1-13-2016

Managing User Delay with a Focus on Pedestrian Operations

Andrew Kading
Portland State University, andykading@hotmail.com

Managing User Delay with a Focus on Pedestrian Operations

Presentation from:

Transportation Research Board 95th Annual Meeting

January 13th, 2016

Andrew Kading, Portland State University

Other Contributors:
Christopher Sobie, NAU
Edward Smaglik, NAU
Anuj Sharma, ISU
Sirisha Kothuri, PSU
Peter Koonce, PBOT

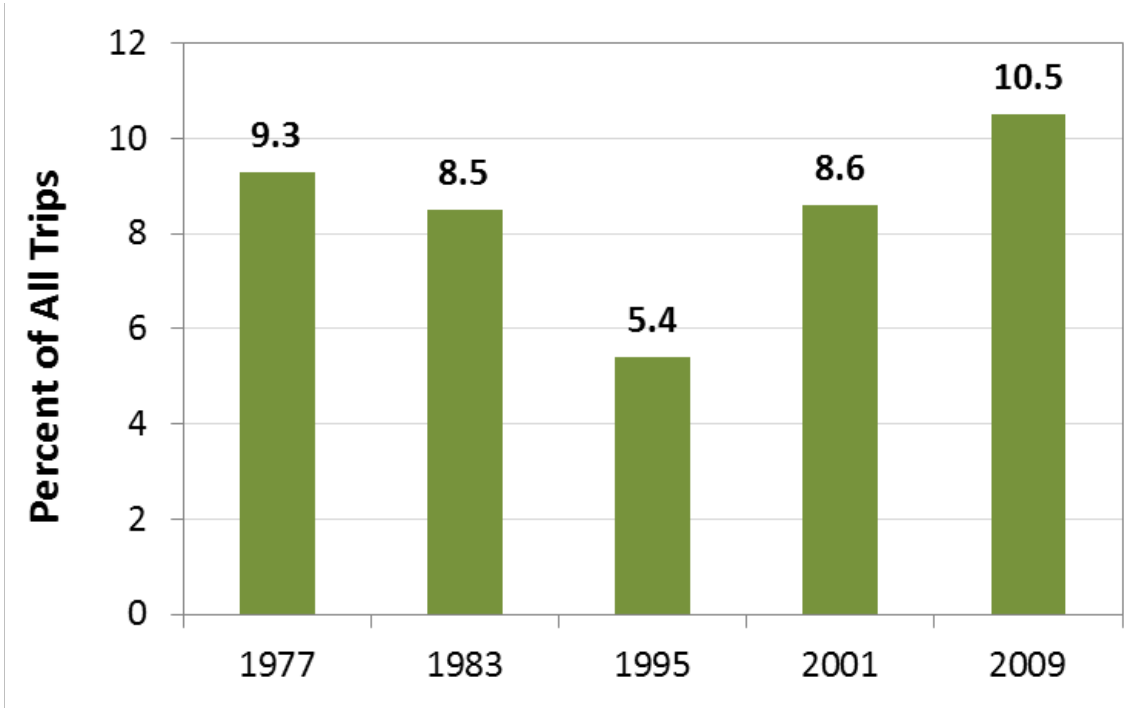
Paper #: 16-1487

Agenda

- Introduction
- Background
- Motivation
- Objectives
- Signal Timing 101
- Algorithm Development
- Simulation Development
- Simulation Results
- Conclusion

Introduction

- Increase in walking trips nationally
- Walking ⟷ healthy, livable communities



National Walking Trends

Source: Data from Pucher et al.,(2011)

Background

- Limited signal control strategies for pedestrians
  - Typically focused on safety
  - Little on efficiency

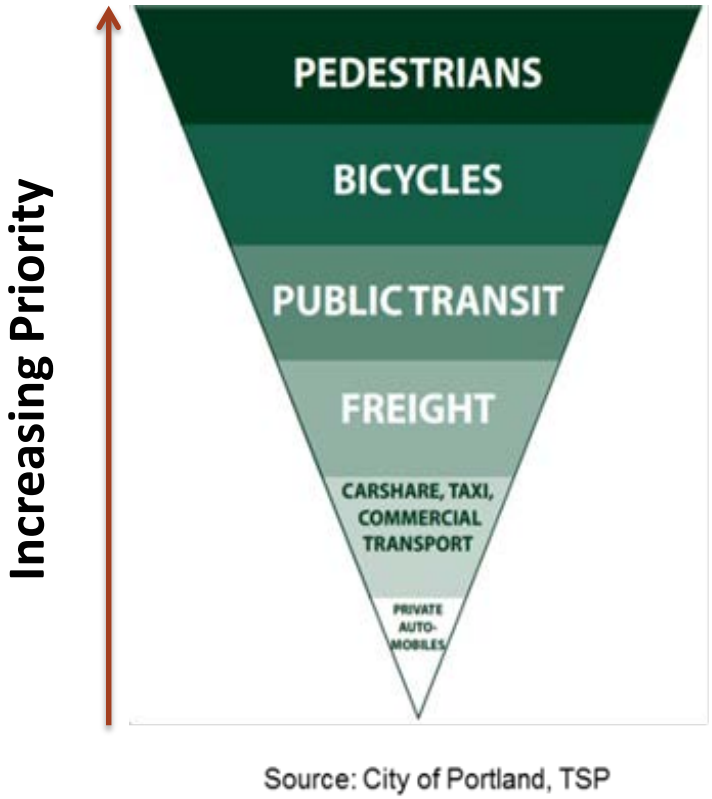
Exclusive Pedestrian Phase (Barnes Dance)

Leading Pedestrian Interval (LPI)

Motivation

- Delays affect pedestrians disproportionately
- "Everyone is a pedestrian"

How do we translate "pedestrian first" policies into specific operational strategies at intersections?

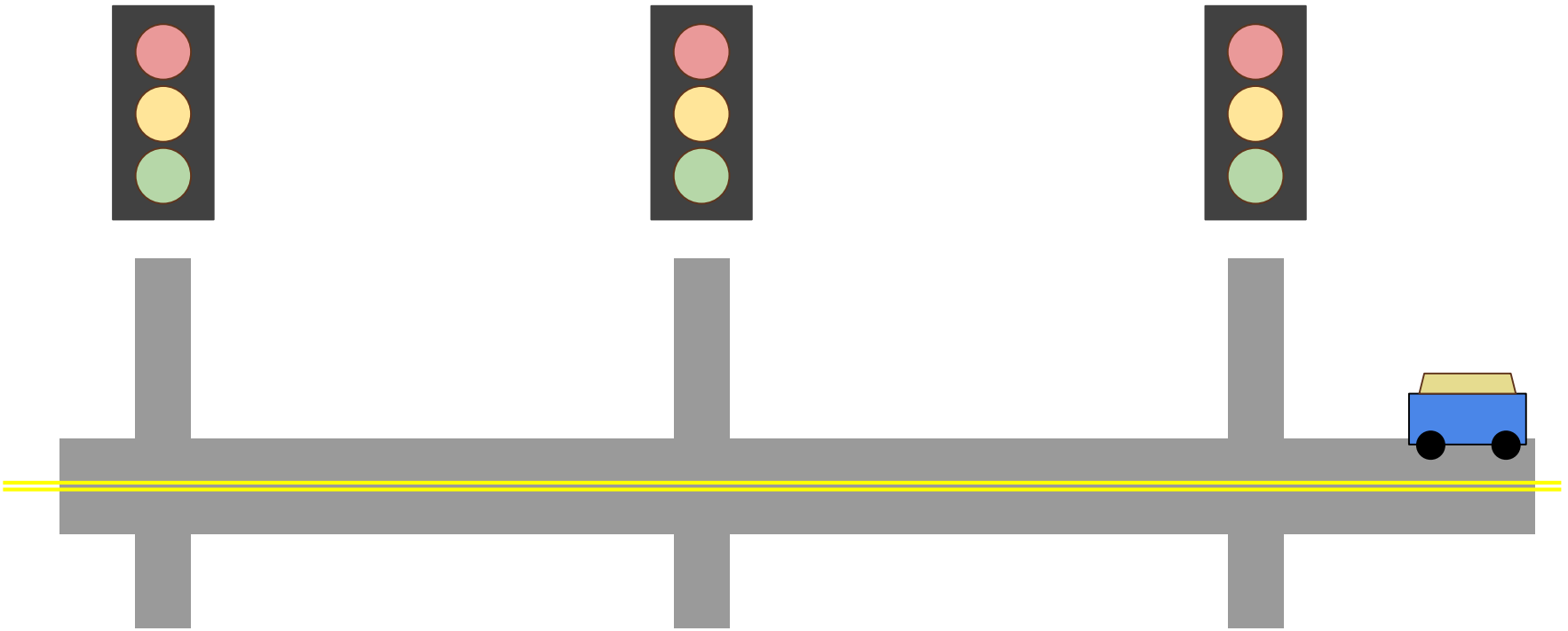


Source: City of Portland, TSP

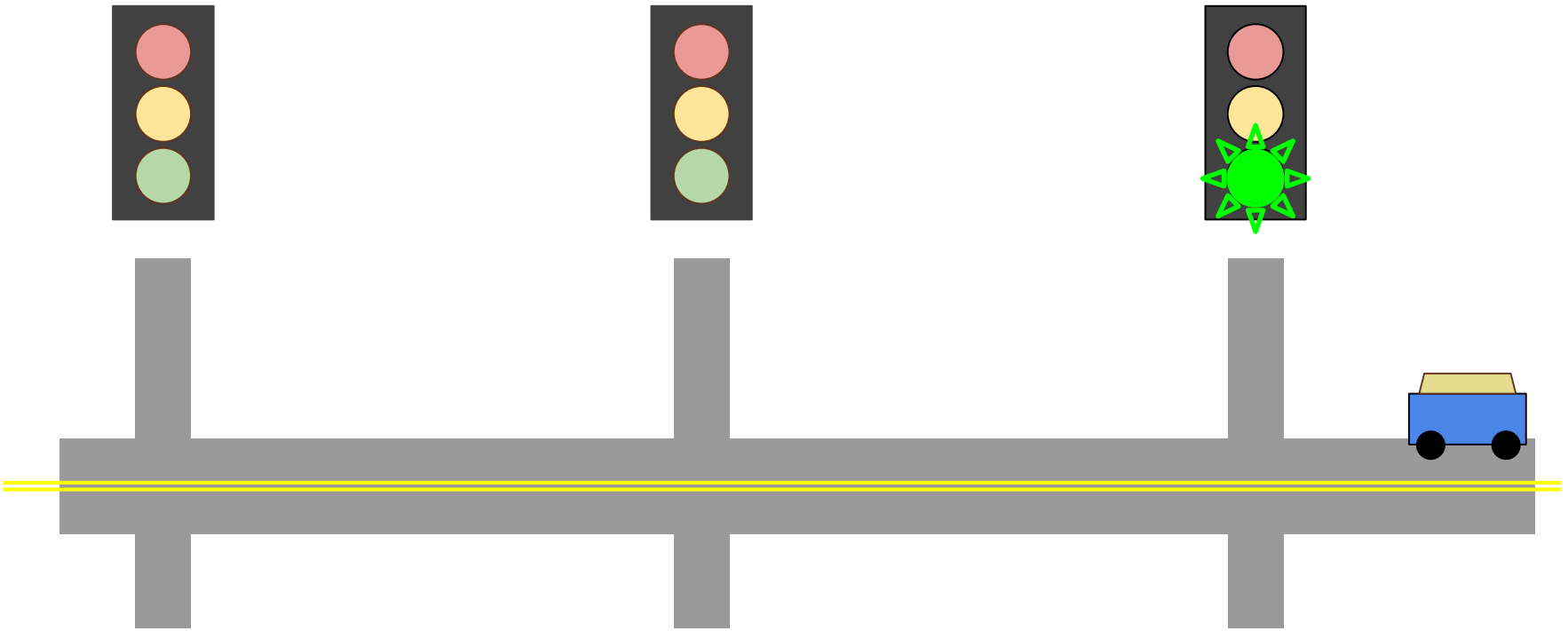
Objectives

- Assess the efficiency impacts of various control strategies on all users
  - Free
  - Actuated Coordinated
    - Veh Ext Timer Sensitivity Analysis
  - Coordinated
  - Algorithm
- Develop and implement a pedestrian priority algorithm based on
  - Vehicle volumes

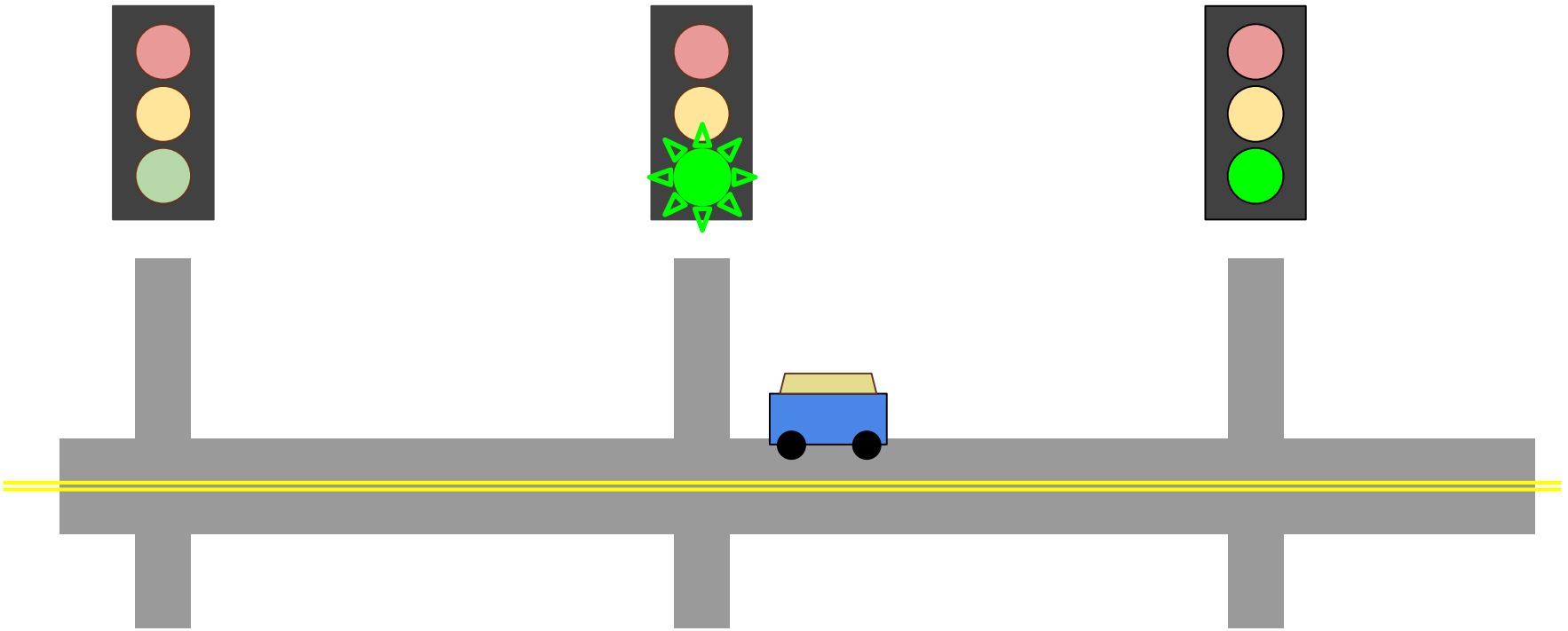
Signal Timing 101: Coordinated



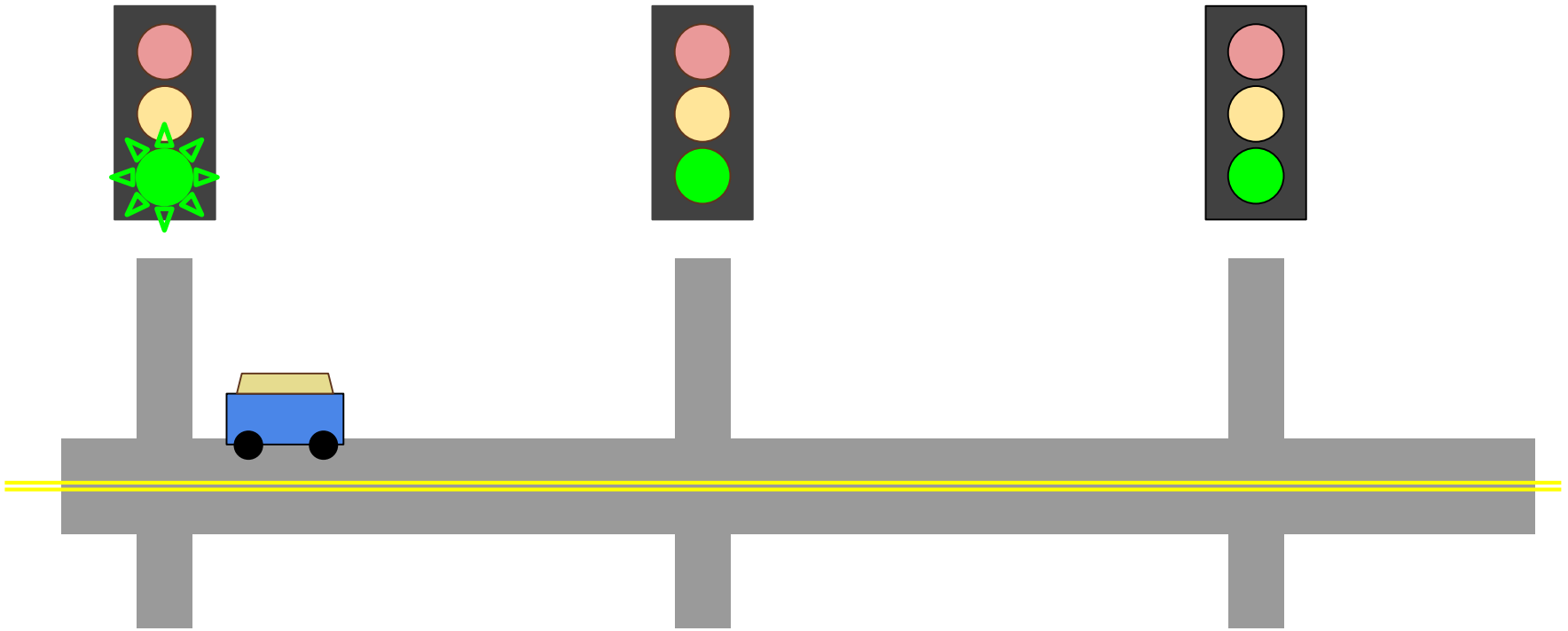
Signal Timing 101: Coordinated



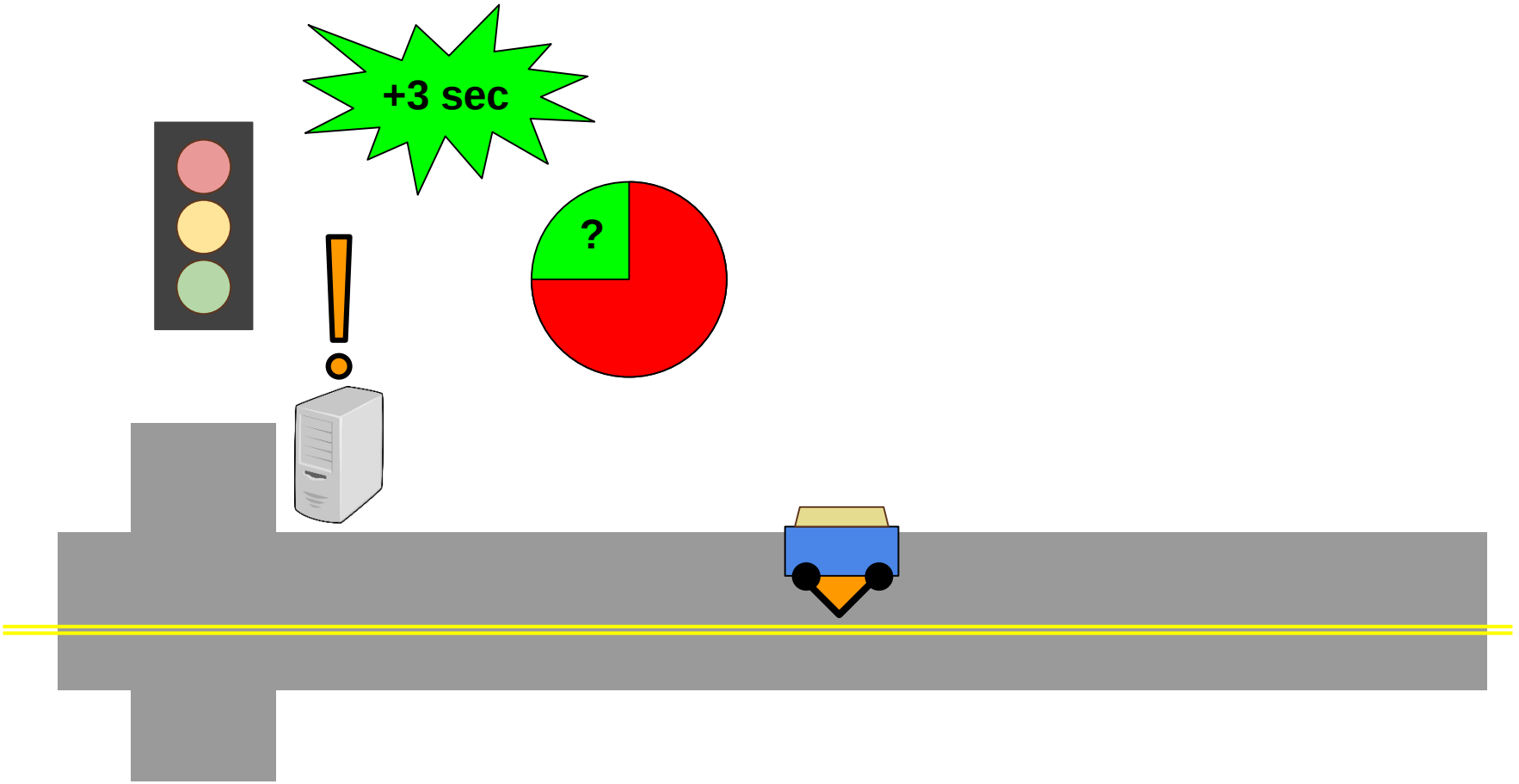
Signal Timing 101: Coordinated



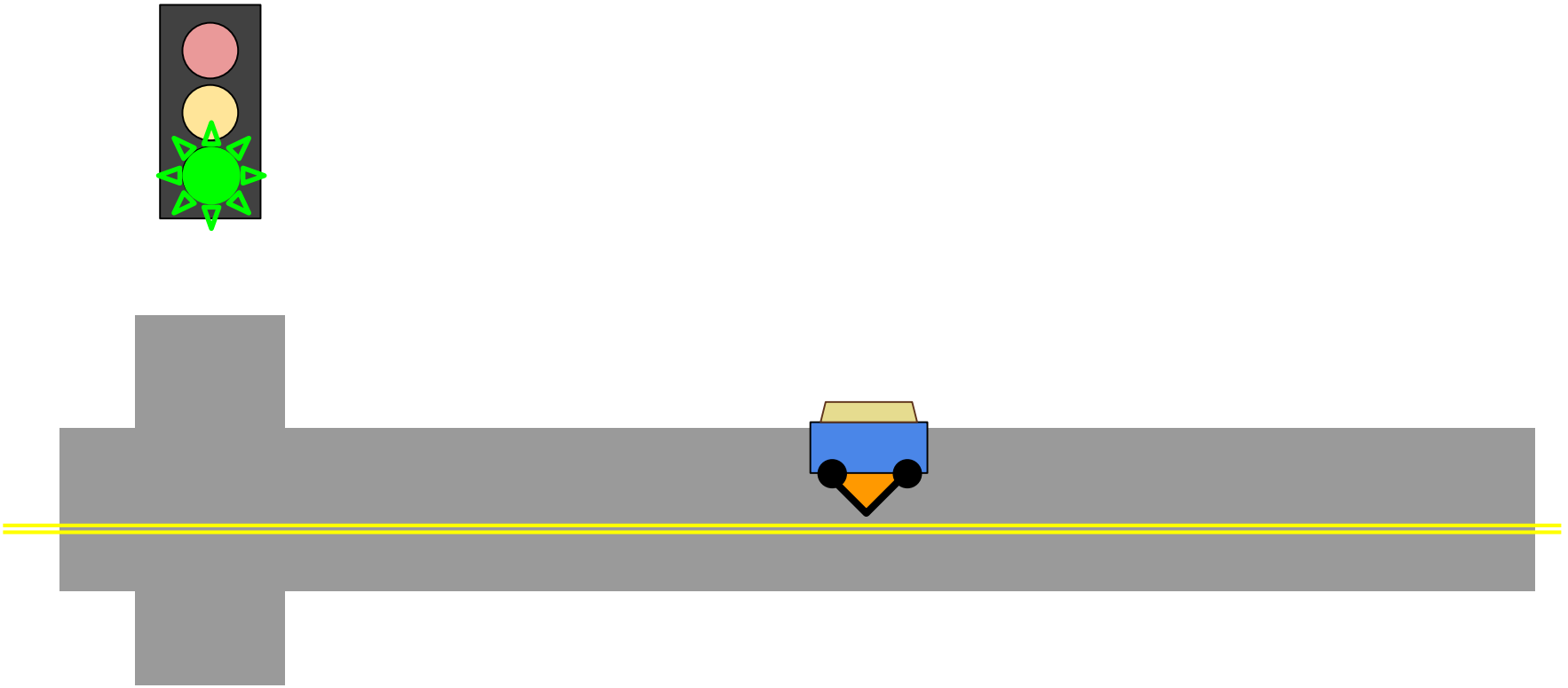
Signal Timing 101: Coordinated



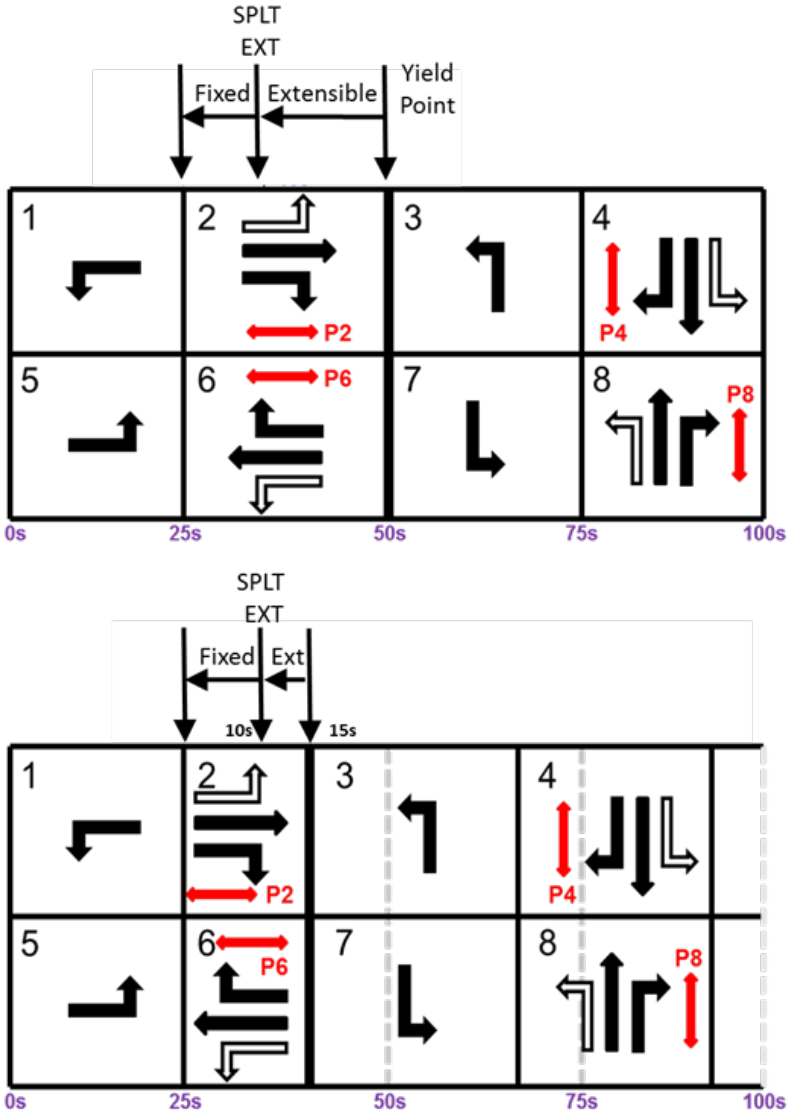
Signal Timing 101: Actuated Coordinated



Signal Timing 101: Actuated Coordinated



Actuated Coordinated Operation



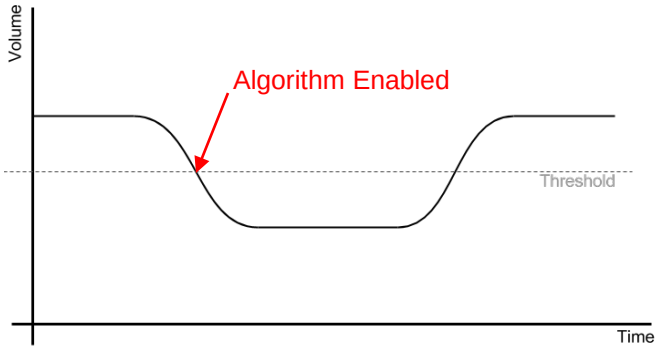
Free

- AKA: Non-coordinated
- First come first serve

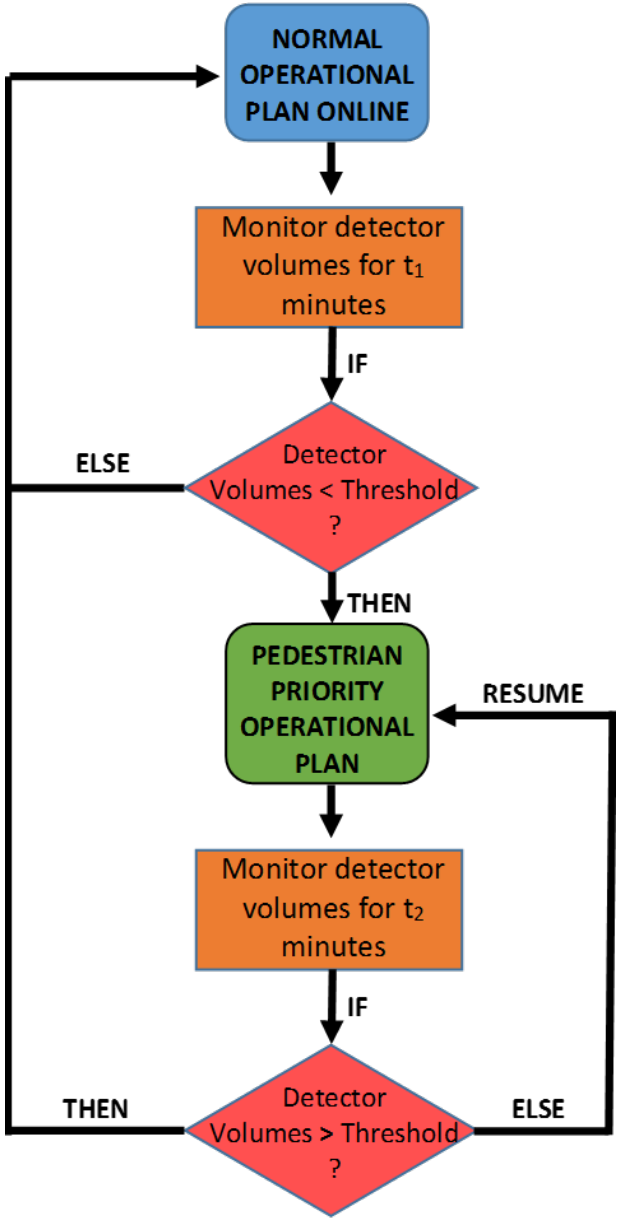
Image Source: http://phys.org/news/2012-09-length-yellow-caution-traffic-accidents.html

Algorithm Development

- Pedestrian Priority Operational Plan (PPOP)
  - Veh volume < threshold (user defined) for a given time period
  - Two scenarios analyzed
    - Actuated-coordinated
    - Free



- ASC/3 logic processor used for implementation
  - Inputs
    - Veh volume (detectors)



ASC/3 Logic Processor

Menu | Configuration | Controller | Coordination | Preempt | Time Base | Detectors

Logic Statement (MM) 1-8-2

Logic #: 14 — Clear LP Sequence

If

	Assignment	#		State
IF:	LP LOGIC FLAG	7	IS	ON
AND	LP LOGIC FLAG	8	IS	ON
AND	LP LOGIC FLAG	9	IS	ON
AND	LP LOGIC FLAG	10	IS	ON
AND	LP LOGIC FLAG	11	IS	ON

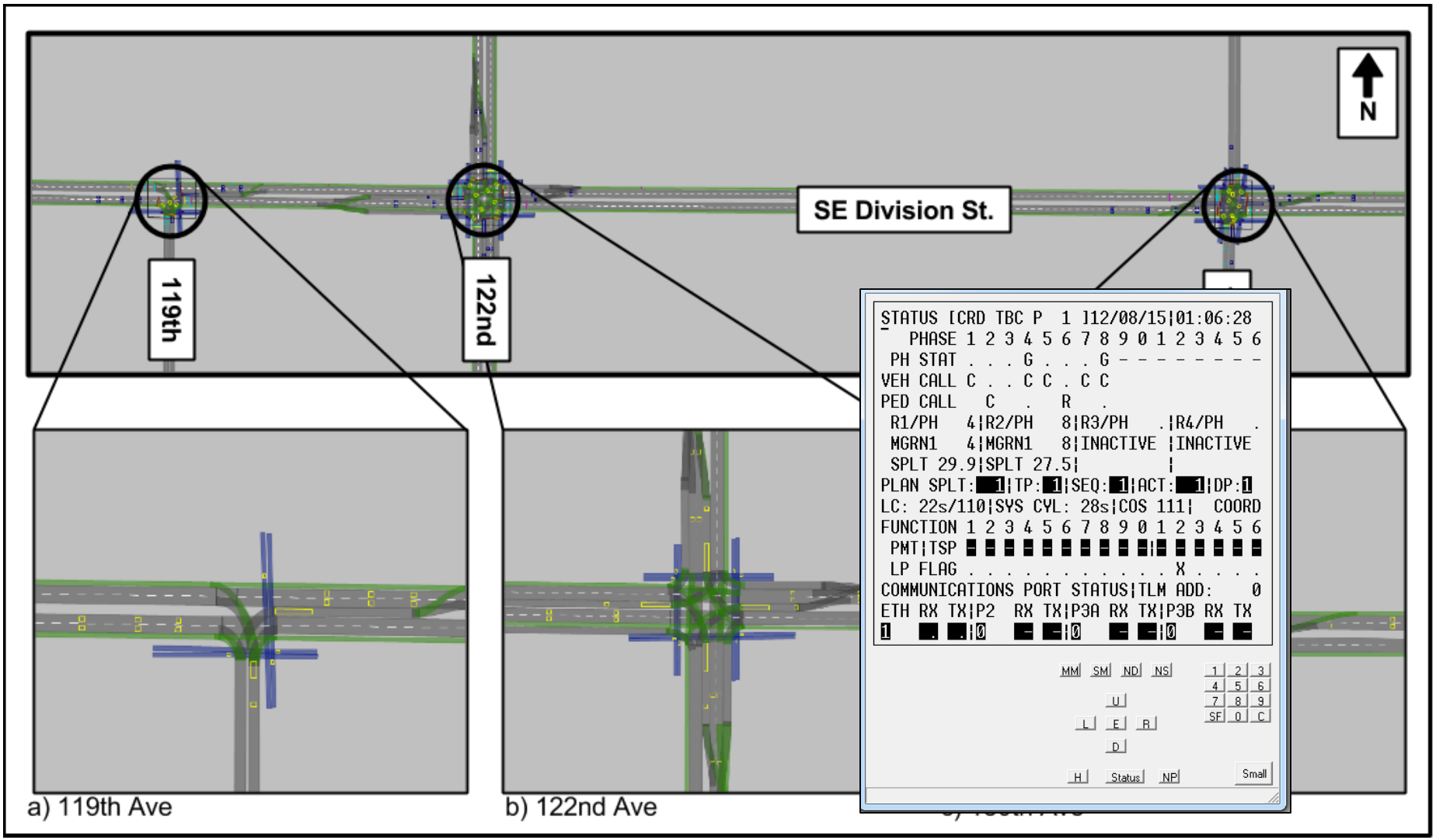
Then

Assignment	#	State
LP SET LOGIC FLAG	12	ON

Else

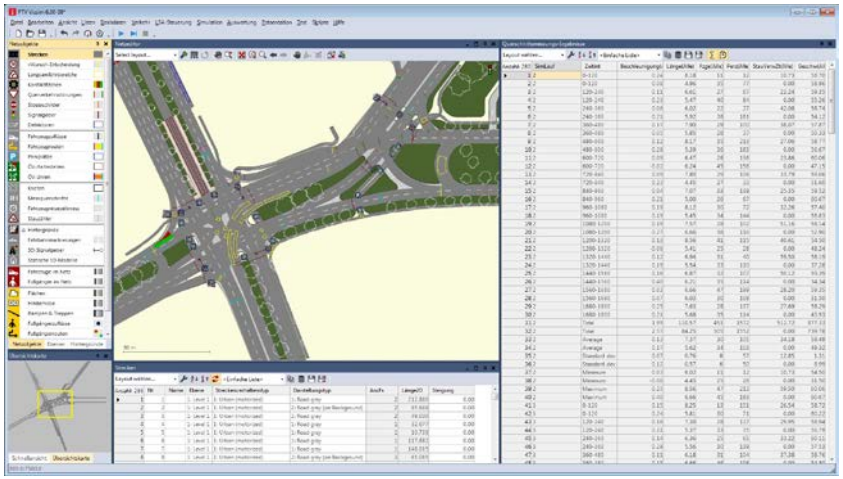
Assignment	#	State

Simulation Development



Simulation Results

- Scenarios
  - Coordinated-Base
  - Actuated-Coordinated using algorithm
  - Free using algorithm
  - Free
- Metrics
  - User delay (veh, ped)
  - Travel time
- Vehicle Extension Sensitivity Analysis



Extension Timer Value Sensitivity Analysis

Vehicle Extension Timer (s)	Avg. Overall Delay (s)	Avg. Veh Delay (s)	Avg. Ped Delay 2/6 (s)	Avg. Ped Delay 4/8 (s)	Avg. TT (s) (EB)	Avg. TT (s) (WB)	Avg. TT (s) (NB)	Avg. TT (s) (SB)
0	26.74	26.14	48.07	38.33	104.89*	89.76	94.69	90.28
0.5	26.73	26.14	48.08	38.33	104.89*	89.76	94.70	90.26
1.0	26.73	26.91	48.14	38.44	104.86*	89.64	94.63	90.37
1.5	26.65	26.04	48.08	38.86	104.13*	89.53	94.70	90.33
2.0	26.70	26.07	48.27	39.59	103.50*	89.44	94.84	90.68
2.5	26.75	26.11	48.60	41.66	102.92*	89.58	95.09	90.57
3.0	26.68	26.04	48.64	42.57	101.98	89.19	95.23	90.68
3.5 (Base)	26.57	25.94	48.49	42.19	101.08	89.16	94.99	90.51

*Statistically significant at 95% confidence level. For all scenarios, ped call every 4th cycle on P4/8.

Comparison of Scenarios

Scenario	Avg. Veh Delay (s)	Avg. Ped Delay 2/6 (s)	Avg. Ped Delay 4/8 (s)	Avg. TT (s) (EB)	Avg. TT (s) (WB)	Avg. TT (s) (NB)	Avg. TT (s) (SB)
Coordinated (Base)	26.55	25.43	44.95	100.71	90.61	94.79	90.77
Actuated - Coordinated	26.73	36.45*	43.45	101.98	90.99	94.81	91.28
Free with Algorithm	25.11*	28.44*	41.28	102.25	99.93*	87.69*	84.39*
Free	22.81*	32.87*	30.25*	104.25*	107.62*	77.73*	74.50*

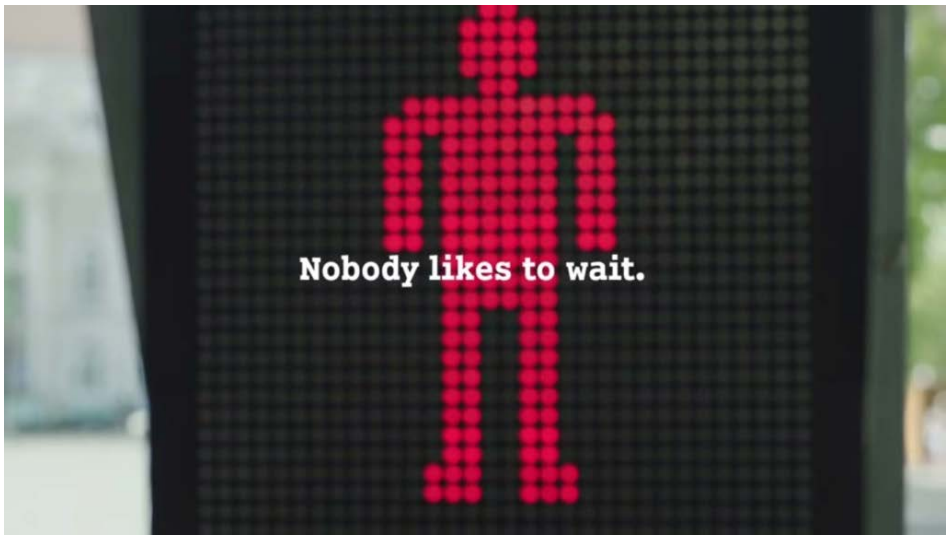
*Statistically significant at 95% confidence level. For all scenarios, ped call every 4th cycle on P4/8.

Key Takeaways

- Free operation most effective method to reduce delay
  - 5 – 14% reduction in average vehicle delays
  - 8 – 33% reduction in average minor street pedestrian delays
- Modifying extension timer of actuated-coordinated phase can:
  - Reduce minor street ped delay (1.3% - 9.1%) with minimal impact on overall vehicle delay

Conclusions

- Incorporated pedestrian efficiency considerations into signal timing strategies
- Developed pedestrian priority algorithm using ASC/3 SITL signal controller
- Results show that algorithm can be effective in reducing
  - Overall delay
  - Ped delay



Next Steps

- Field Deployments
  - ASC/3 controllers
    - Mesa, AZ
    - Flagstaff, AZ
  - Type 2070 controllers
    - Portland, OR
- Compare efficiency impacts with other pedestrian strategies
- Ped Priority Algorithm using pedestrian delay

Thank you!

Portland State UNIVERSITY

NITC
NATIONAL INSTITUTE for TRANSPORTATION and COMMUNITIES

TREC
Transportation Insight for Vibrant Communities

NORTHERN ARIZONA UNIVERSITY

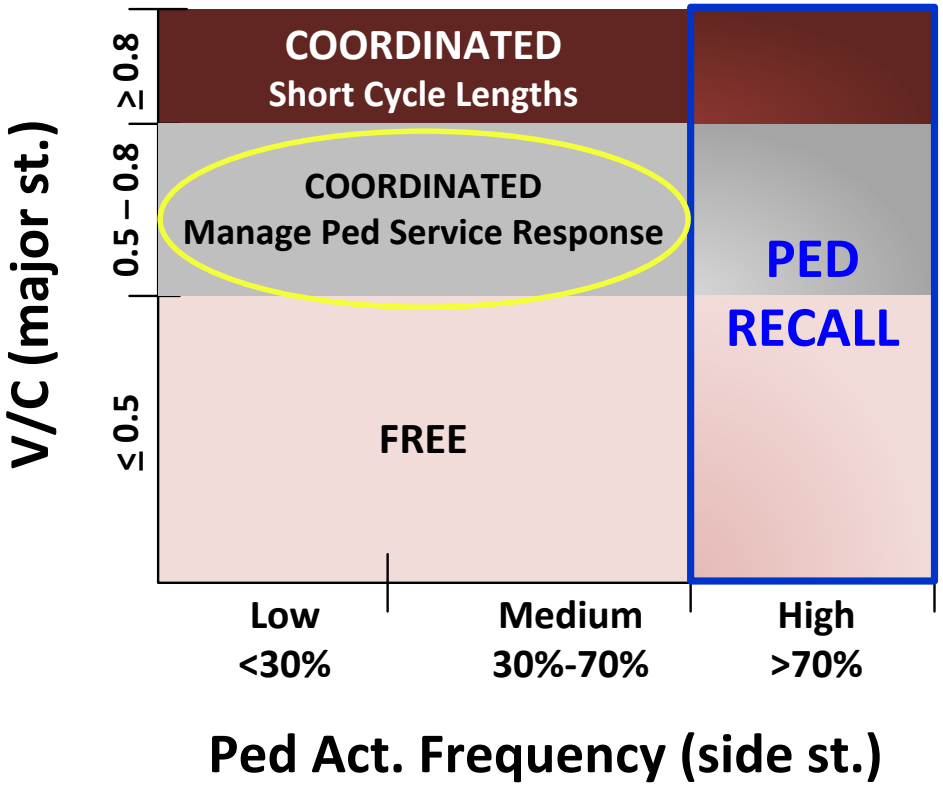
CITY OF PORTLAND, OREGON 1851

CITY OF FLAGSTAFF
SERVICE AT A HIGHER ELEVATION

mesa·az

Threshold Determination

- Exploring Pedestrian Responsive Signal Timing Strategies in Urban Areas



Platoon Dispersion Modeling

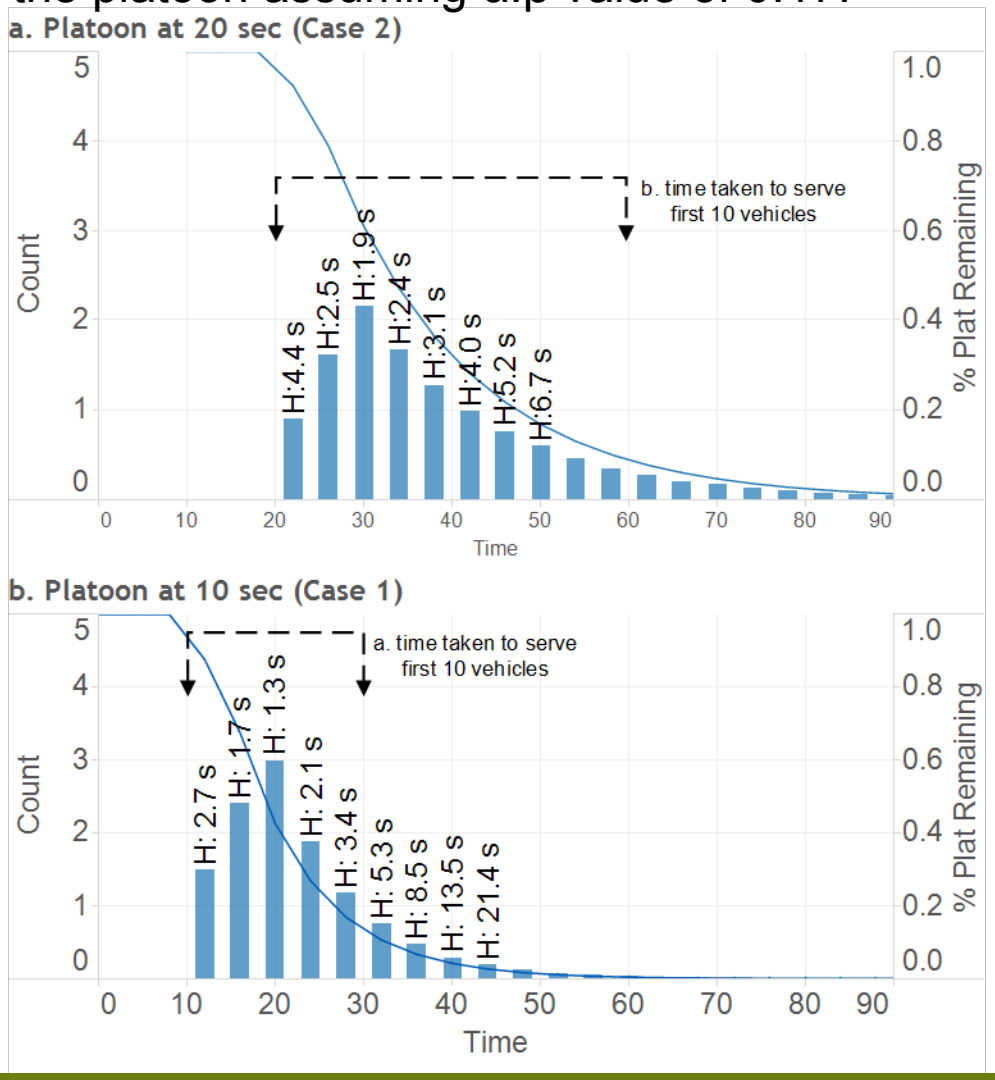
- Robertson's Model:

Where,

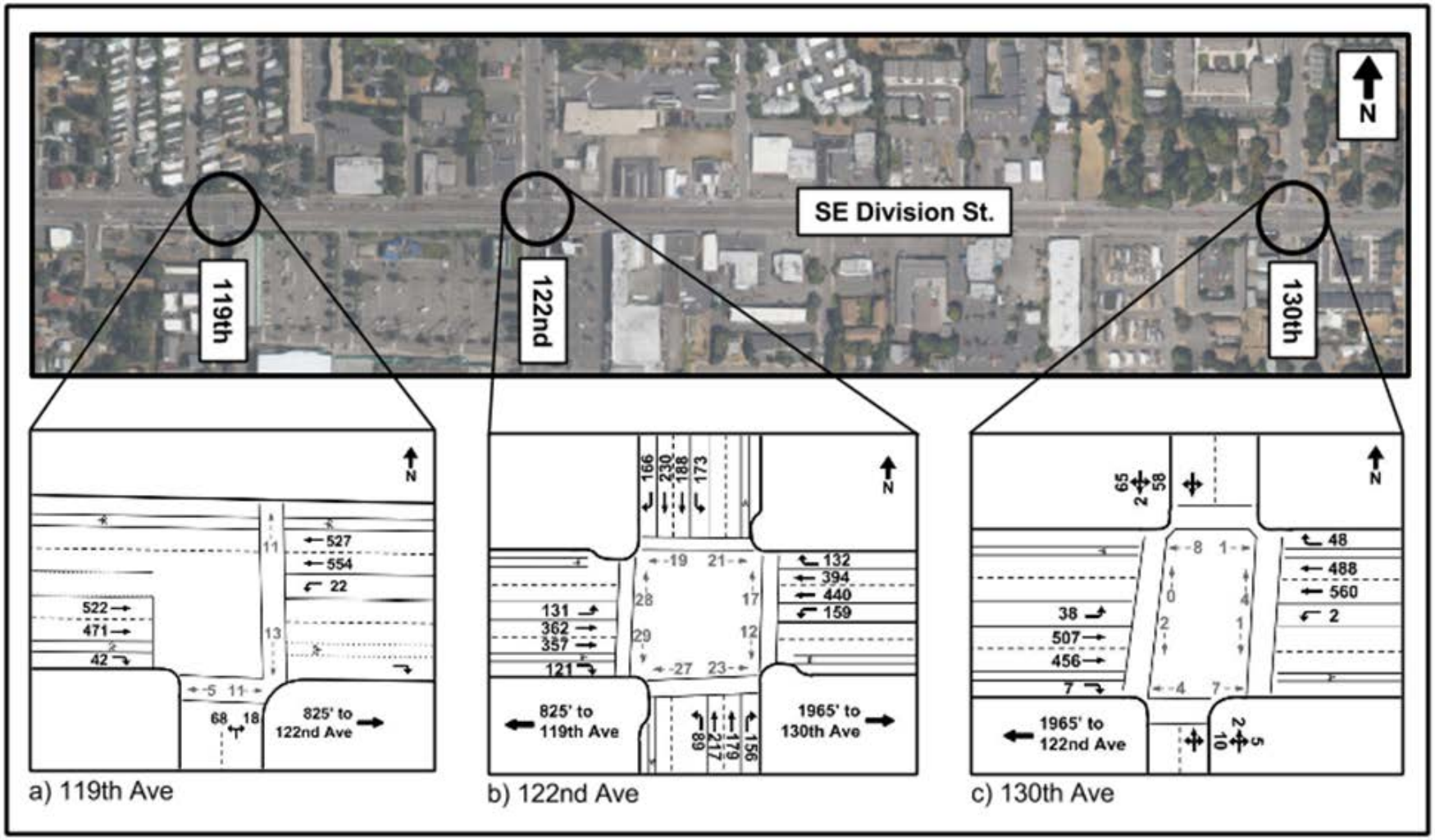
- q_i = i^{th} time interval
- α = platoon dispersion factor
- β = travel time factor
- T = average travel time between upstream signal to downstream signal
- F = smoothing factor

Platoon Dispersion Modeling

Robertson's platoon dispersion diagram for locations 10 sec and 20 sec away from the point of origin of the platoon assuming α.β value of 0.17.



Simulation Development



References

"Loop Intersection Begins Test of 'pedestrian Scramble'" N.p., 31 May 2013. Web. 05 Jan. 2016

"Video Detectors as Loop Replacement - Aldridge Traffic Controllers – SCATS Traffic Management Systems | Traffic Signal Controllers." *Video Detectors as Loop Replacement - Aldridge Traffic Controllers – SCATS Traffic Management Systems | Traffic Signal Controllers*. N.p., n.d. Web. 05 Jan. 2016.

"VISualising and SIMulating Traffic." *PTV COMPASS BLOG*. N.p., n.d. Web. 05 Jan. 2016.

"Silhouette of Pedestrians on Bridge in Ront of Münster." *Dreamstime*. N.p., n.d. Web. 05 Jan. 2016.

"This Dancing Crosswalk Lights Are Made To Make Pedestrians Safe And Happy!" *Wereblog*. N.p., 03 Nov. 2014. Web. 05 Jan. 2016.

"Western US - The Water Issues." *The Water Issues*. N.p., n.d. Web. 05 Jan. 2016.