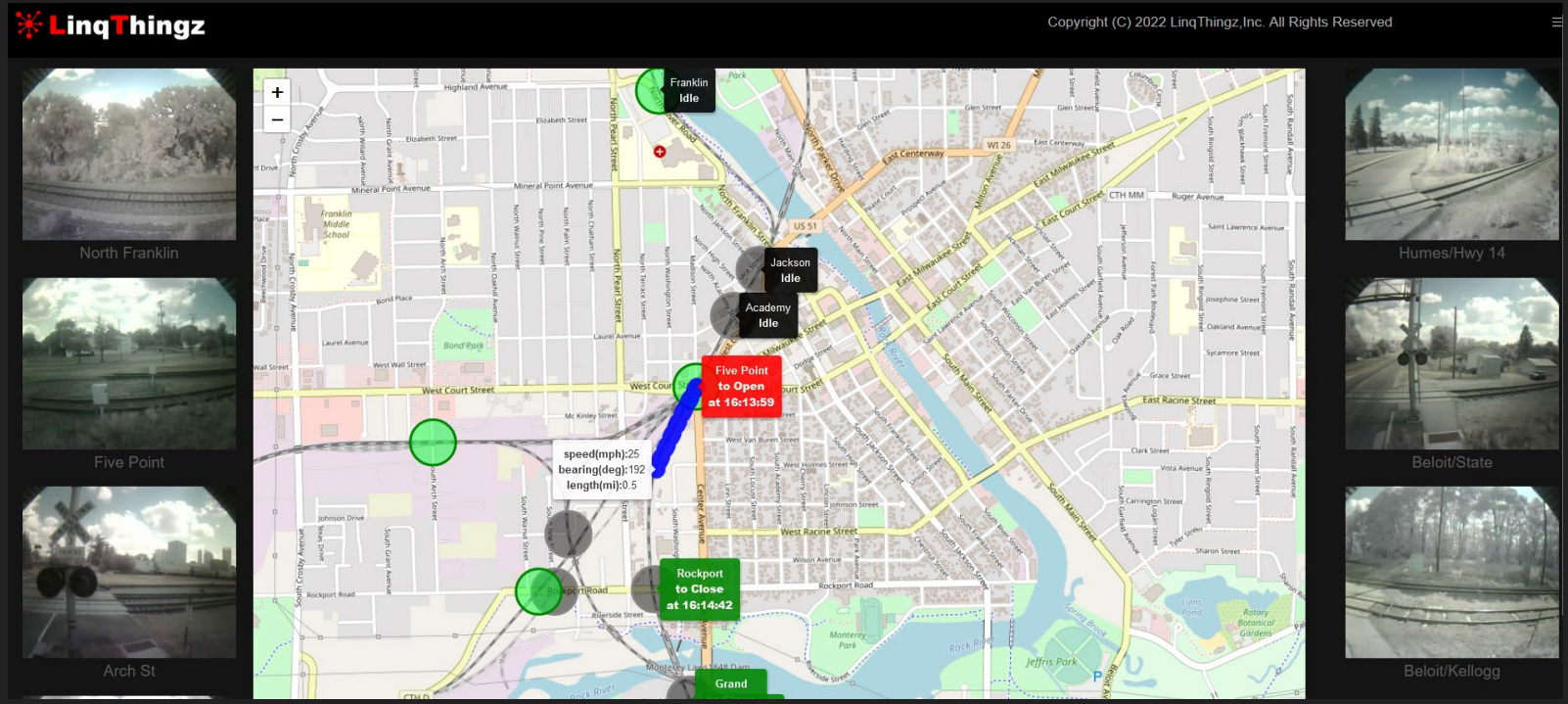
Drivewyze

Variable Message Signage (VMS)



Apps

Dispatch Applications

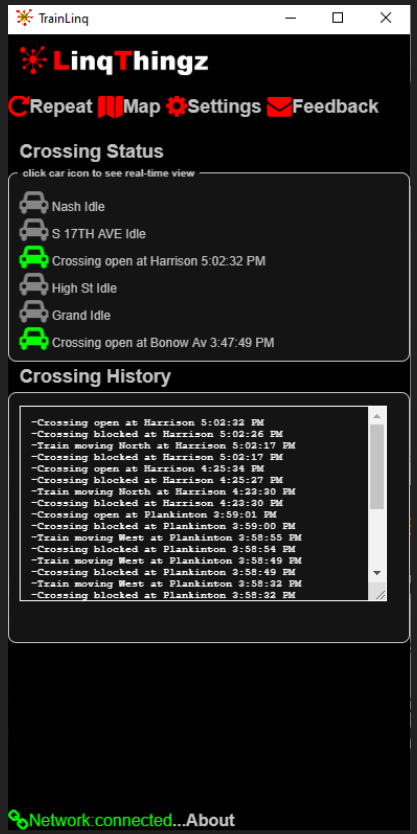


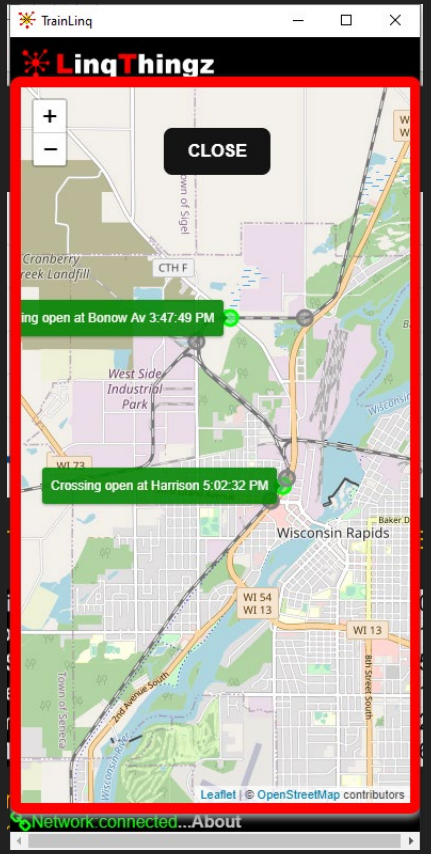
Connect and Autonomous Vehicle (CAV)

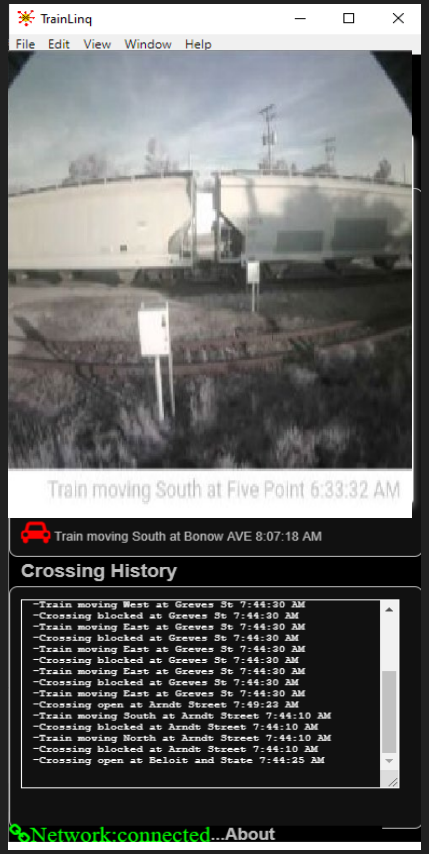
Road Side Unit (RSU) connectivity

Traveler Information Message

Mobile Applications







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Solution/Testing
(Community)

1) Measure Existing Traffic Details (O/D)
2) Perform Public Surveys
3) Implement Predictive Mobility Solution
4) Perform Public Surveys
5) Measure Existing Traffic Details (O/D)

SUMMARY

Rail Traffic has a big impact in the communities where it operates!

There significant safety and congestion impacts

Rail Traffic is a complex combination of through, switching and commuter rail

There are few places to find sufficiently detailed information regarding rail traffic

Fusion sensors provide robust data suitable for Predictive Mobility in CAV

Predictive Mobility and Crossing Intent are key for CAV applications

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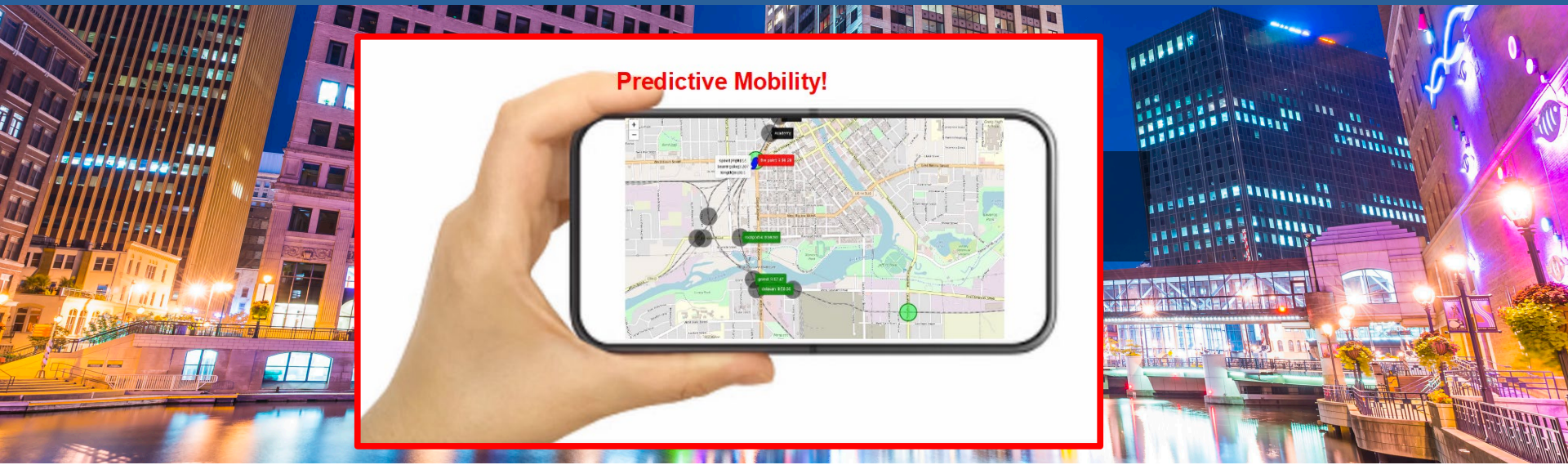
Predictive Mobility

THANK YOU! THANK YOU! THANK YOU! THANK YOU!



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