

 Hollywood, FL

 June 13-14, 2024

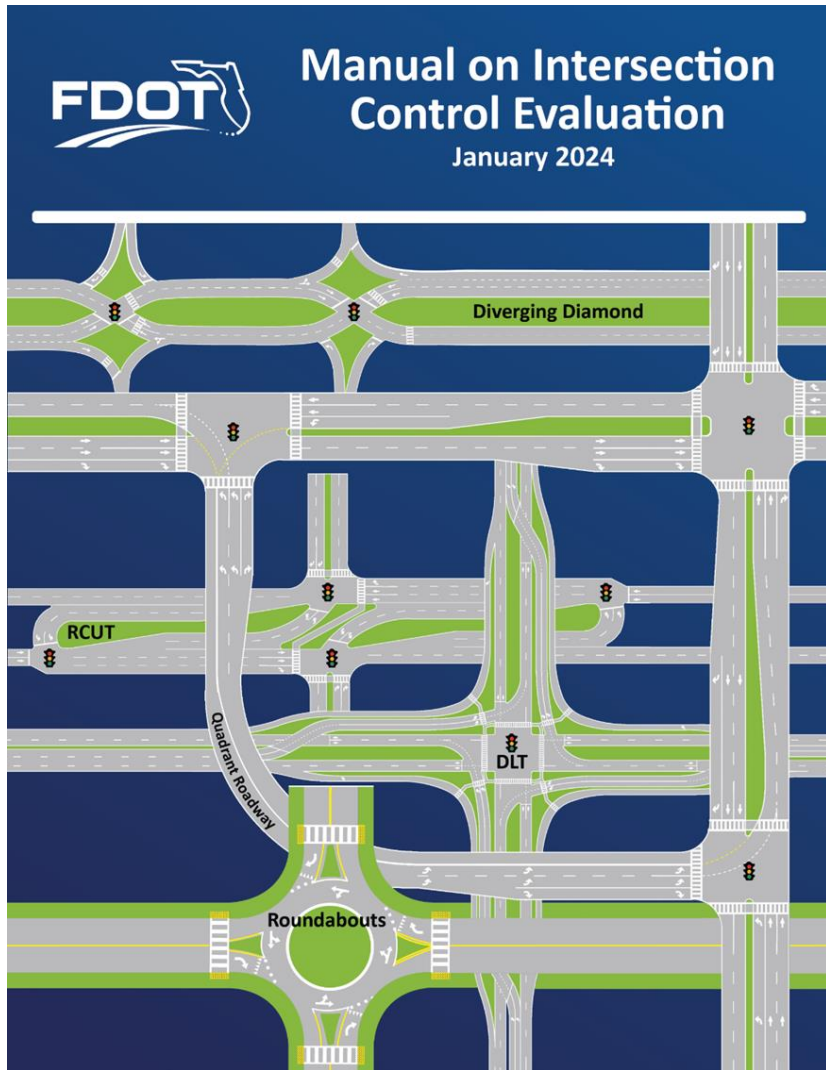
2024 TRANSPORTATION SYMPOSIUM

Intersection Control Evaluation (ICE) Implementation in Florida

Dibakar Saha, PhD, PE, PTOE, RSP21
FDOT Traffic Engineering and Operations Office



What is ICE?



- Intersection Control Evaluation (ICE) entails a performance-based analytical approach to
 - screen intersection alternatives among conventional and innovative intersection designs,
 - identify an optimal context-sensitive solution for all road users
- The first FDOT ICE policy in 2018
- Several updates made to ICE procedure, with latest in January 2024

Applicability of ICE

When is ICE Required?

Signalization of a new or existing intersection

Major reconstruction of an existing signalized intersection

Conversion of a directional/ bi-directional median opening to a full median opening

Driveway/Connection permit applications for category E, F, G

DTOE and DDE consider an ICE a good fit

When is ICE NOT Required?

Midblock pedestrian signal

No substantive changes to the intersection

Minor intersection operational improvements (e.g., adding a right-turn lane)

Non-state roads

Intersection Types in ICE

At-Grade Intersection

- Two-way Stop
- All-way Stop
- Signalized
- Roundabout
- Median U-Turn (MUT)
- Restricted Crossing U-Turn (RCUT)
- Jughandle
- Displaced Left Turn (DLT)
- Thru-Cut
- Bow-Tie
- Continuous Green T (CGT)
- Quadrant Roadway

Ramp Terminal Intersection

- Diamond
- Partial Cloverleaf
- Diverging Diamond
- Single-Point Diamond
- Roundabout
- Tight Diamond

Innovative Intersection Designs

- Reduce the number of conflict points
- Reduce the collision angle

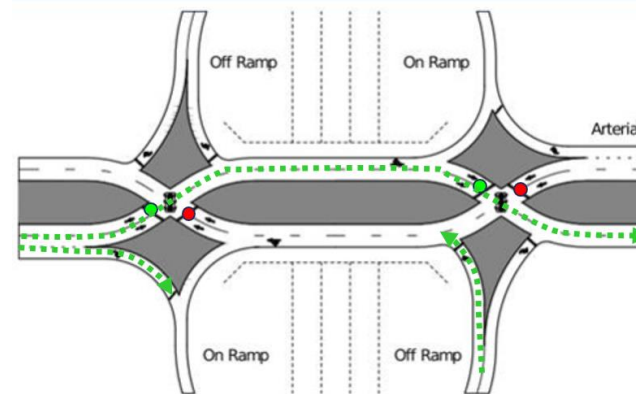
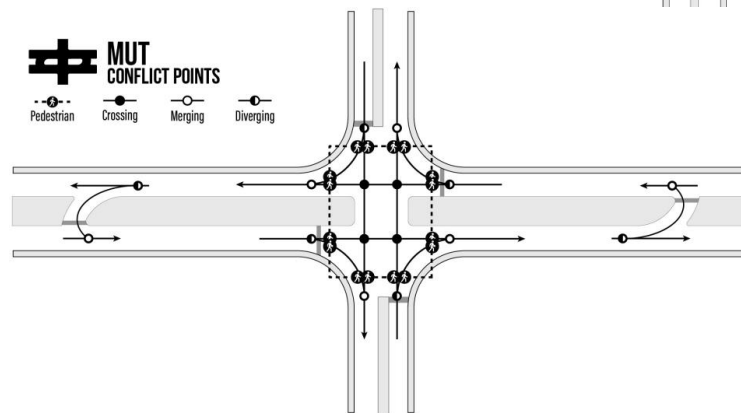
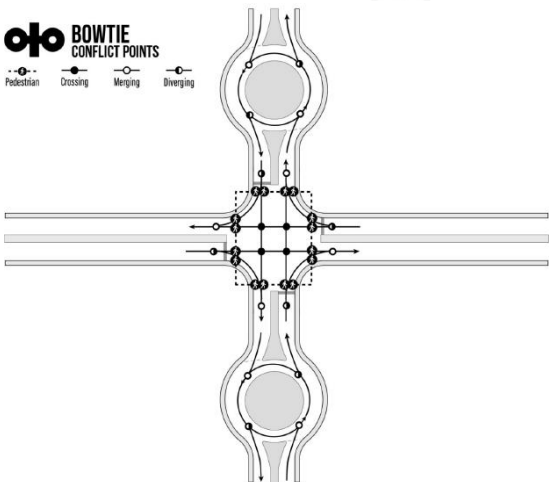
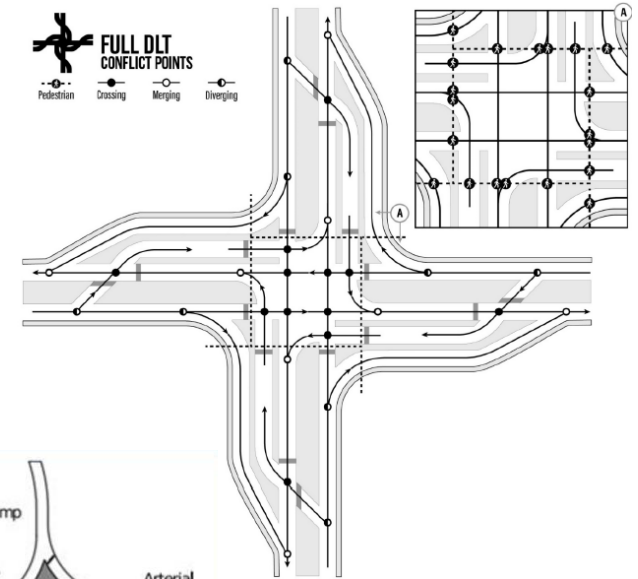
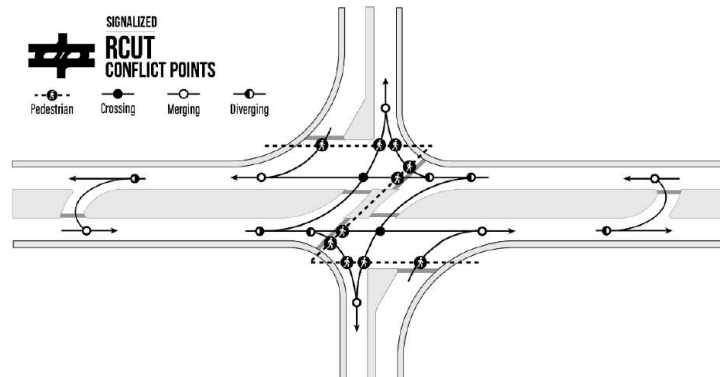
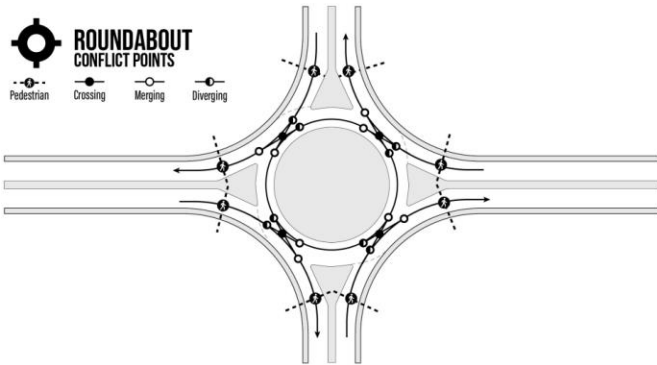


Image Sources: FHWA

Conducting an ICE

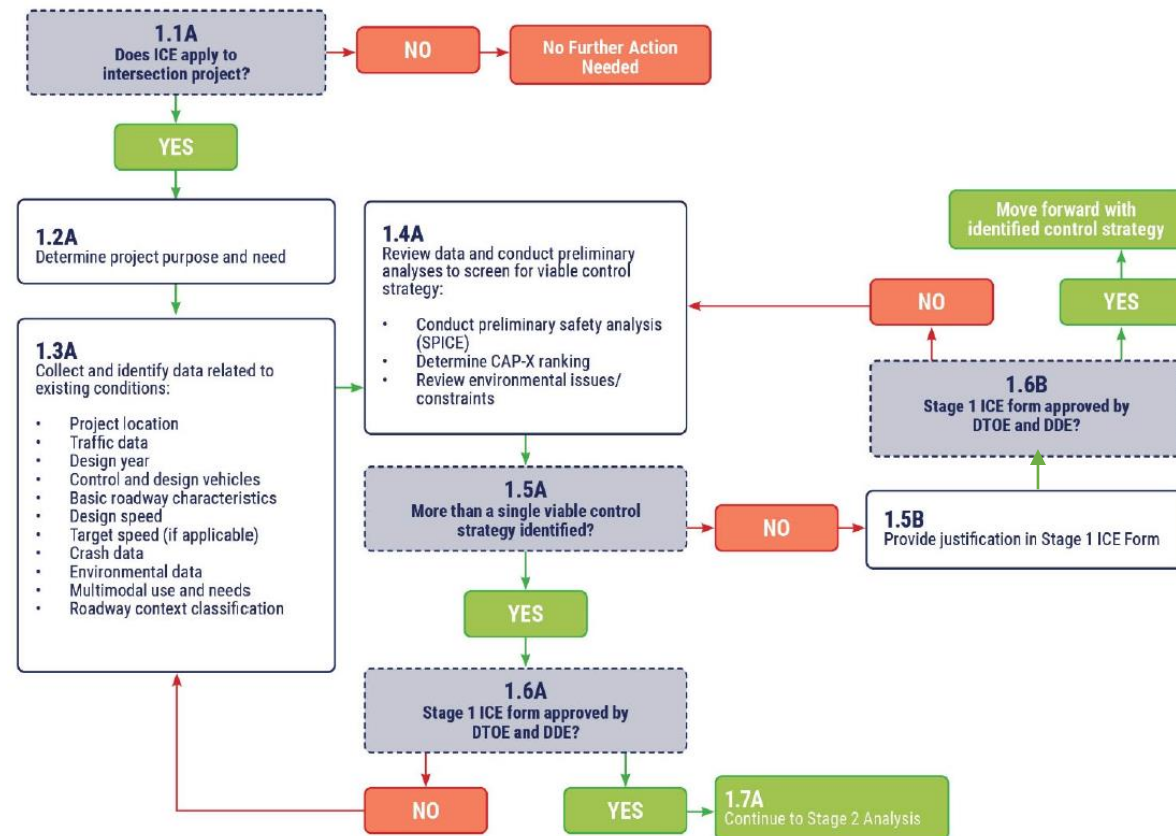
- ICE procedure consists of 3 stages
 - Stage 1: Screening/Preliminary Analysis
 - Stage 2: Detailed Analysis
 - Stage 3: Supplemental Analysis
- Not all stages are required for every project
 - A single control strategy cannot be identified at a given stage
 - Funding source

Factors to be Considered

- Project purpose and need
- Basic roadway characteristics
- Context classification
- Multimodal use and needs
- Safety performance
- Operational performance
- Environmental, Utility, and ROW impacts
- Benefit-cost ratio
- Public input

Stage 1: Screening/Preliminary Analysis

- At planning level/initial stage of a project
- Two Tools
 - CAP-X: Capacity Analysis for Planning of Junctions
 - SPICE: Safety Performance for Intersection Control Evaluation
- Narrow down the list of viable control strategies
- Complete and submit Stage 1 ICE Form with justification to selection to DDE and DTOE for approval



CAP-X: Capacity Analysis for Planning of Junctions

- Microsoft Excel-based spreadsheet tool
- Evaluate and compare operational performance
- Simplified HCM methodology based on Critical Lane Volume
- Multimodal (Pedestrian and Bicyclist) Accommodations
- Inputs
 - Turning movements counts during peak hour
 - Truck percentage
 - Lane configuration
 - Pedestrian and Bicycle Facilities



U.S. Department of Transportation
Federal Highway Administration



Capacity Analysis for
Planning of Junctions

CAP-X

Cap-X Tool Customization
for Florida DOT

January, 2024



TRANSPORTATION
SYMPOSIUM

Pedestrian and Bicycle Evaluations in Cap-X

Multimodal Ped Inputs

Required Input Fields

- Roadway Speeds (per crossing)

Default Input Fields

- Out of direction travel (per intersection)
- Multistage crossing (per intersection)
- Conflicting vehicle type (per crossing)
- Marking type (per crossing)

Auto-Populated Fields

- Number of lanes (per crossing)
- Vehicular volume (per crossing)

Multimodal Bike Inputs

New Input Fields

- Major and minor street bicycle facility type

Default Input Fields

- Conflicting control type (per leg)
- Out of direction travel (per leg)
- Riding between travel lanes (per leg)
- Riding across free flow ramp (per leg)

Auto-Populated Fields

- Number of adjacent thru lanes (per leg)
- Leg AADT
- Roadway speeds

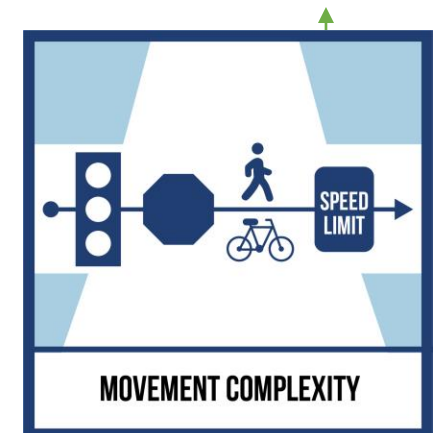
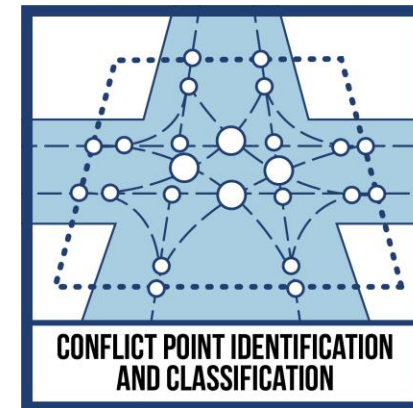
SPICE: Safety Performance for Intersection Control Evaluation

- Microsoft Excel-based spreadsheet tool
- Evaluate and compare safety performance based on
 - Crash prediction method
 - Highway Safety Manual
 - NCHRP Project
 - FDOT Research
 - FHWA CMF Clearinghouse
 - Safe System for Intersection (SSI) method

Safety Performance for Intersection Control Evaluation Tool																																																																																																					
Introduction 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. FDOT SPICE Tool is a Florida specific adaptation of Federal Highway Administration (FHWA) SPICE Tool.	Overview 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 to 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.																																																																																																					
At-Grade Inputs: SPF and Part C CMF inputs for At-Grade intersections. Ramp Terminal Inputs: SPF and Part C CMF inputs for Ramp Terminal intersections. SSI Inputs: Safe System for Intersection inputs used to calculate SSI. Calibration: Input optional override values for SPF calibration. Historical: Crash Data inputs used for Empirical Bayes (EB) analysis. Results: Summary of opening year and (if applicable) design year. Additional Worksheets: Additional worksheets to support analysis. Maintenance: Input optional override values for maintenance. Version: SPICE Tool 5.1.1 [Changelog] Maintained By: FDOT Traffic Engineering & Operations Office Contact Information: FDOT.StateTrafficServicesSection@dot.fl.gov	Control Strategy Selection and Inputs <small>Specify the Facility Level Inputs and the Control Strategies to be Included in the SPICE Analysis.</small> <table border="1"> <thead> <tr> <th>Input</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>At-Grade Intersection</td> <td>Opening and Design Year</td> </tr> <tr> <td>Analysis Year</td> <td>2025</td> </tr> <tr> <td>Opening Year</td> <td>2045</td> </tr> <tr> <td>Design Year</td> <td>On Urban and Suburban Arterial</td> </tr> <tr> <td>Facility Type</td> <td>4-leg</td> </tr> <tr> <td>Number of Legs</td> <td>2-way Intersecting 2-way</td> </tr> <tr> <td>1-Way/2-Way</td> <td>5 or fewer</td> </tr> <tr> <td># of Major Street Lanes (Both directions)</td> <td>Less than 50 mph</td> </tr> <tr> <td>Major Street Approach Speed</td> <td>34,000</td> </tr> <tr> <td>Opening Year - Major Road AADT</td> <td>5,000</td> </tr> <tr> <td>Design Year - Major Road AADT</td> <td>35,000</td> </tr> <tr> <td>Opening Year - Minor Road AADT</td> <td>6,000</td> </tr> <tr> <td>Design Year - Minor Road AADT</td> <td></td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Control Strategy</th> <th>Include</th> <th>Base Intersection</th> <th></th> </tr> </thead> <tbody> <tr> <td>Traffic Signal</td> <td>Yes</td> <td>--</td> <td></td> </tr> <tr> <td>Traffic Signal (Alternative Configuration)</td> <td>No</td> <td>--</td> <td></td> </tr> <tr> <td>Minor Road Stop Control</td> <td>No</td> <td>--</td> <td>Design Year AADT Outside of SPF Development Range</td> </tr> <tr> <td>1-Way Stop Control</td> <td>No</td> <td>--</td> <td>Opening Year AADT Outside of SPF Development Range</td> </tr> <tr> <td>1-Lane Roundabout</td> <td>No</td> <td>--</td> <td>Opening Year AADT Outside of SPF Development Range</td> </tr> <tr> <td>2-Lane Roundabout</td> <td>Yes</td> <td>--</td> <td>Opening Year AADT Outside of SPF Development Range</td> </tr> <tr> <td>Displaced Left Turn (DLT)</td> <td>Yes</td> <td>Traffic Signal</td> <td></td> </tr> <tr> <td>Median U-Turn (MUT)</td> <td>No</td> <td>Traffic Signal</td> <td></td> </tr> <tr> <td>Signalized Restricted Crossing U-Turn (RCUT)</td> <td>No</td> <td>--</td> <td></td> </tr> <tr> <td>Unsignalized Restricted Crossing U-Turn (RCUT)</td> <td>No</td> <td>--</td> <td></td> </tr> <tr> <td>Signalized Thru-Cut*</td> <td>No</td> <td>--</td> <td>*SSI Only, No Crash Prediction Available</td> </tr> <tr> <td>Unsignalized Thru-Cut*</td> <td>No</td> <td>--</td> <td>*SSI Only, No Crash Prediction Available</td> </tr> <tr> <td>Bowtie*</td> <td>Yes</td> <td>--</td> <td>*SSI Only, No Crash Prediction Available</td> </tr> <tr> <td>Continuous Green-T Intersection</td> <td>No</td> <td>Traffic Signal</td> <td></td> </tr> <tr> <td>Jughandle</td> <td>No</td> <td>Traffic Signal</td> <td></td> </tr> <tr> <td>Other 1*</td> <td>No</td> <td>Traffic Signal</td> <td>*Please Select</td> </tr> <tr> <td>Other 2*</td> <td>No</td> <td>Minor Road Stop</td> <td>*Please Select</td> </tr> </tbody> </table>	Input	Value	At-Grade Intersection	Opening and Design Year	Analysis Year	2025	Opening Year	2045	Design Year	On Urban and Suburban Arterial	Facility Type	4-leg	Number of Legs	2-way Intersecting 2-way	1-Way/2-Way	5 or fewer	# of Major Street Lanes (Both directions)	Less than 50 mph	Major Street Approach Speed	34,000	Opening Year - Major Road AADT	5,000	Design Year - Major Road AADT	35,000	Opening Year - Minor Road AADT	6,000	Design Year - Minor Road AADT		Control Strategy	Include	Base Intersection		Traffic Signal	Yes	--		Traffic Signal (Alternative Configuration)	No	--		Minor Road Stop Control	No	--	Design Year AADT Outside of SPF Development Range	1-Way Stop Control	No	--	Opening Year AADT Outside of SPF Development Range	1-Lane Roundabout	No	--	Opening Year AADT Outside of SPF Development Range	2-Lane Roundabout	Yes	--	Opening Year AADT Outside of SPF Development Range	Displaced Left Turn (DLT)	Yes	Traffic Signal		Median U-Turn (MUT)	No	Traffic Signal		Signalized Restricted Crossing U-Turn (RCUT)	No	--		Unsignalized Restricted Crossing U-Turn (RCUT)	No	--		Signalized Thru-Cut*	No	--	*SSI Only, No Crash Prediction Available	Unsignalized Thru-Cut*	No	--	*SSI Only, No Crash Prediction Available	Bowtie*	Yes	--	*SSI Only, No Crash Prediction Available	Continuous Green-T Intersection	No	Traffic Signal		Jughandle	No	Traffic Signal		Other 1*	No	Traffic Signal	*Please Select	Other 2*	No	Minor Road Stop	*Please Select
Input	Value																																																																																																				
At-Grade Intersection	Opening and Design Year																																																																																																				
Analysis Year	2025																																																																																																				
Opening Year	2045																																																																																																				
Design Year	On Urban and Suburban Arterial																																																																																																				
Facility Type	4-leg																																																																																																				
Number of Legs	2-way Intersecting 2-way																																																																																																				
1-Way/2-Way	5 or fewer																																																																																																				
# of Major Street Lanes (Both directions)	Less than 50 mph																																																																																																				
Major Street Approach Speed	34,000																																																																																																				
Opening Year - Major Road AADT	5,000																																																																																																				
Design Year - Major Road AADT	35,000																																																																																																				
Opening Year - Minor Road AADT	6,000																																																																																																				
Design Year - Minor Road AADT																																																																																																					
Control Strategy	Include	Base Intersection																																																																																																			
Traffic Signal	Yes	--																																																																																																			
Traffic Signal (Alternative Configuration)	No	--																																																																																																			
Minor Road Stop Control	No	--	Design Year AADT Outside of SPF Development Range																																																																																																		
1-Way Stop Control	No	--	Opening Year AADT Outside of SPF Development Range																																																																																																		
1-Lane Roundabout	No	--	Opening Year AADT Outside of SPF Development Range																																																																																																		
2-Lane Roundabout	Yes	--	Opening Year AADT Outside of SPF Development Range																																																																																																		
Displaced Left Turn (DLT)	Yes	Traffic Signal																																																																																																			
Median U-Turn (MUT)	No	Traffic Signal																																																																																																			
Signalized Restricted Crossing U-Turn (RCUT)	No	--																																																																																																			
Unsignalized Restricted Crossing U-Turn (RCUT)	No	--																																																																																																			
Signalized Thru-Cut*	No	--	*SSI Only, No Crash Prediction Available																																																																																																		
Unsignalized Thru-Cut*	No	--	*SSI Only, No Crash Prediction Available																																																																																																		
Bowtie*	Yes	--	*SSI Only, No Crash Prediction Available																																																																																																		
Continuous Green-T Intersection	No	Traffic Signal																																																																																																			
Jughandle	No	Traffic Signal																																																																																																			
Other 1*	No	Traffic Signal	*Please Select																																																																																																		
Other 2*	No	Minor Road Stop	*Please Select																																																																																																		

Safe System for Intersection Method

- A technical framework to apply Safe System principles for informed intersection planning and design decisions
- Kinetic energy management approach
- Key characteristics
 - Conflict point identification and classification - Crossing, merging, diverging, non-motorized
 - Conflict point exposure – AADT or Turning movement counts
 - Conflict point severity – P(FSI) based on MAIS scale, estimated speed, and conflict angle
 - Movement Complexity – Conflicting traffic, traffic control devices, additional complexity for non-motorized users



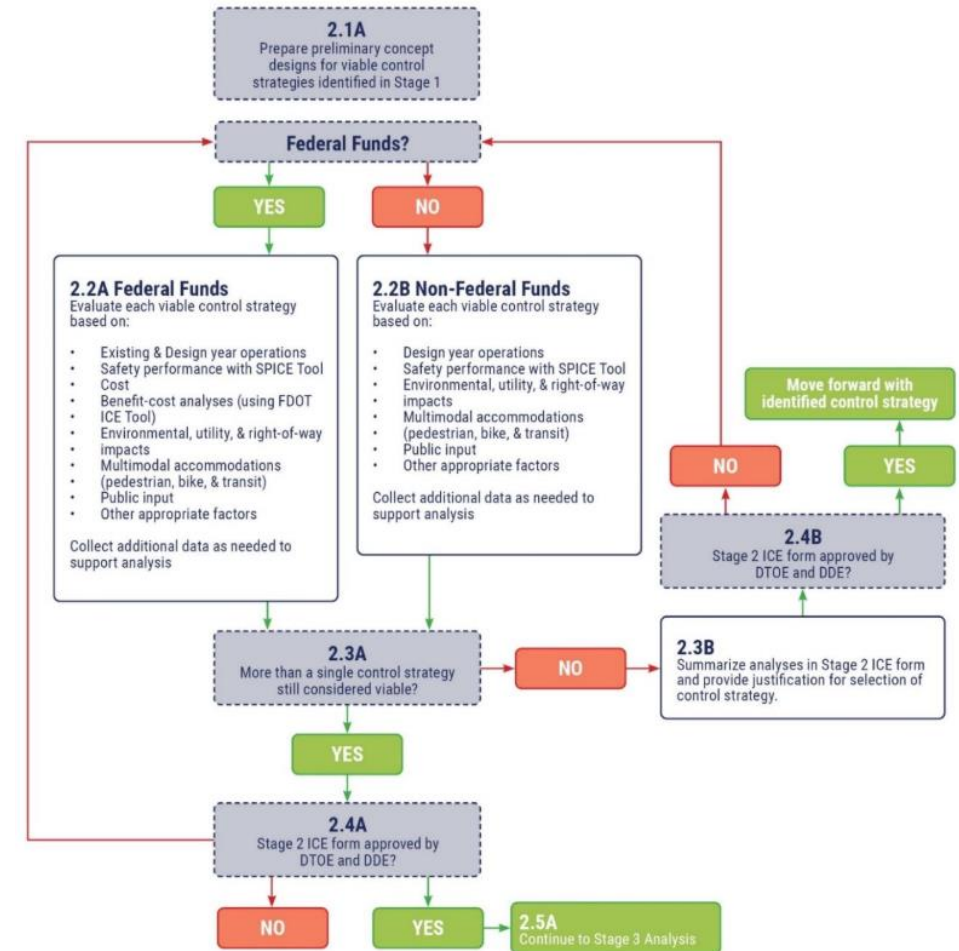
Source: VHB

SSI Inputs and Score

- Required Inputs
 - Number of through lanes
 - Median presence
 - Posted speed limit
- Ensure inputs for non-motorized activity match with inputs at other sheets
- SSI score is not based on actual crash frequency or crash predictions
- SSI score at an intersection is a combined score of four conflict types (crossing, merging, diverging, and non-motorized) based on exposure, severity, and complexity factor
- SSI score ranges from 0 to 100: 100 indicating low probability of F&SI crashes

Stage 2: Detailed Analysis

- Prepare preliminary conceptual design
- Determine funding source
- Three Tools
 - FDOT SPICE Tool for comprehensive safety analysis
 - FDOT ICE Tool for benefit/cost analysis
 - Traffic simulation software (e.g., Synchro, SIDRA)
- Complete and submit Stage 2 ICE Form with justification to selection to DDE and DTOE for approval



SPICE Tool for Stage 2 Analysis

- Use actual values for the CMF variables based on conceptual design
- Enter historical crash data if not already done in Stage 1
- SSI method intended only for Stage 1 analysis, NOT for Stage 2 analysis
 - Assumptions on intersection designs may not match the conceptual design prepared in Stage 2
 - Variation between conceptual design and SSI assumptions may not reflect in SSI score
- No separate Stage 2 analysis for Thru-cut and bowtie intersections

FDOT ICE Tool

- Compare life-cycle cost estimations between different intersection control strategies
- The tool incorporates the following costs:
 - safety
 - vehicular delay
 - operations and maintenance, design and construction, and ROW
- Current version (FDOT ICE Tool 2.1) has estimation procedure for
 - 1-lane and 2-lane roundabout
 - Unsignalized RCUT
 - Thru-Cut (signalized and unsignalized)
 - Jughandle (forward and reverse ramps)

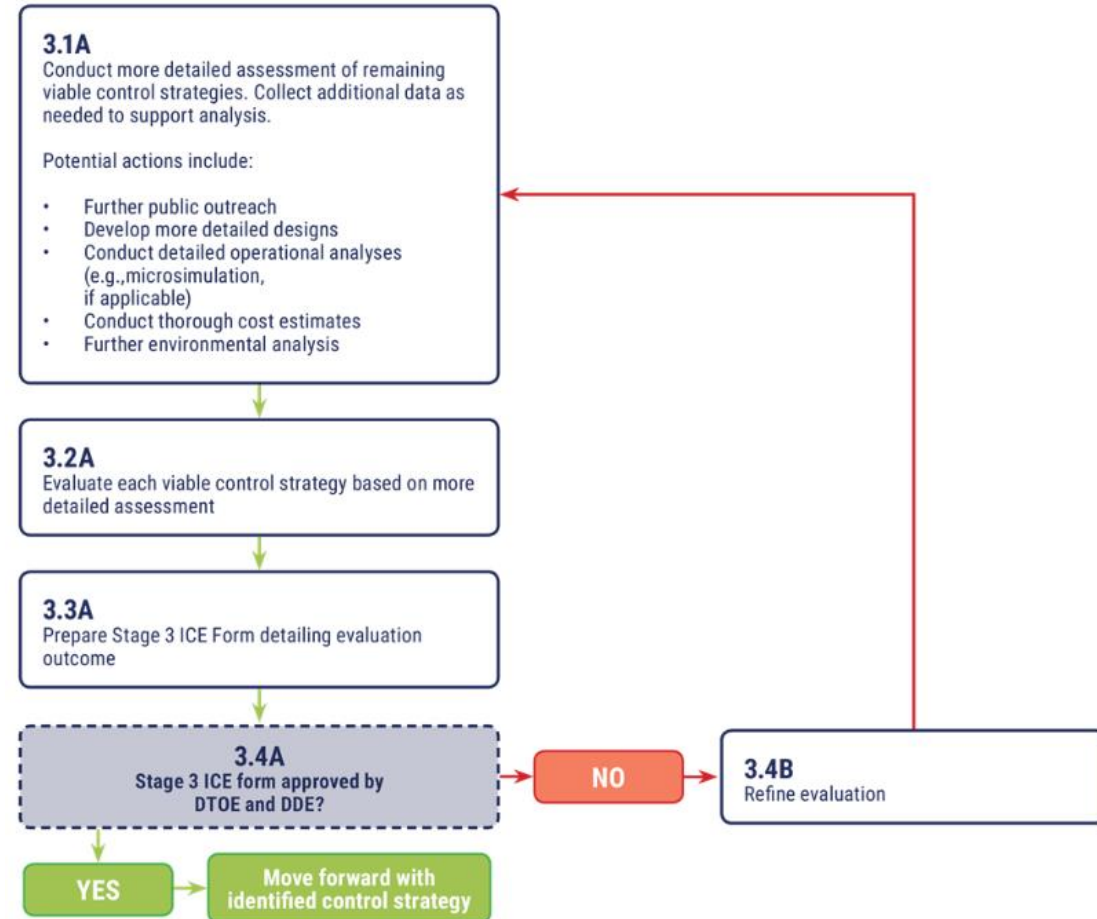
Synchro Templates

- Synchro Templates are available for alternative intersection types in the FDOT webpage
 - Bowtie
 - Continuous Green T-Section
 - Displaced Left-Turn
 - Diverging Diamond
 - Jughandle
 - Median U-Turn
 - Quadrant Roadway
 - Restricted Crossing U-Turn
 - Thru-Cut



Stage 3: Supplemental Analysis

- No additional tools
- Conduct more in-depth analysis and/or public vetting
 - Advancement of design plans
 - More detailed traffic analysis
 - More detailed cost estimation and ROW need determination
 - Additional assessment of environmental impacts
 - Additional engagement with the public or local officials
 - Additional engagement with road users



Benefits of ICE



Integration of **Safety** into decision making



Data- driven process



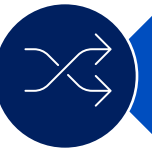
Consistent documentation



Increased awareness of innovative intersections



Cost-Effective Solutions

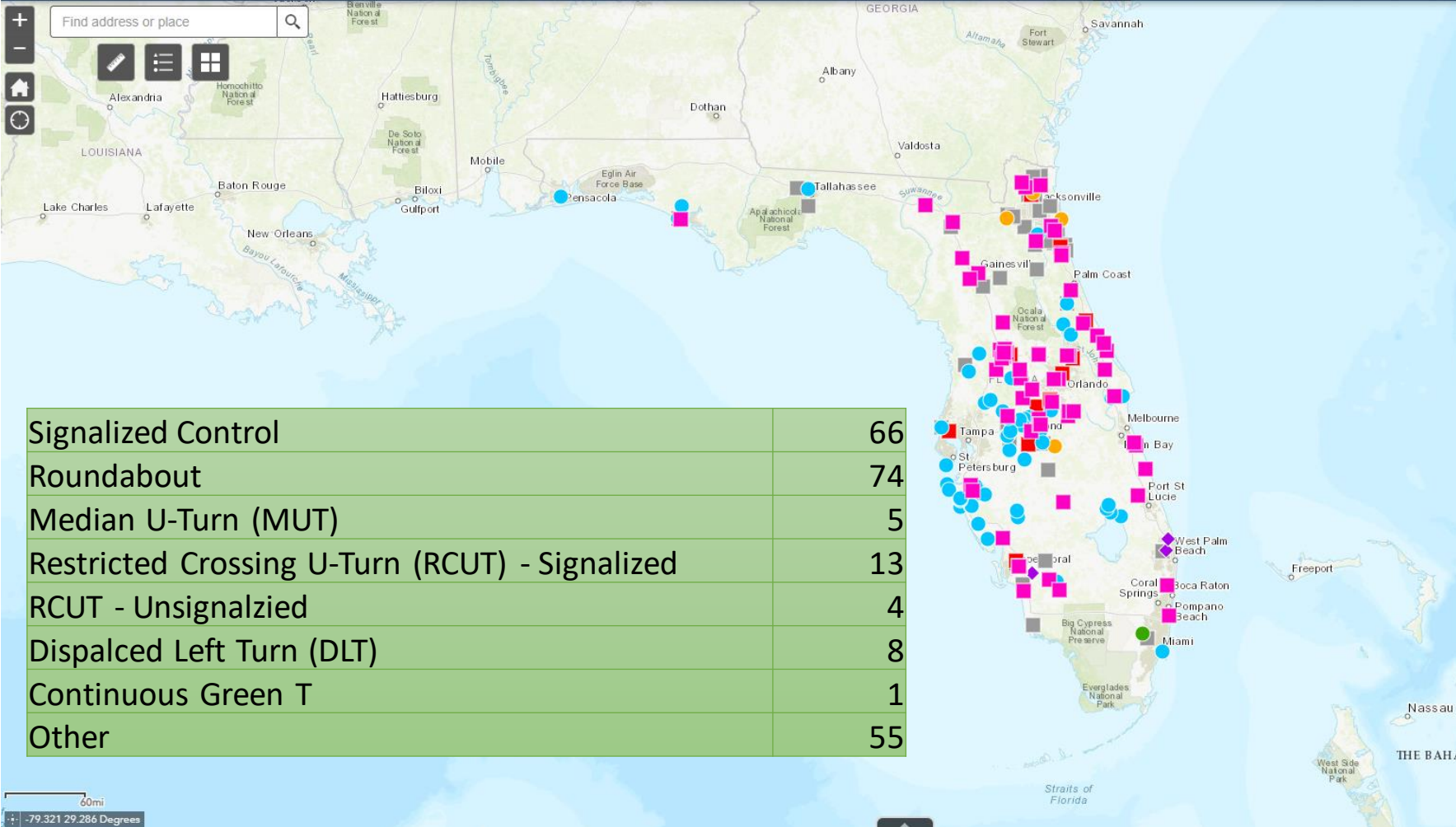


Flexible and Scalable procedures

eTraffic

FDOT Internal eTraffic

Traffic Engineering and Operations



Intersection Control Evaluations

Layers

- Signalized Control
- Roundabout
- Median U-Turn
- RCUT (Unsignalized)
- RCUT (Signalized)
- Displaced Left Turn
- Continuous Green-T
- Other Type

Signalized Control	66
Roundabout	74
Median U-Turn (MUT)	5
Restricted Crossing U-Turn (RCUT) - Signalized	13
RCUT - Unsignalized	4
Dispalced Left Turn (DLT)	8
Continuous Green T	1
Other	55



Implementation - Displaced Left Turn (DLT)



- District 1
- Lee County
- SR 82 and Daniels Parkway

What are We Currently Working On?

- Multimodal ped and multimodal bike analyses for 3-leg intersections
- Revision of default values in the multimodal ped and bike analysis
- Add Traffic Signal (Alt) as an alternative in CAP-X (current present in SPICE and ICE spreadsheets)
- Add analysis methods in SSI and CAP-X for remaining ramp terminal intersection
- Investigate new CMFs to differentiate between PDLT and DLT and between PMUT and MUT in SPICE

Safety Message

An isometric illustration of a four-way intersection on a blue road with white lane markings and crosswalks. A large yellow diamond-shaped sign on the left contains the text 'SHARE THE ROAD'. The scene includes a blue box truck, a yellow pickup truck, a purple semi-truck, a blue station wagon, a person walking a dog, a person on a bicycle, and a person on a motorcycle. Stop signs are visible at the corners of the intersection. The background is a light blue sky.

SHARE THE ROAD

**TRAFFIC IS NO ONE'S JAM:
SHARE THE ROAD AND ALLOW EVERYONE
TO TRAVEL SAFELY TOGETHER.**

FLHSMV.GOV/ShareTheRoad

FLHSMV
FLORIDA HIGHWAY SAFETY AND MOTOR VEHICLES



Contact Info

Dibakar Saha, PhD, PE, PTOE, RSP₂₁

Traffic Services Safety Engineer

Traffic Engineering and Operations Office

Dibakar.Saha@dot.state.fl.us

850-410-5417