

Public Transport in MATSim

Present and Future, Features and Design

Why Public Transport?

- For a long time, MATSim only looked at car-users
- But reaction to some measure can be a change of transportation mode
E.g. tolls, new infrastructure (Westumfahrung)
- ▶ People should be able to choose between car-mode and other modes

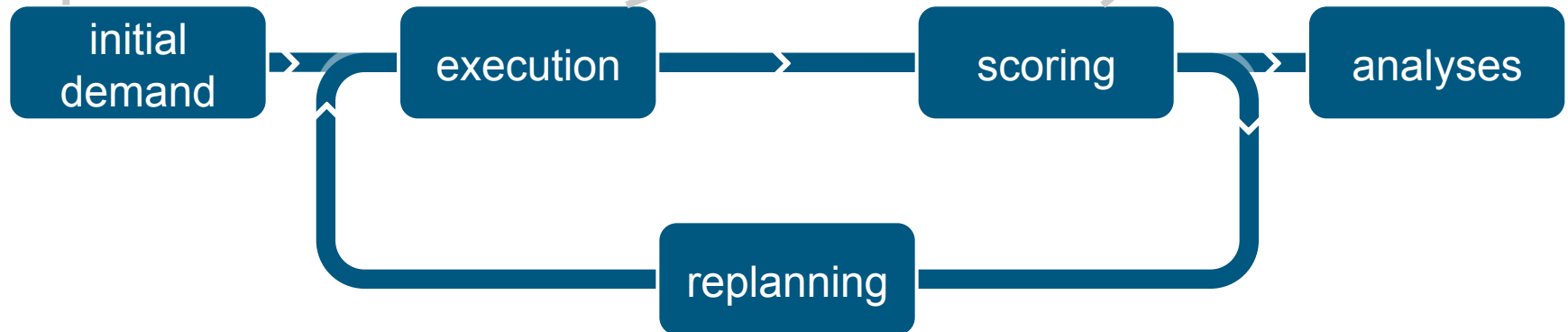
Simple Implementation

Give everybody two plans:

- one plan where all legs have car mode
- one plan where all legs have non-car mode

QSim teleports the agents to their destination in non-car mode

Scoring uses different marginal costs for time spent traveling depending on mode



Router estimates non-car travel time (currently: $2 * \text{free speed travel time}$)

Ensure that both modes always exist:
Do not delete last plan with certain mode

- Evolutionary Algorithm will select the mode that is better for the agent

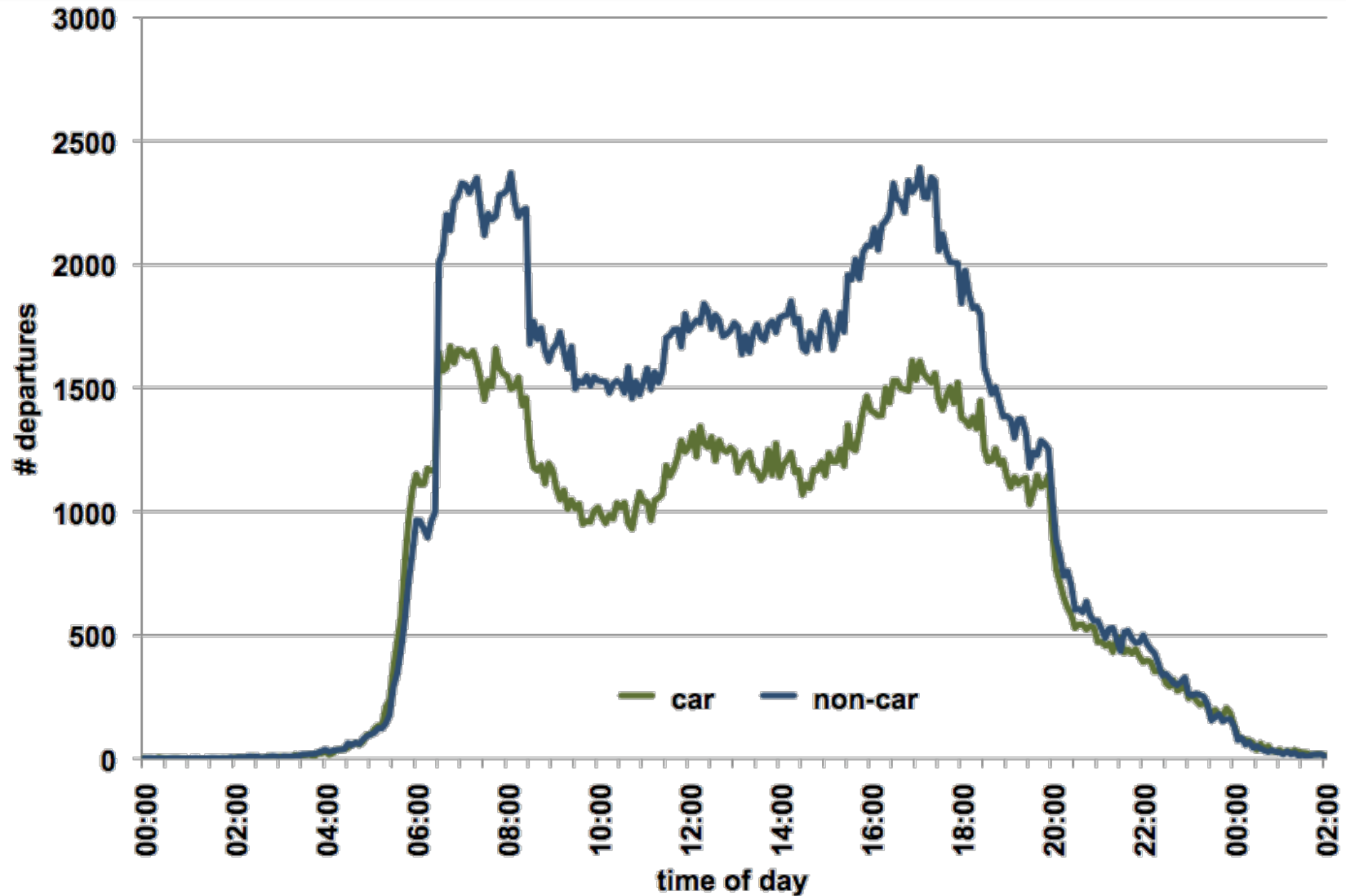
Results with Simple Implementation

- Toll-Scenario in Zurich / Sensitivity-Tests
- Westumfahrung Zürich with Mode Choice
(scenario setup by Yu Chen)

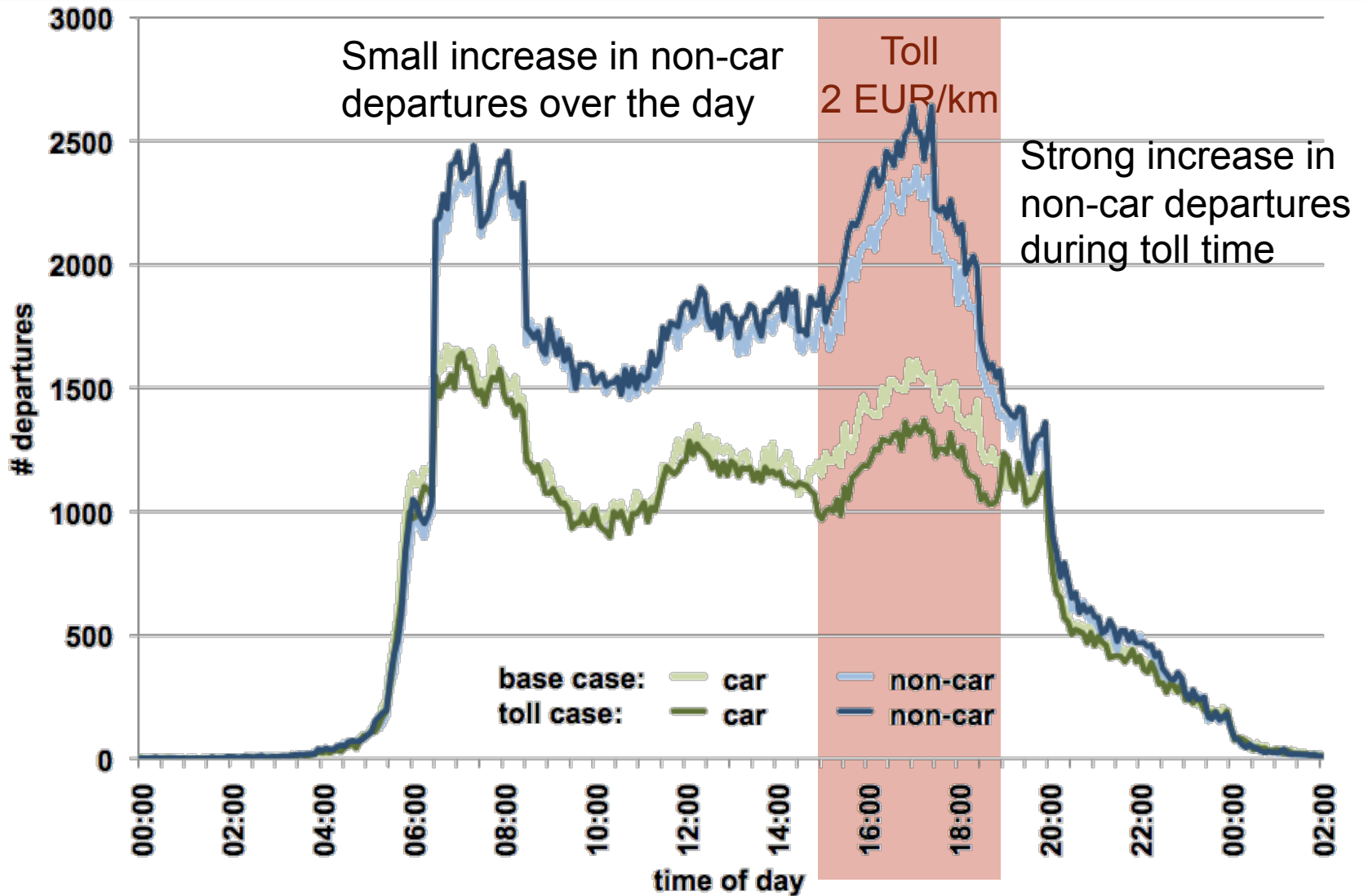
Scenario: Zurich, Switzerland



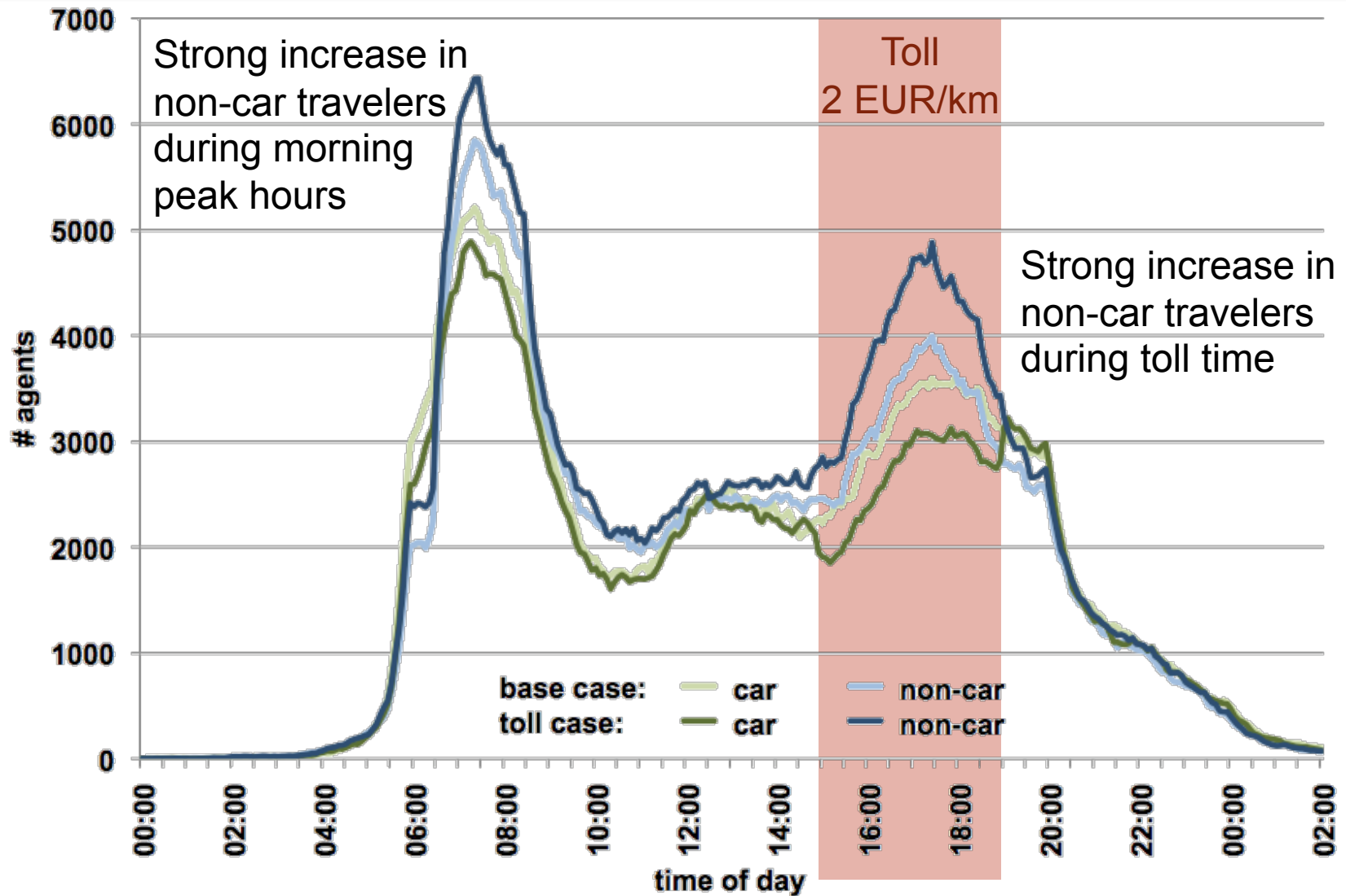
Base Case with Full Activity Patterns



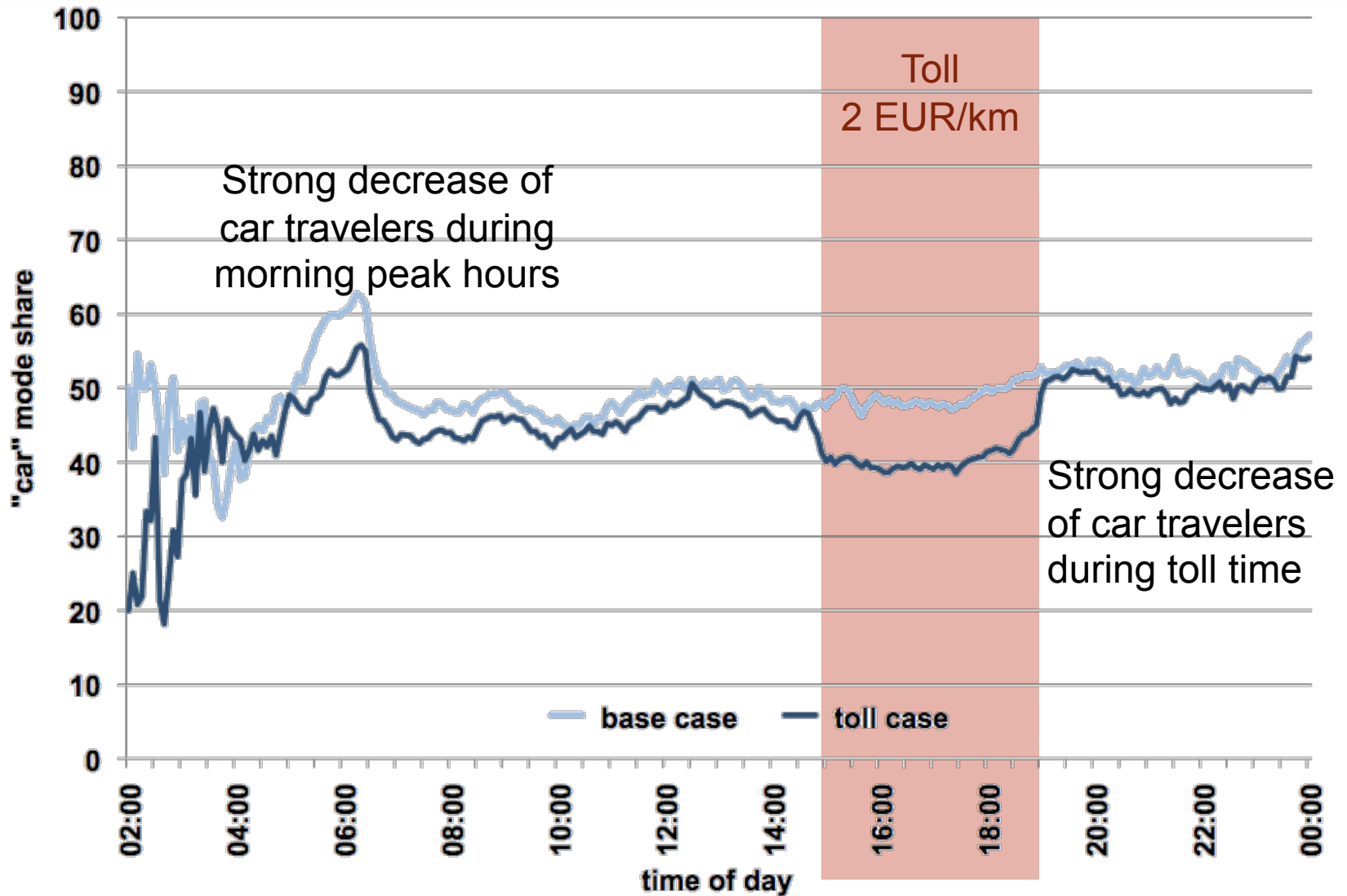
With Toll (2 EUR / km, 3pm – 7pm)



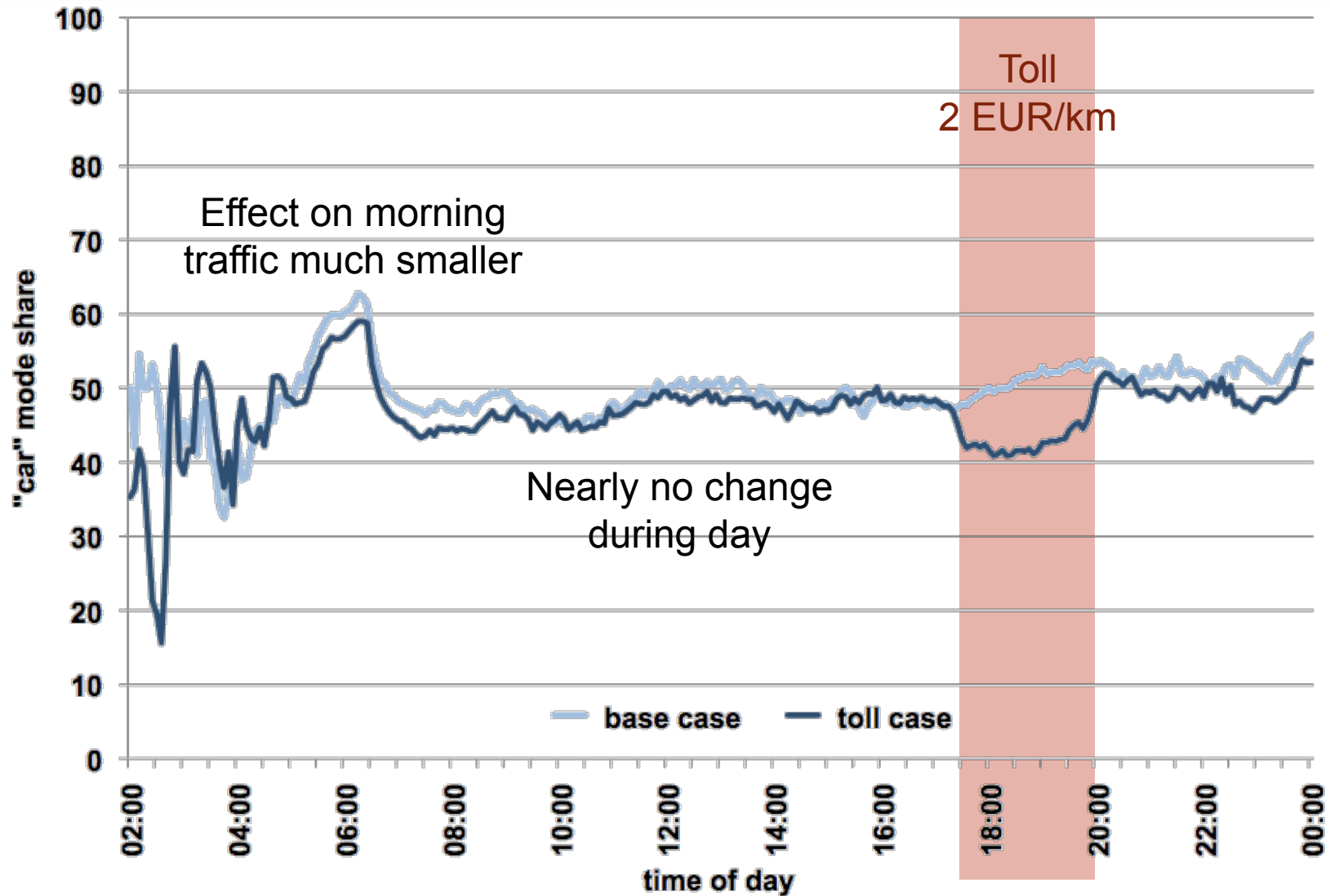
Agents en Route



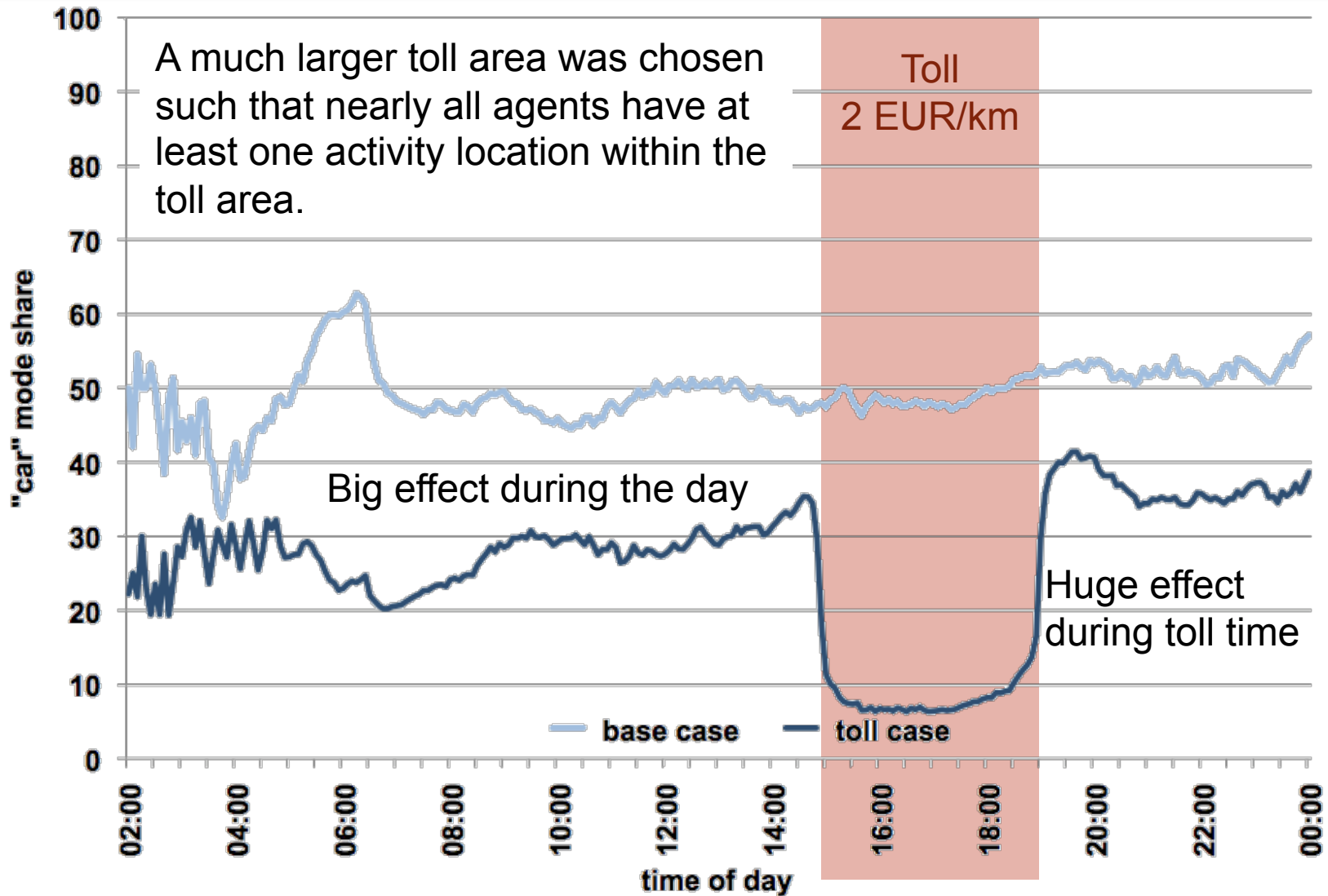
Mode Share



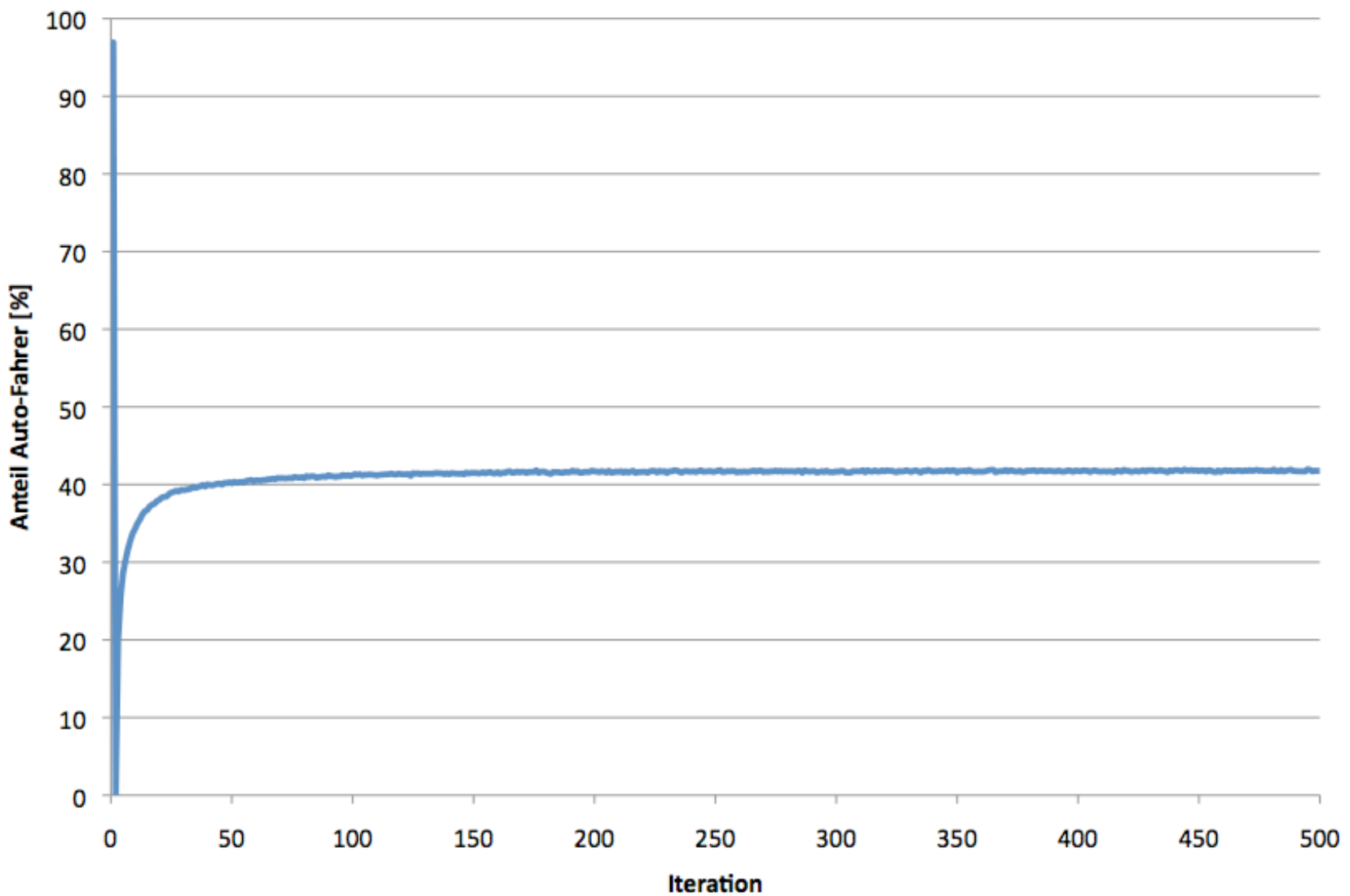
Sensitivity Test: Toll 5:30pm – 8pm



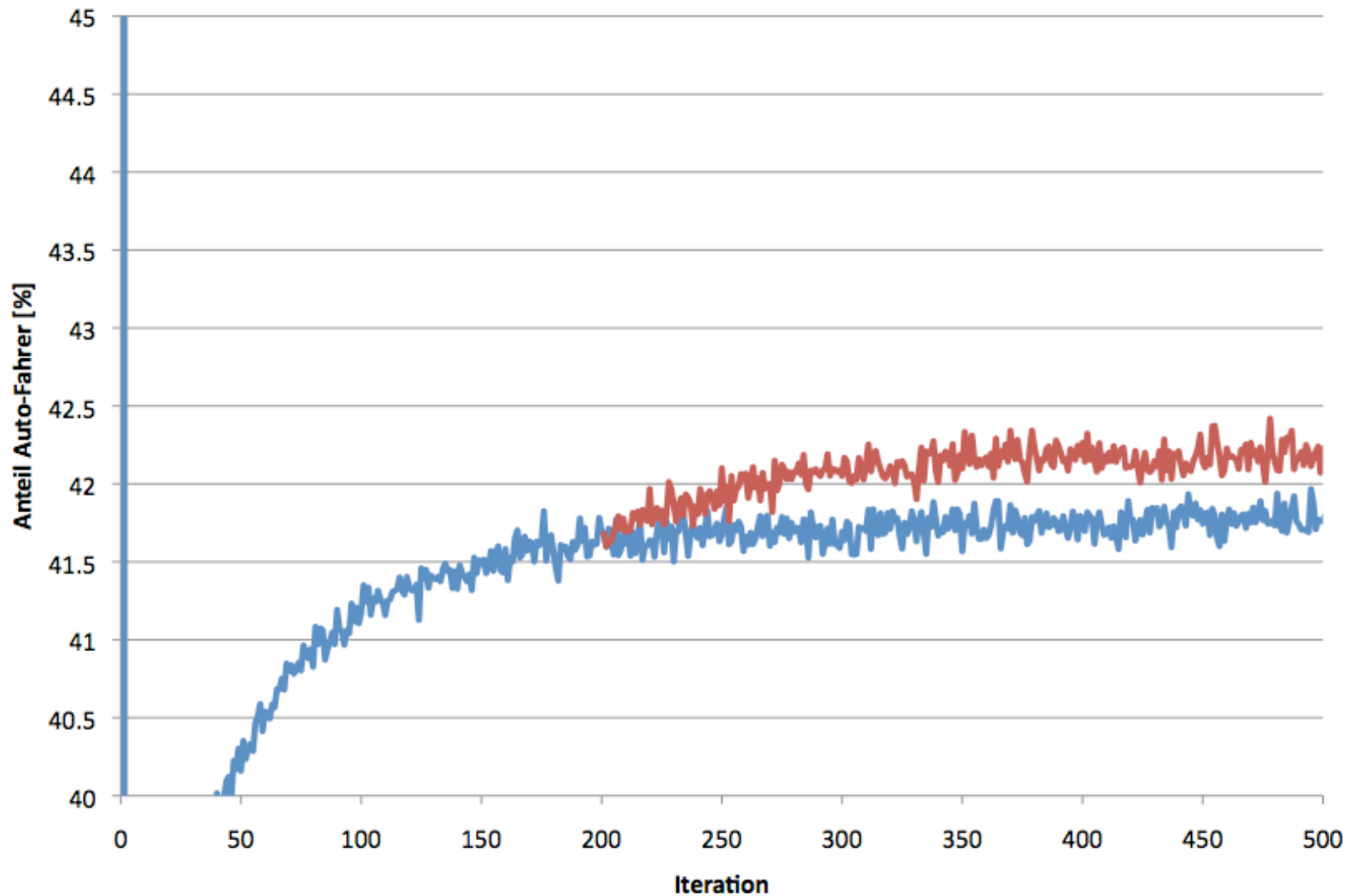
Sensitivity Test: Much Larger Toll Area, 3pm – 7pm



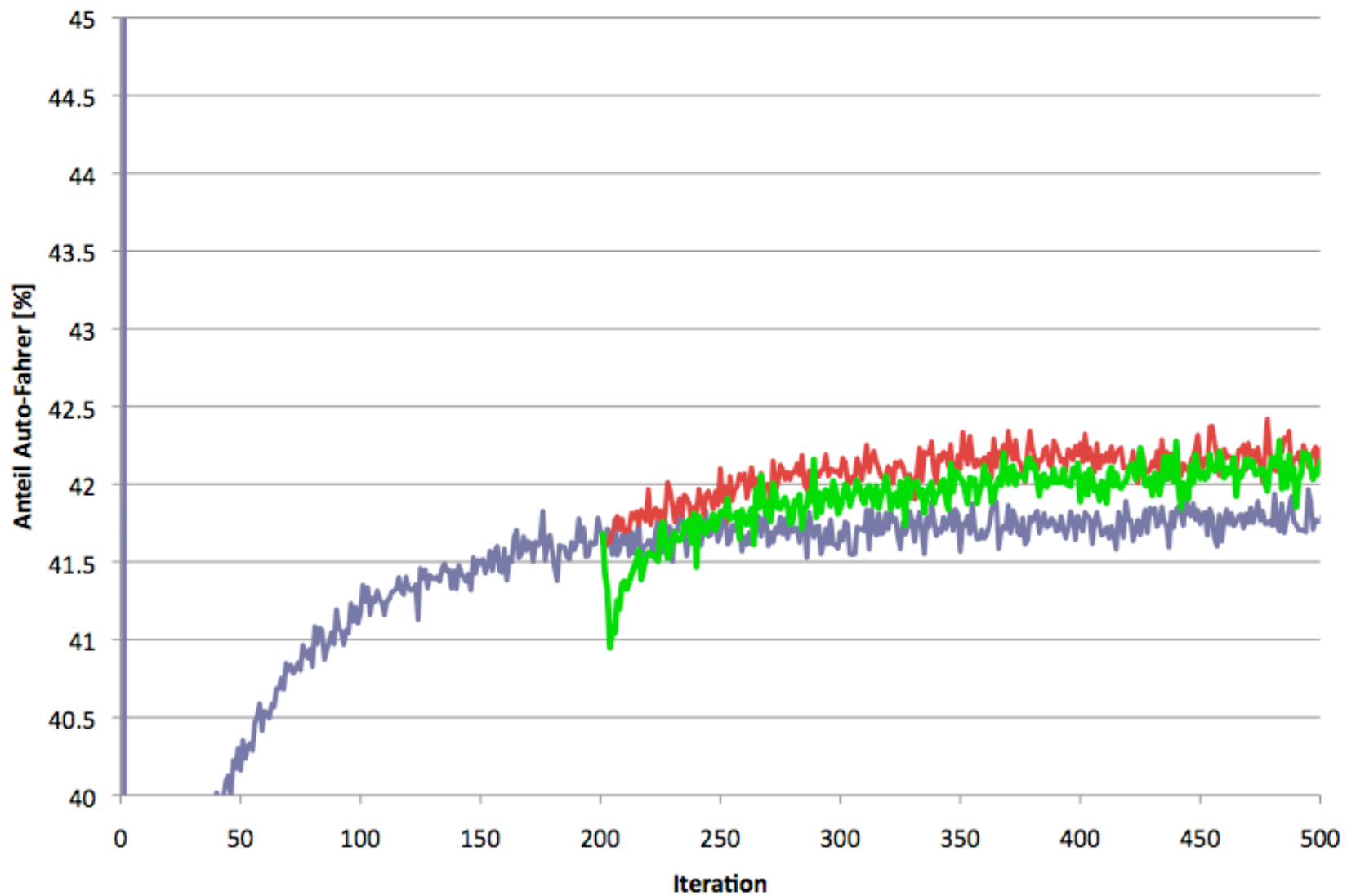
Westumfahrung Base-Case



Westumfahrung, Without Measures



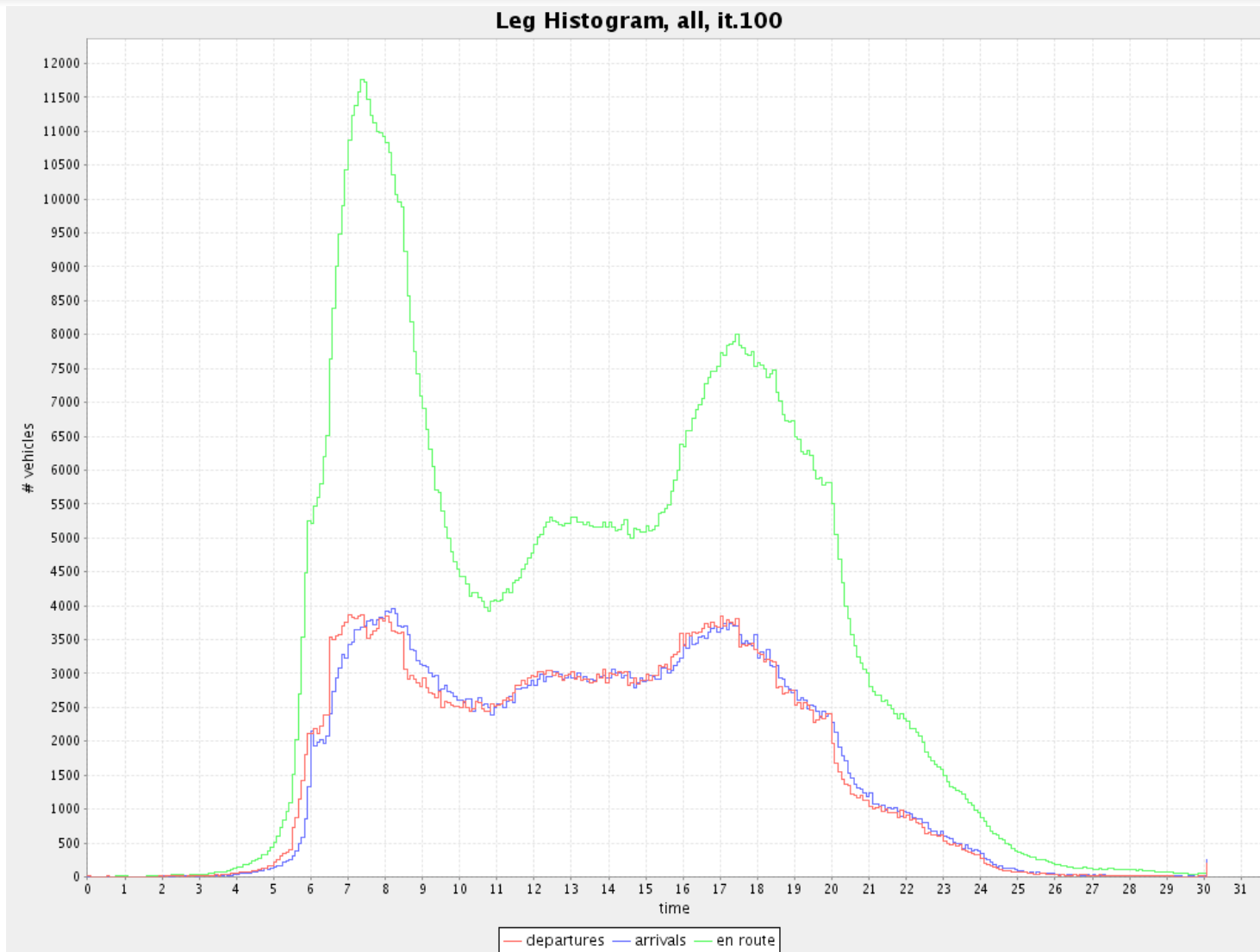
Westumfahrung, with Measures



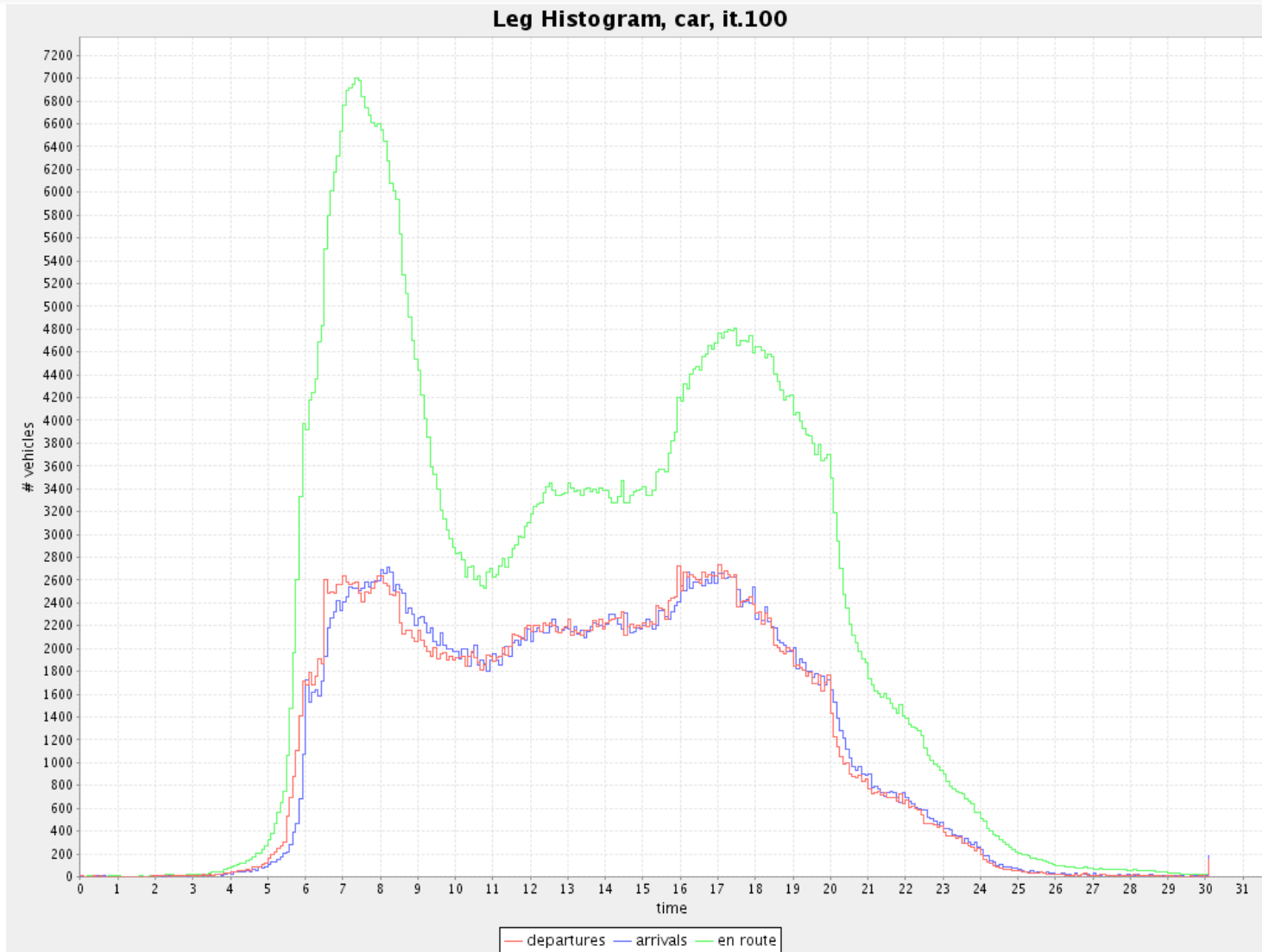
Available Analyses

- LegHistogram now available for different transportation modes
- Available as data as well as graphics

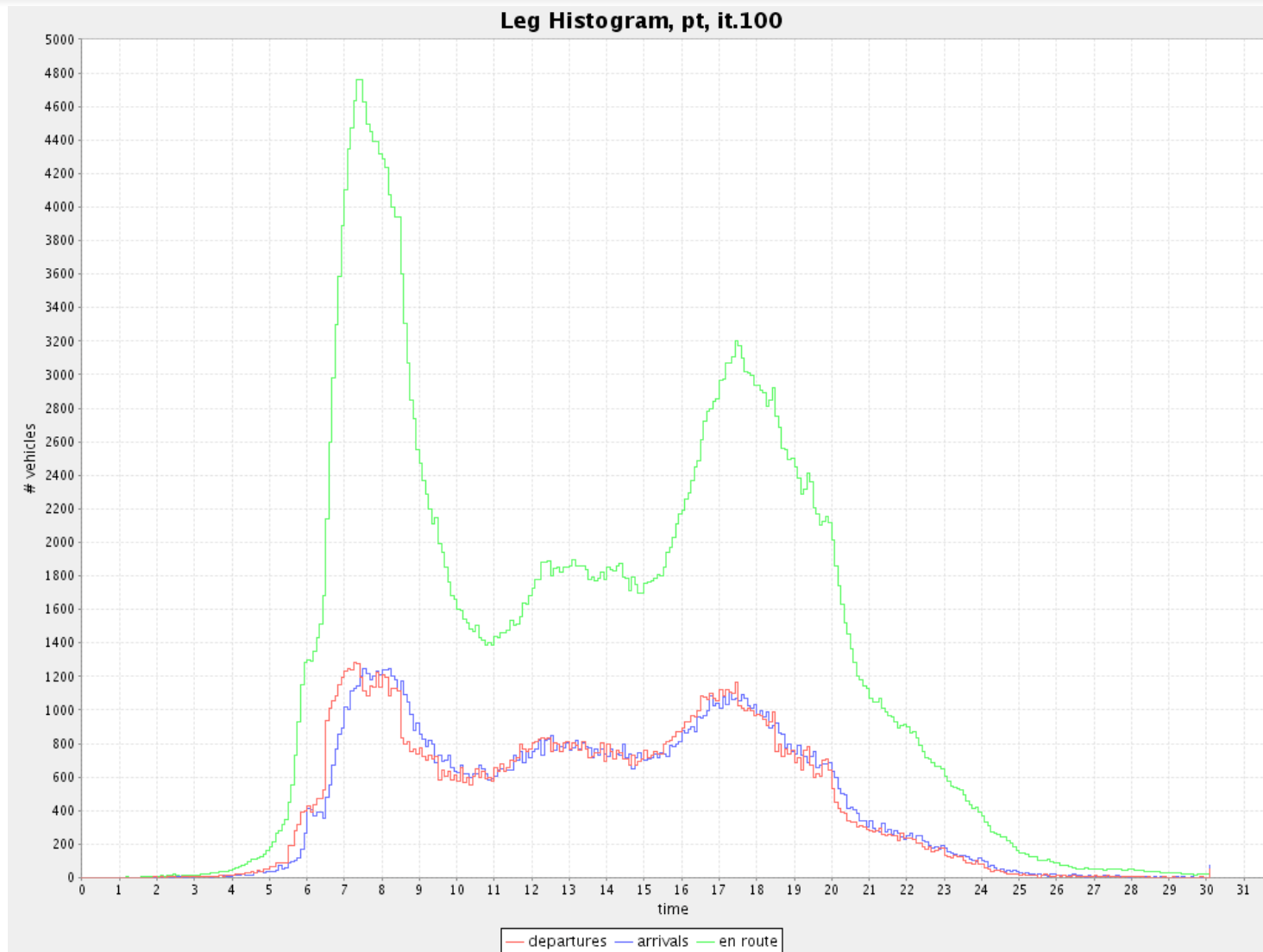
LegHistogram, all modes



LegHistogram, car-mode



LegHistogram, pt-mode



Findings of Simple Implementation

- "Two Plans per Agent" is cumbersome, not possible for mixed-mode plans
- ▶ Re-Planning module should generate plans with different modes, e.g. randomly or best-response with Planomat
- ▶ Router: better values than estimation
- ▶ Real Simulation, no more teleportation

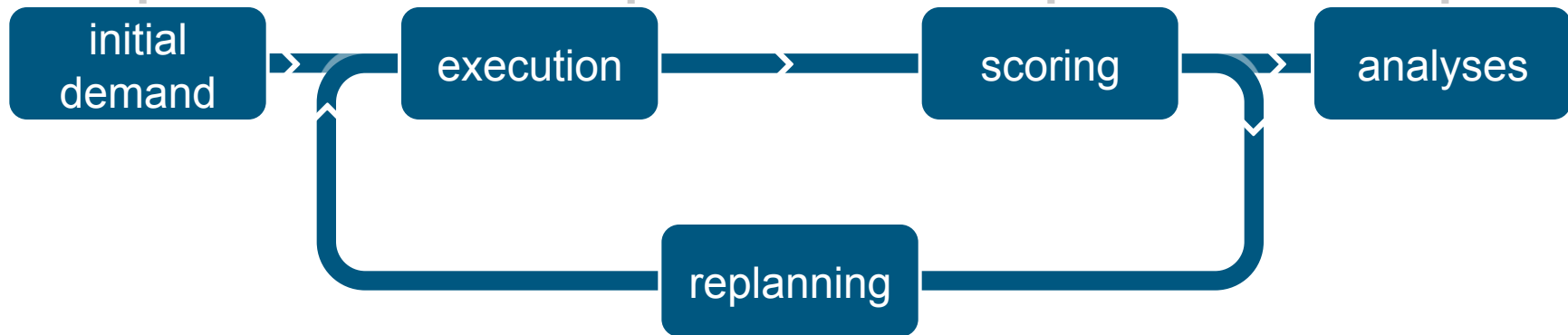
Future Development

- New Zrh demand will have different modes for subtours (Balmer)
- New data structure for plans/population will have to accommodate new modes (Rieser, Grether, Balmer)

- If possible, implementation as abstract as possible to work with QSim and JDEQSim (Rieser, Waraich, Grether)

- Define ScoringFunction (Rieser, Moyo)
- Connect Events to ScoringFunction (Rieser)

We'll see, what will be useful (Rieser, Chen, Moyo, ...?)



Re-Routing: improved Routers with time-tables (Moyo)
 Mode Choice: Random Module (?), Planomat (Meister)

Mobility Simulation

- No longer teleport, but simulate pt-vehicles (capacity, timetables, ...)
- ▶ This will require additional events
 - Board vehicle
 - Exit vehicle
- ▶ New Events will likely influence existing events
 - Renaming
 - Switch to facilities instead of links as primary location attributes
- ▶ This will require changes to plans-format:
 - How to encode a pt-route?
 - How to encode mixed-mode routes?
 - Switch to link-based routes (may not be required, but still helps)
- ▶ This will require changes to the network-format
 - Where can buses drive? Where trains? ...

Scoring

- Figure out how much an agent has paid for traveling with public transit; likely to be similar to road-pricing, energy project, ...
- Simulation sends “Money-Events” (–), or as “post-processing” as Events-Handler (+)
- Integrate into existing scoring function

Re-Planning

- Router
 - ReRoute based on time-table data and pt-lines
 - Manuel Moyo is looking into routing strategies, costs for passengers, ...
- Generate pt-mode alternatives
 - Randomly, on sub-tour level

Current Event Types

ActEnd



AgentDeparture

Wait2Link

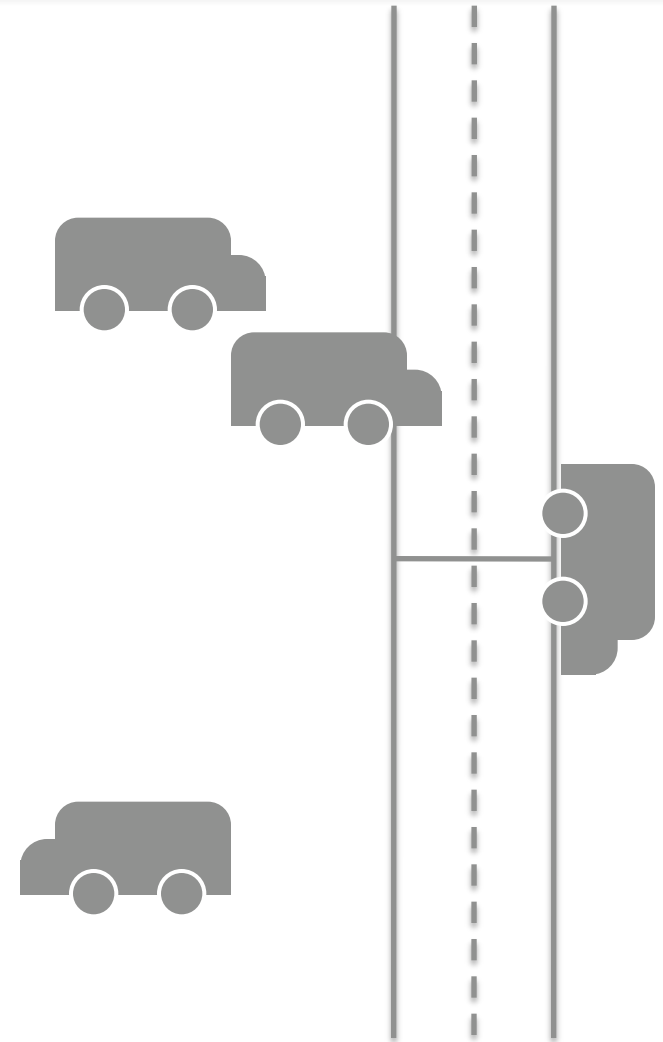
LeaveLink

EnterLink

Link2Parking ??

AgentArrival

ActStart

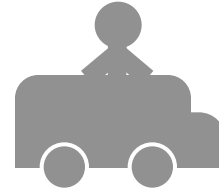


New Event Types (Proposal)

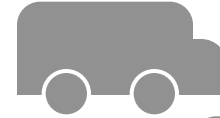
EndActivity



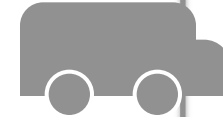
EnterVehicle (car, bus, ...)



DepartureAtFacility (home, bus-stop, ...)



FacilityToLink



LinkToIntersection

IntersectionToLink

LinkToFacility



ArrivalAtFacility



LeaveVehicle



StartActivity



New Event Types (Proposal)

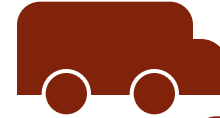
EndActivity



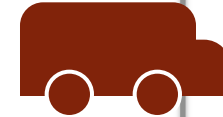
EnterVehicle



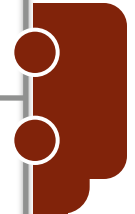
DepartureAtFacility



FacilityToLink



LinkToIntersection



IntersectionToLink

LinkToFacility



ArrivalAtFacility



LeaveVehicle



StartActivity



New Event Types (Proposal)

EndActivity

EnterVehicle

DepartureAtFacility

FacilityToLink

LinkToIntersection

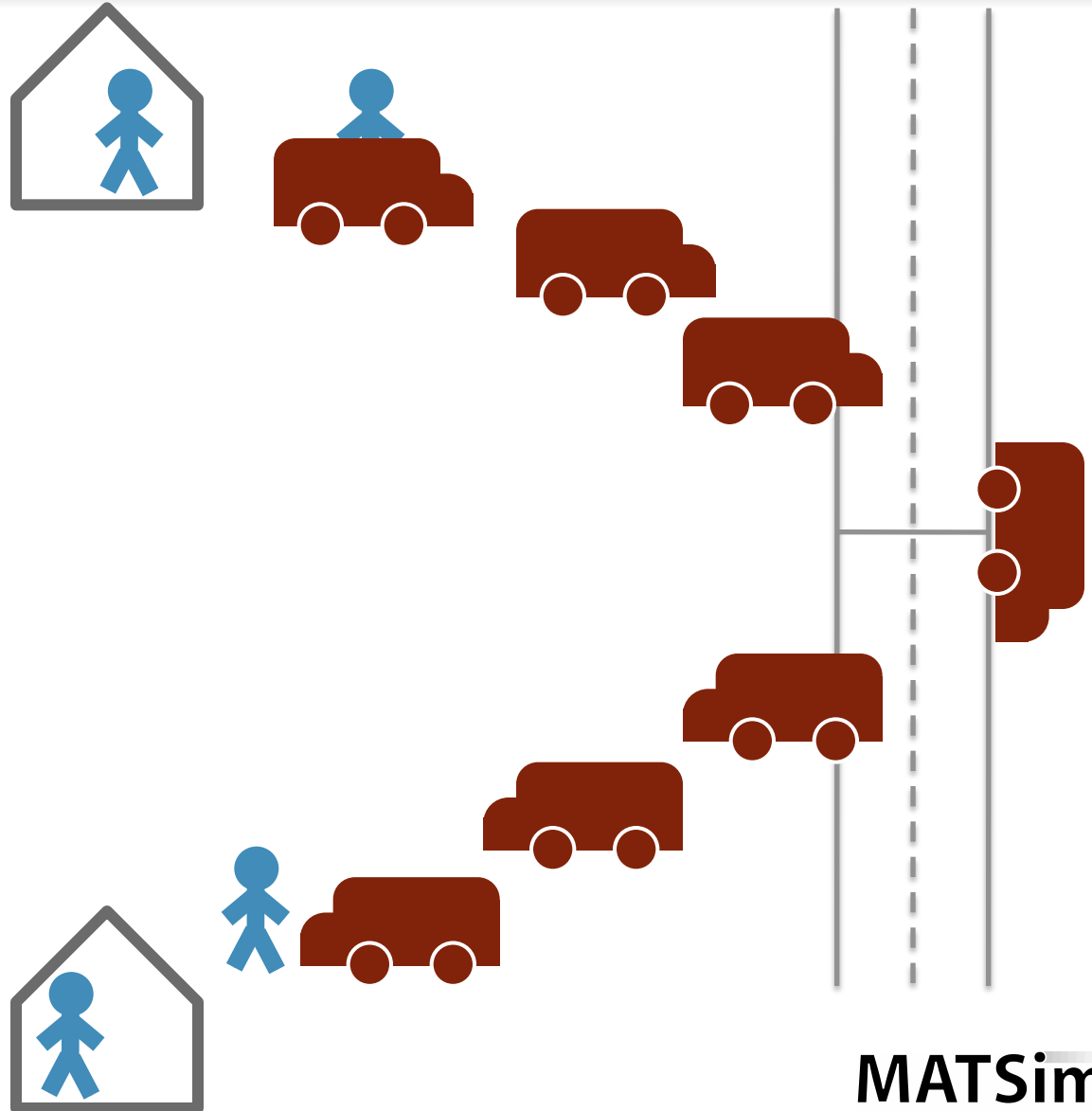
IntersectionToLink

LinkToFacility

ArrivalAtFacility

LeaveVehicle

StartActivity



New Event Types (Proposal)

EndActivity

— Events will contain agent id

EnterVehicle

— Events will contain agent id and vehicle id

DepartureAtFacility

— Events will contain vehicle id

FacilityToLink

LinkToIntersection

▶ Most EventHandlers need modification ☹️

IntersectionToLink

▶ Current Events-File-Format makes no more sense → Switch to XML

LinkToFacility

ArrivalAtFacility

▶ What about Pedestrians? Ped-Vehicle?

LeaveVehicle

StartActivity

Current Plan-Format

```
<person id="123">  
  <plan>  
    <act type="h" end_time="07:00" link="73" />  
    <leg mode="car">  
      <route>583 20 872</route>  
    </leg>  
    <act type="w" duration="8:30" link="611" />  
  </plan>  
</person>
```

New Plan-Format (Proposal)

- Variant A

```

<person id="123">
  <plan>
    <act type="h" end_time="07:00" link="73" />
    <leg mode="car">
      <route>583 20 721</route>
    </leg>
    <act type="change" duration="00:01" link="122" />
    <leg mode="train">
      <route>{S3 S12} 2954</route>
    </leg>
    <act type="change" duration="00:00" link="9" />
    <leg mode="walk">
      <route>978 872</route>
    </leg>
    <act type="w" duration="8:30" link="611" />
  </plan>
</person>

```

Activities to switch modes
What about Re-Planning?

Different encoding for non-car routes

New Plan-Format (Proposal)

- Variant B

```

<person id="123">
  <plan>
    <act type="h" end_time="07:00" facility="8220" />
    <leg>
      <route mode="car">583 20 721</route>
      <route mode="train">{S3 S12} 2954</route>
      <route mode="walk">978 872</route>
    </leg>
    <act type="w" duration="8:30" facility="26637" />
  </plan>
</person>

```

Leg has no mode
Route has mode

Activity-Location is a facility

Agent-Interfaces

- Split data from behavior
- Driver-Agents
 - Bus-Driver, Tram-Driver
 - Taxi-Driver
 - Autonomous Driver (e.g. Polybahn)
 - Use different Replanning for different Agents?
- Passenger-Agents
 - Only Persons can be passengers, but not autonomous drivers
 - Drivers may have to communicate with the passengers

New Network-Format

- Not yet decided in detail, but:
- Time-table for PT stored externally
- Actual pt-lines also likely to be stored externally ("logical network")
- But pt-infrastructure may be stored in network
- Use Facilities for Bus-Stations etc
 - Mode changes happen at facilities (station, parking lot, ...)
 - All trips start / end at a facility (→ requires facilities as standard)
- Gives possibilities to:
 - Optimize infrastructure
 - Optimize usage of infrastructure (pt-lines, time-tables, pt-vehicles)
- Challenges:
 - Different attributes for different transportation links
 - What about mixed links / lanes?

Challenges

- How to configure which routers to be used:
 - Likely to have specialized car-routers, pt-routers, bike-routers, ...
- How to configure the scoring function:
 - Do we want to mix different ways to score car-trips with different ways to score pt-trips?
- How to calculate mode share per Leg, when a Leg can have more than one mode?
- Is "PT" a mode, or are "bus", "train", ... the modes?

Thanks for your attention!

Questions? Comments?

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MATSim
Multi-Agent Transport Simulation