

Then. Now.
Tomorrow.

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UC
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Te Whare Wānanga o Waitaha

Modelling disrupted networks: A review of the modelling simulators

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Background

Simulation models

Simulation packages

Case studies

Conclusion

Background

- Efficient transportation system is important: economic growth & enhancing social wellbeing
- Road networks efficiency is reduced by:
 - Recurrent congestion: during peak hours
 - Non-recurrent congestion: traffic accidents & adverse weather conditions



Background

- ▶ The duration of the degradation in road networks:
 - Long-term
Earthquakes, hurricanes, floods, landslides, tsunamis, volcanic eruptions...
 - Short-term
Road accidents, road maintenance work ...

Background

- Various computer packages are used to simulate degradations of a road network
- “Simulation” means:

“An alternative to analytical models consisting of a technique that imitates on a computer the operation of a real-world system as it evolves over time”

Background

- ▶ Simulation packages are based on user equilibrium principle
- ▶ Wardrop's first principle (1952):

“The journey times on all the routes actually used are equal, and less than those which would be experienced by a single vehicle on any unused route”

Background

Simulation models

Simulation packages

Applications

Summary



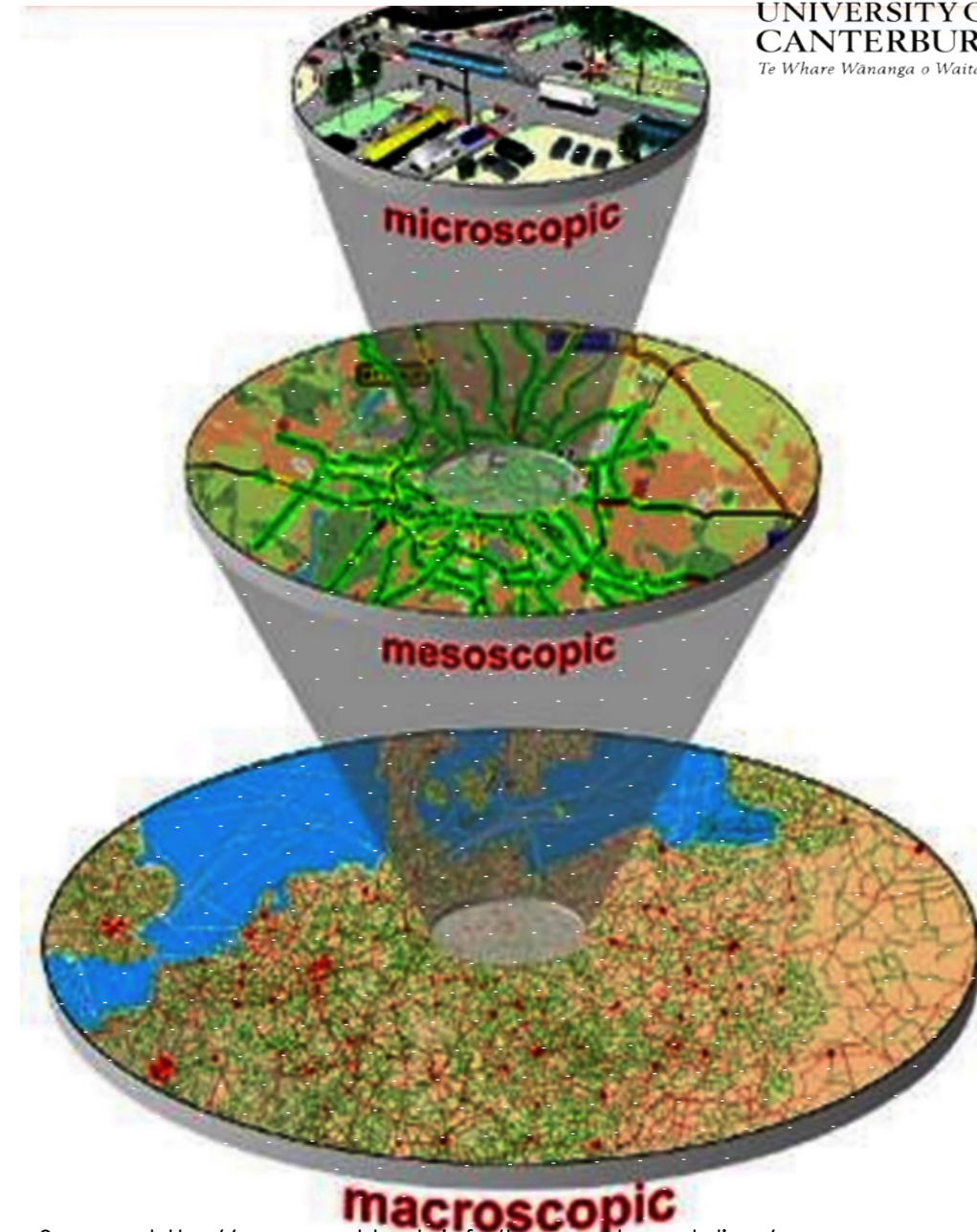
Simulation Models

► Three different levels of detail:

➤ Macroscopic models

➤ Microscopic models

➤ Mesoscopic models



Simulation Models

➤ Macroscopic models

- 4-stage models: generation, distribution, modal choice, and assignment.
- Usually have fewer parameters to calibrate.
- Less sensitive to small changes in network.
- Limited to the cases where the interaction of vehicles is not crucial to the results of the simulation

(Burghout & Wahlstedt, 2007)

Simulation Models

➤ Microscopic models

- The amount of detail
- Running time
- Calibration difficulties
- Limited to small areas
- Optimal paths are recalculated periodically and vehicles re-assigned to new optimal paths.
- Take account of route changes after a trip has begun in case of blockage to reduce delay.
- Suited to model both vehicle interactions & drivers' reactions in the presence of ITS applications
- Do not allow for re-assignment of traffic after a trip has commenced.
- Over-estimate the impact of the blockage.


Simulation Models

➤ Mesoscopic models

- Concerns related to accurate modelling of adaptive signal control as both the positions and behaviour of vehicles are approximated (Burghout, 2004).

Background

Simulation models



Simulation packages

Applications

Summary

Simulation Packages

- ▶ The most common used simulation packages are:
 - ✓ Paramics (**P**arallel **m**icroscopic **s**imulation)
 - ✓ VISSIM (**V**erkehr **i**n **S**taeden **S**imulation)
 - ✓ AIMSUN (**A**dvanced **I**nteractive **M**icroscopic **S**imulator for **U**rban and nonurban **N**etworks)
 - ✓ SATURN (**S**imulation and **A**ssignment of **T**raffic to **U**rban **R**oad **N**etwork)
 - ✓ Cube
 - ✓ Emme

Simulation Packages

- The classification of traffic modelling software is a controversial issue.
- SATURN was classified as:
 - ✓ A microscopic modelling software (Ratrouf and Rahman, 2009)
 - ✓ A macroscopic modelling software (Andjic, 2000)
 - ✓ A mesoscopic modelling software (Berdica et al., 2003)

Background

Simulation models

Simulation packages



Degraded network simulation

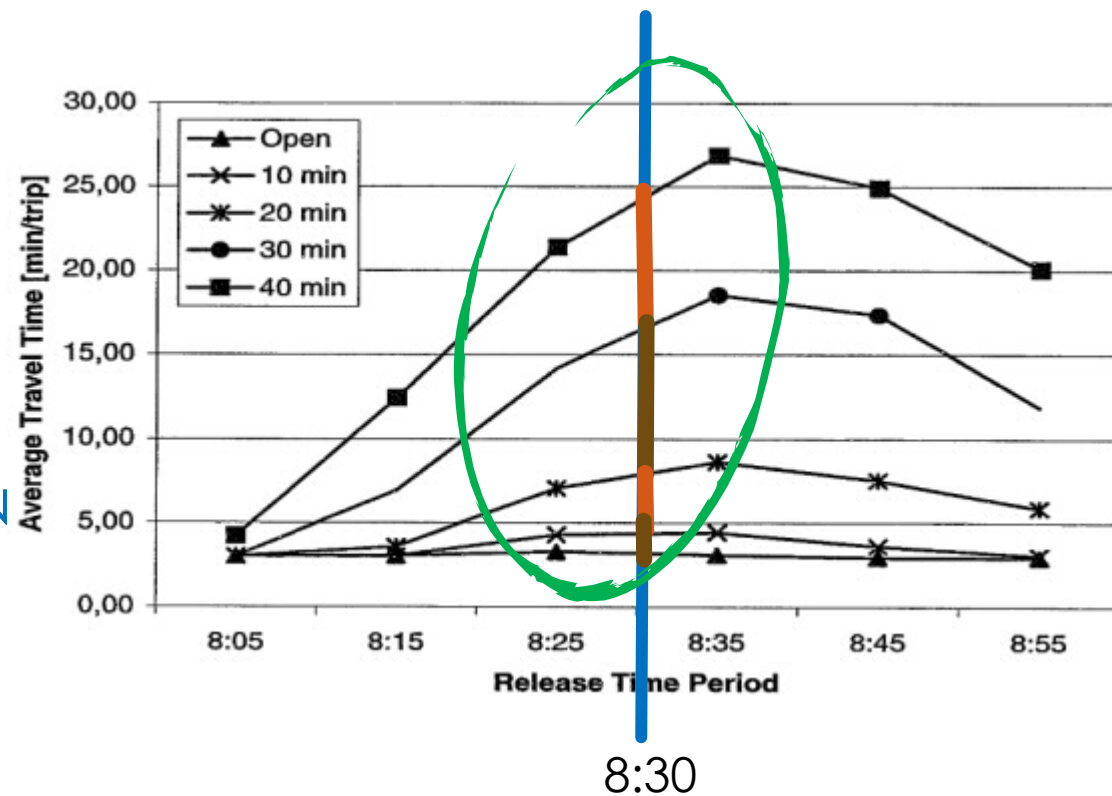
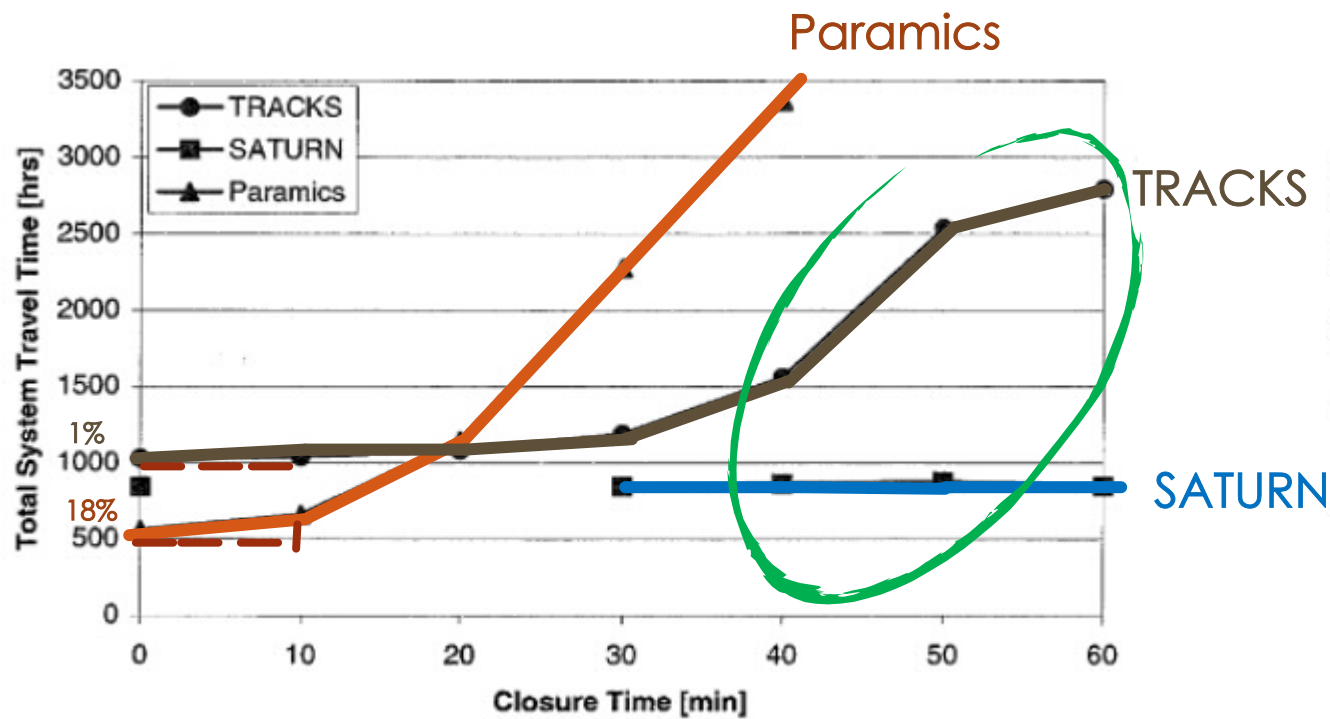
Summary

Network simulation

- ▶ Traffic demand simulation around the University of Canterbury:
 - ✓ Laird and Nicholson (2000): developed PARAMICS microscopic model
 - ✓ Cameron (1996): developed SATURN model
 - ✓ Andjic (2000): has developed & compared TRACKS and SATURN. The two models have been compared with Paramics

Degraded network simulation

- Berdica et al. (2003):



Model comparison of system travel time for different closure durations

Average travel time for different closures durations using Paramics

Degraded network simulation

- ▶ Wilmshurst et al. (2015) applied CUBE, SATURN, and PARAMICS models which to measure incident impacts northern Christchurch.
- ▶ The studied area is covered by:
 - ✓ Bluetooth (BT) journey time data system.
 - ✓ NZ Transport Agency permanent traffic count sites.
- ▶ Two main concerns when collecting data using BT detectors:
 - ▶ BT data is not able to count the volume accurately.
 - ▶ To work effectively under long-term disruption.

Driver's familiarity modelling

- The driver response to different road network degradations depends on:
 - Event characteristics (i.e. both the severity, and duration);
 - Driver characteristics (i.e. familiarity with the road network);
 - The real time information availability to drivers.

Background

Simulation models

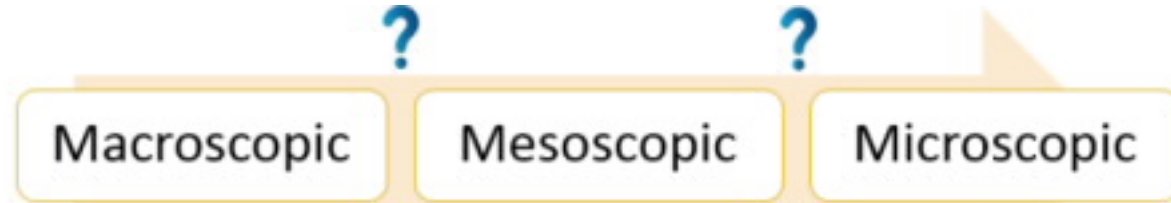
Simulation packages

Applications

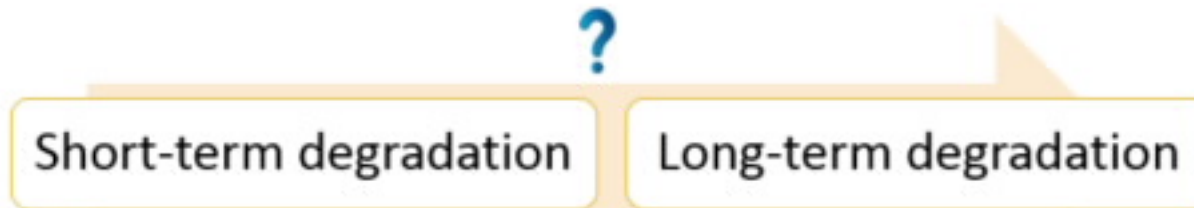
Summary



A method for classification



A. The level of detail



B. The duration of the degradation



C. The extent of the degradation

Degraded network simulation

- The size of the road network should be large enough to cover all rerouting of trips caused by the proposed changes (Andjic, 2000)
- The greater the size and complexity of the model the greater is the running time for the model, and the running time exceeding the real time (Koorey et al., 2015)

Summary

- To develop a guidance on which type of model should be used in which circumstances
- To discuss the circumstances in which each type of model is most appropriate for modelling different types of traffic disruption
- The size of the network by considering the level and duration of the degradation

Acknowledgment

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Thank you