Unit 6: Network Performance Monitoring and Management

Module 6-4

Traffic Modelling

Traffic Management Training Module

Austroads

Today’s presenter

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Outline of this Module

- Types of Models
- Model Selection
- Data Required for Modelling
- Model Calibration, Validation and Auditing

Types of Models

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Modelling in Transport

Transport and traffic modelling are tools to help planners and engineers to examine outcomes of traffic measures. (Austroads, 2020)

Types of transport models:

- Analytical models
- Transport planning models or the Four-step Model
- Simulation models

Modelling in Transport

1. **Analytical models:** Expressing a real-world phenomenon in terms of mathematical equations. E.g. Speed = Distance / Time

Advantages:

- Easy to solve due to a closed form solution
- Applicable to a vast area using lower computational effort

Shortcoming:

- Inability to account for stochastic processes. E.g. travel time on a link can be different on weekdays vs weekends; rainy vs sunny days, etc.

Modelling in Transport

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2. The Four-step Model

- In existence since 1950s and still widely used by planning agencies worldwide
- Easy to implement and solve on a computer
- Comprises 4 steps:
    1. Trip Generation
    2. Trip Distribution
    3. Mode Split
    4. Traffic Assignment

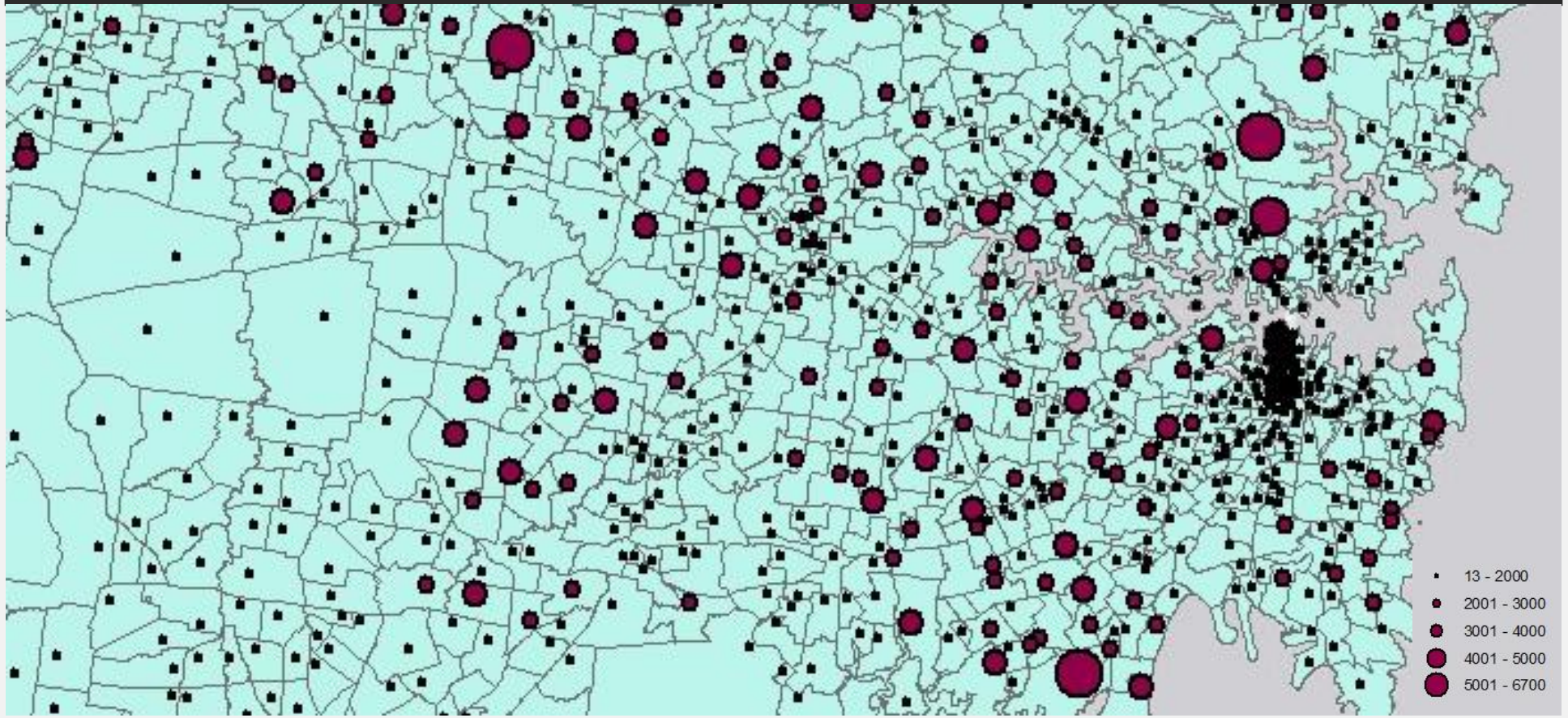
Modelling in Transport

1. Trip Generation

Source: UNSW (2019)

Modelling in Transport

1. Trip Generation (Trip Production)



Source: UNSW (2019)

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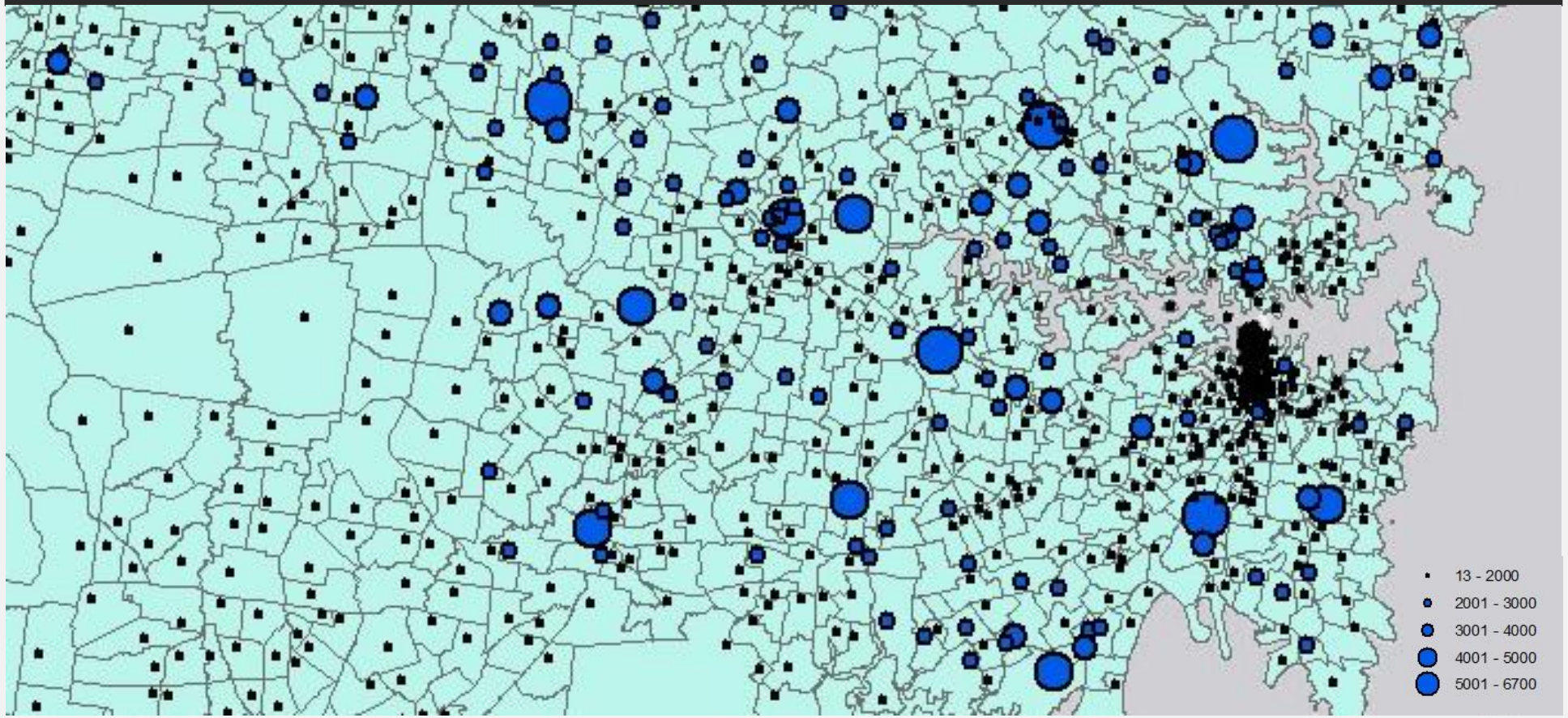
1. Trip Generation (Trip Attraction)



Source: UNSW (2019)

Modelling in Transport

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2. Trip Distribution

Source: UNSW (2019)

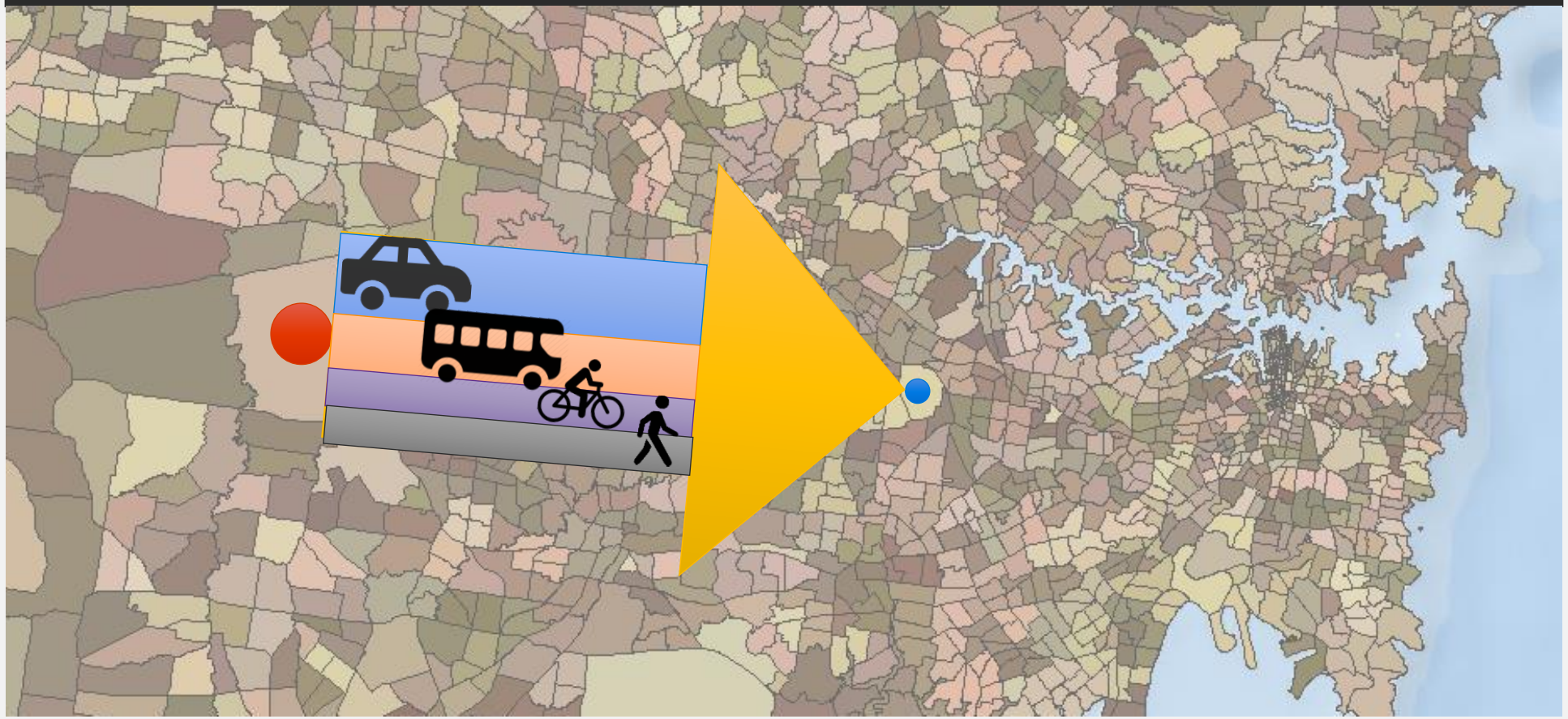
Modelling in Transport

2. Trip Distribution

Source: UNSW (2019)

Modelling in Transport

3. Mode Choice



Source: UNSW (2019)

Modelling in Transport

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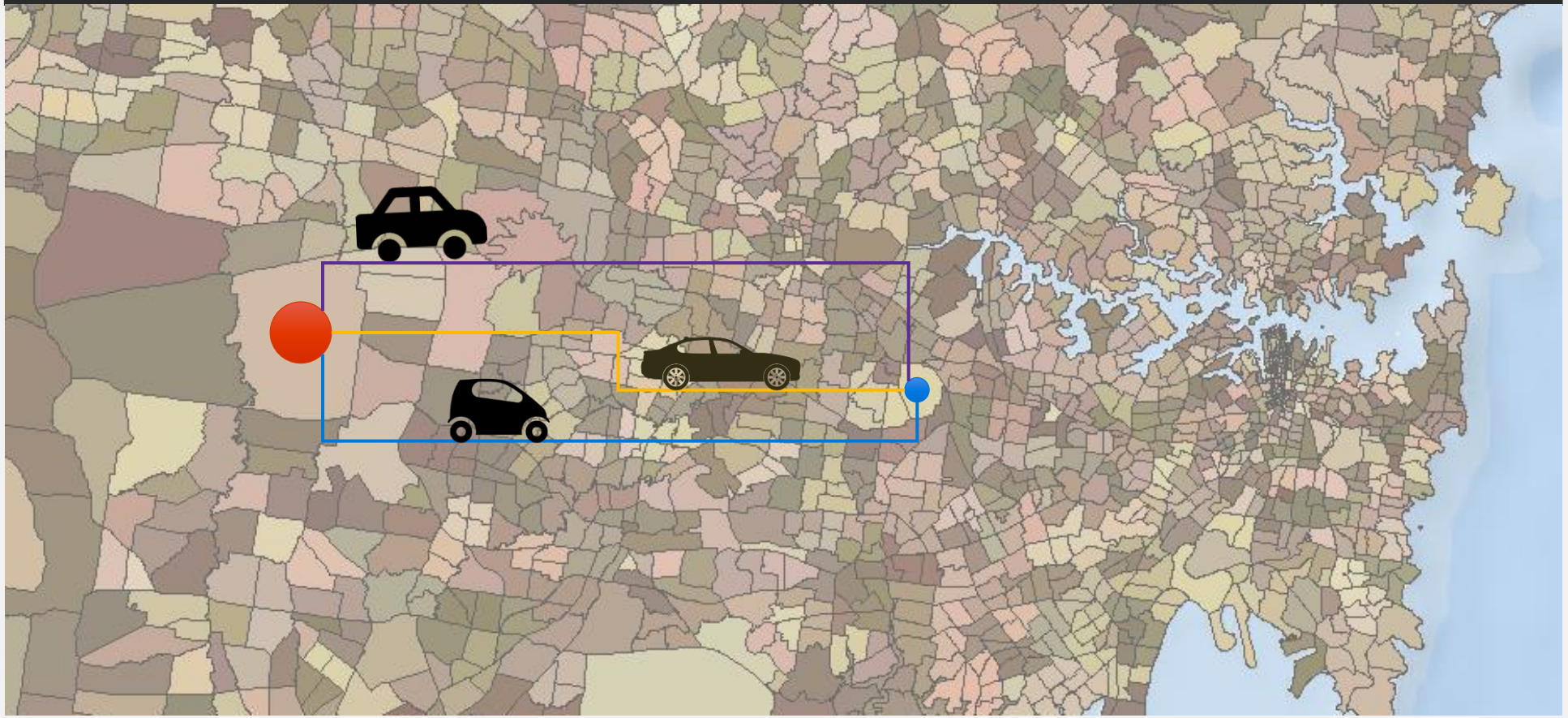
4. Traffic Assignment



Source: UNSW (2019)

Modelling in Transport

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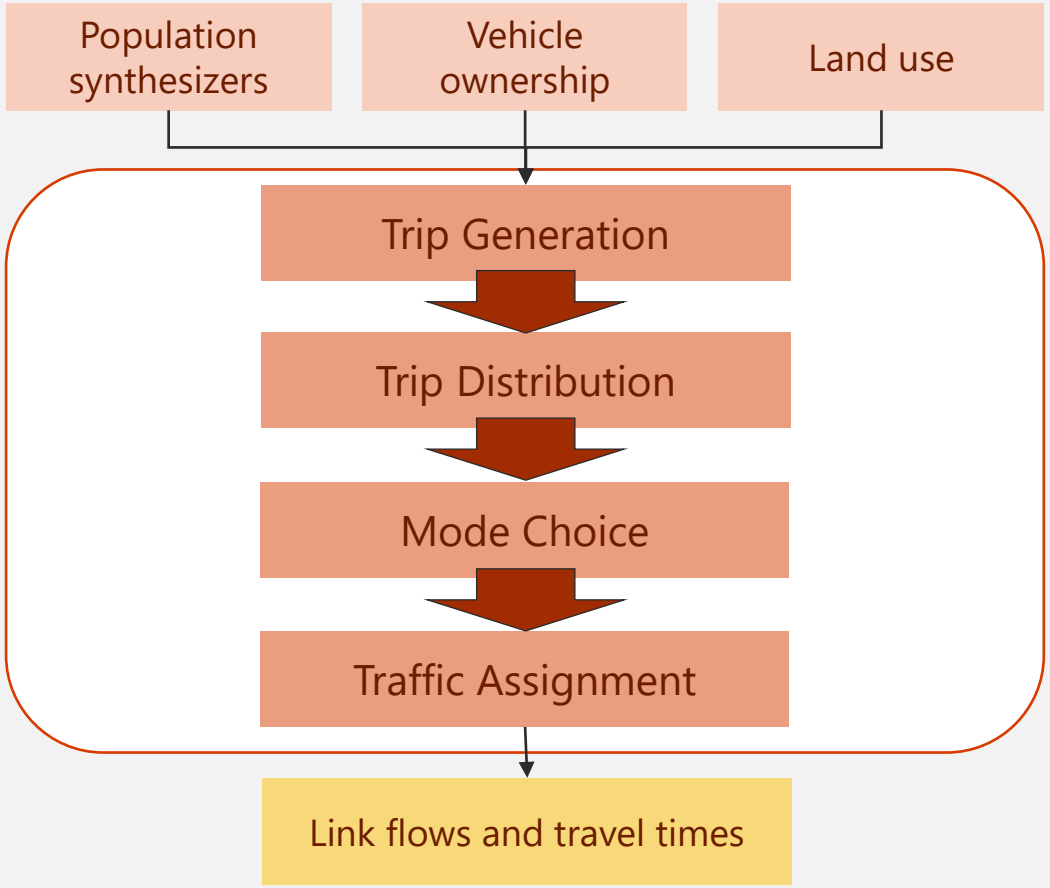
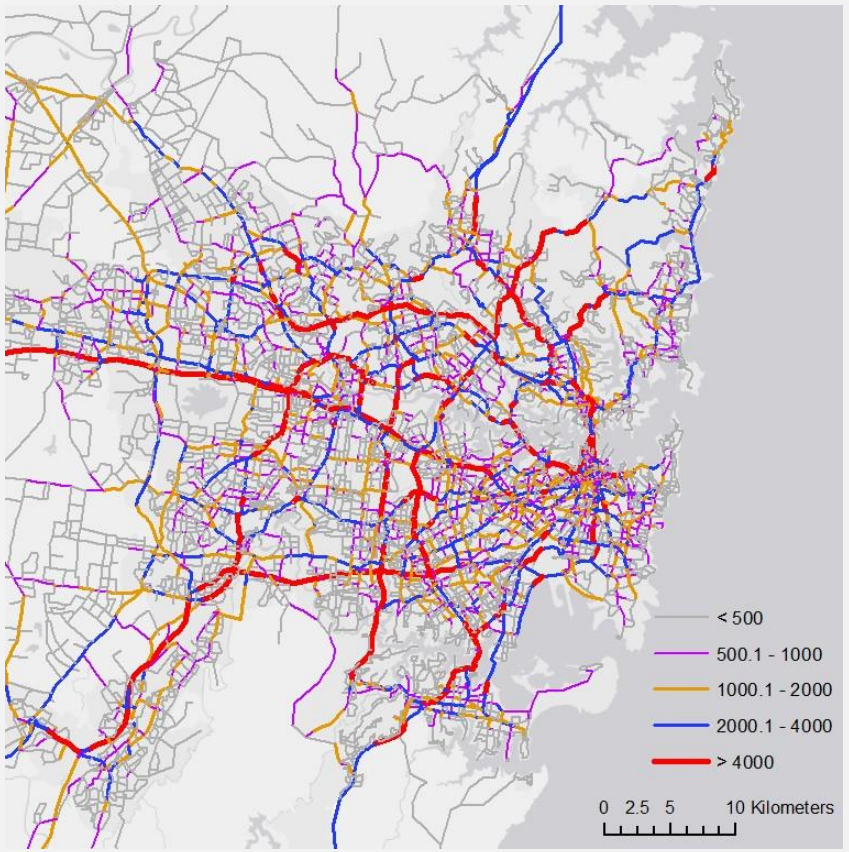
Four-Step Approach





Source: UNSW (2019)

Modelling in Transport

3. **Simulation models:** For solving complex problems where analytical methods are not possible or too slow. E.g. Studying lane changes around motorway ramps

Types of simulation tools used:

1. Macroscopic
2. Mesoscopic
3. Microscopic
4. Nanosimulation

Modelling in Transport

Example packages for modelling

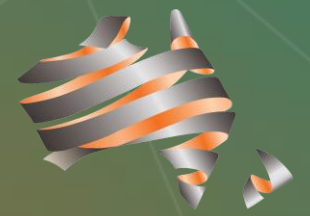
Macroscopic	Mesoscopic
• EMME	• TRANSYT
• CUBE	• SATURN
• TransCAD	• SYNCHRO
• CUBE Voyager	• LinSig

Hybrid	Microsimulation
• CUBE Avenue	• Aimsun
• VISUM	• Paramics
• OmniTRANS	• Vissim
• Intro Dynameq	• SIDRA Trip
• AIMSUN	

Intersection
• SIDRA Intersection
• HCS
• ARCADY

See Appendix M, Austroads (2020)

Model Selection

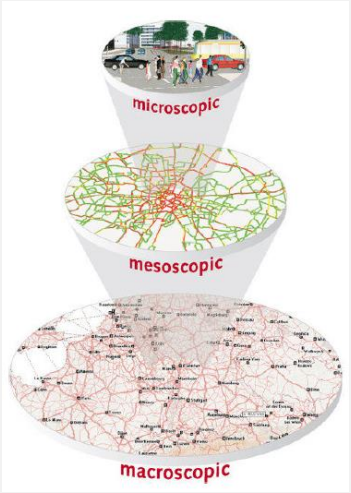


Model Selection

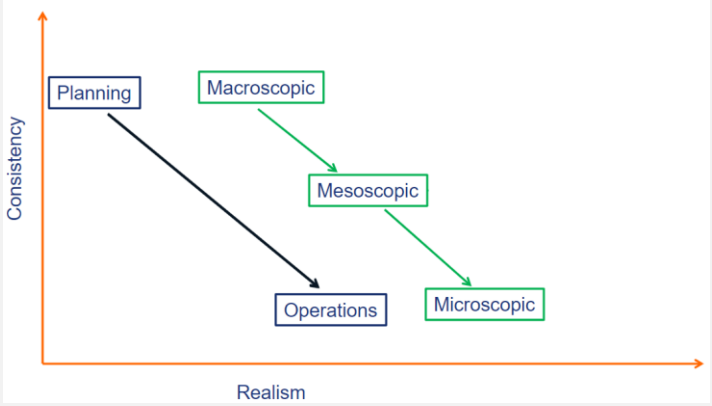
Criteria:

- Goal of the project
  - Strategic Models e.g. STM, VITM – *Macro*
  - Impact of bus lanes, other policies – *Meso*
  - Modelling intersection, TIA – *Micro*
- Available inputs and outputs
  - *Micro model*: Finest resolution, but data intensive
- Budget and time constraints
  - Higher realism implies more cost and time

All models are wrong some are useful – George Box



Source: Vicroads (2011)



Source: UNSW (2014)

Time to Reflect

Which would be an appropriate modelling approach for the following situation:

1. Assessing the impact of a bus-lane on the arterial connecting the residential areas to the commercial district.

A. Macroscopic B. Mesoscopic C. Microscopic

Answer:

Option B is correct!

A mesoscopic model is suitable to assess the impact of transport policies on the overall network performance. Mesoscopic models can provide information on delays, bottleneck formation, etc. which can be compared against the do-nothing option thus indicating the effectiveness of providing a bus-lane.

Time to Reflect

Which would be an appropriate modelling approach for the following situation:

2. Design and control advice for major intersections within the proposed development area. Consideration of signals, roundabout facilities or yield/stop intersections is necessary.

A. Macroscopic B. Mesoscopic C. Microscopic

Answer:

Option C is correct!

A microscopic model is suitable to meet this objective. Coordination of signalised intersections will need to be completed using the microsimulation software to get an idea of the appropriate timings and phases for each major intersection.

Data Required for Modelling

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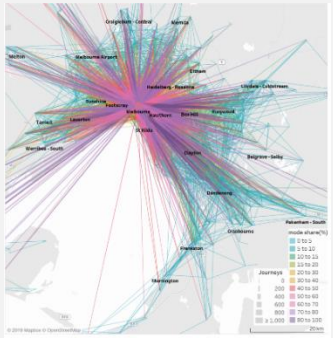
Demand

- TAZ information
- OD matrix
- HTS Survey



Source: Charting Transport (2018)

Network

- Nodes and link data (available as shapefiles in general)
- Speed limit, number of lanes, etc. on each link
- Location of intersections, roundabouts, etc.

Source: Vic. Govt. (2017)

Public Transit

- Bus routes
- Scheduling
- Dwell time

Source: Charting Transport (2011)

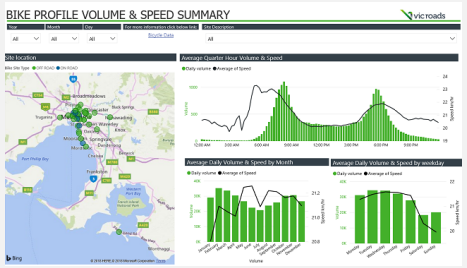
Turning Movement

- Turning volume at intersections
- Phase plan and duration
- Real-time data available from SCATS

Source: ATC (2019)

Traffic Volume

- Hourly traffic counts on major roads
- Travel time or speed data using Google/HERE platforms



Source: Vicroads (2019)

Model Calibration, Validation and Auditing

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Model Calibration

Objective: *To improve the model's ability to reproduce driver behaviour and traffic performance characteristics such as travel time, delay or queue length by varying model parameter values from the default values supplied by the software supplier.* (Austroads, 2020)

- Vital step in model development: Calibration differences of 13% inflated to 68% for future forecasts (FHWA, 2004)
- Generally done using traffic volume data, i.e. comparing simulated and observed traffic flows

Model Calibration

Recommendations for calibrating a microscopic model (Austroads, 2006)

- Limit calibration to a workable set of parameters
- Calibrate the global parameters first followed by local/site-specific
- Undertake multiple runs using different random seeds

See Section 8.2.4, Austroads (2020)

Model Validation

See Section 8.2.5, Austroads (2020)

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Validation can be defined as a comparison of model outputs with observed data independent from the calibration procedure. (Austroads, 2020)

Available data is split into two parts:

- Training dataset – Used for model calibration
- Validation dataset – Used for model validation

Performance Outputs:

- Travel Time
- Delay or Queue Length

Validation to be carried out on a statistical basis.

Model Validation

Statistical Measures for Goodness-of-fit:

- Confidence Limits (Austroads, 2020)

$$CL_{1-\alpha} = \left(\bar{x} - z_{1-\alpha/2} \frac{\sigma}{\sqrt{N}}, \bar{x} + z_{1-\alpha/2} \frac{\sigma}{\sqrt{N}} \right)$$

- GEH Statistic (Wikipedia, 2019)

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

$GEH \leq 5$ is considered a good match while developing the base model

Model Auditing

See Section 8.2.6, Austroads (2020)

Auditing a model is broadly defined as a process to verify the results from the model. (Austroads, 2020)

Process involved:

- General error checking by an independent analyst
- An independent reviewer who can provide a ‘sanity check’ on model outputs
- Examine whether the adopted modelling strategy is appropriate
- A comparative study of model outputs from several other models if time and budget are available

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Thank you for participating

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