U.S. Department of Transportation
Federal Highway Administration

Intersection & Interchange Geometrics

National Use of Alternative Intersections

Mark Doctor – FHWA Resource Center

2013 TxDOT Short Course

October 15, 2013

What are Intersection & Interchange Geometrics?

Innovative designs that:

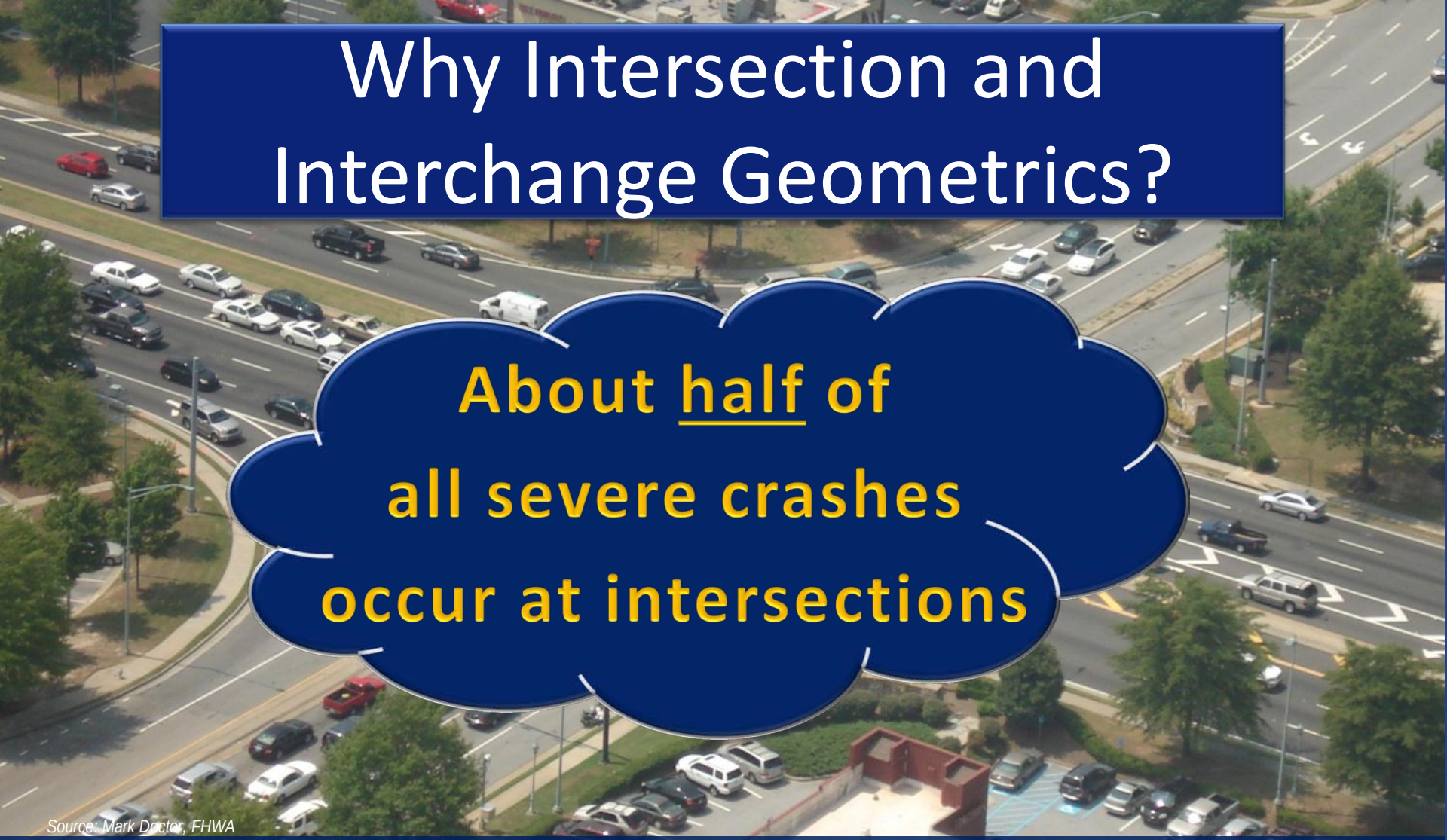
- Improve the way traffic makes certain movements
- Eliminate, relocate or modify conflict points
- Strategically improve signalization


Source: Mark Doctor, FHWA


Source FHWA


Source: Missouri Department of Transportation

Why Intersection and Interchange Geometrics?

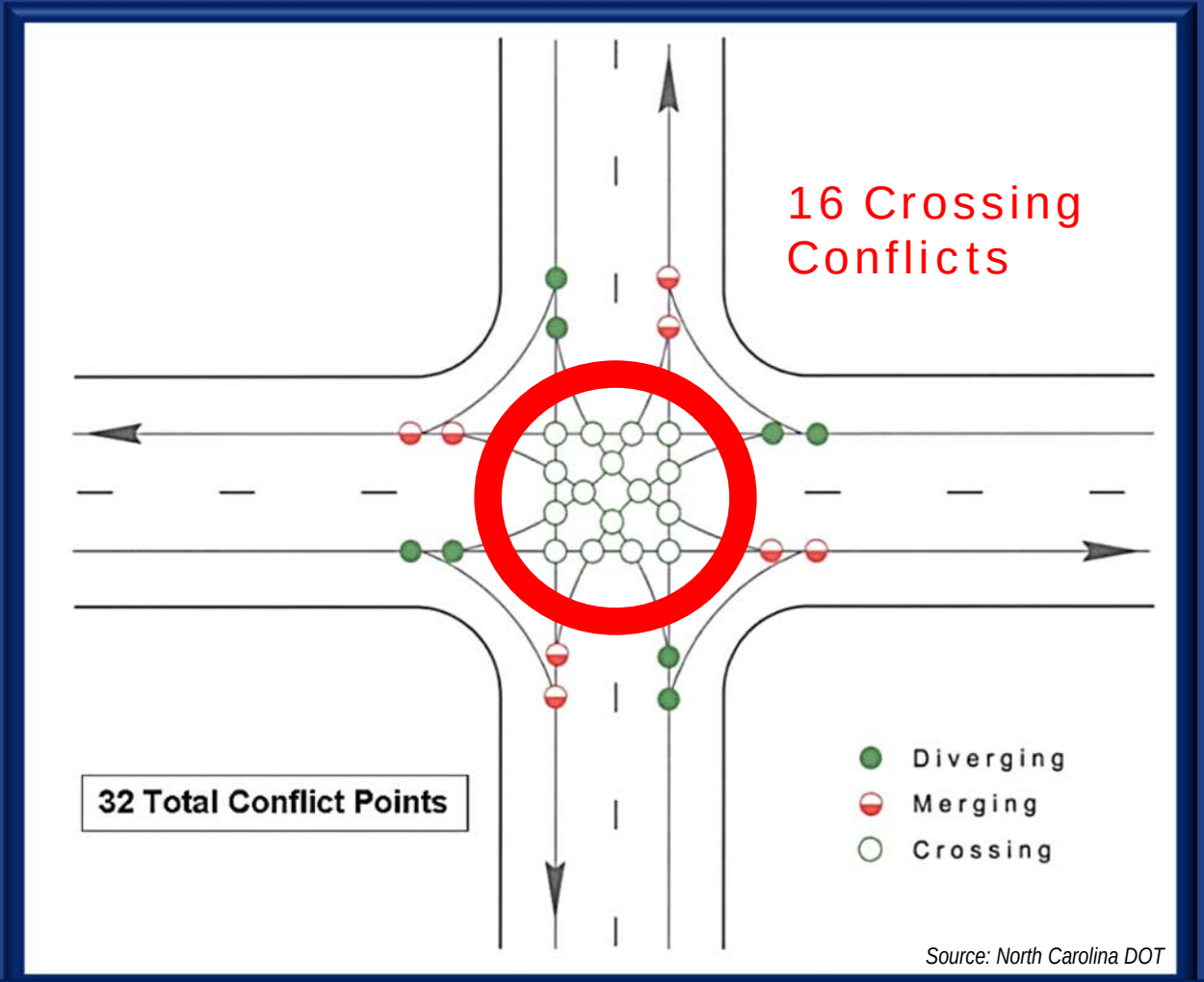


As planned points of crossing and conflict, intersections are a major safety issue and may become bottlenecks along high-volume roadways

Why Intersection & Interchange Geometrics?

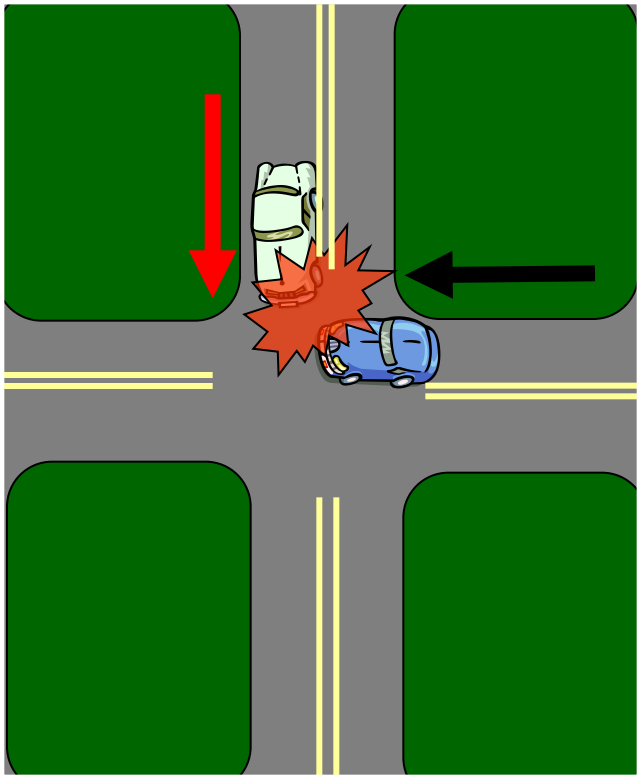
- Growing traffic demands
- Scarce funding
- Restricted ability to add more lanes or build grade separations
- Need for improved safety for pedestrians, bicyclists and drivers

Intersection Conflicts



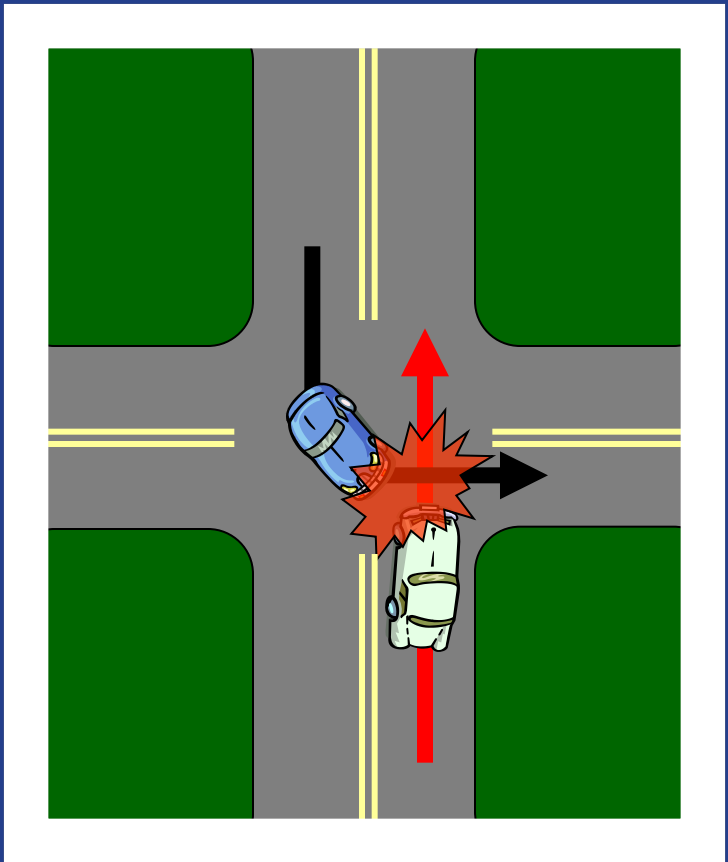
Conflict Points at a Typical Intersection

Intersection Safety Facts



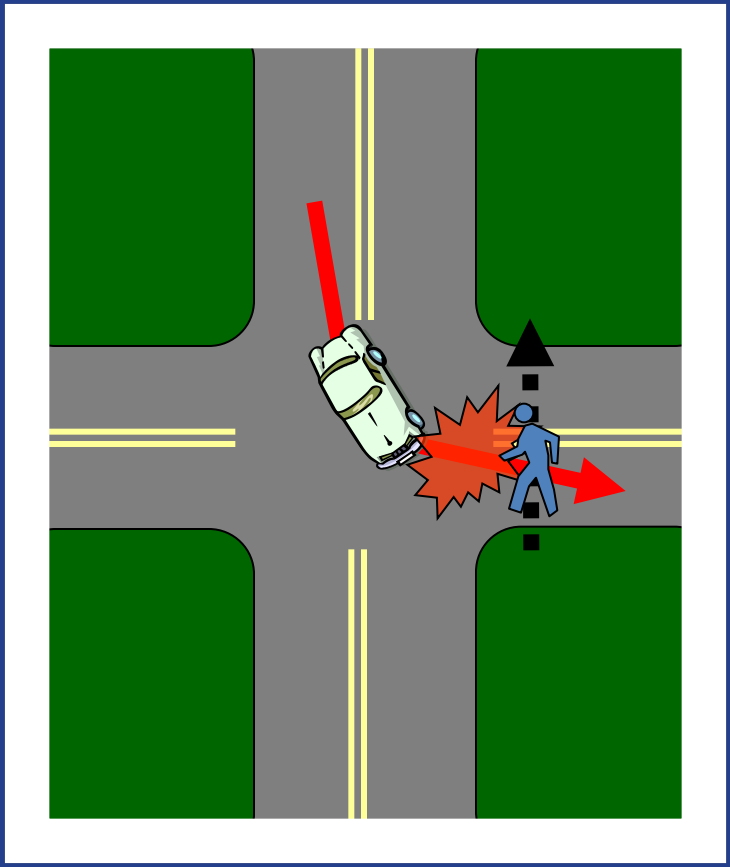
Angle crashes account for over 40% of fatal crashes at intersections

Intersection Safety Facts



Left-turn crashes account for over 20% of fatal crashes at intersections

Intersection Safety Facts



Ped/Bike crashes account for 25% of fatal crashes at signalized intersections

Why Intersection & Interchange Geometrics?

Changing the way we design intersections can save lives and allow more efficient and effective projects.

Source: Mark Doctor, FHWA

Benefits of Intersection & Interchange Geometrics

SAFETY

- **Fewer conflict points**
- **Significant Before/After Crash Reductions**

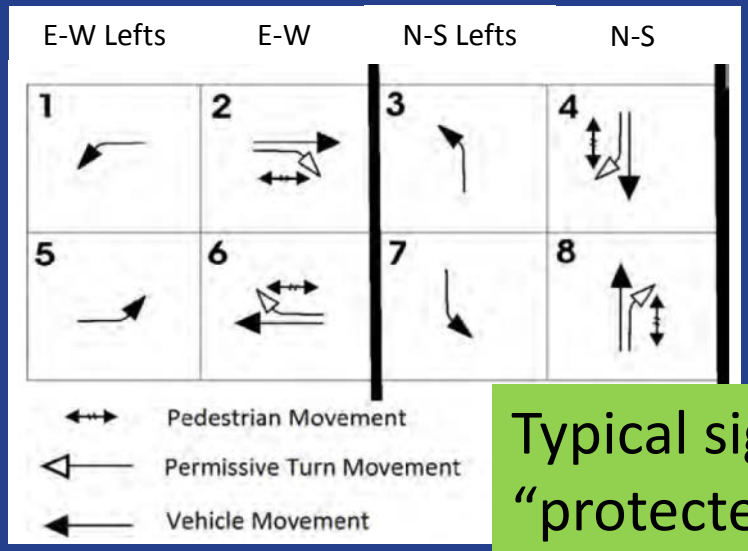
MOBILITY

- **Less delay**
- **Reduced congestion**

VALUE

- **Less ROW**
- **Less construction costs**
- **Implemented quicker**

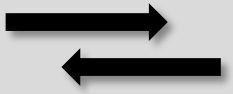
Signalized Intersections



Typical signal scheme with "protected" left-turn phasing

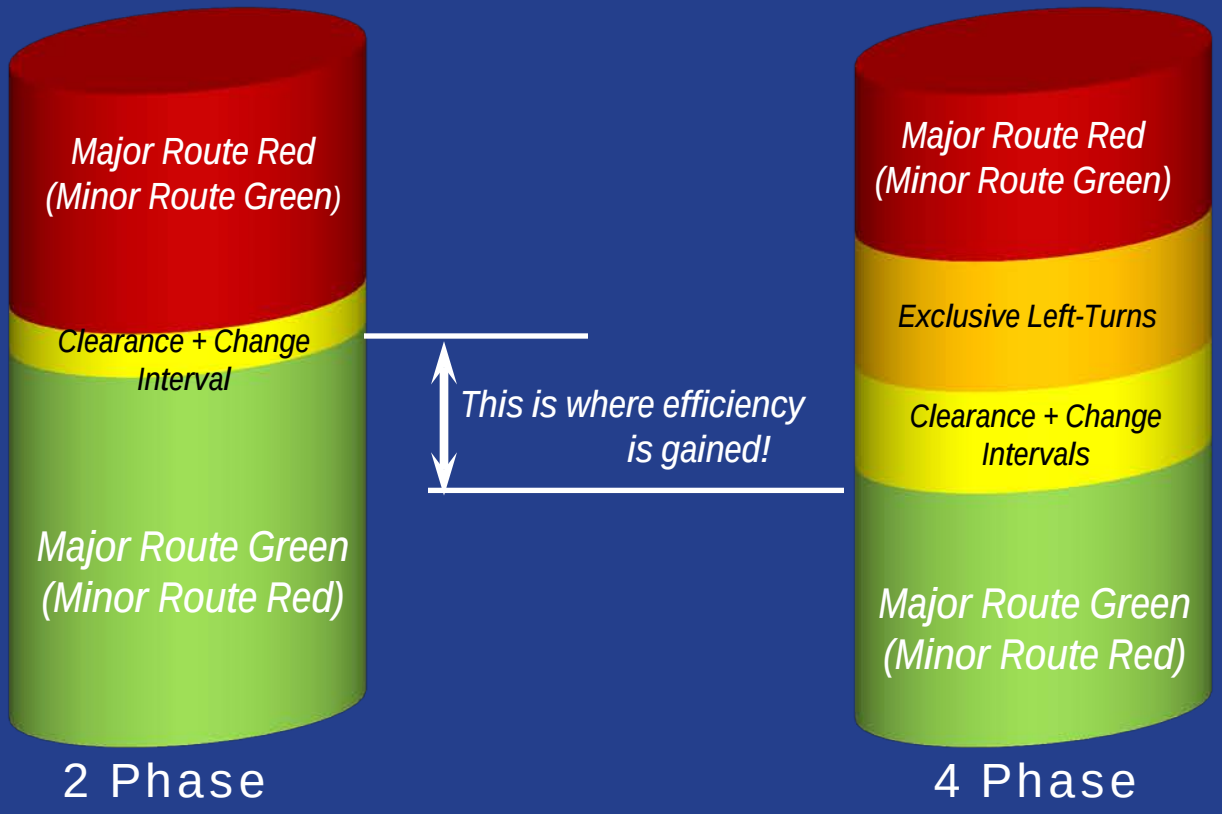
Signal Phases

Eliminating or strategically relocating left-turn movements from an intersection can provide more green time to through traffic

4 Phase Signal				
	 Minor Street	 Minor Street	 Major Street	 Major Street

Signalized Intersections

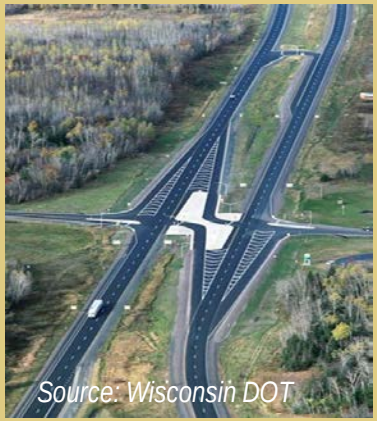
Eliminating or strategically changing how left turns are handled can allow more green time allocated to through traffic



Featured Innovations

EDC2 IIG Innovations

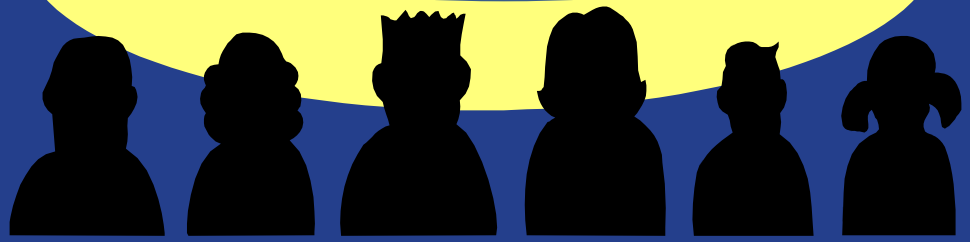
Roundabouts



U-Turn Intersections

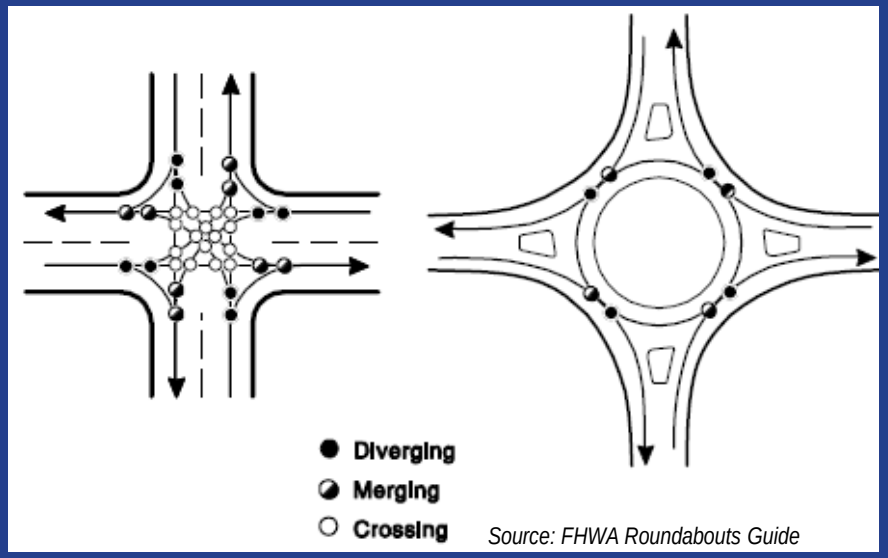
Displaced Left Turn Intersections

Diverging Diamond Interchanges

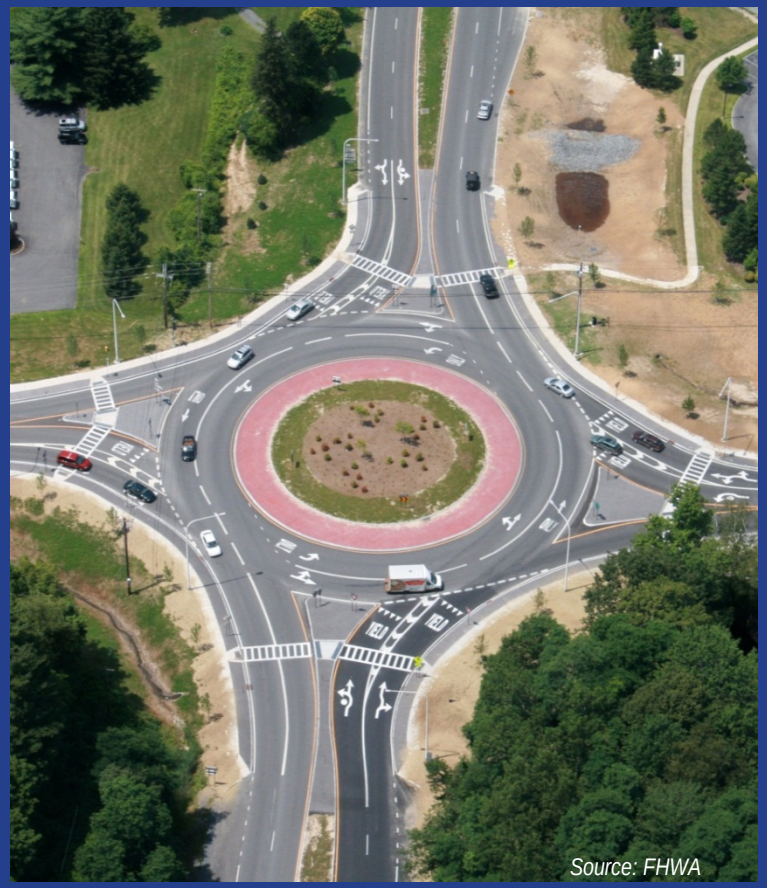


Roundabouts

- Modern designs are safer and more efficient than old circles and rotaries
- Measurable progress in last 10+ years, but still underutilized



Source: FHWA Roundabouts Guide


Source: FHWA

Roundabouts Track Record


Source: Jeff Shaw, FHWA

Source: Jeff Shaw, FHWA

- Effective for both corridor and spot improvements
- Can complement other program goals such as Access Management, Active Transportation, etc.
- Proven in both low-speed urban and high-speed rural environments

Roundabout Opportunities

Mini-Roundabouts

Roundabouts at interchanges

78-82% Reduction in Severe Crashes[1]

1. *AASHTO Highway Safety Manual, Chapter 14*

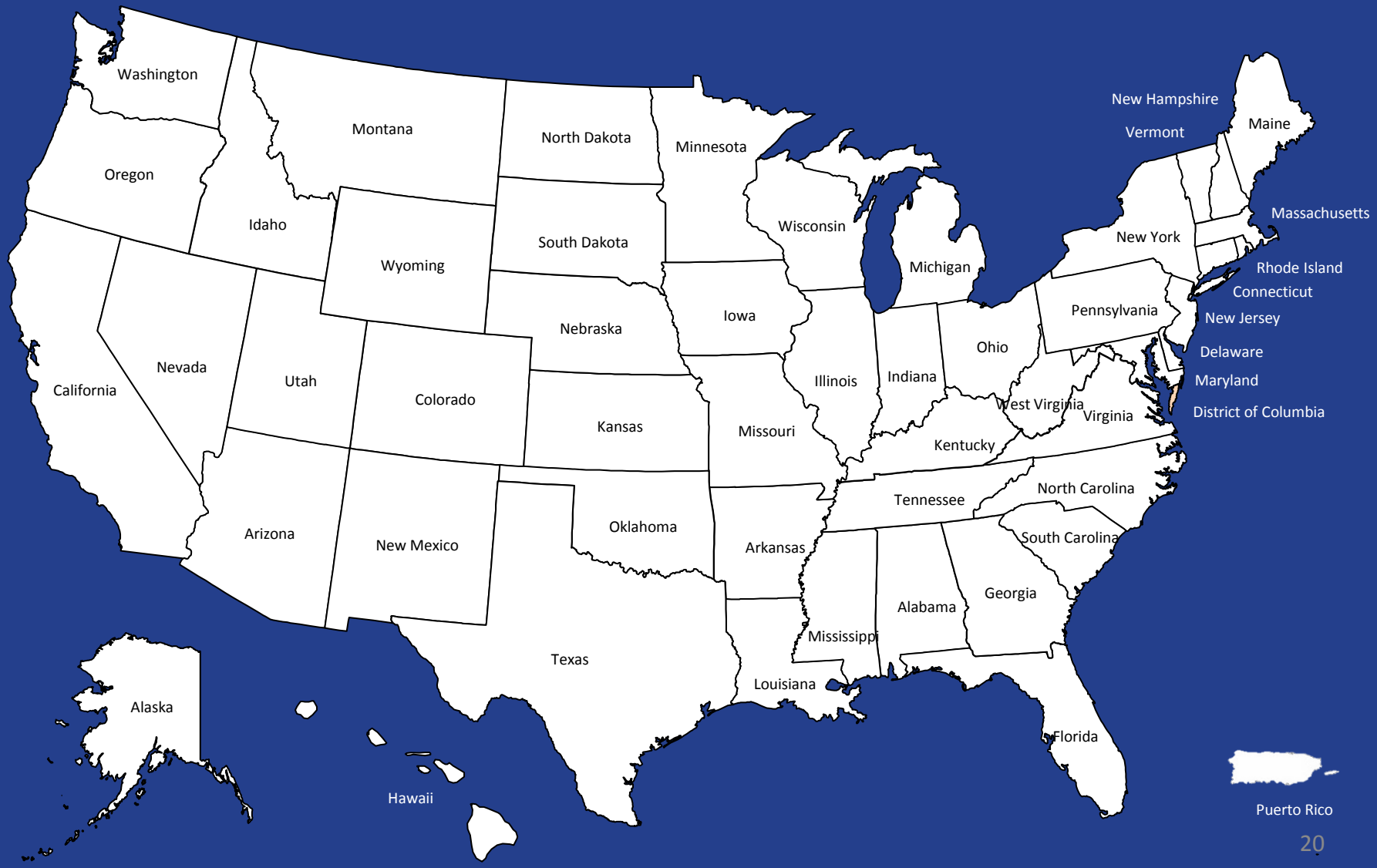
Roundabouts Education

Outreach & Education are Critical to Success

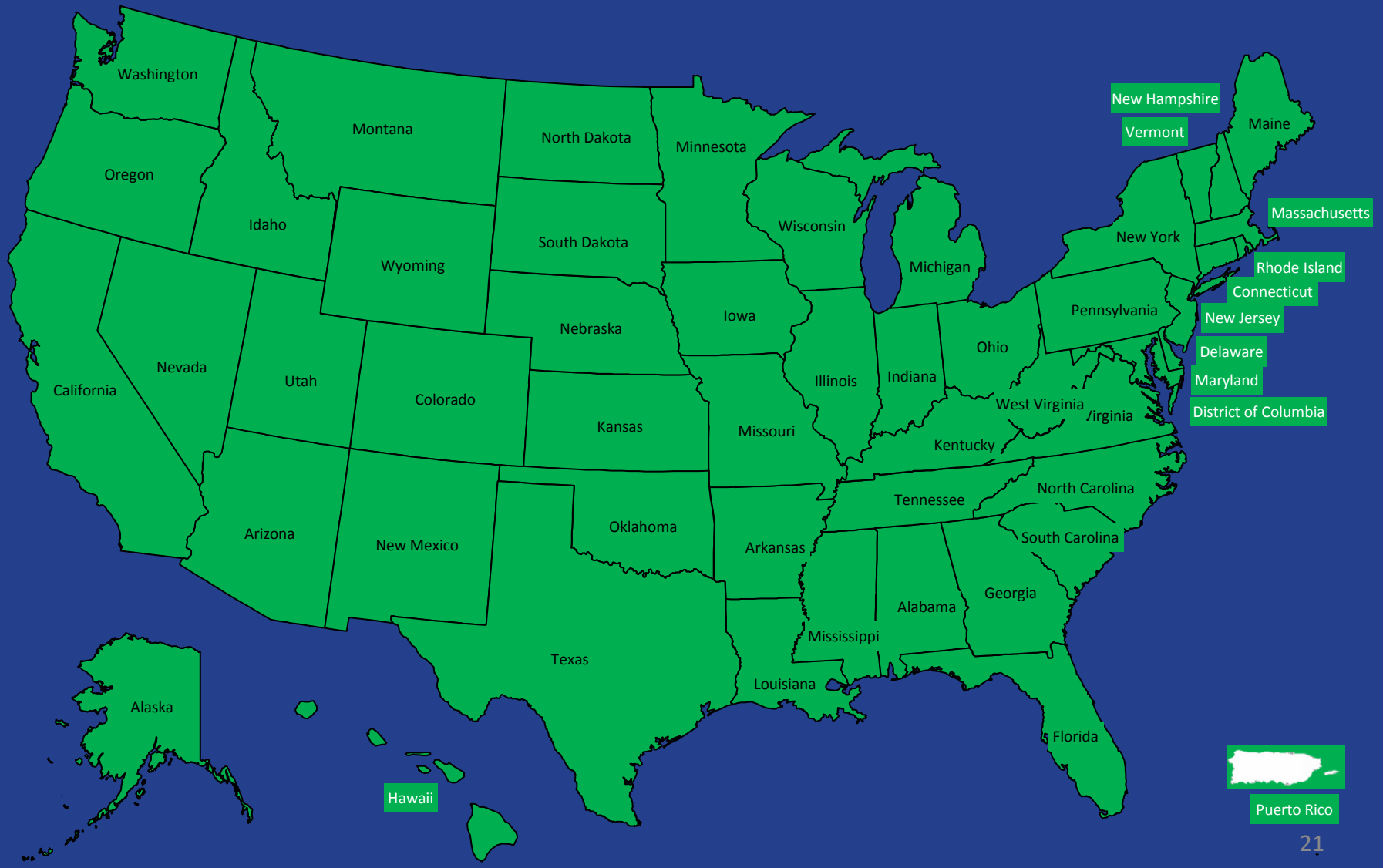
- Toolbox of case studies documenting successful implementation of roundabouts from around the U.S.

Source: FHWA Office of Safety

Roundabouts



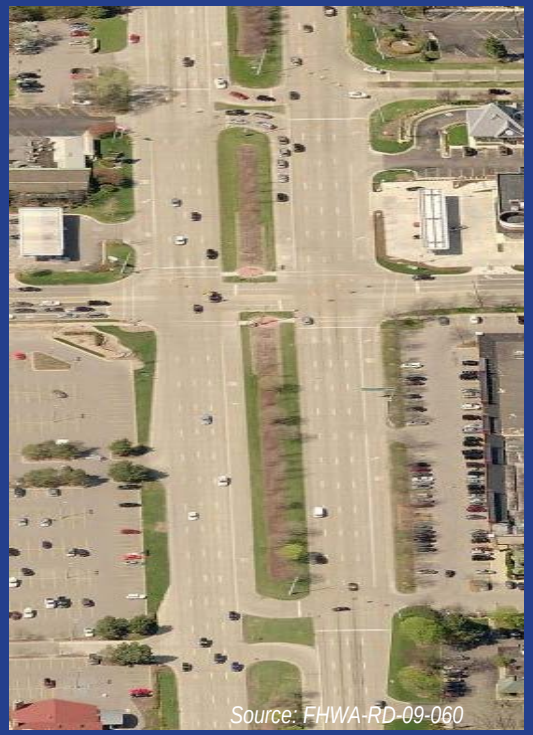
Roundabouts



U-Turn Intersections

Restricted Crossing U-turn (RCUT)
(aka J-turn, Superstreet)

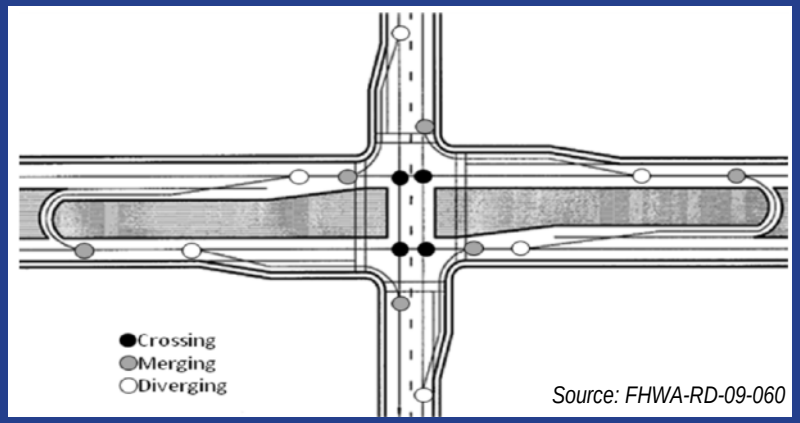
Median U-Turns
(aka Michigan Left, Indirect Left)



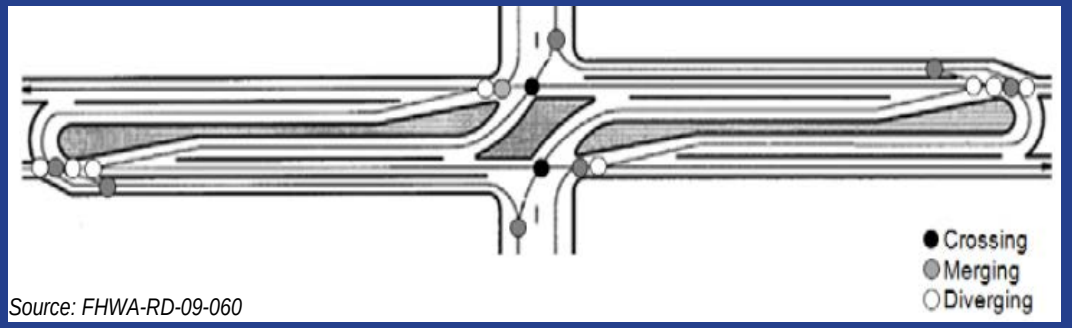
ThrU Turn

U-Turn Intersection Basics

Conflict Point Comparison by Intersection Type (2X2)			
Conflict Type	**Conventional Signalized 4-leg**	**Median U-Turn**	**Restricted Crossing U-Turn**
Merging/Diverging	16	12	16
Crossing (left turn)	12	0	2
Crossing (angle)	4	4	0
Total	**32**	**16**	**18**



Source: FHWA-RD-09-060

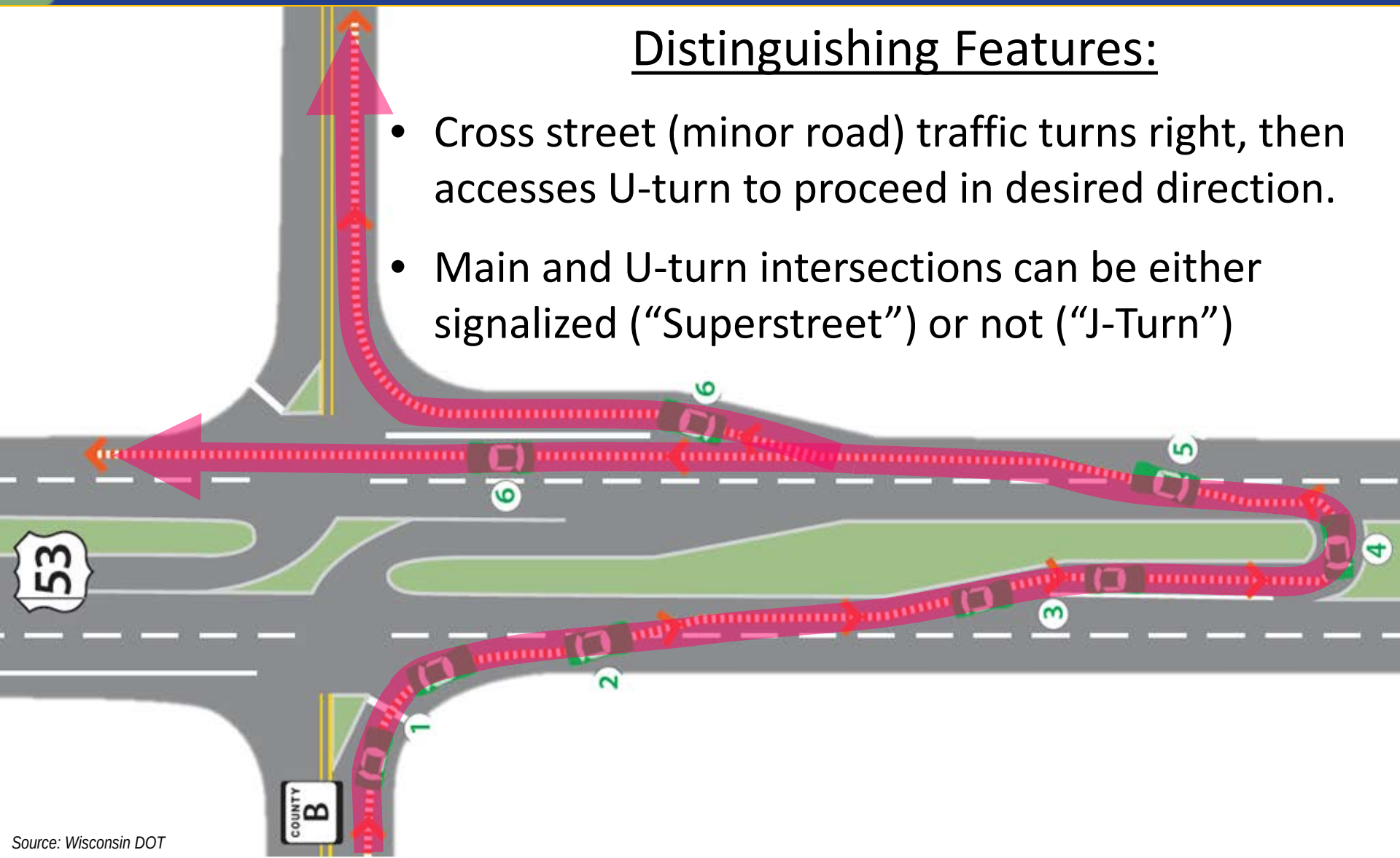


Source: FHWA-RD-09-060

U-Turn Intersections: RCUT

Distinguishing Features:

- Cross street (minor road) traffic turns right, then accesses U-turn to proceed in desired direction.
- Main and U-turn intersections can be either signalized ("Superstreet") or not ("J-Turn")



Source: Wisconsin DOT

U-Turn Intersections: MU-T

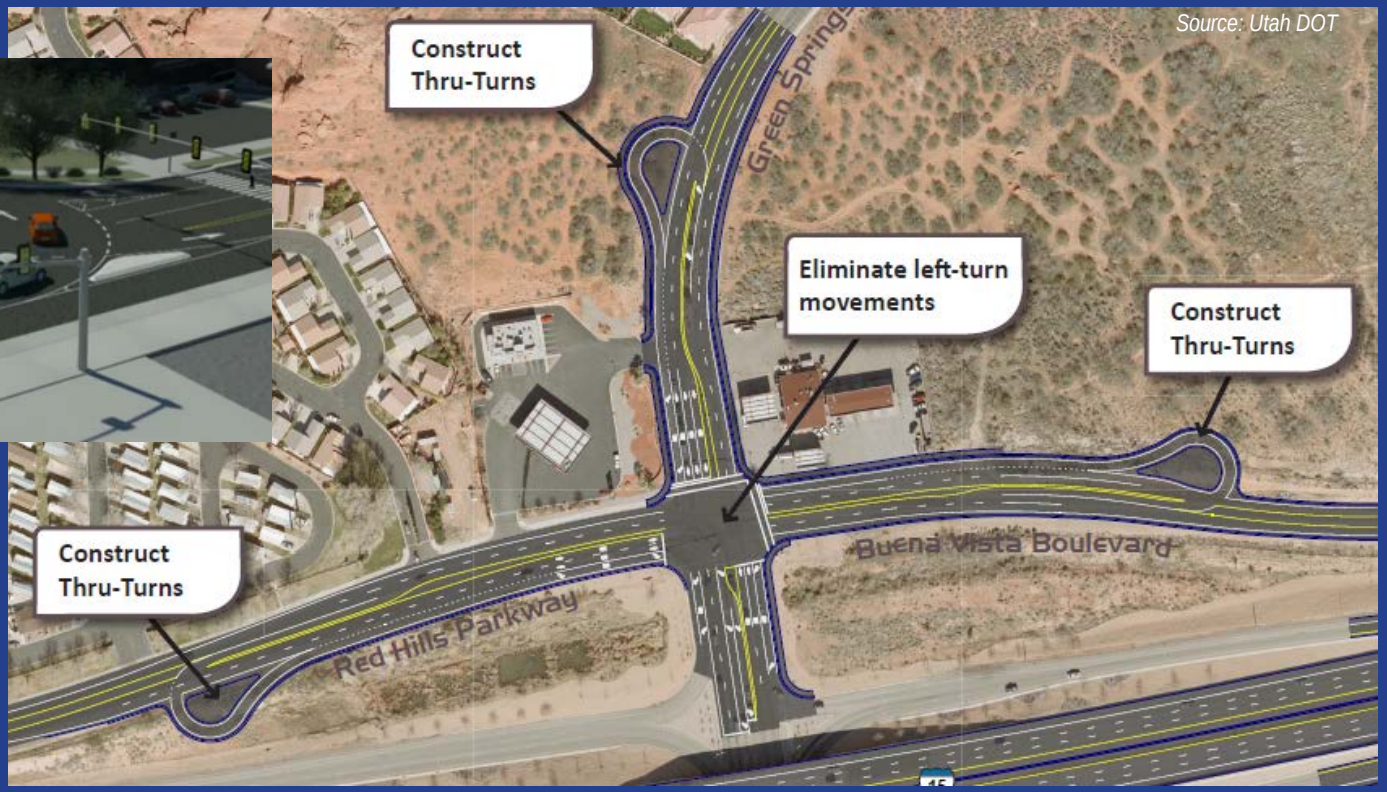
Distinguishing Features

- Eliminates direct left-turns at main intersection
- Left turning traffic proceeds past main intersection to a U-turn location downstream
- Traffic then turns right at main intersection
- U-turn locations can be signalized and coordinated with main intersection

Source: FHWA-RD-09-060

U-Turn Intersections: ThrU Turn


Source: Utah DOT



Distinguishing Features

- Similar to MU-T in that direct left-turns are eliminated from main intersection
- Main difference is design of U-turn, substituting a paved bump-out or “loon” beyond the outside lane (or coinciding with a sidestreet tee intersection or driveway) for the wide median of a MU-T

U-Turn Intersections Safety

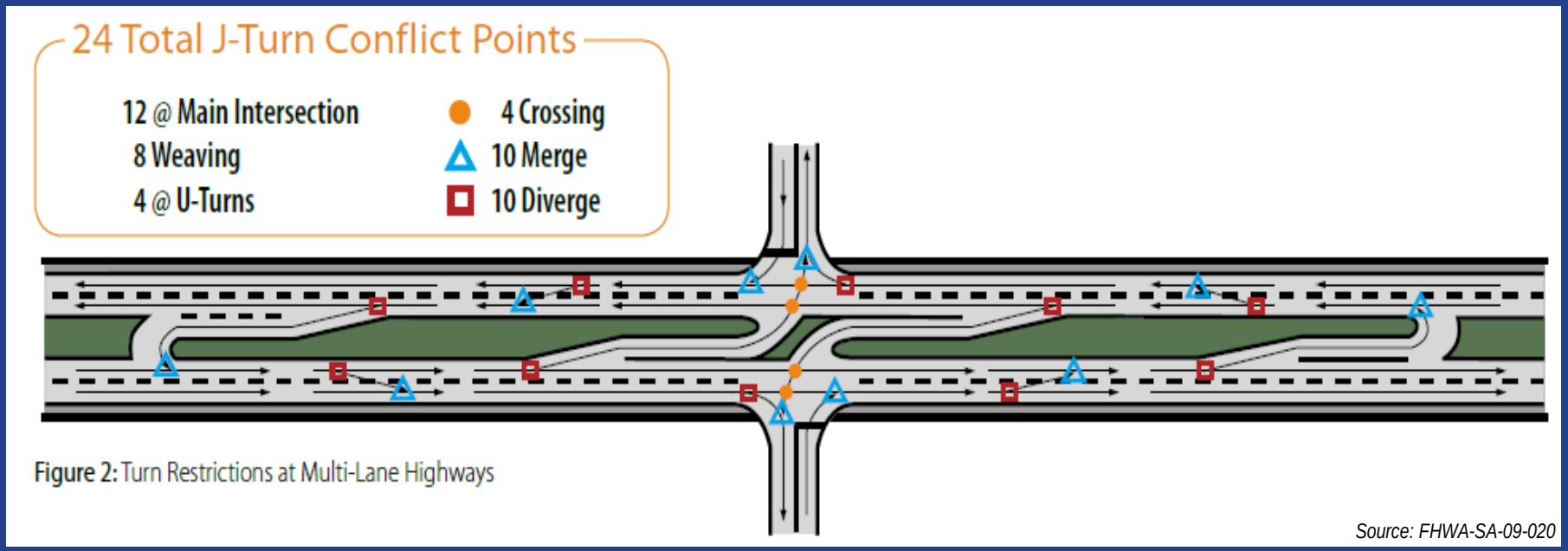


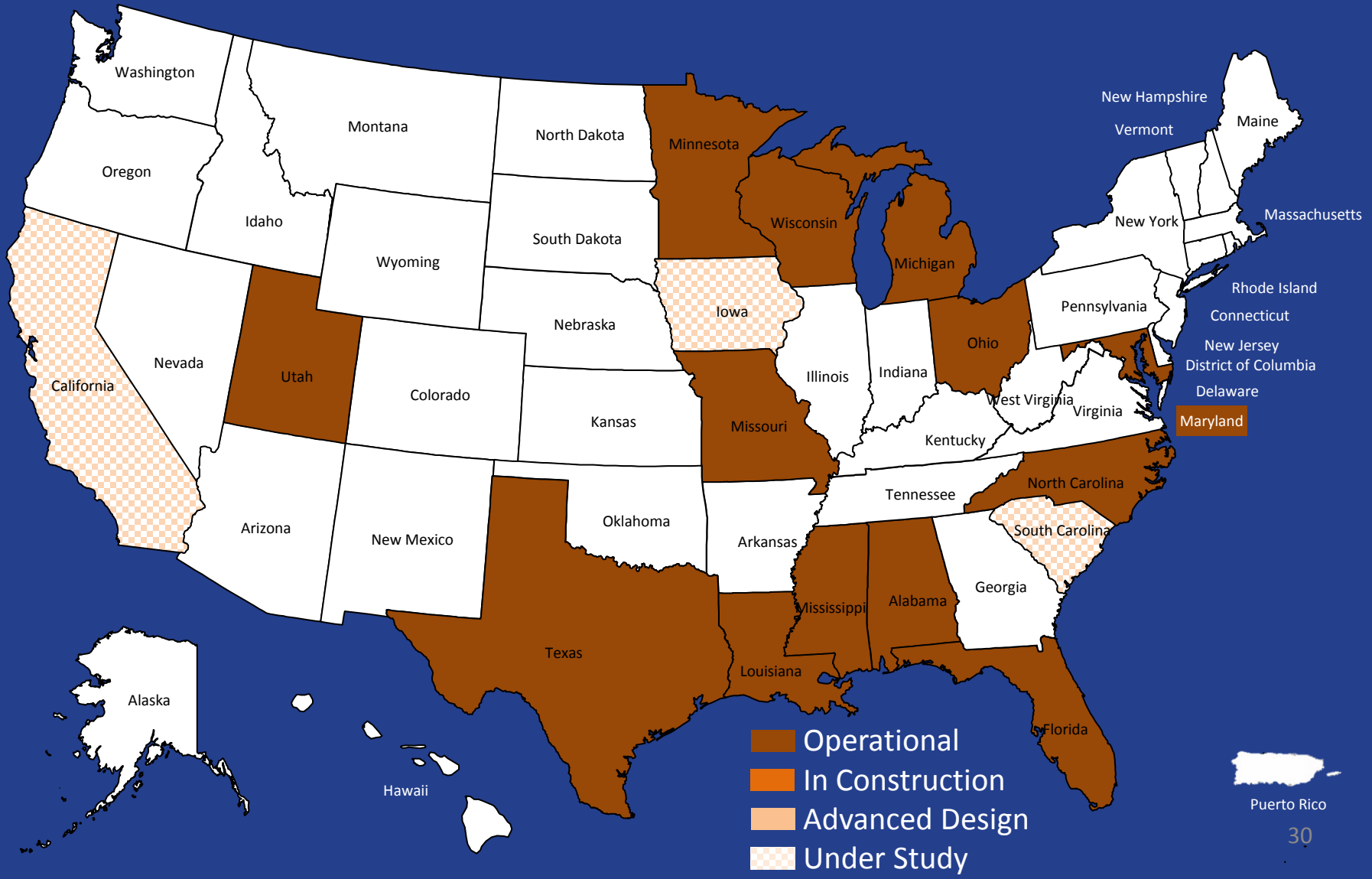
Figure 2: Turn Restrictions at Multi-Lane Highways

Source: FHWA-SA-09-020

Crash Reductions by Severity (MD RCUT sites)[1]		
PDO	Injury	Fatal
21%	**42%**	**70%**

1. *Field Evaluation of a Restricted Crossing U-Turn Intersection (FHWA-HRT-11-067)*

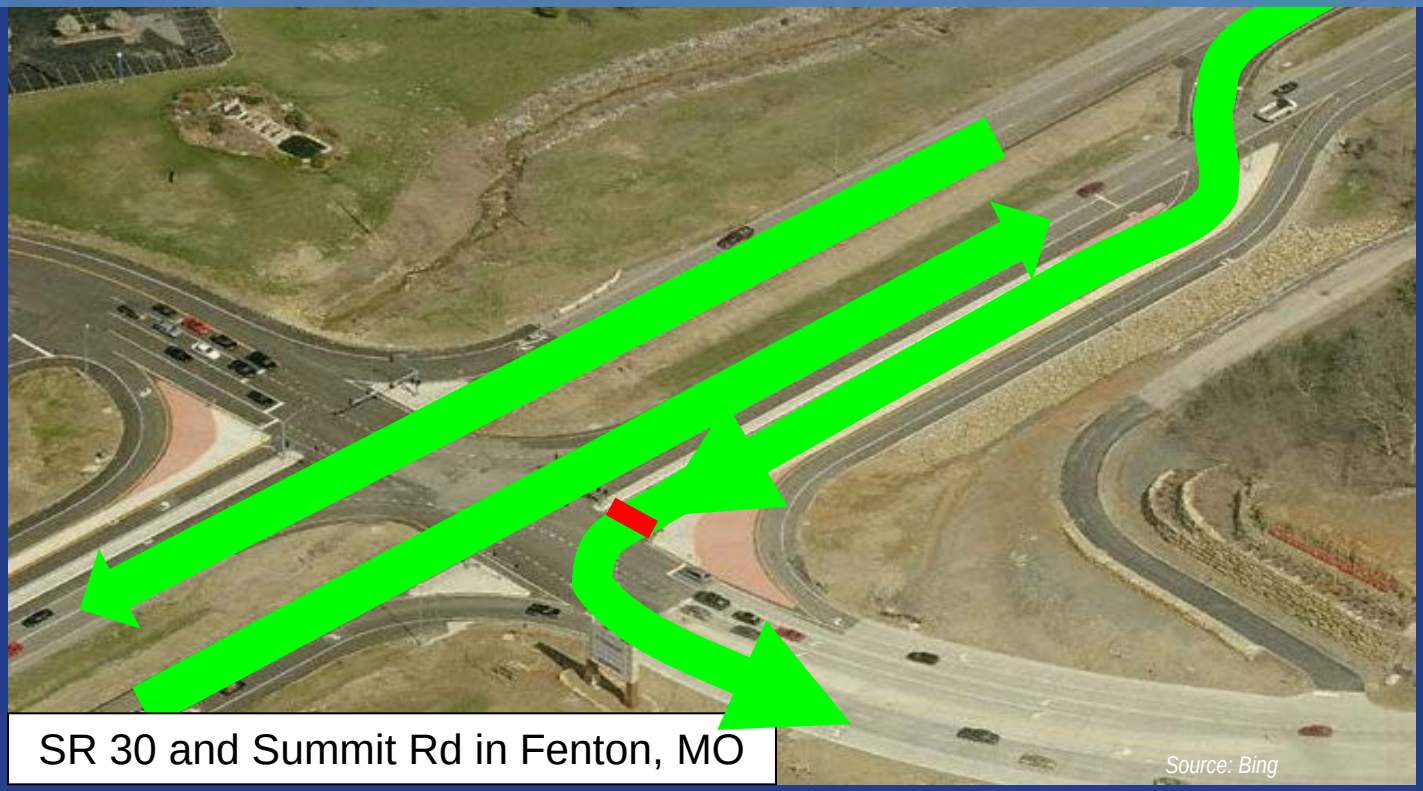
U-Turn Intersections



Displaced Left Turn (DLT) Intersection

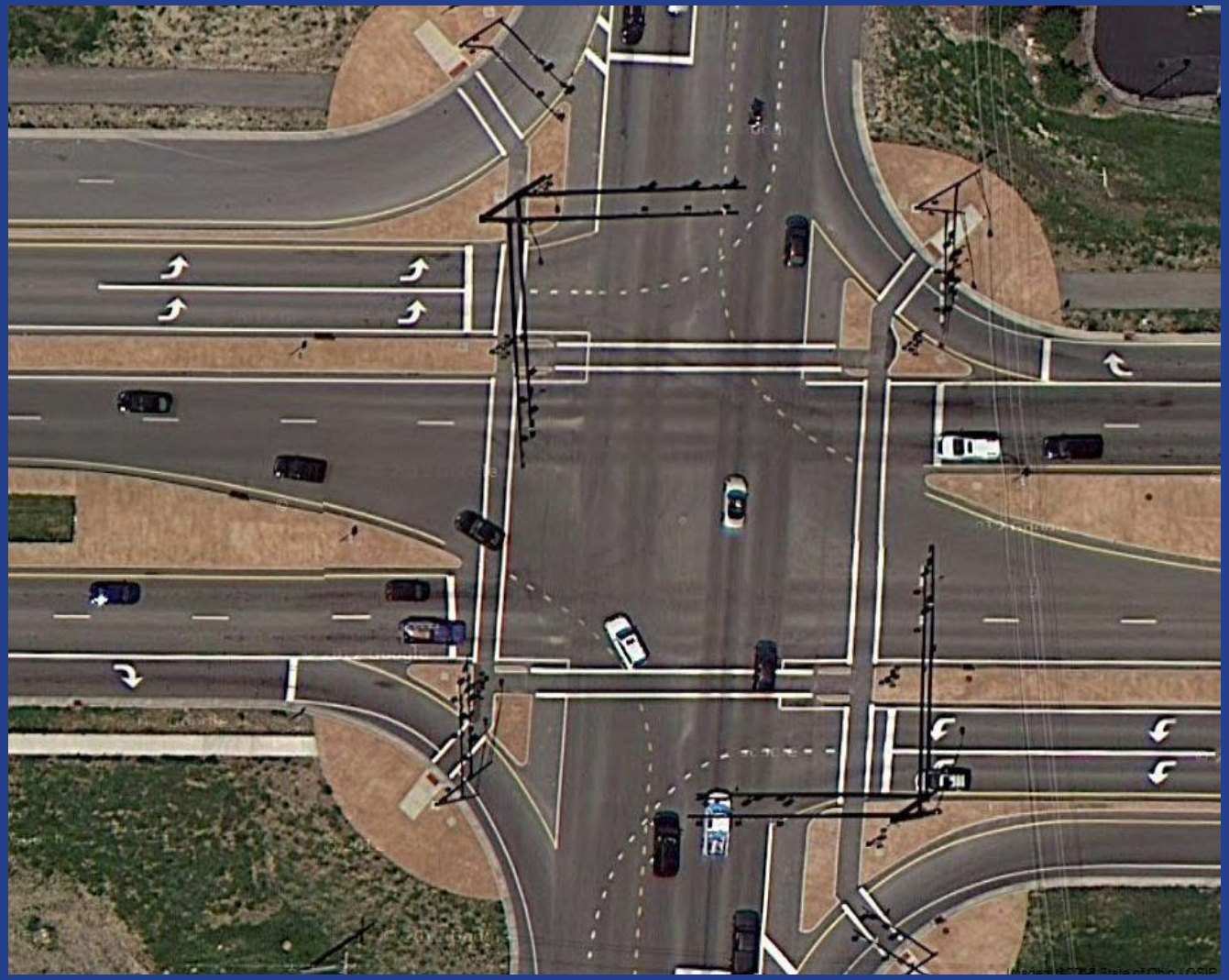
Distinguishing Feature:

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 Intersection – Pedestrian Crossings



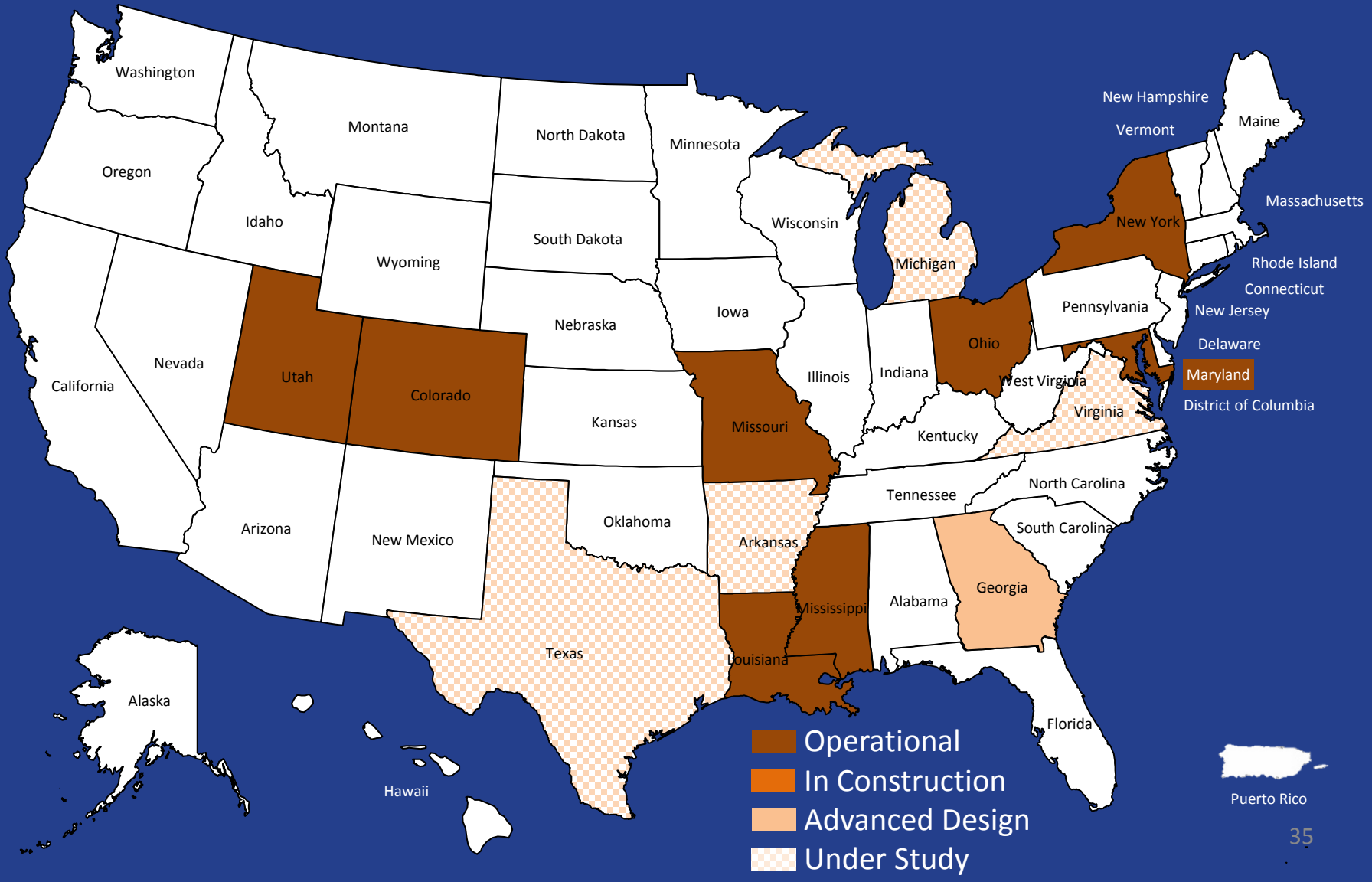
Displaced Left Turn (DLT) Intersection

- Observed crash reductions of 60%
- Total travel time reduction

Before and After Comparison for

BANGERTER HIGHWAY IMPROVEMENTS

Displaced Left-Turn Intersections



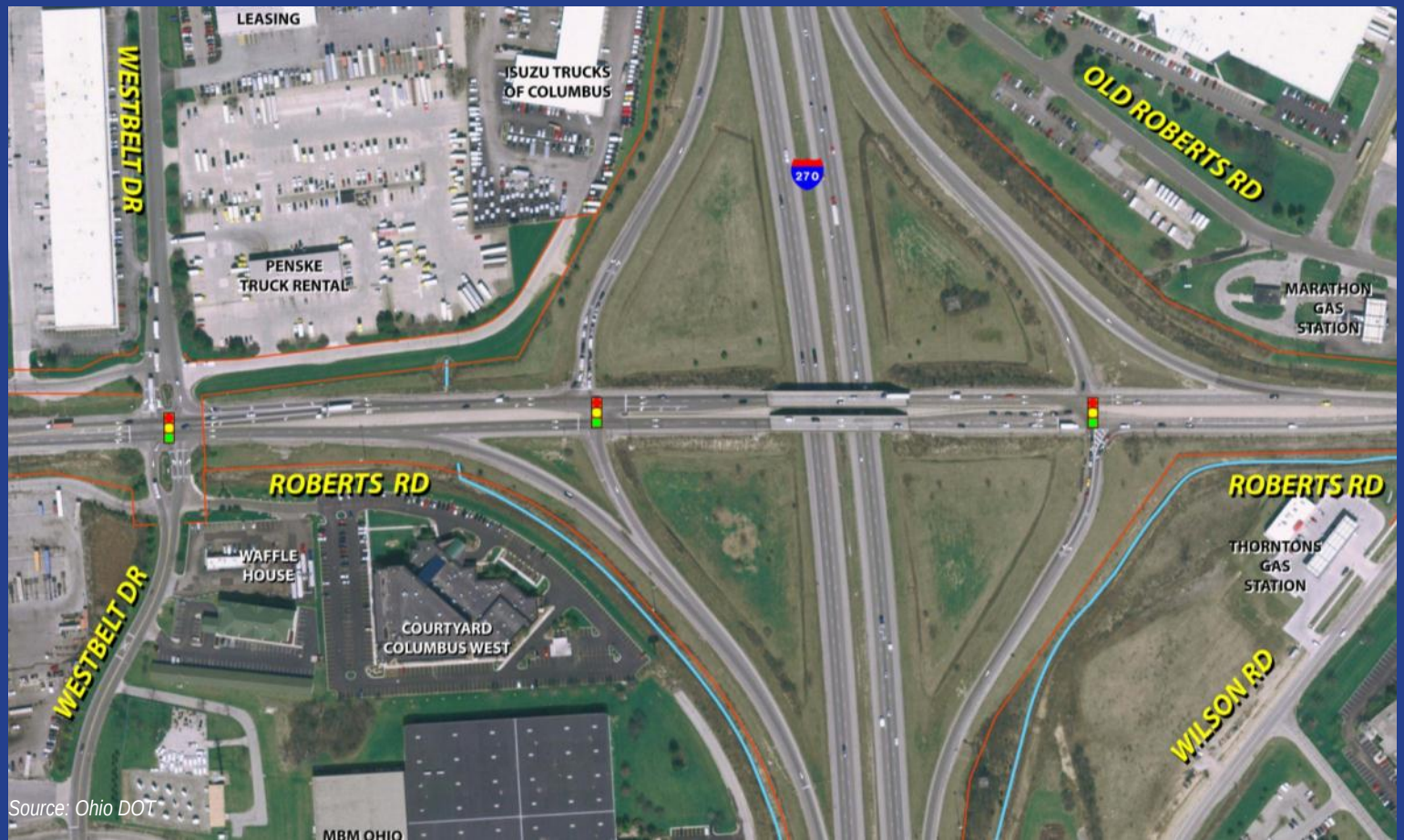
Diverging Diamond Interchange

Distinguishing Feature:

Geometry that temporarily channelizes traffic to the left side of the roadway (between the ramp terminals); thus allowing left-turn movements without the need for an exclusive signal phase.

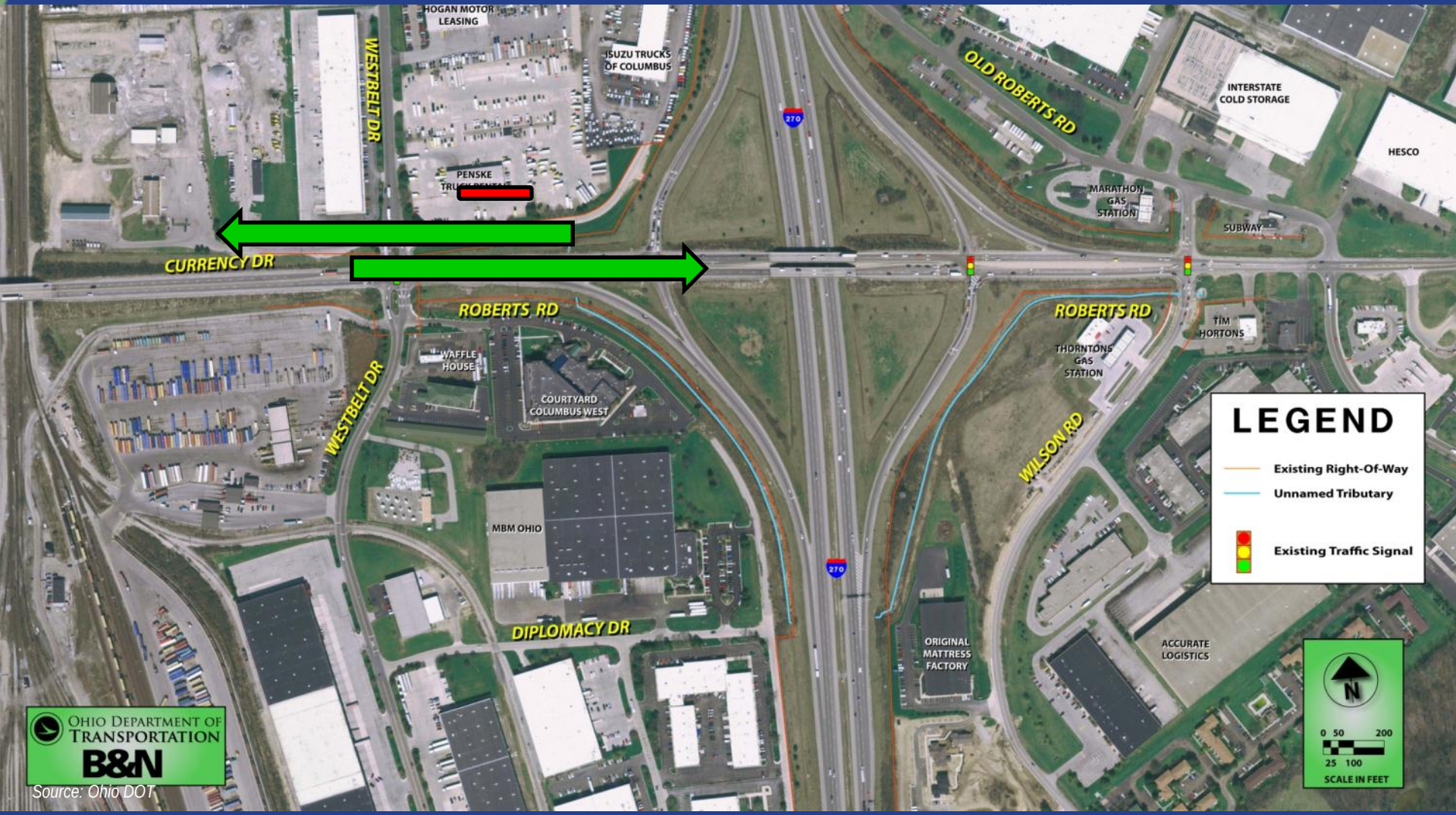
What is a Diverging Diamond Interchange?

- Essentially a diamond interchange with crossover intersections at the ramp terminals



Source: Ohio DOT

What Makes the DDI Different?



Source: Ohio DOT

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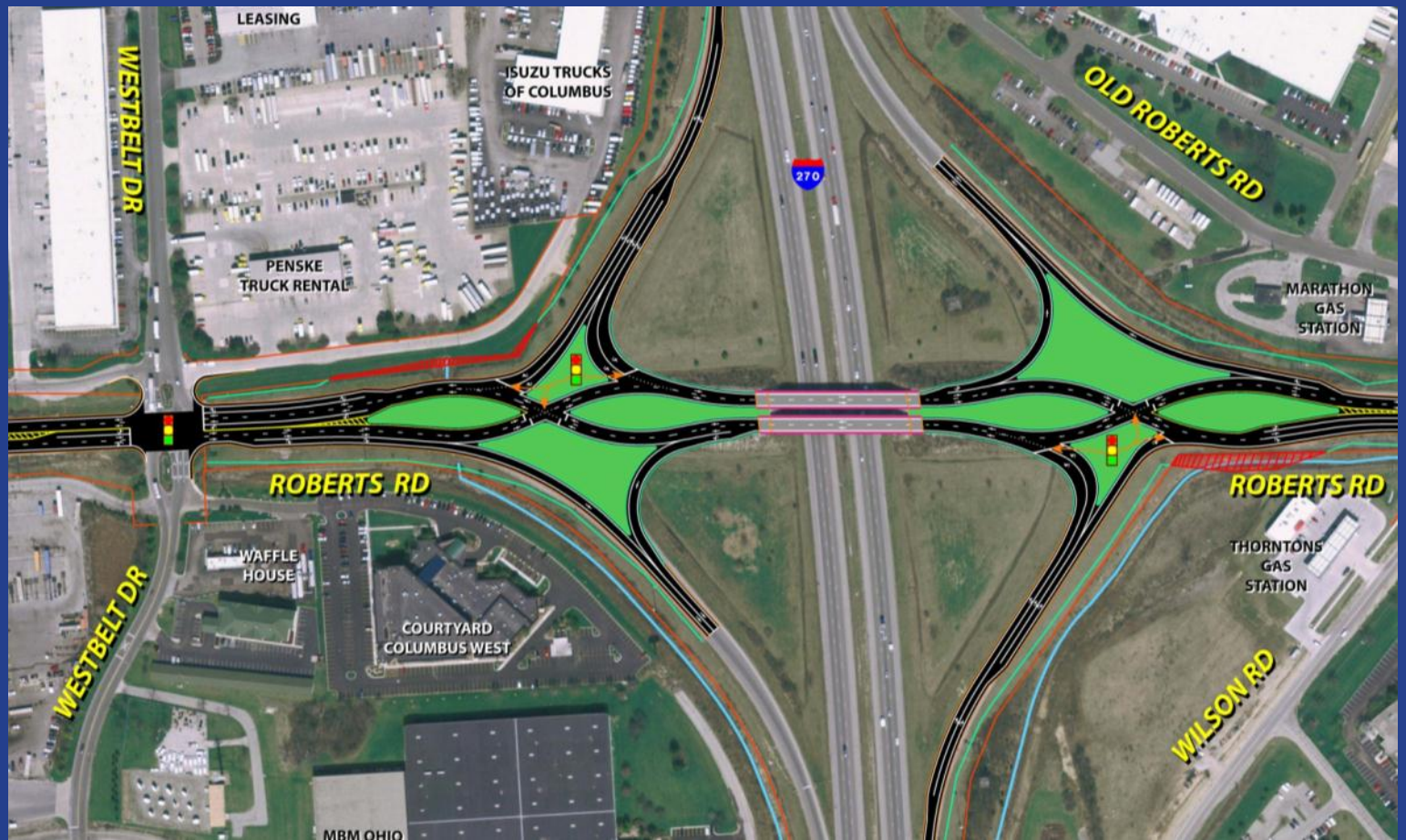
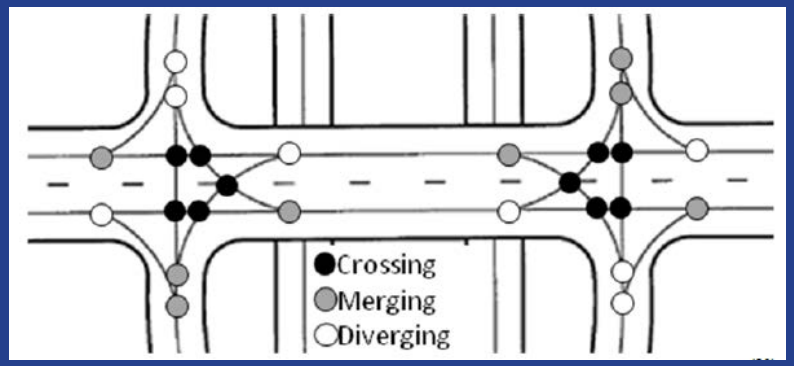
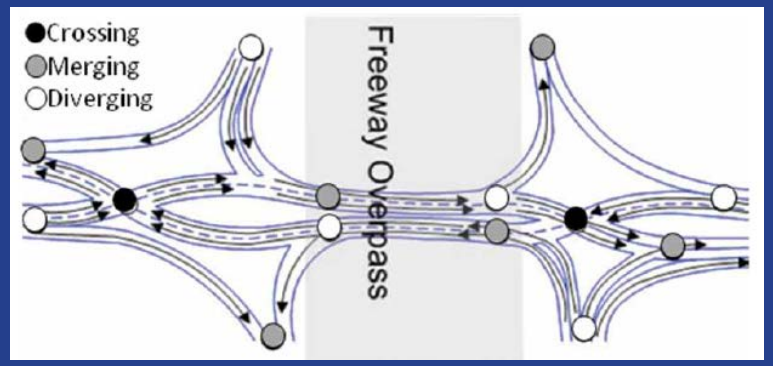


Early DDI Safety Results

Crash Reductions By Crash Type[1]		
Left-Turn Type	**Left-Turn Right Angle**	**Total Crashes**
100%	**72%**	**46%**



Conventional Diamond
26 conflict points



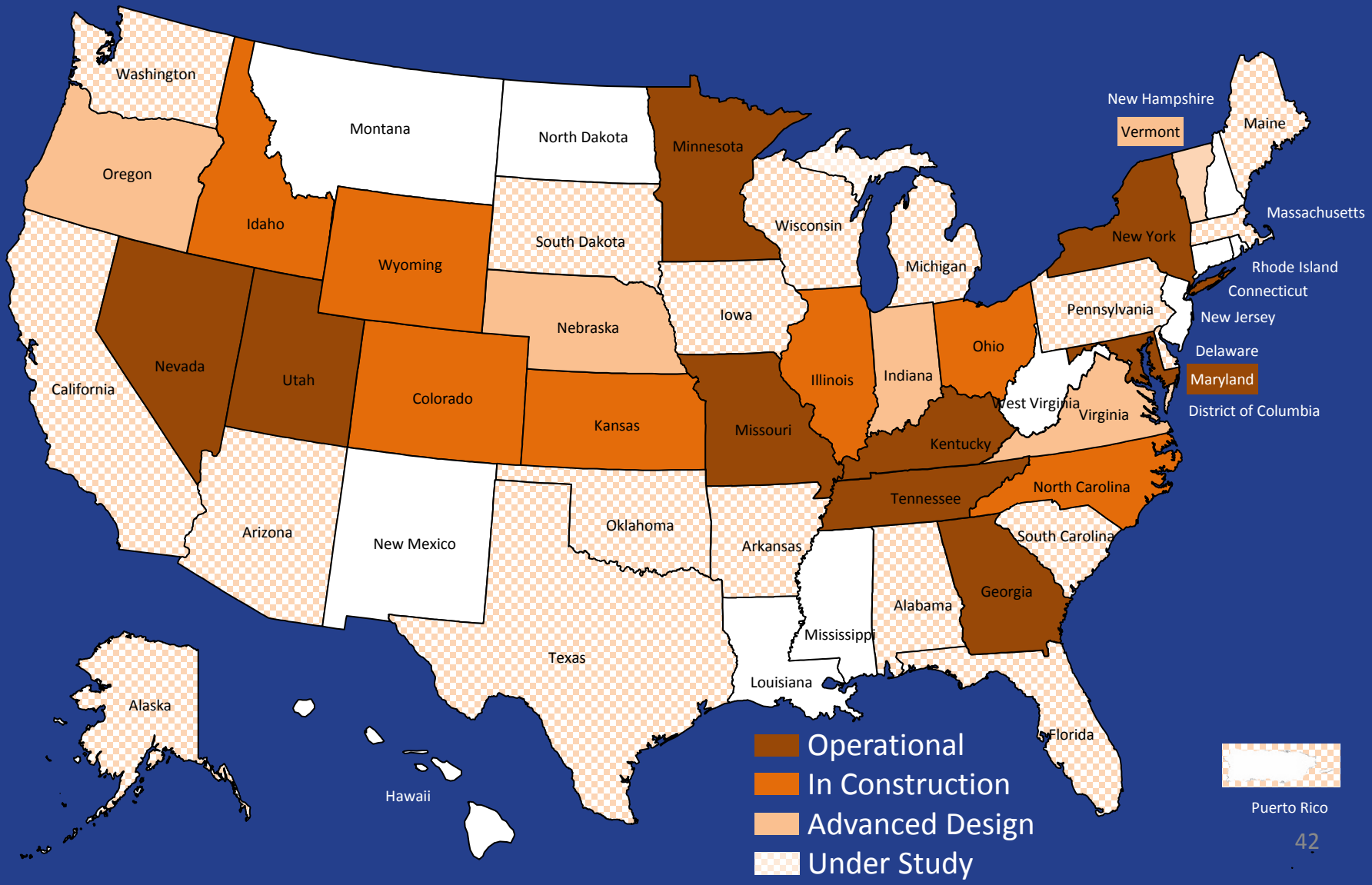
Diverging Diamond
14 conflict points

1. *Diverging Diamond Interchange Performance Evaluation, MODOT, February 2011*

DDI - Noteworthy Attributes

- Relatively small footprint
- Existing bridge can often be salvaged on retrofits
- Versatile alternative for low and high volume locations
- Non-motorized accommodation

Diverging Diamond Interchanges



Our EDC Vision

Agencies include these EDC intersection designs in their evaluation processes or policies in a manner that ensures they are considered and evaluated alongside other improvement alternatives, and implemented when appropriate.

Key Issues/Challenges

- Lack of knowledge regarding these concepts
- Ambiguity on criteria for when to apply them
  - No formal screening process
  - No process to assess “best value”
  - Lack of tools to analyze operations
- Public/Political Reaction
  - Apprehension/Resistance to change
  - Fear of failure

Strategies for Advancing Deployment

- ***Awareness and Outreach (communication and marketing)***
- ***Training***
  - Web-based and instructor-led workshops
- ***Knowledge and Information Exchange***
  - Peer Exchanges of successful practices and projects
  - Communicate and share lessons learned
  - Intersection and Interchange Geometrics website
- ***Analysis Tools and Evaluation Processes***
  - HCM methodologies and use of screening tools such as CAP-X

Selected Resources

- ***Alternative Intersections/Interchanges: Informational Report (AIIR)***
  - http://www.fhwa.dot.gov/publications/research/safety/09060/
- ***Roundabout Outreach and Information Toolbox***
  - http://safety.fhwa.dot.gov/intersection/roundabouts/RoundaboutToolbox/
- ***Mobility Investment Priorities***
  - http://mobility.tamu.edu/mip/strategies.php

How can I get more information?

Mark Doctor
FHWA Resource Center
mark.doctor@dot.gov or (404) 562-3732

Marcus Brewer
TTI Roadway Design Program
m-brewer@tamu.edu or (979) 845-7321