Innovative Intersection Traffic Modeling

Tips, Tricks, & Things You May Have Missed

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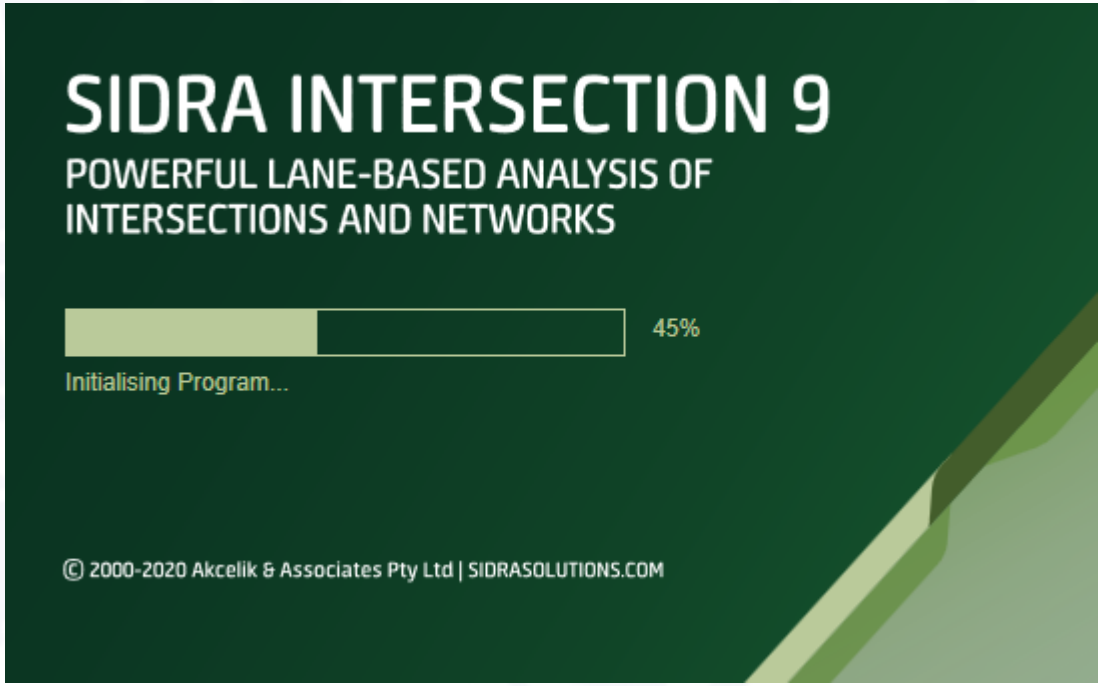
Part 1: Modeling Tools

What are they, how are they different, and which one should I use?

What Modeling Tools Do We Use?

- HCS
- Synchro
- SIDRA
- VISSIM

PTV VISSIM



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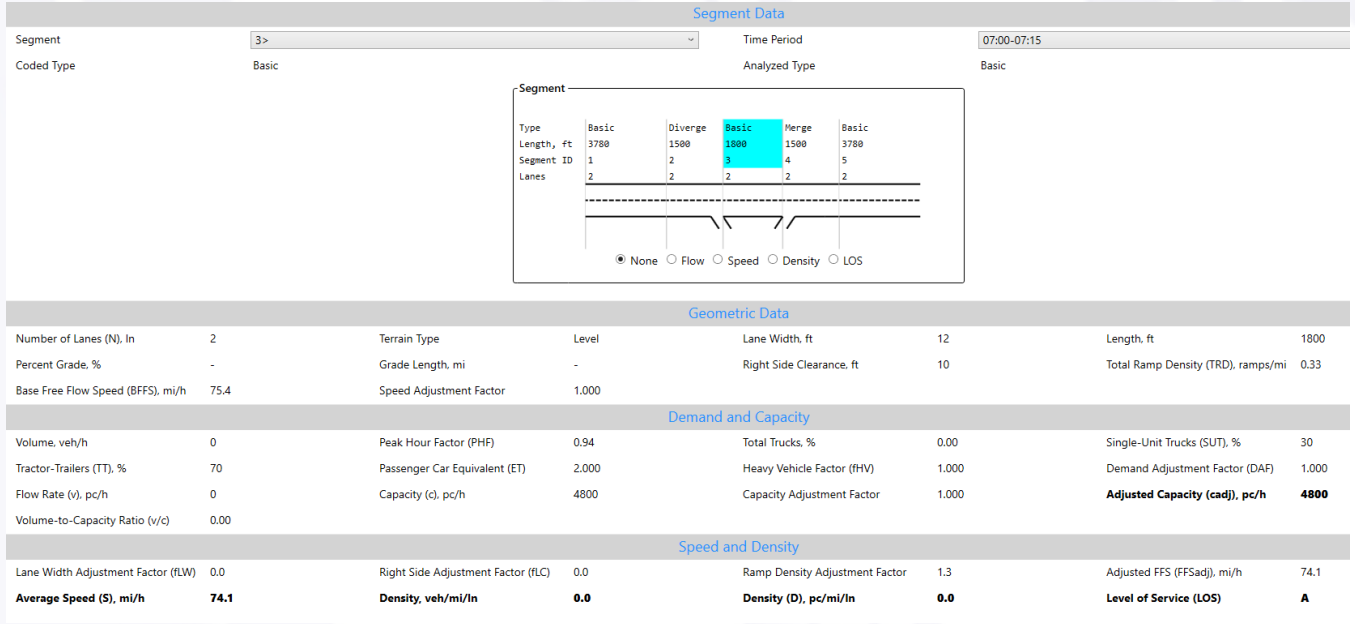
Highway Capacity Software (HCS, v7)

- Most basic application of the HCM
- Module based (e.g. basic freeway, two-lane highway, TWSC, etc.)
- No simulation, only basic analysis results
- **Best for:** simple analyses, basic freeway analysis, passing lanes
- **Not well suited for:** Simulation, complex analyses



Segment Data

Segment	3>	Time Period	07:00-07:15
Coded Type	Basic	Analyzed Type	Basic

Segment

Type	Basic	Diverge	Basic	Merge	Basic
Length, ft	3780	1500	1800	1500	3780
Segment ID	1	2	3	4	5
Lanes	2	2	2	2	2

None Flow Speed Density LOS

Geometric Data

Number of Lanes (N), ln	2	Terrain Type	Level	Lane Width, ft	12	Length, ft	1800
Percent Grade, %	-	Grade Length, mi	-	Right Side Clearance, ft	10	Total Ramp Density (TRD), ramps/mi	0.33
Base Free Flow Speed (BFFS), mi/h	75.4	Speed Adjustment Factor	1.000				

Demand and Capacity

Volume, veh/h	0	Peak Hour Factor (PHF)	0.94	Total Trucks, %	0.00	Single-Unit Trucks (SUT), %	30
Tractor-Trailers (TT), %	70	Passenger Car Equivalent (ET)	2.000	Heavy Vehicle Factor (fHV)	1.000	Demand Adjustment Factor (DAF)	1.000
Flow Rate (v), pc/h	0	Capacity (c), pc/h	4800	Capacity Adjustment Factor	1.000	**Adjusted Capacity (cadj), pc/h**	**4800**
Volume-to-Capacity Ratio (v/c)	0.00						

Speed and Density

Lane Width Adjustment Factor (fLW)	0.0	Right Side Adjustment Factor (fLC)	0.0	Ramp Density Adjustment Factor	1.3	Adjusted FFS (FFSadj), mi/h	74.1
Average Speed (S), mi/h	**74.1**	**Density, veh/mi/ln**	**0.0**	**Density (D), pc/mi/ln**	**0.0**	**Level of Service (LOS)**	**A**

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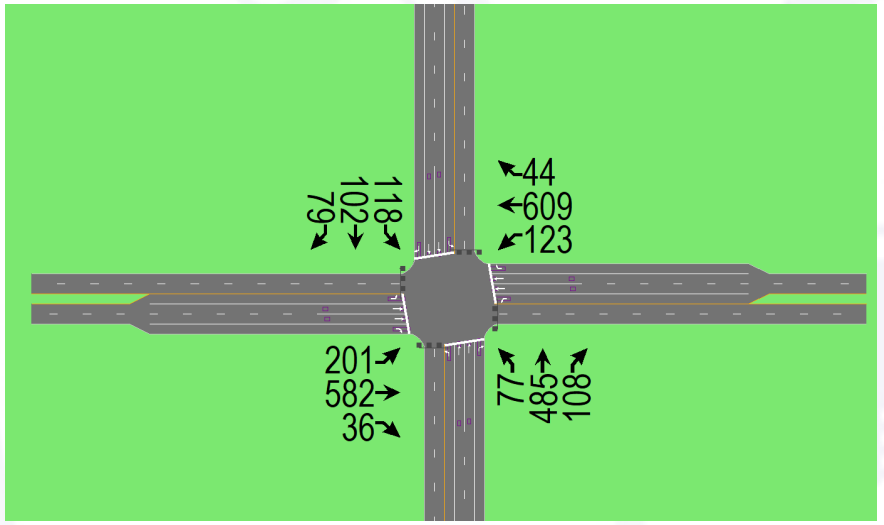
Synchro (v11)

- Application of HCM methodology
- Signals and signal operations
- Both HCM analysis results and simulation-based results.
- **Best for:** Signalized corridor analysis, urban arterials, intersection improvement analysis
- **Not well suited for:** Complex analyses, freeway/free-flow conditions



HCM 6th Signalized Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	26	529	0	3	699	160	11	1	1	158	0	21
Future Volume (veh/h)	26	529	0	3	699	160	11	1	1	158	0	21
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1470	1796	1900	1900	1752	1559	1900	1900	418	1307	1900	1707
Adj Flow Rate, veh/h	40	811	0	5	1071	245	17	2	2	242	0	32
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	29	7	0	0	10	23	0	0	100	40	0	13
Cap, veh/h	103	1103	0	53	1073	812	234	28	18	489	0	372
Arrive On Green	0.61	0.61	0.00	0.20	0.20	0.20	0.26	0.26	0.26	0.26	0.00	0.26
Sat Flow, veh/h	328	1796	0	2	1747	1321	550	109	69	1500	0	1447
Grp Volume(v), veh/h	40	811	0	1076	0	245	21	0	0	242	0	32
Grp Sat Flow(s),veh/h/ln	328	1796	0	1749	0	1321	728	0	0	1500	0	1447
Q Serve(g_s), s	0.0	22.2	0.0	8.6	0.0	11.0	0.3	0.0	0.0	0.0	0.0	1.2
Cycle Q Clear(g_c), s	43.0	22.2	0.0	43.0	0.0	11.0	9.9	0.0	0.0	9.6	0.0	1.2
Prop In Lane	1.00		0.00	0.00		1.00	0.81		0.10	1.00		1.00
Lane Grp Cap(c), veh/h	103	1103	0	1126	0	812	280	0	0	489	0	372
V/C Ratio(X)	0.39	0.73	0.00	0.96	0.00	0.30	0.07	0.00	0.00	0.50	0.00	0.09
Avail Cap(c_a), veh/h	103	1103	0	1126	0	812	280	0	0	489	0	372
HCM Platoon Ratio	1.00	1.00	1.00	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	0.91	0.00	0.91	1.00	0.00	0.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	35.0	9.5	0.0	27.9	0.0	15.2	21.5	0.0	0.0	22.9	0.0	19.8
Incr Delay (d2), s/veh	10.7	4.4	0.0	16.9	0.0	0.9	0.5	0.0	0.0	3.6	0.0	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	7.5	0.0	24.7	0.0	3.6	0.3	0.0	0.0	3.8	0.0	0.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	45.7	13.9	0.0	44.8	0.0	16.0	22.1	0.0	0.0	26.4	0.0	20.2
LnGrp LOS	D	B	A	D	A	B	C	A	A	C	A	C

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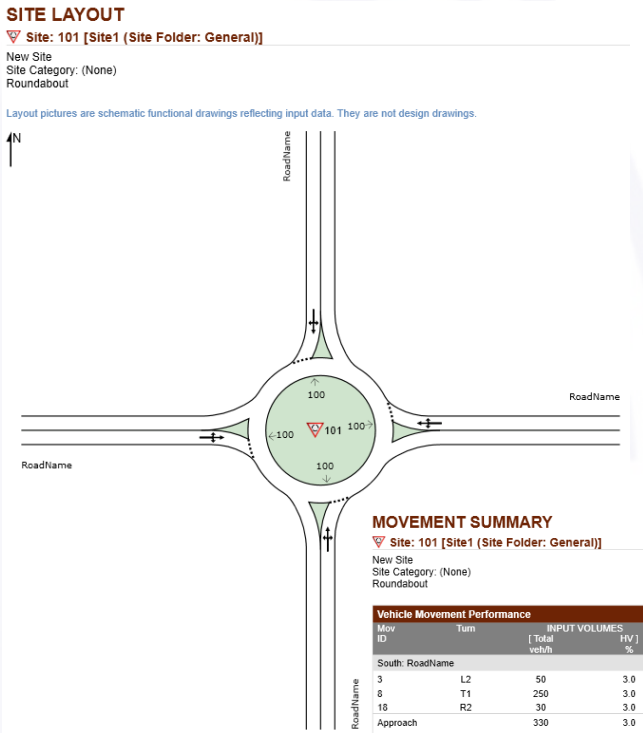
SIDRA (v9)

- INDOT's preferred software for modeling roundabouts
- See INDOT Traffic Analysis Procedures for important SIDRA defaults
- Provides additional calibration and configuration parameters
- **Best for:** Roundabouts (Standalone or interchange
- **Not well suited for:** Non-roundabout analysis



SITE LAYOUT

Site: 101 [Site1 (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.

MOVEMENT SUMMARY

Site: 101 [Site1 (Site Folder: General)]

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service
South: RoadName								
3	L2	50	3.0	54	3.0	0.443	10.2	LOS B
8	T1	250	3.0	272	3.0	0.443	10.2	LOS B
18	R2	30	3.0	33	3.0	0.443	10.2	LOS B
Approach		330	3.0	359	3.0	0.443	10.2	LOS B
East: RoadName								
1	L2	79	3.0	86	3.0	0.381	8.6	LOS A
6	T1	180	3.0	196	3.0	0.381	8.6	LOS A
16	R2	43	3.0	47	3.0	0.381	8.6	LOS A
Approach		302	3.0	328	3.0	0.381	8.6	LOS A
North: RoadName								
7	L2	4	3.0	4	3.0	0.163	5.4	LOS A
4	T1	121	3.0	132	3.0	0.163	5.4	LOS A
14	R2	16	3.0	17	3.0	0.163	5.4	LOS A
Approach		141	3.0	153	3.0	0.163	5.4	LOS A
West: RoadName								
5	L2	87	3.0	95	3.0	0.522	9.6	LOS A
2	T1	351	3.0	382	3.0	0.522	9.6	LOS A
12	R2	72	3.0	78	3.0	0.522	9.6	LOS A
Approach		510	3.0	554	3.0	0.522	9.6	LOS A
All Vehicles		1283	3.0	1395	3.0	0.522	9.1	LOS A

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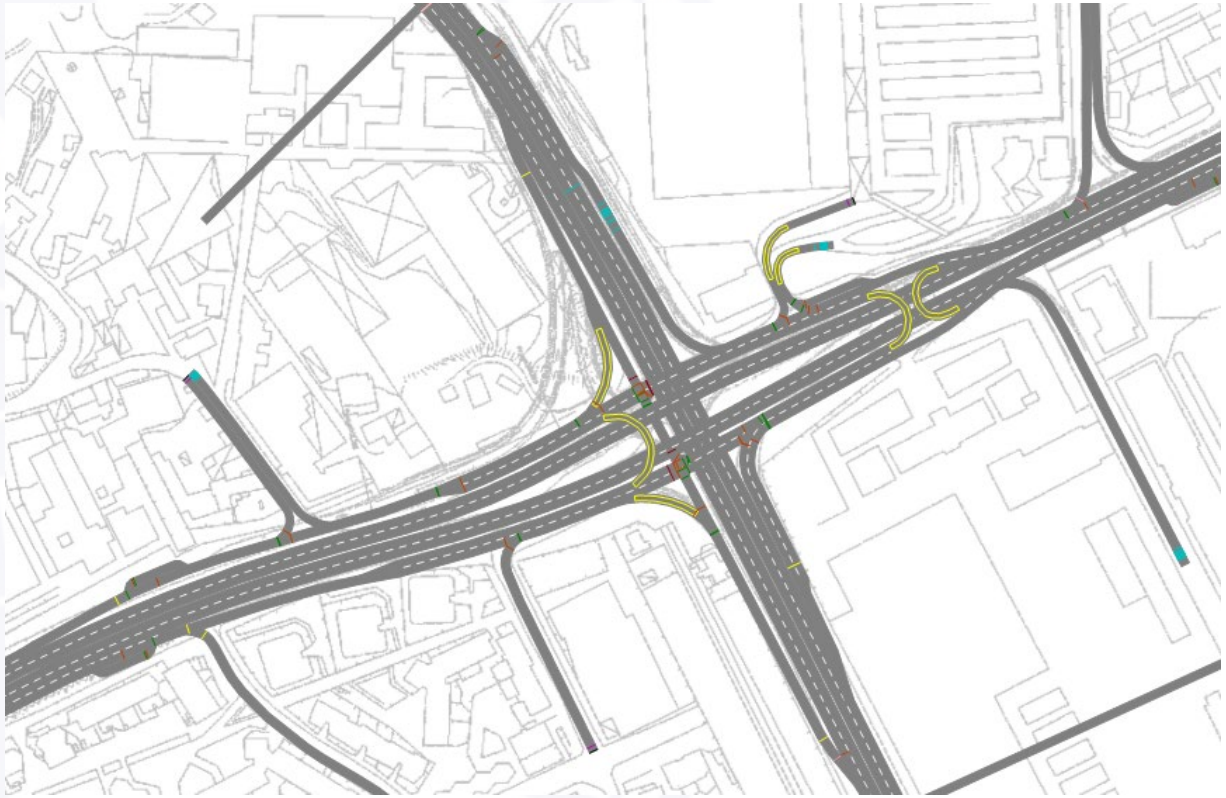
PTV VISSIM (v2023)

- Complex microsimulation software
- Can handle freeway simulation and freeway/arterial interactions
- **Best for:** Complex freeway interactions & complex alternative intersection corridors
- **Not well suited for:** Simple analyses where HCM results are all that are needed.



When should I use Synchro (or VISSIM, or HCS, etc)?

Intersection Form	HCM/HCS	Synchro/SimTraffic	SIDRA	Vissim
Standard	✓	✓		
Median U-Turn		✓		✓
Roundabout	✓		✓	✓
Arterial System	✓	✓		
Displaced Left Turn	✓	✓		✓
Other Forms		✓		✓

This is only a guide - see INDOT Intersection Traffic Analysis Procedures for more information.

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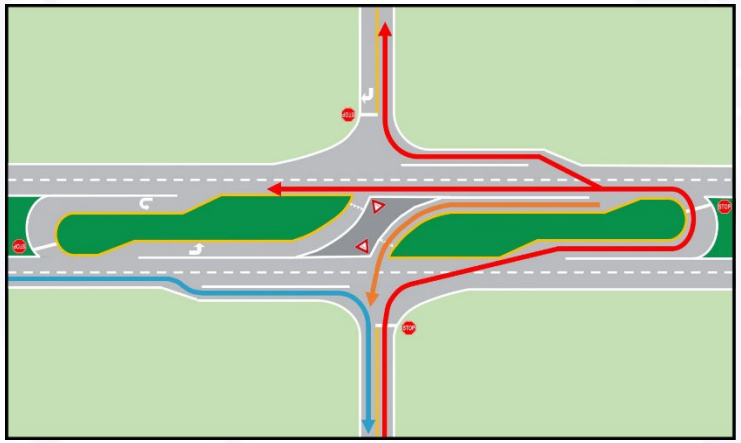
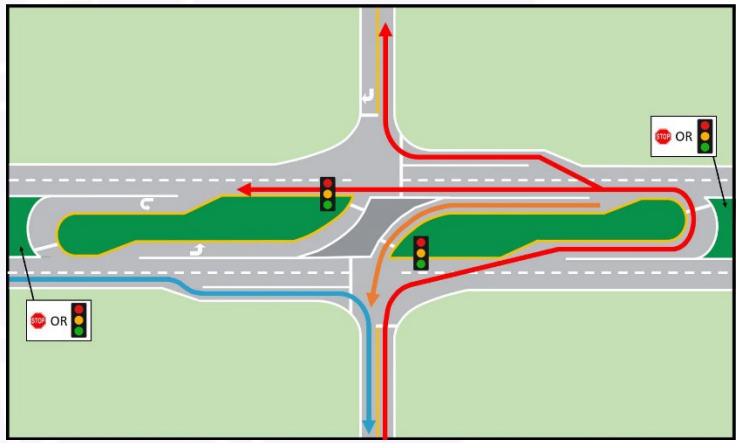
Part 2: Modeling Innovative Intersections

Aka: What the heck is O-D balancing and why is it important?

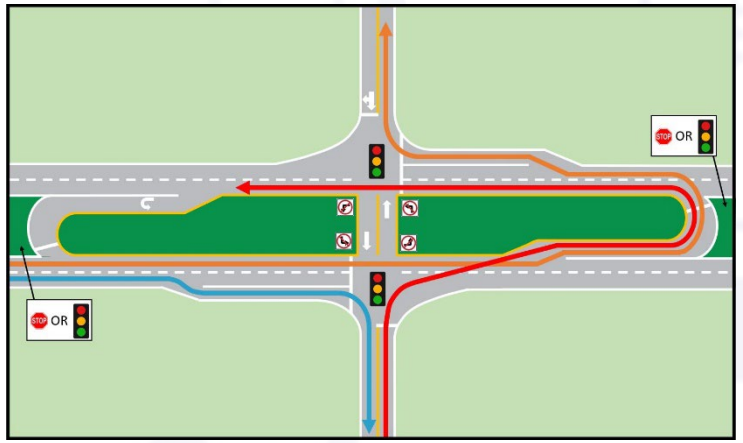
Median U-Turns (RCIs, RCUTs, Boulevard Lefts)



Reduced Conflict Intersection (RCI)

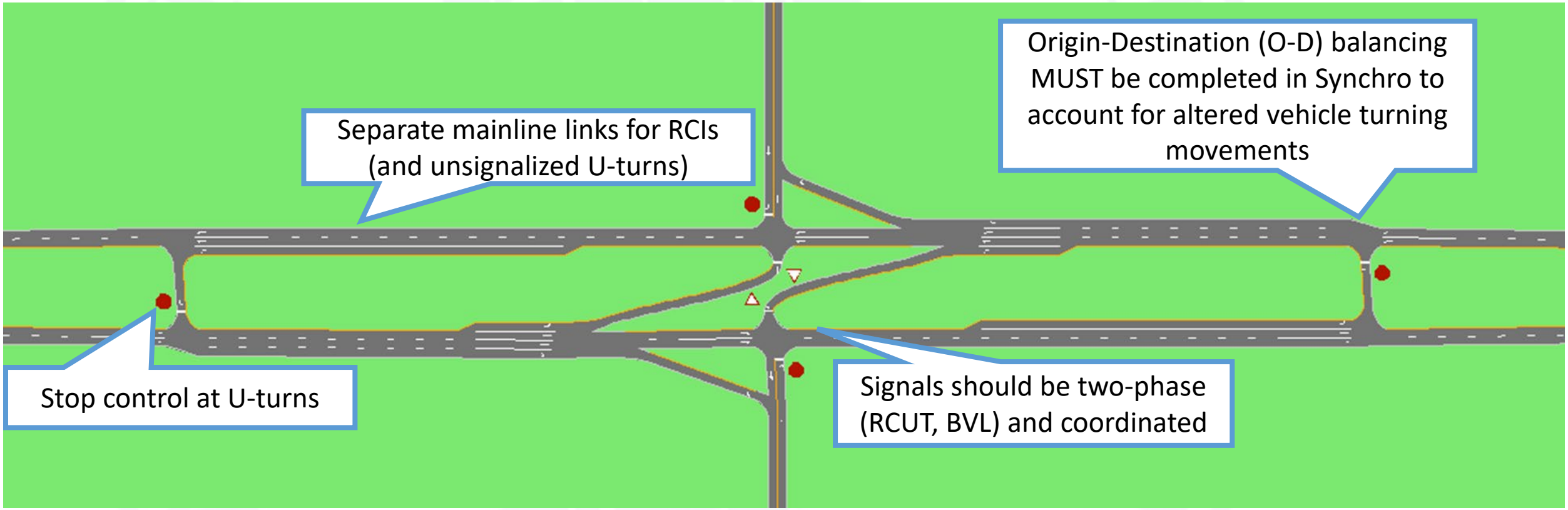


Restricted Crossing U-Turn Intersection (RCUT)



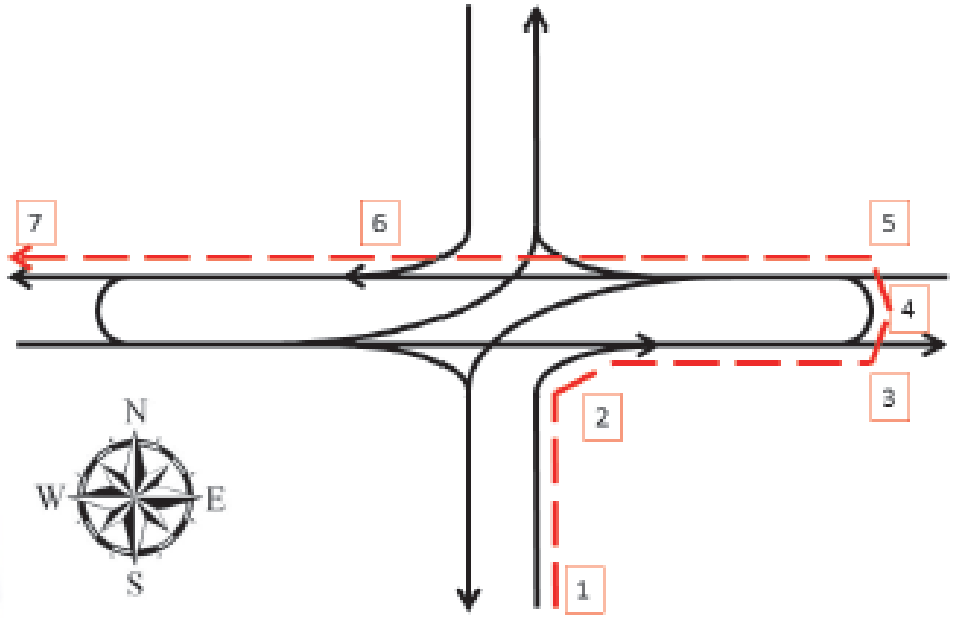
Boulevard Left Turn Intersection

Median U-Turn Modeling



Median U-Turn Analysis and Measures Of Effectiveness (MOEs)

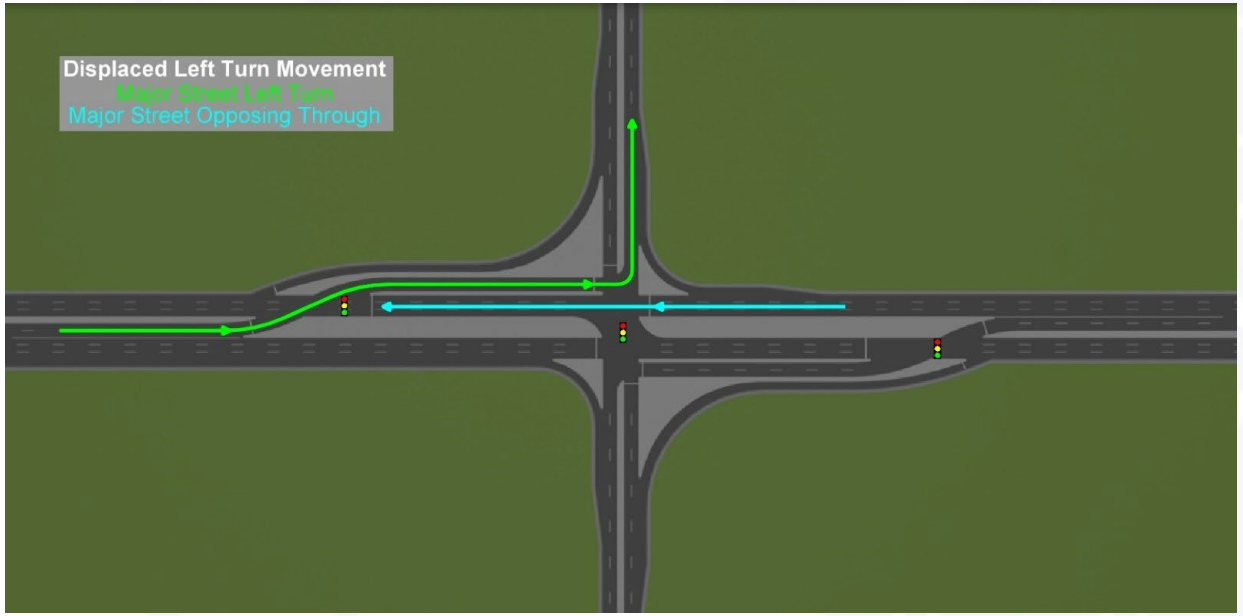
- HCM Chapter 23
  - LOS of intersections not enough
- Experienced Travel Time (ETT)
  - Evaluates impact of rerouted turning movements
- HCM provides guidance for converting ETT to LOS
- Will likely require hand calculations to supplement Synchro results – consider HCS



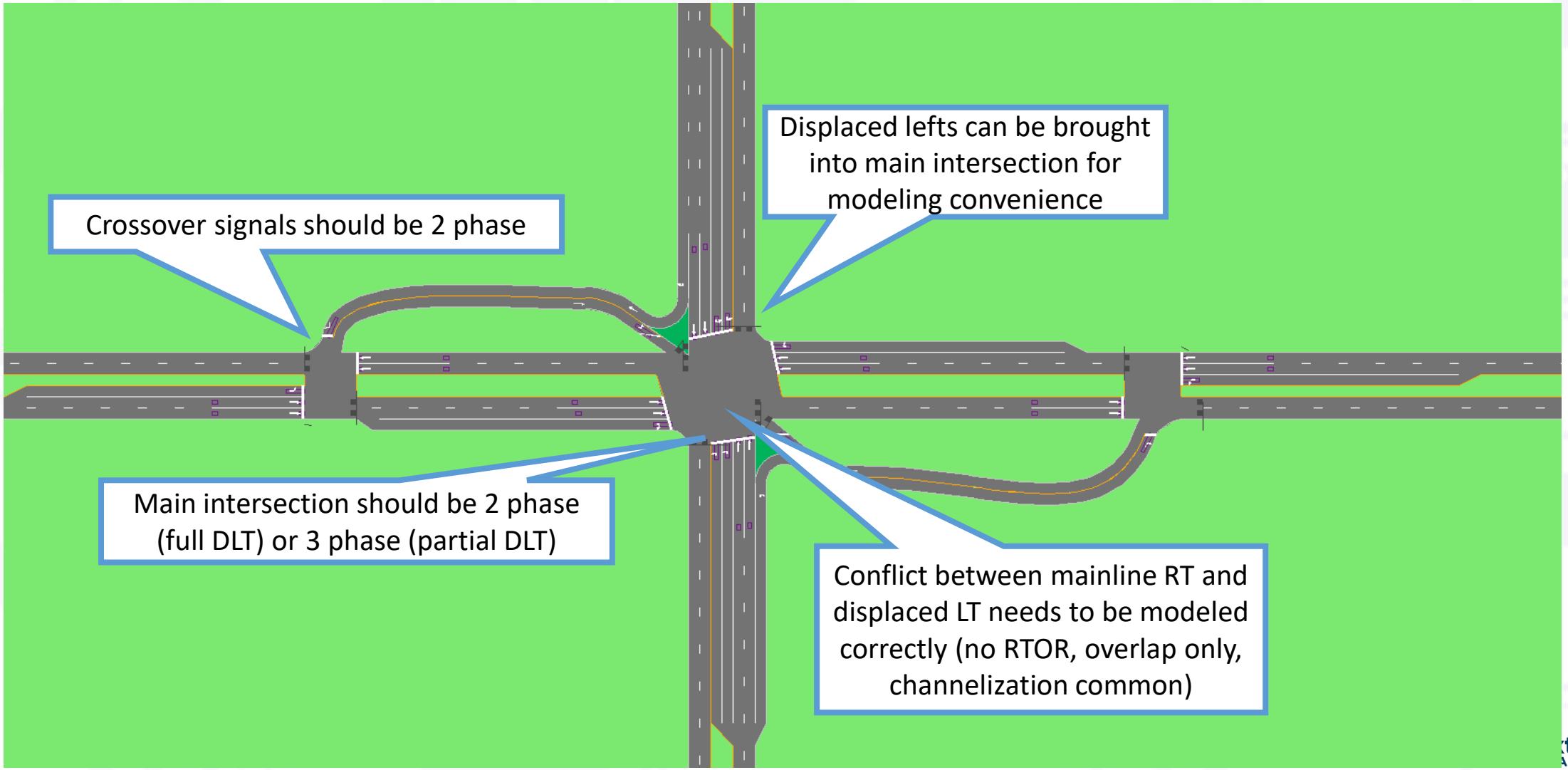
ETT includes:

- Control delay at 2 & 4
- Diverted-path travel times (2-3 and 5-6)

Displaced Left Turns

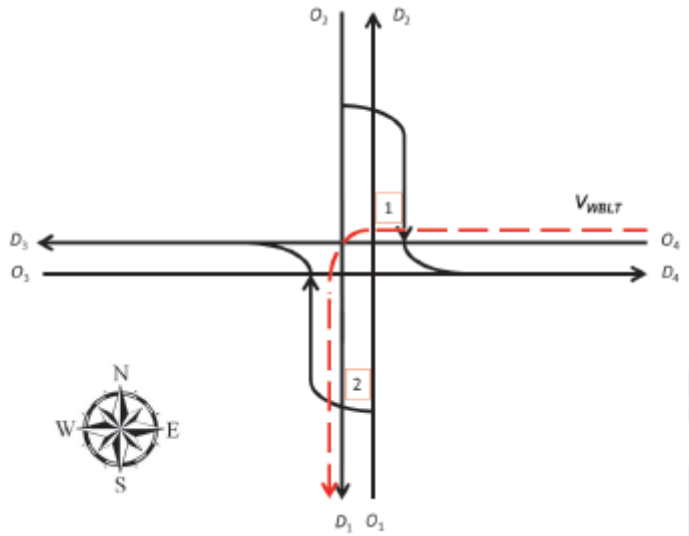


Displaced Left Turn Modeling



Displaced Left Turn Analysis and MOEs

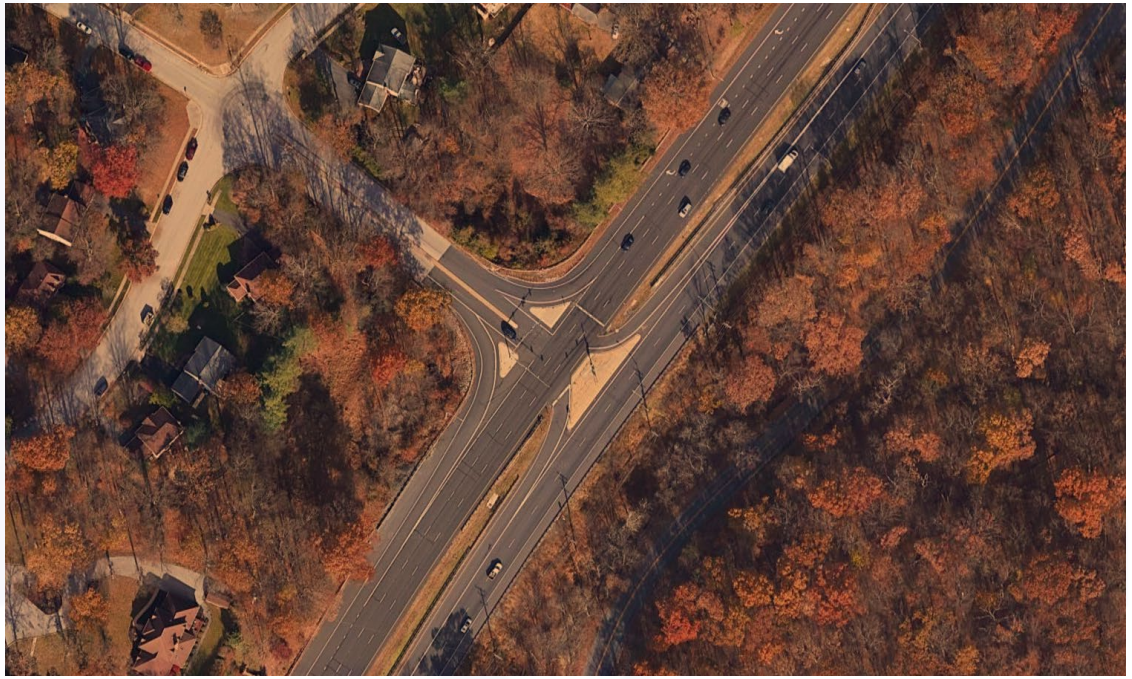
- Similar to MUTs – HCM Chapter 23
  - LOS is not enough
- Experienced Travel Time (ETT)
  - Can be converted to LOS
- Typically negligible additional travel distance, but control delay at multiple points
- Will likely require hand calculations to supplement Synchro results – consider HCS



ETT includes:

- Control delay at 1 & 2

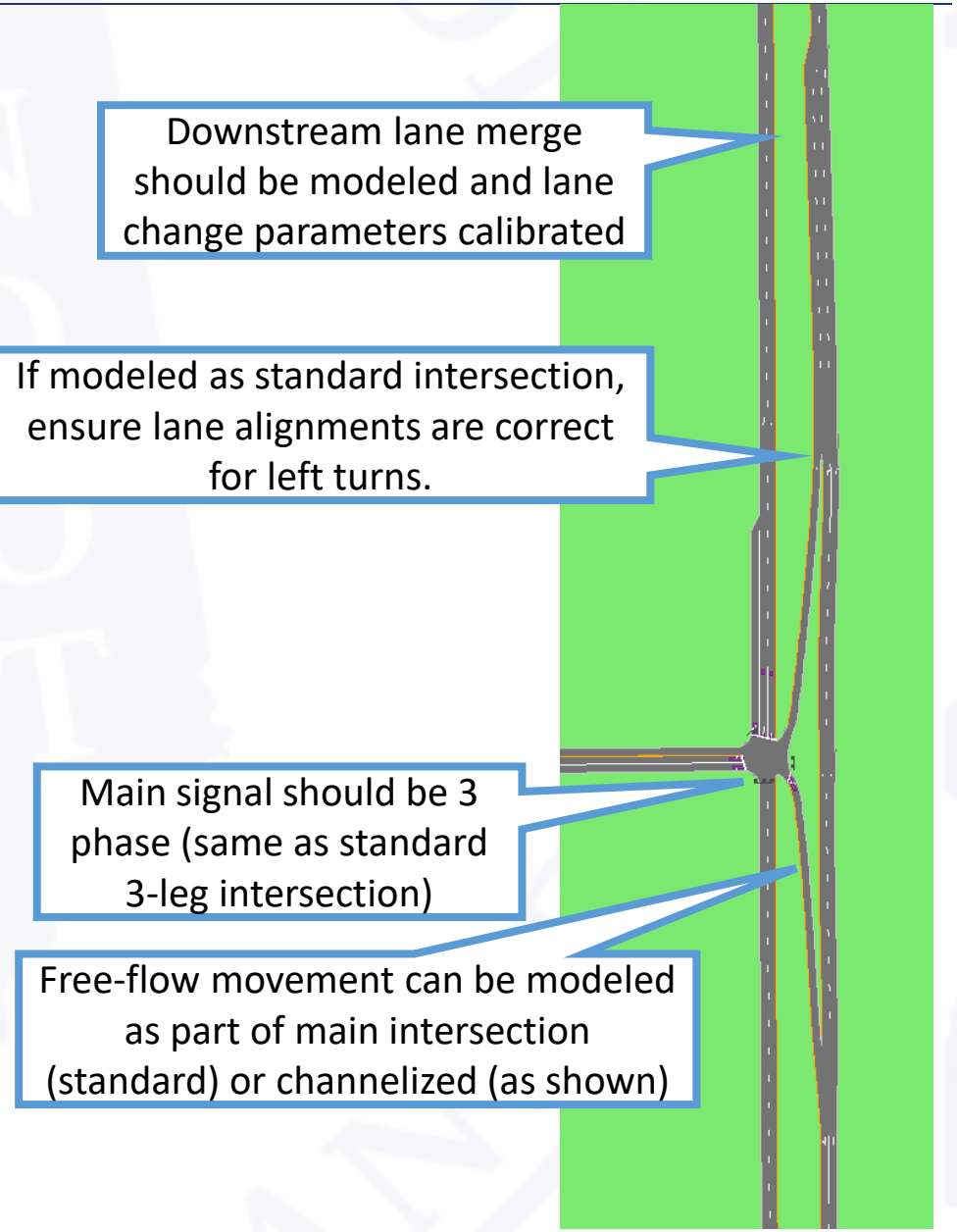
Green T Intersection



US 40 at River's Edge Rd, Columbia, MD

Green T Intersection Modeling and Analysis

- Model is similar to standard 3-leg intersection
- MOEs and analysis similar to standard 3-leg intersection



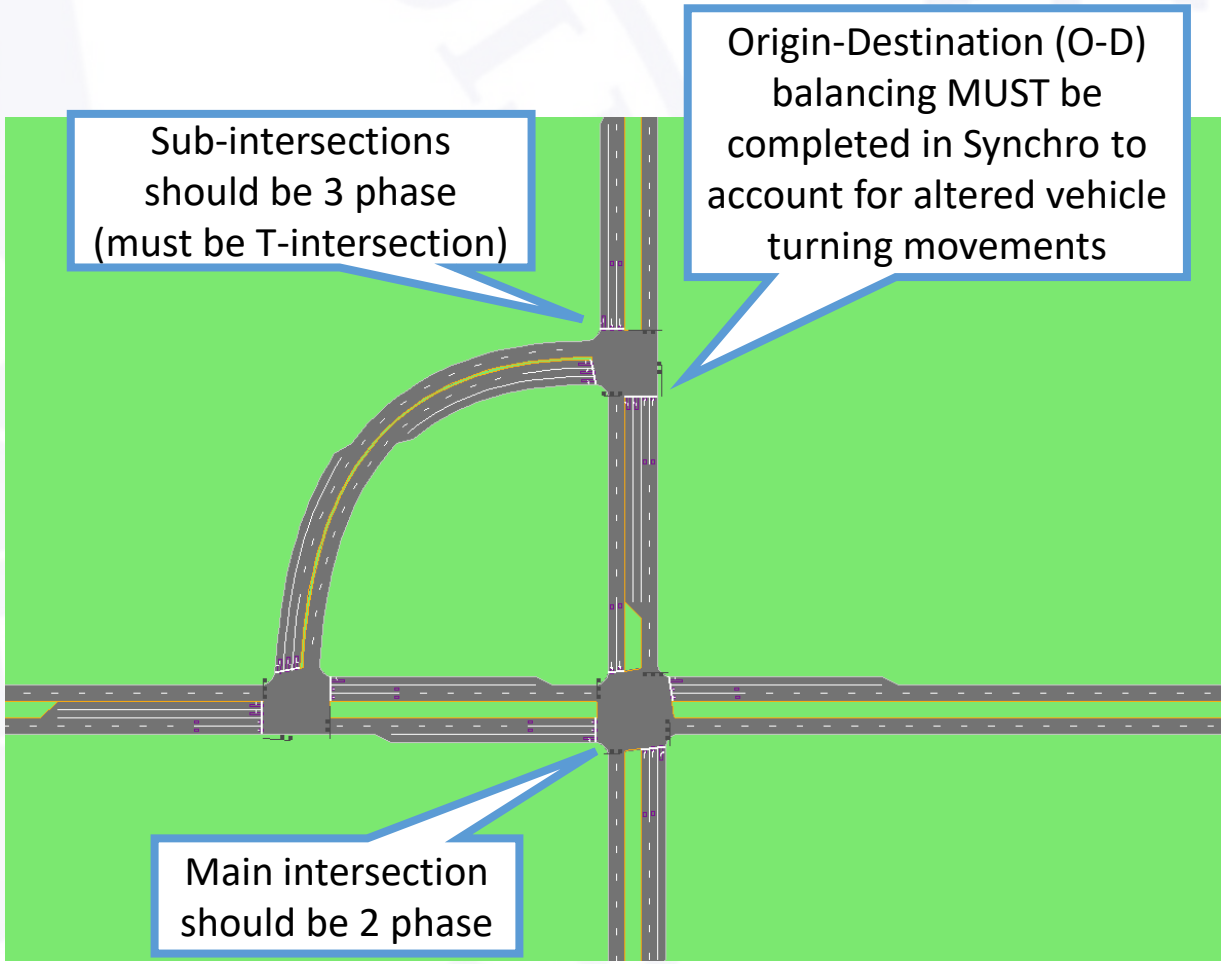
Quadrant Roadway

OH 4 at Dixie Highway, Fairfield, OH

Quadrant Roadway Modeling and Analysis

- Not explicitly discussed in HCM
- ETT concept still applies
  - Control delay + diverted path TT

- Generally, ETT will apply to most innovative intersections/interchanges
  - New HCM may provide additional guidance

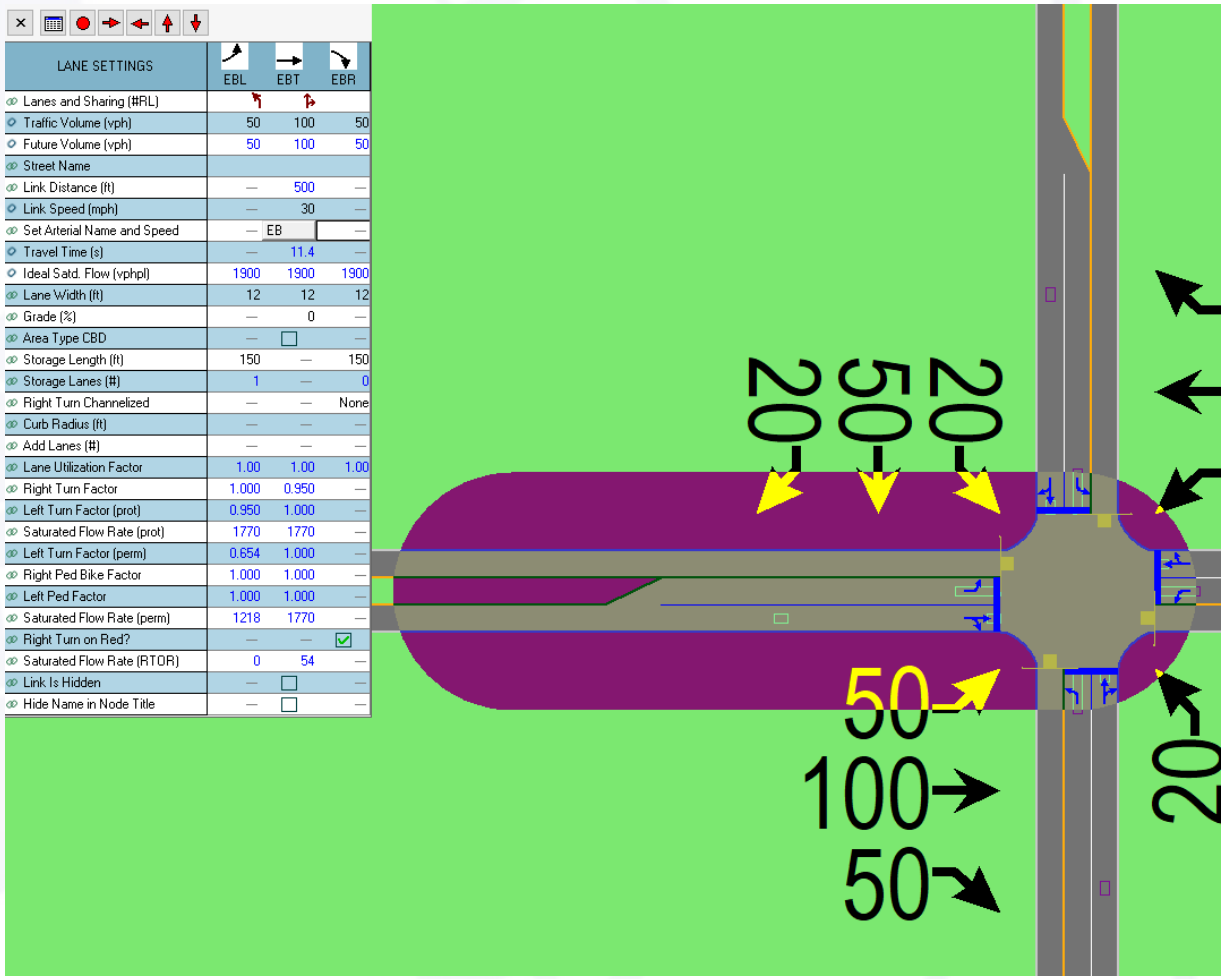


Commonly Missed Items in Modeling

Lane Settings

- Avoid short links and “endless” turn lanes
- Model lane drops accurately
- Link speeds need to be set accurately
- Don’t use nodes to create a curve

LANE SETTINGS	EBL	EBT	EBR
Lanes and Sharing (#RL)			
Traffic Volume (vph)	50	100	50
Future Volume (vph)	50	100	50
Street Name			
Link Distance (ft)	—	500	—
Link Speed (mph)	—	30	—
Set Arterial Name and Speed	—	EB	—
Travel Time (s)	—	11.4	—
Ideal Satd. Flow (vphpl)	1900	1900	1900
Lane Width (ft)	12	12	12
Grade (%)	—	0	—
Area Type CBD	—	☐	—
Storage Length (ft)	150	—	150
Storage Lanes (#)	1	—	0
Right Turn Channelized	—	—	None
Curb Radius (ft)	—	—	—
Add Lanes (#)	—	—	—
Lane Utilization Factor	1.00	1.00	1.00
Right Turn Factor	1.000	0.950	—
Left Turn Factor (prot)	0.950	1.000	—
Saturated Flow Rate (prot)	1770	1770	—
Left Turn Factor (perm)	0.654	1.000	—
Right Ped Bike Factor	1.000	1.000	—
Left Ped Factor	1.000	1.000	—
Saturated Flow Rate (perm)	1218	1770	—
Right Turn on Red?	—	—	☑
Saturated Flow Rate (RTOR)	0	54	—
Link Is Hidden	—	☐	—
Hide Name in Node Title	—	☐	—



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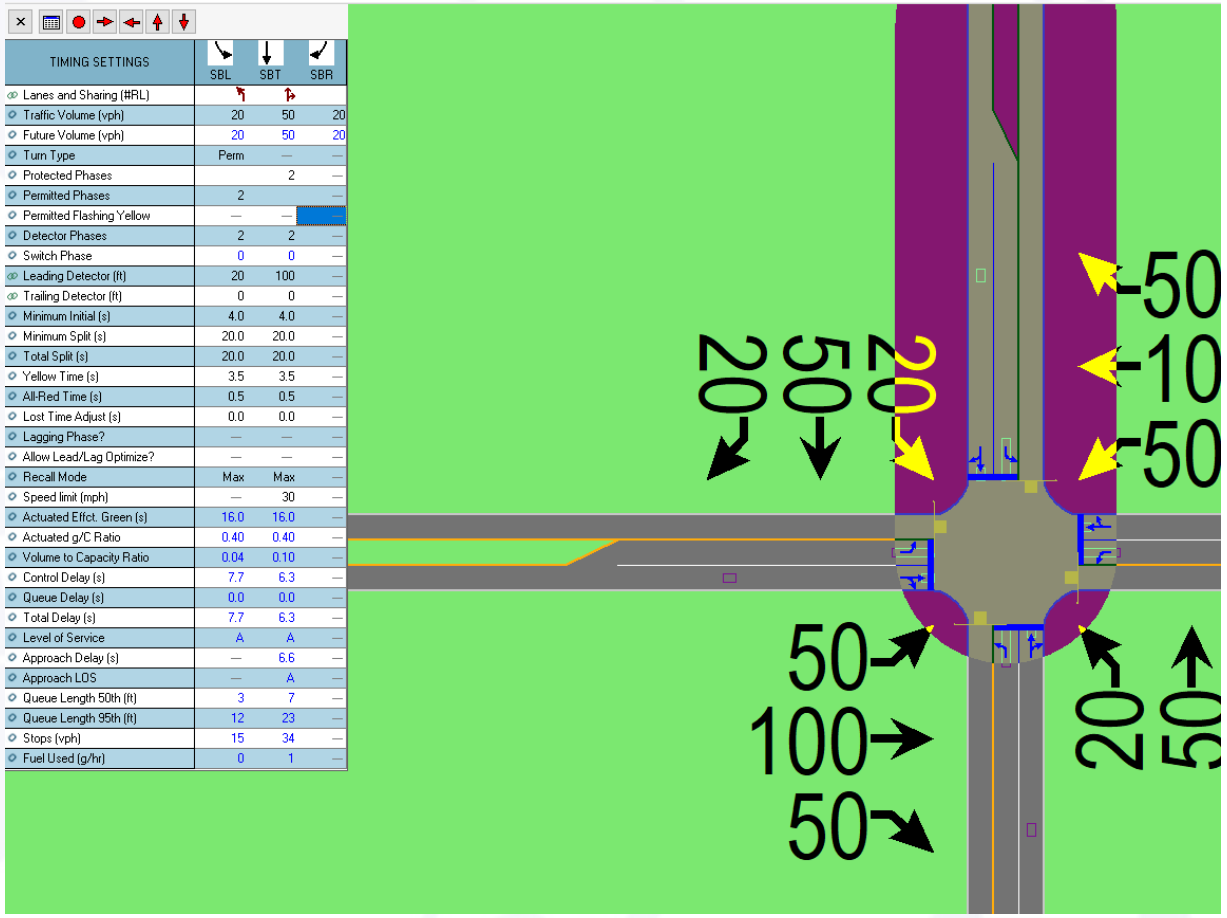
Commonly Missed Items in Modeling

Volume & Signal Settings

- PHF and Heavy Vehicles should not be left at default values
  - Don’t set PHF by movement
- Traffic volumes should be (reasonably) balanced
- Pedestrian phases should be configured
- For coordinated signals, set reference phase

TIMING SETTINGS	SBL	SBT	SBR
Lanes and Sharing (#RL)			
Traffic Volume (vph)	20	50	20
Future Volume (vph)	20	50	20
Turn Type	Perm	—	—
Protected Phases		2	—
Permitted Phases	2		—
Permitted Flashing Yellow	—	—	—
Detector Phases	2	2	—
Switch Phase	0	0	—
Leading Detector (ft)	20	100	—
Trailing Detector (ft)	0	0	—
Minimum Initial (s)	4.0	4.0	—
Minimum Split (s)	20.0	20.0	—
Total Split (s)	20.0	20.0	—
Yellow Time (s)	3.5	3.5	—
All-Red Time (s)	0.5	0.5	—
Lost Time Adjust (s)	0.0	0.0	—
Lagging Phase?	—	—	—
Allow Lead/Lag Optimize?	—	—	—
Recall Mode	Max	Max	—
Speed limit (mph)	—	30	—
Actuated Effct. Green (s)	16.0	16.0	—
Actuated g/C Ratio	0.40	0.40	—
Volume to Capacity Ratio	0.04	0.10	—
Control Delay (s)	7.7	6.3	—
Queue Delay (s)	0.0	0.0	—
Total Delay (s)	7.7	6.3	—
Level of Service	A	A	—
Approach Delay (s)	—	6.6	—
Approach LOS	—	A	—
Queue Length 50th (ft)	3	7	—
Queue Length 95th (ft)	12	23	—
Stops (vph)	15	34	—
Fuel Used (g/hr)	0	1	—



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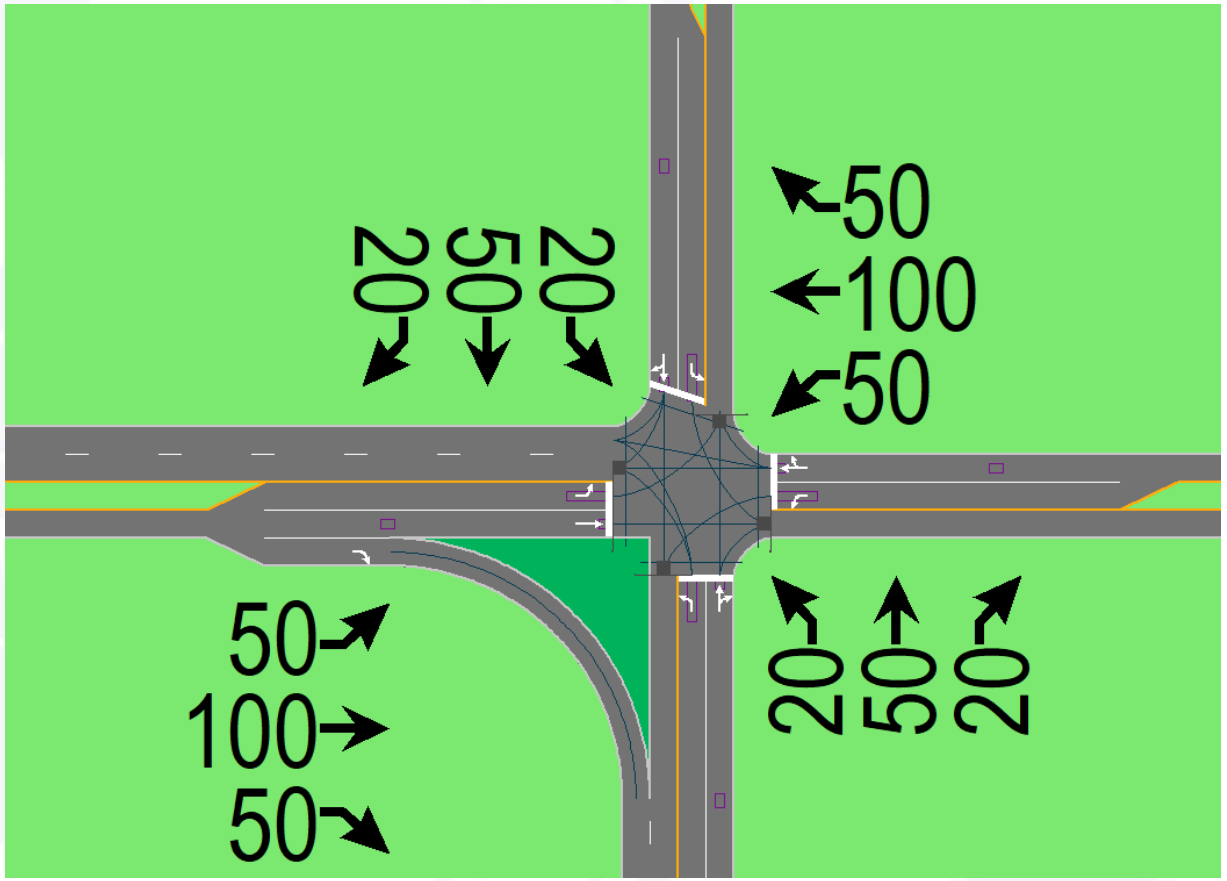
Commonly Missed Items in Modeling

Other Settings

- Check for and resolve errors
- Change turning speeds where appropriate
- Change lane alignments where appropriate
- Simulations should run with 15 min seed time and 60 min simulation
- Report HCM 6th Edition results, not Synchro results**
- Use scenario manager

**In select cases (alternative intersections), HCM results are unavailable. Synchro results are acceptable in these cases



INDOT Expectations for Traffic Modeling

- **What Growth Rate Should I use?**
  - Check with INDOT at the start of every project – no assumptions!
- **Should I balance and adjust my counts?**
  - Yes! Counts need to be adjusted to be more representative of typical traffic and balanced to ensure corridor consistency
- **What Measures of Effectiveness (MOE) are appropriate?**
  - Not just LOS
  - LOS, Delay, V/C ratio, Queue Length, and Travel Time all have their uses
- **Model Quality**
  - Use our Synchro checklist
  - Run error checking in Synchro and resolve as appropriate
  - Validate that the model results make sense – Did we model reality?
  - Submit completed models to INDOT for review and future reference on every project

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Helpful Links

- INDOT Traffic Engineering Division (https://www.in.gov/indot/traffic-engineering/)
- INDOT Intersection Decision Guide (IDG) (https://www.in.gov/indot/traffic-engineering/corridor-development-office/)
- INDOT Traffic Analysis Procedures (https://www.in.gov/indot/traffic-engineering/corridor-development-office/)
- INDOT Synchro Review Checklist (https://www.in.gov/indot/traffic-engineering/corridor-development-office/)
- FHWA Cap-X Tool (https://www.fhwa.dot.gov/software/research/operations/capx/)
- VDOT Innovative Intersection Page (https://www.virginiadot.org/innovativeintersections/)
- Highway Capacity Manual – Chapter 23

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Questions?

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- http://michiganhighways.org/indepth/michigan_left.html
- Highway Capacity Manual, Transportation Research Board

Thank you!