SAXTON TRANSPORTATION LABORATORY

New HCM Chapter(s)/
Alternative Intersections/Interchanges

2010 HCM Major Update

July 2014

U.S. Department of Transportation
Federal Highway Administration

Project Vision and Goals

To develop HCM analysis procedures for evaluating capacity and quality of service for

MUT intersection

RCUT intersection

DDI/DCD interchange

CFI/DLT intersection

State Members

State	Individuals	
Alabama	Jeffrey Brown George Connor Kidada C. Dixon	John Lorentson Michelle Owens Tim Taylor
Florida	Patti Brannon Alan S. El-Urfali	Fred Heery
Missouri	Ashley Reinkemeyer	Julie Stotlemeyer
Nevada	Hoang Hong Denise Inda	Dave Partee
Ohio	Dirk Gross	James Young
Wisconsin	John Shaw	
Colorado	Jake Kononov	Richard Sarchet
North Carolina	Kevin Lacy	
Washington	Doug McClanahan	
California	Sarah Chesebro Doug Macivor	Kalin Pacheco

Inclusion in the 2015 HCM

- 30+ states have expressed interest in this material
- Dramatic increase in Alternative Intersection/Interchange deployments nationwide
- Alternative Intersections/Interchanges on the FHWA EDC-2 program
- Strong macroscopic analysis tools needed before deploying complex and expensive microscopic analysis
- Project Ongoing - Materials will be ready for inclusion into 2015 HCM

Location of Material in the 2015 HCM – Option A

Inclusion in chapter 22

Pros
• Existing Chapter in the HCM
• OD Procedures for interchanges can be extended to intersections
• Similarity between Alt. Intersections and Interchanges
• Subcommittee willing to champion
Cons
• Traditionally interchange chapter
• The procedures in Chapter 16, 17, 18, etc. have to be tweaked to conform

DLT

Distinguishing Feature:

Left-turn movement (on one or more approaches) strategically relocated to the far-side of the opposing roadway via interconnected signalized crossover in advance of the main intersection

SR 30 and Summit Rd in Fenton, MO

DLT

- Interchange footprint vs. DLT footprint
- Effects on built environment
- Interchange cost vs. DLT cost
- Capacity vs signal?

MUT

- Corridor Capacity increases 20-50%
- 2 phase signal creates better progression-large “green bands” without very long cycles

RCUT

- **50%-70% crash reduction**
- **Reduced mainline delay + stops**
- **Corridor treatments?**

Data Collection

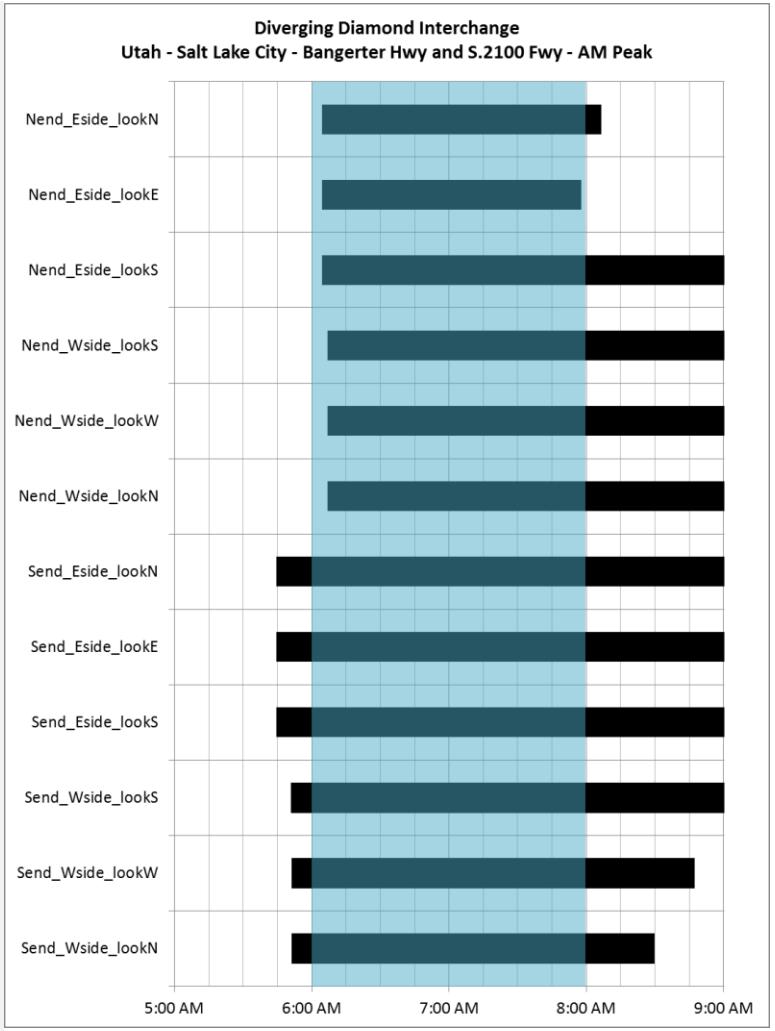
Video Feed Data

Type	State	Locations	Peaks	Cameras	Video Hours
Double Crossover Diamond	Utah	4	8	95	251.2
Displaced Left-turn	Colorado	1	2	16	37.2
	Louisiana	2	4	31	63.3
	Mississippi	1	2	9	14.4
	Ohio	1	2	16	28.2
	Utah	7	14	106	176.2
Restricted Crossing U-turn (Signalized)	Michigan	2	2	11	14.1
	North Carolina	3	6	38	89.9
Restricted Crossing U-turn (Unsignalized)	Maryland	7	14	43	101.2
Median U-turn (Signalized)	Michigan	2	3	16	26
Median U-turn (Unsignalized)	Michigan	4	6	24	36.1
Summary	**9**	**34**	**63**	**405**	**837.8**

Data Collection

Data Collection Reports

- Peak hour bar charts
  - Document the time recorded relative to the desired peak hour being observed.
  - Quick reference to see length of overlap time for critical views in data reduction.



Data Collection

Data Collection Reports

PM Video Feeds – Salt Lake City, Utah – Bangerter Hwy and S. 2100 Fwy

North End – East Side – Looking North – CAM 01 – Start at 15:52:20 – Duration of 2:43:07

North End – East Side – Looking East – CAM 02 – Start at 15:52:22 – Duration of 2:43:14

- Video Feed images
  - Back check that the video recorded picks up the necessary data desired.
  - Quick reference to identify desired combinations of videos for data reduction.

Data Collection

Data Collection Reports

- Typ. Video Feeds – Diverging Diamond




Data Collection

Data Collection Reports

- Video Feed Images – Displaced Left-turn

North DLT (East) Side – Looking Southwest – CAM 16 – Start at 15:10:00 – Duration of 0:20:15

North DLT (East) Side – Looking Northwest – CAM 20 – Start at 15:10:00 – Duration of 1:21:06

West DLT (South) Side – Looking West – CAM 9.2 – Start at 14:30:00 – Duration of 1:40:45

West DLT (South) Side – Looking Northeast – CAM 9.1 – Start at 14:30:00 – Duration of 0:58:28

Northwest Side – Looking Southwest – CAM 06 – Start at 14:20:00 – Duration of 0:31:08

Northwest Side – Looking Southeast – CAM 02 – Start at 14:20:00 – Duration of 1:02:41

East DLT (South) Side – Looking Northeast – CAM 26 – Start at 15:10:00 – Duration of 2:51:04

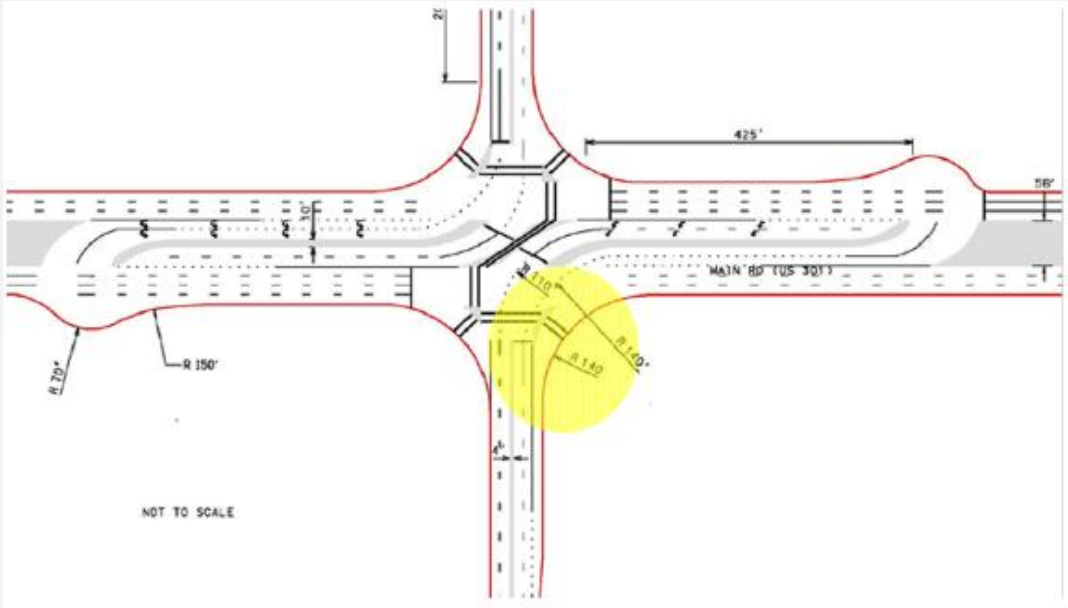
East DLT (South) Side – Looking Northwest– CAM 27 – Start at 15:10:00 – Duration of 2:51:30

South DLT (West) Side – Looking Northeast – CAM 18 – Start at 15:00:00 – Duration of 1:48:26

South DLT (West) Side – Looking Southeast – CAM 13 – Start at 15:00:00 – Duration of 0:17:04

Data Analysis
Identifying Data Needs

- Implementing the adaptations requires algorithm formulation and parameter calibration.
  - Example: Signalized RCUT – Critical gap for ROR from minor road.



Data Analysis
Fulfilling Data Needs

- Videos allow for the generation of observations to calibrate the parameters of proposed adaptations.
  - Example: Signalized RCUT – Critical gap for ROR

Northwest side – looking east – CAM 9 – Start at 15:55:00 – Duration of 2:30:39

Southeast side – looking west – CAM 5 – Start at 6:04:00 – Duration of 2:30:20

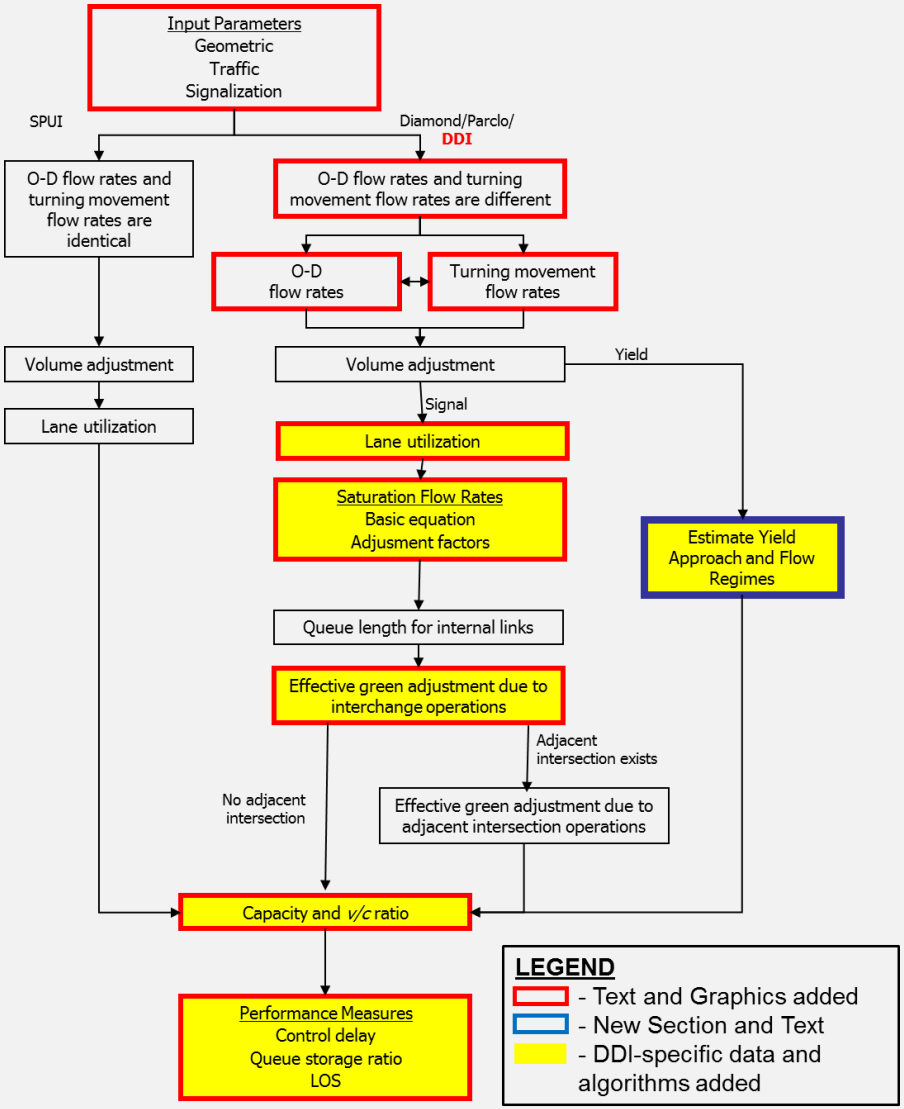
Diverging Diamond Interchange (DDI)

Bastian Schroeder, Ph.D., P.E.

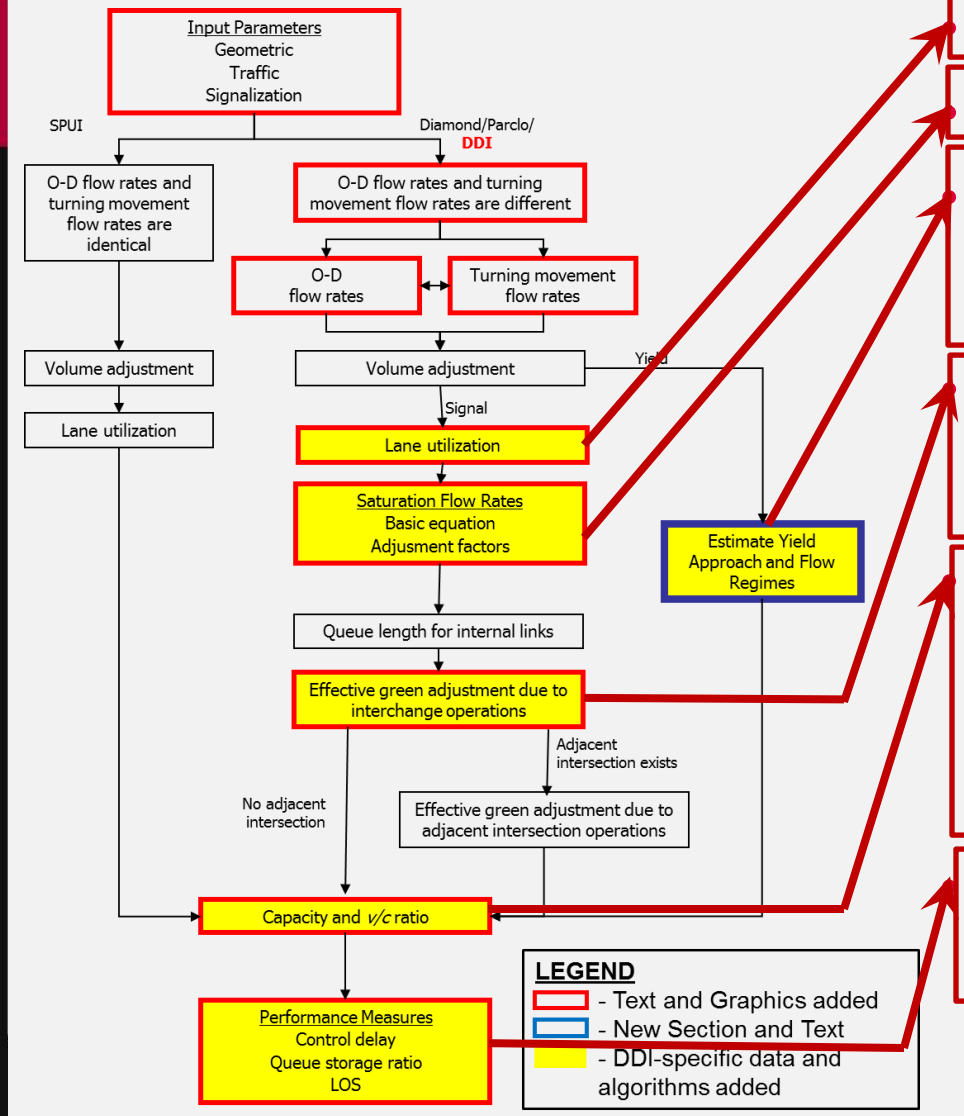
ITRE at N.C. State University

Proposed Adaptations

- Add text or Graphics to 8 of 11 steps
- Add data and new algorithms to 5 steps
- Add one new step for yield-controlled movements
- SEE HANDOUT



Proposed Adaptations



DDI Lane utilization models

DDI Sat. Flow Models

Yield-Controlled Turn Model

- Gap Acceptance Model (like RBT)
- Opposing Flow Regimes (like TWSC)

Added Lost Time due to

- Internal Queue
- Demand Starvation

DDI v/c Estimation

- Additional Lost Time for Overlap Phasing
- Proportion Arrival During Green
- DDI Phase Duration

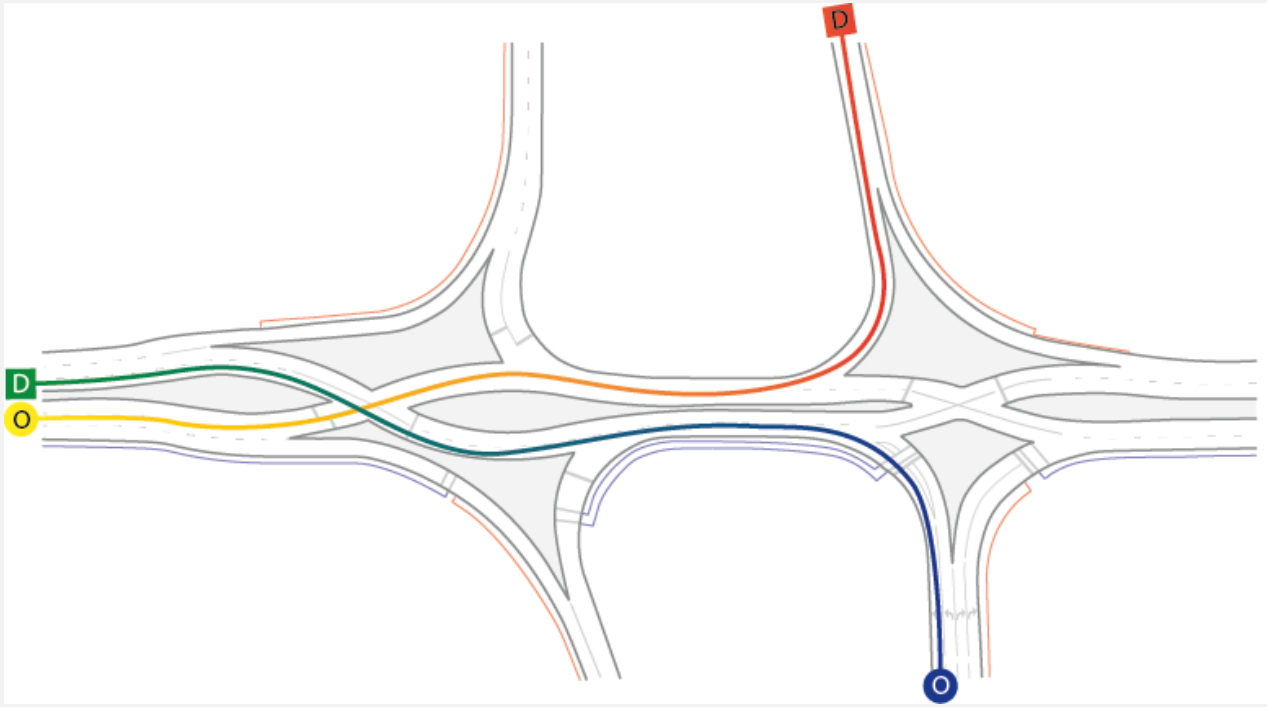
Travel Time Data for Validation

Ch. 22 – Interchange Ramp Terminals

DDI/DCD Interchanges – Item A

- Section 22-1. Introduction, Unique Operational Characteristics of Interchanges, p22-8 (cont.)
  - Sample diagram of DDI OD patterns:

***Exhibit 22-8**
Illustration of O-D Demands Through a DDI



Sample Data – Lane Utilization

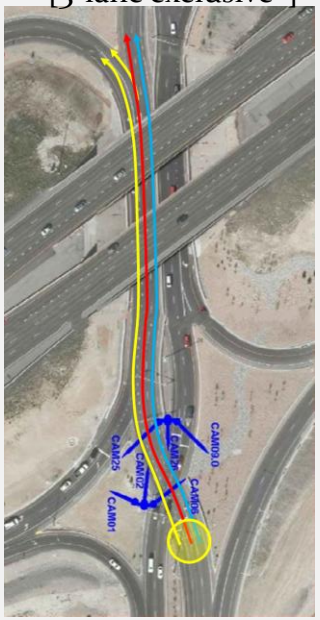
- **DDI Lane Utilization Model Development**

[2-lane shared]

[3-lane shared]

[3-lane exclusive]

[3-lane exclusive*]

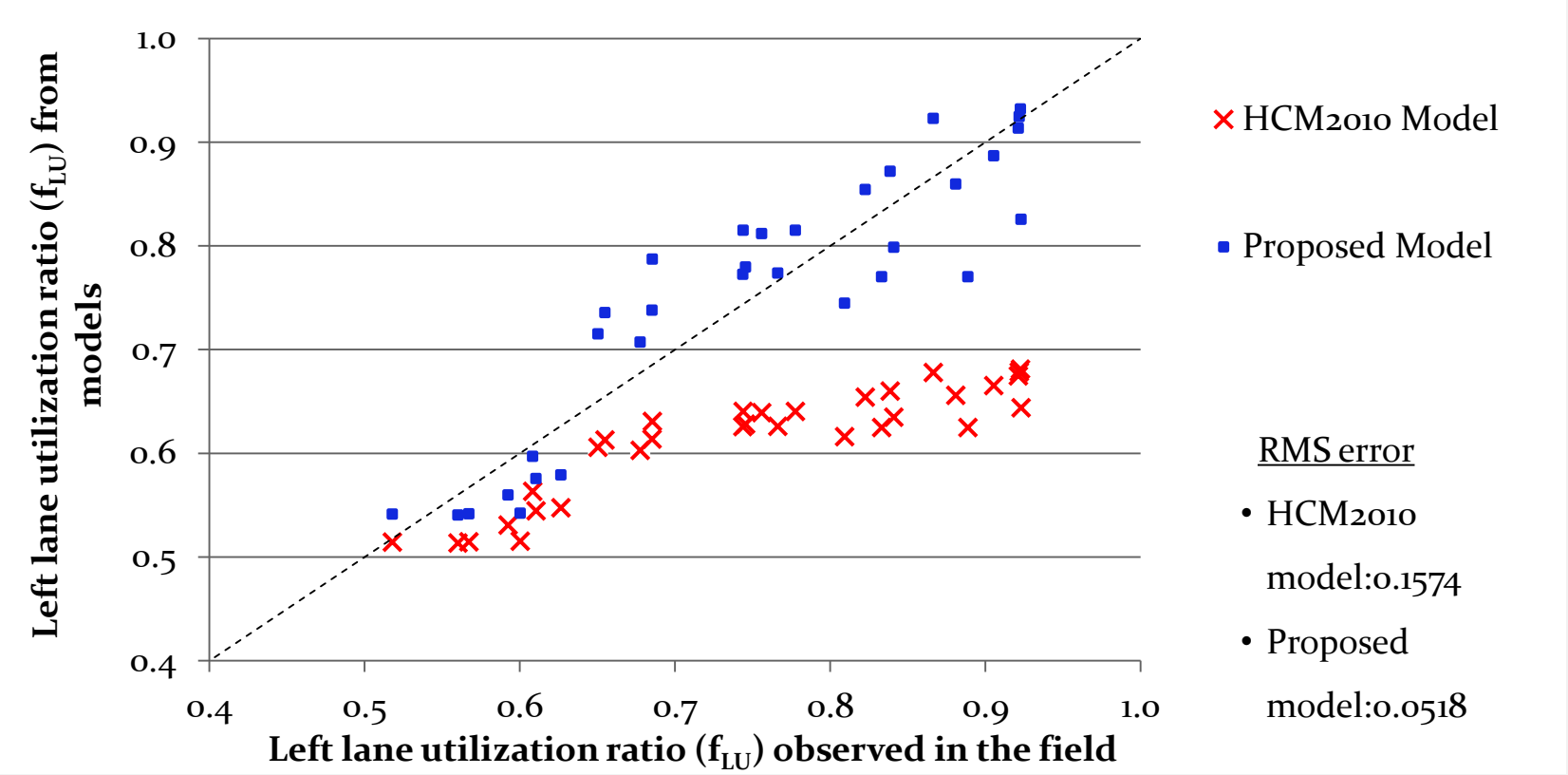


[4-lane exclusive]

Lane Configuration	2-lane shared	3-lane shared	3-lane exclusive	3-lane exclusive*	4-lane exclusive
Model development	• Springfield, MO • Kansas City, MO • Rochester, NY	• Lexington, KY	• Maryland Height, MO	• Lehi(WB), UT	• American Fork(Main Street), UT
Model validation	• Salt Lake City(NB), UT • Lehi(EB), UT • American Fork, UT	• Salt Lake City(SB), UT	-	-	-

Model Validation for Lane Utilization

- Additional field data collected at three different DDIs located in Utah
- Leftmost lane utilization prediction comparisons between the HCM2010 and proposed model

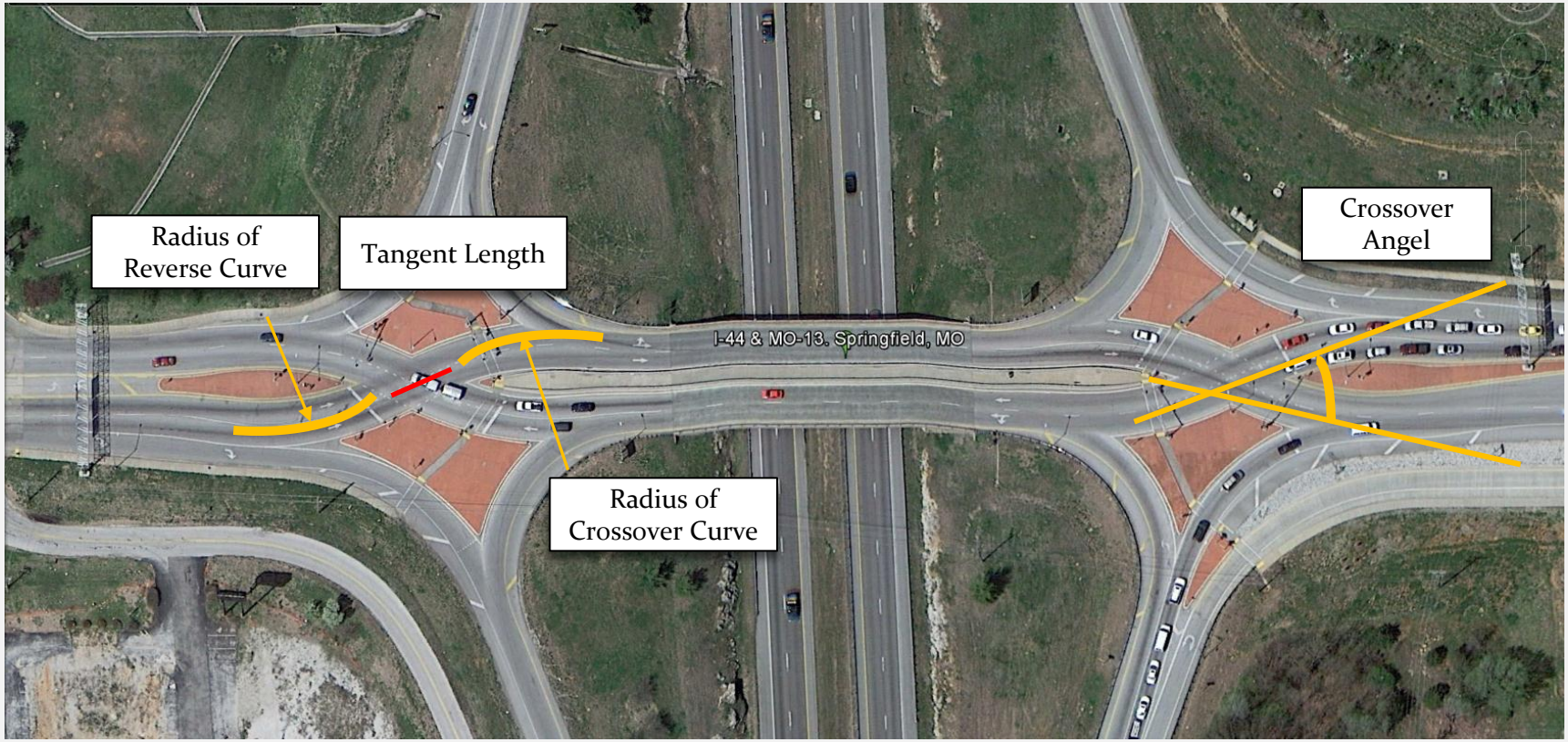


Sample Data
Saturation Flow Rate

- $S = s_0 N f_w f_{HV} f_g f_p f_{bb} f_a f_{RT} f_{LT} f_{Lpb} f_{Rpb} f_{LU} f_v * f_{DDI}$
- Adopt Chapter 22 Sat Flow function of
  - Base saturation flow rate
  - Adjustment for lane width, Heavy vehicle, Approach grade, Area type, Lane utilization, Traffic pressure, …
- Development of DDI-specific factors as necessary
  1. Crossover angle
  2. Tangent length at each crossover
  3. Radius of Reverse Curve
  4. Radius of crossover curve
  5. Adjustment for number of lanes at the crossover

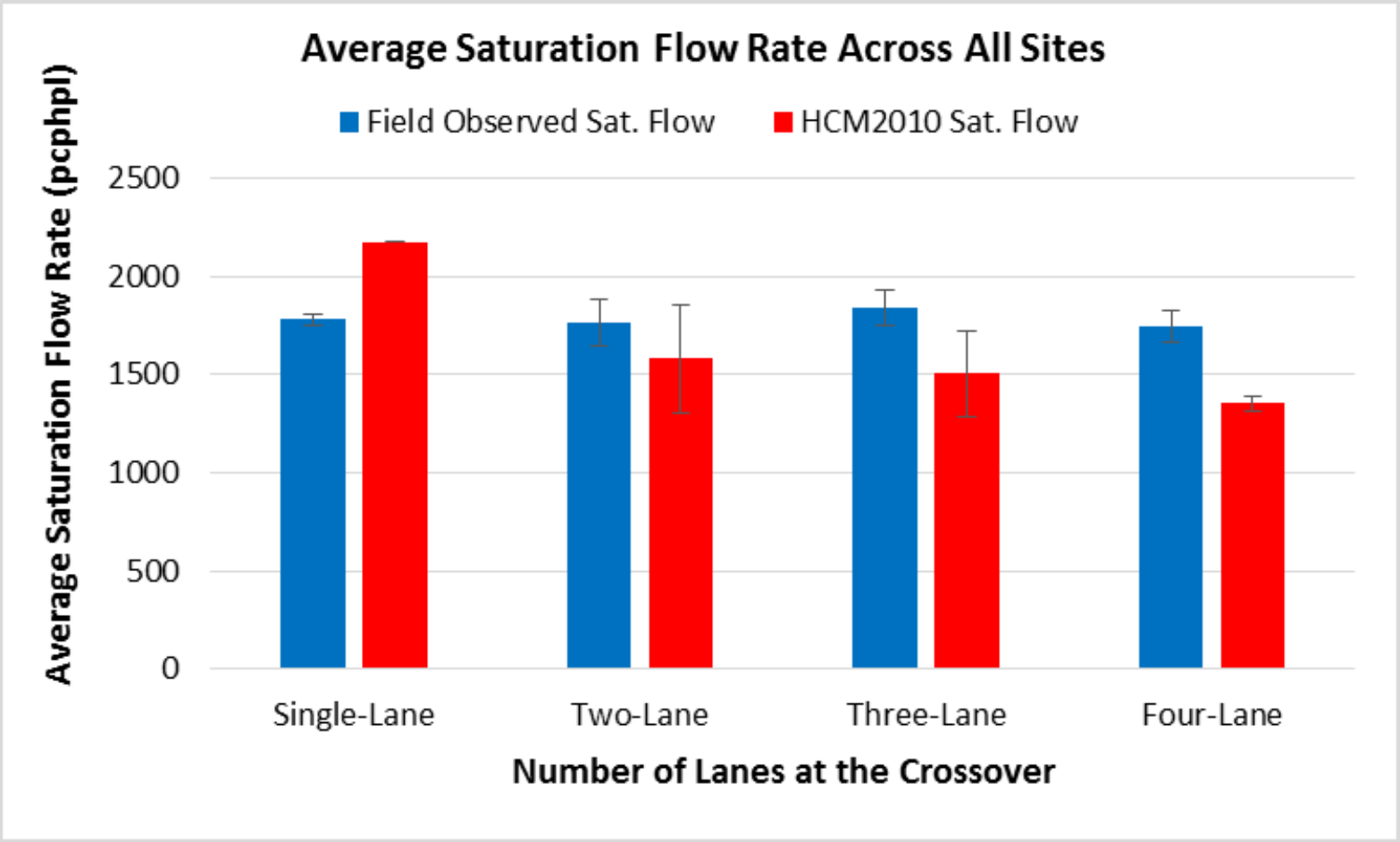
Other Variables for Consideration

- Proposed variables



DDI Saturation Flow Comparisons

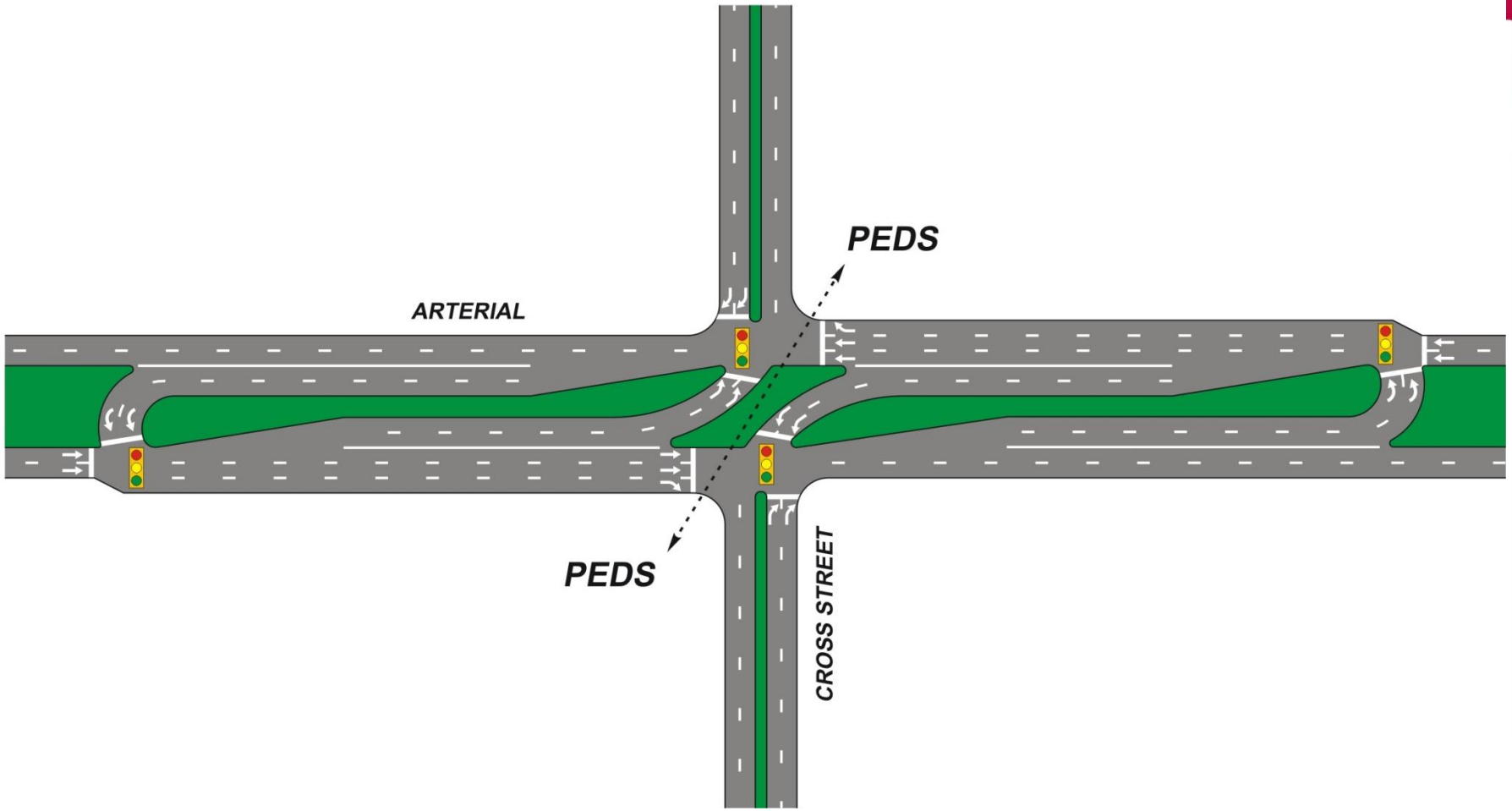
- Field observed vs. HCM2010 model



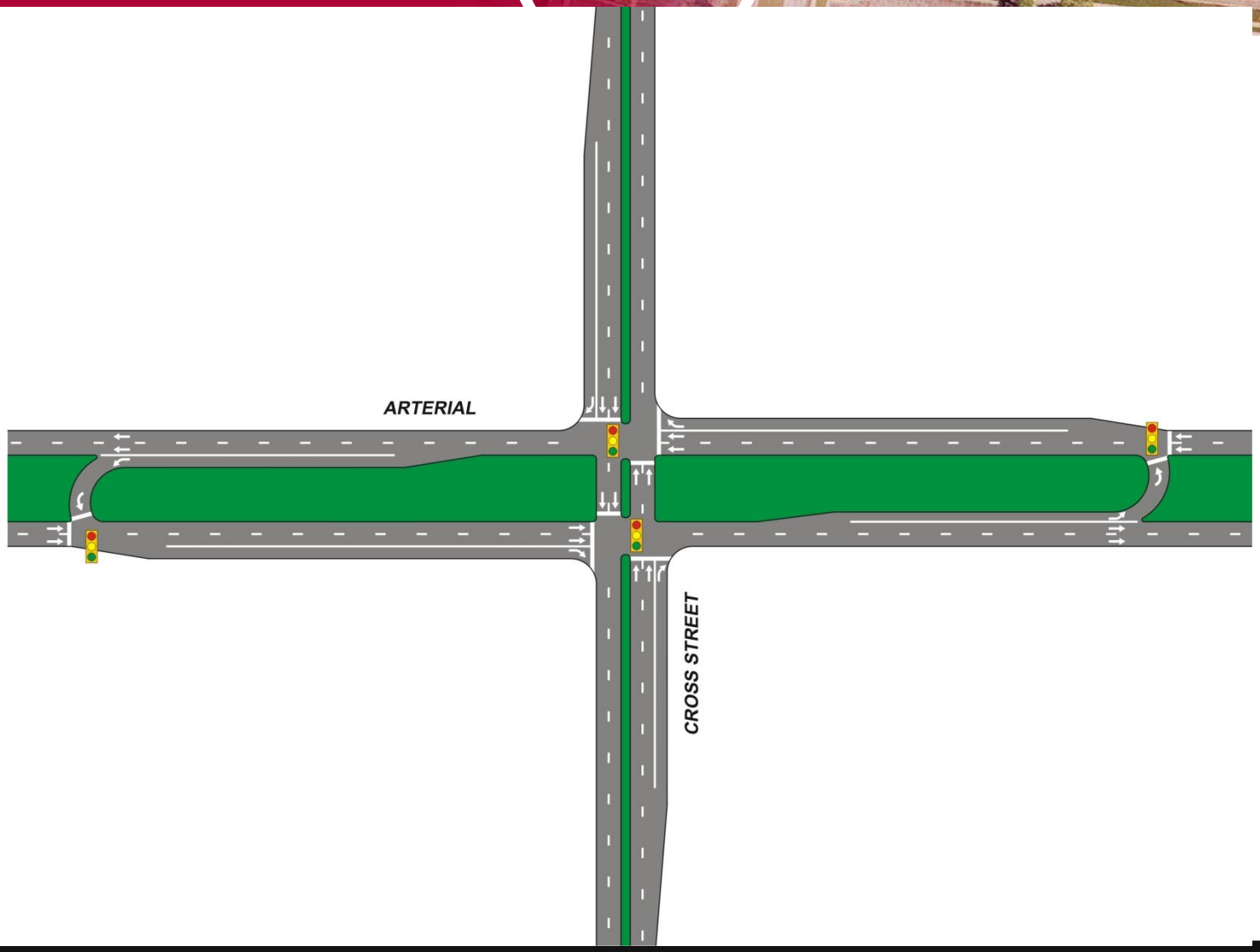
RCUTs and MUTs
HCM Method Development

Joseph E. Hummer, Ph.D., P.E.
Department of Civil Engineering
Wayne State University

RCUT



Median U-Turn (MUT)



Scope

Three Types of RCUT

1. All Signalized
2. All stop signs
3. U-turn and minor street right turn merges

Two Types of MUT

1. All signalized
2. Main intersection signalized, u-turns stop signs

MOE

- Need to factor in extra distances
- Need to factor in extra traffic control

- **Therefore recommend “experience travel time”**
  - Compared to direct travel time with no control
  - Like 2010 Chapter 22
- Will also compute and report control delay at each junction
- HCM 2010 update will fix free right delay problem

RCUT With Signals

- Major street movements sum of control delays at crossover and main signals
- Minor street right turn just control delay at main intersection
- Minor street lefts and throughs sum of:
  - control delay at right turn,
  - control delay at u-turn crossover,
  - control delay back at main intersection, and
  - travel time to and from u-turn crossover
    - **i.e. “experienced travel time**

Median U-Turns

- Similar logic to RCUTs
  - Except it is the major street and minor street left turns that travel the extra distances
- Sharing much data with RCUTs

Thank You!

Jim McCarthy 651-291-6112
james.mccarthy@dot.gov