Why are RED cars better than green ones?

THE twinLIN TEAM

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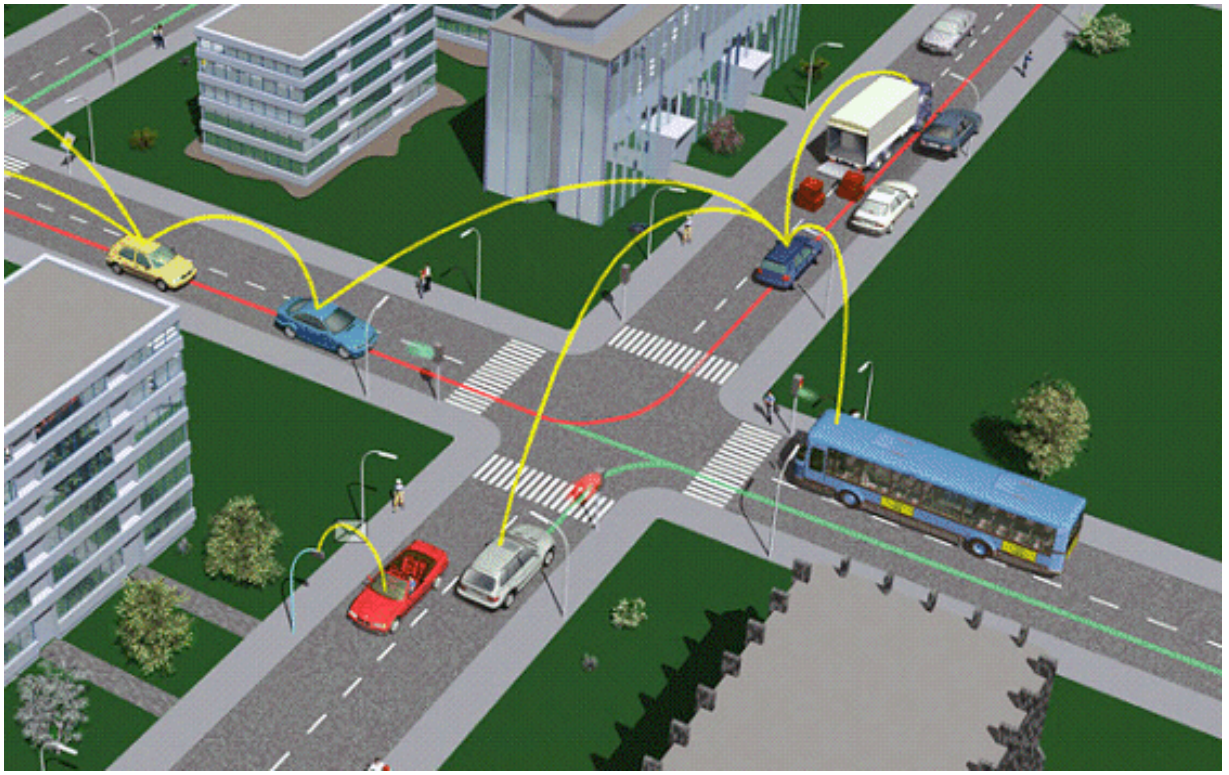
1. BACKGROUND

ITS: Cooperative Mobility



Thanks: networkonwheels

SOME RECENT DEVELOPMENTS

- VEHICLE AND INFRASTRUCTURE TALK TO EACH OTHER
  Smarter vehicles and infrastructure
  The cloud and real time updates

- NEW VEHICLE TYPES
  Electric vehicles and plug-in hybrid
  Hybrid vehicles and Fuel Cell

- ALGORITHMIC
  Infrastructure (lights, speed-limits)
  Vehicle mixing (routes) and vehicles

- REGULATION

REGULATION

- CONGESTION AND NETWORK EFFICIENCY
  More efficient use of road infrastructure

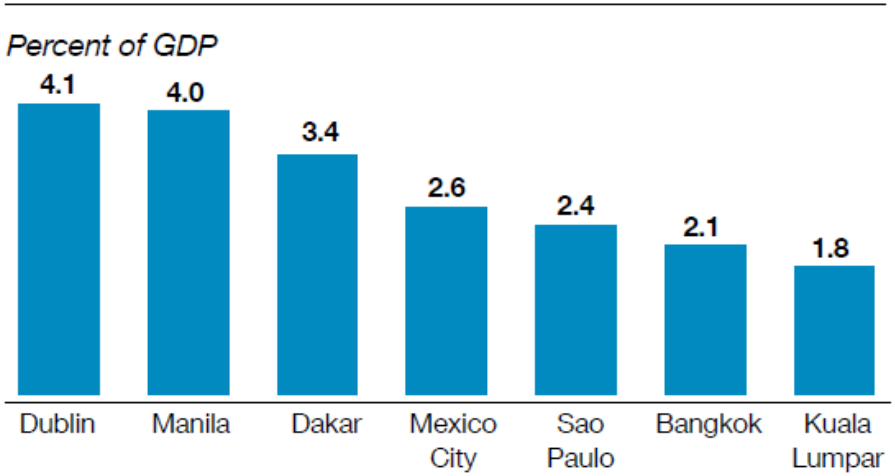
- ACTIVE SAFETY
  Making transport safer for road users and pedestrians

- GLOBAL WARMING (CARBON DIOXIDE)
  Reducing carbon footprint of global transportation

- POLLUTION
  Reducing pollution related deaths from road transportation
  Road noise

REGULATION

Average cost of congestion in 2007

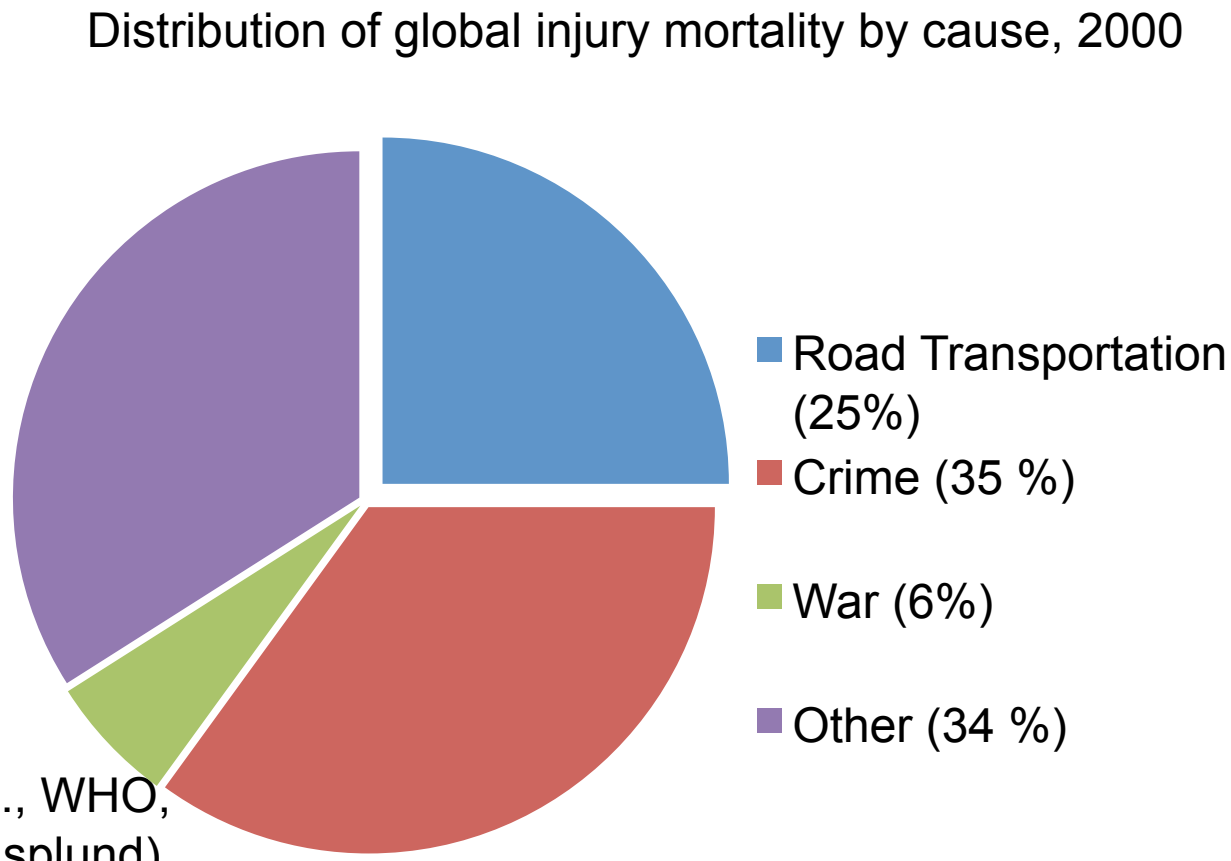


Sources: Ley, E. and J. Boccardo. "The Taxation of Motor Fuel: International Comparison." The World Bank. Poverty Reduction and Economic Management Network. Economic Policy and Debt Department Working paper series 5212. February 2010; Central Statistics Office. County Incomes and Regional GDP 2007. 2010.

Figure 4: **Congestion imposes significant costs on cities.**

Source: IBM Institute for business value

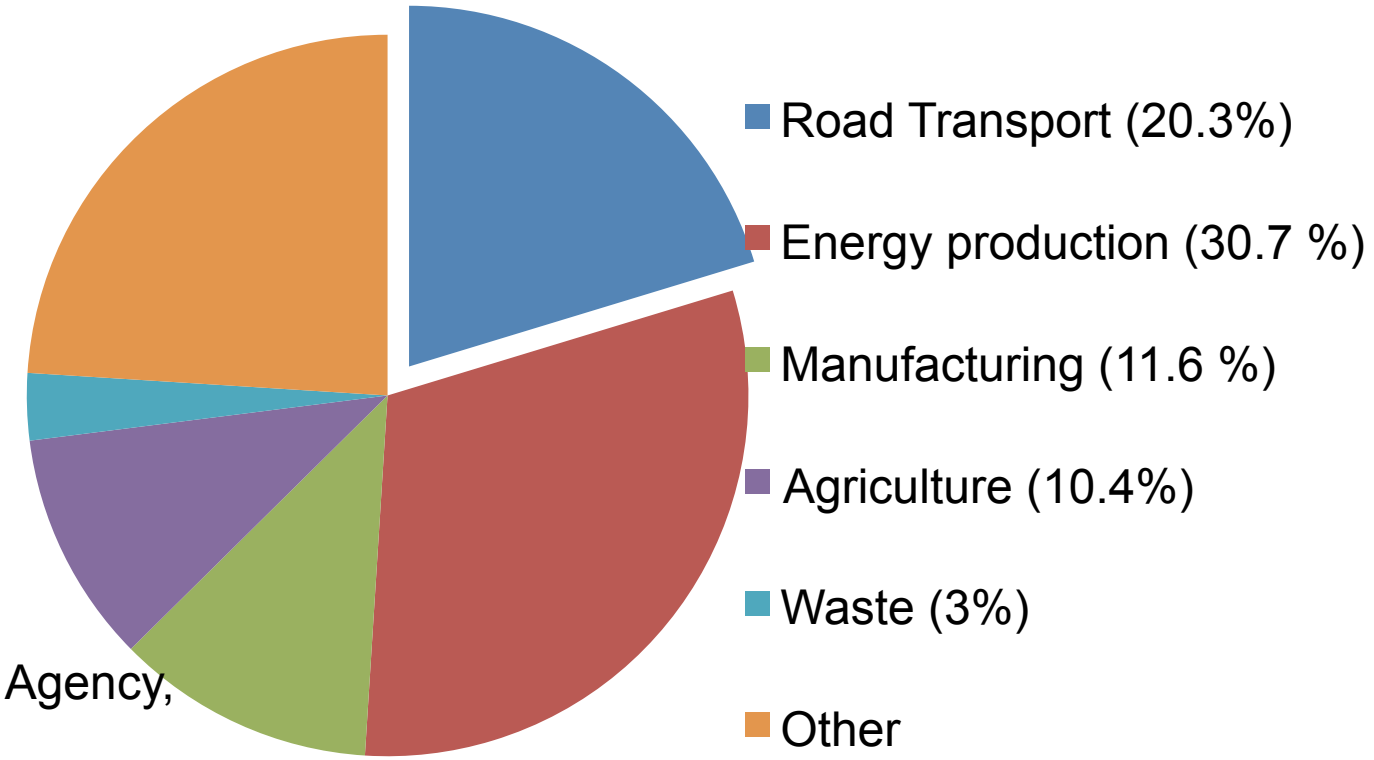
REGULATION



Source: Peden et al., WHO, 2002 (Thx. Mikael Asplund)

REGULATION

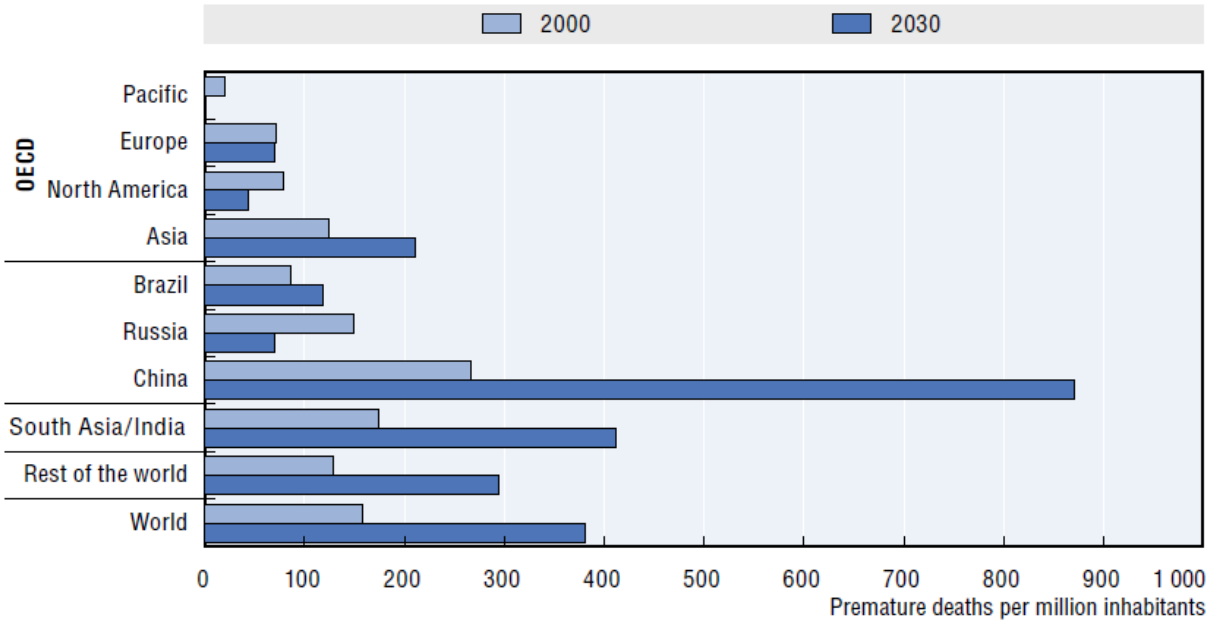
Total Greenhouse gas emissions by sector (EU), 2009



Source: EU Env. Agency, 2011

REGULATION

1. Carbon monoxid
2. Nitrate Oxide
3. Benzene
4. Ozone
5. PM10 (Feinstaub
6. PM25



3400 deaths related to vehicle safety (2008)

9400 deaths related to air pollution (2008)

California Environmental Protection Agency

2. RESPONSE

RESPONSE

- CLEAN VEHICLES
  EU Vehicle regulations
- ACCESS CONTROL
  Germany (Umweltzone)
  UK (congestion charging)
- BAN PETROL/DIESEL VEHICLES
  EU (2050)
  UK (2035)

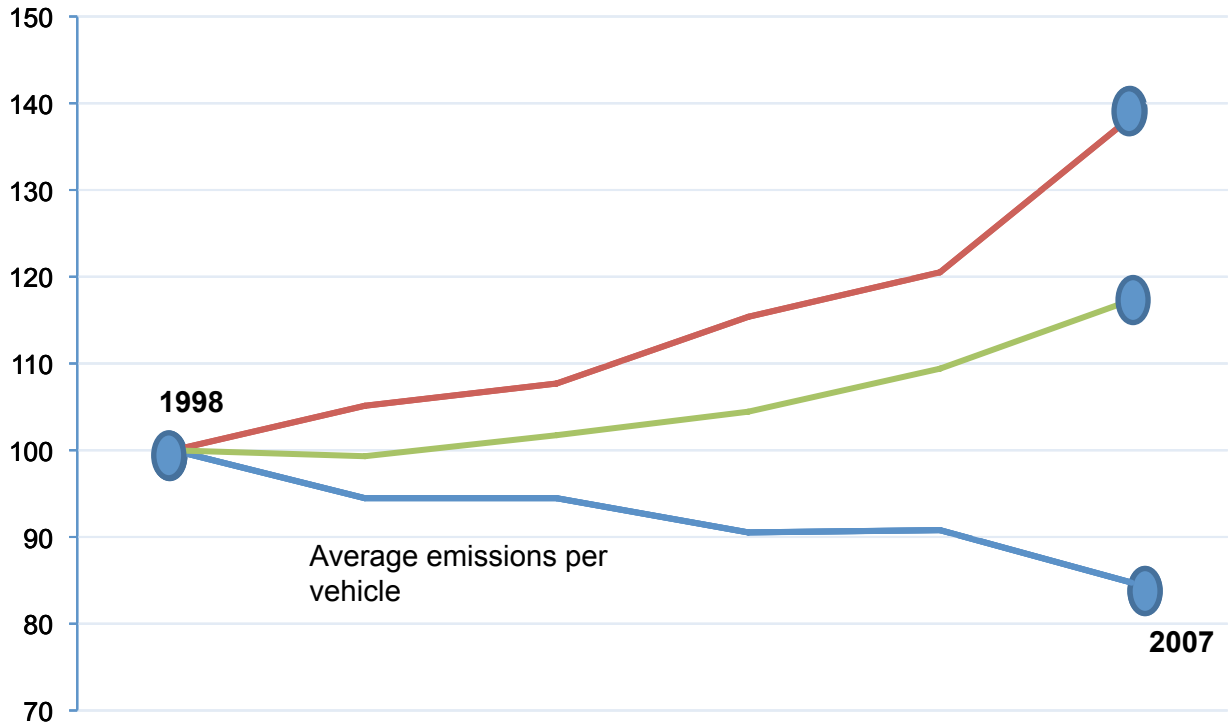
Reduced carbon emissions

No explicit account for air quality

Prediction of pollution peaks in cities

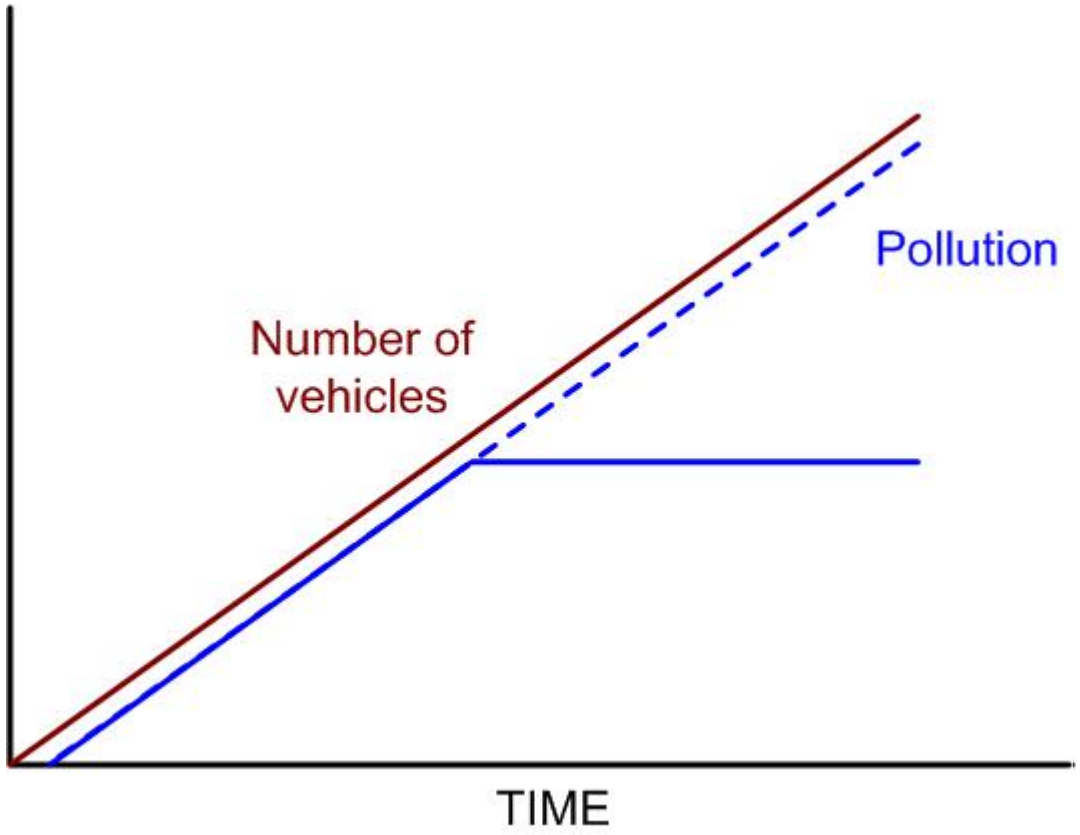
RESPONSE

Sao Paulo: 1000 new cars every day



1998: BASELINE STATISTICS

POLLUTION CONTROL

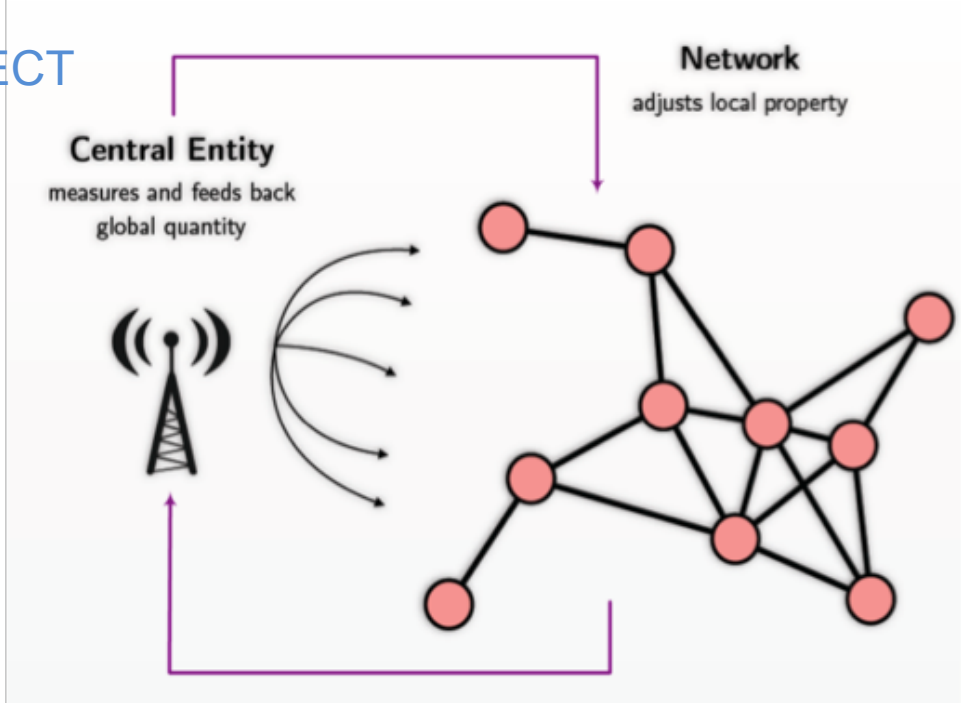


3. twinLIN

FEEDBACK LOOPS AROUND ENTIRE CITIES

AGGREGATE EFFECT

BEST EFFORT BEHAVIOUR AND ELASTICITY



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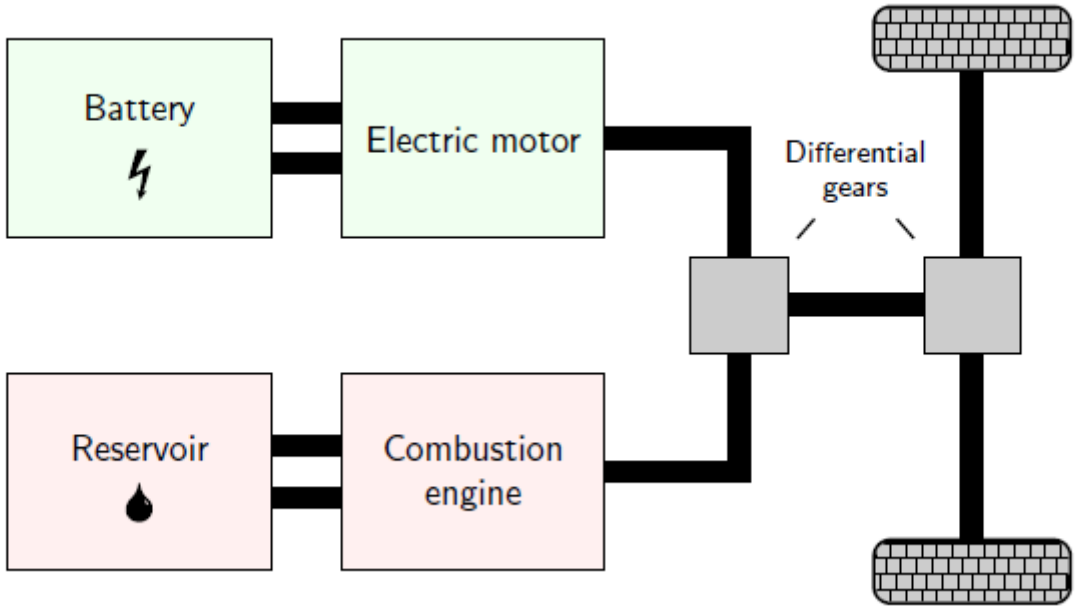
Hamilton Institute

NUI MAYNOOTH
Ollscoil na hÉireann Má Nuad

The twinLIN


Battery
Electric motor
Differential gears
Reservoir
Combustion engine

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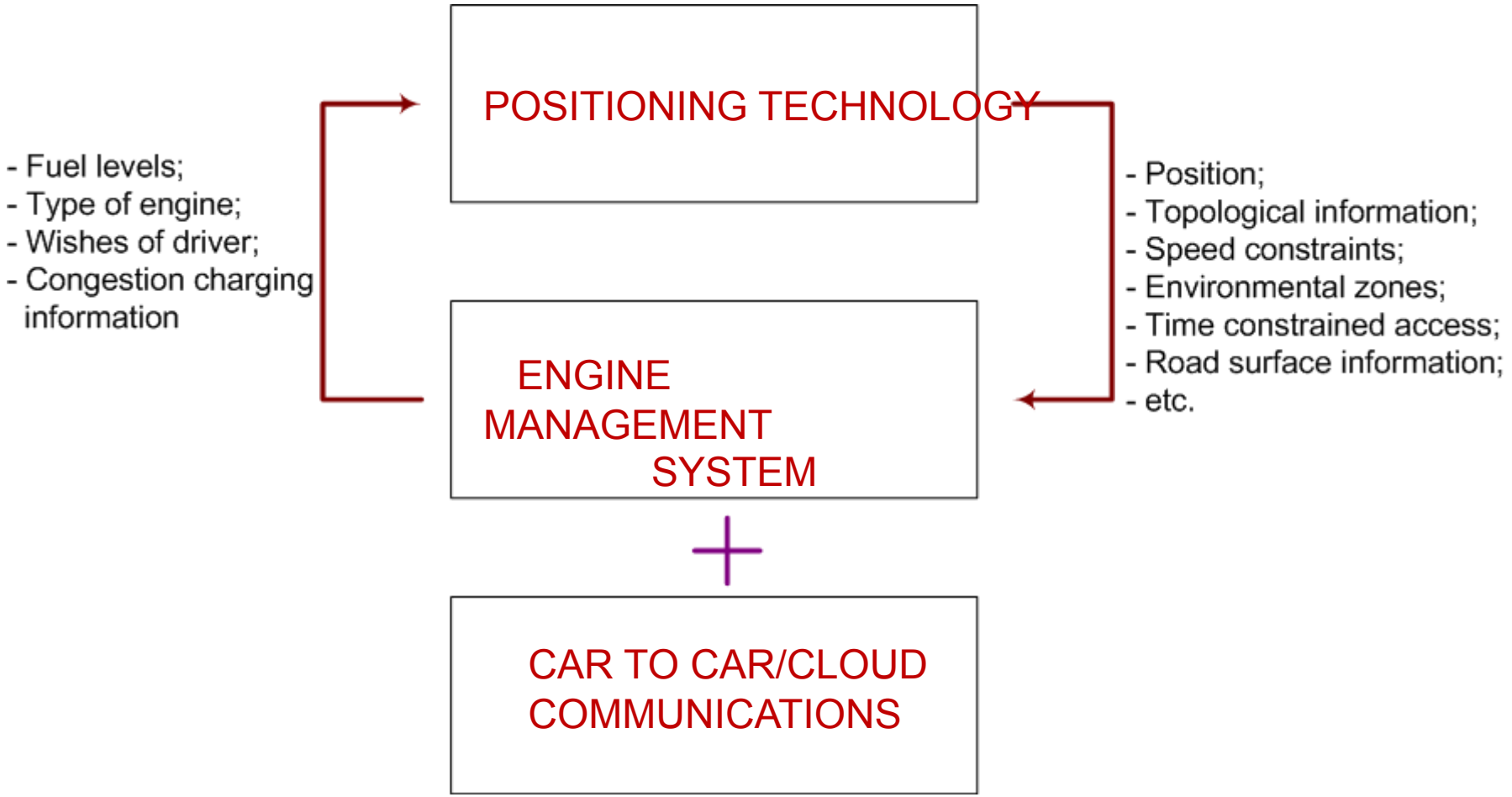
POSITIONING TECHNOLOGY
- Fuel levels;
- Type of engine;
- Wishes of driver;
- Congestion charging information
- Position;
- Topological information;
- Speed constraints;
- Environmental zones;
- Time constrained access;
- Road surface information;
- etc.
ENGINE MANAGEMENT SYSTEM
CAR TO CAR/CLOUD COMMUNICATIONS

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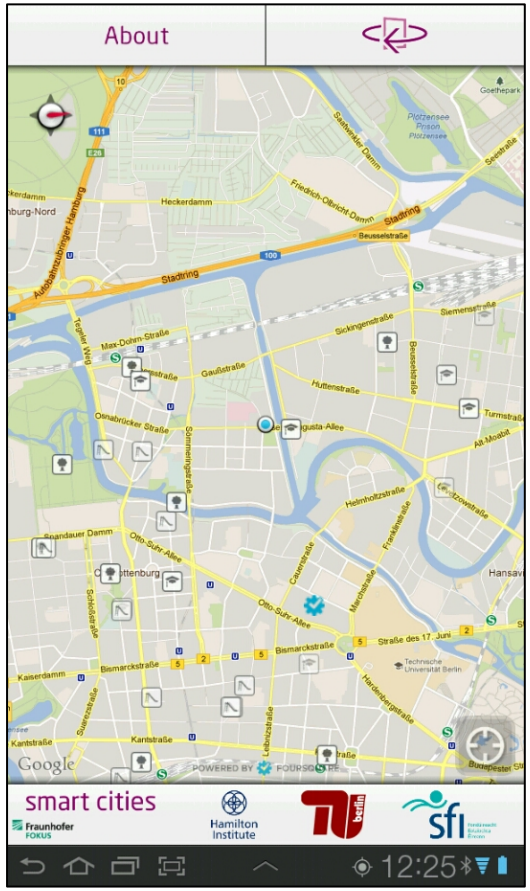

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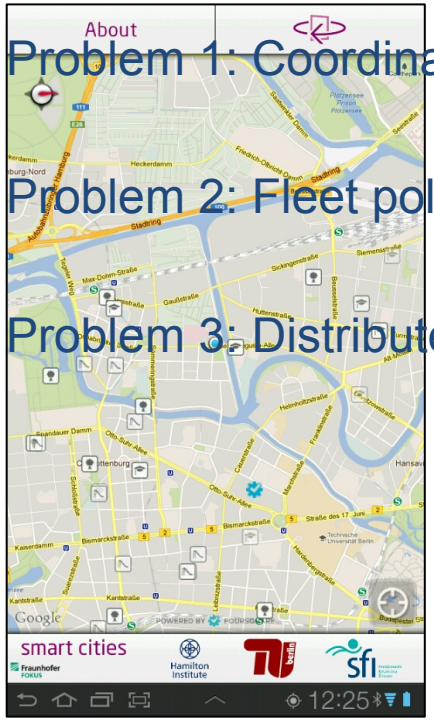
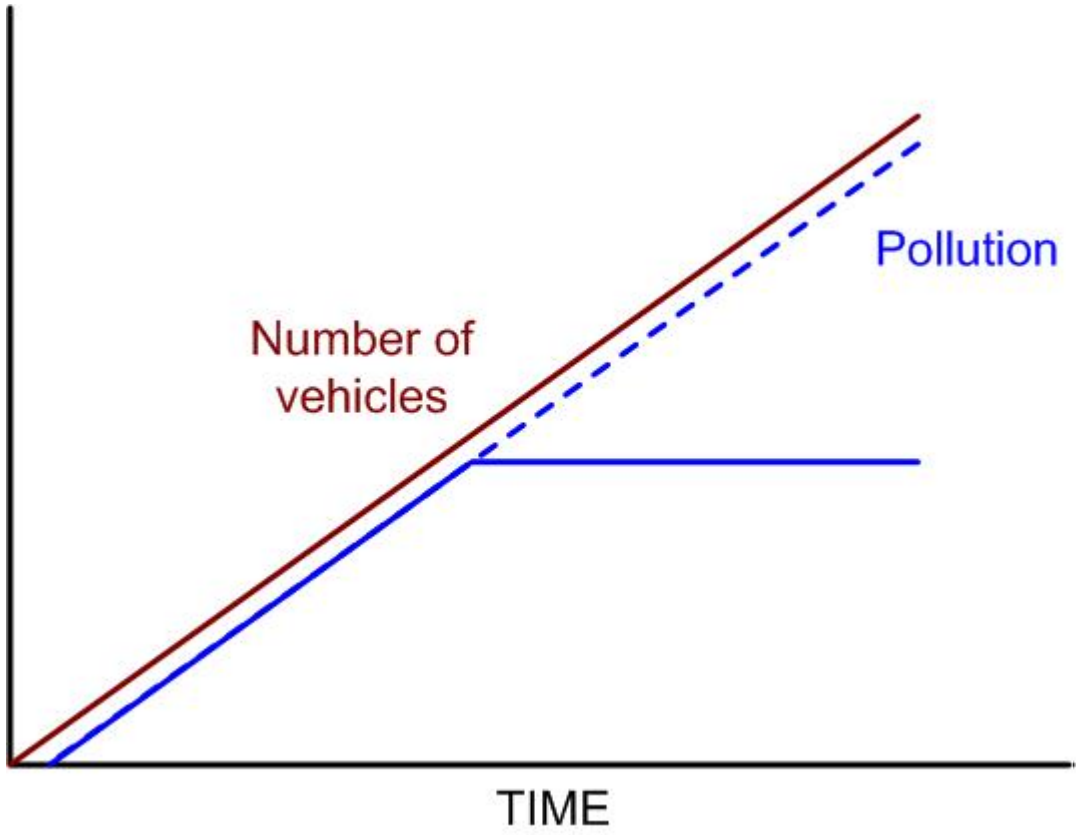
4. RED and green cars

twinLIN VEHICLES: NEW POSSIBILITIES

- WHAT CAN WE DO WITH A FLEET OF CONTEXT AWARE VEHICLES?
- Problem 1: Coordinat
- Problem 2: Fleet pollu
- Problem 3: Distribute

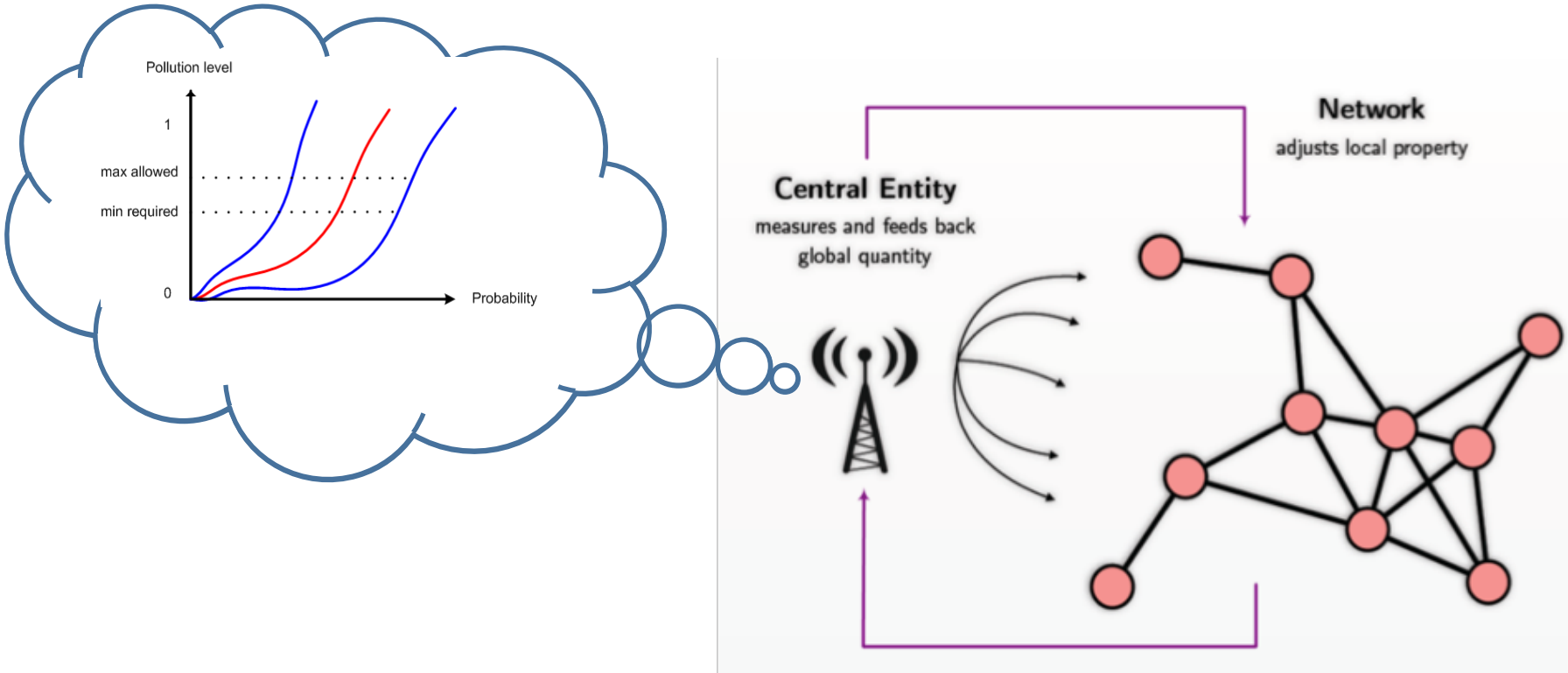


PROBLEM 1: COORDINATED POLLUTION CONTROL



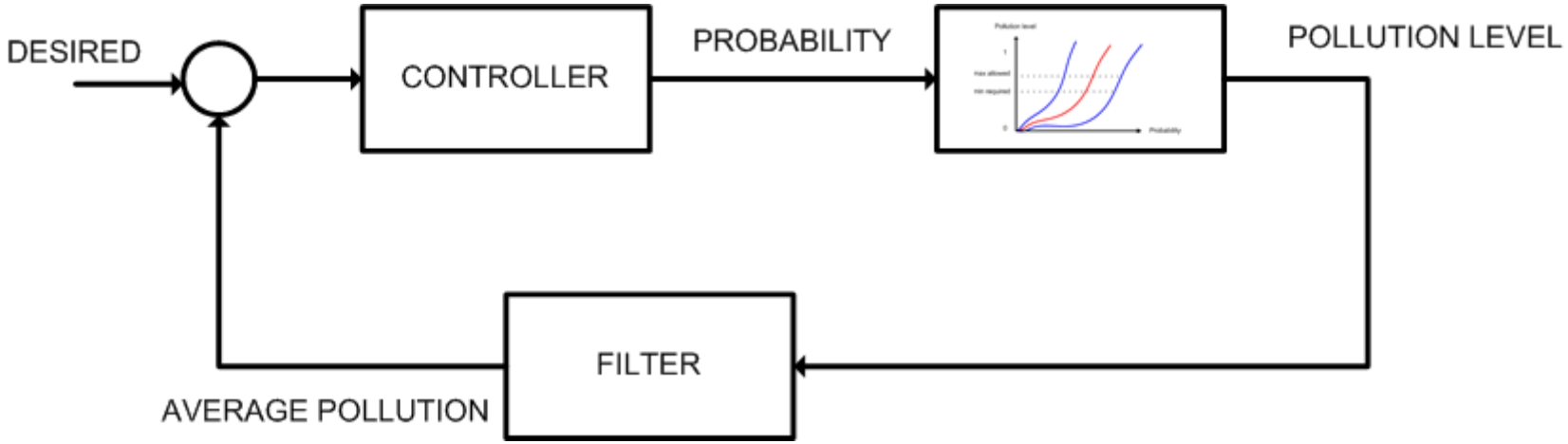
PROBLEM 1: COORDINATED POLLUTION CONTROL

RED ALGORTHM FROM INTERNET CONGESTION CONTROL



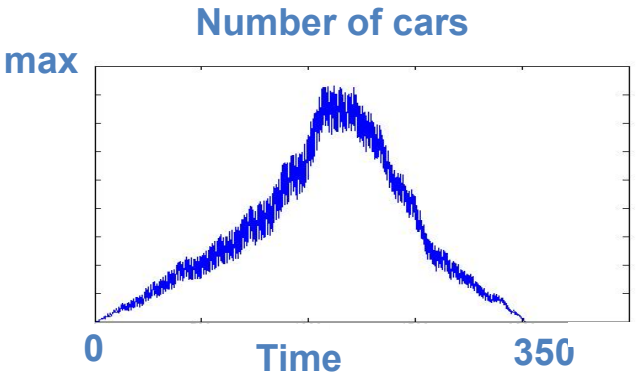
PROBLEM 1: COORDINATED POLLUTION CONTROL

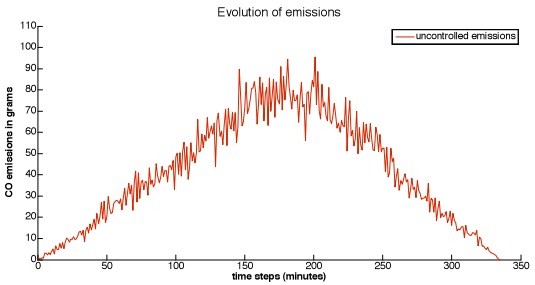
CONVERGENCE: **LUR'E PROBLEM**

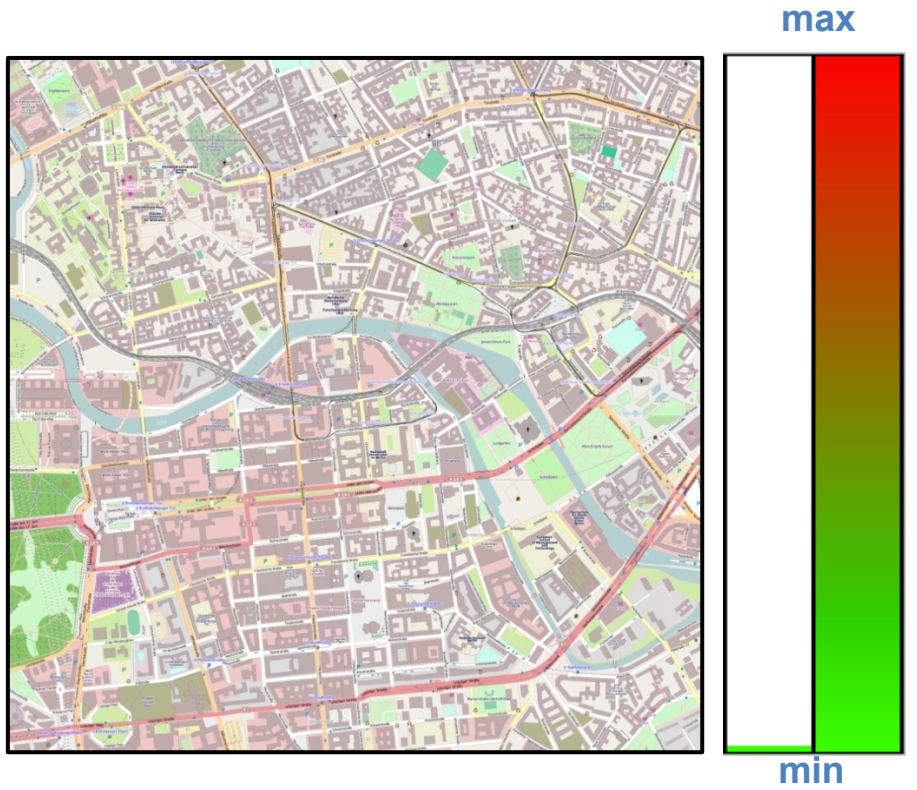


CLASSICAL ENGINEERING PROBLEM

PROBLEM 1: SUMO SIMULATION

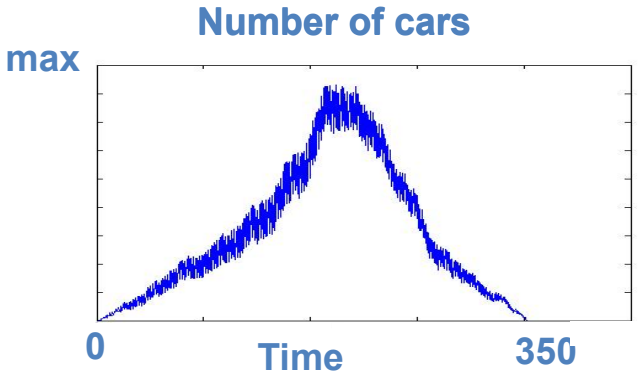


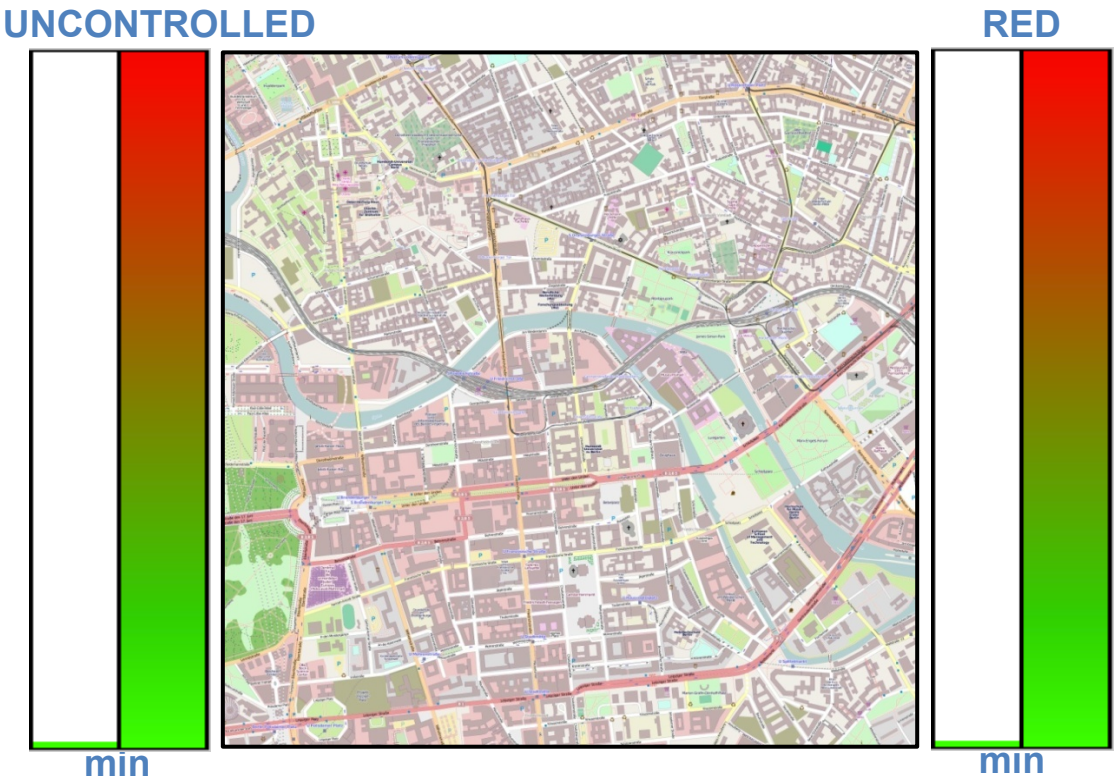




Boulter, P.G., Barlow, T.J., McCrae, I.S.: Emission factors 2009: Report 3 – exhaust emission factors for road vehicles in the United Kingdom, Published project report PPR356, TRL Limited (2009)

PROBLEM 1: SUMO SIMULATION





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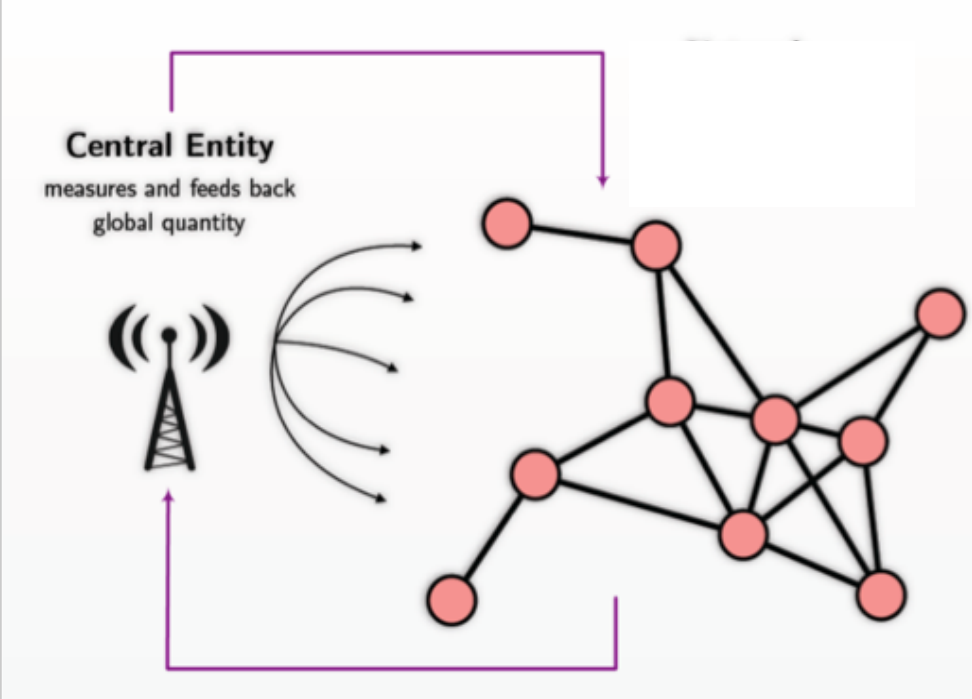
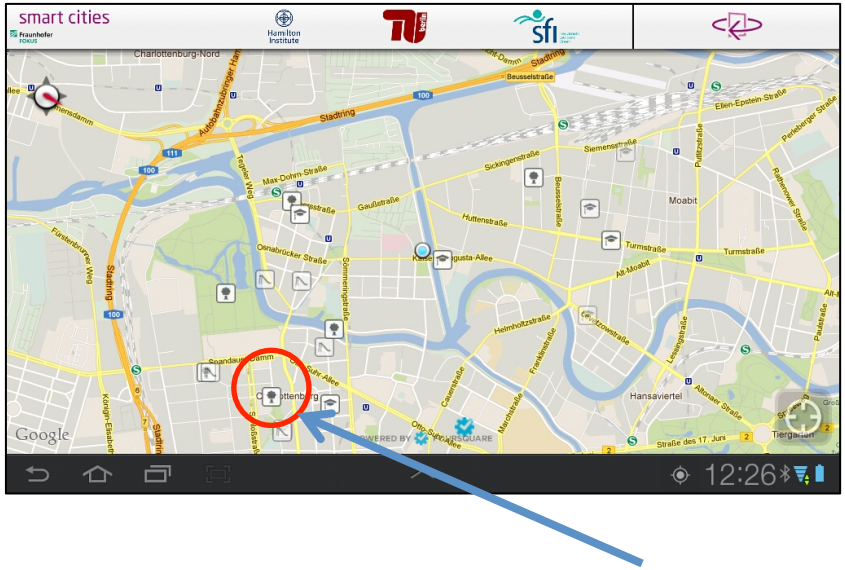
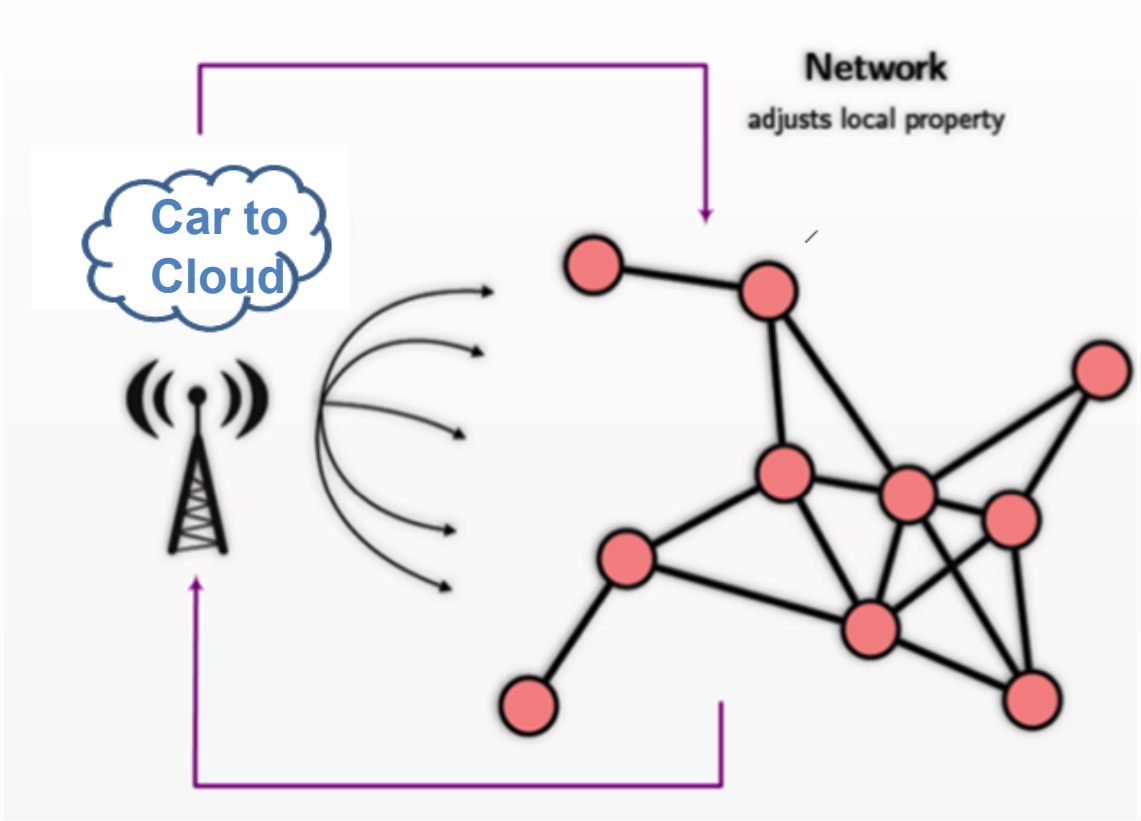




Probability 1
for all cars

(noise and pollution)

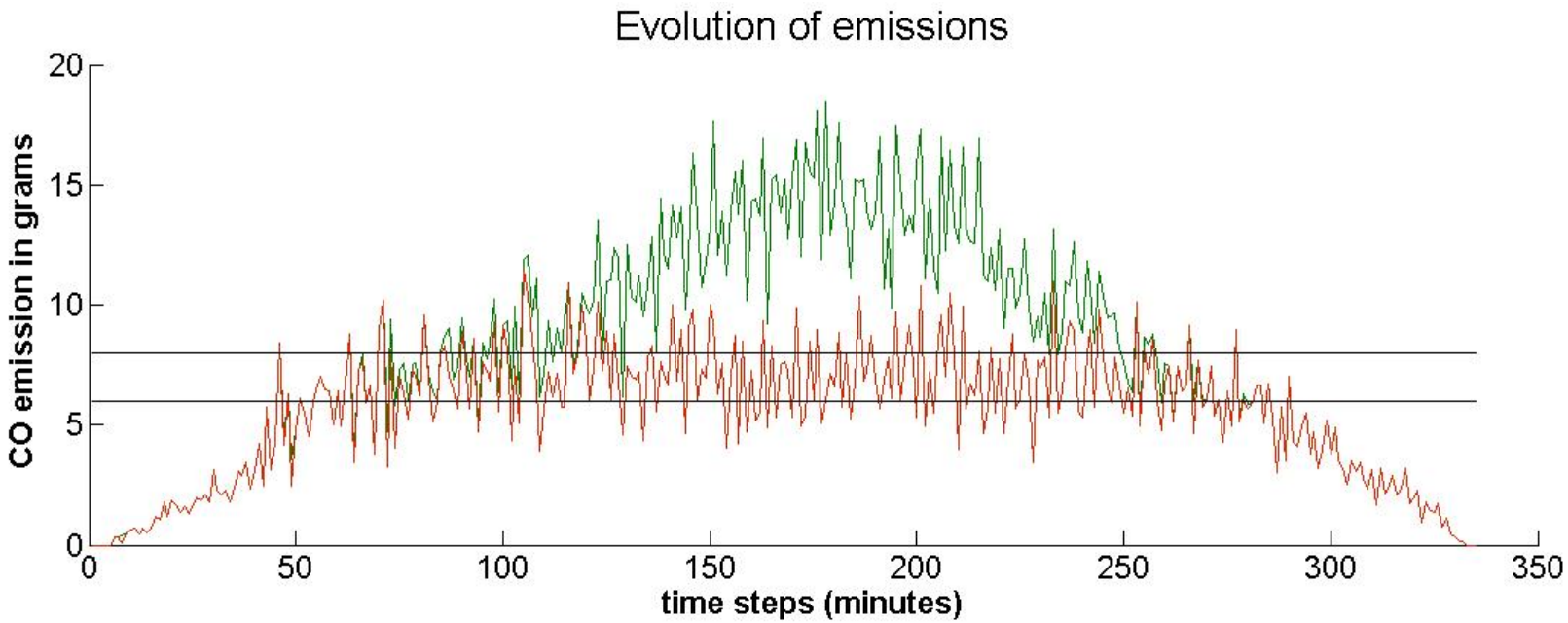
PROBLEM 2:FLEET POLLUTION CONTROL



PROBLEM 2: FLEET POLLUTION CONTROL

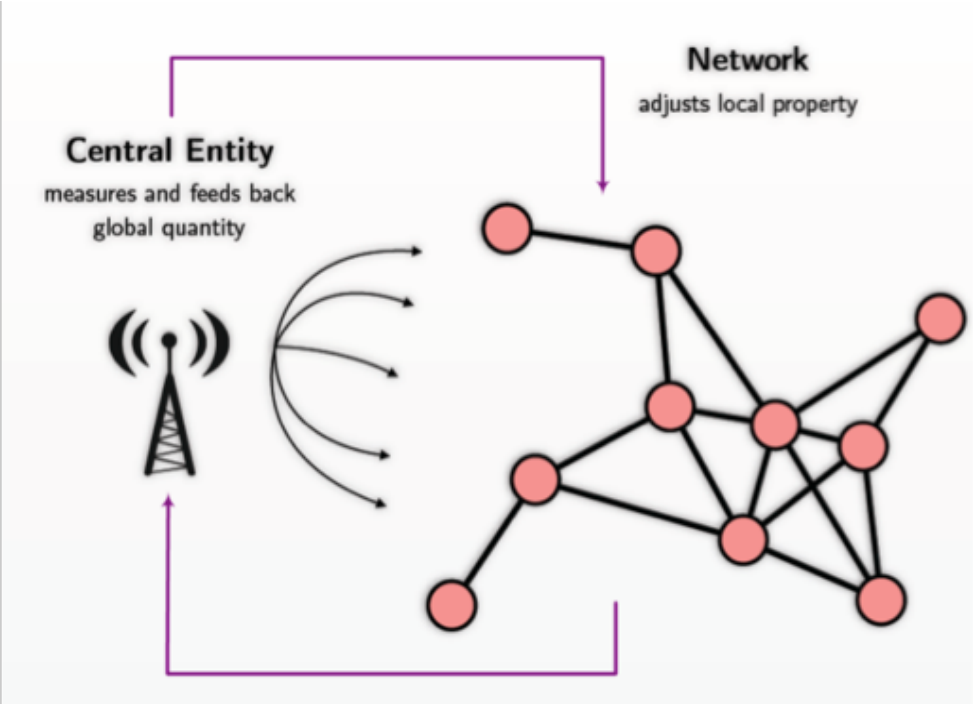
- FLEET MANAGERS
  - Postal and delivery services
  - Car rental companies
  - Logistics
  - Freight
- MUNICIPAL AUTHORITIES
  - Buses
  - Garbage collection and services
  - Universities
- COMMUNITIES OF ECO-DRIVERS
  - Incentive of free parking?

PROBLEM 2: SUMO SIMULATION



PROBLEM 3: DISTRIBUTED EMISSIONS TRADING

AN IMPORTANT OPTIMIZATION



Maximize sum of network utility

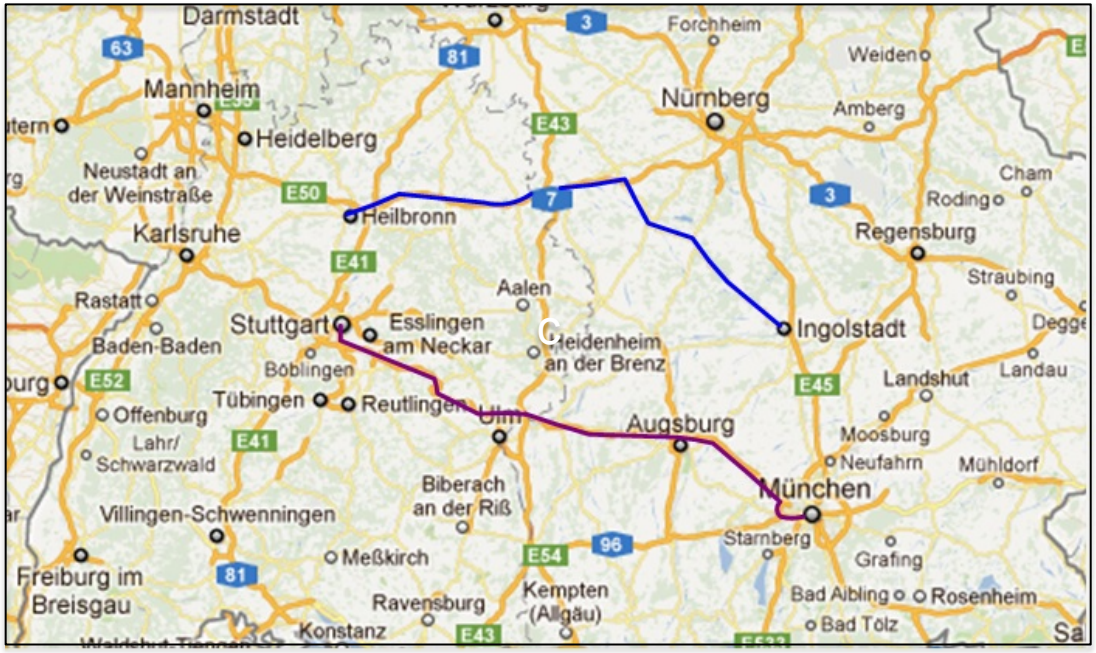
$$N(P_1, P_2, \ldots, P_n) = \sum_i U(P_i)$$

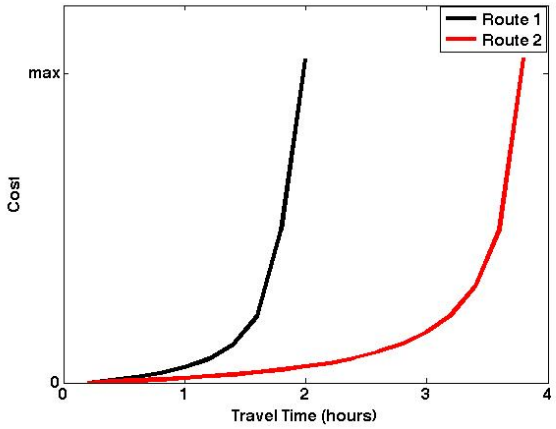
subject to constraint that

$$\sum_i P_i \leq C$$

$$P_j > C_j \qquad j \in \Theta$$

PROBLEM 2: DISTRIBUTED EMISSIONS TRADING





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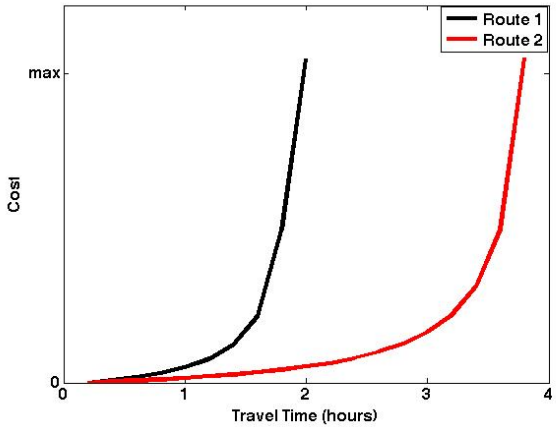


5. CONCLUSIONS

COMMENTS

MANY WAYS:

- Routing
- Speed limits
- Traffic light sequencing

NEW VEHICLE TYPES

- Offer new control/optimization possibilities
- No range problems
- Non-invasive
- Elasticity
- Fairness

Battery is a filter for turning dirty energy into clean energy

CONCLUSIONS: KEY IDEAS

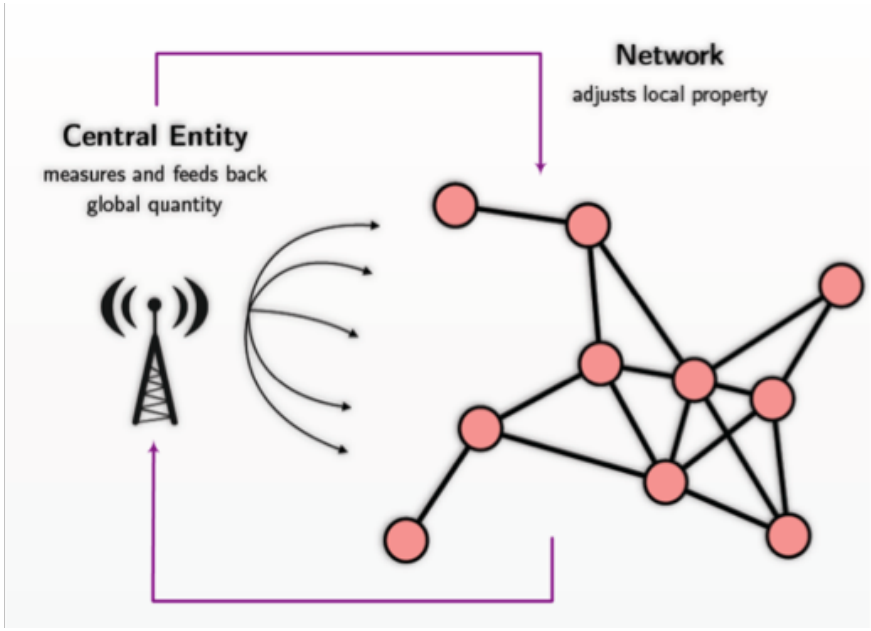
VEHICLES AS FILTERS

POLLUTION AS SHARED RESOURCE

AGGREGATE EFFECT

BEST EFFORT BEHAVIOUR AND ELASTICITY

CONCLUSIONS: FUTURE WORK (SUMMER 2012)



Hardware in the loop testing.

EIN DANKESCHÖN AN DAS ANDERE “LIN”

BERLIN Stadt der Ideen

Kronecker

Leibniz

Planck

Einstein

Karl Marx

Schur

Euler

Voltaire

Cantor

MARK TWAIN, 1891

“man kann alles in Berlin lernen, *außer Deutsch”,*

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Schlote, A., Crisostomi, E., Kirkland, S., Shorten , R.
International Journal of Control, 2012.

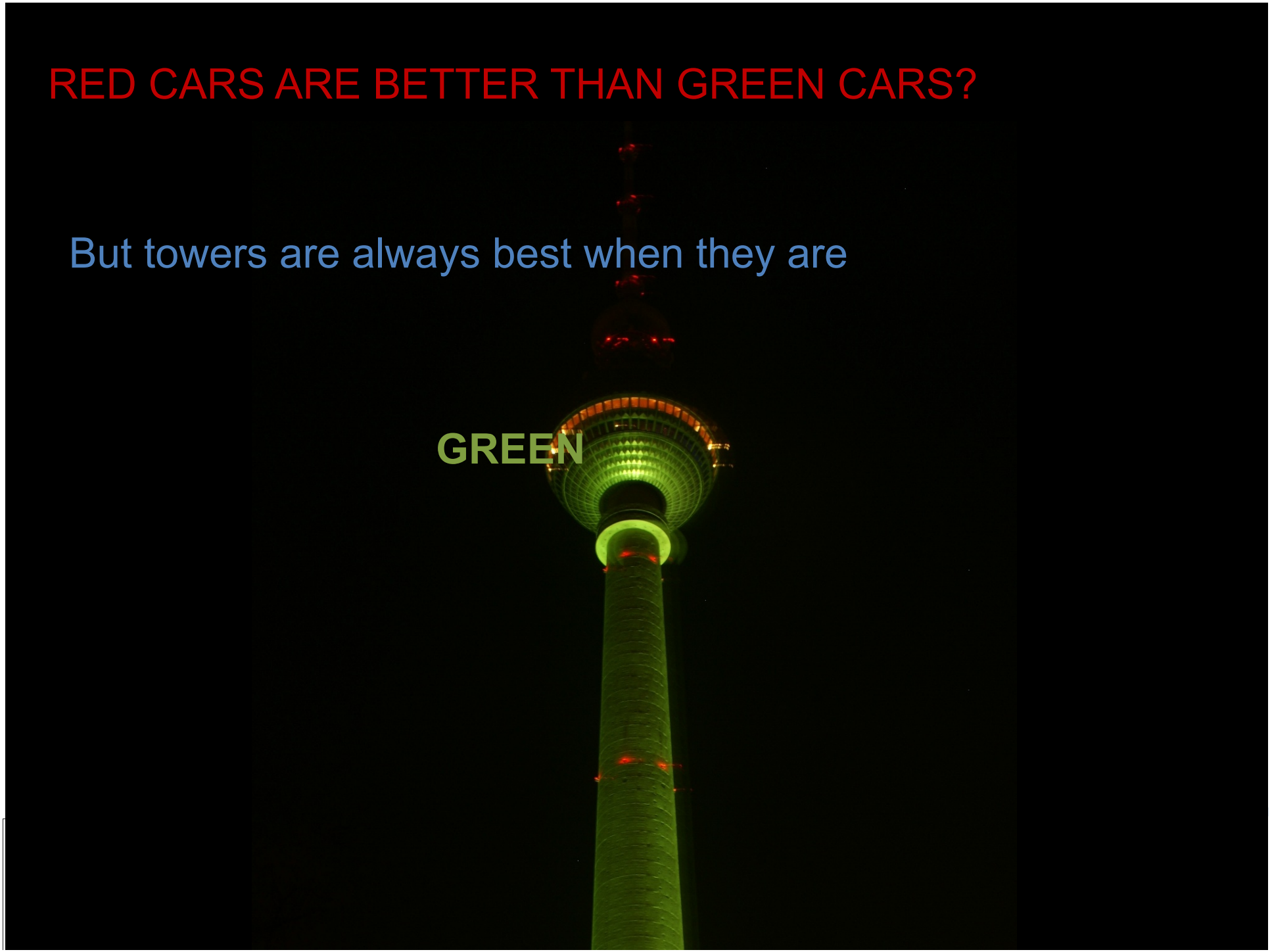
A flexible distributed framework for realising plug-in-hybrid vehicle charging policies,
S. Studll, E. Chrisostomi, R. Middleton, R, Shorten
International Journal of Control, 2012.

TWINLIN REPORT, 2012

RED CARS ARE BETTER THAN GREEN CARS?

But towers are always best when they are

GREEN



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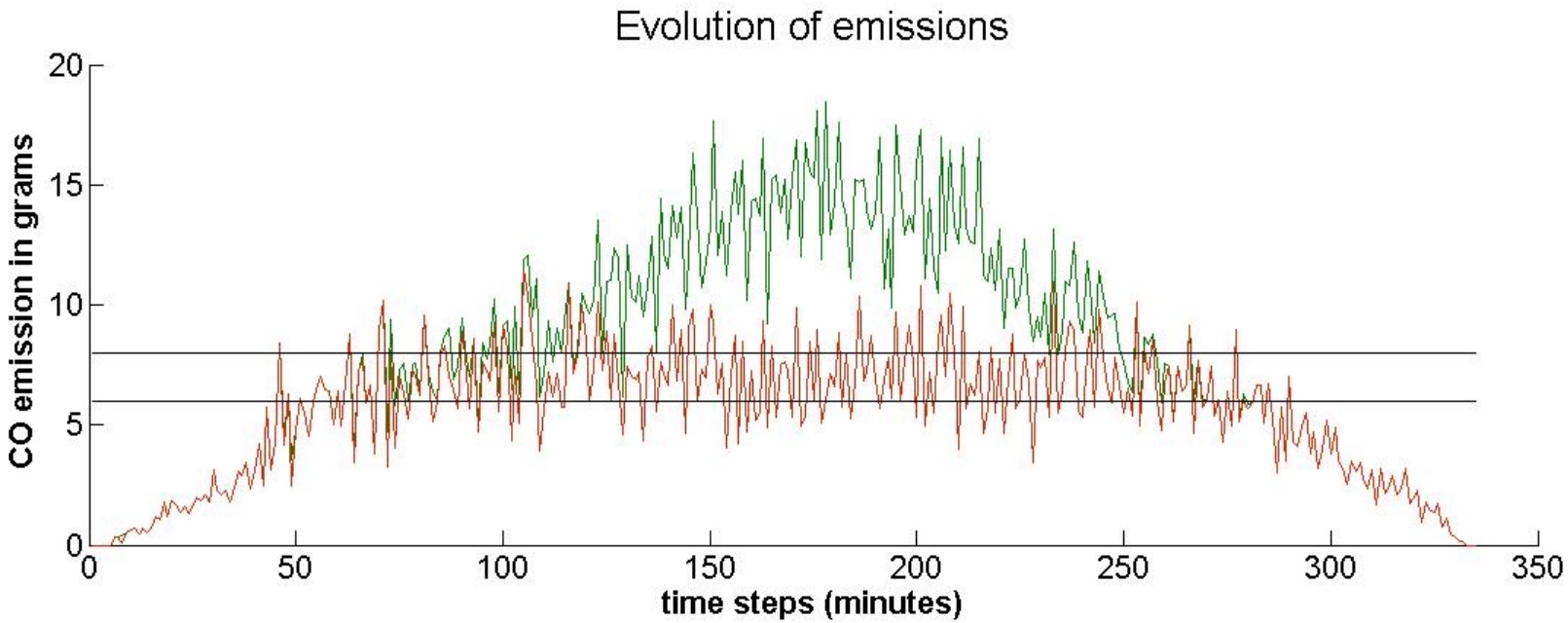

PROBLEM 2: SUMO SIMULATION

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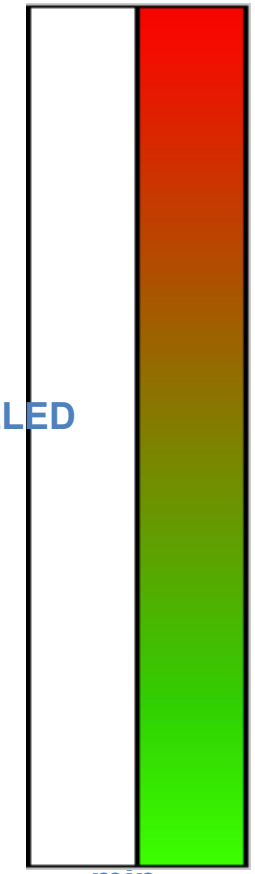

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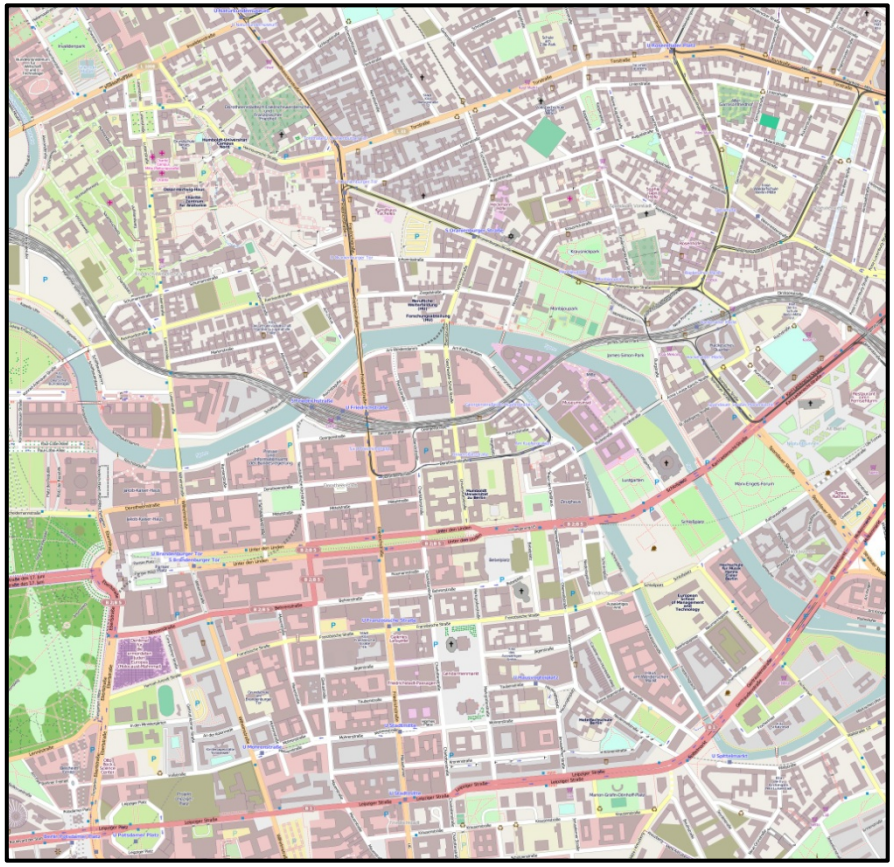

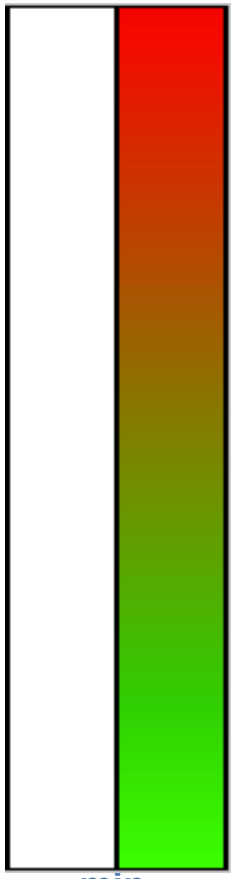

min

CONTROLLED