Intersection Control Evaluation (ICE)

Alan El-Urfali and Mark Doctor
ICE in Florida?

• Don’t worry ... it will melt soon
What is ICE?

• Intersection Control Evaluation

• Purpose: To facilitate **objective** evaluations of intersection alternatives

• Intent: To promote “innovative” thinking and overcome reluctance to look at new options
National Perspective

• Minnesota DOT first implemented ICE in 2007

• Wisconsin, Indiana, Washington and California also have ICE policies

• Georgia DOT has draft ICE under review

• Nevada, Pennsylvania and at least 9 others are considering ICE
Current Perspectives

• Proliferation of “Innovative” Intersections

• Multimodal Emphasis

• Vision Zero / Systemic Safety / Safe Systems

• Performance-Based Practical Design
  • Considering the likely “value” of an improvement versus simply designing to address traffic projections
  • Design Year vs. “Year to Failure”
  • Lifecycle cost considerations
Intersection Considerations

• STOP, Roundabout, Signal
• Single-lane or Multi-lane Roundabout
• Two-phase Signal or Multi-phase Signal
  • We now have a plethora of “2-phase” intersection choices (Superstreets, Michigan-Lefts, Quadrant Intersections, Jug-handles, Continuous Flow Intersections, Bowtie Intersections
  • Left-turn phasing: Protected Only or Protected-Permissive
  • Dual or Triple Left Turn Lanes? / Dual Right Turn Lanes?
  • Cycle Lengths: 240 sec or 300 sec?
• Pedestrians / Bicyclists / Transit Users
Intent of ICE

• Adopting “performance based” policies such as for Intersection Control Evaluation (ICE) creates a transparent and consistent approach for agencies to consider intersection alternatives based on metrics such as safety, operations, cost, and social, environmental and economic impacts.
  • … and document the decisions!!!

• ICE is intended to be a data driven, performance-based framework to optimize our investment and provide solutions that consider all users.
  • Encourage the evaluation of an array of options including innovative intersection designs such as roundabouts, U-turn based intersections, continuous flow intersections, and diverging diamond interchanges—by comparing key performance metrics.
FDOT ICE Program Overview

- Alternative Intersections
- ICE Process & Applicability
- ICE Tools
- Coordination Timeline
Alternative Intersections – what are they?

• Median U-Turn (MUT)

No left turns allowed at main signalized intersection
Alternative Intersections – what are they?

• Restricted Crossing U-Turn (RCUT)
Alternative Intersections – what are they?

- Restricted Crossing U-Turn (RCUT)
Alternative Intersections – what are they?

- Restricted Crossing U-Turn (RCUT)
Alternative Intersections – what are they?

- Restricted Crossing U-Turn (RCUT)

First Super Street RCUT in Florida

Crosstown Pkwy at Floresta Blvd. in Port St. Lucie
Alternative Intersections – what are they?

- Jughandle
Alternative Intersections – what are they?

• **Displaced Left Turn**

• Left turns and through movements operate concurrently
Alternative Intersections – what are they?

- Displaced Left Turn
Alternative Intersections – what are they?

• Continuous Green T
Alternative Intersections – what are they?

• Quadrant Roadway

No left turns allowed at main signalized intersection
ICE Applicability

An ICE is required when:

• New signalization is proposed

• Major reconstruction of an existing signalized intersection is proposed (e.g., adding a left-turn lane, adding an Intersection leg)

• Driveway/Connection permit applications for Category E, F, and G (defined by average daily trips thresholds in Rule 14- 96.004, F.A.C.)

• District Design Engineer (DDE) and District Traffic Operations Engineer (DTOE) consider an ICE a good fit for the project.
ICE Applicability

An ICE is **not** required if any of the following apply:

- Work involved does not include any substantive proposed changes to an intersection (e.g., a project limited to only “mill and resurface” pavement with no change to intersection geometry or control).

- Minor intersection operational improvements (such as adding right-turn lanes or changing signal phasing) or signal replacement projects where the primary purpose is to upgrade deficient equipment and installations.
Stages of ICE

- **Stage 1:** Preliminary Analysis
  - CAP-X

- **Stage 2:** Conceptual Design Analysis
  - SPICE
  - Analysis Guidance
  - Default SYNCHRO
  - FDOT ICE Tool

- **Stage 3:** Detailed Design Analysis
  - No specific tools. Reuse Stage 2 tools or address qualitative issues
Who Completes the ICE Form?

- FDOT staff
- Consultants

- Applicant
ICE Stage 1 – Preliminary Analysis

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Intent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is there one viable control strategy or more than one?</td>
<td>If only one control strategy, Stages 2 and 3 are not necessary</td>
<td>Don’t make ICE a burden if the choice is straightforward</td>
</tr>
</tbody>
</table>
ICE Stage 1 Process

1.1A Does ICE apply to intersection project?
- Yes
  - 1.2A Determine project purpose and need
  
1.3A Collect data on existing conditions:
- Project location
- Traffic Data
- Control and Design Vehicles
- Basic Roadway Characteristics
- Target Speed
- Crash Data
- Environmental Data
- Multimodal Use and Needs
- Land Use (existing and future)
- Community Goals and Objectives

Identify:
- Context Classification (existing and future)
- Design years
- Control and Design Vehicles
- Target Speed

1.4A Review data and conduct preliminary analyses to screen for viable control strategy:
- Conduct preliminary safety analysis
- Determine CAP-X ranking
- Review ICE Threshold Spreadsheet
- Review environmental issues/constraints

1.5A More than a single viable control strategy identified?
- No
  - 1.5B Provide justification in Stage 1 ICE form.
  
1.6A Stage 1 ICE form approved by DTOE and DOE?
- No
  - 1.6B Stage 1 ICE form approved by DTOE and DOE?
  
1.7A Continue to Stage 2 Analysis

- Yes
  - Move forward with identified control strategy
ICE Stage 2 – Concept Design

- Detailed analysis to help differentiate control strategies
- Concept design drawings prepared for each control strategy

Consider a wide range of criteria
- Operations
- Safety Performance
- Right-of-way impacts
- Costs
- Environmental impacts
- Political/public considerations
- Terrain
- Adjacent intersections and coordinated signal systems
- System consistency
- Pedestrian/bike accommodations

Possible outcomes
- One control strategy is clearly preferred → ICE ends
- Further analysis needed → Continue to Stage 3
ICE Stage 2 Process

2.1A Prepare preliminary concept designs for viable control strategies identified in Stage 1

2.2A Evaluate each viable control strategy based on anticipated:
- Operations during design year
- Safety performance (HSM analysis with SPICE Tool)
- Cost
- Environmental impact
- Multimodal accommodations (pedestrian, bike, & transit)
- Public input
- Other appropriate factors
Collect additional data as needed to support analysis.

2.3A More than a single control strategy still considered viable?

2.3B Summarize analyses in Stage 2 ICE form and provide justification for selection of control strategy

2.4A Stage 2 ICE form approved by DTOE and DDE?

2.4B Stage 2 ICE form approved by DTOE and DDE?

Yes
Move forward with identified control strategy

No
2.5A Continue to Stage 3 Analysis

No

Yes

No
ICE Stage 3 – Detailed Design Analysis

- Whatever is needed to choose control strategy
  - Not prescriptive
  - Flexible for each project

- May have fewer control strategies than Stage 2

- Consider the same criteria as Stage 2, but in greater detail
  - More developed drawings and associated information (costs, impacts, etc.)?
  - Additional public and local government outreach?
  - Additional traffic analysis / microsimulation?
  - Additional pedestrian and bicycle needs assessment?
ICE Stage 3 Process

3.1A
Conduct more detailed assessment of remaining viable control strategies. Collect additional data as needed to support analysis.

Potential actions include:
- Further public outreach
- Develop more detailed designs
- Conduct detailed operational analyses (e.g., microsimulation, if applicable)
- Conduct thorough cost estimates
- Further environmental analysis

3.2A
Evaluate each viable control strategy based on more detailed assessment

3.3A
Prepare Stage 3 ICE form detailing evaluation outcome

3.4A
Stage 3 ICE form approved by DTOE and DDE?

Yes
Move forward with identified control strategy

No
Refine evaluation

3.4B
Refine evaluation
Tools for ICE Evaluations

- CAP-X  Capacity Analysis for Planning of Junctions
- SPICE  Safety Performance for ICE
- FDOT-ICE Modified NCHRP 3-110 (Lifecycle Cost Analysis)
ICE Tools

Stage 1

Stage 2

Stage 3
No specific tools. Reuse Stage 2 tools or address qualitative issues.
Vision and Need for the CAP-X Tool

- Stage 1 tool for Intersection Control Evaluation
- FHWA tool for planning-level capacity assessment
- Initial screening of intersection control alternatives
  - Can be used during project’s scoping stage
- Simple tool needed for efficient comparisons
  - User-friendly
  - Only require inputs that are readily available to the analyst
- FDOT updates scheduled for Summer 2017
  - Incorporation of multimodal considerations
  - Improved input sheets and output comparisons
  - Additional intersection alternatives
CAP-X Tool Capabilities

- Conducts critical movement analysis to gauge the potential performance of intersection and interchange types
- 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 1/2 lane configurations
  - 3 Lane Roundabouts

- Grade-Separated Interchanges
  - Traditional Diamond
  - Partial Cloverleaf
  - Displaced Left Turn
  - Diverging Diamond Interchange
  - Single Point Diamond
CAP-X Inputs

- Turning Movement Volumes
- Multimodal level of activity (FDOT addition)
- Additional planning level values
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 Interchanges

<table>
<thead>
<tr>
<th>TYPE OF INTERCHANGE</th>
<th>Sheet</th>
<th>Zone 1 (Rt Mrg)</th>
<th>Zone 2 (Lt Mrg)</th>
<th>Zone 3 (Ctr. 1)</th>
<th>Zone 4 (Ctr. 2)</th>
<th>Zone 5 (Lt Mrg)</th>
<th>Zone 6 (Rt Mrg)</th>
<th>Overall v/c Ratio</th>
<th>Pedestrian Accommodations</th>
<th>Bicycle Accommodations</th>
<th>Transit Accommodations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CLV V/C</td>
<td>CLV V/C</td>
<td>CLV V/C</td>
<td>CLV V/C</td>
<td>CLV V/C</td>
<td>CLV V/C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diamond</td>
<td>E-W</td>
<td>840 : 0.48</td>
<td>840 : 0.48</td>
<td>840 : 0.48</td>
<td>840 : 0.48</td>
<td>840 : 0.48</td>
<td>840 : 0.48</td>
<td>0.48</td>
<td>Fair</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Partial Cloverleaf A</td>
<td>E-W</td>
<td>572 : 0.32</td>
<td>572 : 0.32</td>
<td>572 : 0.32</td>
<td>572 : 0.32</td>
<td>572 : 0.32</td>
<td>572 : 0.32</td>
<td>0.32</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>Partial Cloverleaf B</td>
<td>E-W</td>
<td>674 : 0.37</td>
<td>572 : 0.32</td>
<td>1082 : 0.60</td>
<td>572 : 0.32</td>
<td>572 : 0.32</td>
<td>572 : 0.32</td>
<td>0.37</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>Displaced Left Turn</td>
<td>E-W</td>
<td>572 : 0.32</td>
<td>572 : 0.32</td>
<td>1082 : 0.60</td>
<td>572 : 0.32</td>
<td>572 : 0.32</td>
<td>572 : 0.32</td>
<td>0.60</td>
<td>Fair</td>
<td>Fair</td>
<td>Excellent</td>
</tr>
<tr>
<td>Diverging Diamond Interchange</td>
<td>E-W</td>
<td>597 : 0.33</td>
<td>714 : 0.40</td>
<td>572 : 0.32</td>
<td>714 : 0.40</td>
<td>597 : 0.33</td>
<td>597 : 0.33</td>
<td>0.40</td>
<td>Good</td>
<td>Excellent</td>
<td>Fair</td>
</tr>
<tr>
<td>Single Point</td>
<td>E-W</td>
<td>597 : 0.33</td>
<td>684 : 0.40</td>
<td>684 : 0.40</td>
<td>684 : 0.40</td>
<td>684 : 0.40</td>
<td>684 : 0.40</td>
<td>0.40</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
</tbody>
</table>

### 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)

<table>
<thead>
<tr>
<th>Rank</th>
<th>TYPE OF INTERSECTION</th>
<th>Overall v/c Ratio</th>
<th>Automobile Ranking</th>
<th>Pedestrian Accommodations</th>
<th>Bicycle Accommodations</th>
<th>Transit Accommodations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Partial Cloverleaf A E-W (GSI)</td>
<td>0.51</td>
<td>1</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>2</td>
<td>Partial Cloverleaf B E-W (GSI)</td>
<td>0.51</td>
<td>1</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>3</td>
<td>Single Point E-W (GSI)</td>
<td>0.55</td>
<td>3</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>4</td>
<td>Diverging Diamond Interchange E-W (GSI)</td>
<td>0.67</td>
<td>4</td>
<td>Good</td>
<td>Excellent</td>
<td>Fair</td>
</tr>
<tr>
<td>5</td>
<td>Displaced Left Turn (Interchange) E-W (GSI)</td>
<td>0.68</td>
<td>5</td>
<td>Fair</td>
<td>Fair</td>
<td>Excellent</td>
</tr>
<tr>
<td>6</td>
<td>Diamond E-W (GSI)</td>
<td>0.70</td>
<td>6</td>
<td>Fair</td>
<td>Good</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
## ICE Tools

<table>
<thead>
<tr>
<th>ICE Procedure and Forms</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAP-X</td>
<td>Analysis Guidance</td>
<td>No specific tools. Reuse Stage 2 tools or address qualitative issues</td>
</tr>
<tr>
<td></td>
<td>SPICE</td>
<td>Default SYNCHRO</td>
<td>FDOT ICE Tool</td>
</tr>
</tbody>
</table>

- **Stage 1**: CAP-X
- **Stage 2**: SPICE, Analysis Guidance, Default SYNCHRO, FDOT ICE Tool
Vision and Need for the SPICE Tool

- Safety comparisons of intersections becoming more common – ICE, increased use of HSM in general, etc.

- FHWA recognizes everyone is struggling with them
  - Which CMF is right?
  - What should the CMF be applied to (existing, another alt, etc.)?

- Simple tool needed for safety comparisons only
  - Same level of effort as CAP-X
SPICE Tool Capabilities

- Performs predictive safety analysis of at-grade intersection forms/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 forms and control types

- Tool will work for vast majority of intersections

- Development of FHWA tool ongoing

- Preliminary FDOT version scheduled for Summer 2017
SPICE Tool
## SPICE – Introduction

**Federal Highway Administration (FHWA)**

### Safety Performance for Intersection Control Evaluation Tool

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>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.</td>
</tr>
</tbody>
</table>

### Worksheets

- **Project Information:** Provide general project information for reference purposes only.
- **Alternative Selection:** Specify the number of alternatives being considered and the intersection control of each alternative.
- **Predictive Inputs:** Provide inputs needed to compute and apply Part C CMFs.
- **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.

### Input Legend

- **Required data entry field**
- **Optional data entry field**
- **Planning-Level Default Input**
- **Data entry field not used**

### Maintenance

- **Version:** SPICE Tool 1.0
- **Maintained By:** TBD
- **Contact Information:** TBD
- **Disclaimer:**

*Disclaimers may be added, if needed.*
# SPICE – Basic Inputs and Control Strategy Selection

## Control Strategy Selection and Inputs

Specify the Control Strategies to be included in the SPICE Analysis.
Press the "Configure Control Strategy Worksheets" button when all required inputs have been entered.
Use the "Reset to Defaults" Button to return this sheet to the default inputs and selections.

<table>
<thead>
<tr>
<th>Intersection Type</th>
<th>At-Grade Intersections</th>
<th>Analysis Year</th>
<th>Opening and Design Year</th>
<th>Opening Year</th>
<th>Design Year</th>
<th>Freeway Orientation</th>
<th>Facility Type</th>
<th>Number of Legs</th>
<th>1-Way/2-Way</th>
<th># of Major Street Lanes</th>
<th>Major Street Approach Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>2-way 2-way Intersecting 2-way</td>
<td>5 or fewer</td>
<td>&lt;55 mph</td>
</tr>
<tr>
<td>Traffic Signal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>2-way 2-way Intersecting 2-way</td>
<td>5 or fewer</td>
<td>&lt;55 mph</td>
</tr>
<tr>
<td>Minor Road Stop</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>2-way 2-way Intersecting 2-way</td>
<td>5 or fewer</td>
<td>&lt;55 mph</td>
</tr>
<tr>
<td>All Way Stop</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>2-way 2-way Intersecting 2-way</td>
<td>5 or fewer</td>
<td>&lt;55 mph</td>
</tr>
<tr>
<td>1-Lane Roundabout</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt;55 mph</td>
</tr>
<tr>
<td>2-Lane Roundabout</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt;55 mph</td>
</tr>
<tr>
<td>Displace Left Turn (DLT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>2-way 2-way Intersecting 2-way</td>
<td>5 or fewer</td>
<td>&lt;55 mph</td>
</tr>
<tr>
<td>Median U-Turn (MUT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>2-way 2-way Intersecting 2-way</td>
<td>5 or fewer</td>
<td>&lt;55 mph</td>
</tr>
<tr>
<td>Signalized Restricted Crossing U-Turn (RCUT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>2-way 2-way Intersecting 2-way</td>
<td>5 or fewer</td>
<td>&lt;55 mph</td>
</tr>
<tr>
<td>Unsignalized Restricted Crossing U-Turn (RCUT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>2-way 2-way Intersecting 2-way</td>
<td>5 or fewer</td>
<td>&lt;55 mph</td>
</tr>
<tr>
<td>Continuous Green-T Intersection</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>2-way 2-way Intersecting 2-way</td>
<td>5 or fewer</td>
<td>&lt;55 mph</td>
</tr>
<tr>
<td>Jughandle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-leg</td>
<td>2-way 2-way Intersecting 2-way</td>
<td>5 or fewer</td>
<td>&lt;55 mph</td>
</tr>
</tbody>
</table>

## Select At-Grade Intersections for Inclusion in SPICE Analysis

### Include
- All

### Facility Type
- On Urban and Suburban Arterial

### Number of Legs
- 3-leg

### 1-Way/2-Way
- 2-way Intersecting 2-way

### # of Major Street Lanes
- 5 or fewer

### Major Street Approach Speed
- <55 mph
## SPICE – At-Grade Intersection Inputs

- **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

### Table: SPICE At-Grade Intersection Inputs

<table>
<thead>
<tr>
<th>Input</th>
<th>Base Conditions</th>
<th>Traffic Signal</th>
<th>Control Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening Year Major Road AADT</td>
<td>20000</td>
<td>20000</td>
<td>Optional AADT Overrides (0)</td>
</tr>
<tr>
<td>Opening Year Minor Road AADT</td>
<td>10000</td>
<td>10000</td>
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<tr>
<td>Design Year Major Road AADT</td>
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<td>25000</td>
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</tr>
<tr>
<td>Design Year Minor Road AADT</td>
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<td>15000</td>
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<table>
<thead>
<tr>
<th>Additional Required Control Strategy Inputs</th>
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</thead>
<tbody>
<tr>
<td>Number of Major (Uncontrolled) Approaches with Left-Turn Lanes</td>
</tr>
<tr>
<td>Number of Major (Uncontrolled) Approaches with Right-Turn Lanes</td>
</tr>
</tbody>
</table>

### Reset Planning Inputs to Defaults

- Skew Angle
- Lighting Present
- # of Approaches Permissive LT Signal Phasing
- # of Approaches Perm/Prot LT Signal Phasing
- # of Approaches Protected LT Signal Phasing
- Number of Approaches with Right-Turn-on-Red Prohibited
- Red Light Camera Present
- Number of Major Street Lanes (Including Turn Lanes)
- Number of Minor Street Lanes (Including Turn Lanes)
- # of Major St Approaches w/ Right-Turn Channelization
- Number of Approaches with U-Turn Prohibited
- Pedestrian Volume by Activity Level
- User Specified Sum of all daily pedestrian crossing volumes
- Max # of Lanes Crossed by Pedestrians
- Number of Bus Stops within 1000’ of Intersection
- Schools within 1000’ of Intersection
- Number of Alcohol Sales Establishments within 1000’ of Intersection

- **Low [20]**

A yellow cell indicates the value may be used in the SPF computation.
SPICE – CMF Specification and Optional Local Calibration

- Crash Modification Factors (CMFs) used when safety performance functions (SPFs) are unavailable

- CMFs can be overridden with local values

- Local calibration factors can be applied when data is available

<table>
<thead>
<tr>
<th>Control</th>
<th>Type of Crashes</th>
<th>Default CMF</th>
<th>Optional User Override</th>
<th>Use Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displaced Left Turn (DLT)</td>
<td>Total</td>
<td>0.88</td>
<td>0.88</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>Fatal-Injury</td>
<td>0.88</td>
<td>0.88</td>
<td>0.88</td>
</tr>
<tr>
<td>Median U-Turn (MUT)</td>
<td>Total</td>
<td>0.85</td>
<td>0.85</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>Fatal-Injury</td>
<td>0.70</td>
<td>0.70</td>
<td>0.70</td>
</tr>
<tr>
<td>Signalized Restricted Crossing U-Turn (RCUT), also known Superstreet</td>
<td>Total</td>
<td>0.85</td>
<td>0.85</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>Fatal-Injury</td>
<td>0.78</td>
<td>0.78</td>
<td>0.78</td>
</tr>
<tr>
<td>Unsignalized Restricted Crossing U-Turn (RCUT), also known as J-Turn</td>
<td>Total</td>
<td>0.65</td>
<td>0.65</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>Fatal-Injury</td>
<td>0.46</td>
<td>0.46</td>
<td>0.46</td>
</tr>
<tr>
<td>Continuous Green-T Intersection</td>
<td>Total</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
</tr>
<tr>
<td></td>
<td>Fatal-Injury</td>
<td>0.85</td>
<td>0.85</td>
<td>0.85</td>
</tr>
<tr>
<td>Jughandles</td>
<td>Total</td>
<td>0.74</td>
<td>0.74</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td>Fatal-Injury</td>
<td>0.74</td>
<td>0.74</td>
<td>0.74</td>
</tr>
<tr>
<td>Crossover Traffic Signal (of Diverging Diamond Interchange)</td>
<td>Total</td>
<td>0.67</td>
<td>0.67</td>
<td>0.67</td>
</tr>
<tr>
<td></td>
<td>Fatal-Injury</td>
<td>0.59</td>
<td>0.59</td>
<td>0.59</td>
</tr>
</tbody>
</table>
SPICE – Crash Prediction Outputs

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

<table>
<thead>
<tr>
<th>Control Strategy</th>
<th>Crash Type</th>
<th>Opening Year</th>
<th>Design Year</th>
<th>Total Project Life Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Signal</td>
<td>Total</td>
<td>6.29</td>
<td>8.73</td>
<td>166.27</td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td>2.55</td>
<td>3.57</td>
<td>67.72</td>
</tr>
<tr>
<td>Minor Road Stop</td>
<td>Total</td>
<td>4.65</td>
<td>6.13</td>
<td>119.35</td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td>2.23</td>
<td>3.01</td>
<td>57.94</td>
</tr>
<tr>
<td>Displaced Left Turn (DLT)</td>
<td>Total</td>
<td>5.54</td>
<td>7.68</td>
<td>146.31</td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td>2.24</td>
<td>3.14</td>
<td>59.59</td>
</tr>
<tr>
<td>Median U-Turn (MUT)</td>
<td>Total</td>
<td>5.35</td>
<td>7.42</td>
<td>141.33</td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td>1.78</td>
<td>2.50</td>
<td>47.40</td>
</tr>
<tr>
<td>Signalized RCUT</td>
<td>Total</td>
<td>5.35</td>
<td>7.42</td>
<td>141.33</td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td>1.99</td>
<td>2.79</td>
<td>52.82</td>
</tr>
<tr>
<td>Unsignalized RCUT</td>
<td>Total</td>
<td>3.03</td>
<td>3.98</td>
<td>77.58</td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td>1.02</td>
<td>1.38</td>
<td>26.65</td>
</tr>
<tr>
<td>Jughandle</td>
<td>Total</td>
<td>4.66</td>
<td>6.46</td>
<td>123.04</td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td>1.89</td>
<td>2.64</td>
<td>50.11</td>
</tr>
</tbody>
</table>
ICE Procedure

Stage 1
- CAP-X

Stage 2
- SPICE
- Analysis Guidance
- Default SYNCHRO
- FDOT ICE Tool

Stage 3
- No specific tools. Reuse Stage 2 tools or address qualitative issues
Vision and Need for the FDOT-ICE Tool

- Stage 2 tool for more in-depth analysis of intersection alternatives

- Need for life-cycle cost analysis
  - Safety
  - Vehicular delay
  - Design, construction, right-of-way, and operating costs

- Life-cycle cost and benefit-cost analysis can bring these performance measures together

- 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 Capabilities

- Based on the NCHRP 3-110 Life Cycle Cost Estimation Tool (LCCET)
  - Macro-powered Excel spreadsheet

- Includes hourly, daily, and monthly volume profiles for 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

- FDOT customizations
  - Simplified and improved input sheets
  - Local default values where applicable for monetized performance measures
  - Florida-specific volume profiles

- FDOT updates schedule for Summer 2017
### FDOT-ICE Tool - Intersection Selection

#### Operating Period

<table>
<thead>
<tr>
<th>Opening Year</th>
<th>Design Year</th>
<th>2017</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>2035</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Travel time/delay and demand forecasts for the opening year must be provided in the DemandParameters sheet.

Travel time/delay and demand forecasts for the end (horizon) year must be provided in the DemandParameters sheet.

#### Control Strategies

<table>
<thead>
<tr>
<th>Control #</th>
<th>Include</th>
<th>Short Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>☑️</td>
<td>MinorStop</td>
<td>Minor Road Stop</td>
</tr>
<tr>
<td>2</td>
<td>☑️</td>
<td>AllStop</td>
<td>All Way Stop</td>
</tr>
<tr>
<td>3</td>
<td>☑️</td>
<td>TrafficSignal</td>
<td>Traffic Signal</td>
</tr>
<tr>
<td>4</td>
<td>☑️</td>
<td>Roundabout</td>
<td>Roundabout</td>
</tr>
<tr>
<td>5</td>
<td>☑️</td>
<td>DLT</td>
<td>Displace Left Turn (DLT)</td>
</tr>
<tr>
<td>6</td>
<td>☑️</td>
<td>MUT</td>
<td>Median U-Turn (MUT)</td>
</tr>
<tr>
<td>7</td>
<td>☑️</td>
<td>SignalRCUT</td>
<td>Signalized Restricted Crossing U-Turn (RCUT)</td>
</tr>
<tr>
<td>8</td>
<td>☑️</td>
<td>UnsignalRCUT</td>
<td>Unsignalized Restricted Crossing U-Turn (RCUT)</td>
</tr>
<tr>
<td>9</td>
<td>☑️</td>
<td>GreenT</td>
<td>Continuous Green-T Intersection</td>
</tr>
<tr>
<td>10</td>
<td>☑️</td>
<td>Jughandle</td>
<td>Jughandle</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Quadrant Itx</td>
<td>Quadrant Roadway Intersection</td>
</tr>
</tbody>
</table>

Press the "Setup Worksheets" button to create the worksheets corresponding to 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 override by analyst

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Design &amp; Construction</th>
<th>Operating &amp; Maintenance</th>
<th>Signal Retiming</th>
<th>Power</th>
<th>Lighting</th>
<th>Signal Maintenance</th>
<th>Roundabout Landscaping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intx #1</td>
<td>$</td>
<td>-</td>
<td></td>
<td></td>
<td>$750</td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>(Two-Way Stop Control)</td>
<td></td>
<td>Cost</td>
<td>$</td>
<td></td>
<td></td>
<td></td>
<td>$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost Cycle</td>
<td>Every 3 years</td>
<td></td>
<td>1 (yearly)</td>
<td></td>
<td>$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 (yearly)</td>
<td></td>
<td></td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>Intx #2</td>
<td>$</td>
<td>-</td>
<td>$5,000</td>
<td>$750</td>
<td>$750</td>
<td>$3,100</td>
<td>$</td>
</tr>
<tr>
<td>(Traffic Signal)</td>
<td></td>
<td>Cost</td>
<td>Every 3 years</td>
<td></td>
<td>1 (yearly)</td>
<td>1 (yearly)</td>
<td>$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost Cycle</td>
<td>1 (yearly)</td>
<td></td>
<td></td>
<td>1 (yearly)</td>
<td>$</td>
</tr>
<tr>
<td>Intx #3</td>
<td>$</td>
<td>-</td>
<td></td>
<td></td>
<td>$750</td>
<td></td>
<td>$2,000</td>
</tr>
<tr>
<td>(Roundabout)</td>
<td></td>
<td>Cost</td>
<td>Every 3 years</td>
<td></td>
<td>1 (yearly)</td>
<td></td>
<td>1 (yearly)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost Cycle</td>
<td>1 (yearly)</td>
<td></td>
<td></td>
<td>1 (yearly)</td>
<td></td>
</tr>
</tbody>
</table>

- 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 override by analyst
FDOT-ICE Tool - Delay

- Single intersection or detailed AM and PM peak delay inputs
  - Required for opening and design years
  - Optional specification of weekend peak, bicycle, and pedestrian delays

<table>
<thead>
<tr>
<th>Control Strategy</th>
<th>Delay Type</th>
<th>Delay Type</th>
<th>Units</th>
<th>AM peak</th>
<th>PM peak</th>
<th>Weekend peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Signal</td>
<td>Single Input</td>
<td>Single Input</td>
<td>sec/veh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roundabout</td>
<td>Single Input</td>
<td>Single Input</td>
<td>sec/veh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Displace Left Turn (DLT)</td>
<td>Detailed Inputs</td>
<td>Delay 1</td>
<td>sec/veh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delay 2</td>
<td>sec/veh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delay 3</td>
<td>sec/veh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delay 4</td>
<td>sec/veh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Single Input</td>
<td>Single Input</td>
<td>sec/veh</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FDOT-ICE Tool - Safety

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

<table>
<thead>
<tr>
<th>Control Strategy</th>
<th>Crash Type</th>
<th>Open Year</th>
<th>Design Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Signal</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roundabout</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Displace Left Turn (DLT)</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median U-Turn (MUT)</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unsignalized RCUT</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Green-T Intersection</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jughandle</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fatal &amp; Injury</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FDOT-ICE Tool Outputs

- Net present value of costs
- Net present value of Benefits
- Benefit-Cost Ratio

<table>
<thead>
<tr>
<th>Cost Categories</th>
<th>Net Present Value of Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base Case - Intx #1 (Existing Signal)</td>
</tr>
<tr>
<td>Planning &amp; Construction Costs</td>
<td>$ -</td>
</tr>
<tr>
<td>Right of Way Costs</td>
<td>$ -</td>
</tr>
<tr>
<td>Post-Opening Costs</td>
<td>$ 11,065</td>
</tr>
<tr>
<td>Auto Passenger Delay</td>
<td>$ 41,573,063</td>
</tr>
<tr>
<td>Truck Delay</td>
<td>$ 1,683,133</td>
</tr>
<tr>
<td>Safety</td>
<td>$ 54,949,530</td>
</tr>
<tr>
<td>Total cost</td>
<td>$98,216,792</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Benefit Categories</th>
<th>Net Present Value of Benefits Relative to Base Case</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intx #2 (Signal + Widening)</td>
</tr>
<tr>
<td>Auto Passenger Delay</td>
<td>$ (16,086,517)</td>
</tr>
<tr>
<td>Truck Delay</td>
<td>$ (651,281)</td>
</tr>
<tr>
<td>Safety</td>
<td>$ 4,912,050</td>
</tr>
<tr>
<td>Net Present Value of Benefits</td>
<td>$ (11,825,748)</td>
</tr>
<tr>
<td>Net Present Value of Costs</td>
<td>$ 3,997,176</td>
</tr>
<tr>
<td>Present Value of Net Benefits</td>
<td>$ (15,822,924)</td>
</tr>
<tr>
<td>Benefit-Cost Ratio</td>
<td>-2.96</td>
</tr>
</tbody>
</table>
FDOT ICE Tool - Outputs

Net Present Value of Total Costs

Total Net Present Value of Costs (Lower Cost is Better)

- $120,000,000
- $100,000,000
- $80,000,000
- $60,000,000
- $40,000,000
- $20,000,000
- $0

- Safety
- Truck Time
- Auto Passenger Time
- Post-Opening Costs
- Planning & Construction Costs
Synchro Default Values

- Library of SYNCHRO default files
  - Include proper default signal timings
- Review of documents for Florida Synchro practice:
  - FDOT Traffic Analysis Handbook (March 2014)
  - FDOT 2013 Quality/Level of Service Handbook
Florida Specific Synchro Parameters

• Review of documents for Florida Synchro practice:
  ▪ FDOT Traffic Analysis Handbook (March 2014)
  ▪ FDOT 2013 Quality/Level of Service Handbook

  › Default PHF is 0.95 for urban areas and 0.92 for other areas

  › Base saturation flow rate is 1,950 passenger cars per hour per lane (pchpl)

  › Allowed to use lane utilization factor of 1.0 if intersection is near or at capacity

  › No directions on heavy vehicle proportion or critical gap time
FDOT ICE Coordination Timeline

Development & Outreach
- ICE Peer Exchange (6/28/2016)
- Executive Management Direction (8/26/2016)
- DDE - F2F Meeting (10/27/2016)
- Access Management Statewide (12/2/2016)
- ICE Development TWO (2/2/2017)
- Director of Ops Presentation (2/6/2017)
- DTOE - F2F Meeting (3/29/2017)
- FICE (5/11/2017)

District Visits
- Districts 1 and 7 (5/10/2017)
- Districts 5 and TP (5/11/2017)
- Districts 4 and 6 (5/16/2017)
- District 2 (5/17/2017)
- District 3 (6/01/2017)
Discussion & Questions