Efficient Microscopic Simulation of Large Scale Highway Traffic Flows

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General overview

- Problem statement

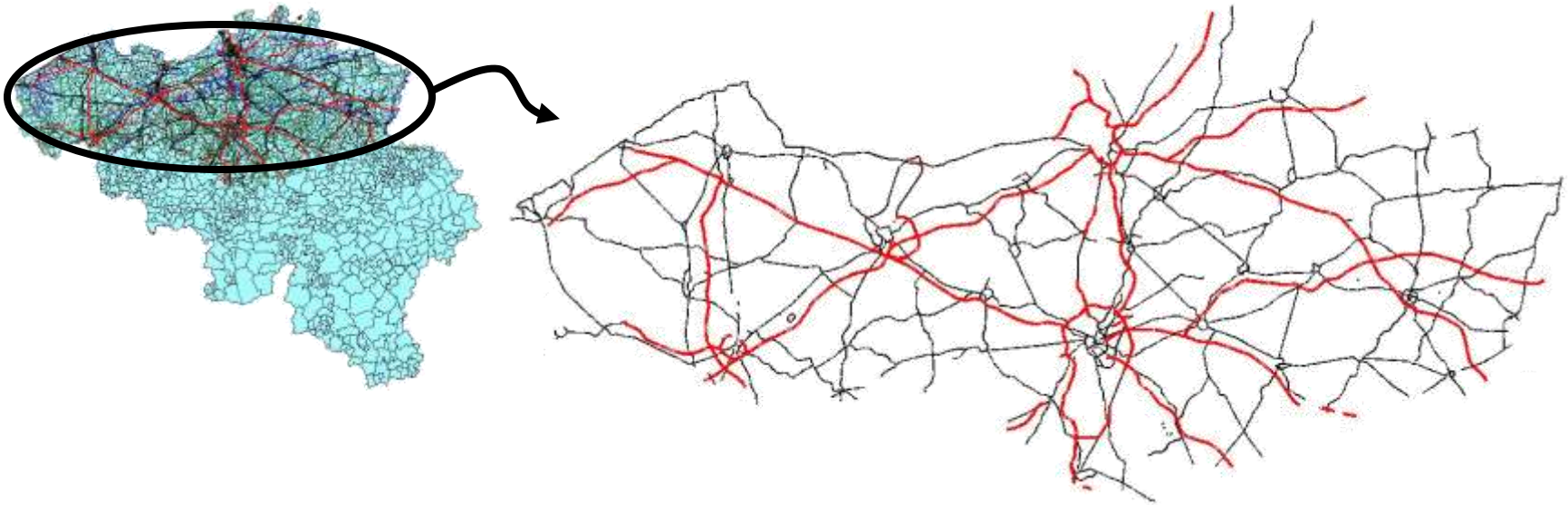
  - Microscopic traffic simulation
  - An efficient modelling scheme
  - Tackling large scale aspects
  - Practical implementation issues

  SOLUTION

- Some possible applications
- Conclusions

The challenge

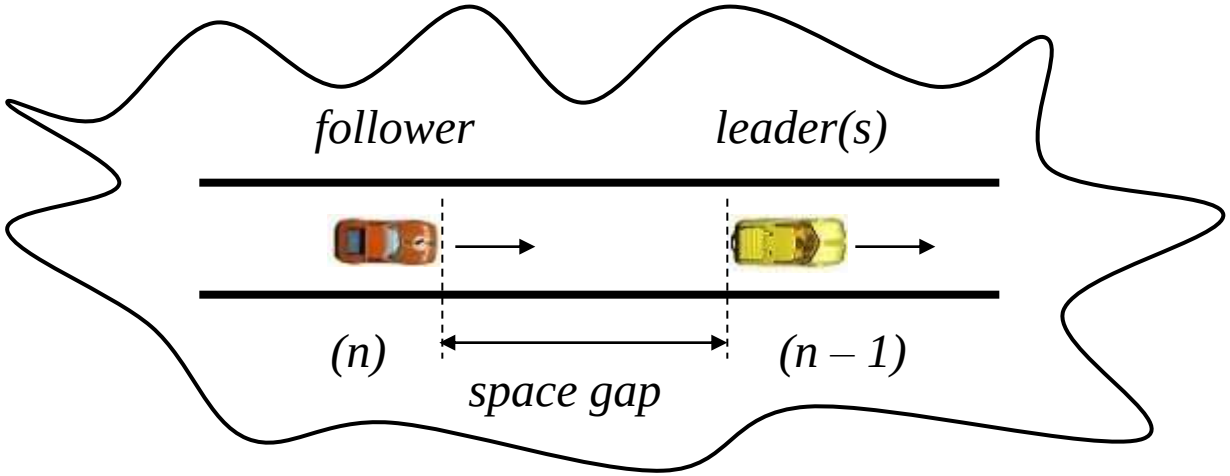
"To simulate all traffic on Flanders' primary highway road network."



... detailed and faster than real-time !

Microscopic traffic simulation

- Bottom up approach: model each vehicle individually.
- **Car-following** and **lane-changing** submodels.



$a_n(t + \tau) \sim f(t, \Theta)$

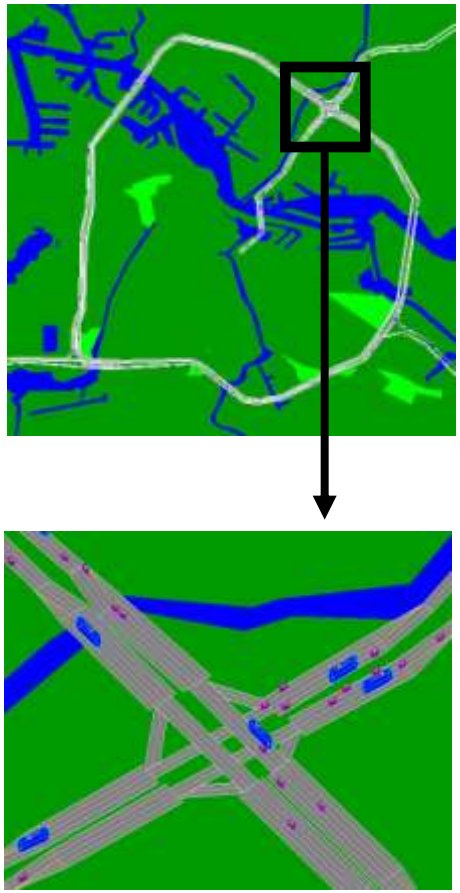
reaction time

space/time gaps, (relative) speeds, …

Microscopic pitfalls

- High **computational burden** involved !

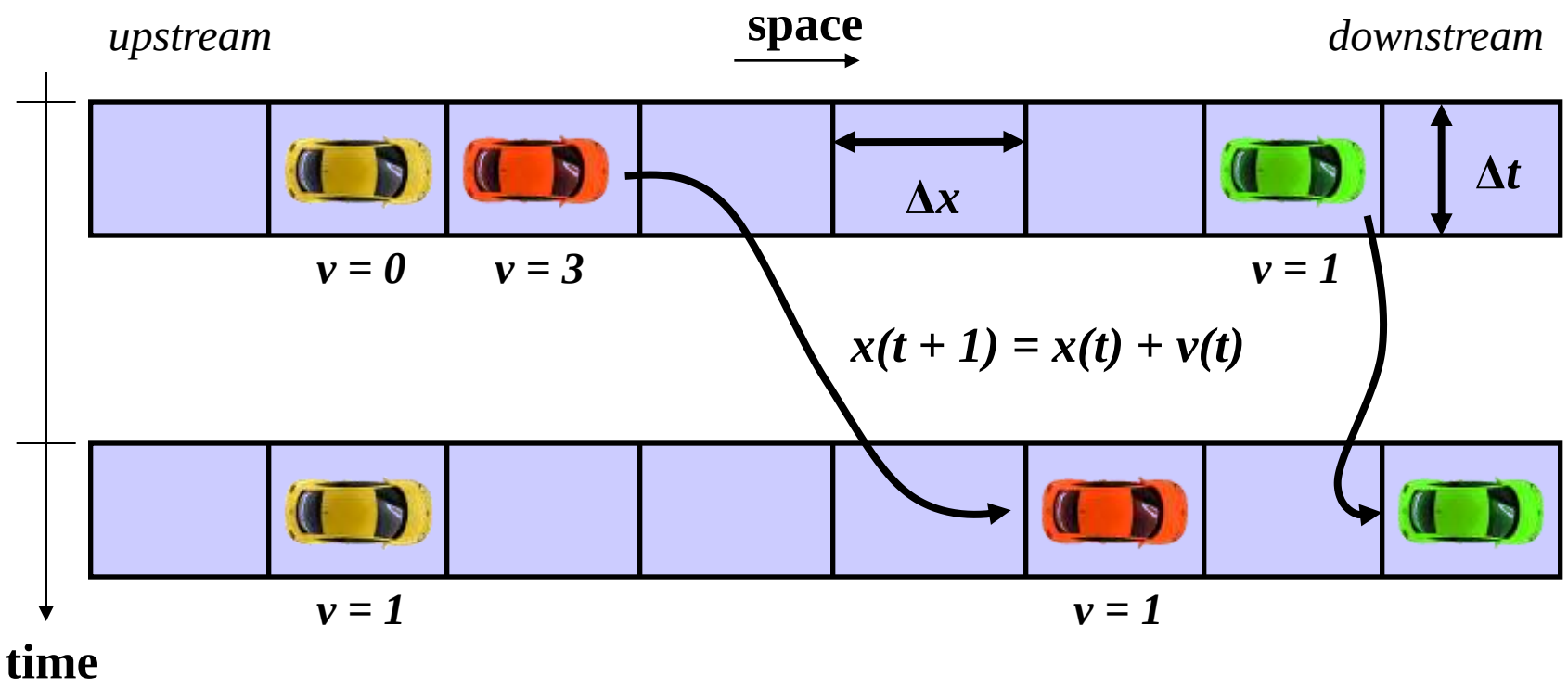
  → apply both submodels
  → to thousands of vehicles
  → each 10th of a second



- Many (unnecessary) parameters.
- Difficult to calibrate and validate.

An efficient modelling scheme

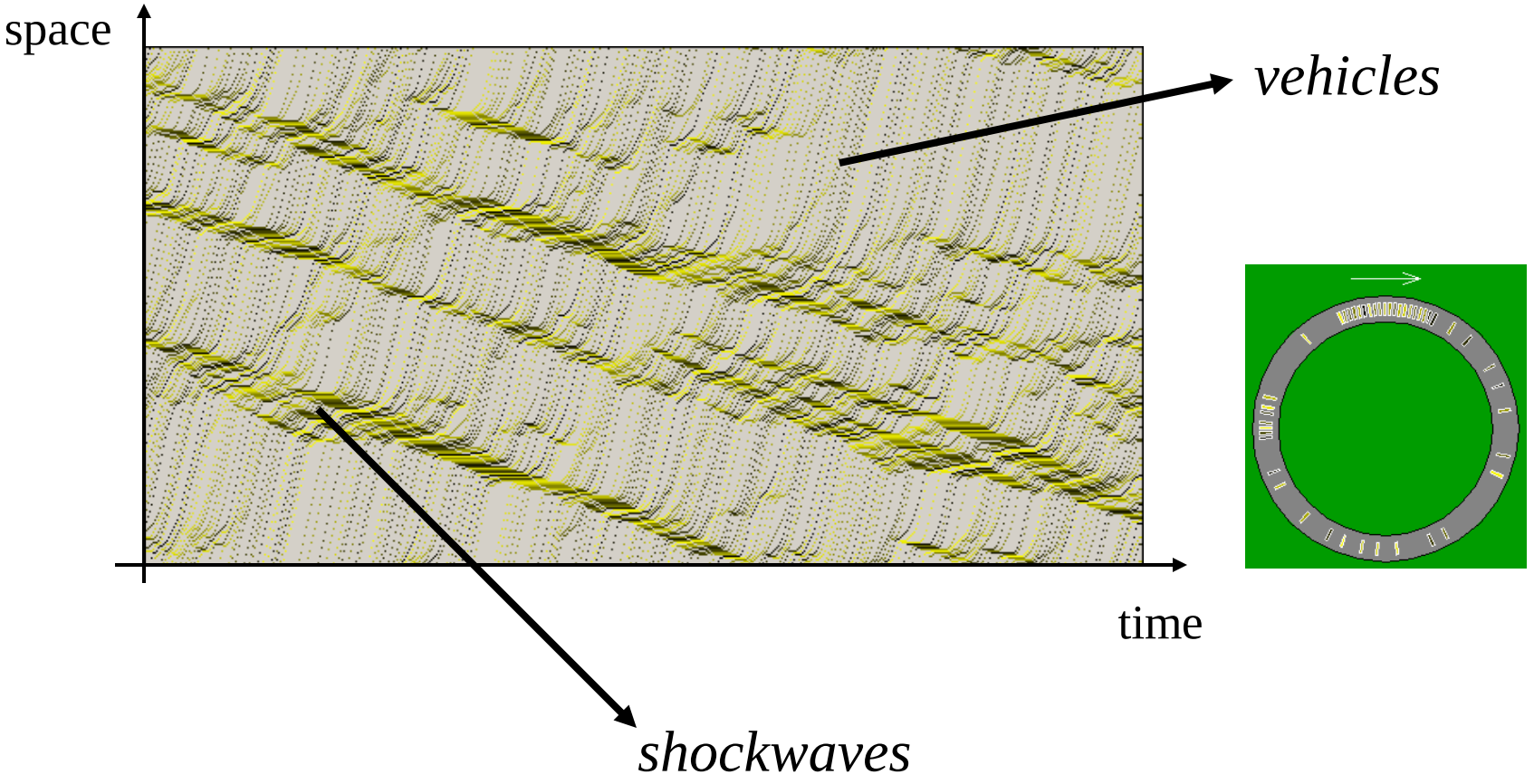
- Space/time discretisation (e.g., $\Delta x = 7.5$ m; $\Delta t = 1$ s).



Traffic Cellular Automata (TCA)

Example: Nagel-Schreckenberg STCA

- Consider a unidirectional, single lane circular road:



Tackling large scale aspects

- *What do we mean by "large scale" ?*

  Flanders has ≈ 1350 km of highway roads.

  ⇒ ≈ **540,000 cells** (7.5 m/cell; 3 lanes/road)

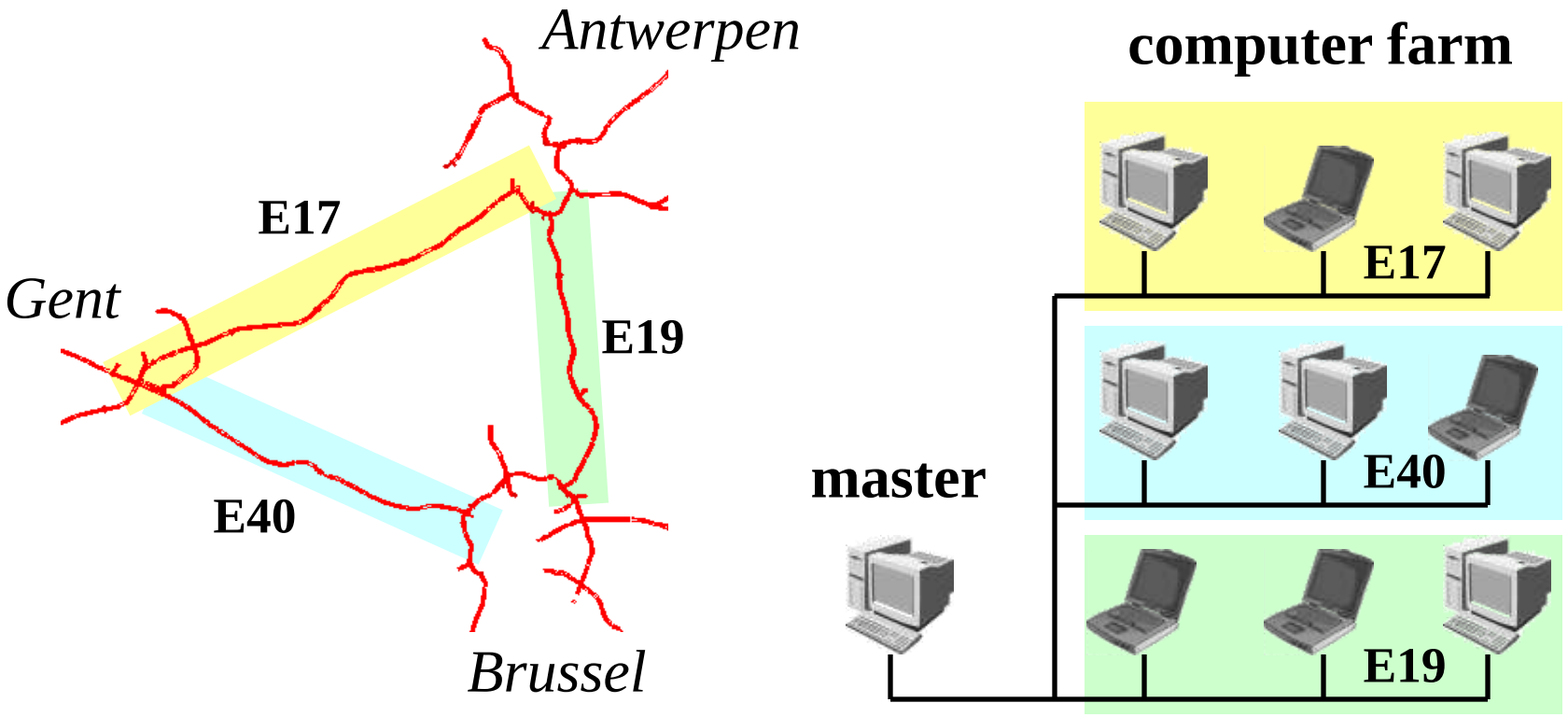
- Divide the workload over different workers:

  ⇒ **parallellism** through distributed computing.

- **Assumption**: deployment in a *heterogeneous computing environment* (cfr. Grid computing).

Distributed computing

- Assign all highways to separate computing units:



Static scheduling versus dynamic load balancing !

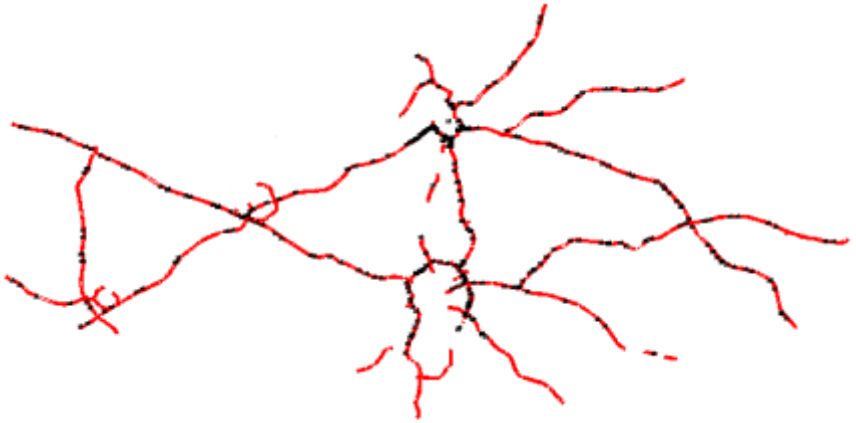
Practical implementation issues

- Using *Java*, we gain true **platform independency**.
- Demand side: different **vehicle types**, **routes**, ...

- Supply side: network structure (**nodes and links**).
- *At this moment:* **unidirectional highway traffic**, unsignalised intersections, ...
- *A a later stage:* incorporate secondary road network, urban areas, ...

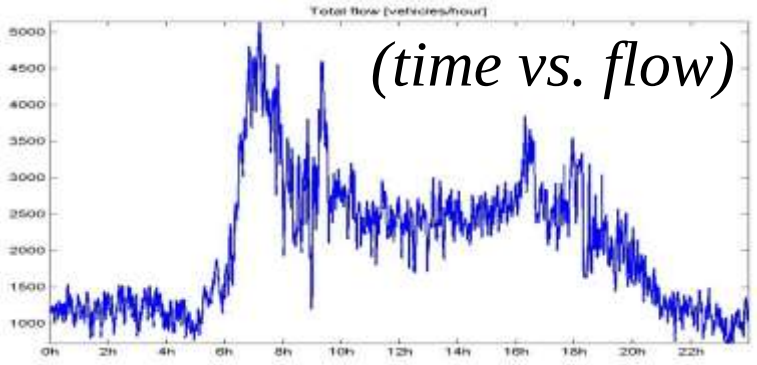
Calibration and validation

- ± **1655** sensors
  ≈ 10^6 measurements/year
  ≈ 3.24 GB



- Create **'checkpoints'** in the network (sources / sinks).

→ { **flow tuning**
density tuning



- Sampling period = 1 minute.

Some possible applications

- **An intelligent routeplanner:**
  - Prediction of future traffic states.
- **“What-if ?” analyses**:
  - Testing different infrastructural scenarios.
  - Estimating impact of incidents, lane closures, policy decisions, ...
- Simulation based **dynamic traffic assignment** (DTA).
- A **detailed control model**.

Conclusions

- Provide a detailed real-world simulation environment.

CATSIM

- Geographical scope:

  ➡ *Flanders' primary highway road network.*

- Efficient microscopic modelling:

  ➡ *Traffic Cellular Automata.*

- Large scale:

  ➡ *parallellism through distributed computing.*