Alternative Intersection Analysis Using SIDRA INTERSECTION

ITEANZ
Innovative Intersections Seminar
Melbourne, 5 Nov 2015

Rahmi Akçelik and Mark Besley
SIDRA SOLUTIONS

Presenter: David Nash
TRAFFINITY

SIDRA SOLUTIONS

Alternative Intersection Analysis Using SIDRA INTERSECTION

Contents of this presentation:

1. Resources on Alternative Intersections
2. SIDRA INTERSECTION Network Model (Introduction)
3. Interchanges and Alternative Intersections Using SIDRA INTERSECTION
4. An Interchange Comparison Example

Alternative Intersection Analysis Using SIDRA INTERSECTION

1. Resources on Alternative Intersections

Useful Sources on Alternative Intersections

- FHWA (2010). Alternative Intersections/Interchanges: Informational Report. US Department of Transportation, Federal Highway Administration, McLean, Virginia, USA. [324 page document]
- HIGHWAY CAPACITY MANUAL (2015 / 2016), Chapter 23 (Ramp Terminals and Alternative Intersections). [Forthcoming major edition of HCM]
- TONDER et al (2013). Diverging diamond interchange – an innovative way of managing traffic at a standard diamond interchange. AITPM National Conference, Perth, Australia. [An application in South Africa]
- WIKIPEDIA: Continuous-Flow Intersection and Diverging Diamond Interchange topics. [Useful references]

FHWA (2010). Alternative Intersections/Interchanges: Informational Report

Selected alternative intersection and interchange treatments in the United States and other countries:

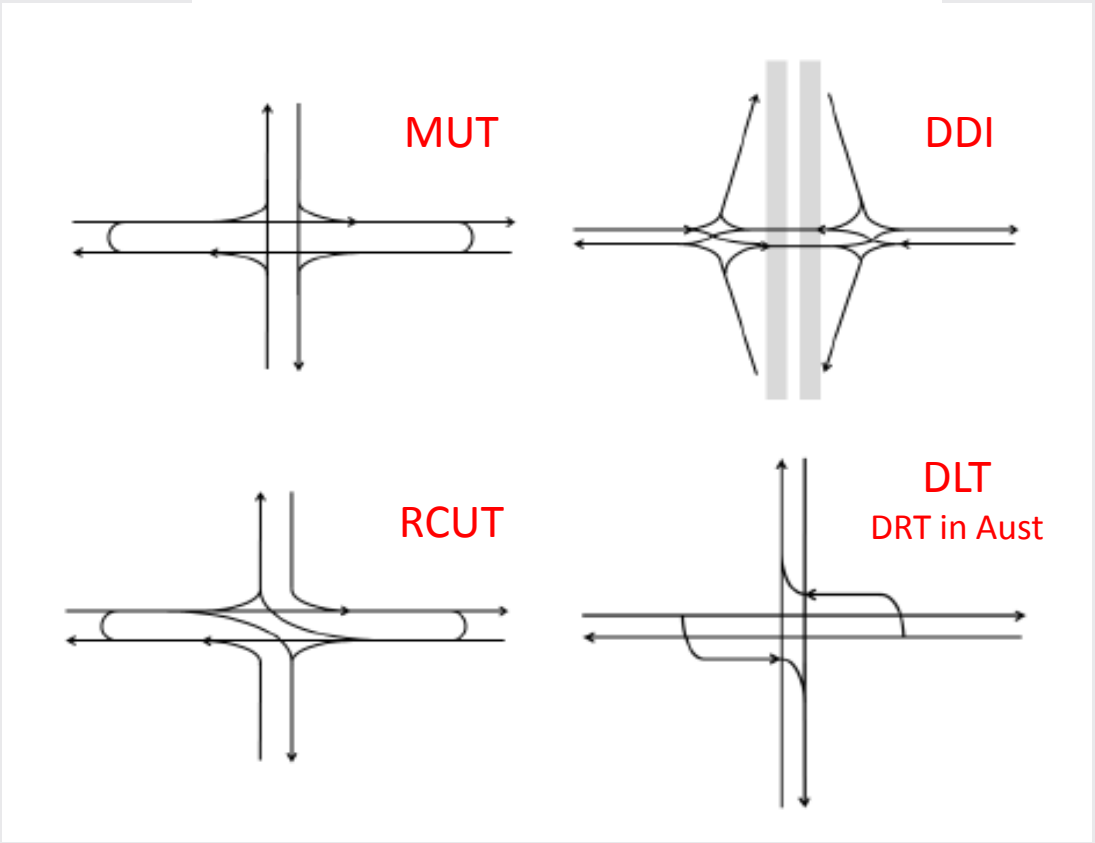
- **Displaced left-turn (DLT) intersection**
- **Median U-turn (MUT) intersection**
- **Restricted crossing U-turn (RCUT) intersection**
- **Quadrant roadway (QR) intersection**
- **Double crossover diamond (DCD) interchange [Diverging Diamond Interchange (DDI)]**
- **DLT interchange**

Highway Capacity Manual (2015 / 2016), Chapter 23 (Ramp Terminals and Alternative Intersections)

Alternative intersection types:

- Diverging Diamond Interchanges (DDI)
- Median U-turn (MUT) intersections
- Displaced left-turn (DLT) intersections
- Restricted crossing U-turn (RCUT) intersections

Converted to left side driving

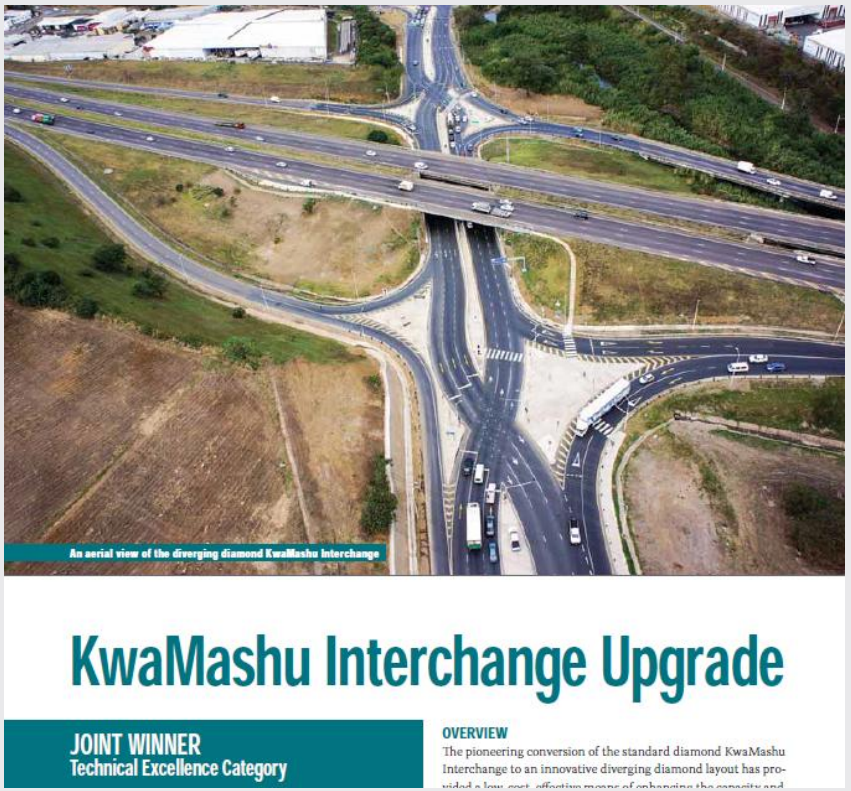


SIDRA SOLUTIONS

TONDER et al (2013). Diverging diamond interchange – an innovative way of managing traffic at a standard diamond interchange.

"The design of the conversion of the KwaMashu interchange (on National Route 2 north of Durban) from a standard diamond to a diverging diamond layout is complete and construction of the conversion commenced in June 2012 and is due for completion in May 2013. This will be the very first diverging diamond interchange to be implemented in the Southern Hemisphere."

Also see:
www.civildesigner.com/press/kwamashu.pdf



SIDRA SOLUTIONS

Continuous Flow Intersection (CFI) and other types

HUMMER, J. E. and REID, J. D. (2000). **Unconventional Left-Turn Alternatives for Urban and Suburban Arterials.** Transportation Research Board E-Circular, E-C019: Urban Street Symposium Conference Proceedings, Dallas, TX, 1999.
[Median U-Turn, Bowtie, Superstreet, Jughandle, CFI]

YANG, X. and CHANG, Y. L. G-L. (2011). **An Integrated Computer System for Analysis, Selection and Evaluation of Unconventional Intersections.** University of Maryland and Maryland State Highway Administration research Report. Publication No. MD-11-SP909B4H.
[114 page report discussing CFI and DDI]

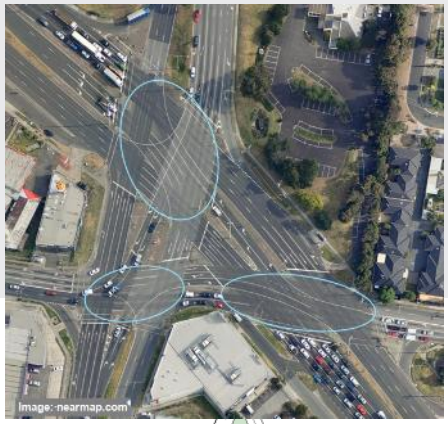
2. SIDRA INTERSECTION Network Model

SIDRA NETWORK Model

Unique lane-based NETWORK model

All intersection types (signals, roundabouts, sign control)

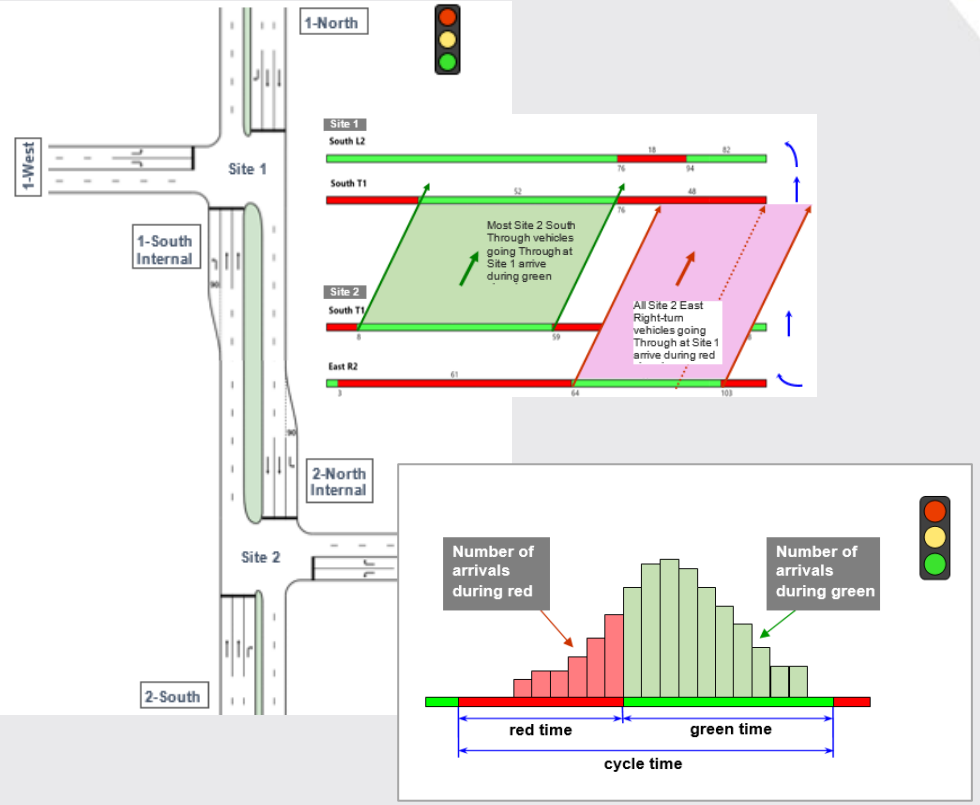
PAIRED INTERSECTIONS (detailed lane-based analysis)



SIDRA SOLUTIONS

SIDRA INTERSECTION features enabling analysis of Alternative Intersections

- **LANE-BASED** network model
- **QUEUE SPILLBACK** and **Capacity Constraint**
- **Movement Classes** (special use for downstream turning movements)
- Second-by-second lane-based **platoon model**
- **Lane Movements** at intersections
- Implied **midblock lane changes**
- **Common Control Group** for signal phasing and timing with one signal controller unit (Version 7)



SIDRA SOLUTIONS

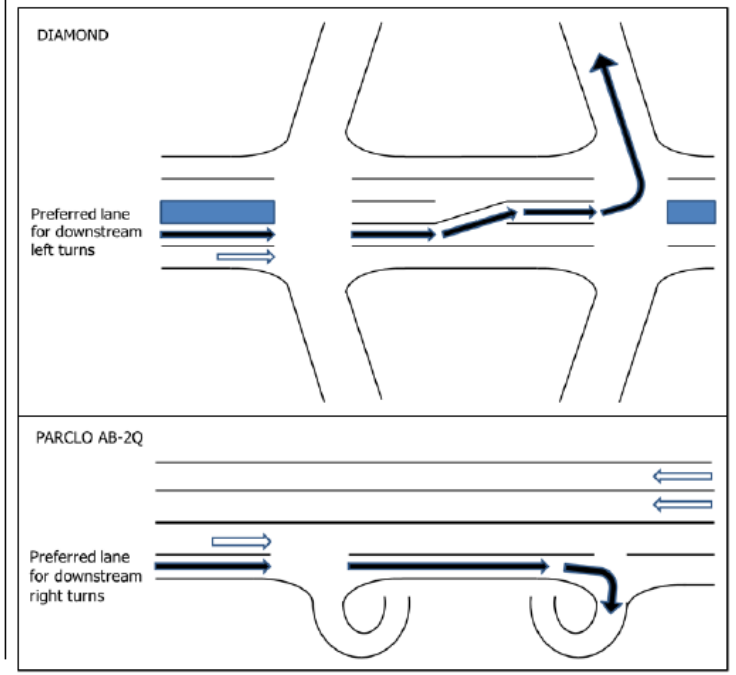
Lane Utilisation at Alternative Intersections

HCM 2015 / 2016, page 23-7 :

Exhibit 23-2
Impact of Interchange Type on Lane Utilization

Lane Utilization Effects

Lane utilization is the extent to which lanes are used equally (or unequally) by drivers. The presence of multiple intersections operating as a single unit can strongly influence drivers' choice of lanes when approaching an upstream intersection. At interchanges, this can mean through-lane utilization at the upstream intersection reflects desired turn movements at the downstream intersection. Likewise, at MUT and RCUT intersections, this can mean dual right-turn lane utilizations reflect downstream movements; with drivers headed for the U-turn crossover using the leftmost of the side-street, right-turn lanes.



This applies to all "paired intersections"

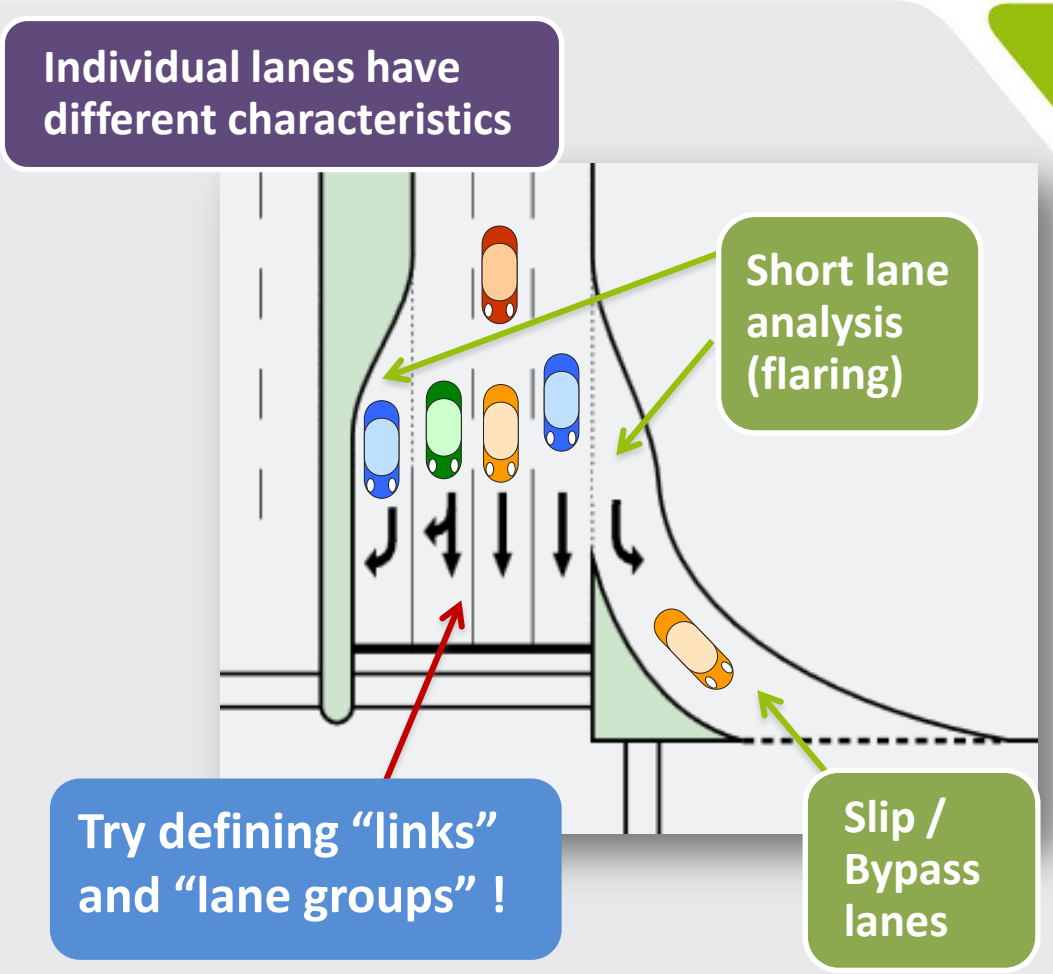
SIDRA SOLUTIONS

SIDRA Lane-based model for intersections since 1984

LANE-BASED MODEL

More realistic and reliable analysis compared with approach-based and lane group (link) - based methods (various UK models and US HCM).

- **General: Unequal lane flows, de facto exclusive lanes, short lanes, slip/bypass lanes (give-way/yield, continuous, signals).**
- **Roundabouts: Circulating lane use; Dominant and subdominant lanes.**
- **NETWORK Model (lane queues, lane blockage, signal platoon arrival and departure patterns).**



SIDRA SOLUTIONS

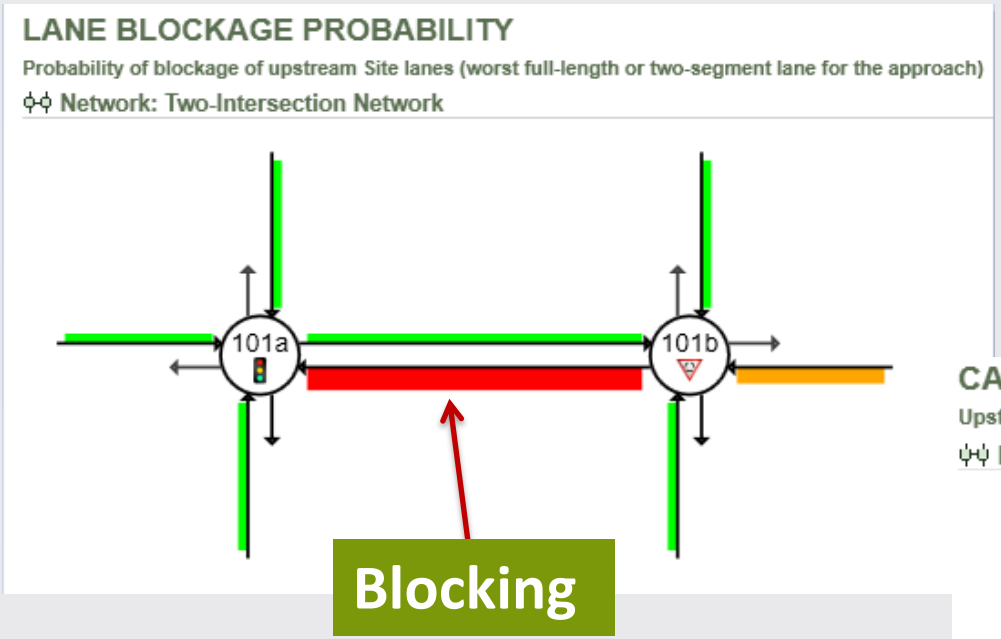
Iterative method for LANE BLOCKAGE and CAPACITY CONSTRAINT

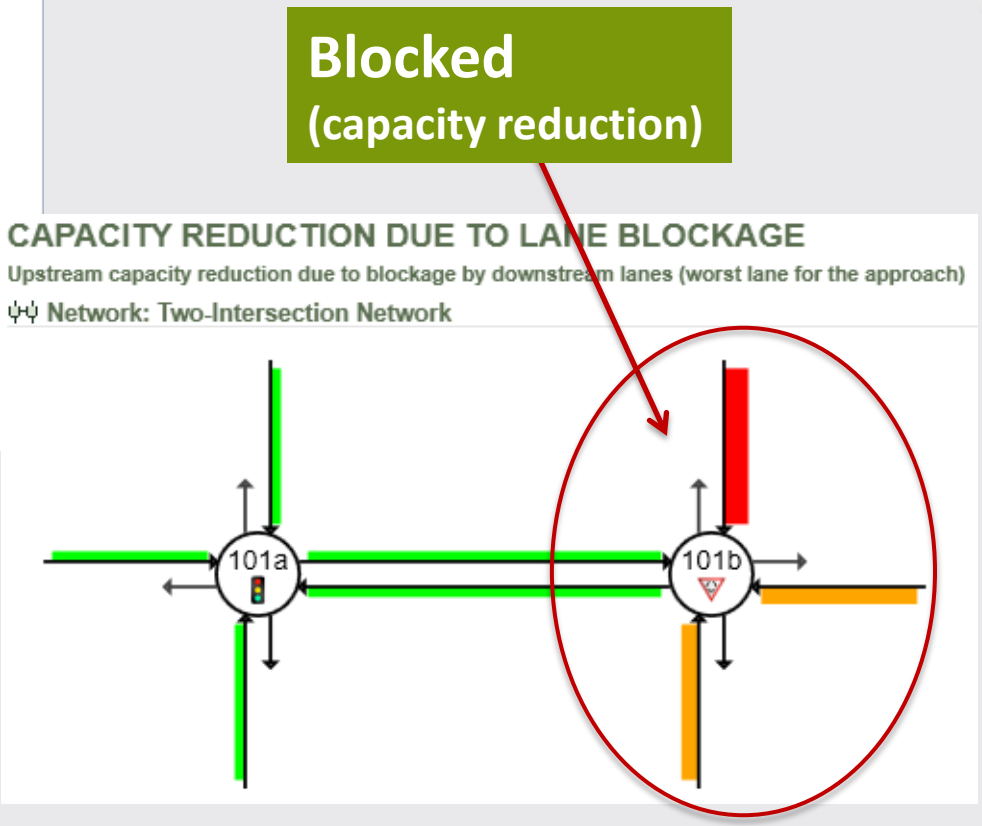
Backward spread of congestion (reduced upstream capacity)

Capacity constraint (reduced downstream arrival flows)

- The two basic elements of the model are highly interactive with opposing effects.
- SIDRA INTERSECTION 6 uses a network-wide iterative process to find a solution that balances these opposing effects.
- Backward spread of congestion and capacity constraint are common to all intersection types.

Importance of Back of Queue Model and Lane-Based Probability of Blockage





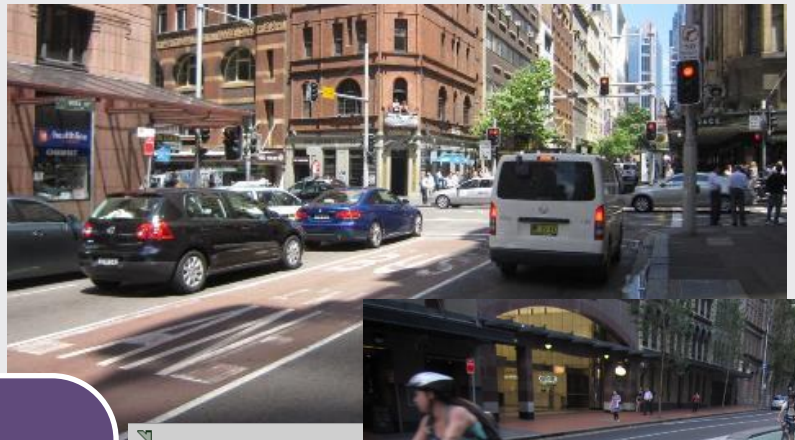
Back of Queue Percentile and Probability of Blockage values are based on back of queue estimates for individual lanes

SIDRA SOLUTIONS

Movement Classes

- Light Vehicles
- Heavy Vehicles
- Buses
- Bicycles
- Large Trucks
- Light Rail / Trams
- Two User Classes for special treatment

Combined with the lane-based method, new Movement Classes allow modelling of Bus Priority Lanes, Bicycle Lanes, and so on …

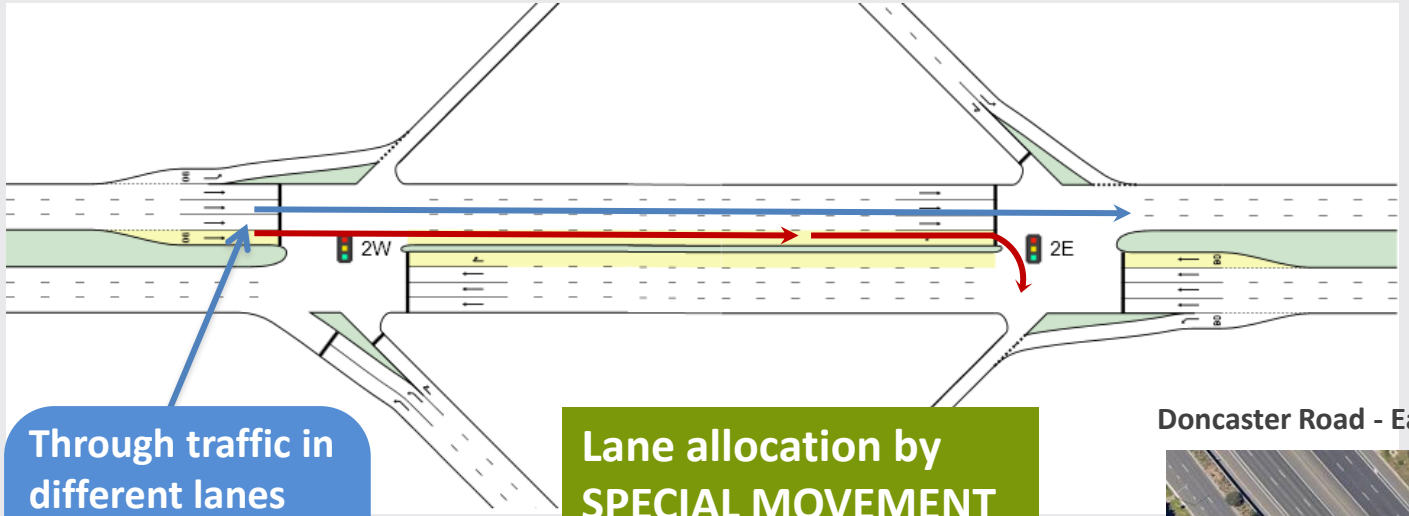


Site Origin-Destination Movements by Movement Class as a basis of all data and modelling

SIDRA SOLUTIONS

3. Interchanges and Alternative Intersections Using SIDRA INTERSECTION

Signalised Diamond Interchange (SDI)



Through traffic in different lanes have different destinations downstream

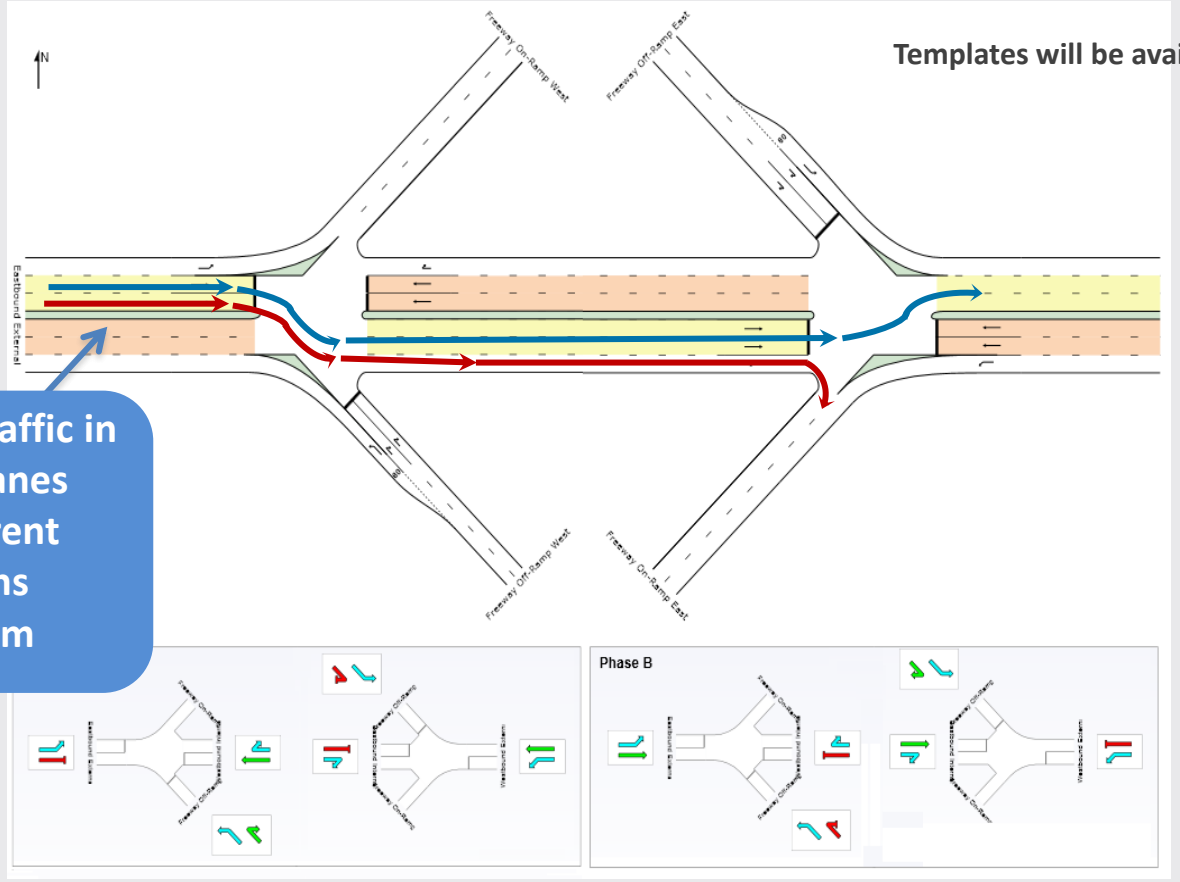
Lane allocation by SPECIAL MOVEMENT CLASSES for turning movements

Common Control Group (single controller)

Doncaster Road - Eastern Freeway, Melbourne

SIDRA SOLUTIONS

Diverging Diamond Interchange (DDI)



Templates will be available

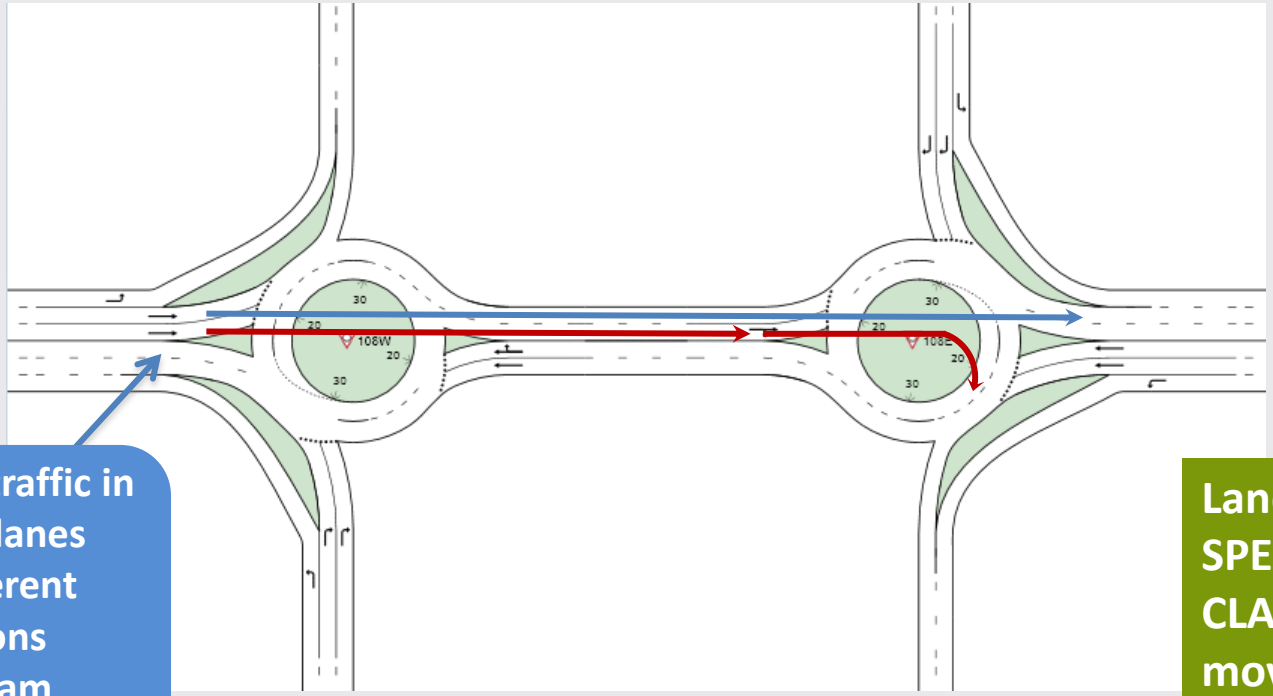
Through traffic in different lanes have different destinations downstream

Lane allocation by SPECIAL MOVEMENT CLASSES for turning movements

Common Control Group

SIDRA SOLUTIONS

Roundabout Interchange

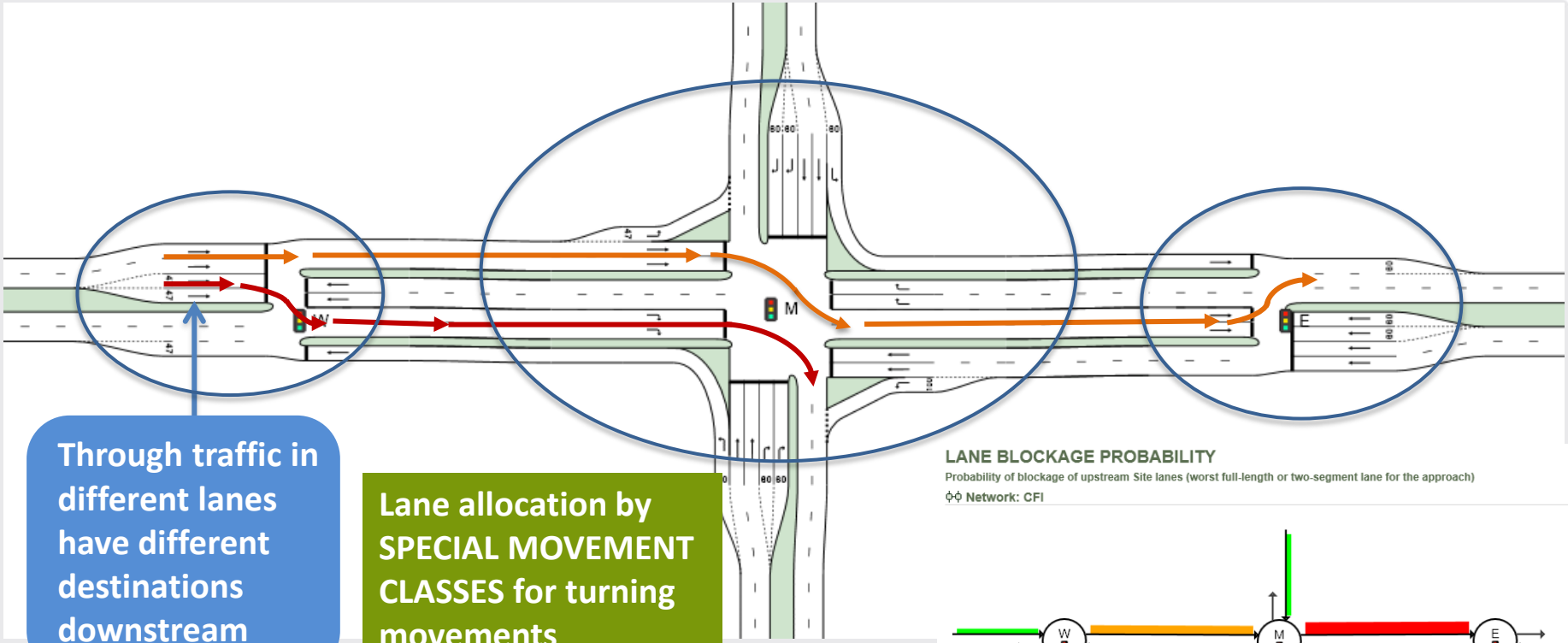


Through traffic in different lanes have different destinations downstream

Lane allocation by SPECIAL MOVEMENT CLASSES for turning movements

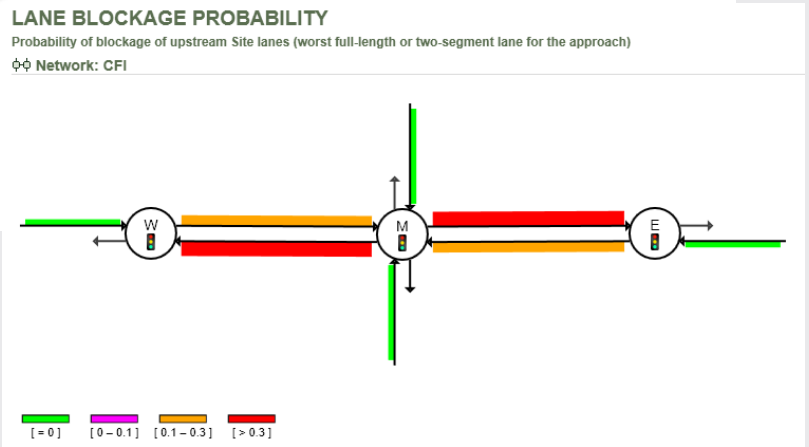
SIDRA SOLUTIONS

Continuous Flow Intersection (CFI)



Through traffic in different lanes have different destinations downstream

Lane allocation by SPECIAL MOVEMENT CLASSES for turning movements

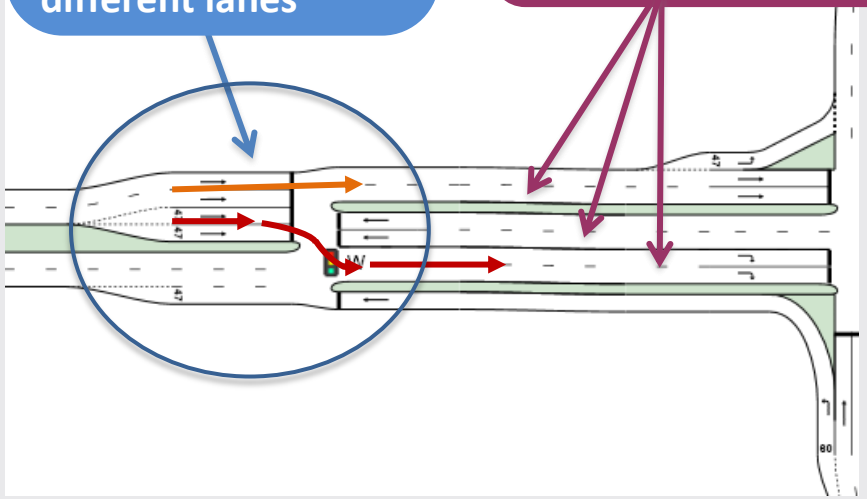


SIDRA SOLUTIONS

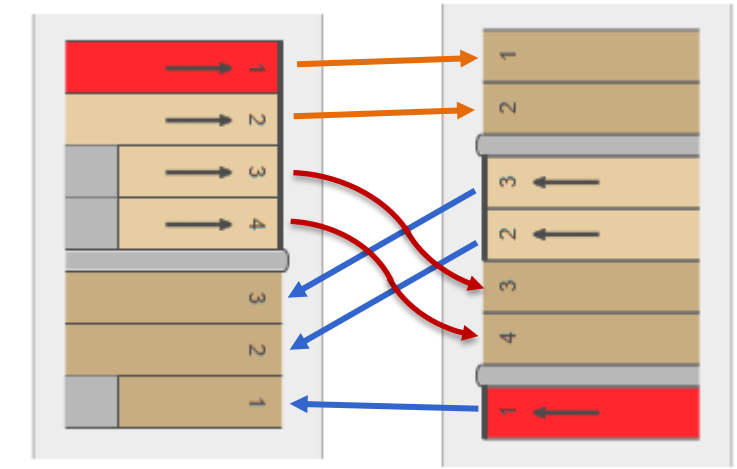
Continuous Flow Intersection (CFI)
West Site

SPECIAL MOVEMENT CLASSES for Through traffic with different downstream destinations in different lanes

CONTRAFLOW lanes help to configure complex layouts



Lane Movements in SIDRA INTERSECTION Lane Data input dialog

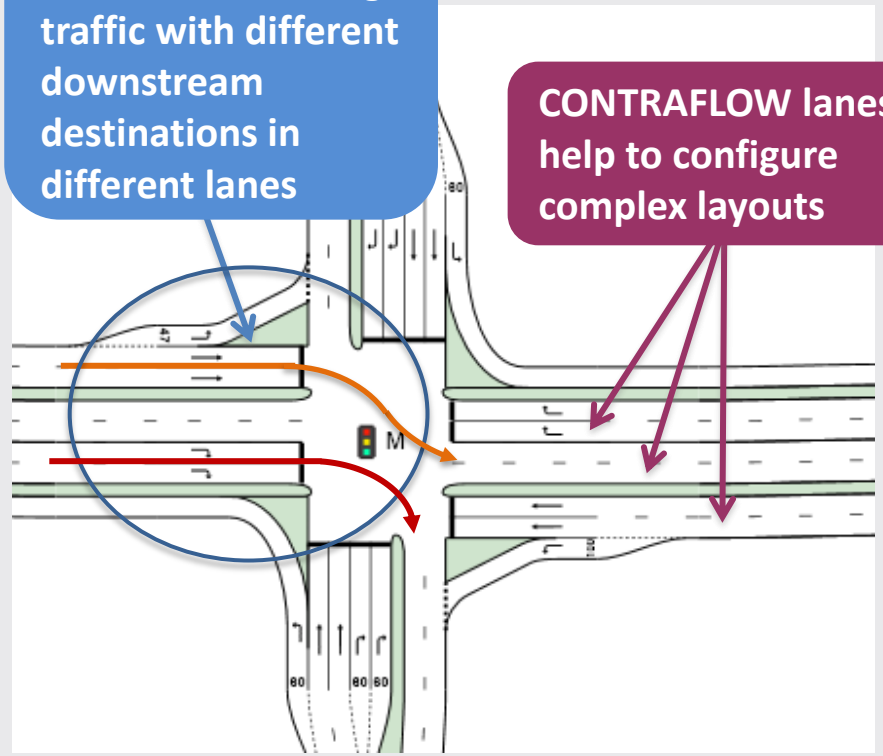


SIDRA SOLUTIONS

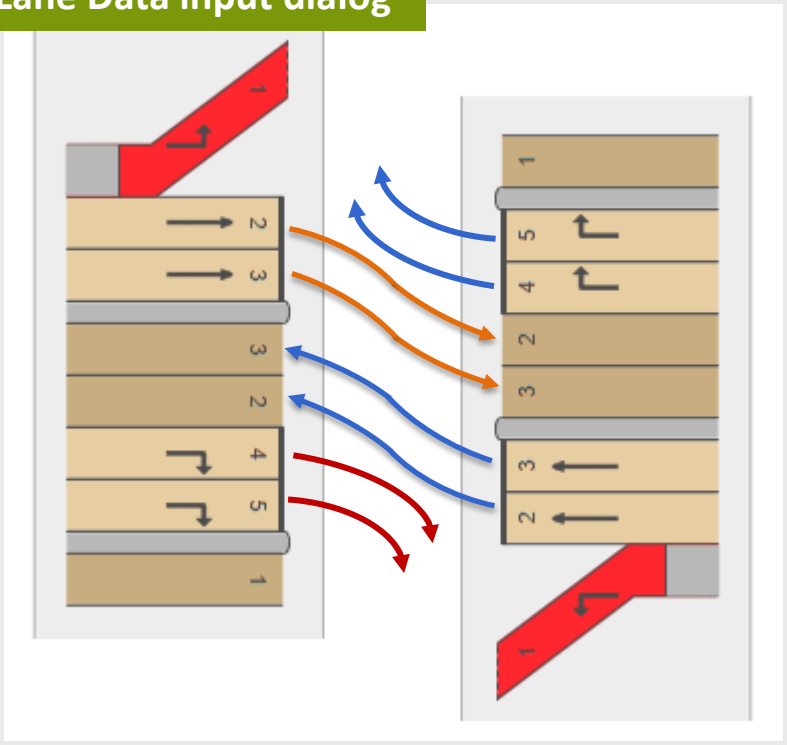
Continuous Flow Intersection (CFI)
Main Intersection

SPECIAL MOVEMENT CLASSES for Through traffic with different downstream destinations in different lanes

CONTRAFLOW lanes help to configure complex layouts



Lane Movements in SIDRA INTERSECTION Lane Data input dialog

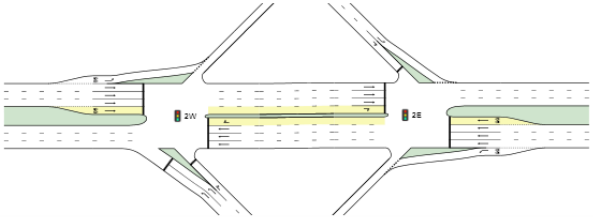


SIDRA SOLUTIONS

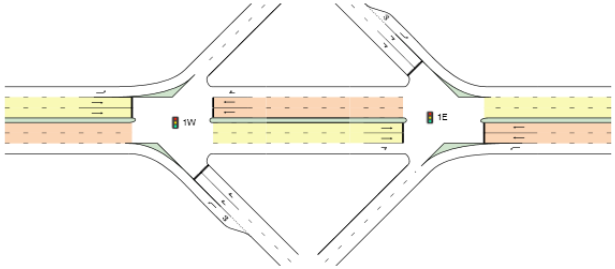
4. An Interchange Comparison Example

An Interchange Comparison: Results with Cycle Time = 100 s specified for both SDI and DDI

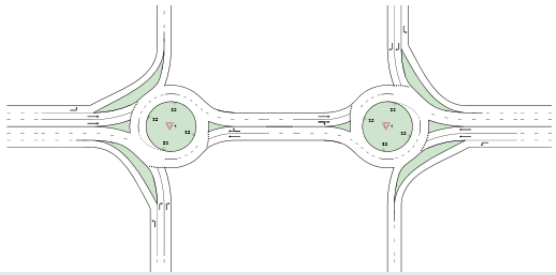
Network: Signalised Diamond Interchange L



Network: Diverging Diamond Interchange L

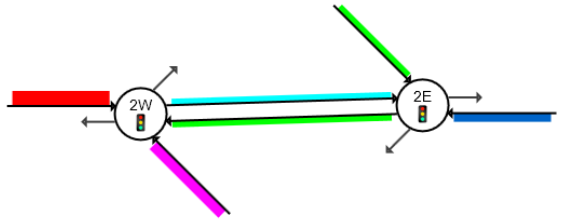


Network: Roundabout Interchange L

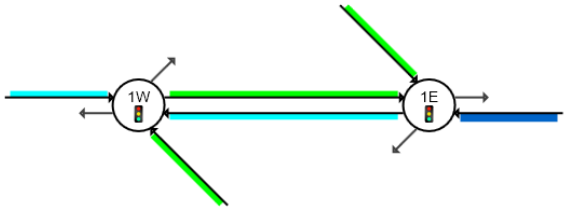


DEGREE OF SATURATION

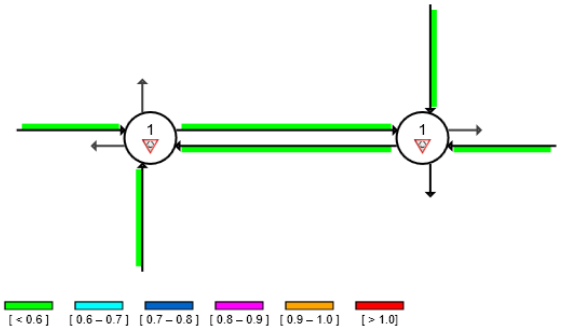
Network: Signalised Diamond Interchange L



Network: Diverging Diamond Interchange L

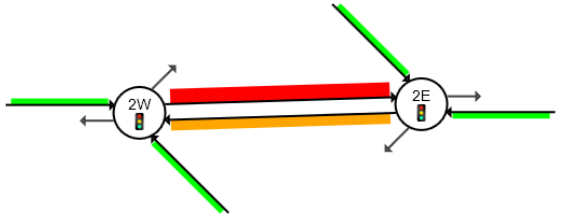


Network: Roundabout Interchange L

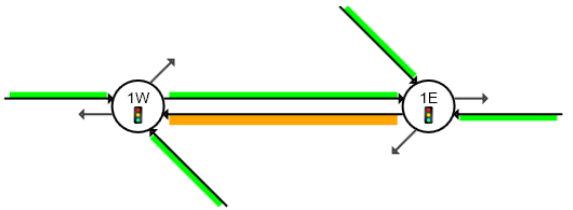


LANE BLOCKAGE PROBABILITY

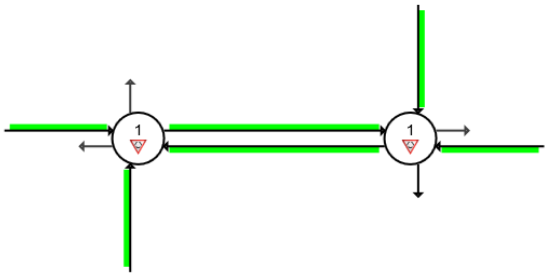
Network: Signalised Diamond Interchange L



Network: Diverging Diamond Interchange L

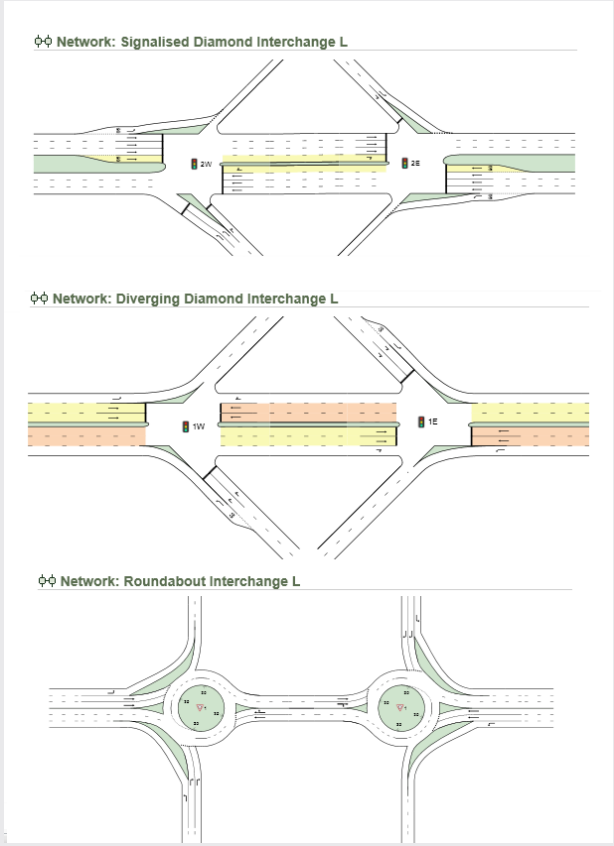


Network: Roundabout Interchange L



SIDRA SOLUTIONS

An Interchange Comparison: Results with Cycle Time = 100 s specified for both SDI and DDI



	Degree of Saturation Worst Lane) (v / c)	Average Delay (Worst Lane) (sec)	Largest Probability of Blockage	Average Network Speed (km/h)	Network LOS (Based on Speed Efficiency)
Signalized Diamond Interchange	1.19	239	37%	28.7	LOS E
Diverging Diamond Interchange	0.77	30	29%	44.3	LOS D
Roundabout Interchange	0.56	14	0%	56.4	LOS B

SIDRA SOLUTIONS

END OF PRESENTATION

Rahmi Akçelik and Mark Besley
SIDRA SOLUTIONS

Thank you!

Presenter: David Nash
TRAFFINITY

SIDRA SOLUTIONS