# New Research on Dynamic Reversible Left-Turn Lanes at Signalized Diamond Interchanges

**ITE Mid-Colonial Annual Meeting (Wilmington, DE)**

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# Preview Outline of Presentation

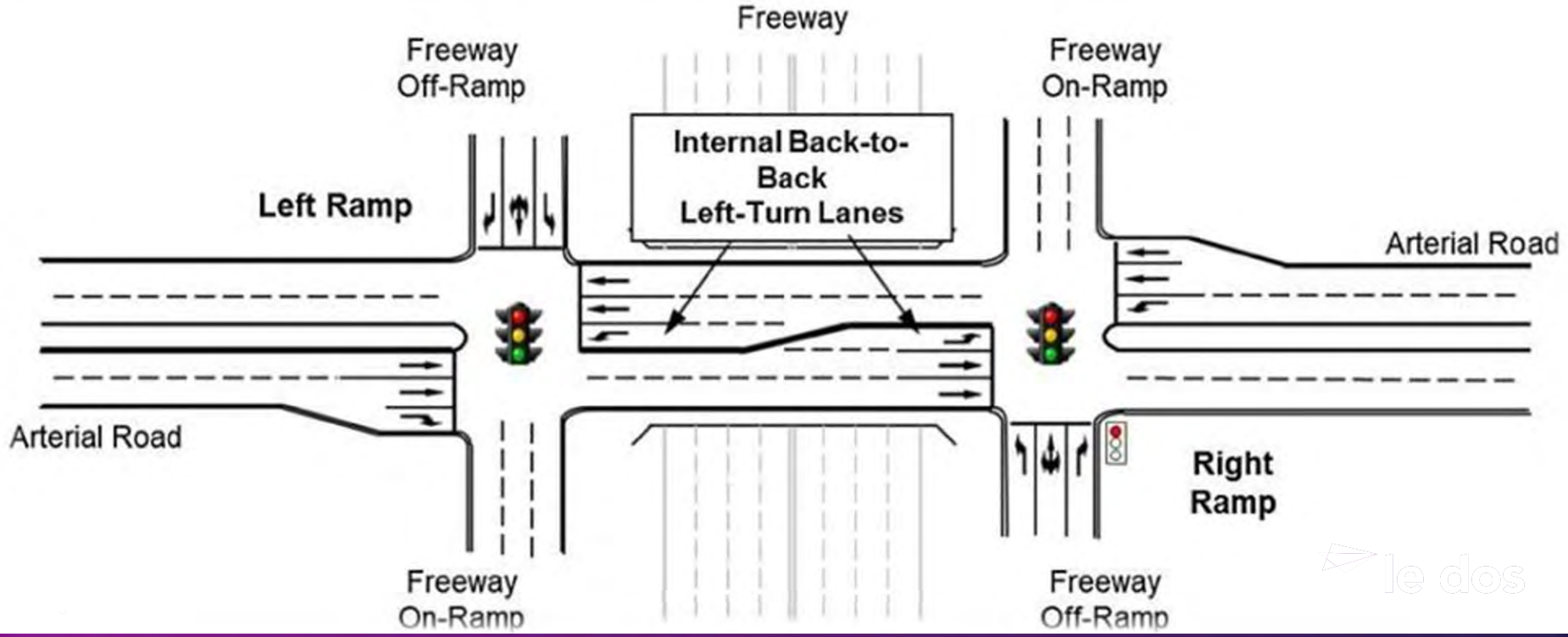
*New research on:*

*Dynamic Reversible Left-Turn Lanes at Signalized Diamond Interchanges*

- Introduction
- Motivation
- Static pictures
- Moving vehicle animation
- Operational benefits
- MUTCD-compliant design
- Human factors study
- Signal timing methods
- Conclusions

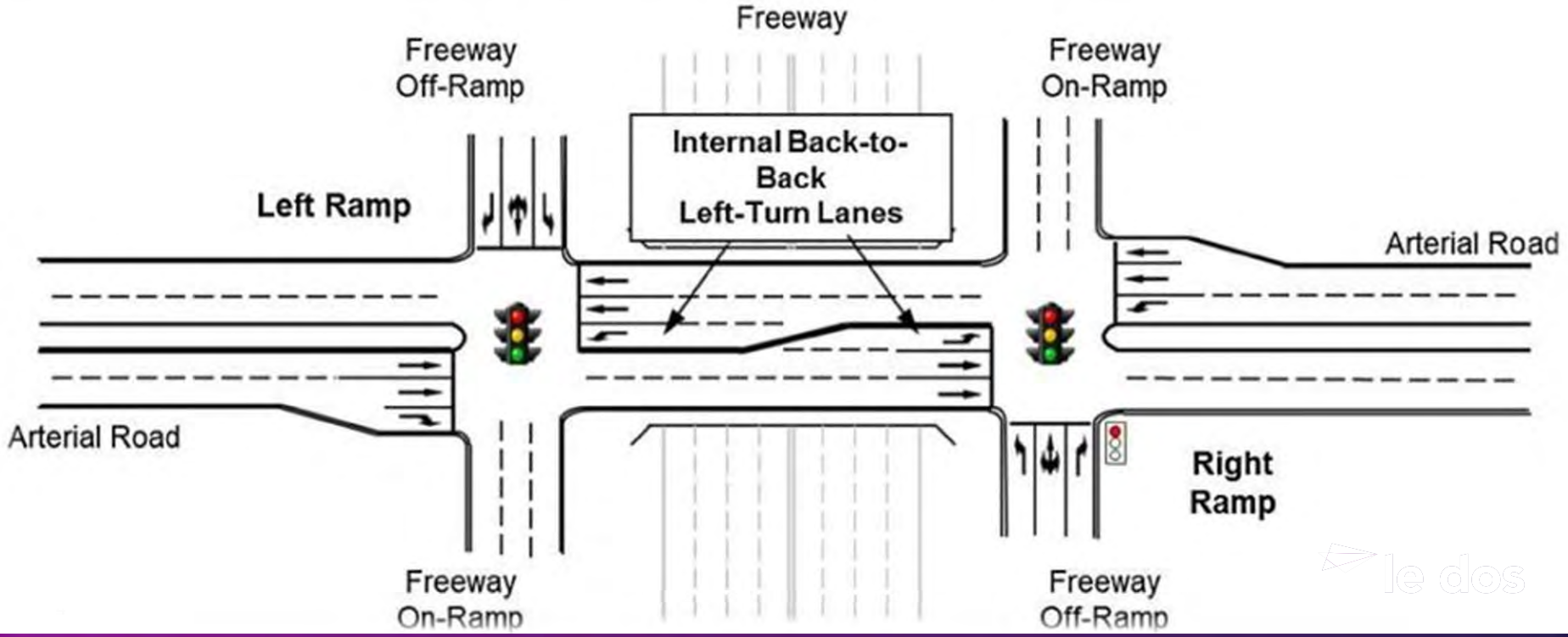
# Introduction

- Dynamic Reversible Left-Turn (DRLT)
- Scope: signalized diamond interchanges
- FHWA's goal: make DRLT "practice-ready"
  - where to implement, safe signing-striping-signalization, signal timing design

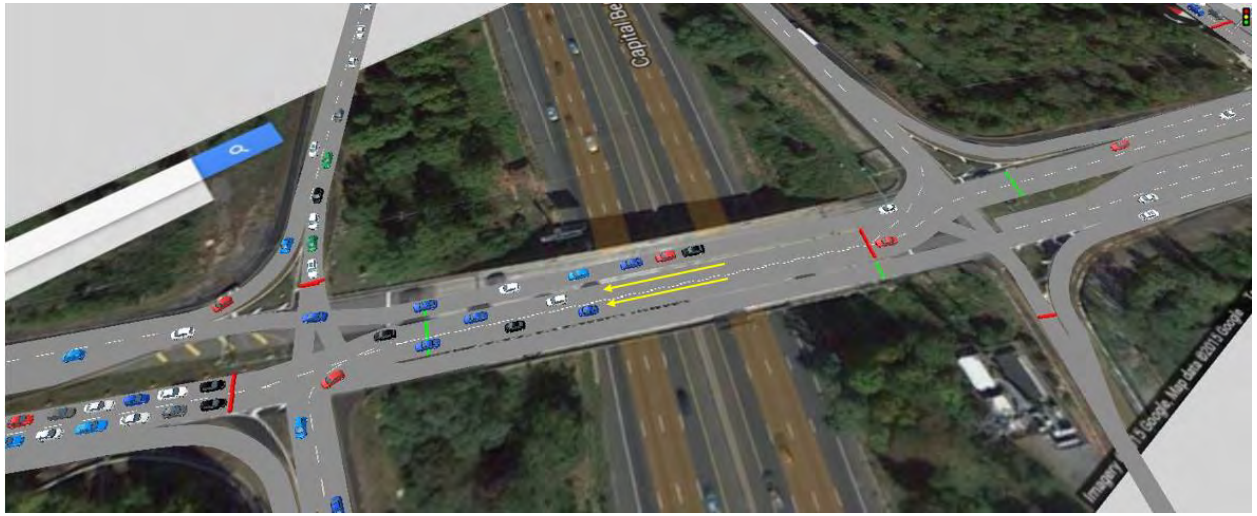


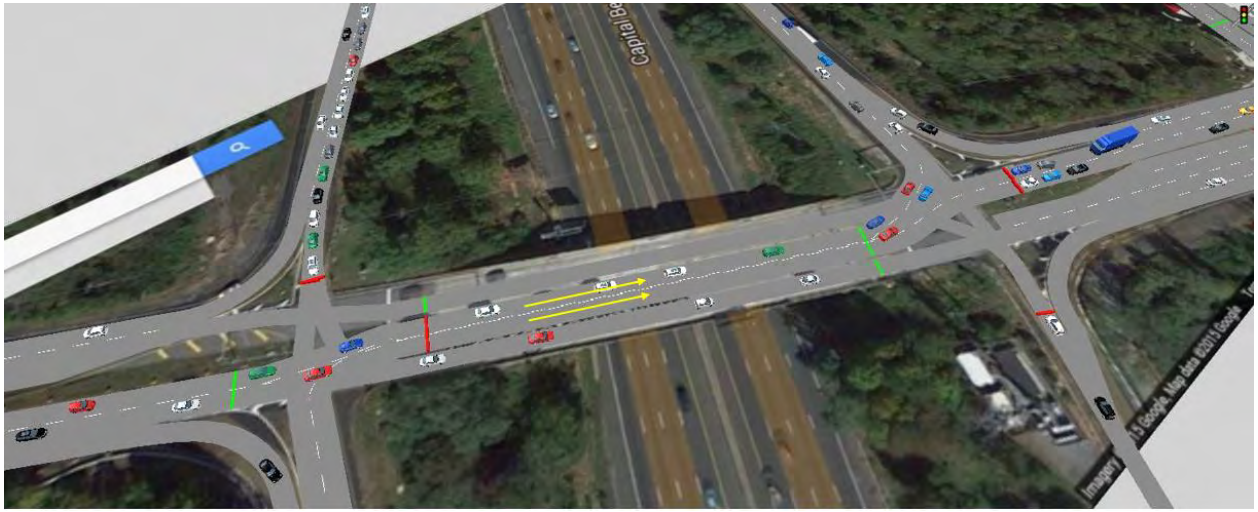
# Motivation

- Advantages vs. traditional diamond interchange
  - Reduced delay
  - Increased throughput
  - Eliminate queue spillover



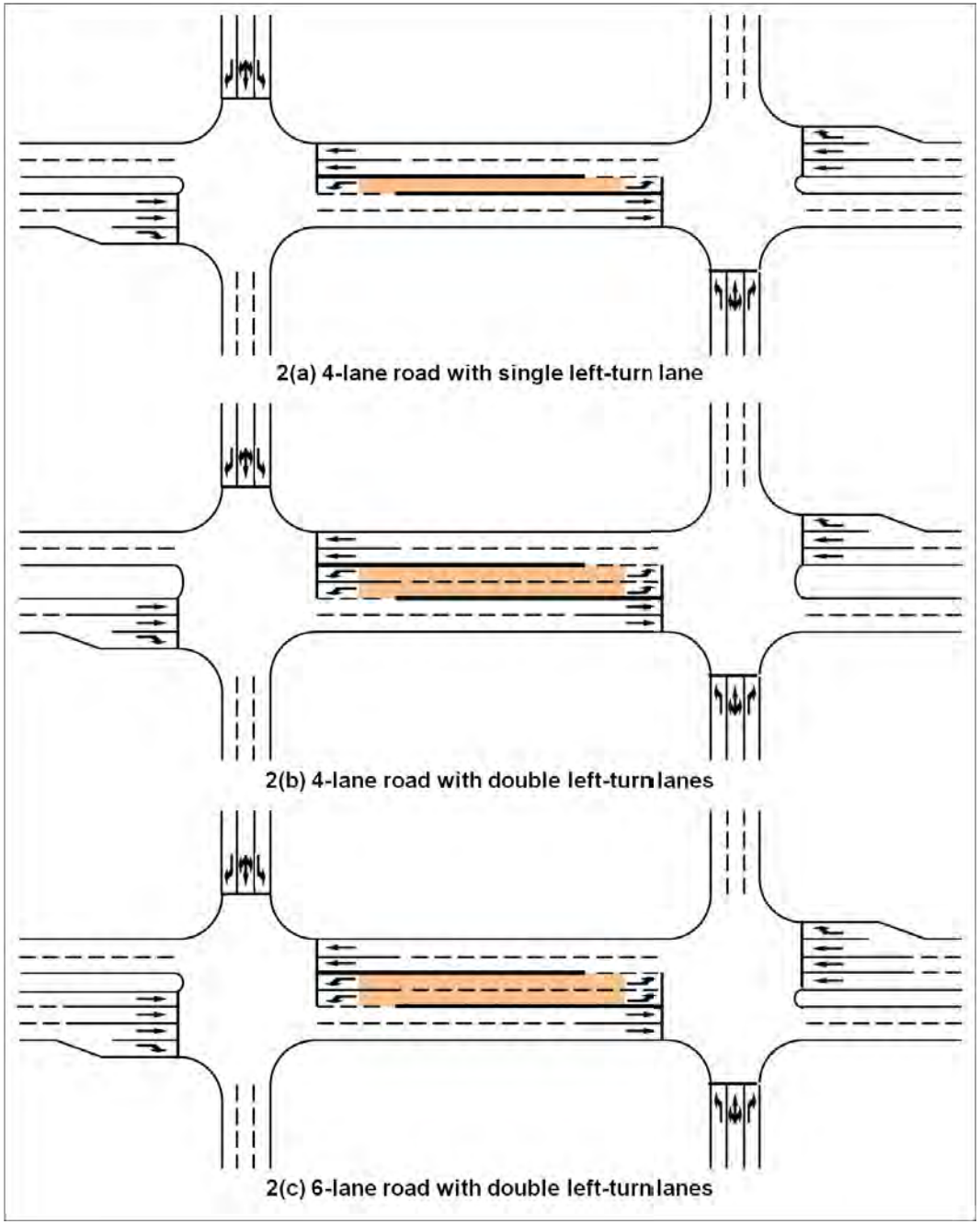
# Static Pictures: Georgetown Pike at I-495





# Static Pictures

- Single-lane DRLT
- Dual-lane DRLT
- Number of external lanes
- Ratio of LT/TH demand




Source: Krause et al. (2014)

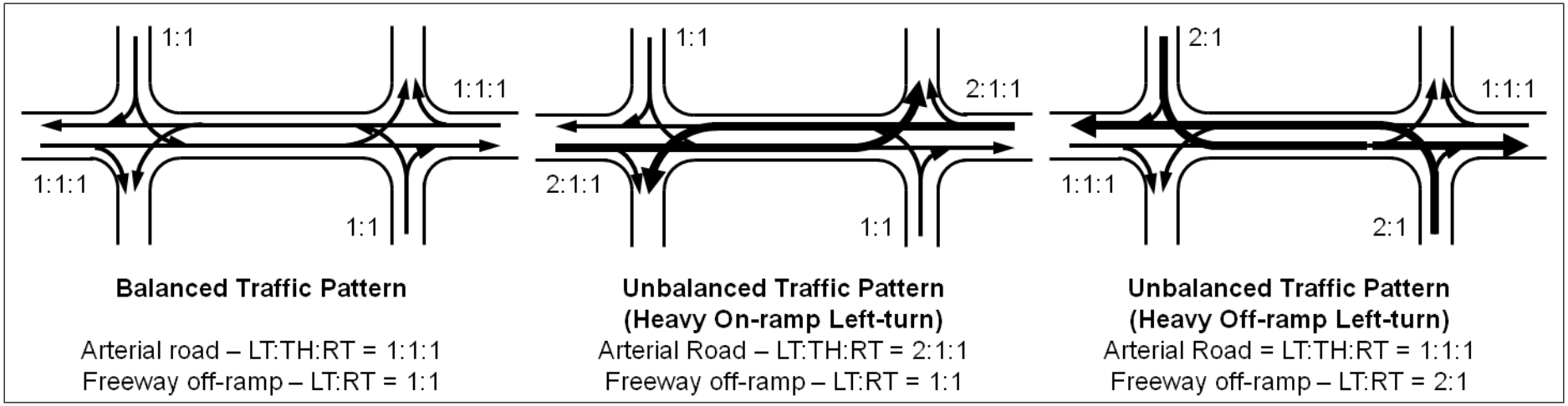
# Moving Vehicle Animation

Play Video (one reversible lane)

Play Video (two reversible lanes)

# Operational Benefits

- Maximum benefit scenario
  - LT on-ramp volumes are heavy and unbalanced
  - Heavy entering volumes
  - LT lane and multiple TH lanes needed in each direction




**Balanced Traffic Pattern**

Arterial road – LT:TH:RT = 1:1:1
Freeway off-ramp – LT:RT = 1:1

**Unbalanced Traffic Pattern (Heavy On-ramp Left-turn)**

Arterial Road – LT:TH:RT = 2:1:1
Freeway off-ramp – LT:RT = 1:1

**Unbalanced Traffic Pattern (Heavy Off-ramp Left-turn)**

Arterial Road = LT:TH:RT = 1:1:1
Freeway off-ramp – LT:RT = 2:1

Source: Krause et al. (2014)

# Operational Benefits

- VISSIM model of real-world site
  - Route 100 at Coca Cola Drive
  - Howard County, Maryland
- Geometric scenarios
  - Arterial # lanes: 4 and 6
  - Bridge # lanes: 5 and 6
  - Left-turn # lanes: 1 and 2
- Traffic demand levels
  - v/c: 1.0 and 1.3
- Best-case scenario
  - Throughput increased by 28%
  - Delays reduced by 60%


Case Study: Paul Pitcher Memorial Highway

# Operational Benefits

- Georgetown Pike at I-495 (VISSIM model)
- PM peak results shown below
- AM peak benefits: significant, but less than PM peak

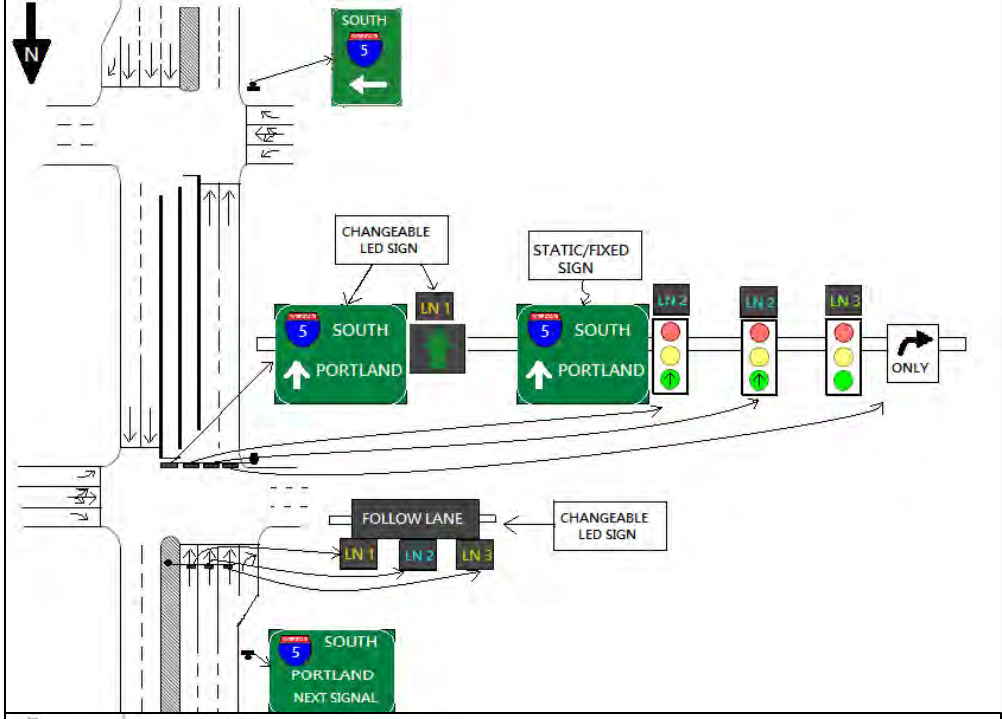
| | Before DRLT | After DRLT | Percent Improvement |
|---|---|---|---|
| Veh. Trips | 4042 | 5430 | 34% |
| Delay per Veh. | 369 | 52 | 86% |

# MUTCD-Compliant Design

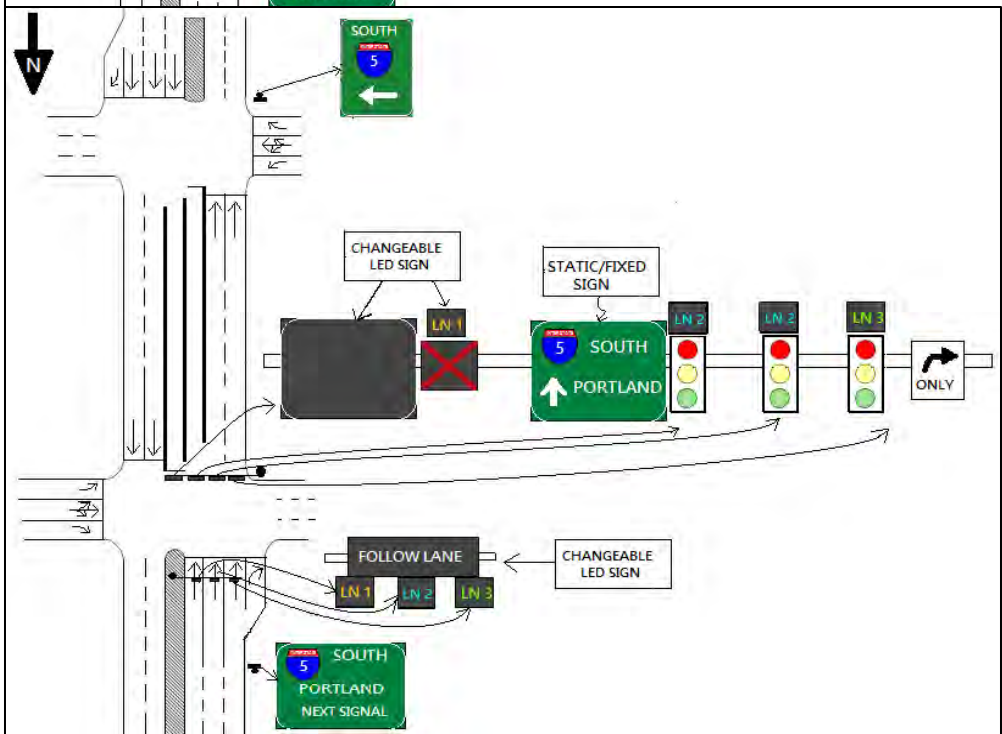
- Prevent crossing of paths (lane-changing collisions)
- Prevent off-ramp vehicles from entering reversible lane(s)
- Prevent vehicles from getting trapped in reversible lane(s)
- Signing, striping, signalization must be safe during the OFF-PEAK period (when DRLT is turned off)
- Advance warning of lane uses not defined by “default rules of the road”
- Changes to the MUTCD may be needed?

# Peak Period (DRLT active)

**Green Phase**

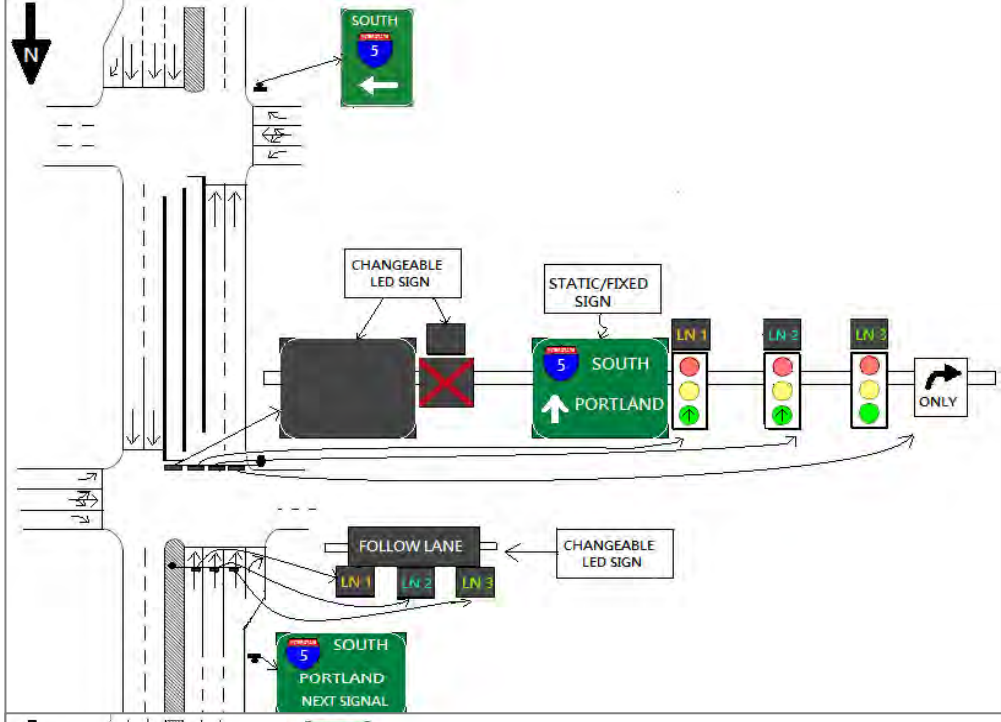



**Red Phase**

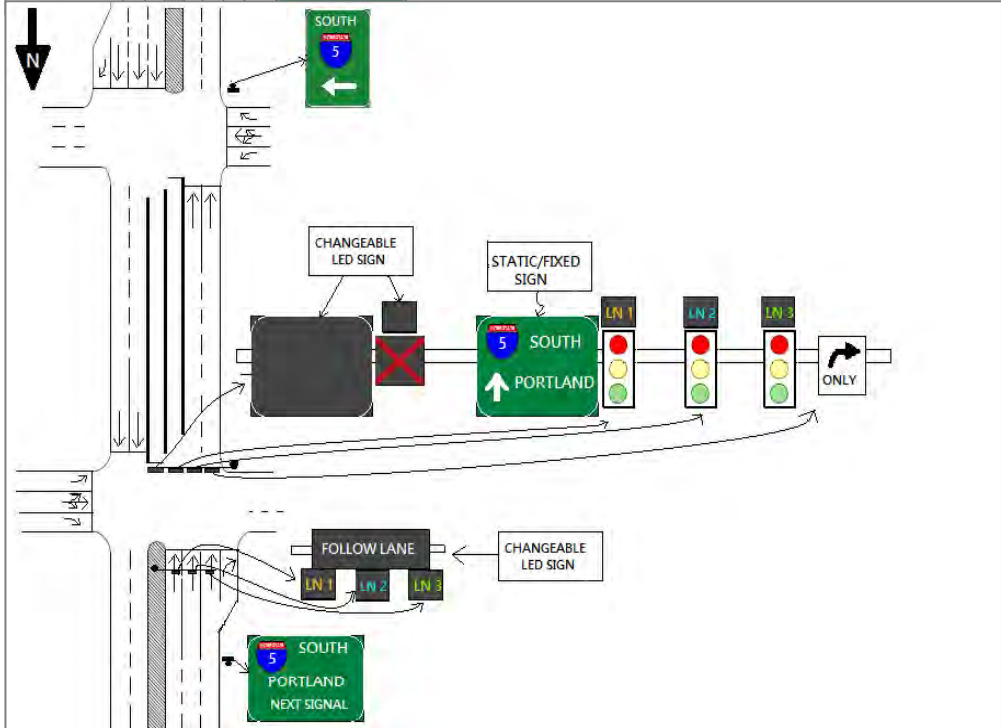


# Off-Peak Period (DRLT disabled)

Green Phase




Red Phase



# Human Factors Study

- Began in April 2016 at the Turner-Fairbank Highway Research Center
- Period of performance: 22 months
- Deliverables: tech brief and final report

**Goals:**

- Develop, test, and evaluate traffic control devices (TCDs) for DRLTs
- Use novel TCD treatments (e.g., changeable symbol signs, colored pavements, LED pavement markings) to prevent unsafe movements

# Human Factors Study

**Work Plan:**

- Human factors sign lab
  - Develop short list of promising TCD options
- Driving simulator experiments with licensed drivers
  - Evaluate promising TCD options

# Human Factors Study

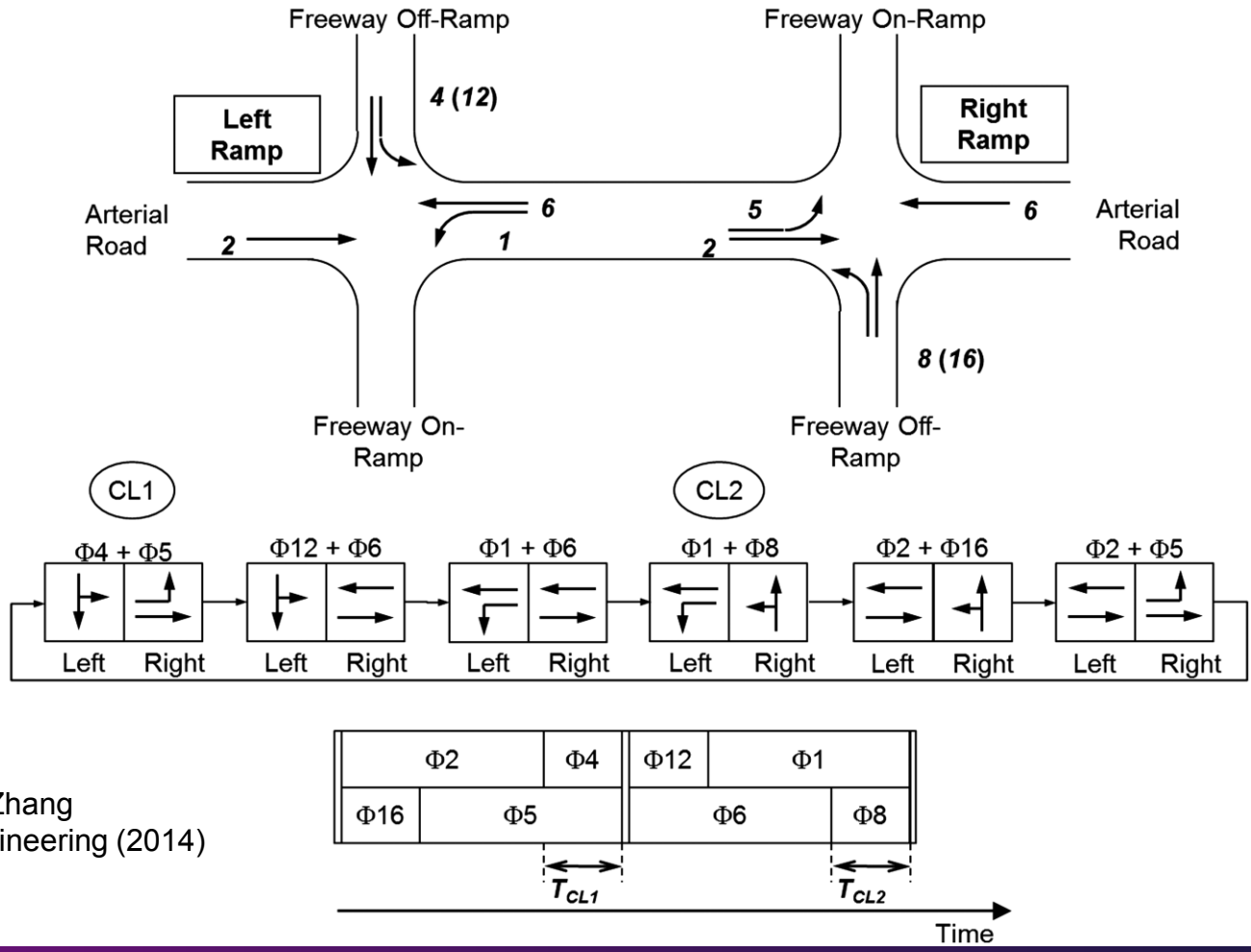
- Sign Lab will use Autodesk Infraworks 360
  - Animated movies show novel TCDs from a driver's perspective
  - Roadway geometry can be exported as AutoCAD drawings to the FHWA driving simulator for further development


Figure 5. Screen capture of divided highway intersection created in Infraworks 350.


Figure 6. Second view of divided highway intersection show animated flashing beacons on warning sign.

# Signal Timing Methods

- Conventional methods might be inadequate
  - Dynamic lane modeling
  - Clearance time
- Prototype method
  - Constraints
  - Research paper




by Krause, Kronpraset, Bared, and Zhang
ASCE Journal of Transportation Engineering (2014)

# Conclusions

- No known real-world implementations of DRLT
- Significant operational benefits in simulation
  - Datasets available through the Saxton Lab!
- Upcoming FHWA bottleneck primer will publish some of this material
- Unanswered question: is DRLT safe?
  - Follow-on human factors study
  - Signal timing methods (co-authors?)

**This research sponsored by:**

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**Located at:**

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