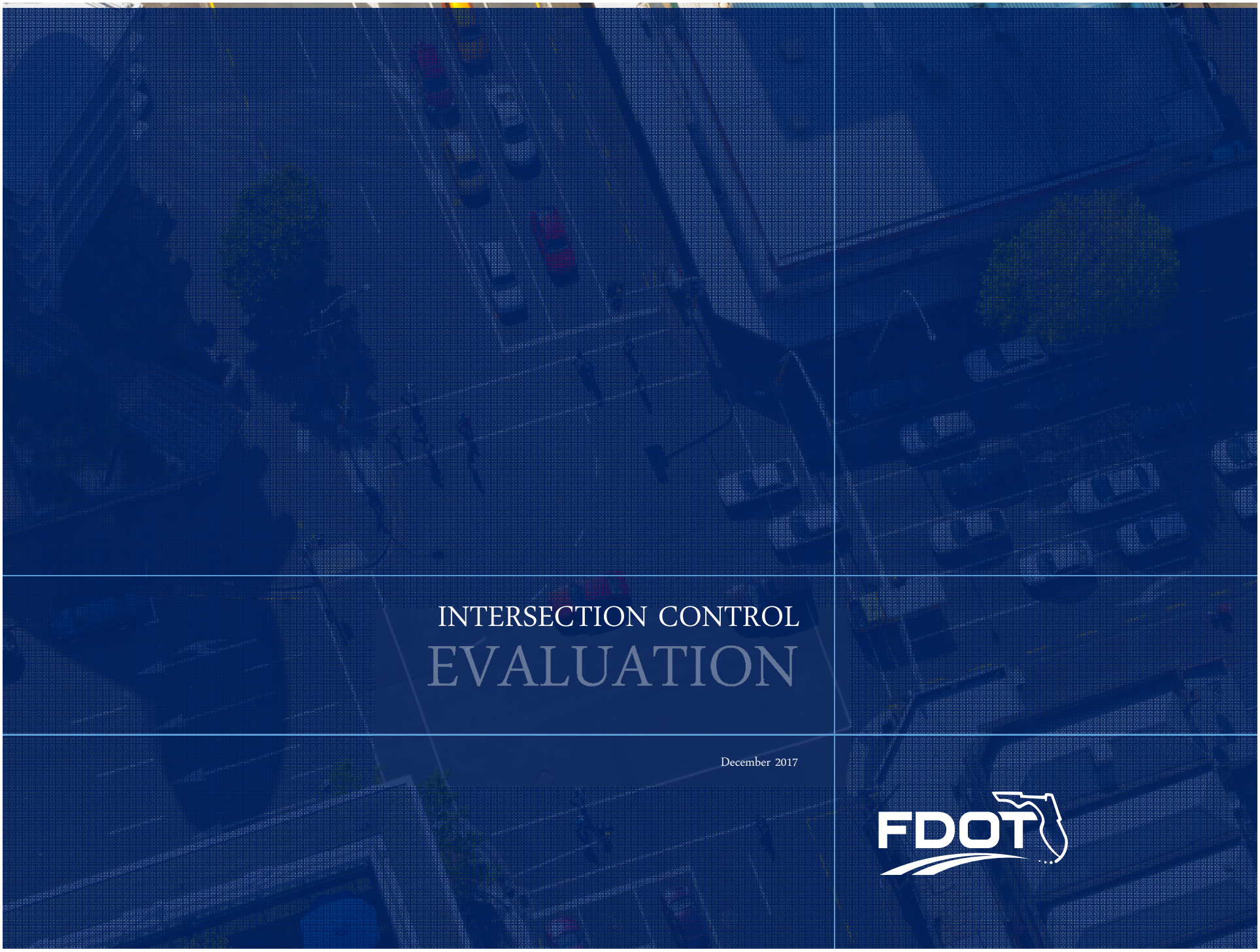


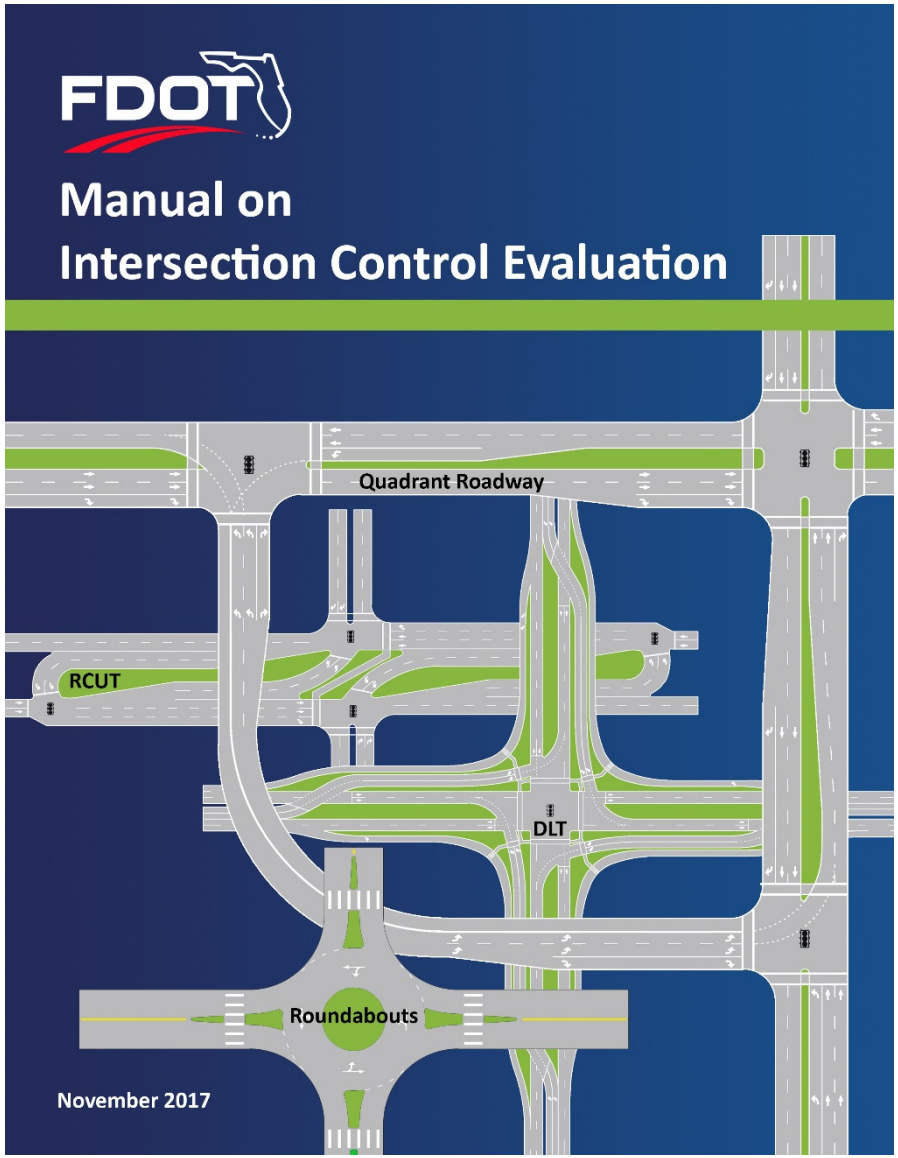
INTERSECTION CONTROL EVALUATION

December 2017

FDOT

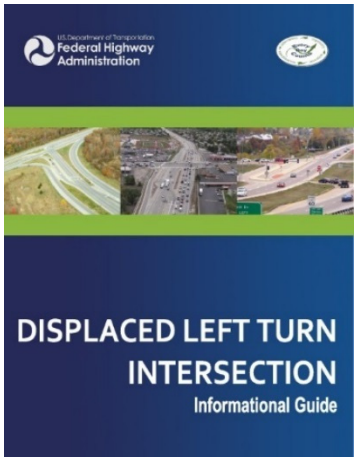
ICE OVERVIEW

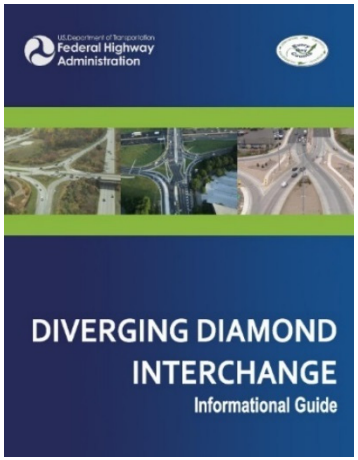
- Why ICE?
- When ICE is Required?
- Applicability & Process
- Forms
- Tools

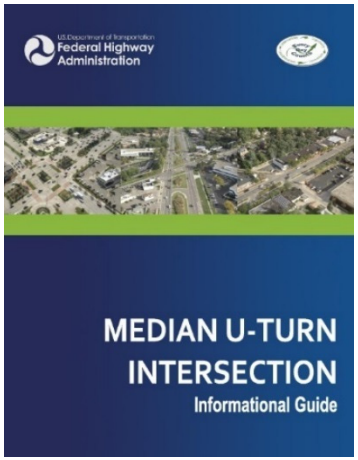


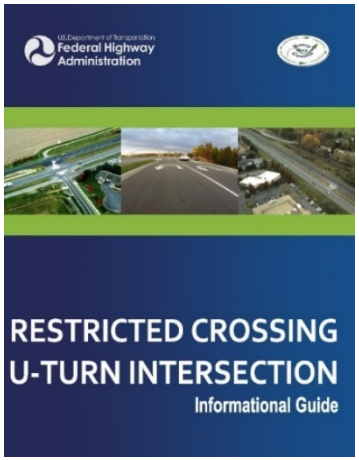
WHY ICE IN FLORIDA

- Intersection choices have historically been stop control, signalization and recently roundabouts
- Raise awareness and increase use of alternative intersections
- Consider context classifications, safety, and all road users
  - Support SHSP by addressing one of the 13 emphasis areas: Intersection Safety
- Quantitative analysis to select intersection control types
- FDOT Developed ICE Manual and Tools
  - ICE Manual released Nov. 1, 2017
  - Spreadsheet tools developed to support safety, operations and benefit-cost analyses







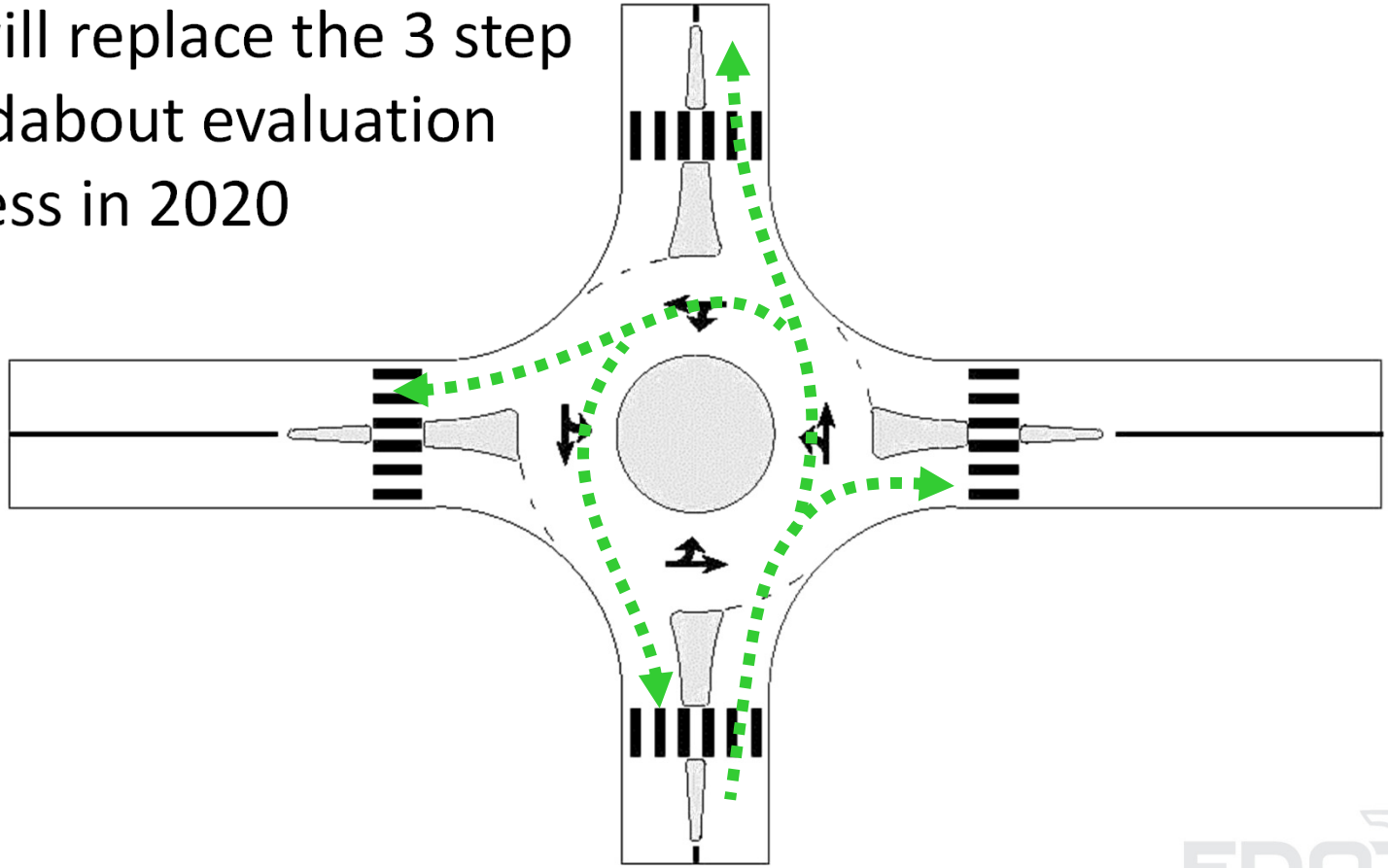


ICE PURPOSE

- Consistently consider multiple context-sensitive control strategies when planning a new or modified intersection through…
  - Informed decision-making considering
    - purpose and need, context classification, safe travel facilities for all road users, with the overall best value
  - Select a context-sensitive control strategy considering
    - the goals and needs of the community and all road users
  - Measure the control strategy's value using
    - performance-based criteria
- Promotes thoughtful consideration of alternative intersection types through quantitative analysis

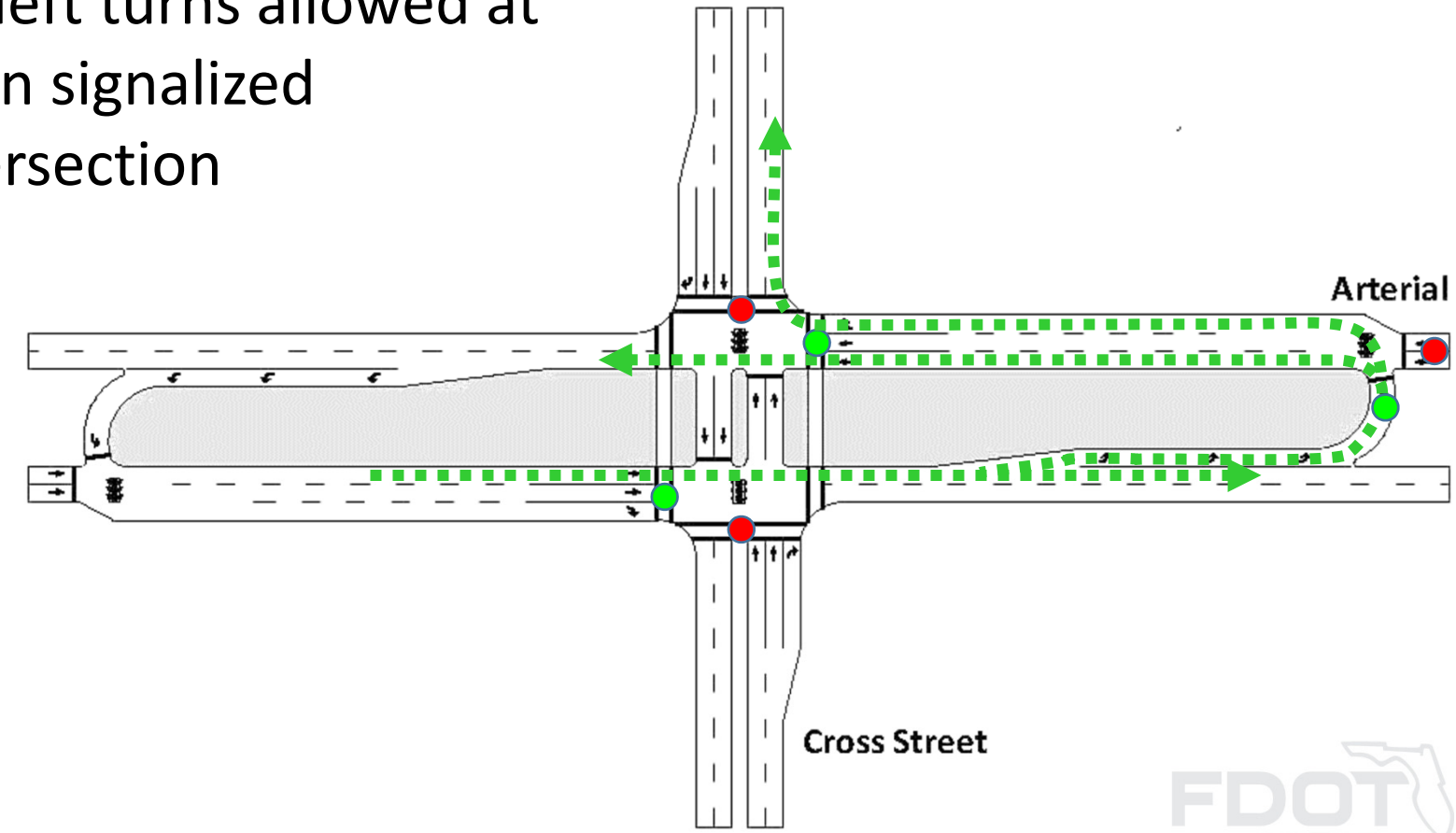
Roundabout

ICE will replace the 3 step roundabout evaluation process in 2020



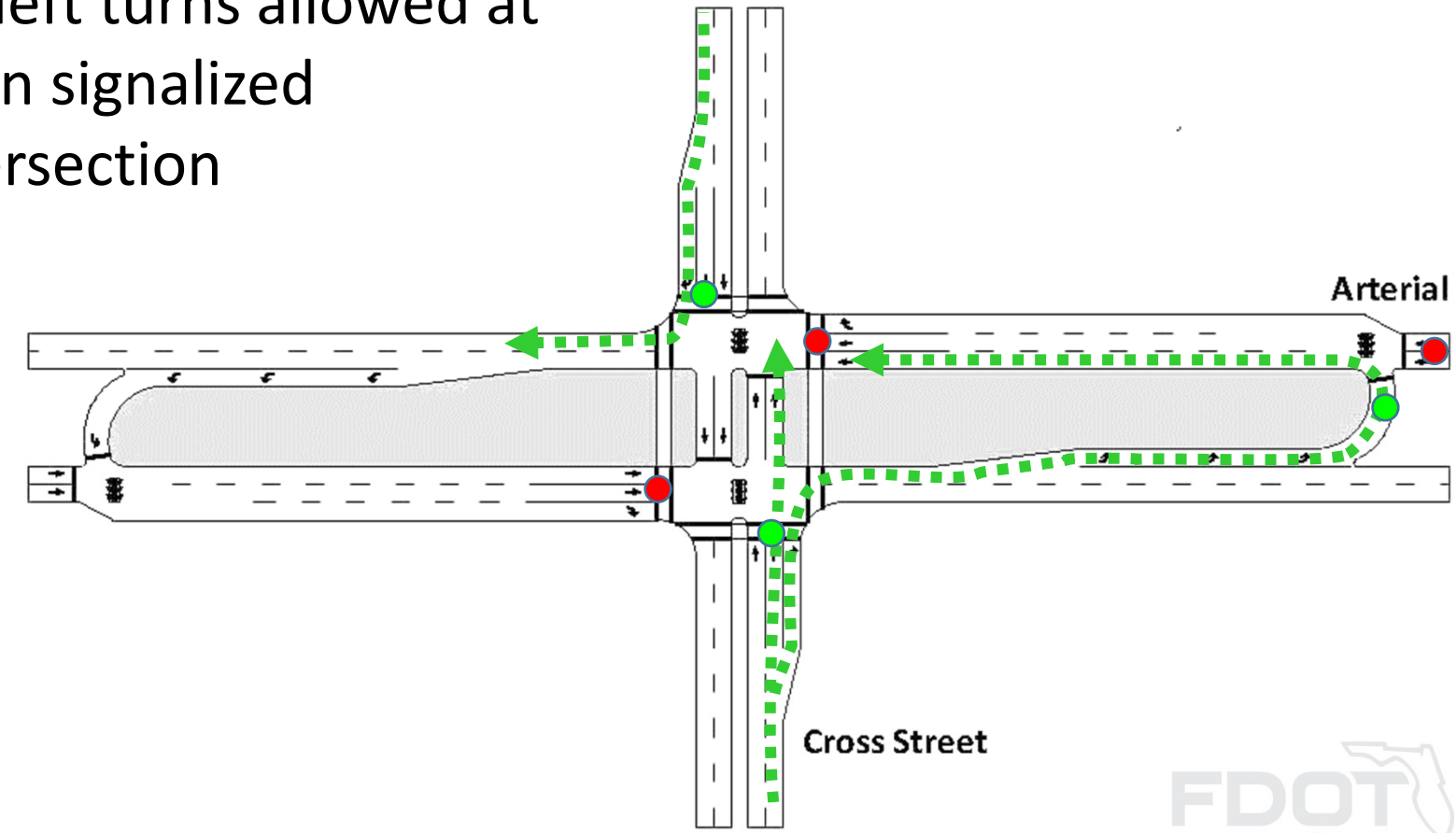
Median U-Turn (MUT)

No left turns allowed at main signalized intersection



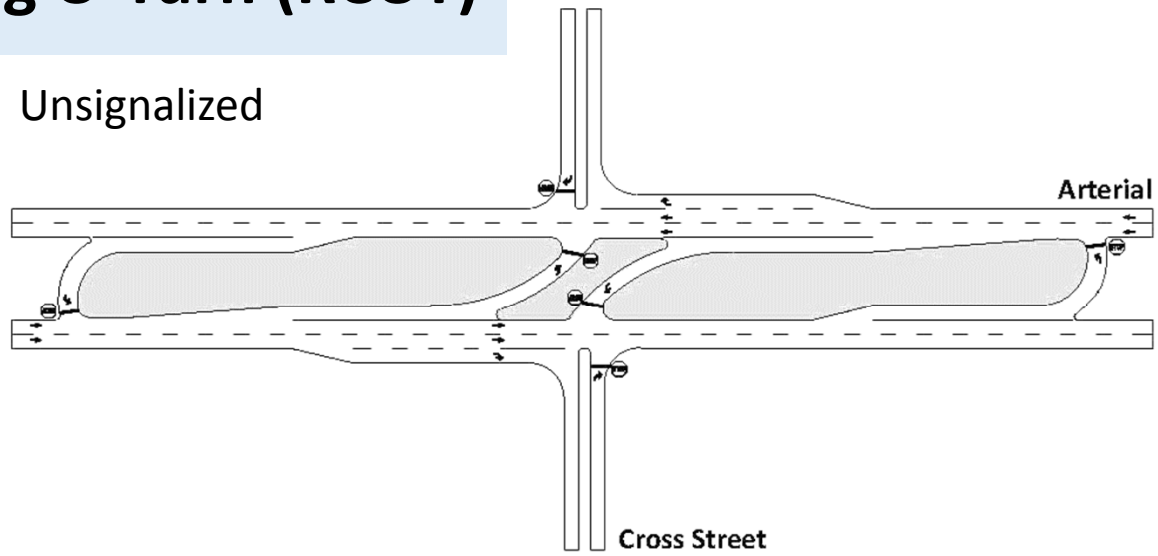
Median U-Turn (MUT)

No left turns allowed at main signalized intersection

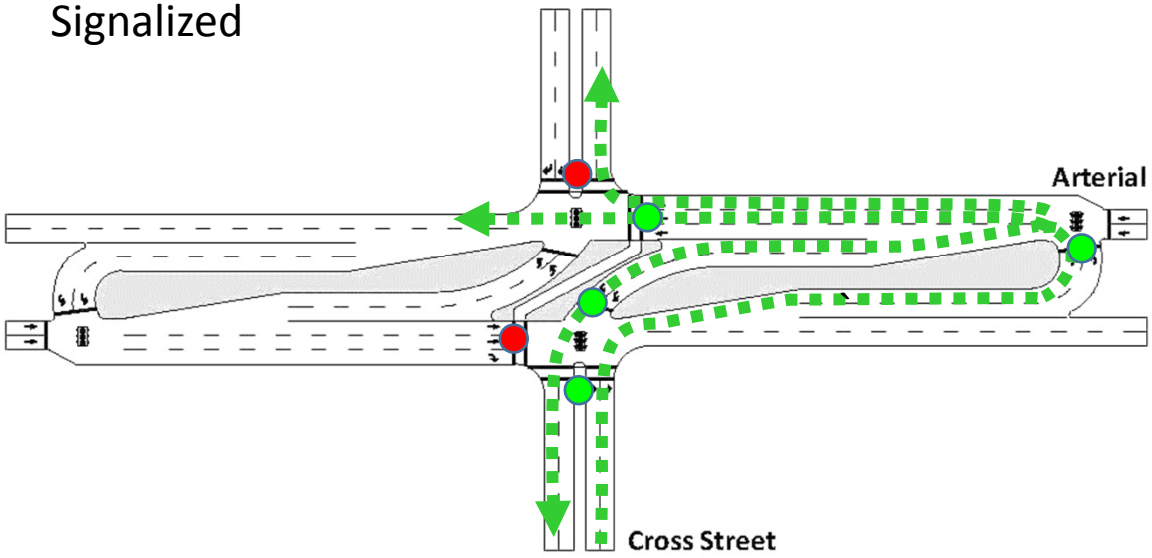


Restricted Crossing U-Turn (RCUT)

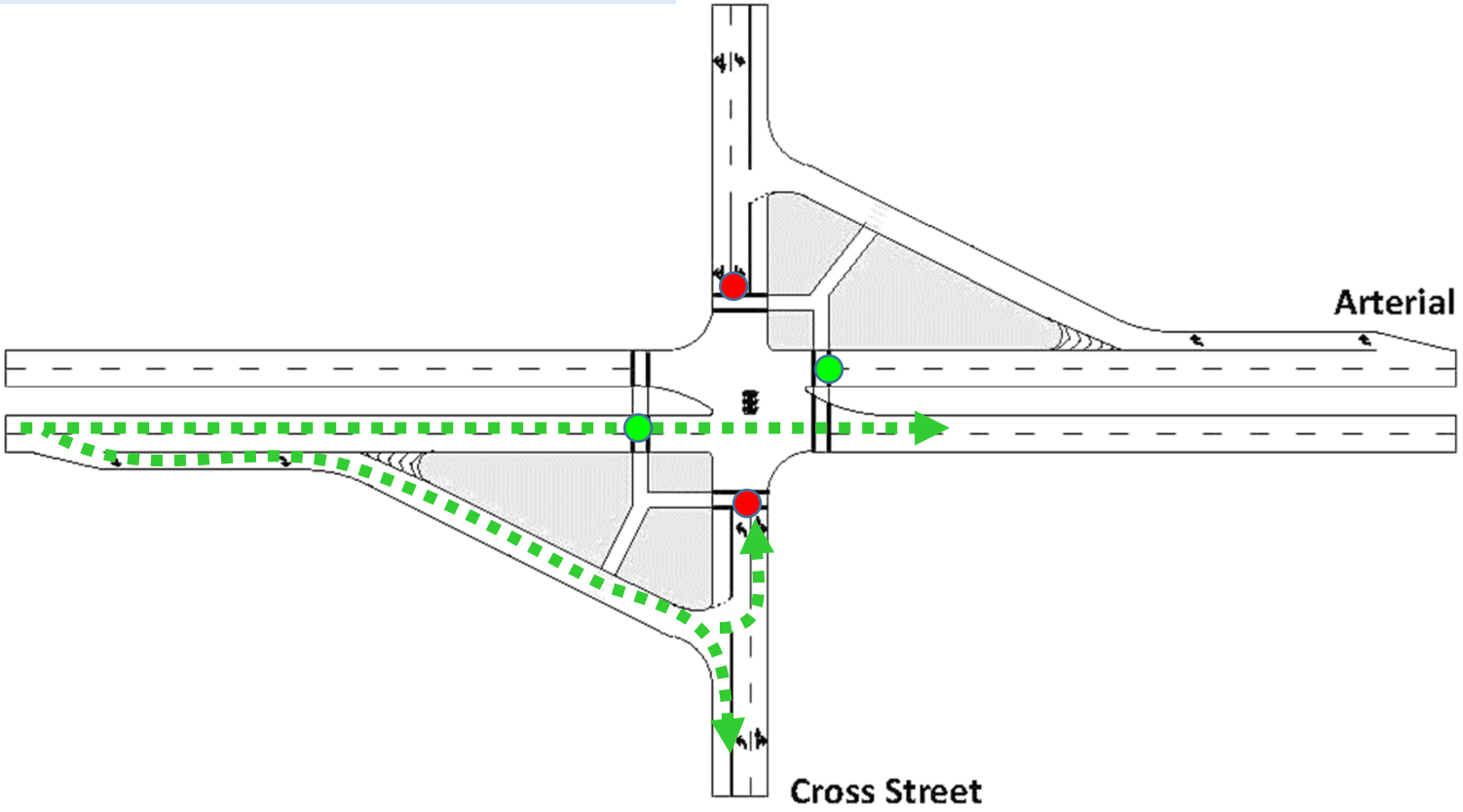
Unsignalized



Signalized

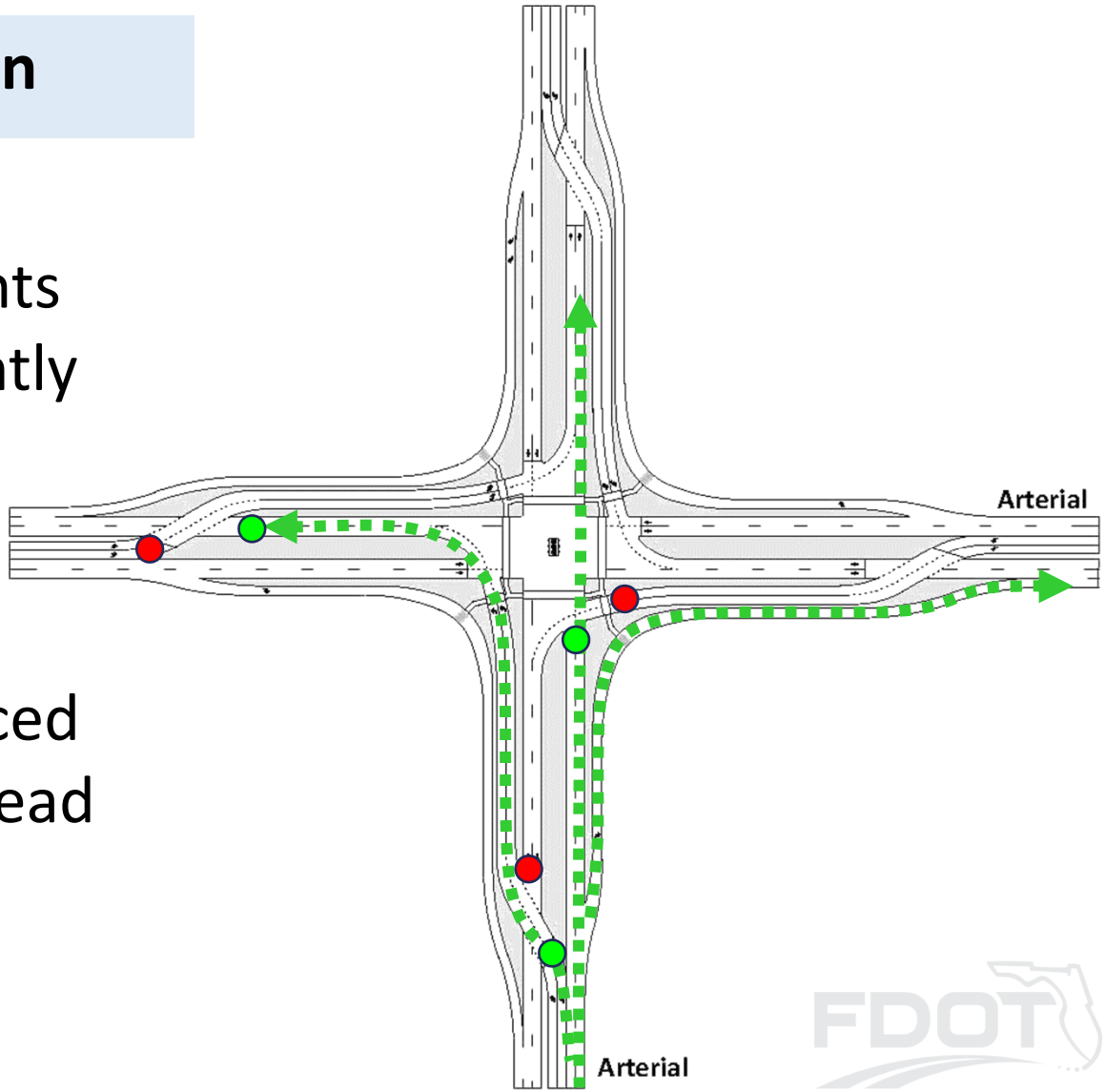


Jughandle

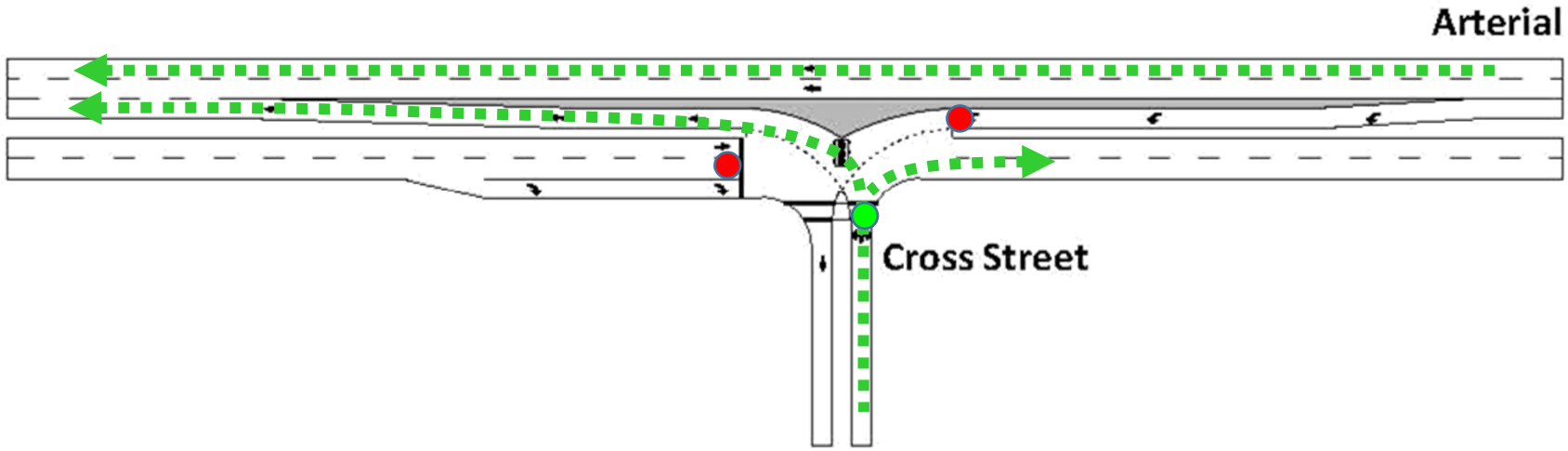


Displaced Left Turn

- Left turns and through movements operate concurrently
- Also called continuous flow intersection
- Could have displaced lefts on 2 legs instead of all 4

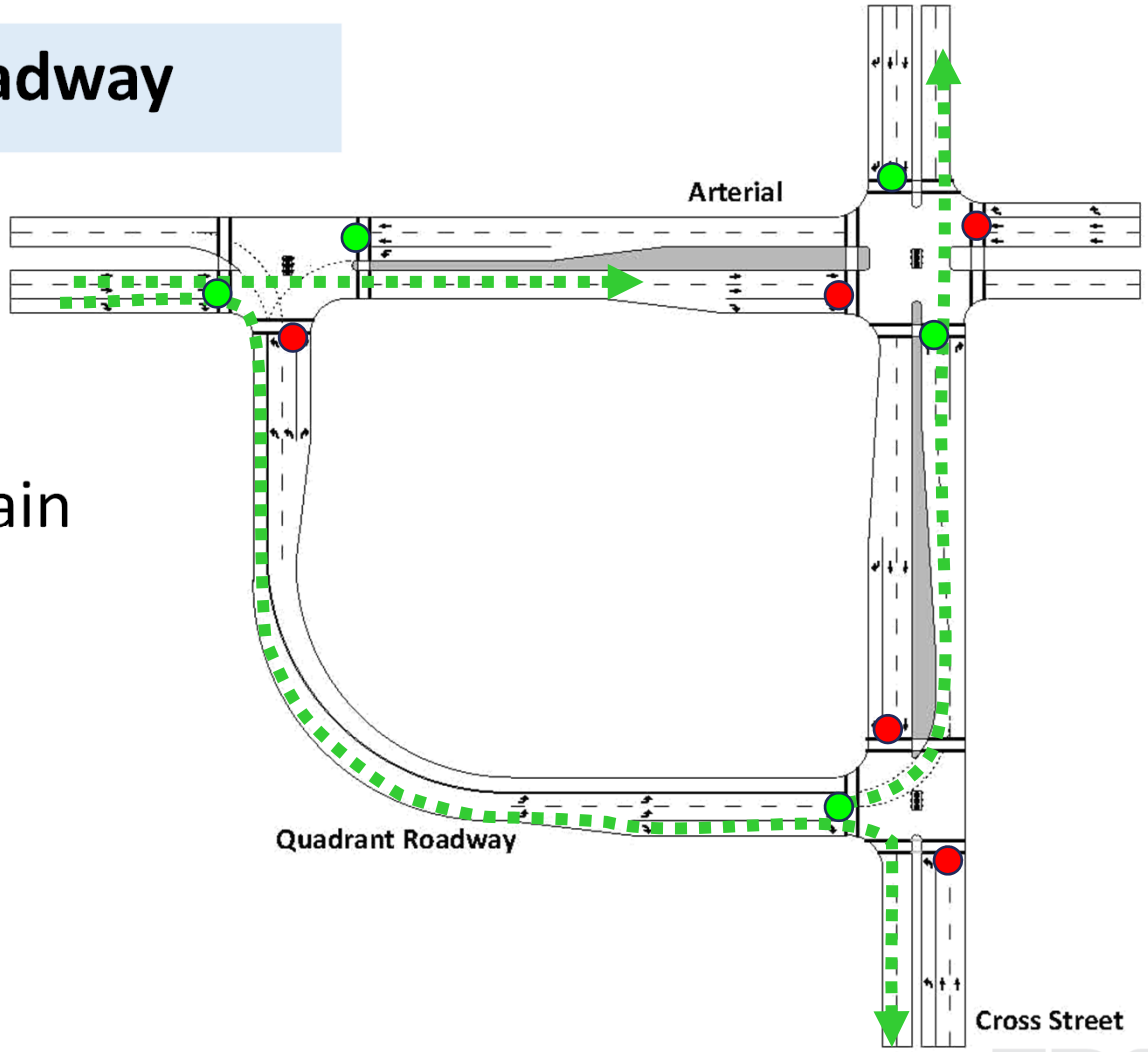


Continuous Green T



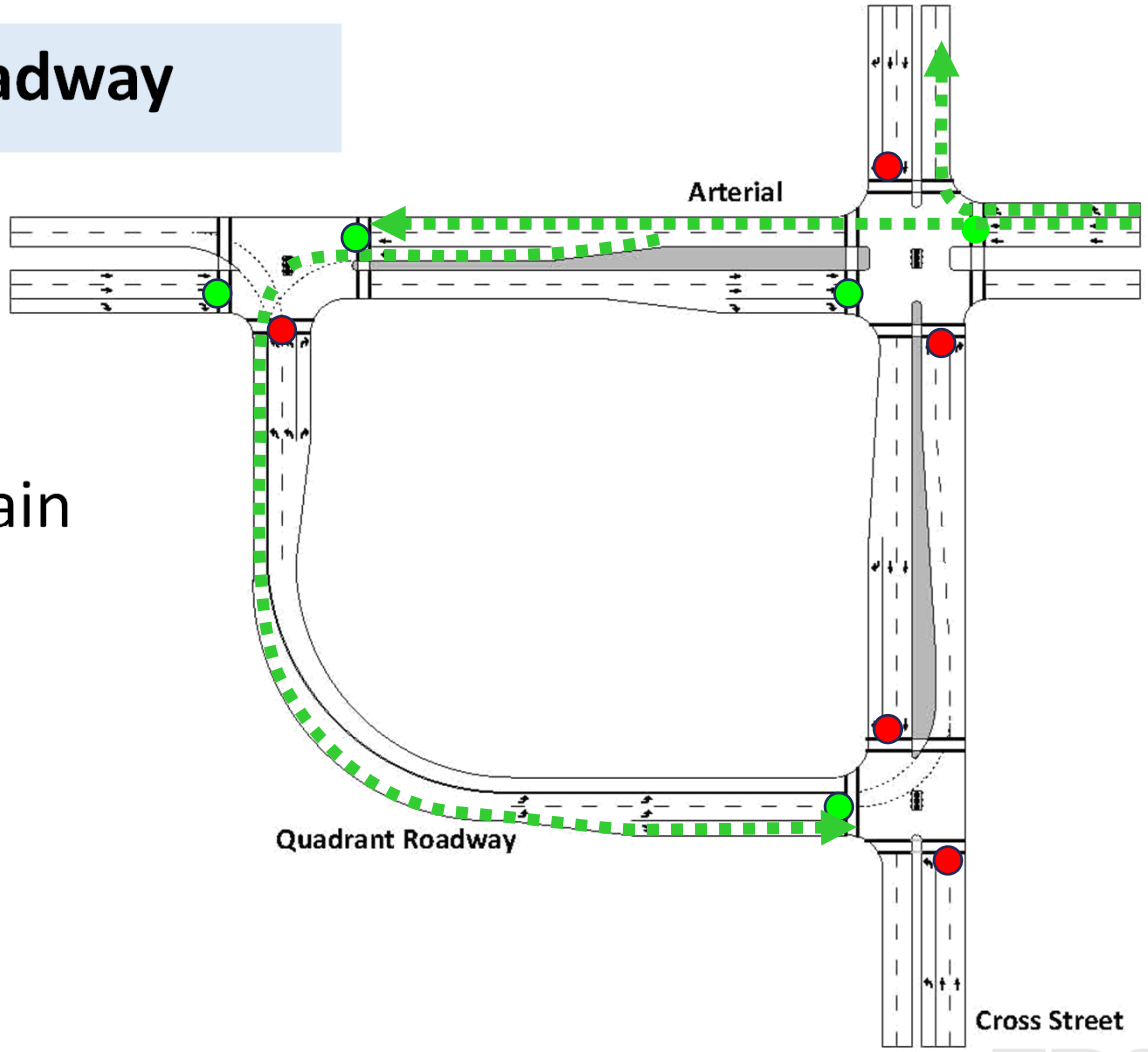
Quadrant Roadway

No left turns allowed at main signalized intersection



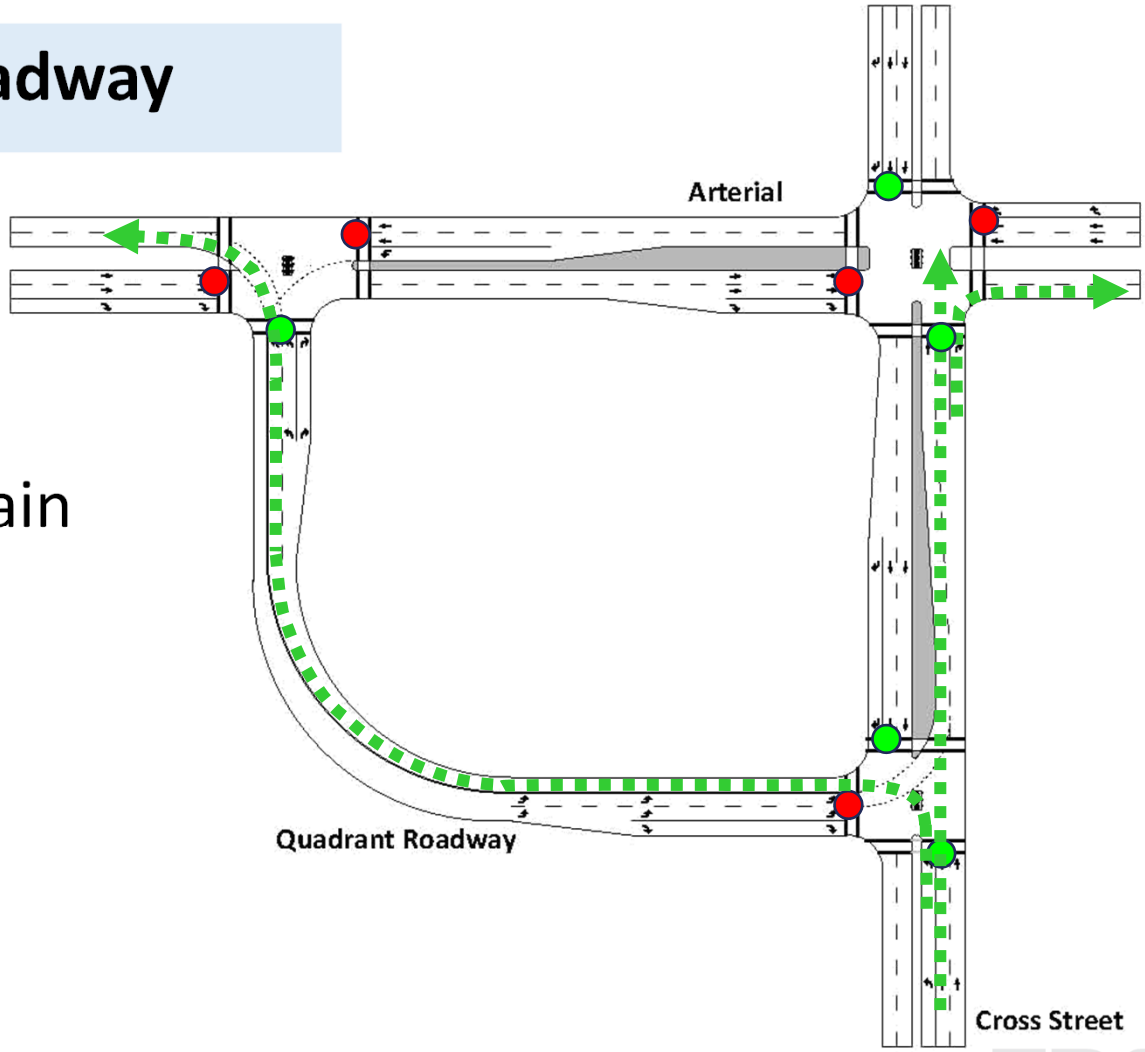
Quadrant Roadway

No left turns allowed at main signalized intersection



Quadrant Roadway

No left turns allowed at main signalized intersection

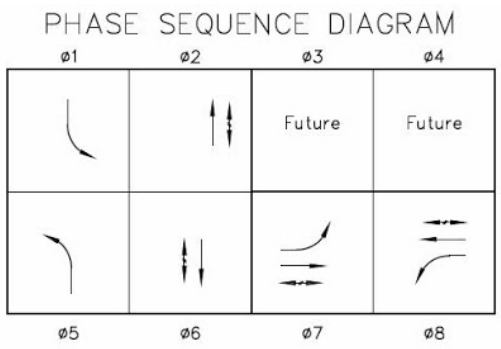


ICE is REQUIRED when

- New signalization is proposed
- Major reconstruction of existing signalized intersection is proposed
    - Adding exclusive left turns, adding intersection legs
- Conversion of a directional or bi-directional median opening to a full median opening is proposed
- Driveway/Connection permit applications for Category E, F, G
- District Design Engineer (DDE) and District Traffic Operations Engineer (DTOE) consider an ICE a good fit for the project

ICE NOT REQUIRED

- Work does not include substantive proposed changes to intersection
  - Mill and resurface pavement; changing full median opening to directional median opening
- Minor intersection operational improvements
  - Adding right turn lane or signal phasing changes or equipment upgrades
- Encouraged for local roadways, not required
- Recommended for ramp terminal intersections (stop control, signalized, or yield), not required



WHO COMPLETES THE FORM?

FDOT PROJECTS

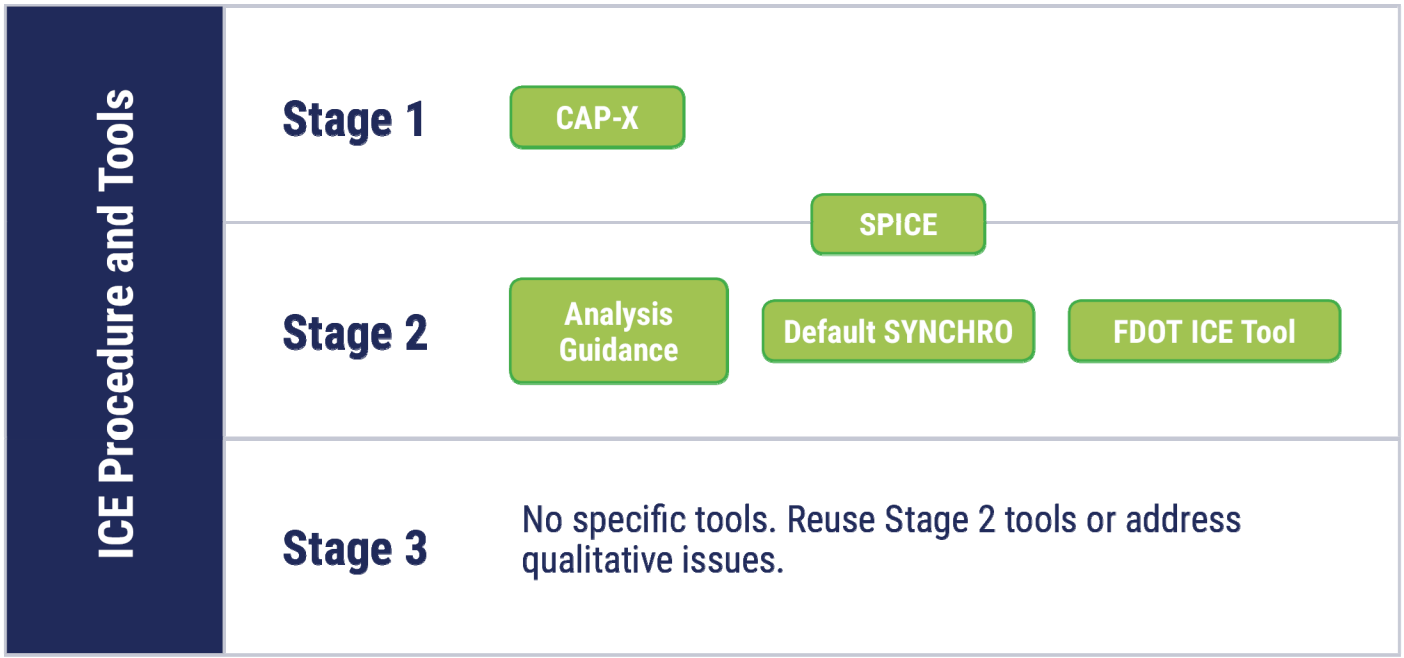
- FDOT staff
- Consultants

Driveway / Connection Permits on State Highways

- Applicant

STAGES OF ICE

Stage 1	Stage 2	Stage 3
Screening	Preliminary Control Strategy Assessment	Detailed Control Strategy Assessment



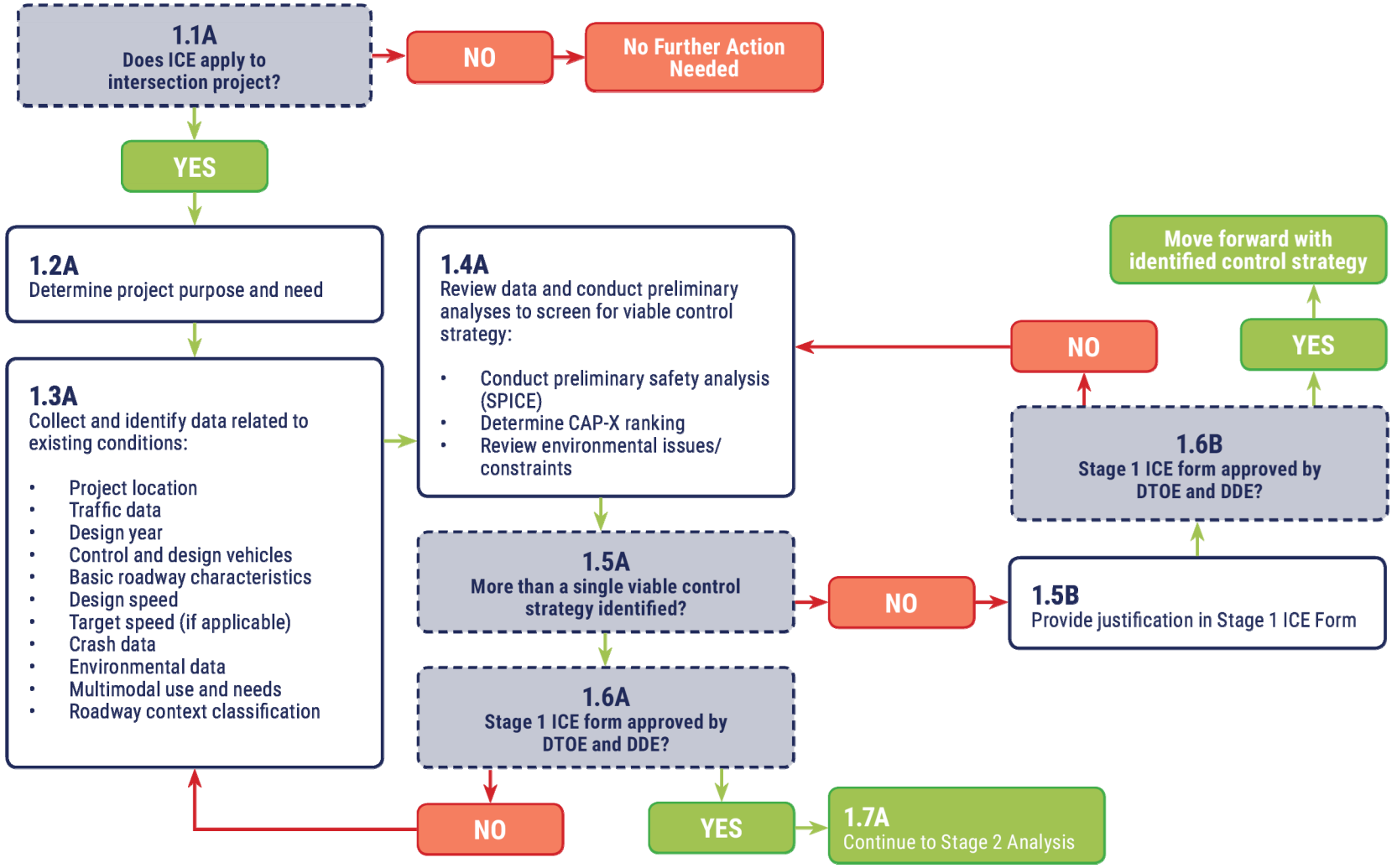
STAGES OF ICE

Is there one viable control strategy or more than one?

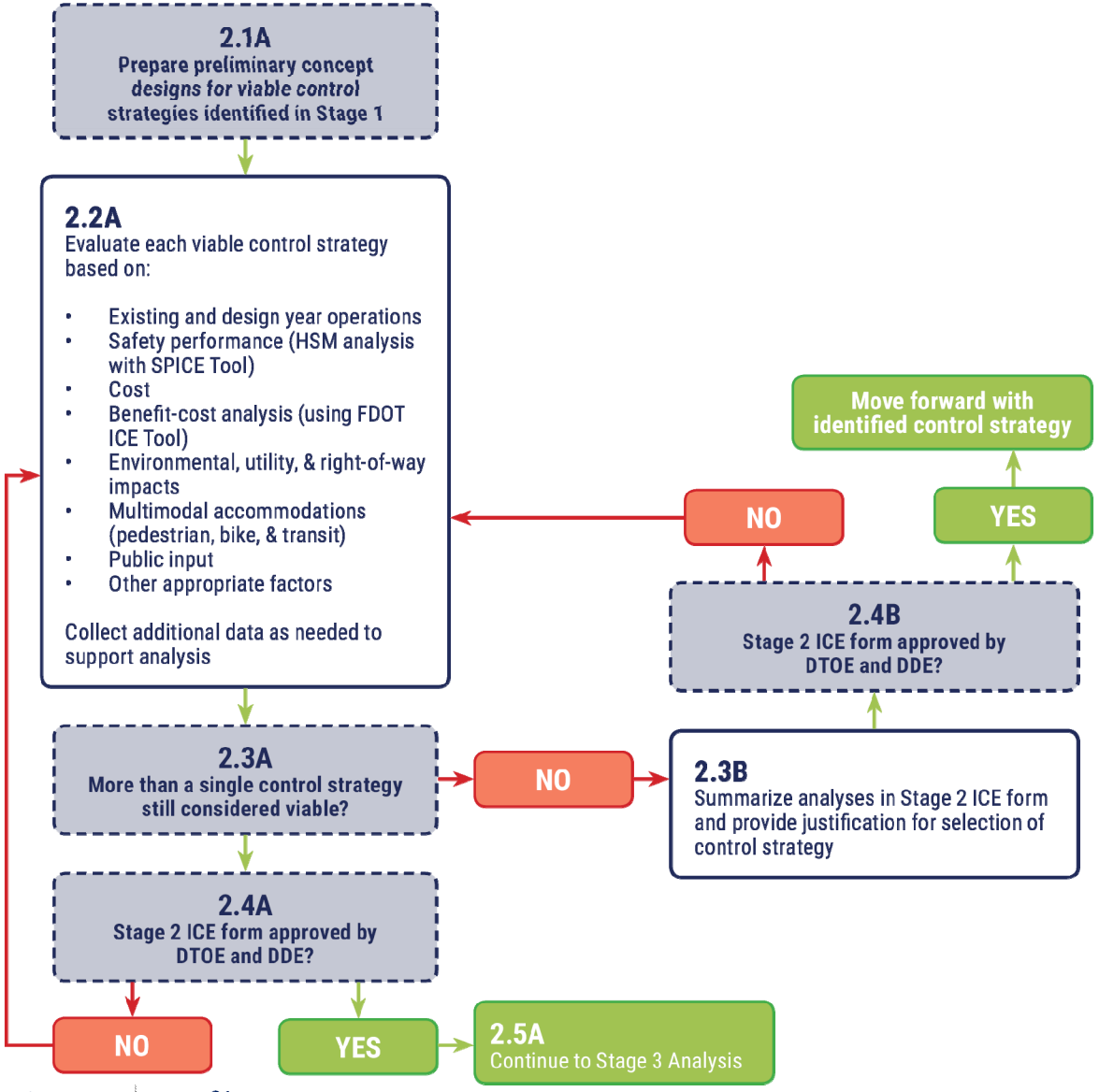
If only one control strategy, Stages 2 and 3 are not necessary

Intent - Don't make ICE a burden if the choice is straightforward

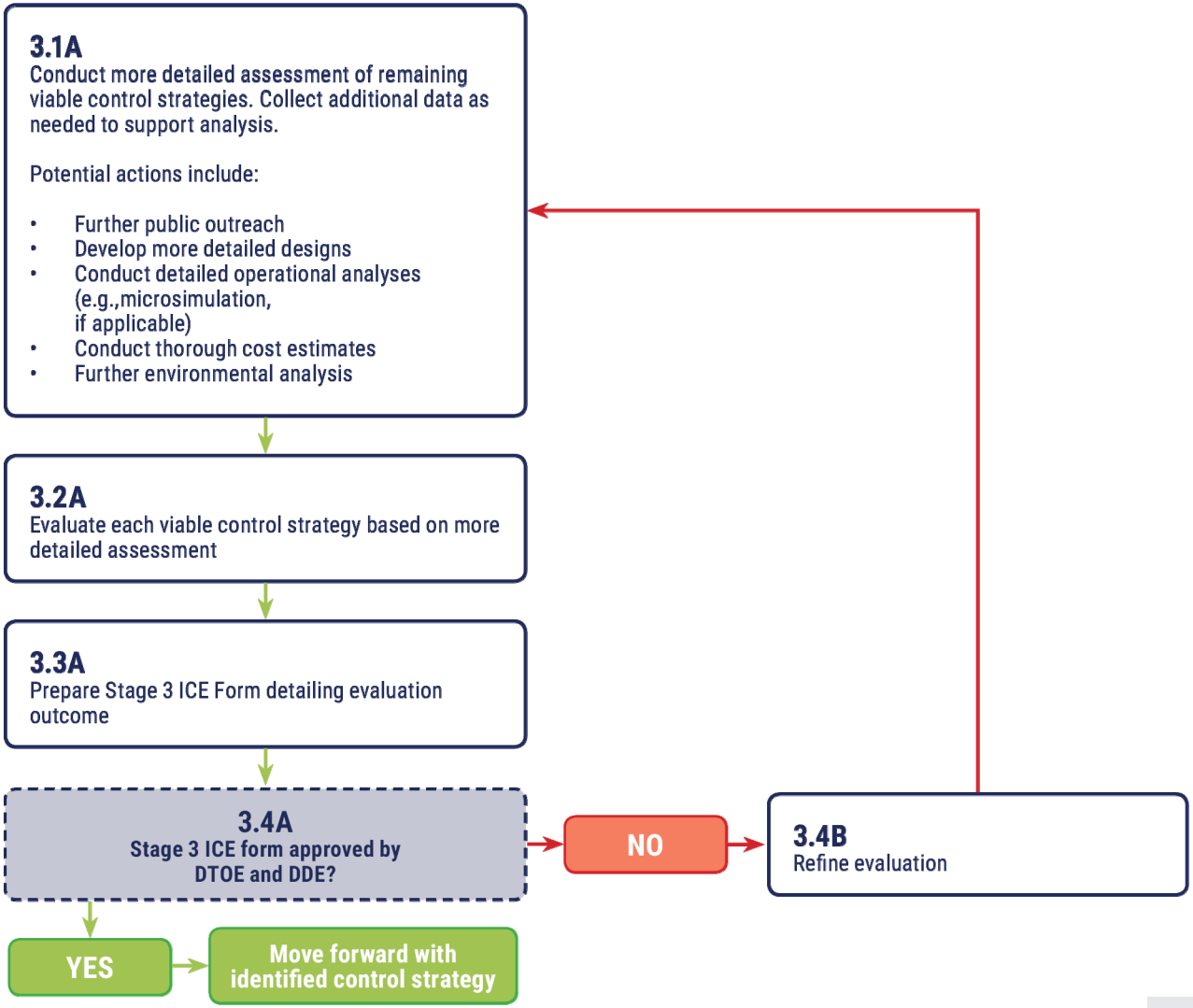
ICE STAGE 1 PROCESS



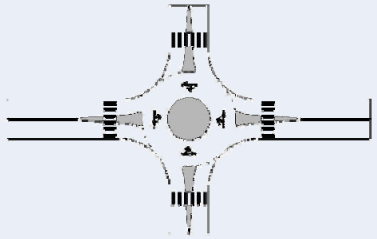
ICE STAGE 2 PROCESS



ICE STAGE 3 PROCESS



- **Procedure includes:**
  - Appendix A with information on intersection forms
  - List of references and tools (*Specifics covered later today*)
  - Recommended Analysis Tools

Intersection Control Type			Mode Accommodations			Reference Material	Recommended Analysis Tool
Intersection Name	Illustration	Description	Vehicles	Pedestrians	Bicycles		
Roundabout							

TOOLS FOR ICE EVALUATION – APPENDIX A

	Mode Accommodations		
Description	Vehicles	Pedestrians	Bicycles
A subset of traffic circles that feature yield control of all entering vehicles, channelized approaches, and horizontal curvature and roadway elements to induce desirable vehicle speeds. Advantages: Usually reduced crashes and delay compared to signalized control Disadvantages: Usually higher cost and require more right-of-way than signalized control	Vehicles approaching the intersection must yield to vehicles circulating within the circulatory roadway.	Pedestrian crossings are located only across the legs of the roundabout, typically separated from the circulatory roadway by at least one vehicle length.	Bicyclists may ride in the roadway with vehicles or transition to multi-use paths via bicycle ramps (if present). Bike lanes should not be used at roundabouts

ICE FORMS

- One form available for each Stage
  - Excel Spreadsheet Format
    - Yellow cells provide a dropdown menu
    - White cells require manual input regarding project specific information
    - Auto-populates project information and control strategies to Stage 2 and Stage 3
- Appendix B provides information details to be provided in each cell
- Approved by District Traffic Operations Engineer (DTOE) and District Design Engineer (DDE)

Florida Department of Transportation

Intersection Control Evaluation (ICE) Form

Stage 3: Detailed Control Strategy Assessment

To fulfill the requirements of Stage 3 (Detailed Control Strategy Assessment) of FDOT's ICE procedures, complete the following form and append all supporting documentation, which may include detailed design plans of each control strategy analyzed. Completed forms can be submitted to the District Traffic Operations Engineer (DTOE) and District Design Engineer (DDE) for the project's approval.

Project Information			
Project Name		FDOT Project Number	
Submitted By	Agency/Company	Email	
List all viable intersection control strategies identified at the end of Phase 2 (Initial Control Strategy Assessment):			

FDOT ICE IMPLEMENTATION PLAN

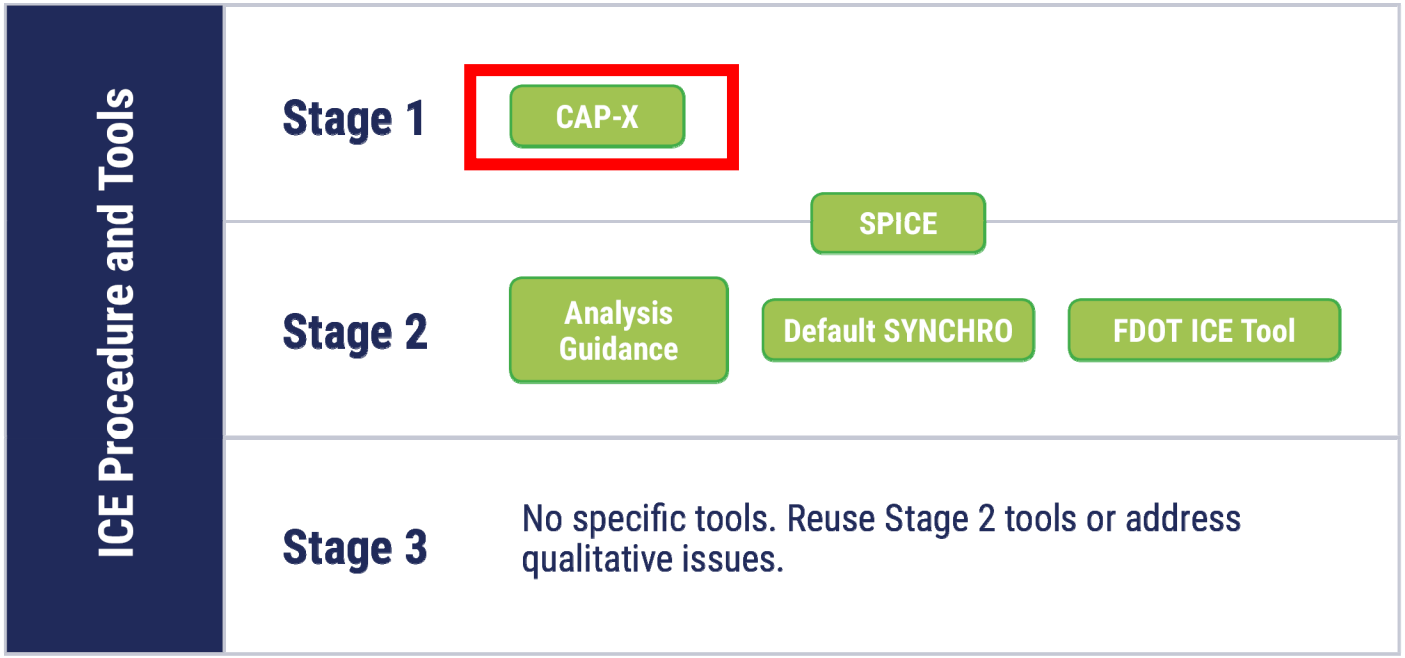
- 2018: Training and Acclimation
  - Implementation Focus: District Training
    - Two intersections per district

- 2019: Districts Identify & Conduct ICE Analysis for Additional Locations
  - Implementation Focus: Refine ICE Process
    - Evaluate minimum of three projects in these offices/focus areas
      - PD&E
      - Traffic Operations
      - Access Management/Permitting

- 2020: Full ICE Procedure Implementation by Districts
  - Implementation Focus: Mainstream ICE Process
    - ICE Manual Procedures fully effective January 1, 2020
    - Quality Assistance Reviews (QAR) starting in Year 4


TOOLS
CAP-X
FDOT

ICE PROCEDURE



VISION AND NEED FOR THE CAP-X TOOL

- Capacity Analysis for Planning of Junctions (CAP-X)
- FHWA tool for planning-level capacity assessment
- Stage 1 tool for Intersection Control Evaluation
- Initial operational screening of intersection control alternatives
  - Can be used during project's scoping stage
- Simple tool for efficient comparisons
  - User-friendly
  - Only requires readily available inputs
- FDOT updates
  - Incorporation of multimodal considerations
  - Improved input sheets and output comparisons
  - Updated inputs to reflect FDOT default values
  - HCM 6th Edition roundabout capacities
  - Additional intersection alternatives

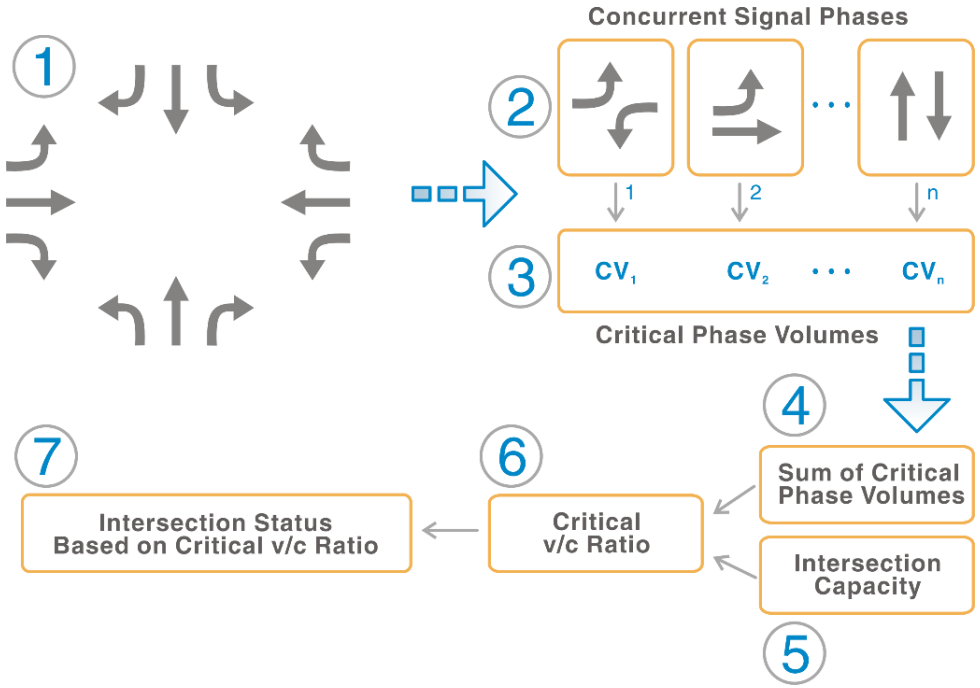
CAP-X TOOL OVERVIEW

- Conducts critical movement analysis (CMA) to gauge the potential performance of intersection and interchange types
- CMA identifies the critical movements at an intersection and estimates whether the intersection is operating below, near, at, or over capacity;
- Includes vast majority of intersections and interchange types

- At-Grade Intersections
  - Conventional
  - Continuous Green T
  - Quadrant Roadway
  - Displaced Left Turn
  - Median U-Turn
  - Restricted Crossing U-Turn
- Roundabouts
  - 50 and 75 ICD Mini-roundabouts
  - 1 Lane Roundabouts
  - 2 Lane Roundabouts
  - Hybrid 1x2 lane configurations
- Grade-Separated Interchanges
  - Traditional Diamond
  - Partial Cloverleaf
  - Displaced Left Turn
  - Diverging Diamond Interchange
  - Single Point Diamond

WHAT IS CRITICAL MOVEMENT ANALYSIS?

Included in the 1985 HCM and NCHRP Report 812: Signal Timing Manual, 1st Edition



Source: Traffic Signal Timing Manual – 1st Edition

1) Identify movements served, # lanes and volumes per lane
2) Arrange in desired sequence of phases
3) Determine critical volume per lane to be accommodated
4) Sum the critical volumes
5) Determine maximum critical volume for intersection – CAP-X
6) Determine volume to capacity ratio

CAP-X INPUTS

Traffic Volume Demand						
	Volume (Veh/hr)				Percent (%)	
	U-Turn	Left	Thru	Right	Heavy Vehicles	Volume Growth
Eastbound	0	100	500	100	2.00%	0.00%
Westbound	0	100	500	100	2.00%	0.00%
Southbound	0	100	500	100	2.00%	0.00%
Northbound	0	100	500	100	2.00%	0.00%
Adjustment Factor	0.80	0.95		0.85		
Suggested	**0.80**	**0.95**		**0.85**		
Truck to PCE Factor				**Suggested = 2.00**	2.00	
FDOT Context Zone				**C2-Rural**		
Critical Lane Volume Threshold	2-phase signal			**Suggested = 1800**	**1800**	
	3-phase signal			**Suggested = 1750**	**1750**	
	4-phase signal			**Suggested = 1700**	**1700**	

Equivalent Pasenger Car Volume				
	Volume (Veh/hr)			
	U-Turn	Left	Thru	Right
Eastbound	0	102	510	102
Westbound	0	102	510	102
Southbound	0	102	510	102
Northbound	0	102	510	102

- Movement Volumes
- Multimodal level of activity (FDOT addition)
- Additional planning-level values
- Individual analysis spreadsheets required for each study period (AM, Midday, PM Peak)

CAP-X INPUTS

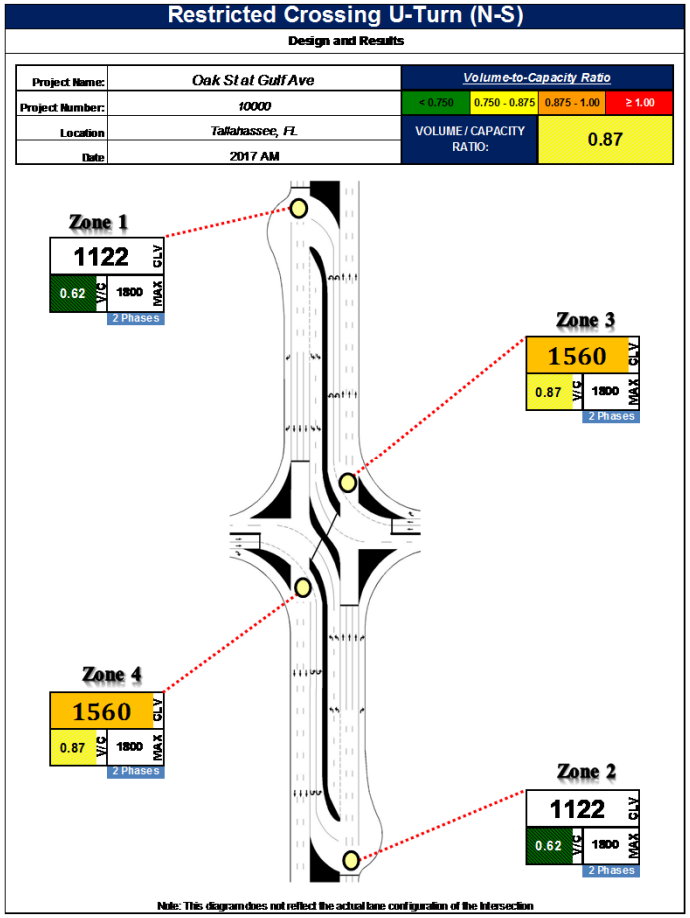
- New and revised input sheets to facilitate more efficient analysis
- Number of lanes inputs consolidated to a single worksheet
- R-CUT and DLT, MUT (Full and Partial) require input for major street direction alternative

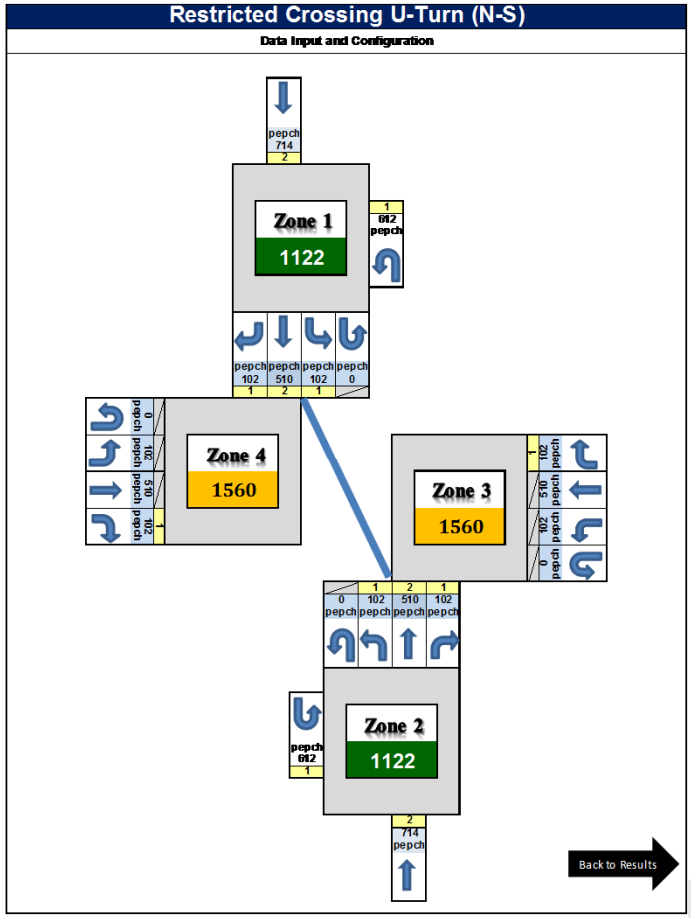
Number of Lanes for Non-roundabout Intersections																	
TYPE OF INTERSECTION	Sheet	Northbound				Southbound				Eastbound				Westbound			
		U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Conventional	FULL		1	2	1		1	2	1		1	2	1		1	2	1
Quadrant Roadway	S-W		1	2	1			2	1		1	2	1		1	2	1
	N-E			2	1		1	2	1		1	2	1		1	2	1
	S-E		1	2	1		1	2	1			2	1		1	2	1
	N-W		1	2	1		1	2	1		1	2	1			2	1
Partial Displaced Left Turn	N-S		1	2	1		1	2	1		1	2	1		1	2	1
Displaced Left Turn	FULL		1	2	1		1	2	1		1	2	1		1	2	1
Restricted Crossing U-Turn	N-S	1	1	2	1	1	1	2	1				1				1
Median U-Turn	N-S	1		2	1	1		2	1			2	1			2	1
Partial Median U-Turn	N-S	1		2	1	1		2	1		1	2	1		1	2	1

For shared lanes, enter "0" in L or R

CAP-X INTERSECTION ANALYSIS

- Evaluation for each intersection alternative is presented using critical movement analysis





CAP-X FULL OUTPUTS

- Full results provided for each zone of each alternative
- Includes multimodal details based on level of activity

Results for Non-roundabout Intersections														
TYPE OF INTERSECTION	Sheet	Zone 1 (North)		Zone 2 (South)		Zone 3 (East)		Zone 4 (West)		Zone 5 (Center)		Overall v/c Ratio	Pedestrian Accommodations	Bicycle Accommodations	Transit Accommodations
		CLV	V/C	CLV	V/C	CLV	V/C	CLV	V/C	CLV	V/C				
Conventional	FULL									730	0.43	0.43	Fair	Fair	Good
Quadrant Roadway	S-W			495	0.28			470	0.27	612	0.34	0.34	Fair	Fair	Fair
	N-E	495	0.28			470	0.27			612	0.34	0.34	Fair	Fair	Fair
	S-E			470	0.27	495	0.28			612	0.34	0.34	Fair	Fair	Fair
	N-W	470	0.27					495	0.28	612	0.34	0.34	Fair	Fair	Fair

- Ped/Bike/Transit Accommodations:
  - crossing control (signal vs. uncontrolled)
  - crossing width (short vs. long)
  - vehicle speed (slow vs. fast)
  - volume (high vs. low)
  - out-of-direction travel

CAP-X SUMMARY OUTPUTS

- Summary with dynamic rankings based on V/C
- Includes multimodal details based on level of activity (based purely on intersection control)

Rank	TYPE OF INTERSECTION	Overall v/c Ratio	V/C Ranking	Pedestrian Accommodations	Bicycle Accommodations	Transit Accommodations
1	Displaced Left Turn	0.28	1	Fair	Fair	Good
2	Quadrant Roadway S-W	0.34	2	Fair	Fair	Fair
3	Quadrant Roadway N-E	0.34	2	Fair	Fair	Fair
4	Quadrant Roadway S-E	0.34	2	Fair	Fair	Fair
5	Quadrant Roadway N-W	0.34	2	Fair	Fair	Fair
6	Median U-Turn N-S	0.34	2	Good	Good	Fair
7	Partial Displaced Left Turn N-S	0.35	7	Fair	Fair	Good
8	Partial Median U-Turn N-S	0.38	8	Good	Good	Fair
9	Conventional	0.43	9	Fair	Fair	Good
10	2 X 2	0.51	10	Good	Good	Good

CAP-X SUMMARY

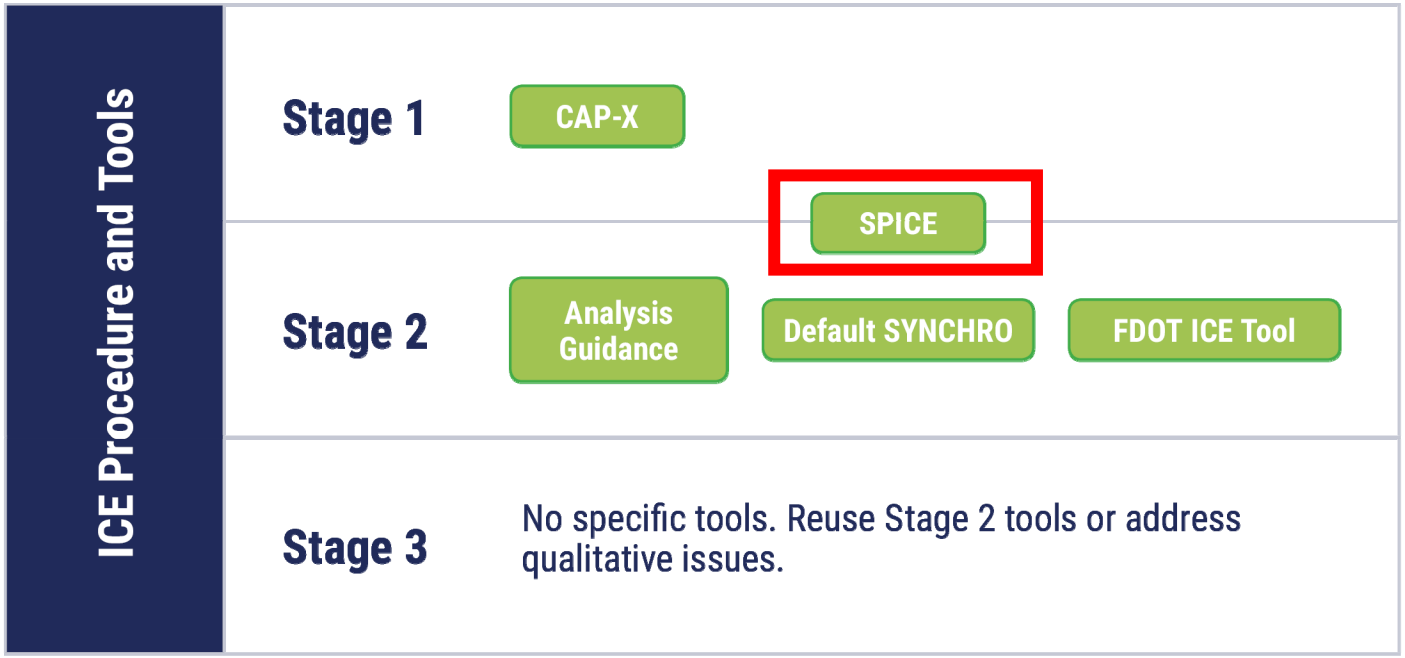
- What does the CAP-X Analysis tell you?
  - Provides a method to identify viable traffic control strategies for the intersection
- How can this data be used for alternative intersection control evaluation analysis?
  - Results provide a ranking for the viable strategies – provides an efficient approach for the initial screening
- How is this reported in the Stage 1 ICE Form?
  - CAP-X Ranking is one of the inputs for the Stage 1 - FDOT ICE Form

CAP-X AND FDOT ICE FORMS – STAGE 1

Screening Evaluation					
Provide a brief justification as to why each of the following control strategies should be advanced or not. Justification should consider potential					
Control Strategy		**CAP-X Ranking** *Select time periods analyzed in CAP-X:*		**SPICE Ranking**	**Strategy to be Advanced?**
Two-way Stop-Controlled					
All-way Stop-Controlled					
Signalized Control					
Roundabout					
Median U-Turn					
Restricted Crossing U-Turn (RCUT) Signalized					
Restricted Crossing U-Turn (RCUT) Unsignalized					
Jughandle					
Displaced Left-Turn					
Continuous Green Tee					
Quadrant Roadway					
Other					


TOOLS
SPICE
FDOT

ICE PROCEDURE



SPICE is used in both: Stage 1 and Stage 2 analyses

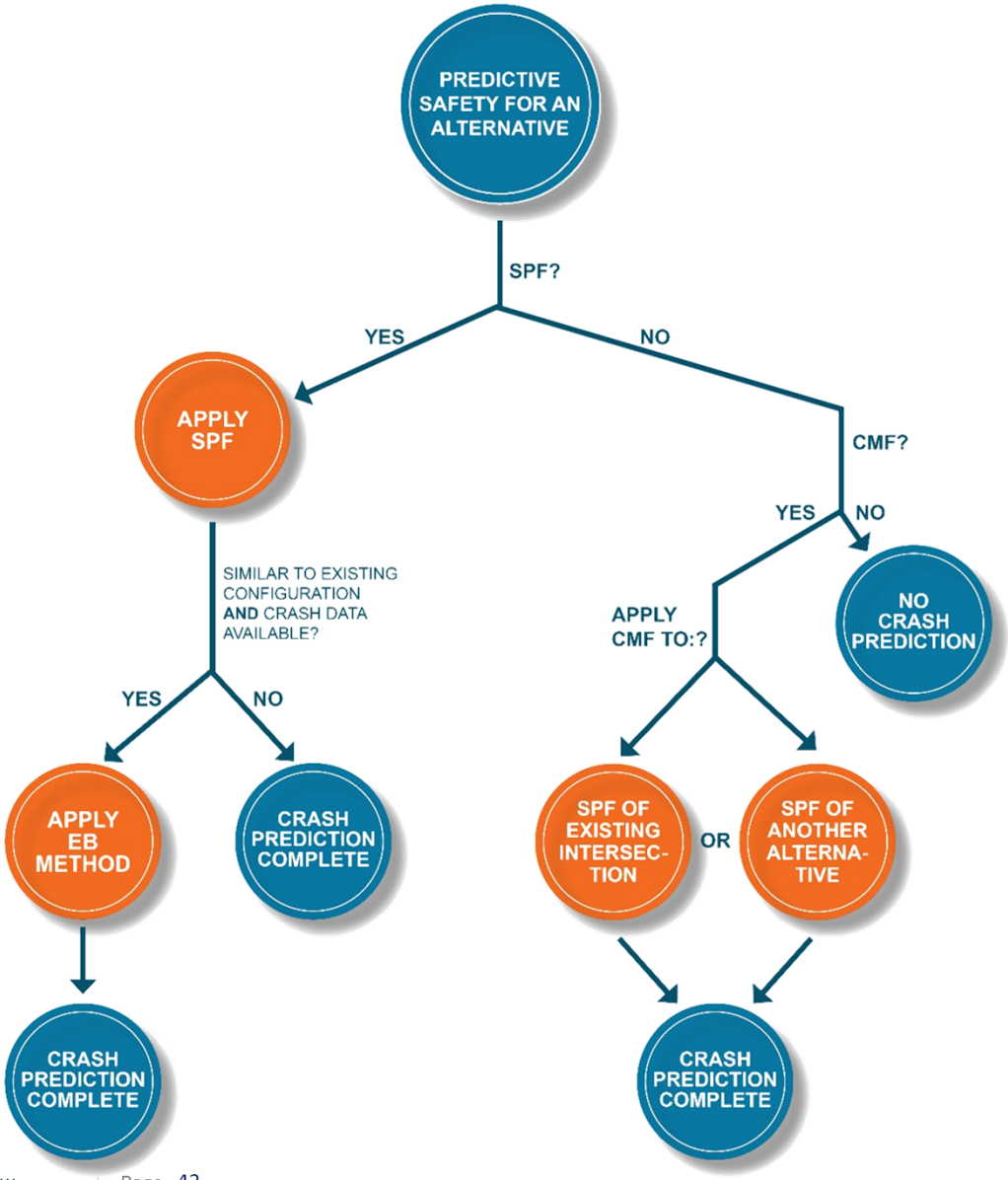
VISION AND NEED FOR THE SPICE TOOL

- Safety Performance Intersection Control Evaluations (SPICE)
- Safety comparisons of intersections becoming more common – ICE, increased use of HSM in general, etc.
- FHWA recognizes everyone is struggling with them
  - Which Crash Modification Factor (CMF) is *right*?
  - What should the CMF be applied to (existing, another alt, etc.)?
  - New Safety Performance Functions (SPFs) being produced through NCHRP (such as 6 and 8 lane arterials/roundabouts)
- Simple tool needed for safety comparisons only
  - Same level of effort as CAP-X

SPICE TOOL OVERVIEW

- Performs predictive safety analysis of at-grade intersection alternatives/control types and ramp terminal intersections
  - Implements the methodologies of the Highway Safety Manual (HSM)
- Developed with goal to be user-friendly
  - Only requires data inputs readily available to the analyst
  - Option to conduct planning level analysis
- Allows simultaneous evaluation of multiple alternatives and control types
- Tool will work for vast majority of intersections
- Development of FHWA SPICE tool ongoing
- Preliminary FDOT version now available

SPICE TOOL OVERVIEW



SPICE – INTRODUCTION

Federal Highway Administration (FHWA)

Safety Performance for Intersection Control Evaluation Tool

Introduction	Overview
The Safety Performance for Intersection Control Evaluation (SPICE) Tool was developed to provide an easy-to-use tool that automates the predictive safety analysis of intersections. This tool will allow analysts conducting Intersection Control Evaluations (ICE) to be equipped with necessary safety information during the decision-making process, without having to research a myriad of crash modification factors (CMFs) and Safety Performance Functions (SPFs) in multiple sources. The SPICE tool will perform a comparative predictive safety analysis of different intersection control strategies. The results – crash frequency and severity for each alternative – will then enable safety performance of alternatives to be considered quantitatively like traffic operations, construction cost, maintenance cost, or other factors.	The SPICE Tool performs safety analysis of at-grade intersection forms/control types and ramp terminal intersections of diamond interchanges. This user-friendly tool requires only data inputs that are readily available to the analyst. In addition, the SPICE tool has an option to conduct planning level analysis, where the tool assumes default values for data inputs that are challenging to obtain in the early stages of a project and/or have a very minor impact on the results. The SPICE tool assumes that certain attributes of the intersection – AADT, facility type, and number of legs – are the same for all alternatives. If they are not, users will be required to use the tool twice to get results. The tool will not allow simultaneous evaluation of at-grade intersections and ramp terminal intersections. For projects where analysis of both intersections and interchanges is needed, users are required use the tool twice to get results.

Worksheets

Project Information: Provide general project information for reference purposes only.
Definitions: Reference sheet with additional information related to inputs for the SPICE tool.
Control Strategy Selection: Choose between At-Grade or Ramp Terminal intersection types to be included in the SPICE analysis.
At-Grade Inputs: SPF and Part C CMF inputs for At-Grade intersections (hidden if Ramp Terminals are being analyzed).
Ramp Terminal Inputs: SPF and Part C CMF inputs for Ramp Terminal intersections (hidden if At-Grade intersections are being analyzed).
Calibration: Input optional override values for SPF calibration factors from locally-developed or updated information.
Results: Summary of opening year and (if applicable) design year and total project life cycle crash frequency and crash severity.
Additional Worksheets: Additional worksheets to support the underlying Macros. Not to be updated by users unless updating future tool versions.

Maintenance	Input Legend	
Version: SPICE Tool 1.0		Required data entry field
Maintained By: TBD		Optional data entry field
Contact Information: TBD		Planning-Level Default Input
Disclaimer		Data entry field not used

Disclaimers may be added, if needed.

SPICE – BASIC INPUTS AND CONTROL STRATEGY SELECTION

Control Strategy Selection and Inputs

Specify the Facility Level Inputs and the Control Strategies to be included in the SPICE Analysis.

Intersection Type	At-Grade Intersections
Analysis Year	Opening and Design Year
Opening Year	2020
Design Year	2040
Facility Type	On Urban and Suburban Arterial
Number of Legs	4-leg
1-Way/2-Way	2-way Intersecting 2-way
# of Major Street Lanes (both directions)	5 or fewer
Major Street Approach Speed	Less than 55 mph
Opening Year - Major Road AADT	8,400
Opening Year - Minor Road AADT	1,400
Design Year - Major Road AADT	10,200
Design Year - Minor Road AADT	1,300

For more information on how to determine these values, see the "Definitions" worksheet

Control Strategy	Include	Base Intersection		
Traffic Signal	Yes	--		
Traffic Signal (Alternative Configuration)	Yes	--		
Minor Road Stop	Yes	--		
All Way Stop	No	--		
1-Lane Roundabout	No	--	Opening Year AADT Outside of SPF Development Range	Design Year AADT Outside of SPF Development Range
2-Lane Roundabout	Yes	--		
Displaced Left Turn (DLT)	Yes	Traffic Signal		
Median U-Turn (MUT)	Yes	Traffic Signal		
Signalized Restricted Crossing U-Turn (RCUT)	Yes	Traffic Signal		
Unsignalized Restricted Crossing U-Turn (RCUT)	Yes	Minor Road Stop		
Continuous Green-T Intersection	No	Traffic Signal		
Jughandle	Yes	Traffic Signal		
Other 1	No	Traffic Signal	*Please Select	
Other 2	No	Minor Road Stop	*Please Select	

SPICE – AT-GRADE INTERSECTION INPUTS

Required

Input		Control Strategy		
		Traffic Signal	Minor Road Stop	2-lane Roundabout
Opening Year Major Road AADT	Optional AADT Overrides	8400	8400	8400
Opening Year Minor Road AADT		1400	1400	1400
Design Year Major Road AADT		10200	10200	10200
Design Year Minor Road AADT		1300	1300	1300
Number of Approaches with Left-Turn Lanes	Additional Required Control Strategy Inputs	2		
Number of Approaches with Right-Turn Lanes		1		
Number of Uncontrolled Approaches with Left-Turn Lanes			2	
Number of Uncontrolled Approaches with Right-Turn Lanes			1	

Optional for Stage 1, Required for Stage 2

Keep default values below here for planning-level analysis, override with actual values for full HSM Analysis

Reset Planning Inputs to Defaults	Part C CMFS Optional For Stage 1 ICE, Required for Stage 2 ICE			
Skew Angle	A yellow cell indicates the value may be used in the SPF computation	N/A	0	N/A
Lighting Present		Yes	Yes	
# of Approaches Permissive LT Signal Phasing		0		
# of Approaches Perm/Prot LT Signal Phasing		0		
# of Approaches Protected LT Signal Phasing		0		
Number of Approaches with Right-Turn-on-Red Prohibited		0		
Red Light Cameras Present		No		
Number of Major Street Through Lanes		0		
Number of Minor Street Lanes		0		
# of Major St Approaches w/ Right-Turn Channelization		0		
Number of Approaches with U-Turn Prohibited		0		
Pedestrian Volume by Activity Level		Low (50)		
User Specified Sum of all daily pedestrian crossing volumes		50		
Max # of Lanes Crossed by Pedestrians		6		
Number of Bus Stops within 1000' of Intersection		2		
Schools within 1000' of intersection		Yes		
Number of Alcohol Sales Establishments within 1000' of Intersection		0		

- AADT Volumes for major/minor roads for the opening and design years
- Number of major approaches with left-turn or right-turn lanes
- Pre-filled planning-level defaults
  - Can be overridden by analyst

SPICE – ROUNDABOUT CMF INPUTS

Input		Control Strategy		
		Traffic Signal	Minor Road Stop	2-lane Roundabout
	Roundabout CMF Inputs			
Inscribed Circle Diameter (ft)				
Leg 1 (Major Leg #1)	Leg 1 (Major Leg #1)			
Opening Year Entering AADT				4,200
Leg has Right-Turn Bypass				No
# of Access Points within 250' of Yield Line				
Entering Width (ft)				29
# of Entering Lanes				2
# of Circulating Lanes				2
Leg 2 (Major Leg #2)	Leg 2 (Major Leg #2)			
Opening Year Entering AADT				4,200
Leg has Right-Turn Bypass				No
# of Access Points within 250' of Yield Line				
Entering Width (ft)				29
# of Entering Lanes				2
# of Circulating Lanes				2
Leg 3 (Minor Leg #1)	Leg 3 (Minor Leg #1)			
Opening Year Entering AADT				700
Leg has Right-Turn Bypass				No
# of Access Points within 250' of Yield Line				
Entering Width (ft)				29
# of Entering Lanes				1
# of Circulating Lanes				2
Leg 4 (Minor Leg #2)	Leg 4 (Minor Leg #2)			
Opening Year Entering AADT				700
Leg has Right-Turn Bypass				No
# of Access Points within 250' of Yield Line				
Entering Width (ft)				29
# of Entering Lanes				1
# of Circulating Lanes				2

SPICE – CMF SPECIFICATION AND OPTIONAL LOCAL CALIBRATION

- Crash Modification Factors (CMFs) used when Safety Performance Functions (SPFs) are unavailable

Local CMFs				
Optional - Override default CMFs with locallly-developed or new CMFs				
Control	**Type of Crashes**	**Default CMF**	**Optional User Override**	**Use Value**
Displaced Left Turn (DLT)	Total	0.88		0.88
	Fatal-Injury	0.88		0.88
Median U-Turn (MUT)	Total	0.85		0.85
	Fatal-Injury	0.70		0.70
Signalized Restricted Crossing U-Turn (RCUT), also known Superstreet	Total	0.85		0.85
	Fatal-Injury	0.78		0.78
Unsignalized Restricted Crossing U-Turn (RCUT), also known as J-Turn	Total	0.65		0.65
	Fatal-Injury	0.46		0.46
Continuous Green-T Intersection	Total	0.96		0.96
	Fatal-Injury	0.85		0.85
Jughandles	Total	0.74		0.74
	Fatal-Injury	0.74		0.74
Crossover Traffic Signal (of Diverging Diamond Interchange)	Total	0.67		0.67
	Fatal-Injury	0.59		0.59

- CMFs can be overridden with local values

- FDOT intersection calibration factors are included but can be overridden.

SPICE – HISTORICAL CRASH DATA

- Empirical Bayes (EB) Analysis – Minimum 5 years crash data recommended
- Existing intersection must be signalized or minor road stop
- Only applies EB to intersections with CMFs – DLT, MUT, RCUT not Roundabout

Historical Crash Data Input

Note: In order to use Empirical Bayes (EB), the historical intersection type must be a traffic signal or a minor road stop. Additionally, this alternative must be selected to be included in the analysis, and the historical intersection specified below. Up to 10 years of historical data can be used to perform the EB adjustment.

Is historical crash data available?	Yes			
Number of years available:	5	(Up to 10)	First Year Data is available:	2011
Historical Intx Type:	4SG			

Historical Crash Counts		Year										
		2011	2012	2013	2014	2015	--	--	--	--	--	Total
Combined	Total											18
	Fatal/Injury											9
	PDO											9
Single-Vehicle	Total	4	4	3	5	3	--	--	--	--	--	19
	Fatal/Injury	1	2	0	1	0						4
	PDO	3	2	3	4	3						15
Multiple-Vehicle	Total	2	4	3	2	1	--	--	--	--	--	12
	Fatal/Injury	1	2	0	0	0						3
	PDO	1	2	3	2	1						9
Veh-Ped	Fatal/Injury	1	2	1	0	1						5
Veh-Bike	Fatal/Injury	0	2	1	1	1						5
Total	All	7	12	8	8	6	--	--	--	--	--	41

SPICE – CRASH PREDICTION OUTPUTS

- Computes predicted crashes for all selected control strategy types
- Predicted crashes are broken into “Total” and “Fatal & Injury” groups
- Ranking is based on “Fatal & Injury” crashes.

Crash Prediction Summary							
Control Strategy	**Crash Type**	**Opening Year**	**Design Year**	**Total Project Life Cycle**	**Rank**	**AADT Within Prediction Range?**	**Source of Prediction**
Traffic Signal	Total	5.41	4.45	103.73	6	Yes	Calibrated SPF w/ EB
	Fatal & Injury	2.44	1.96	46.25			
Traffic Signal (Alt)	Total	7.55	6.20	322.31	8	Yes	Calibrated SPF w/ EB
	Fatal & Injury	3.39	2.70	114.44			
Minor Road Stop	Total	3.96	3.41	77.57	2	Yes	Calibrated SPF
	Fatal & Injury	1.72	1.46	33.42			
2-lane Roundabout	Total	16.29	12.89	306.26	7	N/A	Uncalibrated SPF
	Fatal & Injury	3.04	2.35	56.59			
Displaced Left Turn (DLT)	Total	4.76	3.92	91.28	5	N/A	CMF
	Fatal & Injury	2.15	1.72	40.70			
Median U-Turn (MUT)	Total	4.60	3.79	88.17	1	N/A	CMF
	Fatal & Injury	1.71	1.37	32.38			
Signalized RCUT	Total	4.60	3.79	88.17	4	N/A	CMF
	Fatal & Injury	1.91	1.53	36.08			
Unsignalized RCUT	Total	2.58	2.22	50.42	8	N/A	CMF
	Fatal & Injury	0.79	0.67	15.38			
Jughandle	Total	4.00	3.30	76.76	3	N/A	CMF
	Fatal & Injury	1.81	1.45	34.23			

SPICE SUMMARY

- What does the SPICE Analysis tell you?
  - Allows decision makers to conduct a preliminary safety analysis of viable alternatives
  - Automates predictive safety analysis
- How can this data be used for alternative intersection control evaluation analysis?
  - Provides a quantitative safety comparison of viable alternatives
- How is this reported in the Stage 1 ICE Form?
  - SPICE Ranking is one of the inputs for the Stage 1 - FDOT ICE Form
- What is different regarding the Stage 1 and Stage 2 SPICE evaluation?
  - Part C CMF inputs are optional for Stage 1, Required for Stage 2
  - Evaluate control strategies based on anticipated safety performance

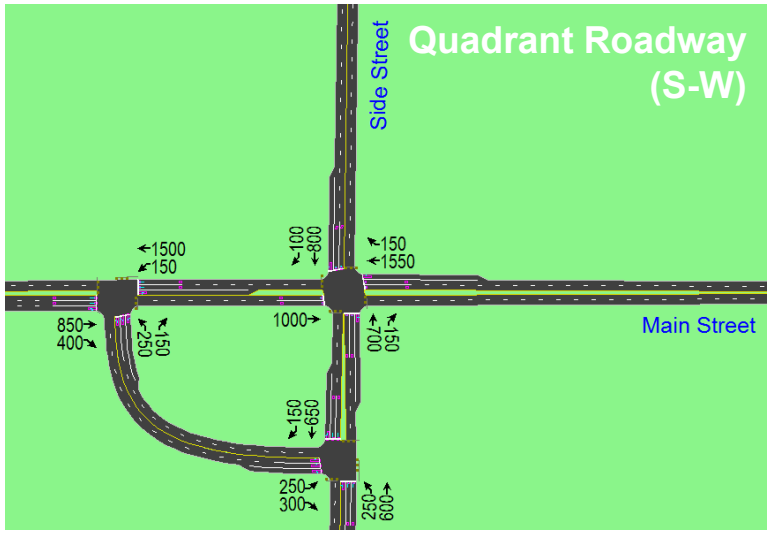
SPICE AND FDOT ICE FORMS – STAGE 1

Screening Evaluation				
Provide a brief justification as to why each of the following control strategies should be advanced or not. Justification should consider potential				
Control Strategy	**CAP-X Ranking** *Select time periods analyzed in CAP-X:*		**SPICE Ranking**	**Strategy to be Advanced?**
Two-way Stop-Controlled				
All-way Stop-Controlled				
Signalized Control				
Roundabout				
Median U-Turn				
Restricted Crossing U-Turn (RCUT) Signalized				
Restricted Crossing U-Turn (RCUT) Unsignalized				
Jughandle				
Displaced Left-Turn				
Continuous Green Tee				
Quadrant Roadway				
Other				


TOOLS
SYNCHRO
FDOT

SYNCHRO DEFAULT VALUES

- Library of SYNCHRO default files
  - Include proper default signal phasing and saturation flow
- Review of documents for Florida SYNCHRO practice:
  - FDOT Traffic Analysis Handbook (March 2014)
  - FDOT 2013 Quality/Level of Service Handbook



LANE SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Lanes and Sharing (#RL)									
Traffic Volume (vph)	0	1000	0	0	1550	150	0	700	150
Future Volume (vph)	0	1000	0	0	1550	150	0	700	150
Street Name				Main Street					
Link Distance (ft)	–	508	–	–	1562	–	–	385	–
Link Speed (mph)	–	40	–	–	40	–	–	30	–
Set Arterial Name and Speed	–	EB	–	–	WB	–	–	NB	–
Travel Time (s)	–	8.7	–	–	26.6	–	–	8.8	–
Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900

ADJUSTED SYNCHRO DEFAULT VALUES

Model Parameter	Default Synchro Value	FDOT Recommended Value	Value Used in Synchro
Peak Hour Factor (PHF)	0.92	Conceptual planning and preliminary engineering levels of analyses may use a PHF of 1.0	1.0 per Quality/Level of Service Handbook – also consistent with the CAP-X assumptions
Base Saturation Flow Rate (passenger cars per hour per lane, pcphpl)	1,900 pcphpl	1,950 pcphpl on arterials and other interrupted flow facilities	1,950 pcphpl per Quality/Level of Service Handbook
Lane Utilization Factor	Varies depending on the number of lanes and lane type	Default lane utilization factors should be overridden with field measurements when more vehicles use one lane group than the other As demand approaches capacity, lane utilization factors that are closer to 1.0 may be used	Default factors were used in the model
Heavy Vehicle Proportion	2%	Heavy vehicle percentages should be calculated based on the existing turning movement counts data. In absence of counts data, guidelines provided in the HCM-based Tools should be used	Default 2% was used

SYNCHRO INNOVATIVE INTERSECTION TEMPLATES: VISION AND NEED

- Stage 2 tool for more detailed operational analysis of alternative intersections

- Need for Synchro templates
  - Modeling alternative intersections in Synchro can be challenging
  - Developing Synchro files on a case-by-case basis is time consuming and prone to error
  - Need for a consistent modeling approach for fair comparisons

- Designed to be quick and easy to use tool
  - Default Synchro files requiring limited data inputs
  - Parameters consistent with HCM 6th Edition and FDOT recommendations

- Flexible enough to accommodate all intersection alternatives and various geometries

ALTERNATIVE INTERSECTION ANALYSIS IN HCS

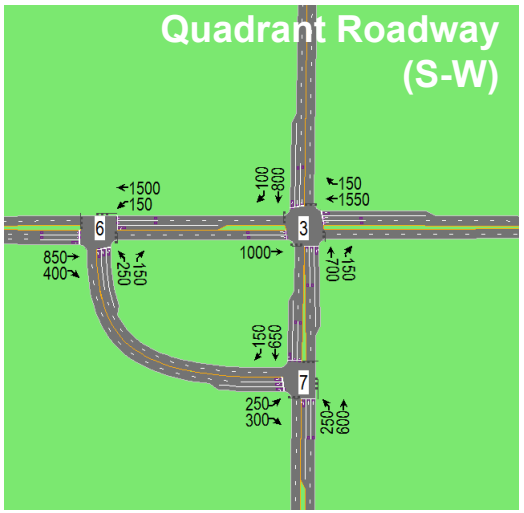
- The latest release of HCS (Release 7.2.1) includes only MUT, RCUT, and DLT, not all the alternative intersections

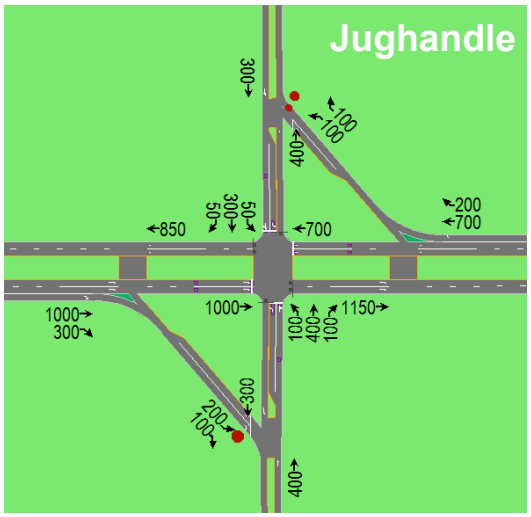
- Modeling everything in one platform (e.g., Synchro) provides consistency across results
  - The ICE tool has worksheets for computing MUT and Signalized RCUT delay from SYNCHRO outputs in manner consistent with HCM 6th Edition

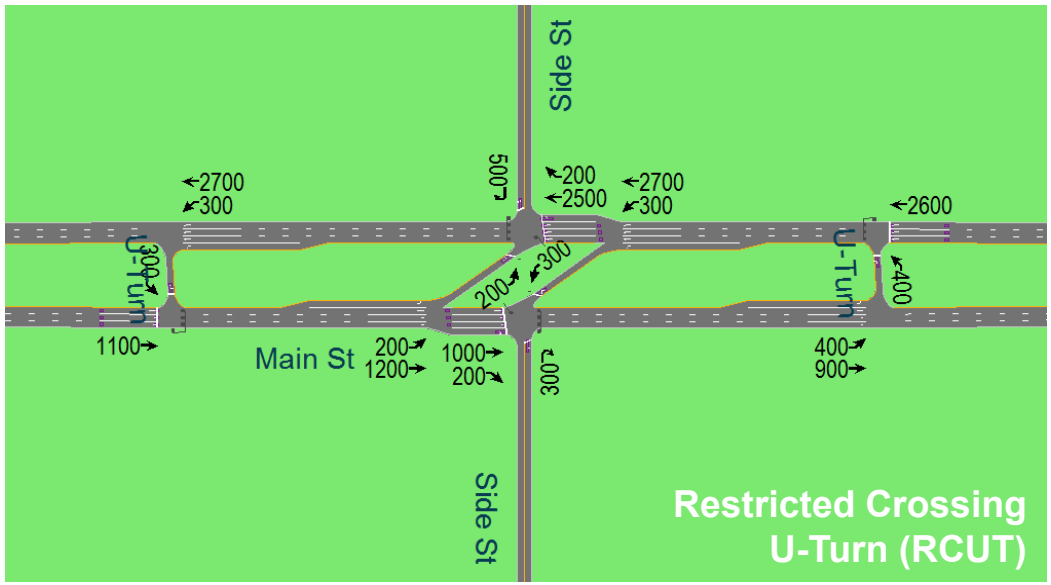
- Modeling alternative intersections in HCS is complicated and creates challenges

SYNCHRO TEMPLATES OVERVIEW

- Median U-Turn (MUT)
- Signalized Restricted Crossing U-Turn (RCUT)
- Unsignalized RCUT
- Jug-handle
- Displaced Left Turn (DLT)
- Continuous Green T
- Quadrant Roadway
- Diverging Diamond Interchange (DDI)



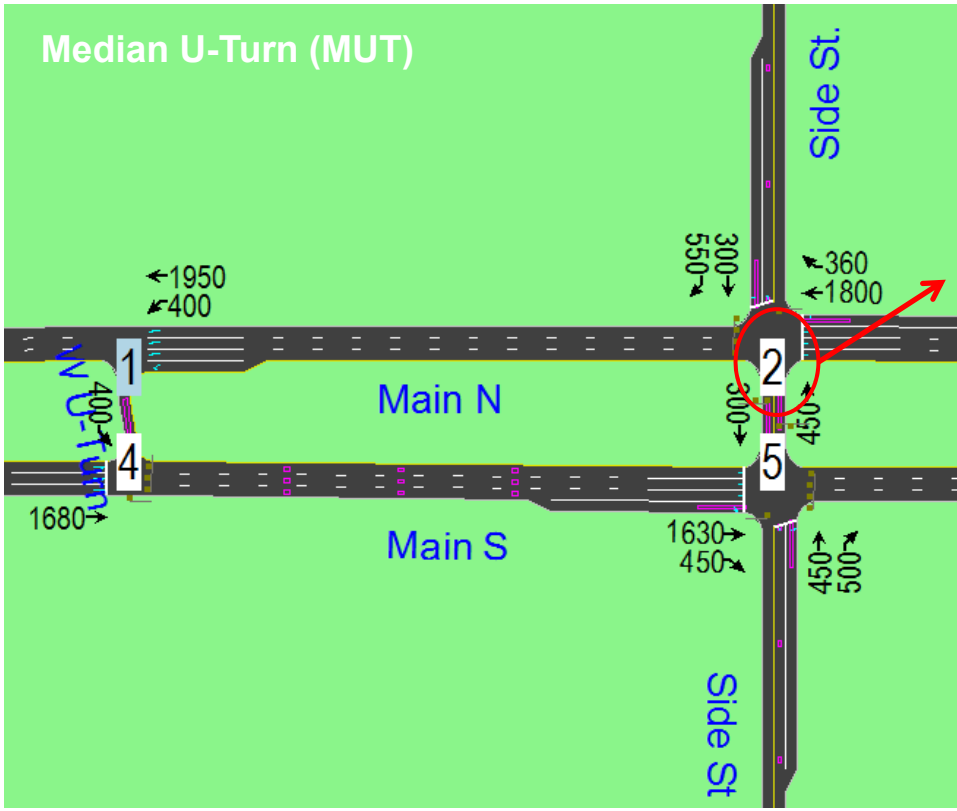




SYNCHRO TEMPLATES: BASIC REQUIRED INPUTS

(LANE CONFIGURATIONS)

- Lane configurations
  - Number of lanes, storage length, link speed, channelized right turn, etc.

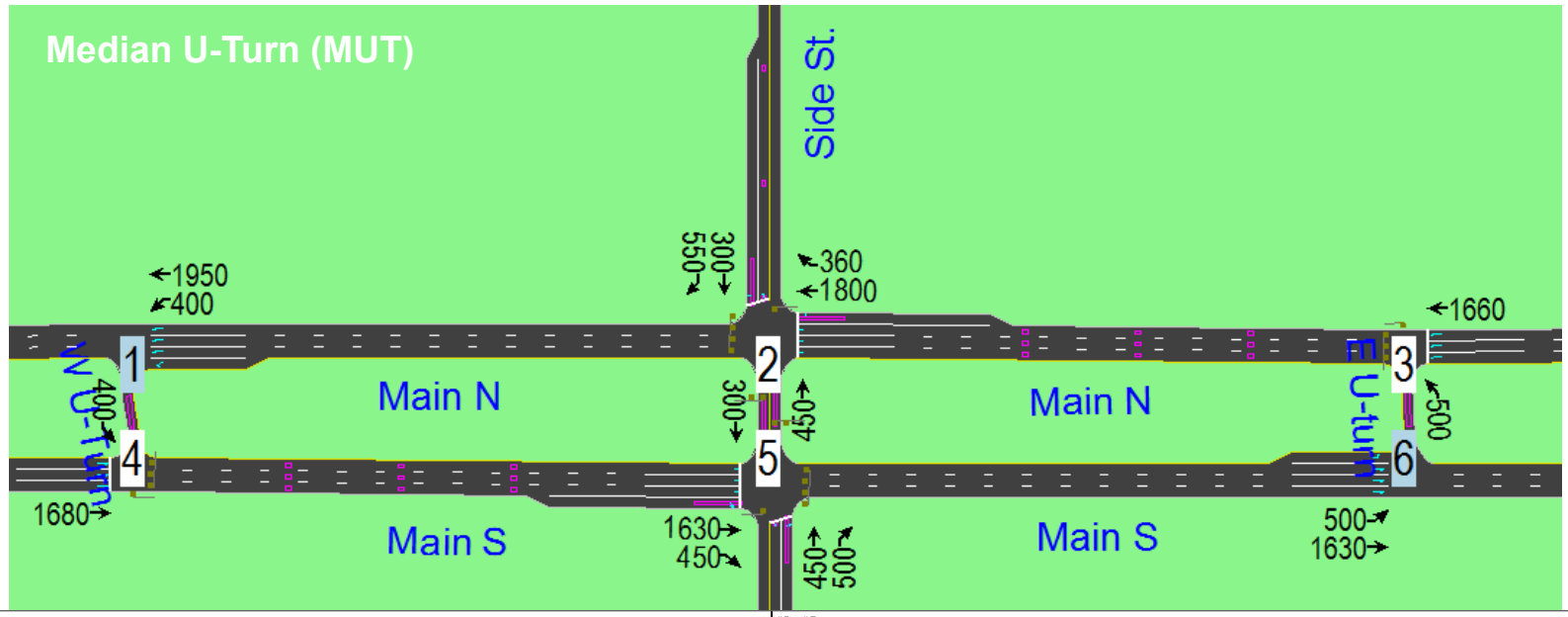


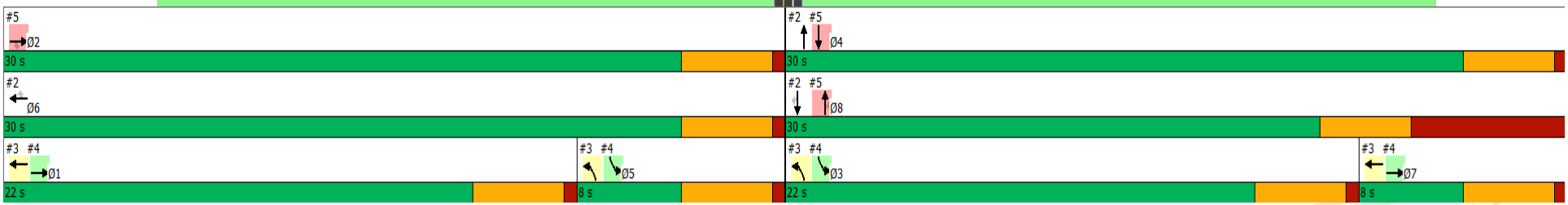
LANE SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)												
Traffic Volume (vph)	0	0	0	0	1800	360	0	450	0	0	300	550
Future Volume (vph)	0	0	0	0	1800	360	0	450	0	0	300	550
Street Name	Main N			Main N						Side St.		
Link Distance (ft)		660			660			100			500	
Link Speed (mph)		55			55			40			40	
Set Arterial Name and Spe		EB			WB			NB			SB	
Travel Time (s)		8.2			8.2			1.7			8.5	
Ideal Satd. Flow (vphpl)	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0			0			0			0	
Area Type CBD												
Storage Length (ft)	0		0	0		200	0		0	0		250
Storage Lanes (#)						1						1
Right Turn Channelized			None			None			None			None

SYNCHRO TEMPLATES: BASIC REQUIRED INPUTS

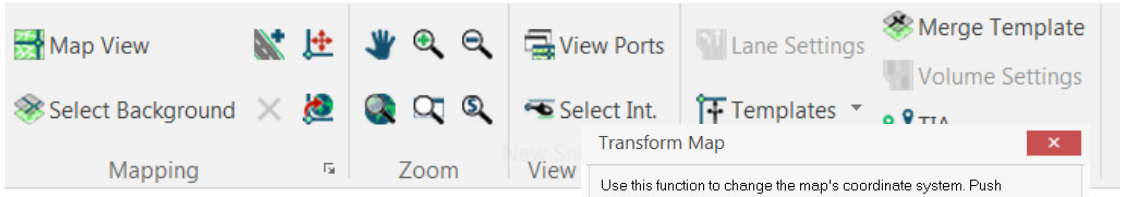
(SIGNAL TIMING)

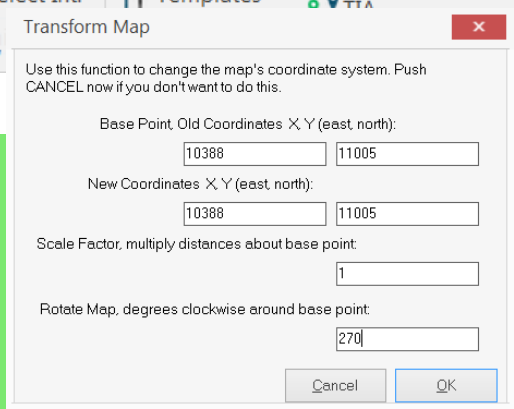
- Signal Timing (modeled as clustered or stand-alone intersections)
  - Splits, yellow and all-red times, pedestrian intervals, right-turn-on-red, minimum and maximum green intervals, etc.

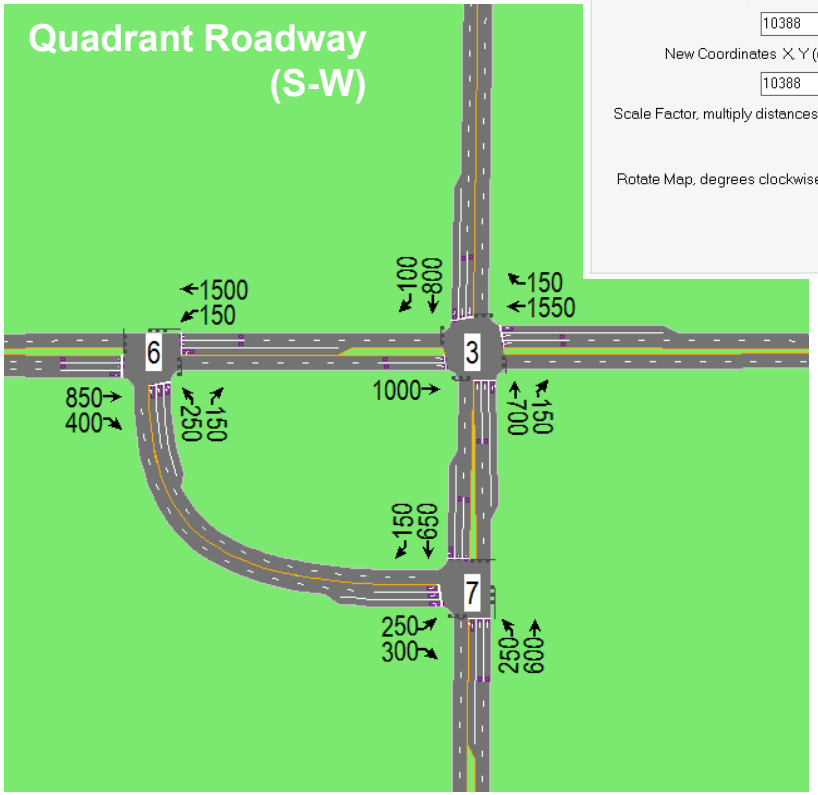


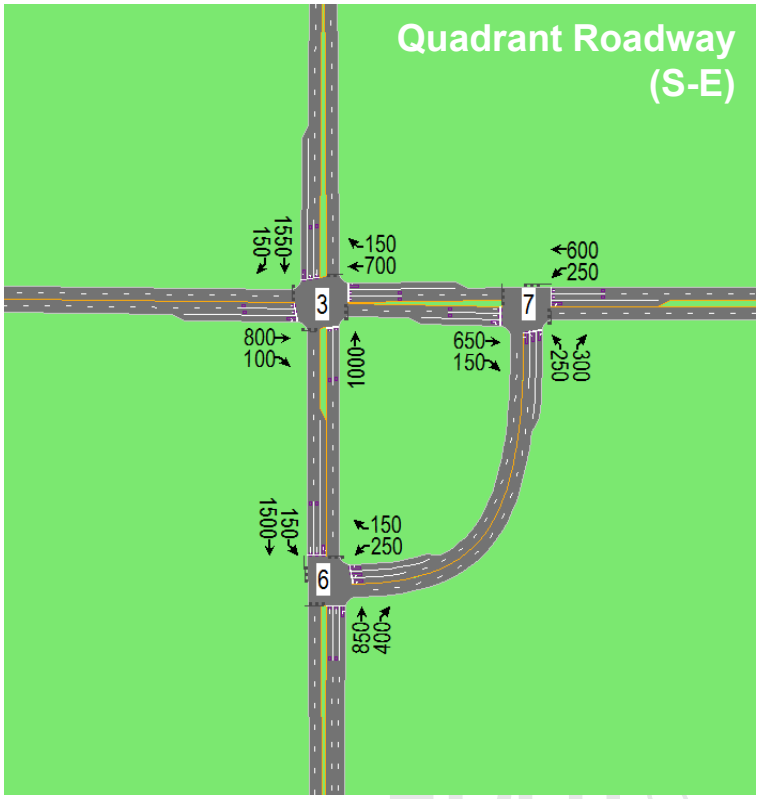


DEALING WITH INTERSECTION ORIENTATION







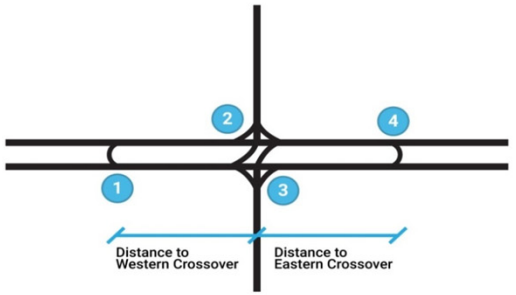


SYNCHRO INNOVATIVE INTERSECTION TEMPLATES: RESULTS

- Custom delay input sheets from Synchro to ICE tool
  - Converts movement delays (e.g., from Synchro) to intersection delays
  - Optional specification of weekend peak delays

RCUT E-W

Use this sheet to enter the delay information for a Signalized RCUT with the major street running East-West. (Requires turning movement count demand inputs)



User must enter value on this sheet

	Eastern Crossover	Western Crossover
Distance from main intersection to:	600	600
Free-flow speed on major street	45	

*Volumes are computed based on values entered in DemandCounts and Exhibit 6-2 of FHWA RCUT Guide

Opening Year AM Peak				
Intersection 1	EB Thru	WB U-Turn		
Volume	450	300		
Delay	3.4	21.9		
Intersection 2	WB Left	WB Thru	WB Right	SB Right
Volume	150	300	300	450
Delay	18.2	4.8	2.7	21.5
Intersection 3	EB Left	EB Thru	EB Right	NB Right
Volume	150	300	300	450
Delay	19.1	4.4	4.3	21.3
Intersection 4	WB Thru	EB U-Turn		
Volume	450	300		
Delay	4.2	22.9		

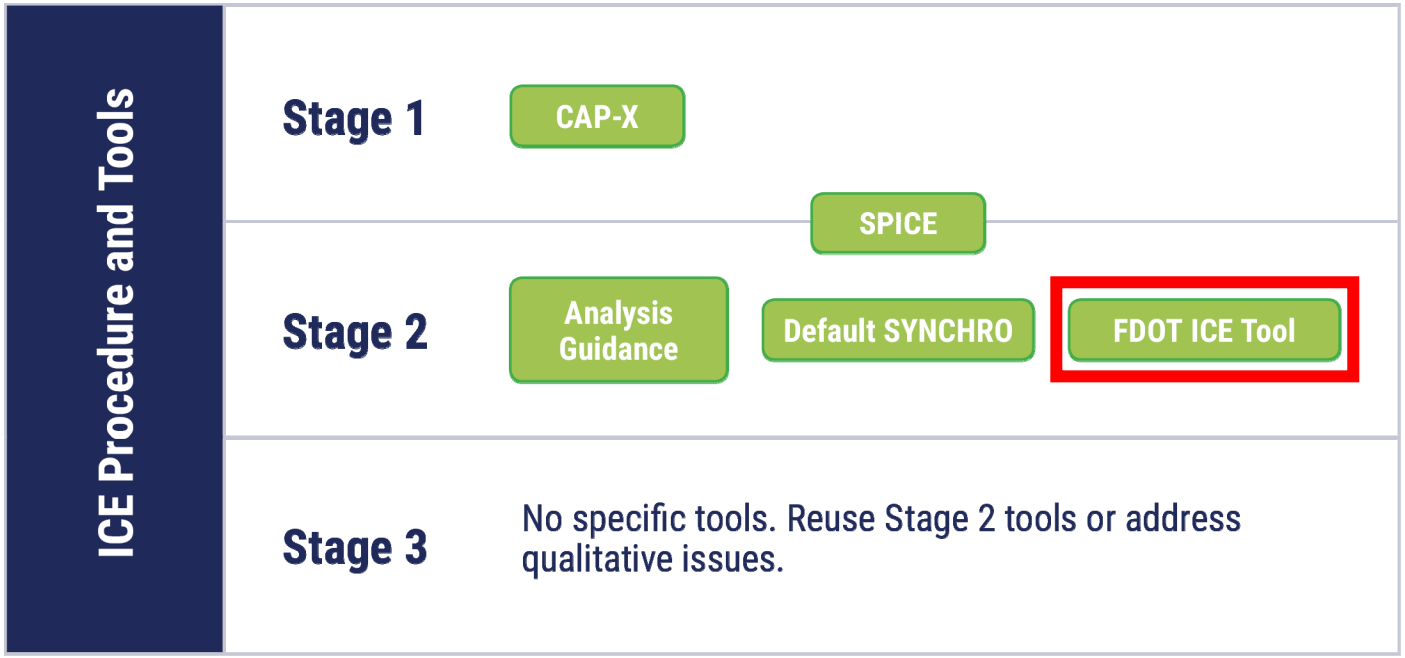
Opening Year PM Peak				
Intersection 1	EB Thru	WB U-Turn		
Volume	450	300		
Delay	3.4	21.9		
Intersection 2	WB Left	WB Thru	WB Right	SB Right
Volume	150	300	300	450
Delay	18.2	4.8	2.7	21.5
Intersection 3	EB Left	EB Thru	EB Right	NB Right
Volume	150	300	300	450
Delay	19.1	4.4	4.3	21.3
Intersection 4	WB Thru	EB U-Turn		
Volume	450	300		
Delay	4.2	22.9		

Opening Year Weekend Peak				
Intersection 1	EB Thru	WB U-Turn		
Volume	0	0		
Delay	3.4	21.9		
Intersection 2	WB Left	WB Thru	WB Right	SB Right
Volume	0	0	0	0
Delay	18.2	4.8	2.7	21.5
Intersection 3	EB Left	EB Thru	EB Right	NB Right
Volume	0	0	0	0
Delay	19.1	4.4	4.3	21.3
Intersection 4	WB Thru	EB U-Turn		
Volume	0	0		
Delay	4.2	22.9		

TOOLS

FDOT ICE TOOL

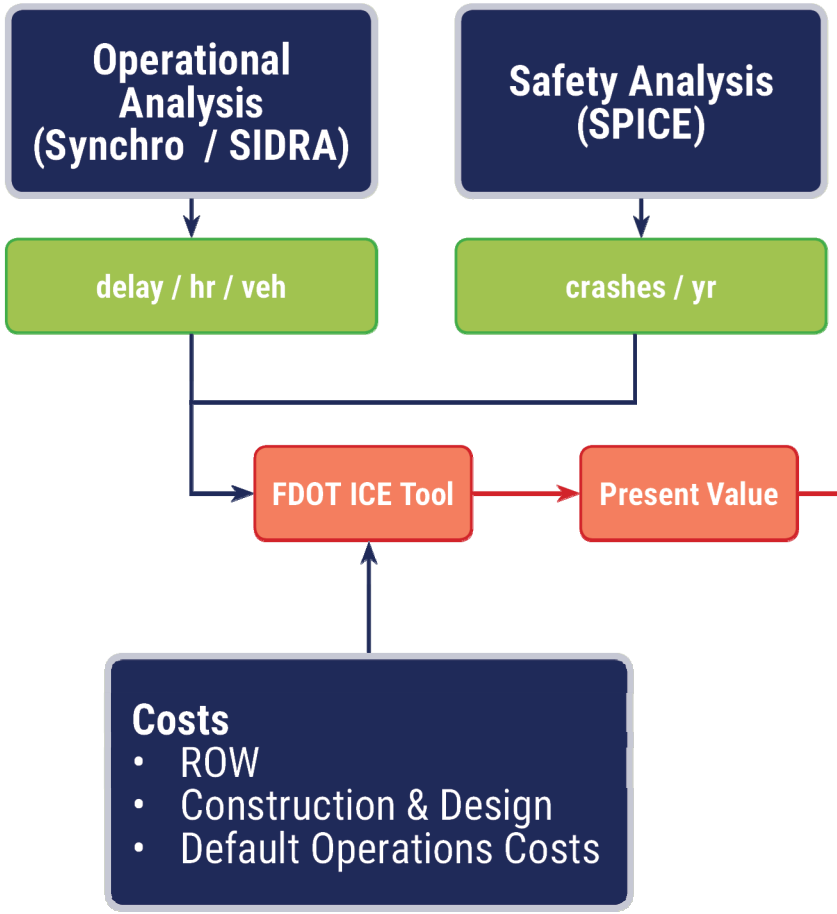
ICE PROCEDURE



VISION AND NEED FOR THE FDOT ICE TOOL

- Stage 2 tool for financial analysis of intersection alternatives
- Needed inputs for life-cycle cost analysis
  - Safety - SPICE
  - Vehicular delay – SYNCHRO, VISSIM, HCS, SIDRA, etc.
  - Design, construction, right-of-way, and operating costs
- Conducts benefit-cost / net present value analysis
- Designed to be quick and easy to use – hour(s) not day(s)
  - Limit data inputs to readily available or computable values
  - Utilize information of previous stages of ICE analysis (e.g., SPICE tool)
- Flexible enough to accommodate all intersection alternatives

FDOT ICE TOOL OVERVIEW



BENEFIT CALCULATIONS
Opening and Design Years
Multiple Control Strategies

COST CALCULATIONS
Life Cycle of 20 and 100 Years

FDOT ICE TOOL OVERVIEW

- Based on the NCHRP 3-110 Life Cycle Cost Estimation Tool (LCCET)
  - Macro-powered Excel spreadsheet
- Includes Florida hourly, daily, and monthly volume profiles for operational life-cycle cost analysis
  - Peak hour volumes are scaled to every hour of a project's lifespan
  - Defaults for urban vs rural, different functional classifications
- Major FDOT customizations
  - Simplified and improved input sheets
  - Local default values where applicable for monetized performance measures
  - Florida-specific volume profiles

FDOT ICE TOOL – INTERSECTION SELECTION

	Open Year	Design Year
Operating Cycle	2020	2040
Peak Hour Start	From	To
AM peak	7:00 AM	8:00 AM
PM peak	5:00 PM	6:00 PM
Weekend peak	10:00 AM	11:00 AM

Enter peak period begin and end times:

Demand forecasts for the opening year *must* be provided below, and travel time/delay forecasts must be given in the Delay worksheet.

Select Analysis Basis: Specific Day/Month

Weekday Count: Wednesday, October 29, 2014 Enter dates as "mm/dd/yyyy"

Weekend Count: Enter dates as "mm/dd/yyyy"

Select facility type: 14 - Urban Principal Arterial -- Other

At intersections of war[illegible]

Specify total volumes or turning counts? Turning Counts (Select from drop-down menu)

Enter the turning movement counts in the DemandCounts worksheet for the peak hours. If data is not available for the weekend peak hour please leave blank.

	Units	Year	
		Opening	Design
		2020	2040
		Intersection 1	
AM peak hour volume	veh/hr	2,786	2,574
PM peak hour volume	veh/hr	3,156	2,887
Weekend peak hour volume:	veh/hr		
Average annual auto occupancy	Passengers per vehicle	1.0	1.0
Average annual % trucks	Average %	0.05%	0.05%

0.0% 0.0%

At-Grade Control Strategies

Control #	Include	Short Name	Description
1	Yes	MinorStop	Minor Road Stop
2	No	AllStop	All Way Stop
3	Yes	TrafficSignal	Traffic Signal
4	No	TrafficSignalAlt	Traffic Signal (Alt.)
5	Yes	Roundabout	Roundabout
6	No	DLT	Displaced Left Turn (DLT)
7	No	MUT	Median U-Turn (MUT)
8	No	SignalRCUT	Signalized Restricted Crossing U-Turn (RCUT)
9	No	UnsignalRCUT	Unsignalized Restricted Crossing U-Turn (RCUT)
10	No	GreenT	Continuous Green-T Intersection
11	No	Jughandle	Jughandle
12	No	Quadrant Itx	Quadrant Roadway Intersection
13	No	Other1	Other 1
14	No	Other2	Other 2

Setup Worksheets

Press the "Setup Worksheets" button to create hidden worksheets that compute performance measures for each selected control strategy.

FDOT ICE TOOL - COSTS

- Analyst must provide design, construction, and ROW costs

- Default operating and maintenance costs
  - Signal retiming, power, lighting, signal maintenance, landscaping, etc.
  - Dynamic based on intersection type
  - Defaults can be overridden by analyst

At-Grade Intersections	Total Design & Construction	Total Right of Way Costs	Operating & Maintenance	Signal Retiming	Lighting	Signal Maintenance	Roundabout Landscaping
Minor Road Stop	$ -	$ -	Cost Period	$ - 1 (yearly)	$ 1,000 1 (yearly)	$ - 1 (yearly)	$ - 1 (yearly)
Traffic Signal	$ 430,000	$ -	Cost Period	$ 5,000 Every 3 years	$ 1,000 1 (yearly)	$ 4,000 1 (yearly)	$ - 1 (yearly)
Roundabout	$ 1,520,000	$ 300,000	Cost Period	$ - 1 (yearly)	$ 3,000 1 (yearly)	$ - 1 (yearly)	$ 2,000 1 (yearly)

FDOT ICE TOOL - SAFETY

- Requires Total, Fatal and Injury crashes for each intersection
- Input SPICE tool outputs

At-Grade Intersection	Crash Type	Opening Year	Design Year
Minor Road Stop	Total	1.30	1.48
	Fatal & Injury	0.49	0.57
Traffic Signal	Total	2.94	3.52
	Fatal & Injury	1.18	1.43
Roundabout	Total	3.21	3.86
	Fatal & Injury	0.51	0.63

FDOT ICE TOOL - DELAY

- AM and PM peak delay inputs
  - Required for opening and design years
  - Optional specification of weekend peak
  - Optional worksheets for aggregating a single delay value for MUTs and RCUTs from multiple intersection SYNCHRO output sheets

				Opening Year			Design Year		
At-Grade Intersections				Average vehicle delay			Average vehicle delay		
Control Strategy		Delay Type	Units	AM peak	PM peak	Weekend peak	AM peak	PM peak	Weekend peak
Minor Road Stop	Single Input	Single Input	sec/veh	18.0	46.4		22.8	96.0	
Traffic Signal	Single Input	Single Input	sec/veh	12.9	14.3		12.9	14.6	
Roundabout	Single Input	Single Input	sec/veh	4.2	5.0		4.6	5.6	

Analysis Summary

Cost Categories	Net Present Value of Costs		
	Minor Road Stop	Traffic Signal	Roundabout
Planning, Construction & Right of Way Costs	$ -	$ 430,000	$ 1,580,000
Post-Opening Costs	$ 14,590	$ 98,229	$ 72,952
Auto Passenger Delay	$ 14,009,014	$ 5,963,187	$ 1,998,905
Truck Delay	$ 26,844	$ 11,464	$ 3,842
Safety	$ 5,722,079	$ 13,240,643	$ 14,390,959
Greenhouse Gases			
Criteria Pollutants			
Total cost	**$19,772,527**	**$19,743,523**	**$18,046,657**

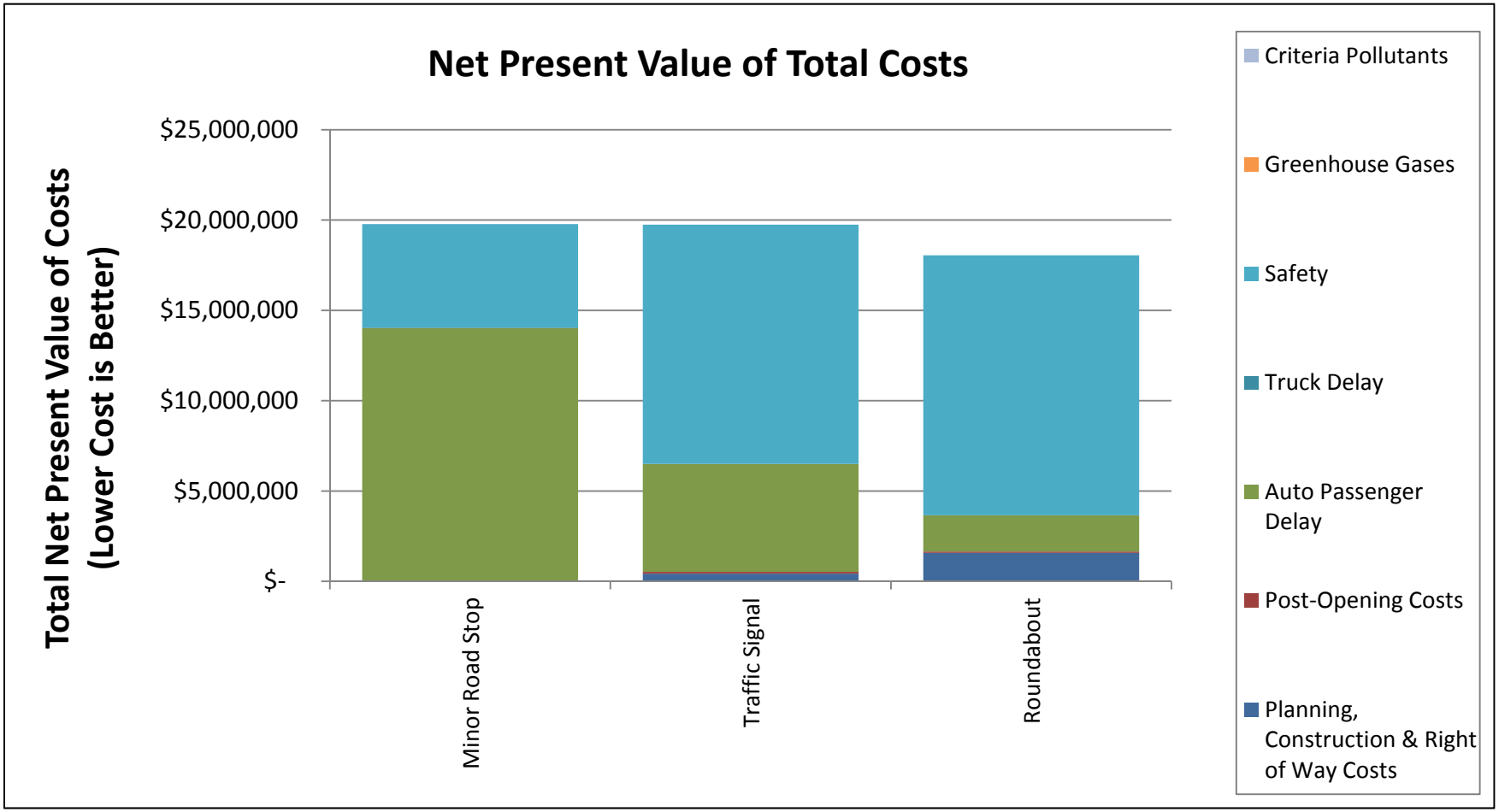
→ Net present value of costs

Select Base Case for Benefit-Cost Comparison:	Minor Road Stop		
Benefit Categories	**Net Present Value of Benefits Relative to Base Case**		
	Minor Road Stop	**Traffic Signal**	**Roundabout**
Auto Passenger Delay		$ 8,045,826	$ 12,010,109
Truck Delay		$ 15,381	$ 23,003
Safety		$ (7,518,564)	$ (8,668,880)
Net Present Value of Benefits		**$ 542,643**	**$ 3,364,232**
Net Present Value of Costs		**$ 513,638**	**$ 1,638,361**
Net Present Value of Improvement		**$ 29,005**	**$ 1,725,870**
Benefit-Cost (B/C) Ratio		**1.06**	**2.05**
Delay B/C		**15.69**	**7.34**
Safety B/C		**-14.64**	**-5.29**

→ Net present value of Benefits

→ Benefit-Cost Ratio (if Base Case exists)

FDOT ICE TOOL - OUTPUTS



FDOT ICE TOOL

- What does the FDOT ICE Tool tell you?
  - Comparatively evaluates the alternative intersections to provide the Benefit/Cost or Net Present Value of each.

- What are the primary information elements needed to perform the FDOT ICE Tool Analysis?
  - Operations analysis – delay
  - Safety analysis – crashes per year
  - Implementation costs – construction, design, ROW

- How is this reported in the Stage 2 ICE Form?
  - Benefit/Cost ratios for Delay, Safety and Overall are reported on Lines 61-69

- What do you need on the Stage 2 ICE Form that the ICE tool does *not* tell you?
  - The control strategy to be recommended as other factors need to be considered.

DISCUSSION & QUESTIONS