

Lane-Based Micro-Analytical Model of a Roundabout Corridor

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Lane-Based Micro-Analytical Network Model

1. Analytical Network Models
2. Lane-Based Network Modeling
3. SIDRA INTERSECTION 6 Network Model
4. An Example: Staggered T Roundabouts
5. SIDRA INTERSECTION 6 Background

Analytical Network Models

Shift of interest from **signal coordination** to **congestion modeling** in high traffic demand conditions experienced in more recent times.

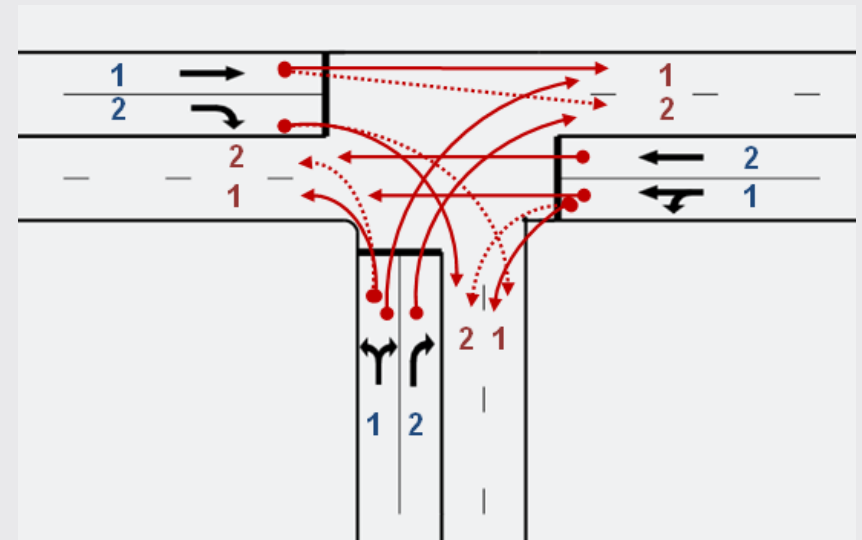
Interest in **all types of intersection** (Signals, Roundabouts, Sign Control).

Same intersection types (e.g. roundabout corridor) **or mixed types of intersection** are of interest.



Basic Elements of NETWORK Model in SIDRA INTERSECTION 6

- ✱ **Backward spread of congestion:** capacity reduction at upstream lanes blocked by downstream lane queues.
- ✱ **Capacity constraint:** oversaturated upstream lanes reduce arrival flows for downstream movements
- ✱ **Lane Movements:** blockage of upstream lanes depends on **lane choices** of movements from approach lanes to exit lanes
- ✱ **Upstream and downstream lane flows** and mid-block lane changes on an approach to determine platooning.
- ✱ At signals, forward movement of vehicle **platoons departing from signals** is another important element of network modeling.



SIDRA NETWORK Model

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.

This paper focuses on **roundabouts**.

LINK-Based vs LANE-Based Models

Traditional analytical network models have been **link-based models**.

Links represent **lane groups** in which traffic conditions of individual lanes are **aggregated** to some assumed **average (balanced)** condition.

An **approach-based model** is a more extreme case of this as it applies aggregation to all approach lanes.

Such link-based or approach-based models cannot identify backward spread of congestion since **average lane queue estimates are not sufficient**.

Poor modeling of lane queues leads to a poor network model.

✱ Lane capacities, lane flows and lane queues for downstream and upstream approaches may be **highly interdependent** in cases of closely spaced intersections, and therefore, a **LANE-BASED method** is essential for reliable modeling of network performance.

Level of Analysis Detail

*more detailed model
of TRAFFIC STREAM*



Individual vehicles				Microsimulation models
Drive cycles (Vehicle paths)				SIDRA INTERSECTION 6
Traffic flows	TRL (UK) Roundabout Model	HCM (US) (Signals, Signs) TRANSYT	HCM (US) (Roundabouts)	
Speed-flow functions	Strategic transport planning models			
	APPROACHES	Lane Groups / LINKS	Individual LANES	Lane SEGMENTS

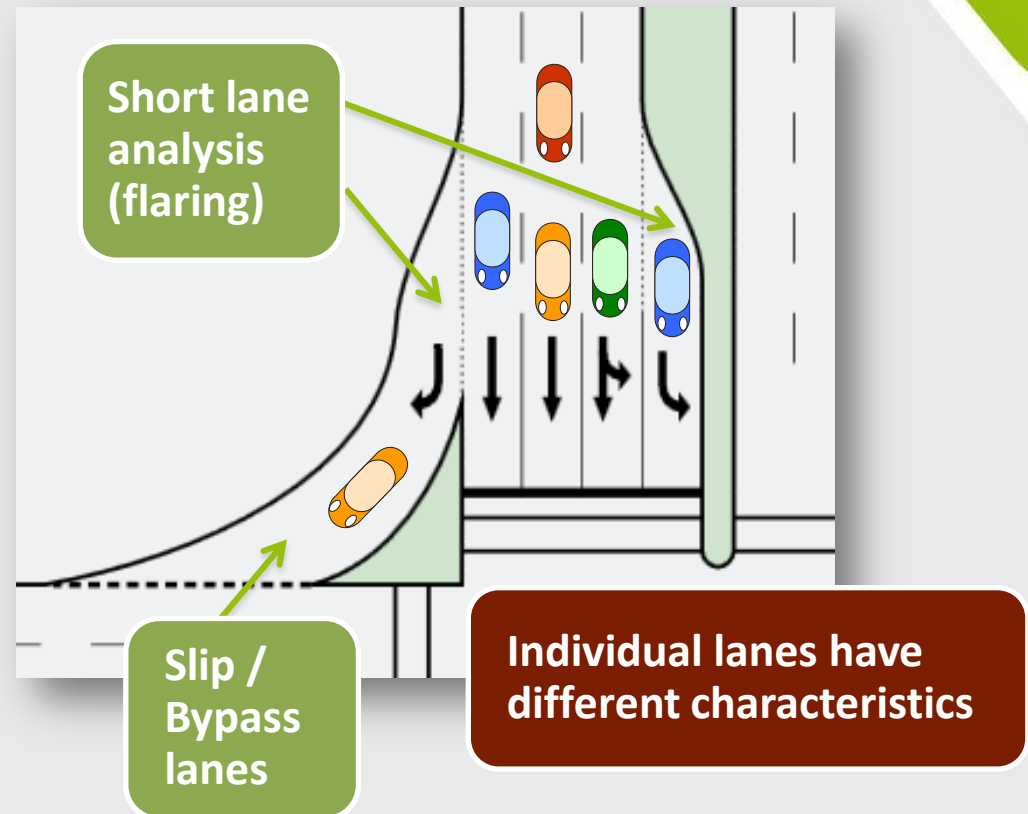
Micro-analytical model

HCM: Highway Capacity Manual (2010)

more detailed model of ROAD GEOMETRY

Importance of Lane-Based Modeling

- **Unequal lane flows** (many reasons)
- De facto exclusive lanes
- Approach and exit **short lanes** (lane use effects)
- **Slip / Bypass lanes** (Give-way / Yield and Continuous)
- **Roundabouts:**
 - Circulating lane use
 - Dominant and subdominant lanes



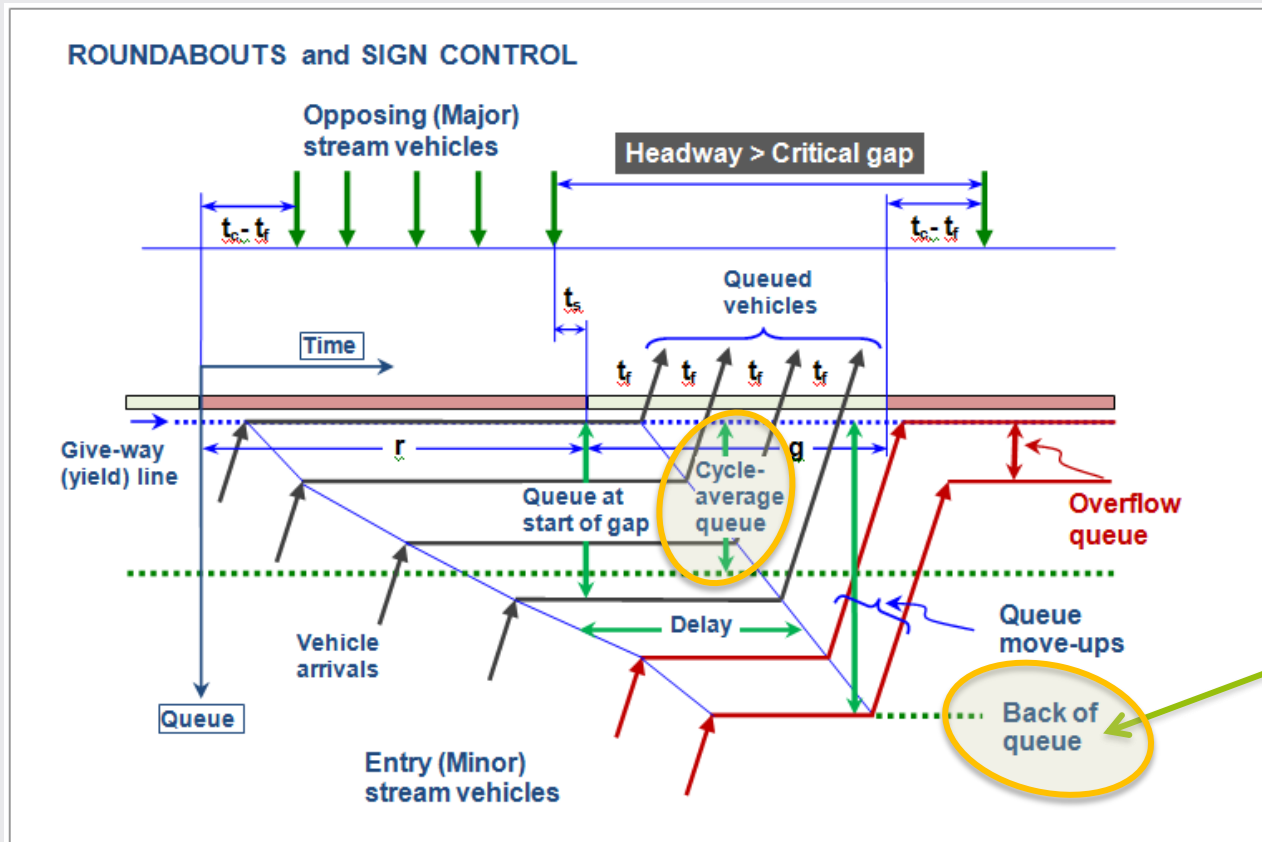
Need for Lane-Based Model

- ✱ **Lane Movements:** Upstream lanes are affected by downstream (exit) lane queues according to the **destinations of movements**.
- ✱ **Saturation levels** (v/c ratios), therefore queue blockage probabilities differ significantly for individual lanes.
- ✱ **Lane under-utilization** exists due to many reasons including differences in the number of lanes available on upstream and downstream approaches.
- ✱ **Balance of upstream and downstream lane flow rates** is also an important consideration due to **lane change implications** within a short distance.



Importance of Back of Queue Model for Networks

Back of Queue vs Cycle-Average Queue



Unique gap-acceptance based BACK OF QUEUE Model for Roundabouts and Sign Control in SIDRA INTERSECTION

A Lane-Based Network Model: SIDRA INTERSECTION 6

Lane-Based Micro-Analytical Network Model for Congestion Modelling ...

Extends its traditional lane-based single intersection model to network modeling.

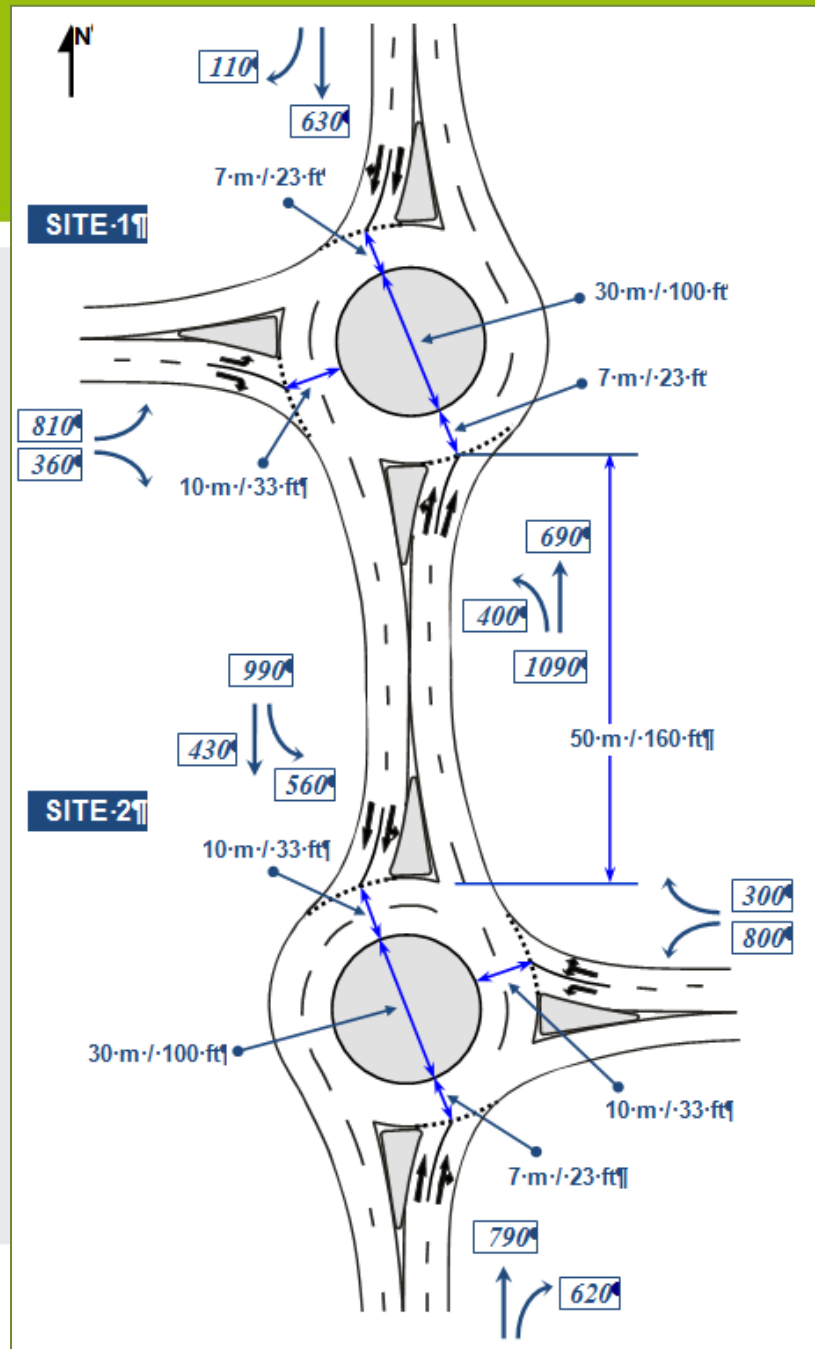
SIDRA INTERSECTION 6 introduces the biggest changes in the 30-year history of the software.

Major data structure and user interface changes have been implemented as a result.



Example: Staggered T Roundabouts

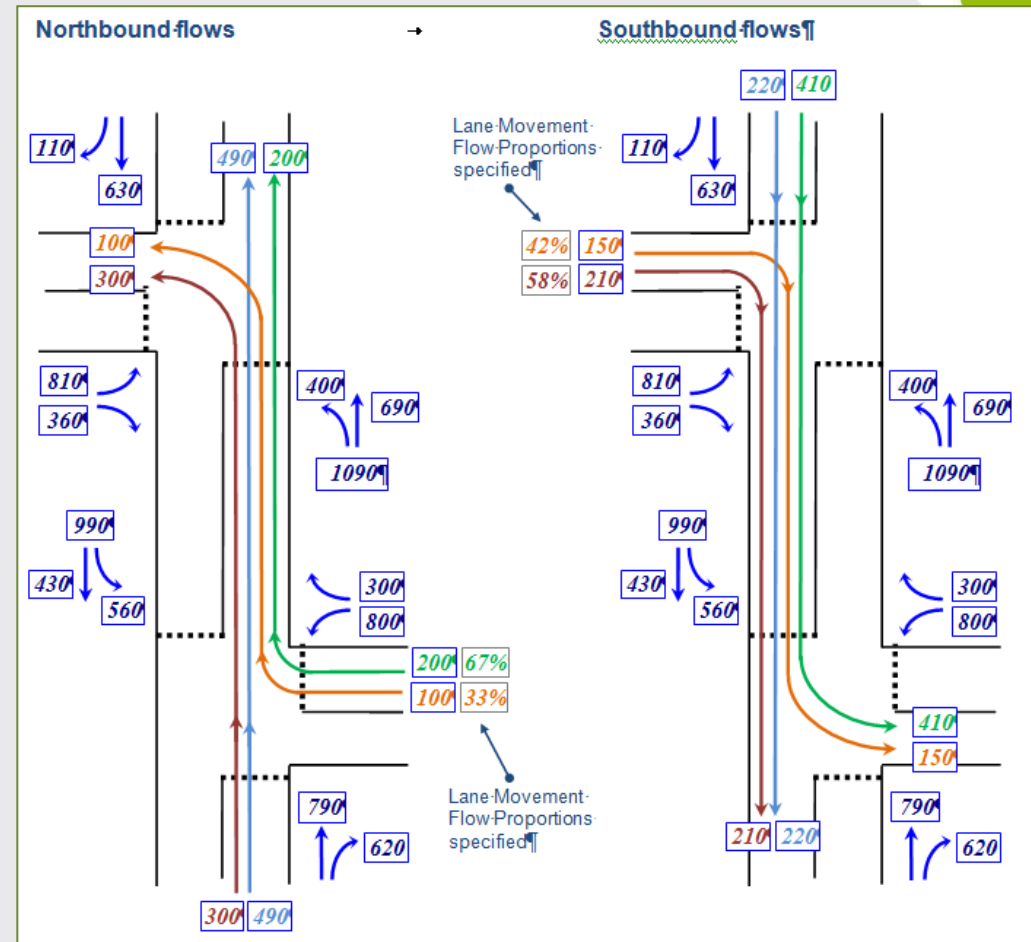
- Two T-shaped roundabouts placed with 50 m distance between them to demonstrate the lane-based network model.



Example

- ✿ **Analysis (i) – “Default Lane Flows”**
It is assumed that **only Turning Volumes are known** at each intersection. Default settings are used.
- ✿ **Analysis (ii) – “Balanced Lane Flows”**
It is assumed that the **Network Origin - Destination flows** are known in addition to the intersection turning volumes.

Results from the two analyses are compared.

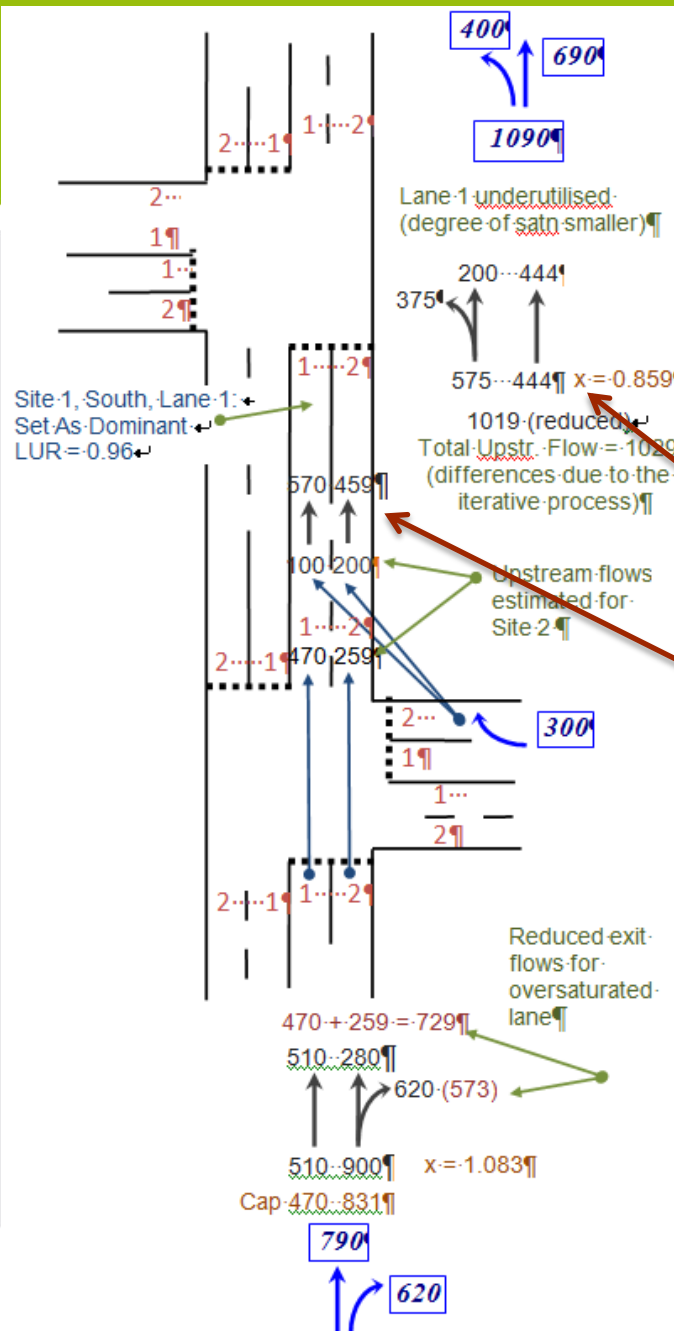


Example

In Analysis (ii) with extra calibration effort, upstream and downstream lane flows match reasonably well.

Calibration of lane flows is possible in SIDRA INTERSECTION 6 as a lane based model. Input parameters used:

- Set As Dominant Lane
- Lane Utilisation Ratio
- Lane Movement Proportions



Analysis (ii)

Upstream and downstream lane flows match well.

Analysis (i)

Upstream and downstream lane flows do NOT match well.

Example

The example also demonstrates that there are other factors contributing to the **interactive nature** of the system. For example:

- ✱ Decreases in **downstream arrival flow** change the circulating flow rates and the balance of circulating lane flows at the downstream roundabout. As a result, roundabout entry lane capacities change.
- ✱ Changes in **Lane Movement Flow Proportions** (specified as input) change lane blockage effects at the upstream intersection. As a result, capacity reductions at the upstream lanes will change.

Example

The results for this example indicate that analysis based on default lane flows may be adequate for **large-scale network** analyses.

However, further investigation is recommended to establish **appropriate levels of model accuracy** depending on the context and purpose of analysis.

SIDRA INTERSECTION Background

SIDRA INTERSECTION 6.0

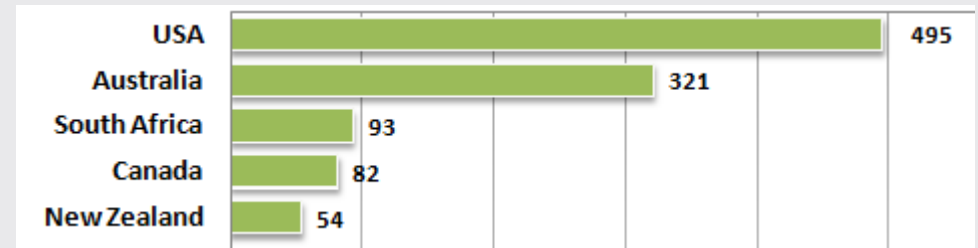
PLUS VERSION
NETWORK VERSION

RELEASED April 2013

First released in 1984

SIDRA INTERSECTION 6
(including NETWORK Model)

Over 9600 licences in more than 1400
organisations across in 75 Countries



SIDRA INTERSECTION Background

STRONG RESEARCH BASE:
Empirical and theoretical methods combined ...



20 years at Australian Road Research Board
13 years at Akcelik & Associates

SIDRA INTERSECTION 6

Other Major New Features

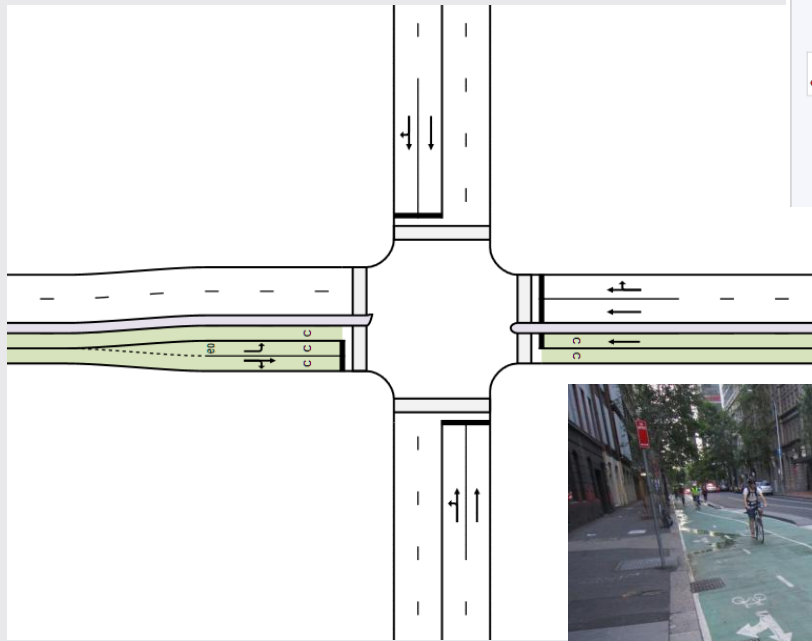
- ✱ **Movement Classes:** light and heavy vehicles, buses, bicycles, large trucks, trams and two user classes with ability for special treatment
- ✱ **Origin-Destination Movements** as a basis of all data and modelling



SIDRA INTERSECTION 6

Bus Priority Lane and Phase

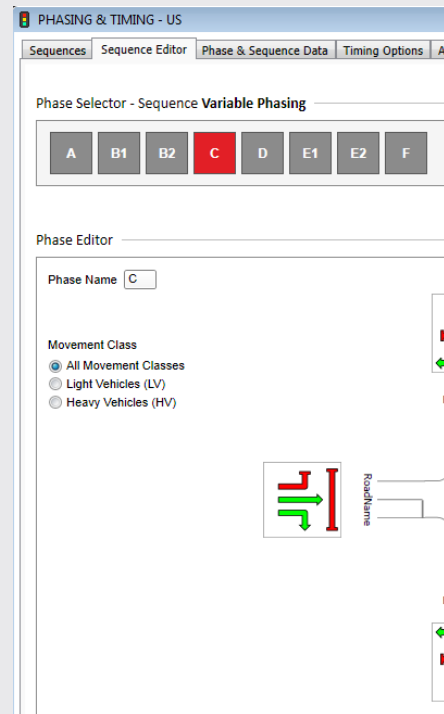
Bicycle lanes



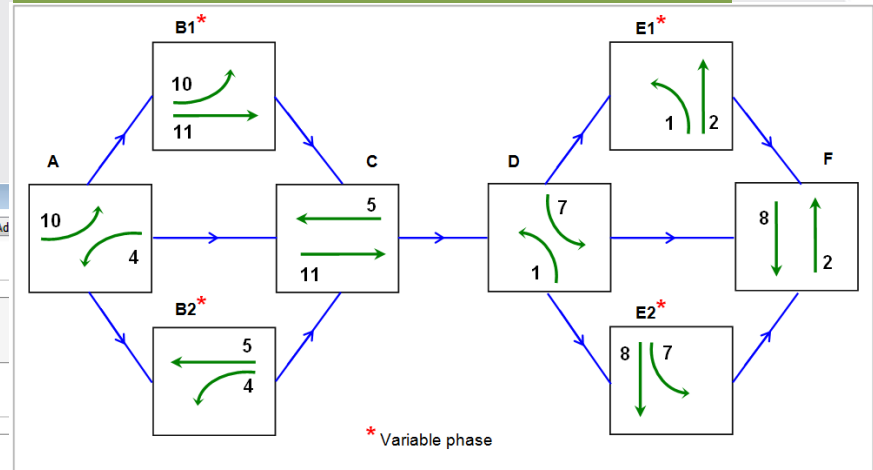
SIDRA INTERSECTION 6

SIGNALS

- Variable phase sequence analysis
- Easier phase sequence data specification



Diamond Overlap Variable Phase Sequence

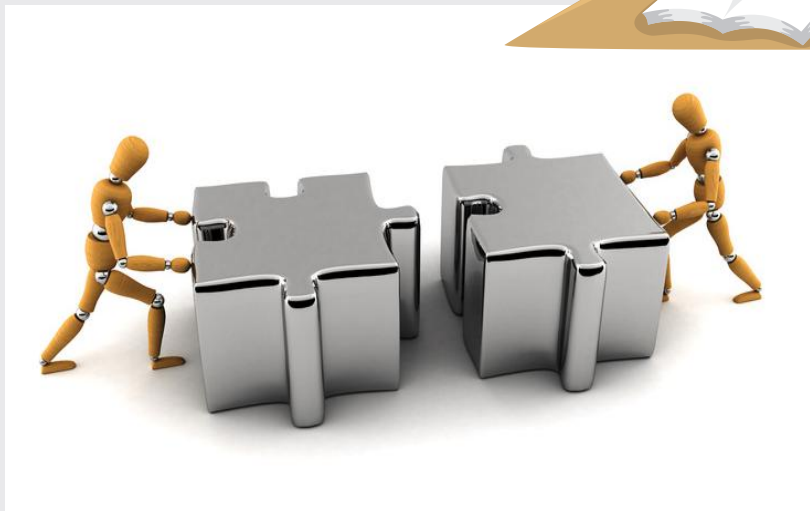


Sequences generated:

A - B1 - C - D - E1 - F
 A - B1 - C - D - E2 - F
 A - B1 - C - D - F
 A - B2 - C - D - E1 - F
 A - B2 - C - D - E2 - F
 A - B2 - C - D - F
 A - C - D - E1 - F
 A - C - D - E2 - F
 A - C - D - F

Model Benefits / Objectives

- ✱ Understanding
- ✱ Problem solving



END OF PRESENTATION

Thank you!

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SIDRA SOLUTIONS