Getting there on Time: *Why Travel Time Reliability Isn't Just for Drivers*

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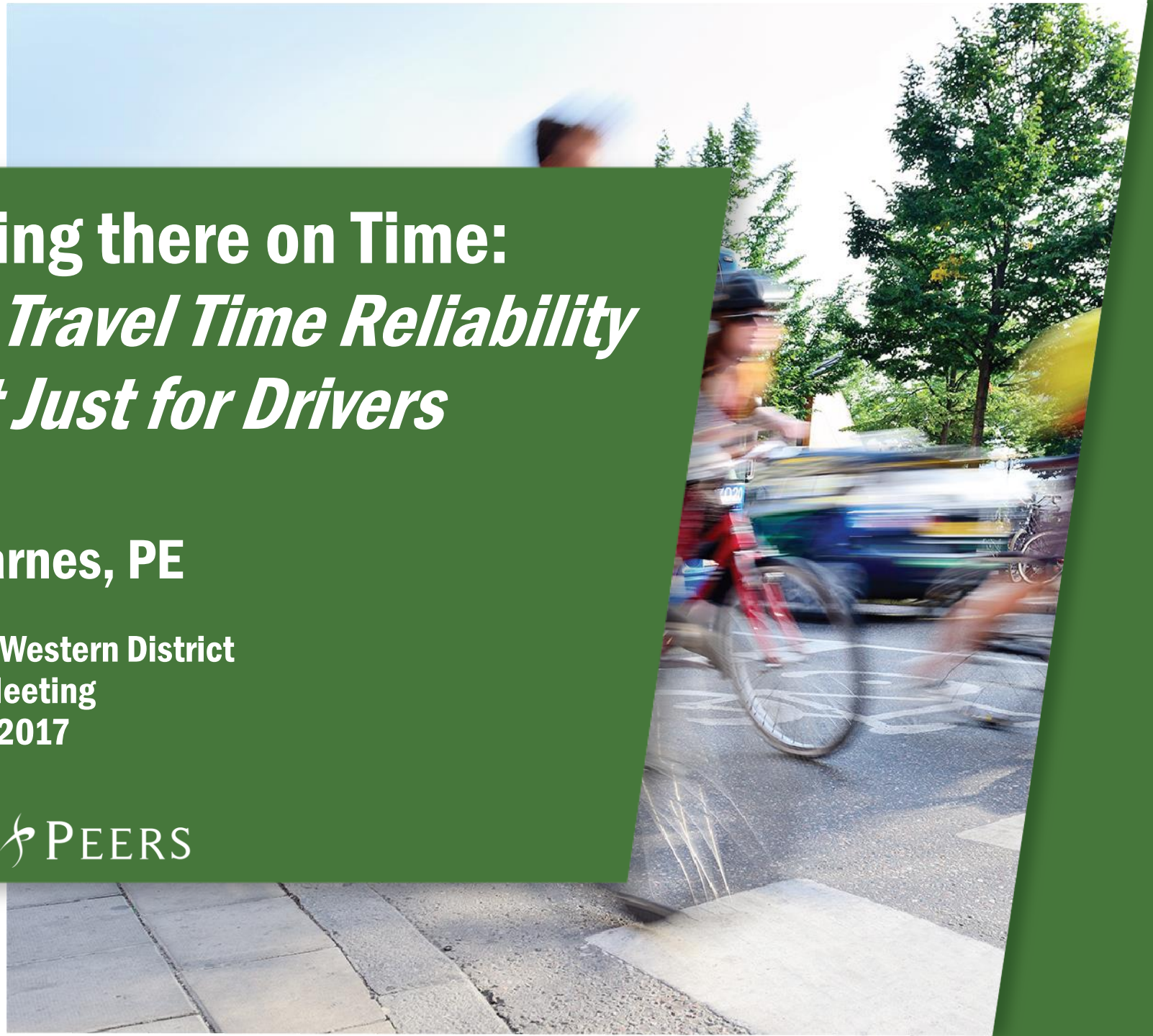
FEHR PEERS



Traditional travel time reliability

WHY IS TRAVEL TIME RELIABILITY IMPORTANT?

Most travelers are less tolerant of *unexpected delays* because such delays have larger consequences than drivers face with everyday congestion. Travelers also tend to remember the few bad days they spent in traffic, rather than an average time for travel throughout the year (see Figure 1).

In order to improve travel time reliability, the first step is to measure it. Measures of travel time reliability better represent a commuter's experience than a simple average travel time. For example, a typical before-and-after study attempts to show the benefits of an incident management program (see Figure 2). Looking at average travel time, the improvement may seem modest. However, travel time reliability provides a different perspective of the improvement: the worst few days have been dramatically improved. Travelers make it to their destinations on time more often or with fewer significant delays.

HOW DO AGENCIES MEASURE TRAVEL TIME RELIABILITY?

Travel time reliability measures are relatively new, but a few have proven effective. Most measures compare high-delay days to those with an average

Figure 1. Averages don't tell the full story

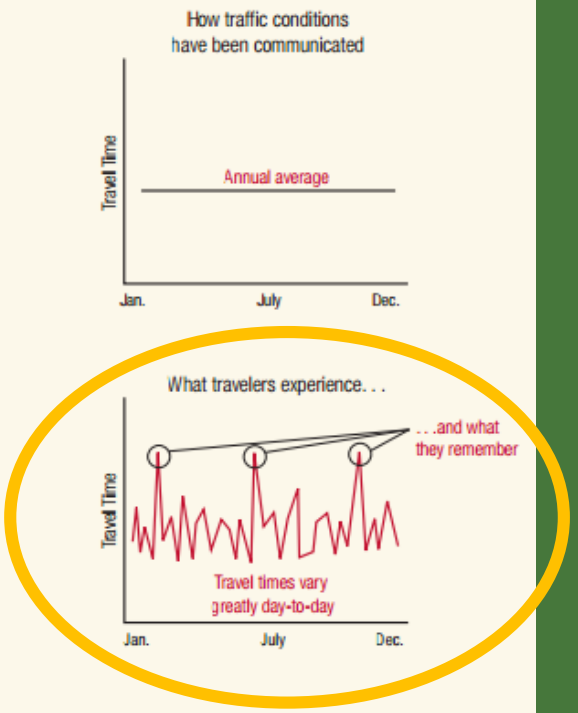
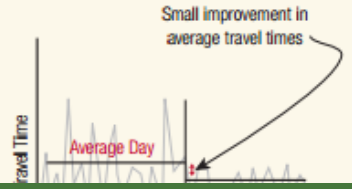
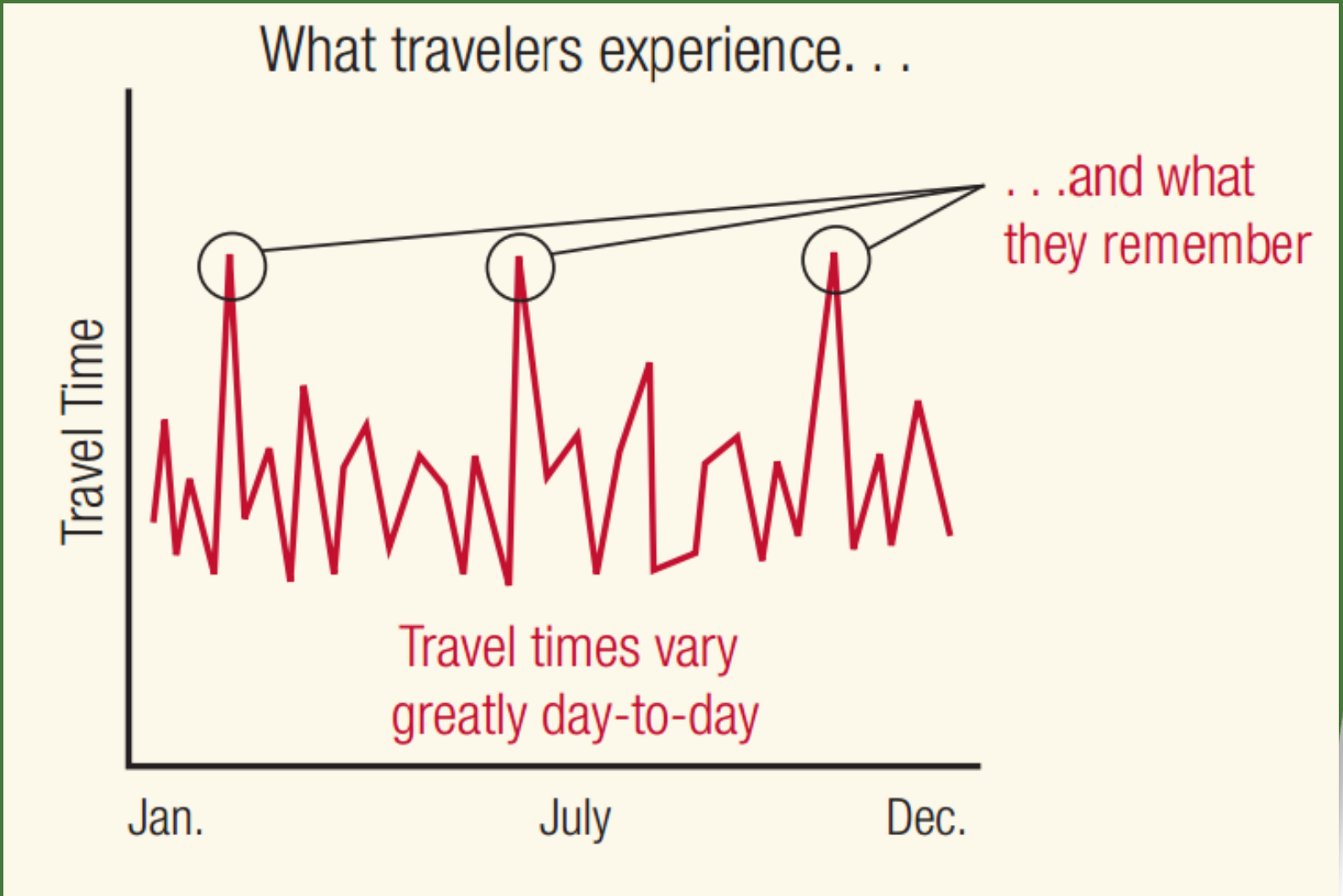


Figure 2. Reliability measures capture the benefits of traffic management



Source: FHWA

Traditional travel time reliability

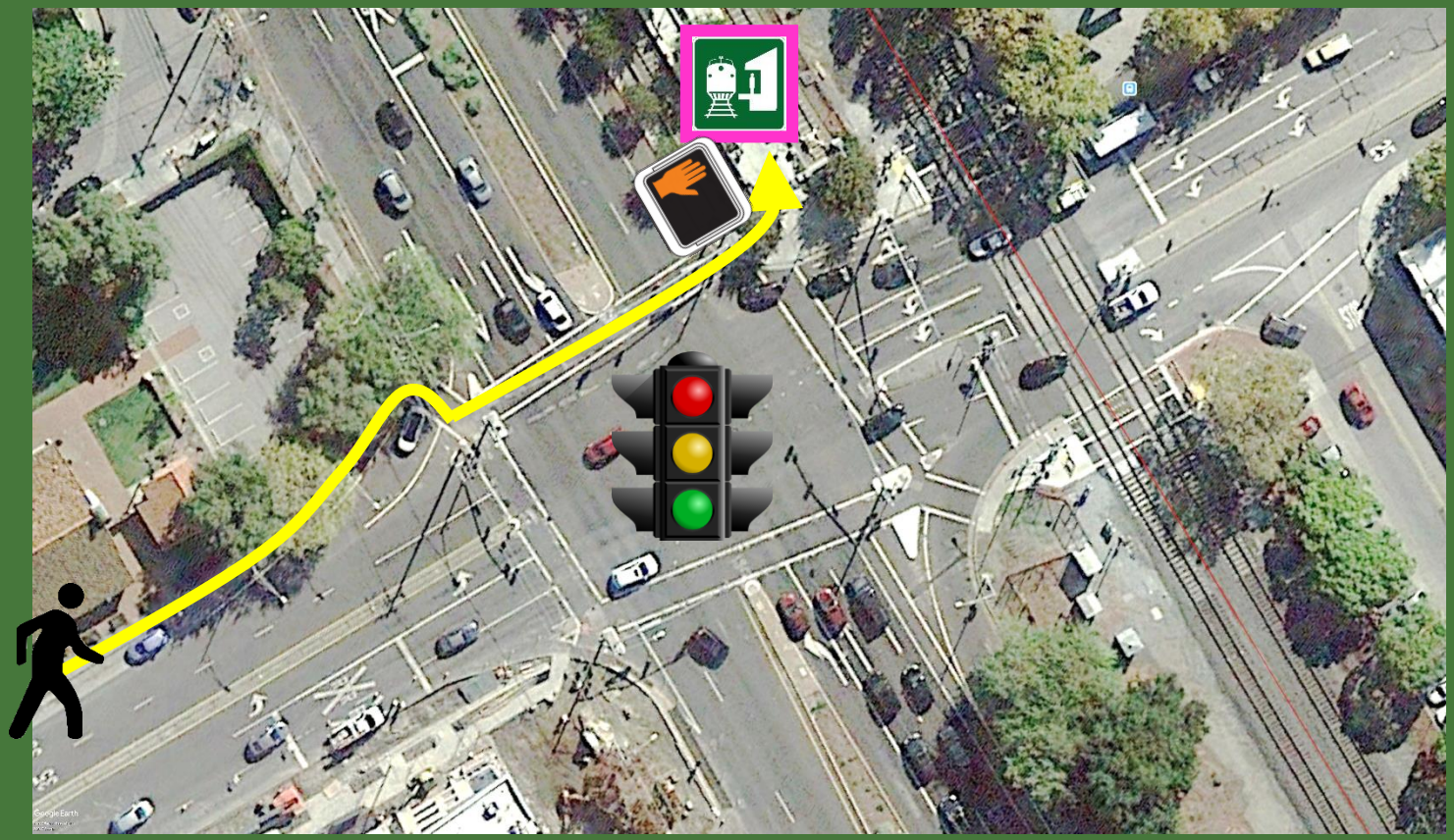


Traditional travel time reliability

- Driver travel time along a corridor
- Travel time while on a train or bus
- How often a plane arrives on time

How does travel time reliability over the course of a trip influence trip making?

Imagine, for a minute…



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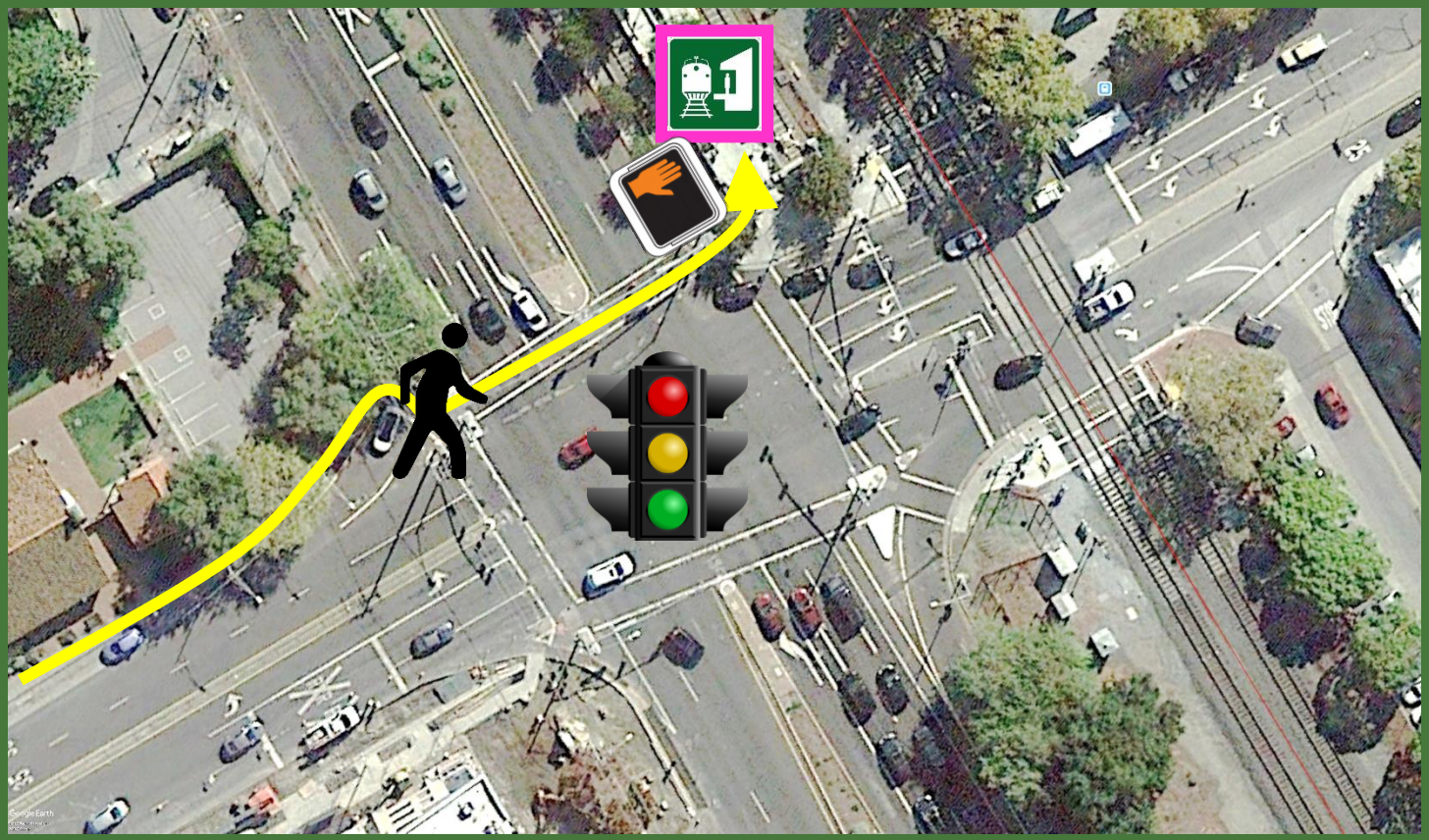

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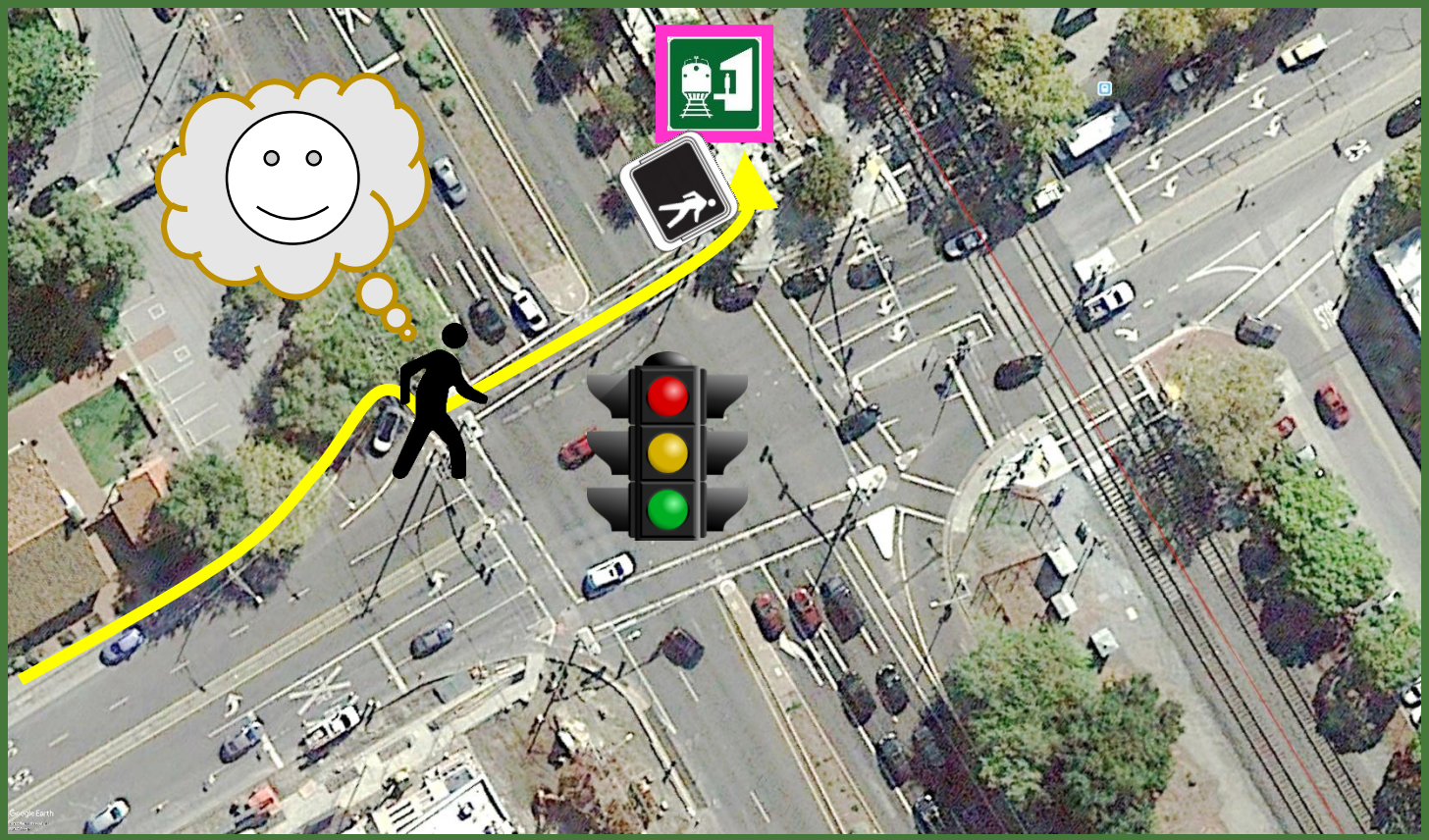

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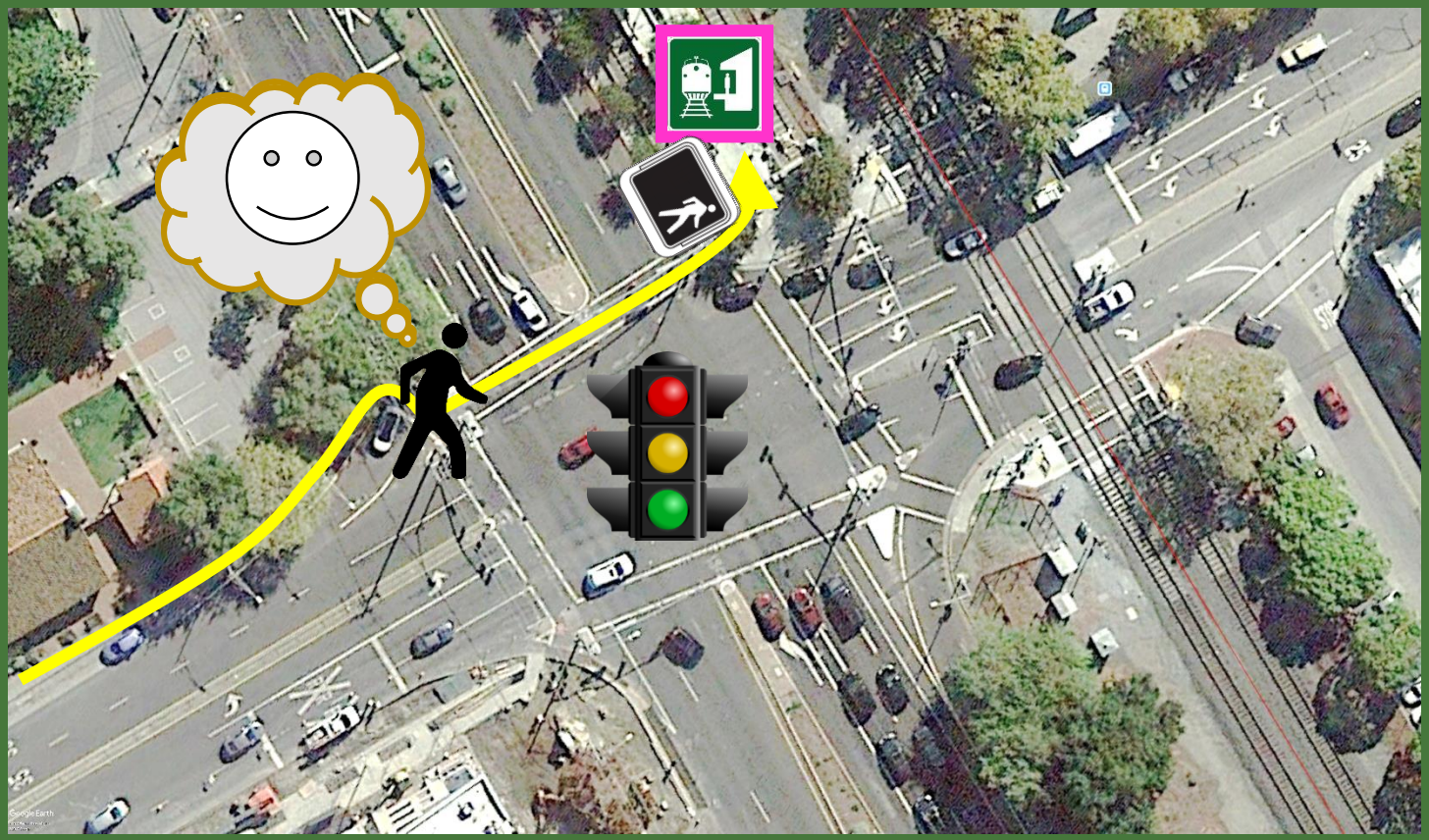
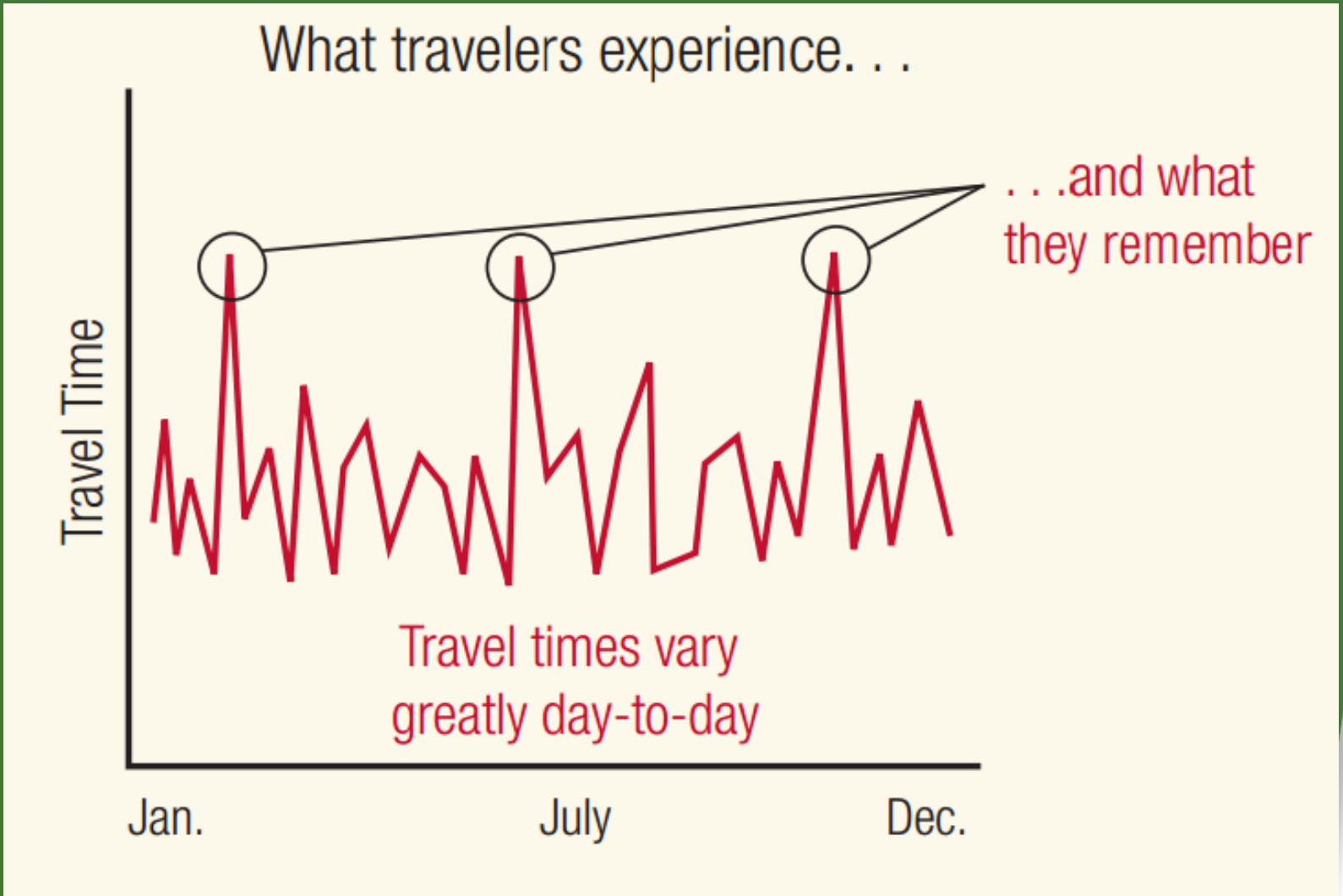


Unforseen Delay Dilemma

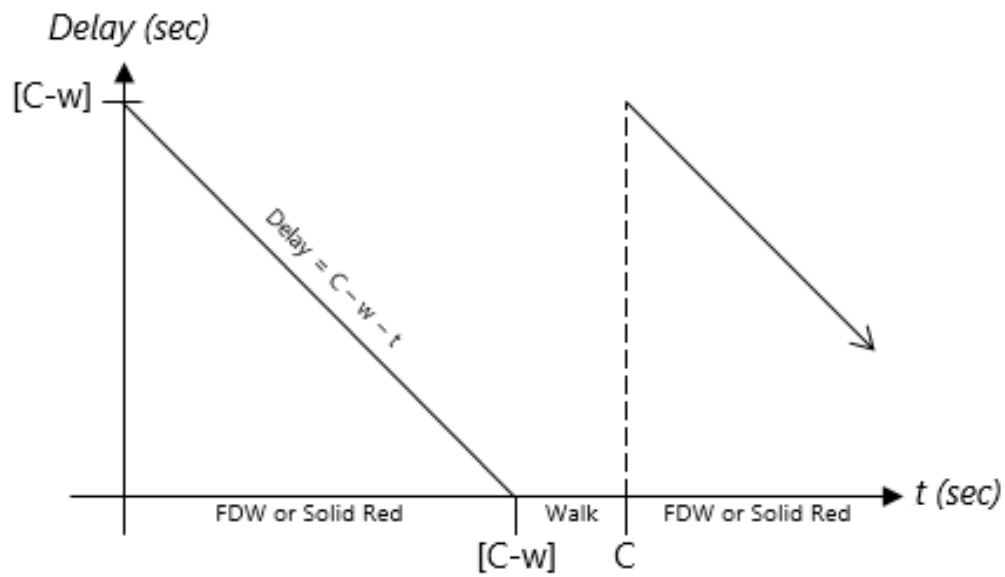
- Wait for the signal?
  - Miss transit trip? (1 headway penalty, missed transfers downstream)
  - Add buffer time next trip (inconvenient)
  - Choose different mode next time?
- Make up the lost time?
  - Walk faster/run (if enough time to do so)
  - Make unsafe movement (jaywalk, cross against red signal)
- Pedestrians impatient at delays over 30 sec

Traditional travel time reliability



Traditional Delay Estimation

Highway Capacity Manual Model



Arrival Time at Intersection Relative to Pedestrian Signal Indications and Cycle Length

Where:

C = Cycle Length

w = Effective Walk Time

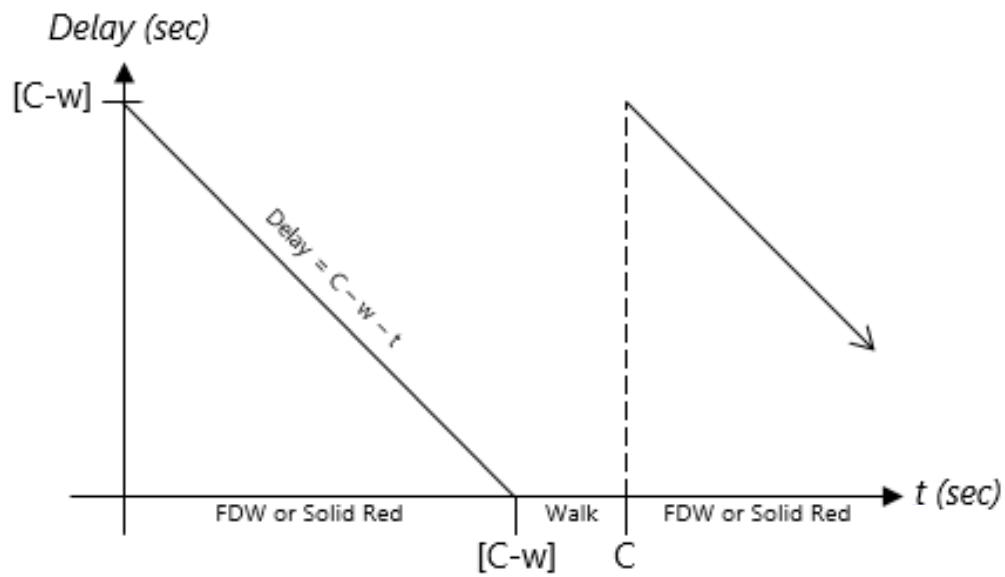
Key Assumptions:

Uniform Pedestrian Arrivals

Pedestrian Call Present Every Cycle

Traditional Delay Estimation

Highway Capacity Manual Model



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Traditional Delay Estimation

Using the equations requires:

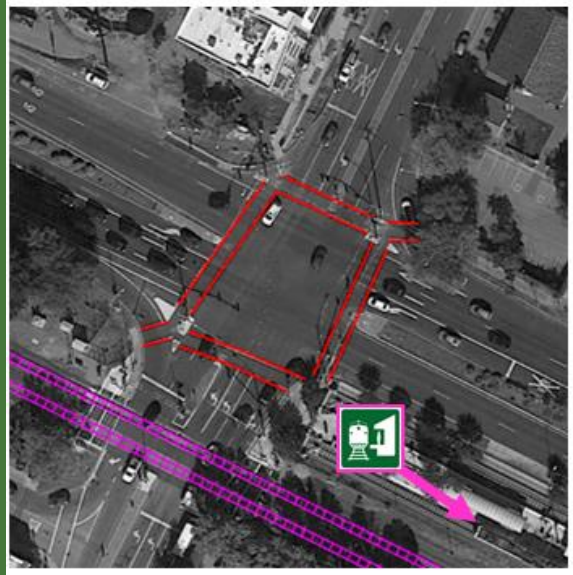
- Predictable signal operations
- Uniform arrival patterns
- Pedestrian call every cycle

Station are intersections are unique:

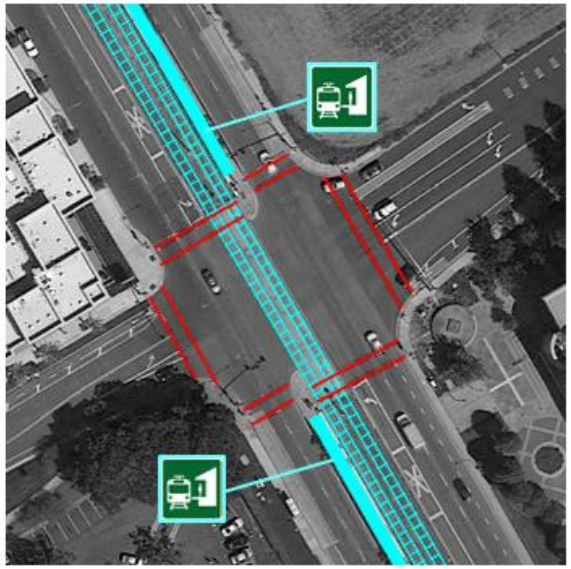
- Signal interruptions due to priority or preemption
- Bunched pedestrian arrivals near stops/stations

Delay Modeling Case Studies

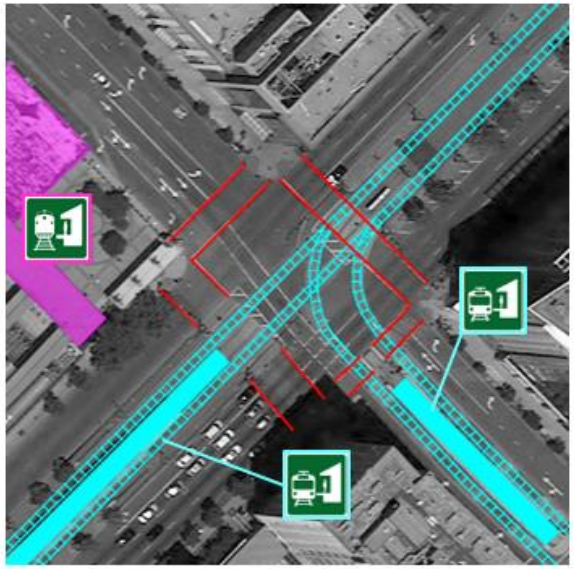
3 case studies using VISSIM models:



Side-running heavy rail transit (HRT) station adjacent to intersection with preemption



Median-running light rail transit (LRT) station adjacent to intersection with TSP



Intermodal hub (HRT terminal with median-running LRT) adjacent to intersection with TSP

Models based on Year 2014-2016 conditions
Calibrated and validated for Existing Conditions

Case Study Scenarios

- Baseline: Removed TSP/preemption (All cases)
  - Heavy rail: grade separation
  - Light rail: standard signals
- Preemption (Heavy rail, median Light Rail cases)
- Transit signal priority (Light Rail cases)
- Reporting:
  - Parallel to tracks
  - Transverse to tracks
  - Station access trips

Case Study Results

Crossing delays measured in seconds

Pedestrian Movement	Baseline[1]		Preemption		Transit Signal Priority	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Scenario 1: Side-Running Heavy Rail Transit Station Adjacent to Intersection						
Parallel to Tracks	71.2	18.2	68.8	20.7	N/A	N/A
Transverse to Tracks *Primary Station Access*	72.1	8.1	109.7	20.6	N/A	N/A
Scenario 2: Median-Running Light Rail Transit Station Adjacent to Intersection						
Parallel to Tracks	58.9	6.8	59.6	9.5	58.3	14.2
Transverse to Tracks	60.9	11.0	87.7	23.6	58.4	10.3
Full Crossing of Street	60.2	10.1	86.3	21.5	57.7	10.9
LRT Station Access Trips	61.0	10.8	89.5	25.7	59.9	8.9
Scenario 3: Intermodal Hub Adjacent to Intersection with LRT and Transit Signal Priority						
Parallel to Tracks	55.9	4.5	N/A	N/A	59.0	16.5
Transverse to Tracks	59.5	14.8	N/A	N/A	69.2	23.7
Full Crossing of Street	63.0	17.6	N/A	N/A	79.2	26.5
LRT Station Access Trips	56.9	9.3	N/A	N/A	62.7	16.7

Case Study Results

Increase >5%
Change <5%
Decrease >5%

Crossing delays measured in seconds

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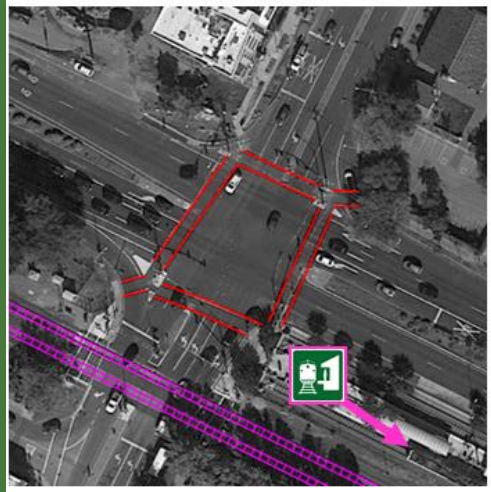

Side-running heavy rail transit (HRT) station adjacent to intersection with preemption

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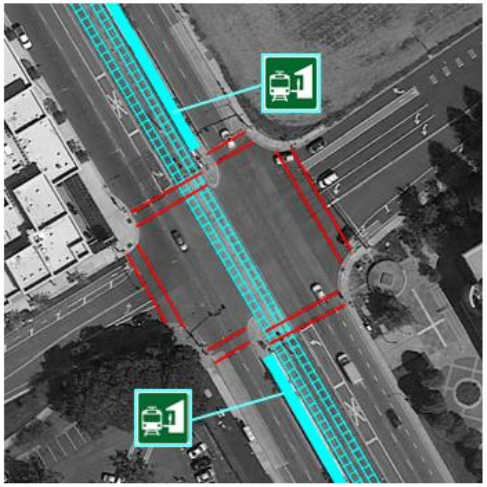

Median-running light rail transit (LRT) station adjacent to intersection with TSP

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Change <5%
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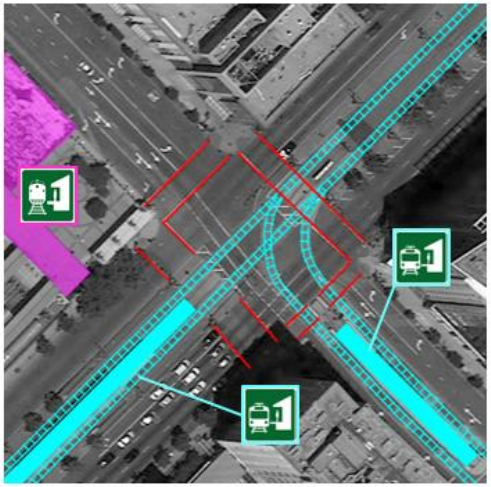

Intermodal hub (HRT terminal with median-running LRT) adjacent to intersection with TSP

Access Trip Monte Carlo Model

- Transit access trips rarely span 1 intersection
- String of signalized intersections over a "first mile"
- 3 sample trips in Monte Carlo model
  - 1.0 mile Suburban trip to heavy commuter rail station
  - 0.5 mile suburban trip to median-running LRT
  - 1.0 mile urban trip to intermodal hub
  - 5-7 crossings assumed in each sample trip

Access Trip Monte Carlo Model

- Standard signals: HCM model with variable signal cycle length:
  - Suburban setting: 120-160 seconds
  - Urban setting: 80-120 seconds
- Station access crossing using case study parameters
- Effective walk time of 7.0 seconds
- Walking speed of 4.0 feet/second (working age commuter)
- Each sample trip modeled 1,300 times (5 years of 260 working days/year)

Access Trip Monte Carlo Model

Sample Trip	Travel Time (minutes)					% of Delay at Transit Access Intersection
	Average	Std. Dev.	98th Percentile	Minimum	Maximum	
Scenario 1: 1.0 mile suburban trip to heavy rail station	28.0	1.6	31.4	23.7	35.4	Average: 32% Range: 11%-79%
Scenario 2: 0.5 mile suburban trip to LRT station	17.2	1.3	19.9	13.7	23.0	Average: 33% Range: 15%-65%
Scenario 3: 1.0 mile urban trip to intermodal hub	26.8	1.1	29.0	23.5	30.6	Average: 25% Range: 5%-72%

- Travel times typically in a tight range
- 15% buffer time for 98% confidence
- Disproportionate, unpredictable delay at transit access intersection
- Lack of opportunity to recover after unforeseen delays

Strategies to Improve Reliability

- Operations, detection and design
- Minimize effects of preemption/TSP
- Lowering overall delay

Operations Strategies

- Pedestrian recall
- Increasing walk times
- Rest in walk phase
- Reduction in cycle lengths near stations
- Pedestrian phases during preemption
- “Walk waves” along coordinated corridors

$$Average\ Delay\ (seconds) = \frac{(C-w)^2}{2C}$$

$$Standard\ Deviation\ of\ Delay\ (seconds) = \left(\frac{(C-w)^3}{3C} - \frac{(C-w)^4}{4C^2}\right)^{\frac{1}{2}}$$

Detection and Design Strategies

- Advanced pedestrian detection
  - Microwave/video detection
  - Flash Don’t Walk phase extension
- Midblock station access crossings
- Two-stage crossings
- Adding missing crosswalks
- Grade separated direct access
- Wayfinding/transit departure time signage

In Closing

- Variability in signal operations near transit stations decreases travel time reliability
- Use microsimulation models to estimate delay where non-standard signal operations occur
- Monte Carlo models may be used to simulate station access trips
- Operations, detection and design strategies are available to improve travel time reliability

Thank You!

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