Models in Aid of Traffic Management

Sven Maerivoet

FWB

Katholieke Universiteit Leuven
Department of Electrical Engineering
ESAT-SCD (SISTA)

Overview

- **Traditional four step approach**
  - OmniTRANS
- **Traffic flow models**
  - Problems with most of the models
  - Macroscopic and microscopic models
- **Module development**
  - Pollutant/noise emissions
- **Models used for traffic management**
  - Evaluation of control strategies / infrastructural changes
- **Conclusions**

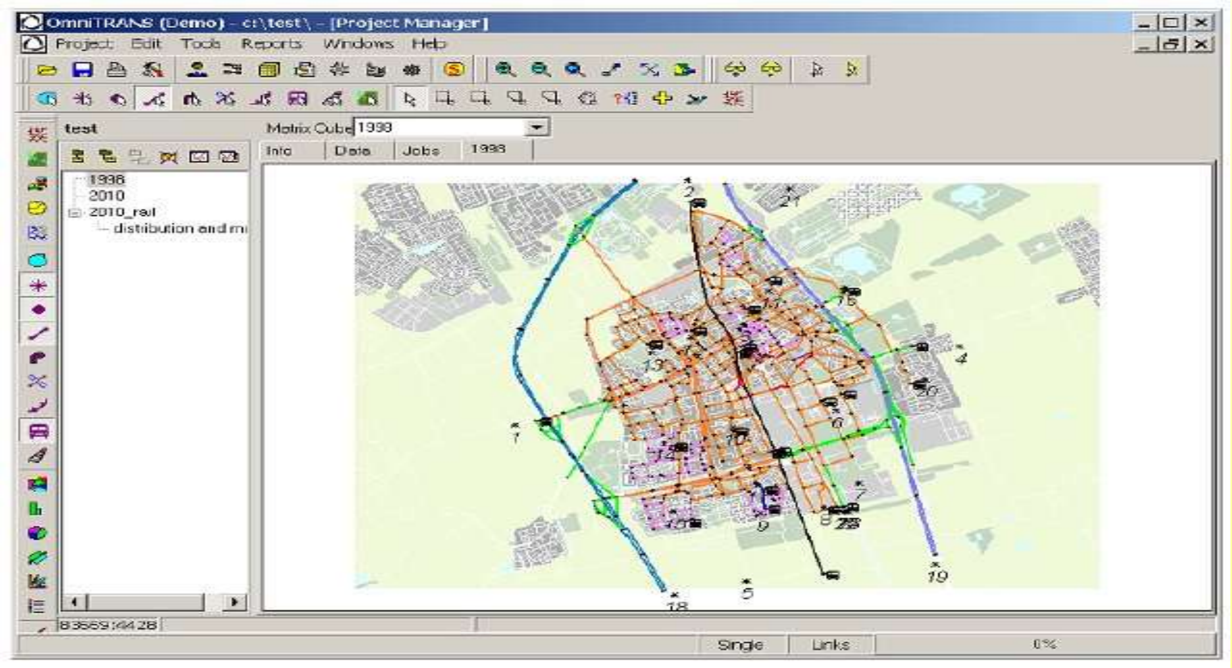
Traditional four step approach

- Historically, travellers make certain decisions, leading to a trip based model (⇔ activity based).

trip generation	*(how many trips ?)*
trip distribution	*(where do they go ?)*
modal split	*(what kind of transportation ?)*
traffic assignment	*(which routes do they take ?)*

www.OmniTRANS-International.com

- Better able to cope with **data flood**.
  - ➡ Efficiently manages *all* your data.
- **Scenario evaluation** (*reproducability*).
  - ➡ Project management.



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- **Standard 'designs'** allow for:
  - Typical analyses.
  - Default graphical outputs and tabular reports.
- **Extensible modelling**:
  - Integrated existing OOP scripting language (*Ruby*).
  - Plugins (e.g., *INDY* for dynamic traffic assignment).

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Traffic flow models

- We consider the *propagation* of road traffic.

trip generation

trip distribution

modal split

traffic assignment

Within the four step approach there exist submodels that "describe" traffic flows.

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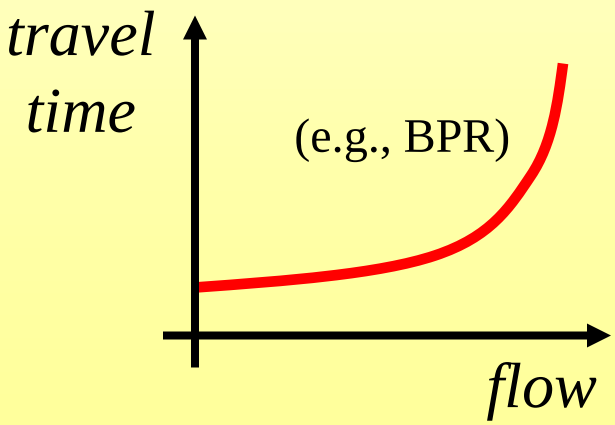
Many traditional models (e.g., TransCAD) are based on simple **travel time functions**.



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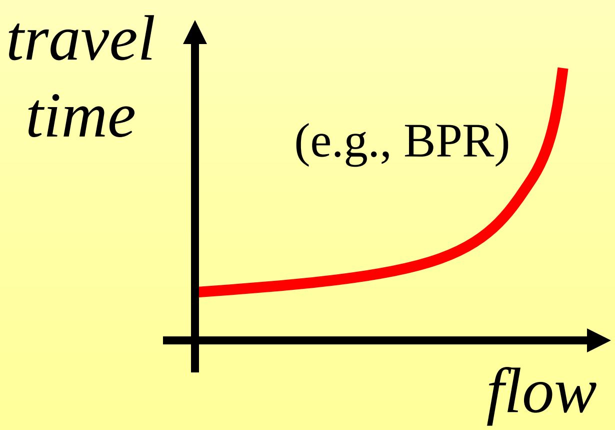

It is difficult (*but necessary*) to capture the concept of "**capacity of a road**" !

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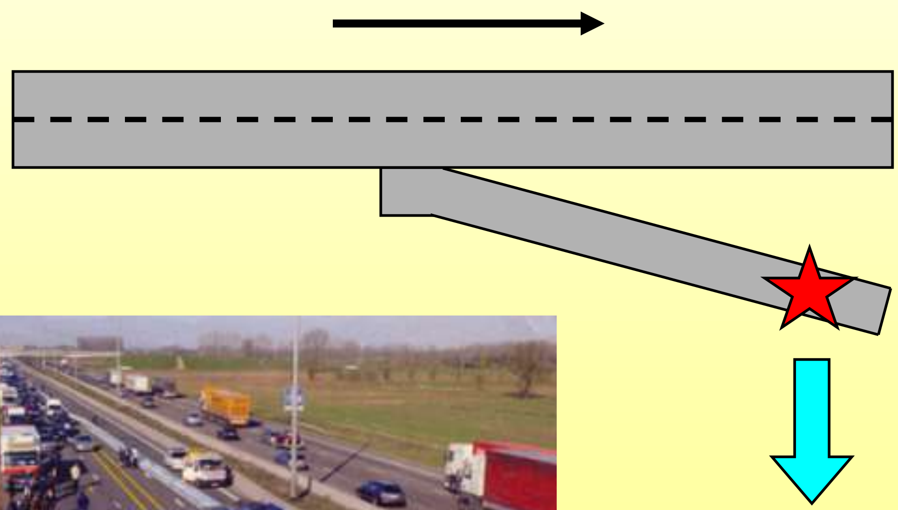
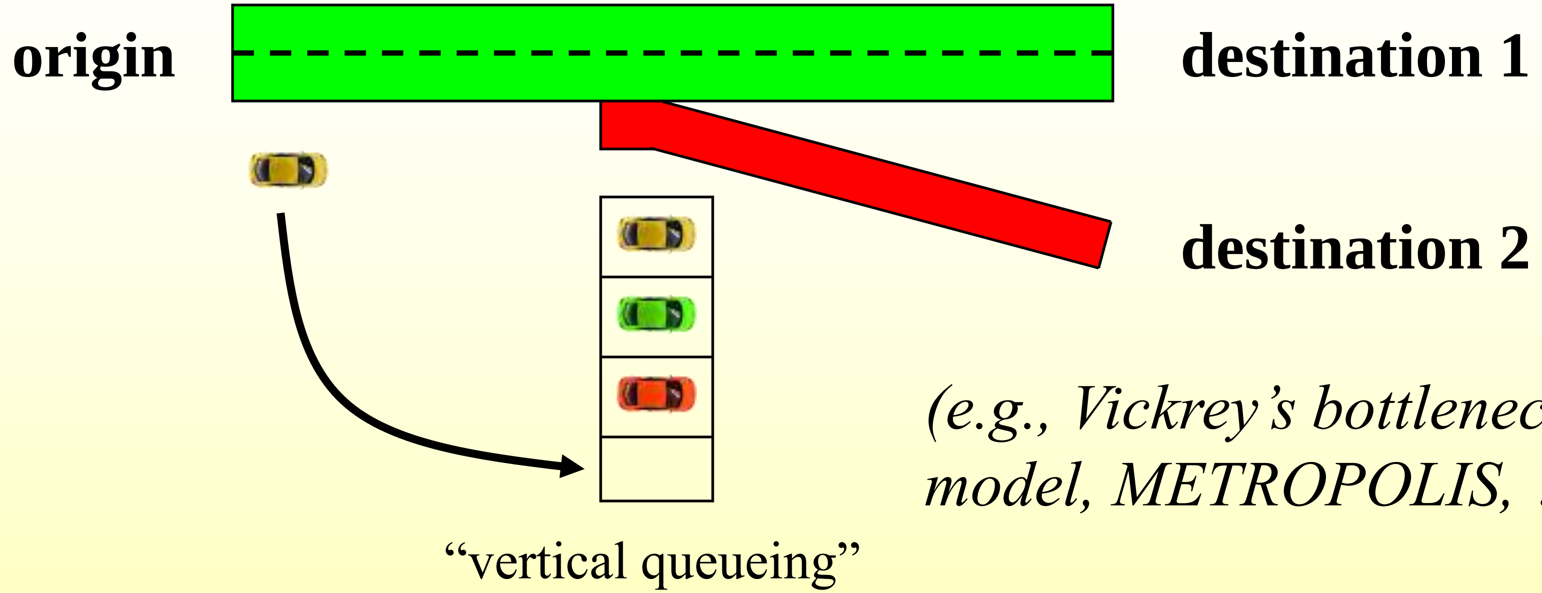
Problems with most of the models

- In reality, congestion is a **dynamic** phenomenon !
- Consider the following typical example of congestion at a *bottleneck* leading to a queue *spill-back* effect (e.g., Brussels' ring road):



The need for dynamic models



(e.g., Vickrey's bottleneck model, METROPOLIS, …)

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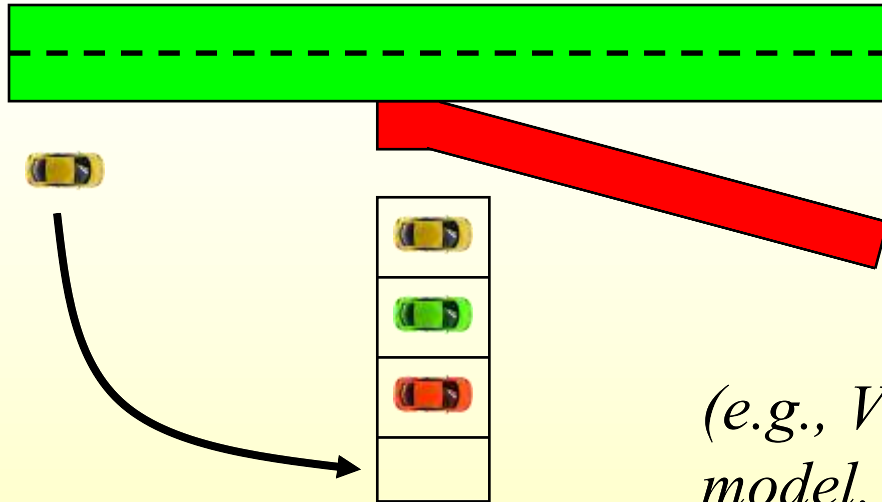
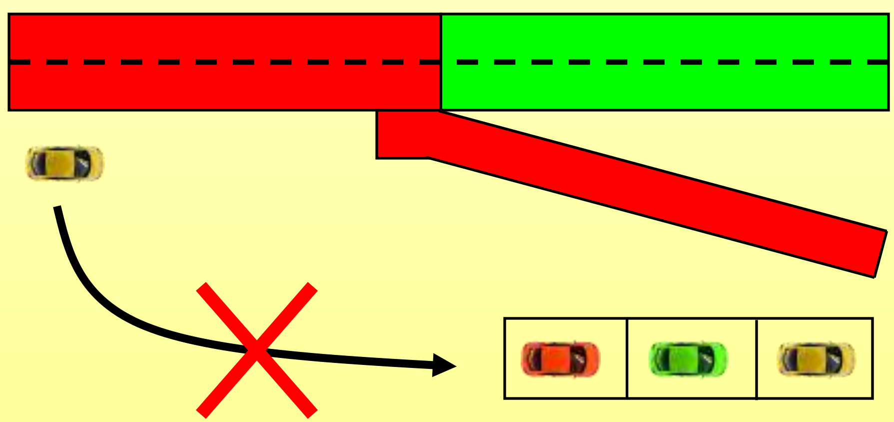


“vertical queueing”

(e.g., Vickrey’s bottleneck model, METROPOLIS, …)



“horizontal queueing”

Scales of dynamic models

- More complex models exist, allowing a more detailed capturing of congestion effects.

- Different levels of detail:
  - Consider traffic stream as a whole:

    ⇨ **macroscopic** continuum models (compressible fluid),

    ⇨ **mesoscopic** gas kinetic models (gas).

  - Consider traffic as being composed of individual vehicles:

    ⇨ **microscopic** models.

Models employed in our research

- Standard fluid dynamic first order macroscopic Lighthill-Whitham-Richards (**LWR**) model.
  ➡ extended to include *heterogeneous* classes.

- Second order macroscopic **METANET** model.

- Detailed microscopic models.
  ➡ **PARAMICS**, **AIMSUN**,
  ➡ traffic cellular automata.

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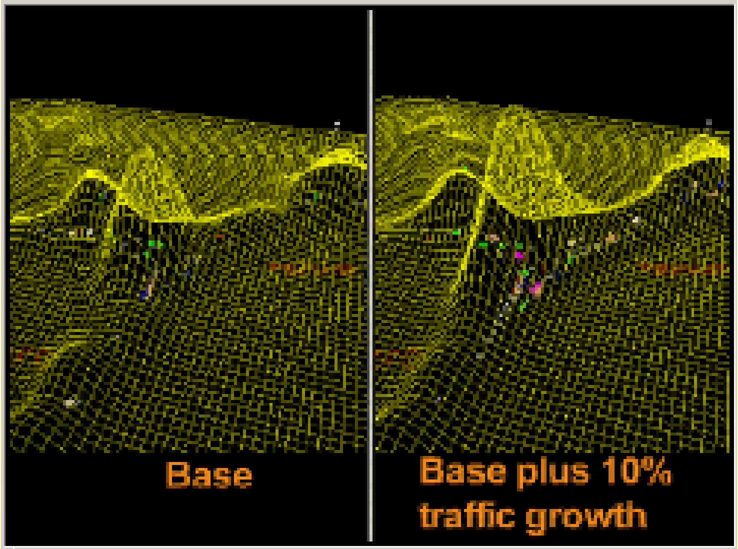
Module development

- Microscopic traffic simulators (e.g., PARAMICS) lend themselves easily to the *extension* with different modules:

  - **pollutants**,
  - **noise emissions**.

    (PODO 2 – CP/37)



  - currently: development of a **traffic safety** module.

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Models used for traffic management

- Evaluation of **control strategies** ?
  - (1) road pricing / congestion charging,
  - (2) overtaking prohibition for trucks,
  - (3) ramp metering,
  - (4) dynamic speed limits.

  } **ATMS**

- Effects of **infrastructural changes** ?
  - (5) capacity of a turbo-roundabout.

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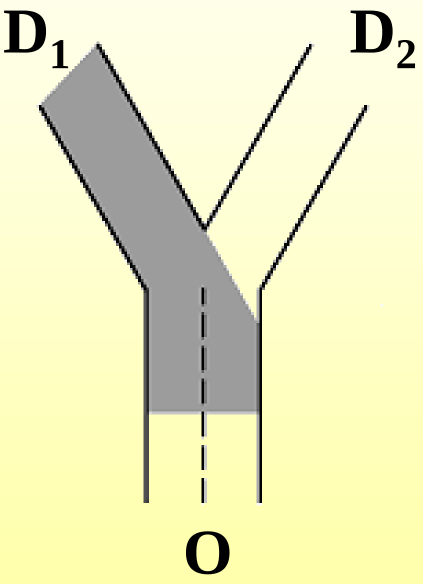
(1) Road pricing / congestion charging

- Demand = Vickrey's bottleneck model.
- Traffic propagation = **dynamic** LWR model.

- Aim towards a system/social optimum.
- Model **queue spill-back** !



(model used: 1st order homogeneous LWR)

(1) Road pricing / congestion charging

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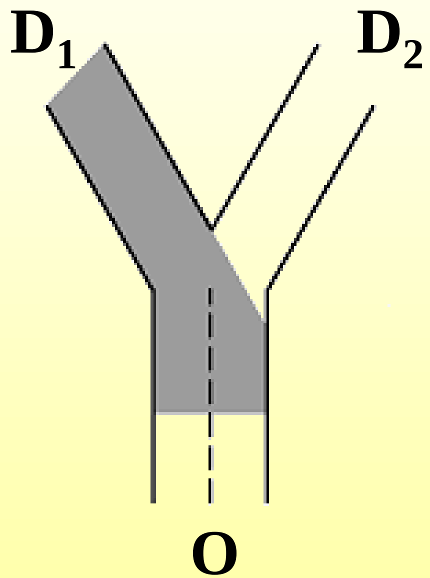
- <u>Traffic propagation</u> = **dynamic** LWR model.



- Aim towards a system/social optimum.
- Model **queue spill-back** !
- Setting a **variable optimal toll** leads to:
  - congestion free (increased) traffic,
  - a better usage of the road network,
  - lower travel times (and travel costs don't increase).

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(model used: 1^{st} order homogeneous LWR)

(2) Overtaking prohibition for trucks

- Is it worthwhile to impose such a policy ?
- Use the possible **gain in travel time** as a criterion *(under free–flow traffic conditions)*.
- Differentiate between VOT of **cars** and **trucks**.

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(model used: 1st order heterogeneous LWR)

(2) Overtaking prohibition for trucks

- Is it worthwhile to impose such a policy ?
- Use the possible **gain in travel time** as a criterion *(under free–flow traffic conditions)*.
- Differentiate between VOT of **cars** and **trucks**.

- There is an <u>advantage</u> if the car demand increases.
- But the advantage <u>diminishes</u>:
  - once the car demand exceeds the lane capacity,
  - and/or the truck demand increases (const. car demand),
  - and/or the number of lanes in one direction increases.

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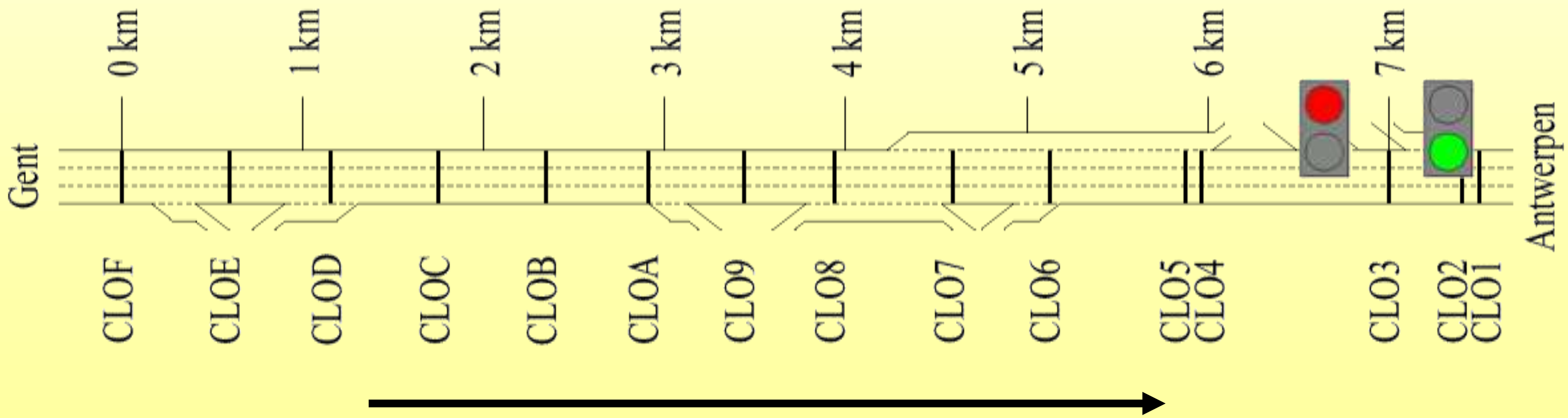
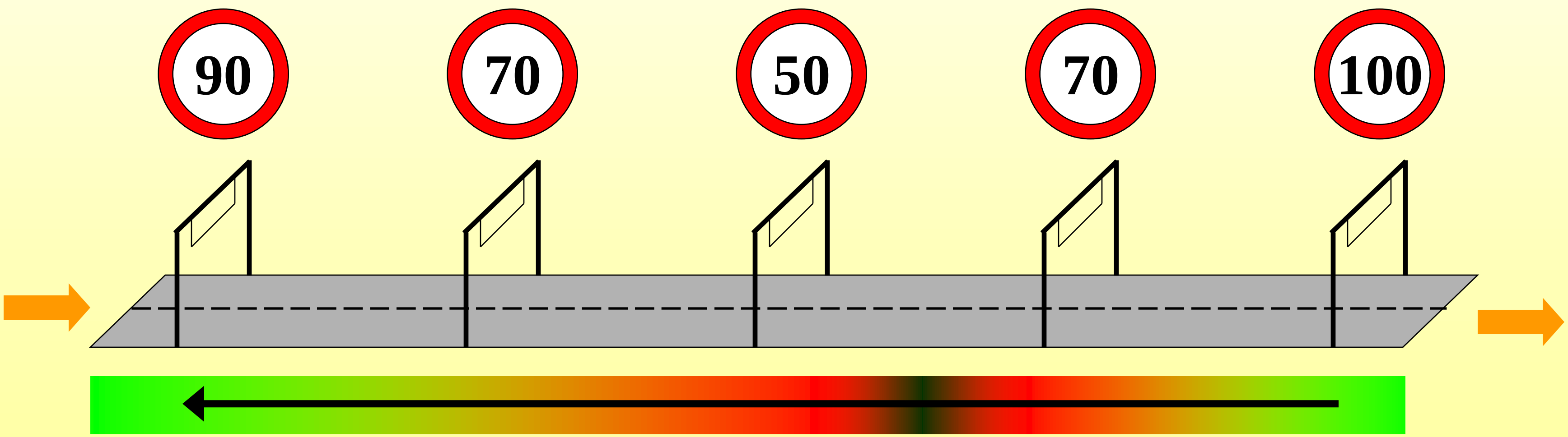
(model used: 1st order heterogeneous LWR)

(3) Ramp metering (with MPC)



SISTA **(model used: 2nd order homogeneous METANET)**

(4) Dynamic speed limits (with MPC)

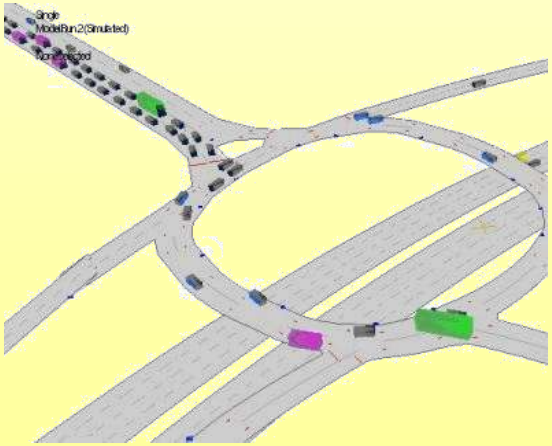


upstream moving shockwave

SISTA **(model used: 2nd order homogeneous METANET)**

(5) Capacity of a turbo-roundabout

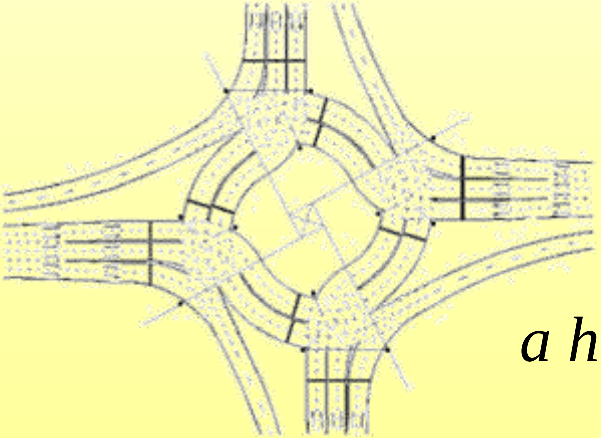
- On classical roundabouts, drivers tend to use the outer lanes, leading to a suboptimal situation.



(model used: PARAMICS)

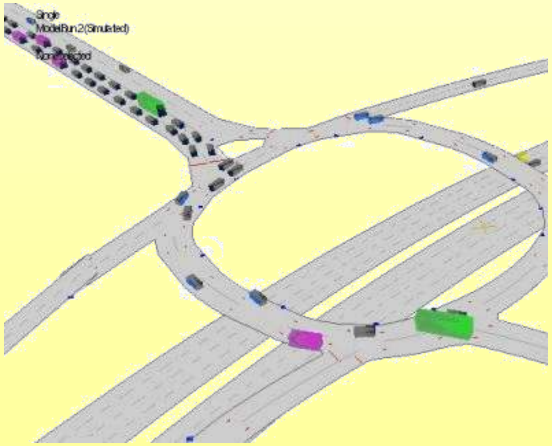
(5) Capacity of a turbo-roundabout

- On classical roundabouts, drivers tend to use the outer lanes, leading to a suboptimal situation.
- A **turbo-roundabout** (TR):
  - forces drivers to select lanes *before* entering the TR,
  - forces drivers to follow a *fixed route* once on the TR,
  - therefore, the inside lanes are used more efficiently.



Result:

a higher capacity.



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(model used: PARAMICS)

Conclusions

- The **temporal character of congestion** is not to be neglected (e.g., changes in travel times, …).
- Therefore, **dynamic models are necessary** !
- Even for long-term transportation planning models.
- Thus, allowing a better estimation of the (future) effects of certain traffic control measures/policies/ strategies.

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