Recent Innovations and Applications in SIDRA INTERSECTION: Lane-Based Network Model

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SIDRASOLUTIONS.COM
The SIDRA INTERSECTION network model is largely built on the sound foundation of the lane-based methodology used in the single intersection model proven via research and used in practice during the last three decades.

The network model elements used beyond single intersection modelling are discussed in this presentation.

See the documentation listed at the end of this presentation. These are downloadable from: sidrasolutions.com/Resources/Articles

This is a modified version of the presentation given at the AITPM Transport Modelling Workshop held in Sydney on 29 July 2016.
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SIDRA INTERSECTION areas of application

- **SINGLE INTERSECTIONS**
- **NETWORKS**
  - General networks and corridors (any mix of intersection types)
  - Closely-spaced (paired) intersections
  - Alternative intersections and interchanges
# SIDRA INTERSECTION areas of application

## SINGLE INTERSECTIONS
- **Signalised** (Fixed-Time, Actuated)
- **Roundabouts**
  - Unsignalised
  - Roundabout Metering
- **Sign Control**
  - Two-Way Stop
  - Two-Way Give-Way
  - All-Way Stop
- **Single-Point Interchange**
- **Pedestrian Crossings** (Signalised and Unsignalised)
- **Merging**

## NETWORKS
- **General networks and corridors** (any mix of intersection types)
- **Closely-spaced (paired) intersections**
  - Staggered T intersections
  - Freeway Diamond Interchange
  - Roundabout Interchange
  - Wide-Median Intersection (Signalised and Unsignalised)
  - Fully Signalised Roundabout
  - Staged Crossing (Unsignalised)
- **Alternative intersections and interchanges**
  - Diverging Diamond Interchange
  - Continuous Flow Intersection
  - Others

## NETWORK SIGNAL TIMING
- **Common Control Group** (single controller)
- **Network timing for signal coordination.**
SIDRA INTERSECTION network model background

- First released in 1984
- Continuous development in response to user feedback

Versions 6.0 | 6.1 | 7.0 released during April 2013 – April 2016.

Biggest changes in the 30-year history of the software
- Network Model
- Network Timings for Signal Coordination
  Common Control Groups
- Routes
- Movement Classes
SIDRA INTERSECTION Version 7 new features

- Network signal timings
  (CYCLE TIME, PHASE TIMES and SIGNAL OFFSETS)

- Common Control Groups
  (cycle time and green split method for multiple Sites controlled by a single controller)

- ROUTES for performance reports and displays, and for signal Offset calculations

- Network output by Routes
  (Route Output Comparison and Network Output Comparison by Routes)

- Larger number of User Movement Classes

- New roundabout capacity model option for HCM Edition 6 (to be available soon)

- Many model and user interface improvements
Unique lane-based NETWORK MODEL

All intersection types
(signals, roundabouts, sign control)

Paired Intersections and
larger networks

Easy to CONFIGURE using Sites:
In SIDRA INTERSECTION, the Sites and their connections define the Network.
Basic Aspects of the Lane-Based Network Model

- Lane-based modelling for intersections
- Lane-based network model with MIDBLOCK LANE CHANGES
- Lane blockage, capacity reduction and capacity constraint using an iterative method
- Importance of the back of queue model and lane-based probability of blockage
- Use of Special Movement Classes for closely-spaced intersections
- Signal platoon model
In traditional lane-group (link) based network models:

- individual lane conditions are aggregated
- there is not sufficient information about queue lengths, lane blockage probabilities, backward spread of queues, and so on
- there are unnecessary approximations in the saturation flow estimation process and this affects:
  - capacity estimation therefore estimation of all performance parameters including queue length
  - signal timing (cycle time and green time) calculations.

Lane level of detail helps with capacity and performance estimation as well as signal timing analysis.
A lane-based model is particularly important in evaluating

- closely-spaced (paired) intersections
- high demand flows
- cases where vehicles have limited opportunities for lane changing between intersections.
Importance of Lane-Based Model

**LANE-BASED (all model steps)**

**INPUT >> MODEL >> OUTPUT**

Important for:
- **INTERSECTIONS**
- **NETWORKS**

Lane queues, queue spillback, capacity constraint, signal platoon arrival and departure patterns, midblock lane changes.

**Midblock Lane Changes**

Individual lanes have different characteristics.
Movement Classes

Light Vehicles
Heavy Vehicles
Buses
Bicycles
Large Trucks
Light Rail / Trams

User Classes (for special movement treatment)

Combined with the lane-based method, Movement Classes allow modelling of BUS PRIORITY, BICYCLE and LIGHT RAIL / TRAM lanes and signals, and so on...
Examples: Bus Priority and Bicycle Lanes and Signals

- **BUS lanes and signals**

- **BICYCLE lanes and signals**
The use of Special Movement Classes

Examples of Special Movement Classes include:

- dogleg movements at staggered T intersections, and
- through movements that become turning movements at downstream internal approaches.

These movements can be assigned to separate lanes and separate signal phases, and their second-by-second platoon patterns can be tracked separately. The use of Special Movement Classes allows better estimation of unequal lane use.
Network Examples:
Freeway Diamond Interchange

Doncaster Road - Eastern Freeway, Melbourne

Lane allocation by SPECIAL MOVEMENT CLASSES for turning movements

THROUGH traffic in different lanes have different destinations downstream

Template available
Network Examples:
Diverging Diamond Interchange, Roundabout Interchange

Diverging Diamond Interchange

Roundabout Interchange

Mike van Tonder (South Africa) - AITPM 2013 National Conference
Network Examples: Continuous Flow Intersection (CFI)

Through traffic in different lanes have different destinations downstream.

Lane allocation by SPECIAL MOVEMENT CLASSES for turning movements.
Iterative method for LANE BLOCKAGE and CAPACITY CONSTRAINT

- Backward spread of congestion (reduced upstream capacity) and capacity constraint are highly interactive with opposing effects.

- SIDRA INTERSECTION 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

Back of Queue Percentile and Probability of Blockage values are based on the variability of back of queue values in individual lanes.

Back of Queue is important for modelling of short lane overflow and queue spillback in networks.
Lane Movement Flow Proportions for signal platoons, lane blockage and midblock lane changes

Lane Movement Flow Proportions is an important parameter that determines:

- which exit lanes are chosen by departing approach vehicles (hence affect midblock lane change rates and signal platoon patterns)
- which upstream lanes are affected by lane blockage (hence reduced capacity).
Short Lane Model for signal platoons and lane blockage

Changes introduced to the model used in old version of the software due to the requirements of Network Model:

- Stop-line saturation flow rates (headways) are needed for second-by-second platoon departure patterns.
- Short lane overflow into a full-length lane blocking upstream intersection lanes.
Signal Timings for Common Control Groups

New cycle time and green split method for multiple Sites controlled by a single controller (Common Control Group)
Network timing method for signal coordination

Network timing for signal coordination (different from Common Control Groups)

- **Network Cycle Time and Green Splits**
- **Offsets** for specified Routes
Using signal offsets, lane-based (not link-based) second-by-second platoon patterns are modelled to estimate:

- Percent Arriving During Green
- Platoon Ratio
- Arrival Types

Option for no PLATOON DISPERSION (for very short distances between intersections)
The lane-based modelling of platoon arrival patterns at downstream approach lanes takes into account:

- **Midblock lane changes** based on matching of upstream and downstream lane flow rates,
- **Midblock inflow and outflow rates** implied by turning volumes, and
- **Movement Classes** (Light Vehicles, Heavy Vehicles, Buses, etc.) due to different lane use and approach cruise speeds.
Unequal lane use at closely-spaced (paired intersections)

Modelling of unequal lane use at closely-spaced intersections is emphasised (significant effects on traffic performance and signal timing results).

This method coupled with a lane-based model allowing for:

- the backward spread of congestion,
- upstream capacity constraint,
- special movement classes,
- midblock lane changes,
- as well as features such as short lane overflow produces improved results in assessing signal coordination quality and optimising signal offsets.
Summary: Unique features of the lane-based network model

The orange-coloured boxes and lines in this flow chart show the unique aspects of the SIDRA INTERSECTION network model.

The central role of Back of Queue (average and probabilities) in this process is emphasised.

Estimation of this KEY PARAMETER is important for signal timings and performance estimates.
Other innovations ...

- **Signal timings:**
  - Phase Frequency (e.g. SCATS)
  - Phase Actuation
  - Pedestrian Actuation
- **Two-way sign control model:** gap acceptance parameters are adjusted as a function of geometry and other conditions
- **Fuel consumption and emission models:** calibration for modern vehicles
University of Pisa researchers studied a 1.5 km road corridor with seven intersections including signals, roundabouts and two-way stop controlled intersections. The SIDRA NETWORK model used to analyze two scenarios showed that significant improvements could be made to traffic performance in the road corridor.

The researchers concluded:

“This study has been possible thanks to SIDRA INTERSECTION (NETWORK version) that showed its capability of modelling both single intersections and the road corridor.”
“AM peak driving time between two points estimated by SIDRA INTERSECTION was much the same as the measured driving time between the same points.”
“The estimated **95th percentile back of queue** values for westbound lanes for the 7.45 - 8.00 AM peak period were **2.9 to 3.3 km** which is close to the observed value of **3.5 km**.”


*Continued >>*


End of Presentation

Thank you!

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