Using MATSim as a Railway Corporation

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Agenda.

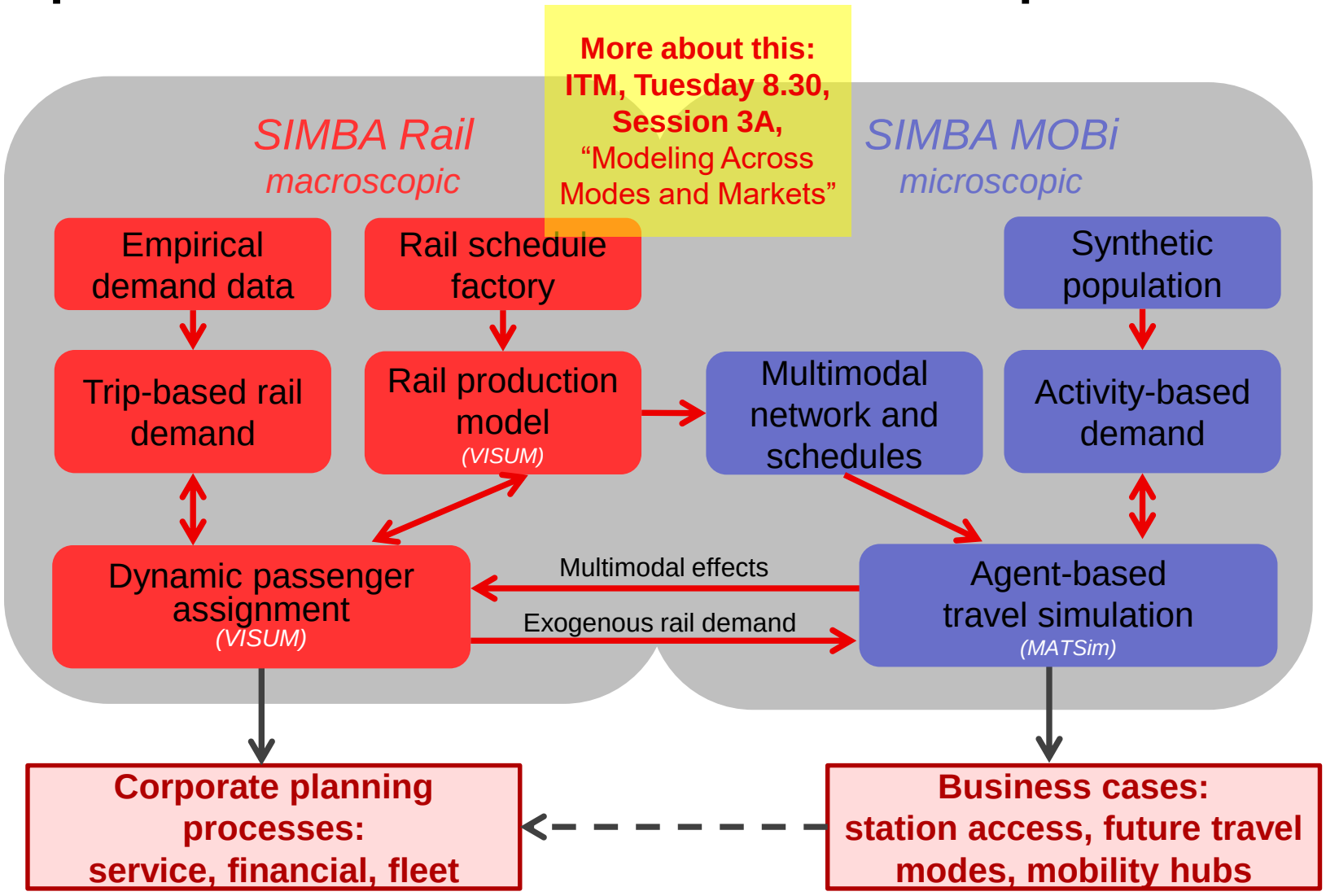
1. Who is SBB?
   ... and transportation modeling @ SBB
2. Model development with MATSim
   - Input data
   - Software development
   - Parameter calibration
3. Application of MATSim: «reality tests»
4. One year with MATSim
   - Where we stand
   - Where we go from here
   - Lessons learned

Acknowledgements, contacts and further information

Swiss Federal Railways (SBB) in numbers 2017.

- Leading railway in Switzerland (population 8.4 million)
- 1.3 million passenger trips per day
  - over the past 15 years: +3.5% in average p.a.
- 3’200 km network length (standard gauge)
  - most densely used rail network in the world
- 33’000 employees
- Punctuality
  - 89% of passengers arrived with less than 3 minutes delay
- Renewable energy
  - > 90% of all electricity used in rail transport

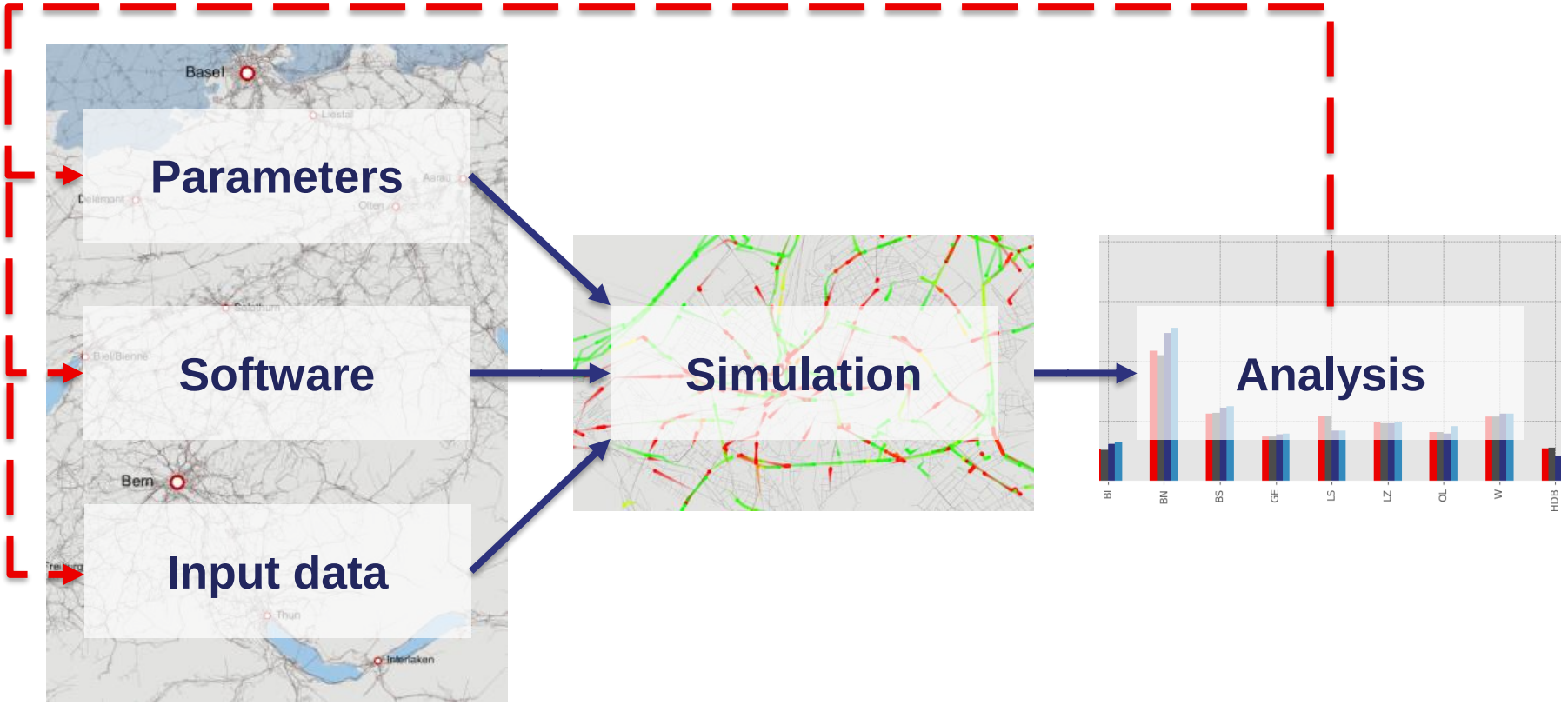
2-pillar architecture of the model landscape SIMBA*



* **S**tandardisierte **I**ntegrierte **M**odellierung und **B**ewertung von **A**ngebotskonzepten

Model development with MATSim

The big picture of our model development.



Work flow

Calibration feedback

We are not first in modeling Switzerland with MATSim.

- Senozon and ETH/IVT provided the following input data for our MATSim model of Switzerland:
  - Synthetic population (Swiss inhabitants, freight and cross-border travellers by car)
  - Agents' plans
  - Road network

- Step by step, we extend and replace the inputs by our own data, e.g.:
  - PT schedule
  - Exogenous rail demand

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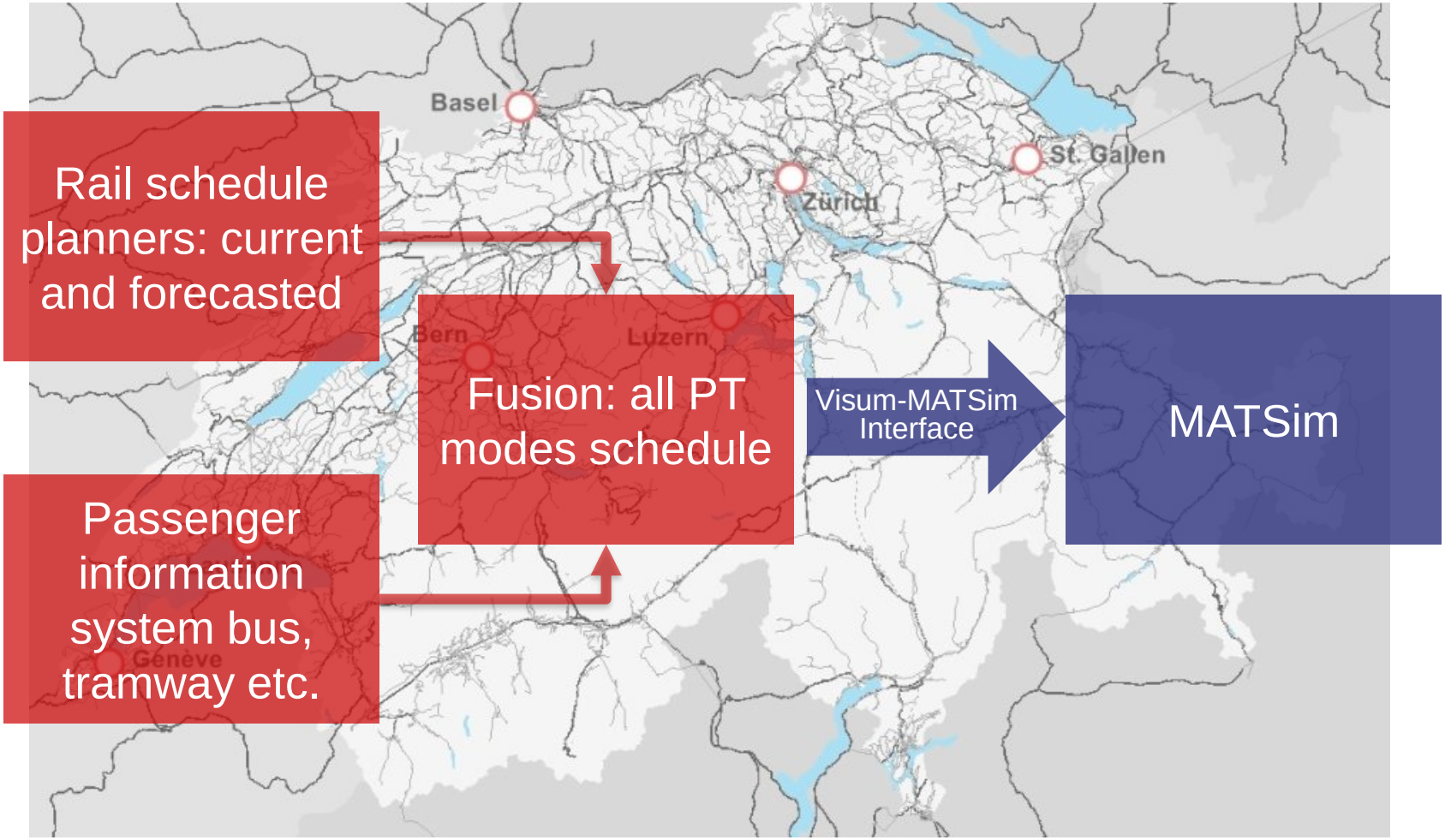
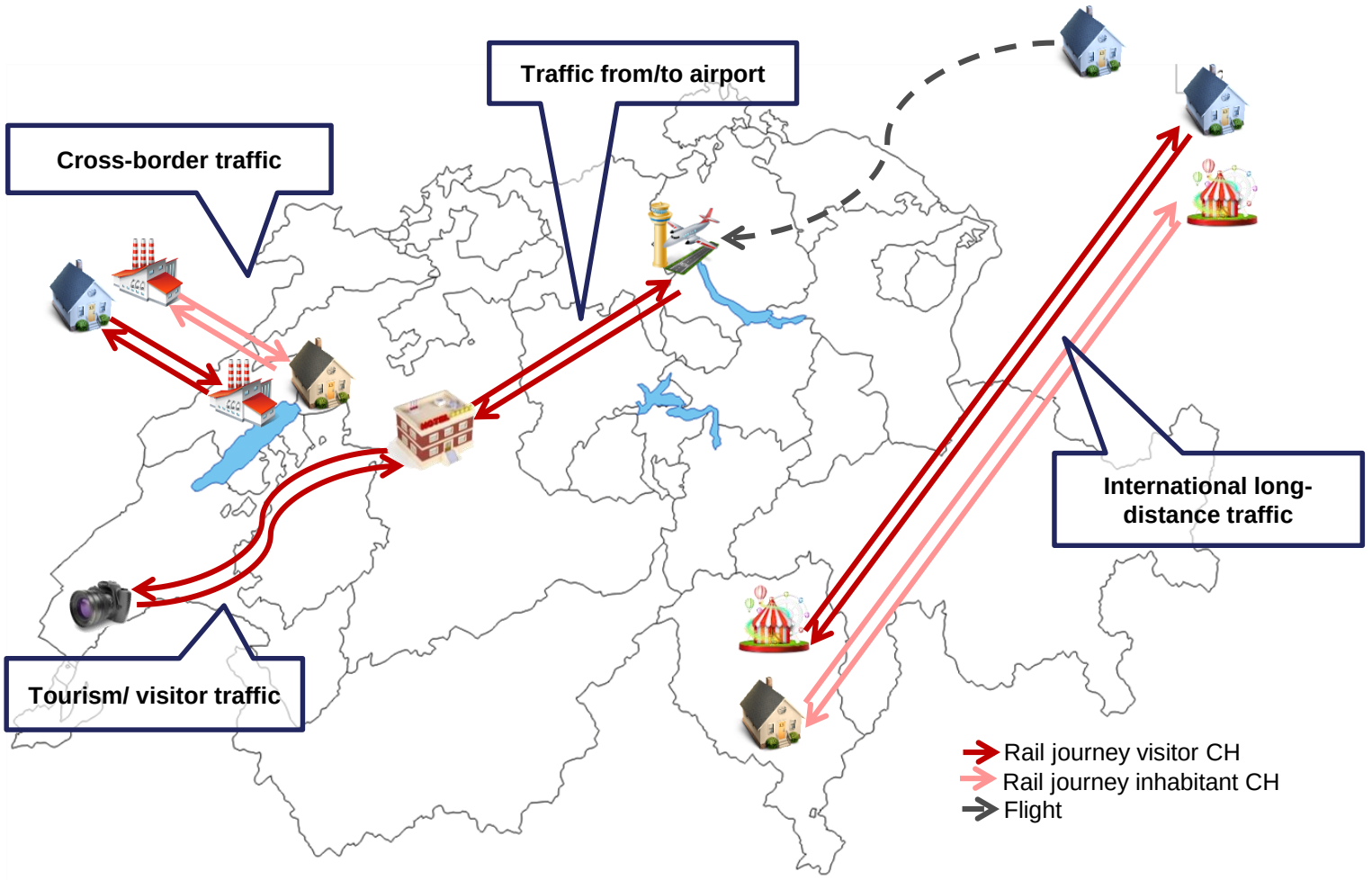
Our PT schedule factory delivers current and future schedules to MATSim.

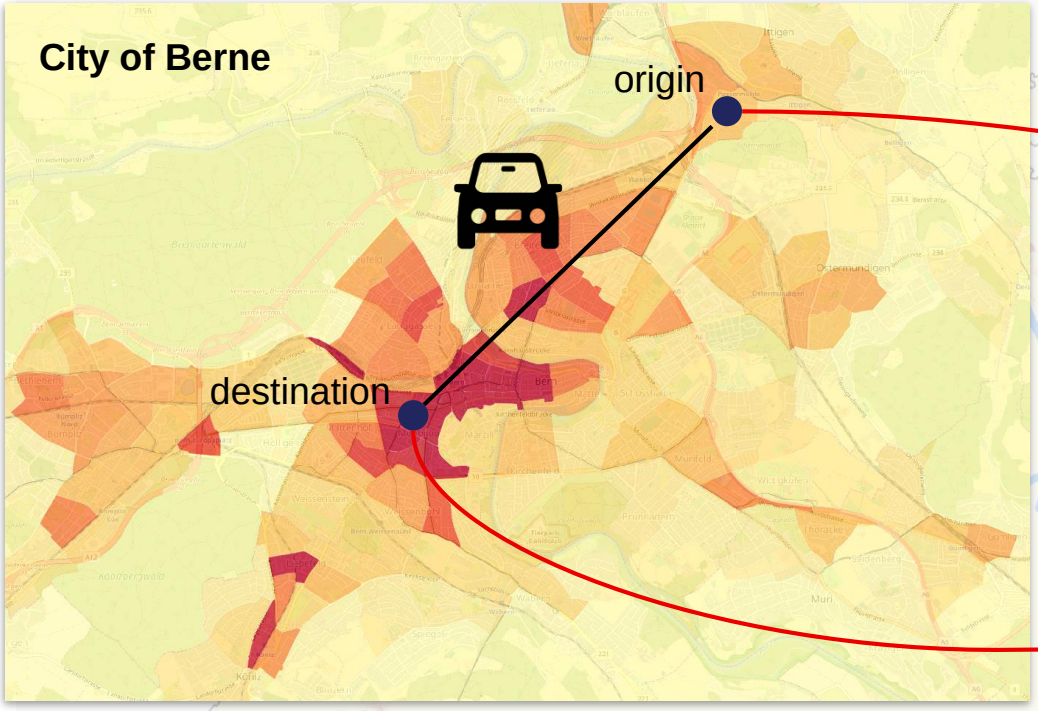


Exogenous rail demand:
Not only Swiss inhabitants travel by train.



Software development

Access times:
Getting a more realistic car scoring.




```
<activity type="home"></activity>
<leg mode="access_walk" dep_time="09:10:58" trav_time="00:00:45" </leg>
<activity type="car interaction"></activity>
<leg mode="car" dep_time="09:11:43" trav_time="00:08:11"></leg>
<activity type="car interaction"></activity>
<leg mode="egress_walk" dep_time="09:19:54" trav_time="00:05:08" </leg>
<activity type="shop_daily"></activity>
```

- → No parking constraints in standard MATSim (searching for a parking space, access times, parking costs)
- → Development: access time = function of urban density
- → Calculated for the 8’000 zones of the NPVM

SwissRailRaptor:
A improved PT router is now open source.

- **90+ times faster**
- Speed-up of the whole CH-simulation: **~3 times**
- Memory consumption: **~10%** of the default MATSim router

- Minimal transfer times
- Range queries: optimal connection within time window

- Intermodal access/ egress
- Person-specific routing parameters
- Mode-specific routing parameters

Version 1.0

«a faster router»

Version 1.5

«a more realistic router»

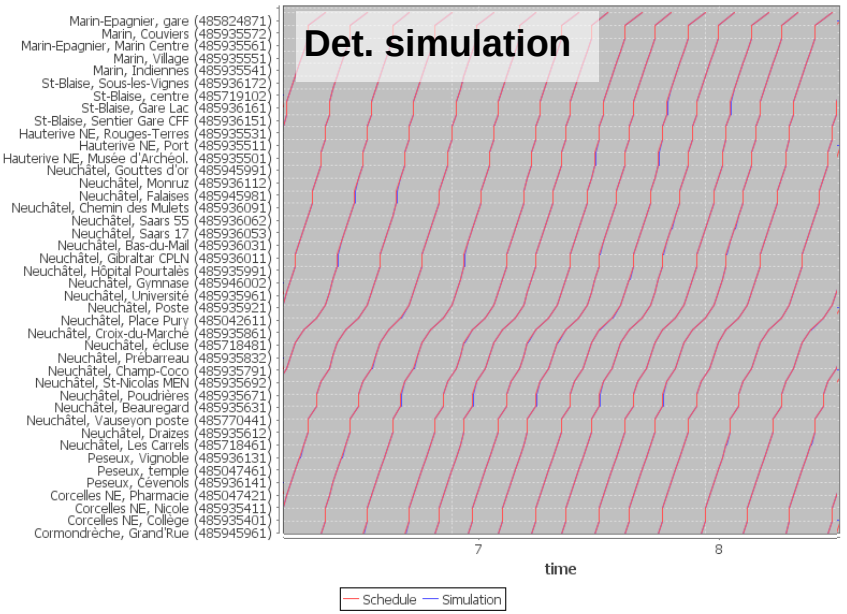
Version 2.0

«a fancy router»

Deterministic PT simulation (DetPt): Realistic PT travel times of agents and vehicles.

- QSim-module to simulate PT vehicles strictly according to the transit schedule
- The defined vehicles are not physically routed through the network, but teleported
- Optimal for **PT on dedicated tracks** (train, metro, ..)

Default MATSim	SBB DetPt
TransitQSimEngine	SBBTransitEngine
queue-based simulation	stop-to-stop teleportation
Interaction with car traffic	no vehicles interaction
passenger interaction	passenger interaction
capacity constraint	capacity constraint



Scoring parameter calibration

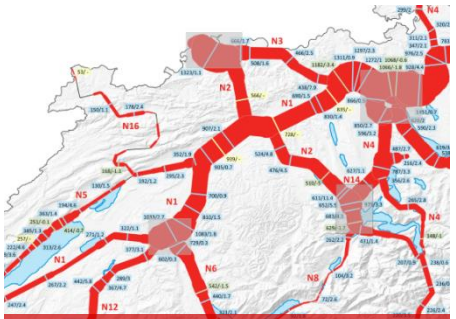
Our calibration is based on multiple criteria.

Rail demand data
(HOP)

- Rail demand global (km travelled, # trips)
- Passenger volumes:
  - per station
  - per link
  - per OD pair
- Distributions of demand by LOS (travel time, distance, transfers)

Travel diary survey
(MZMV 2015)

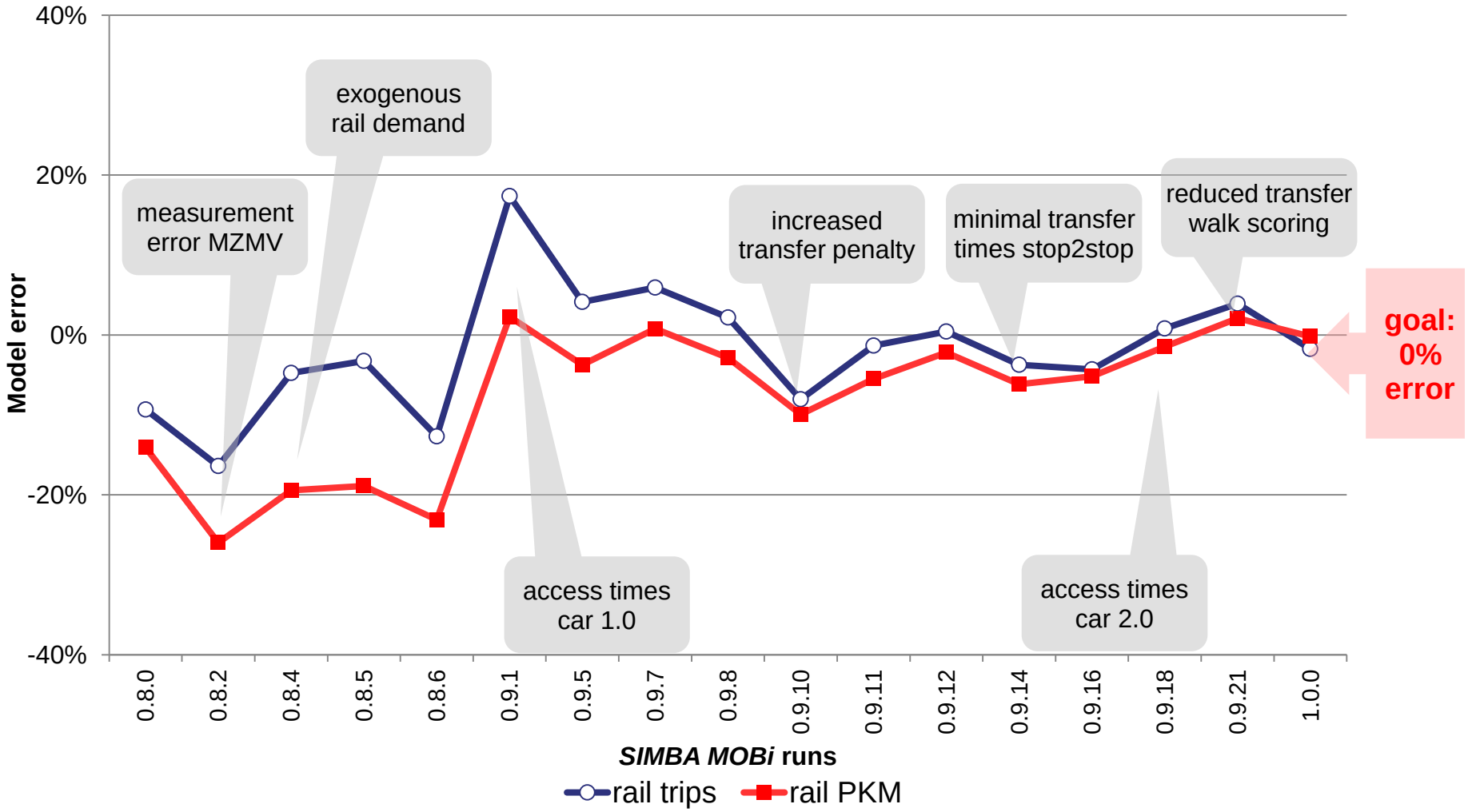
- Mode shares (# trips , pkm)
  - global and by person groups
  - by distance classes
  - aggregated district-to-district
- Direct trips versus transfers in public transport
- Travel time per mode



Road counts
(ASTRA)

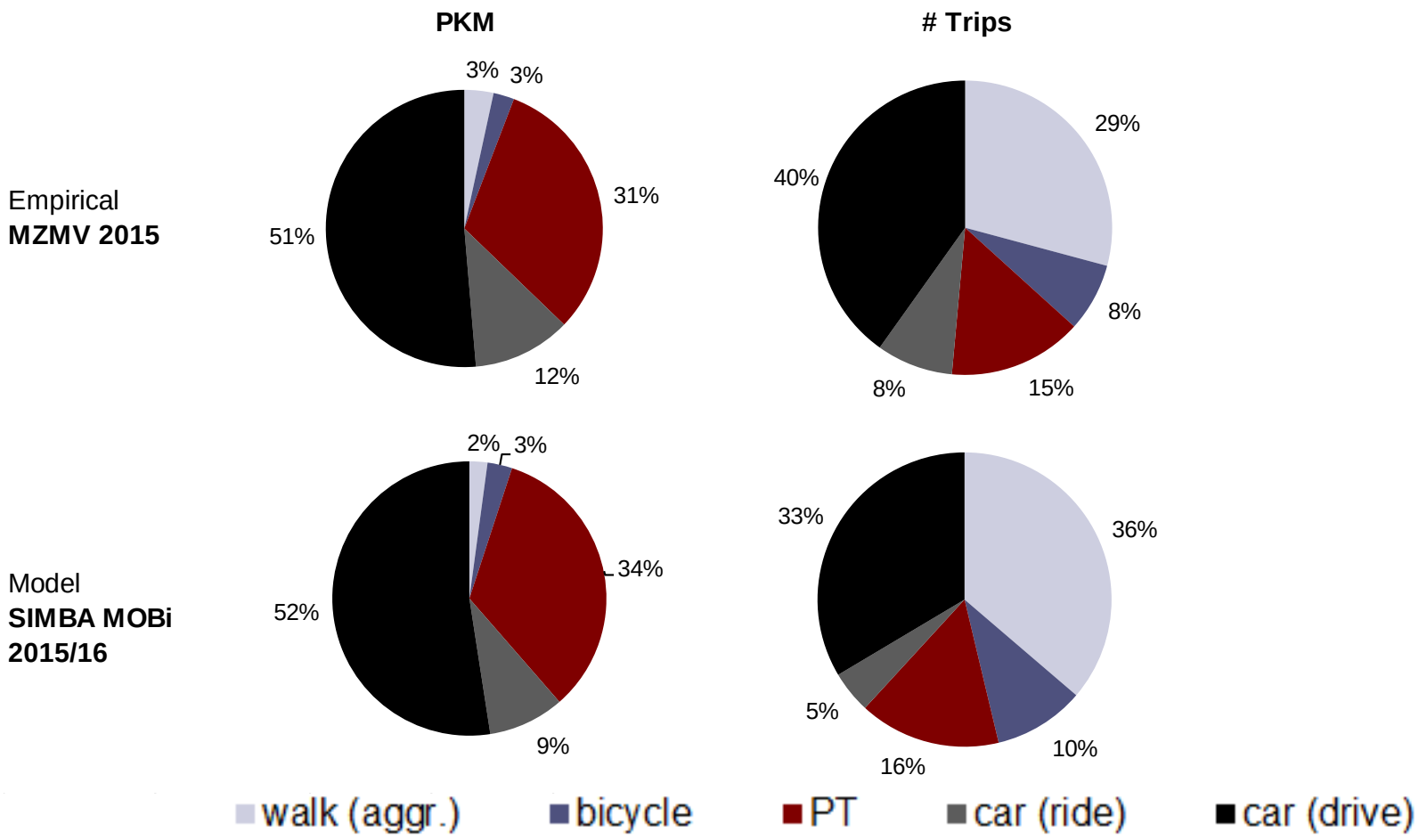
- Link volumes on Motorways and other national roads

Calibration history (dec. 17 – apr. 18).



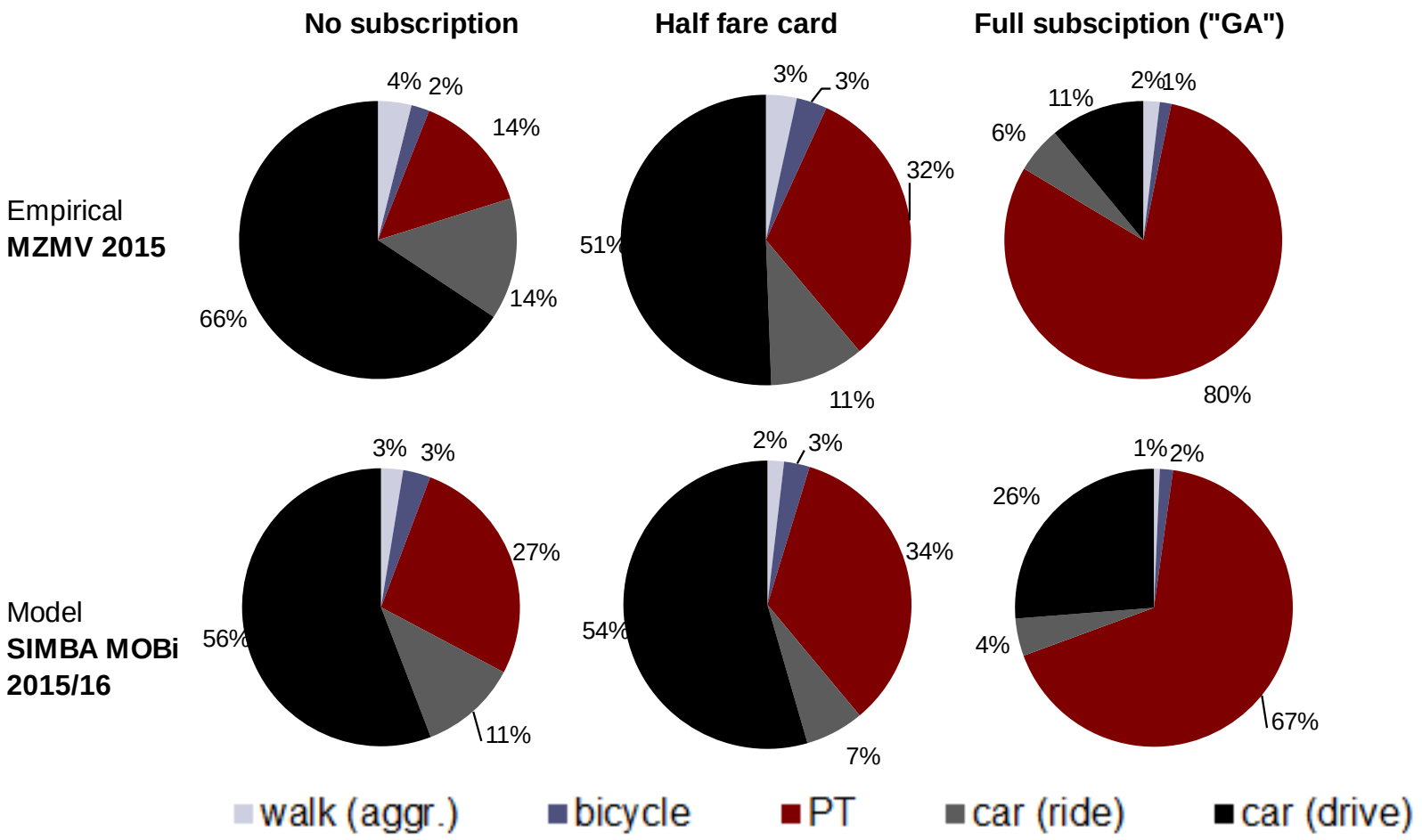
Mode shares:
Person KM traveled (PKM) versus # of trips.

Average weekday travel of inhabitants, in interior travel of CH



Mode shares, PKM:
Some person groups need specific scoring functions.

Public Transport Subscription / FareCard



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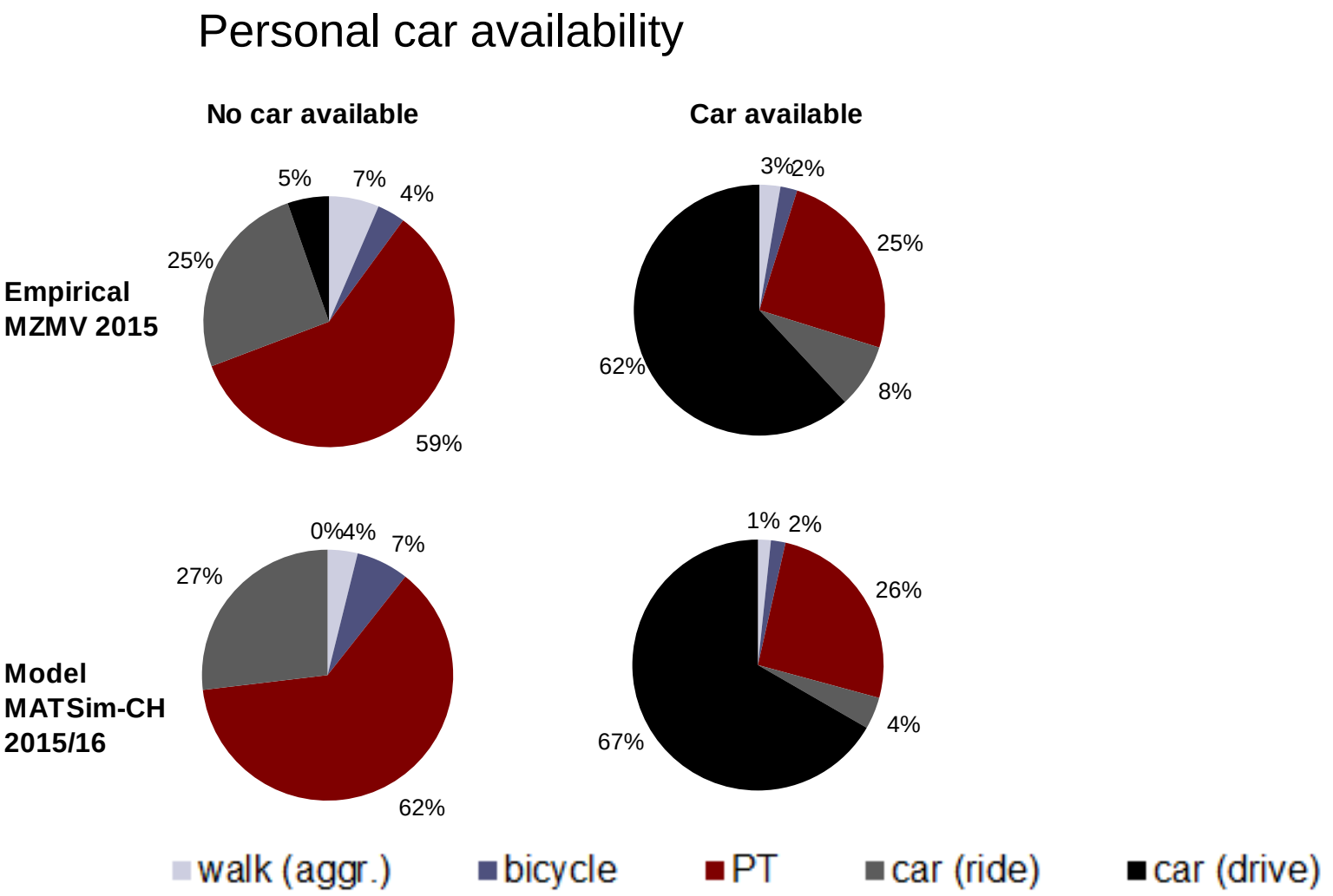
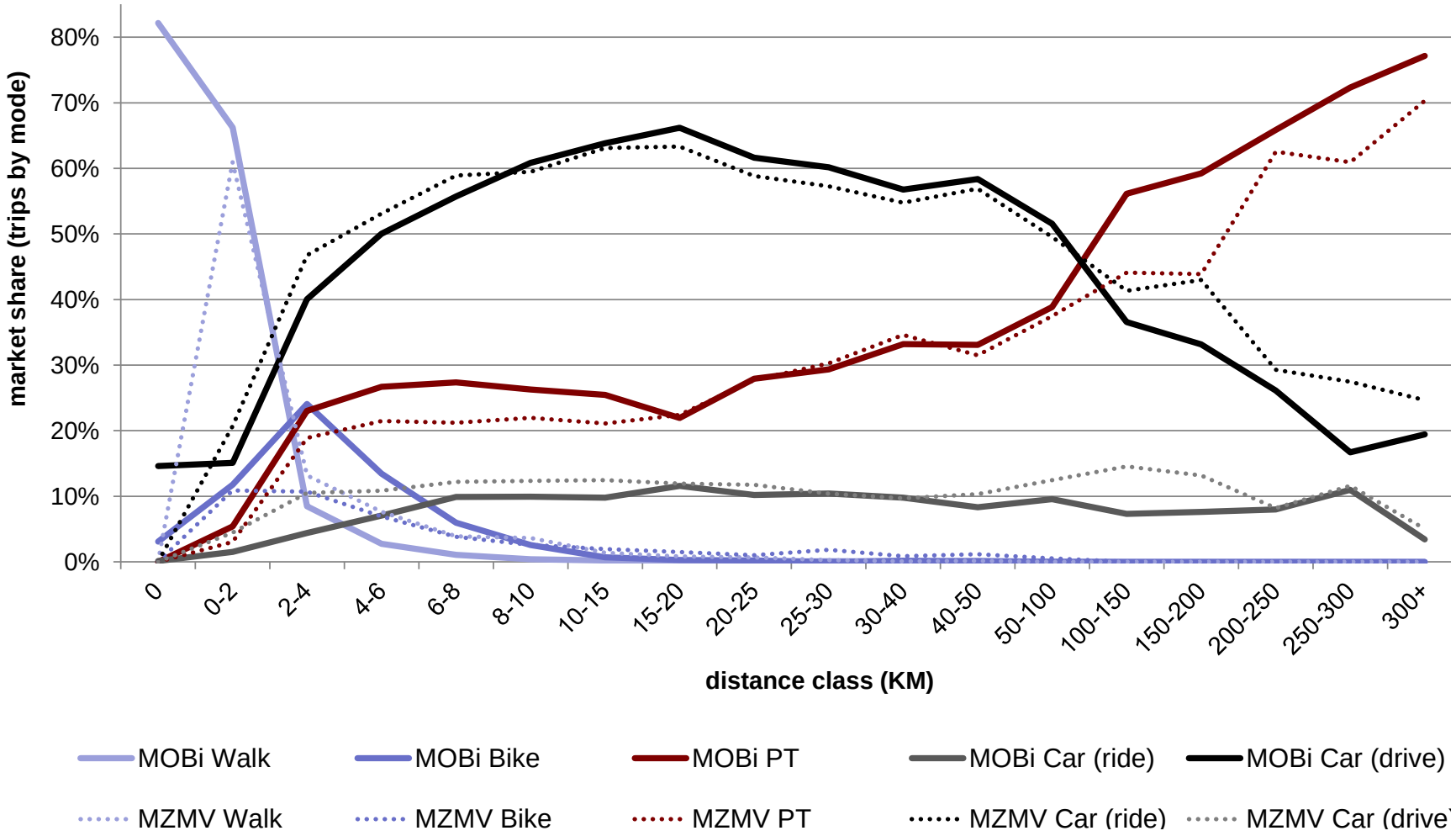


Mode shares by distance class.



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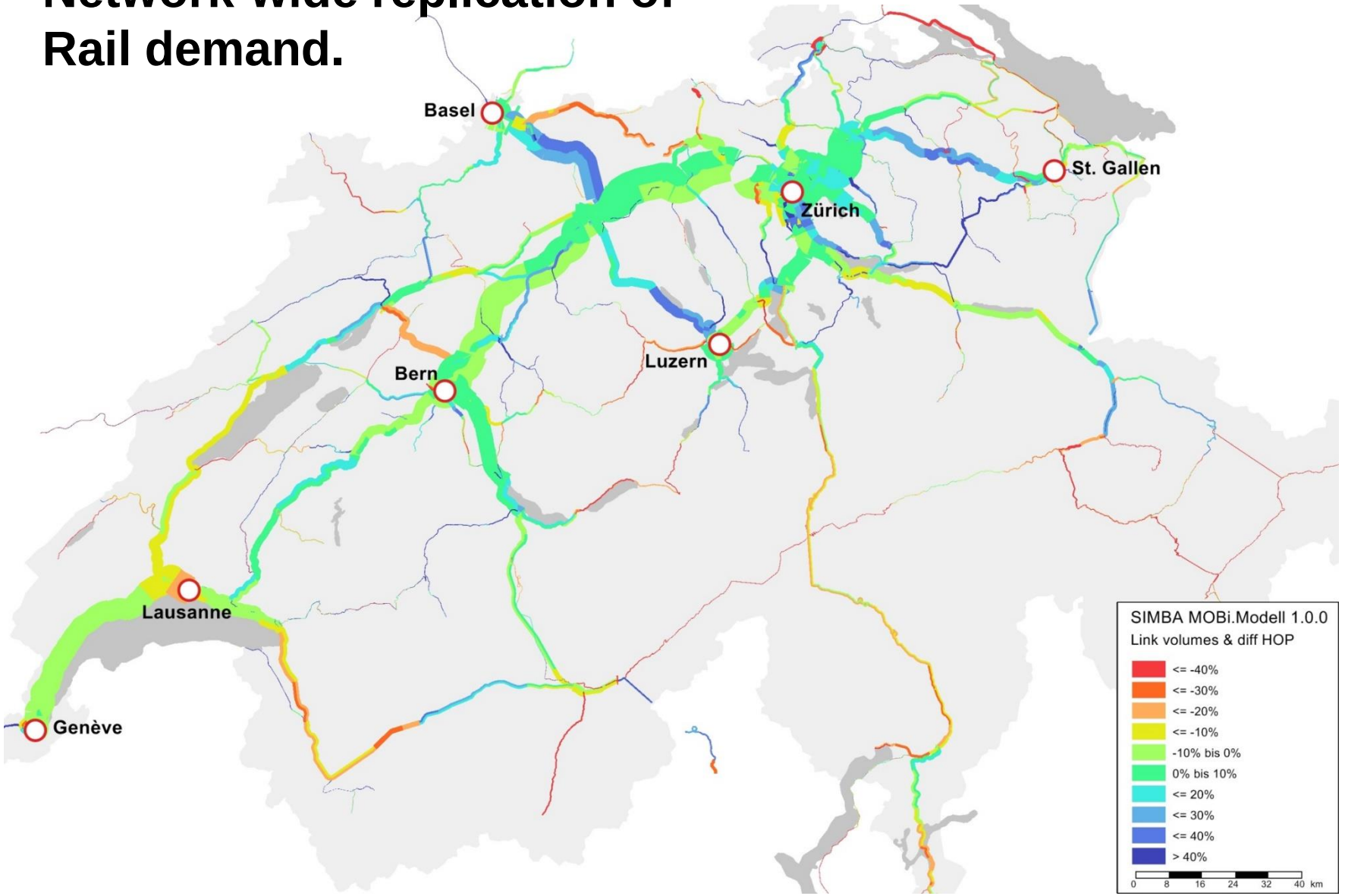
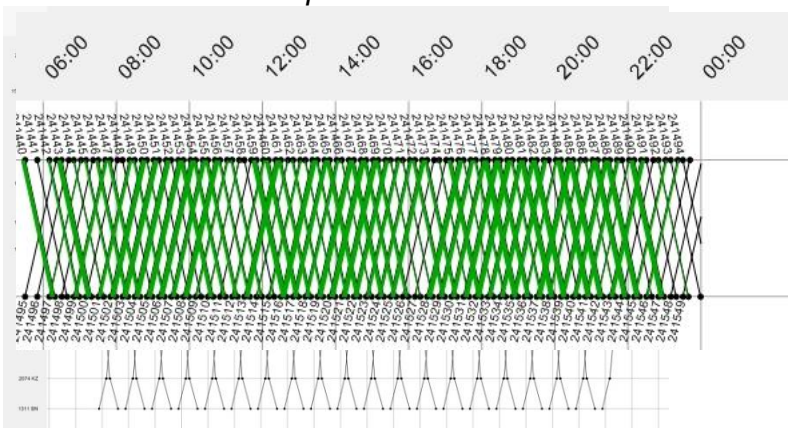
Network-wide replication of Rail demand.



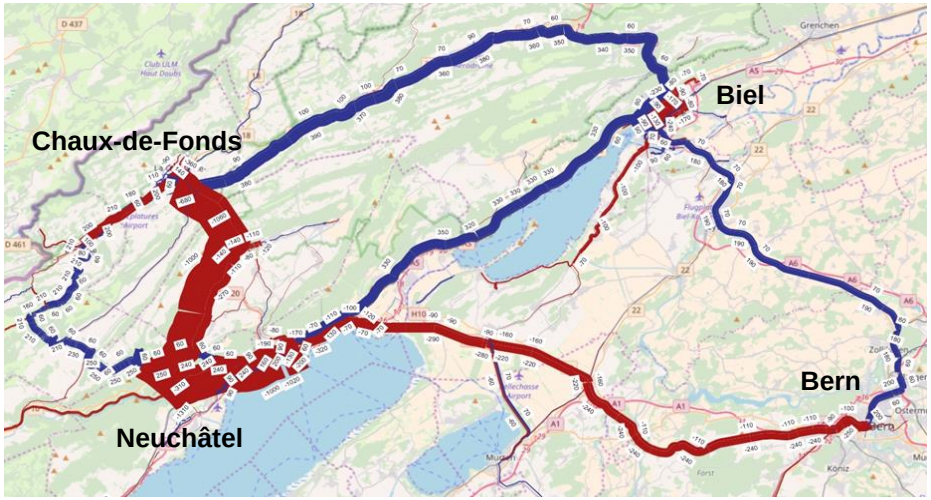
First applications of MATSim: «reality tests»

Replacement of rail service by bus.

Schedule with bus replacement:

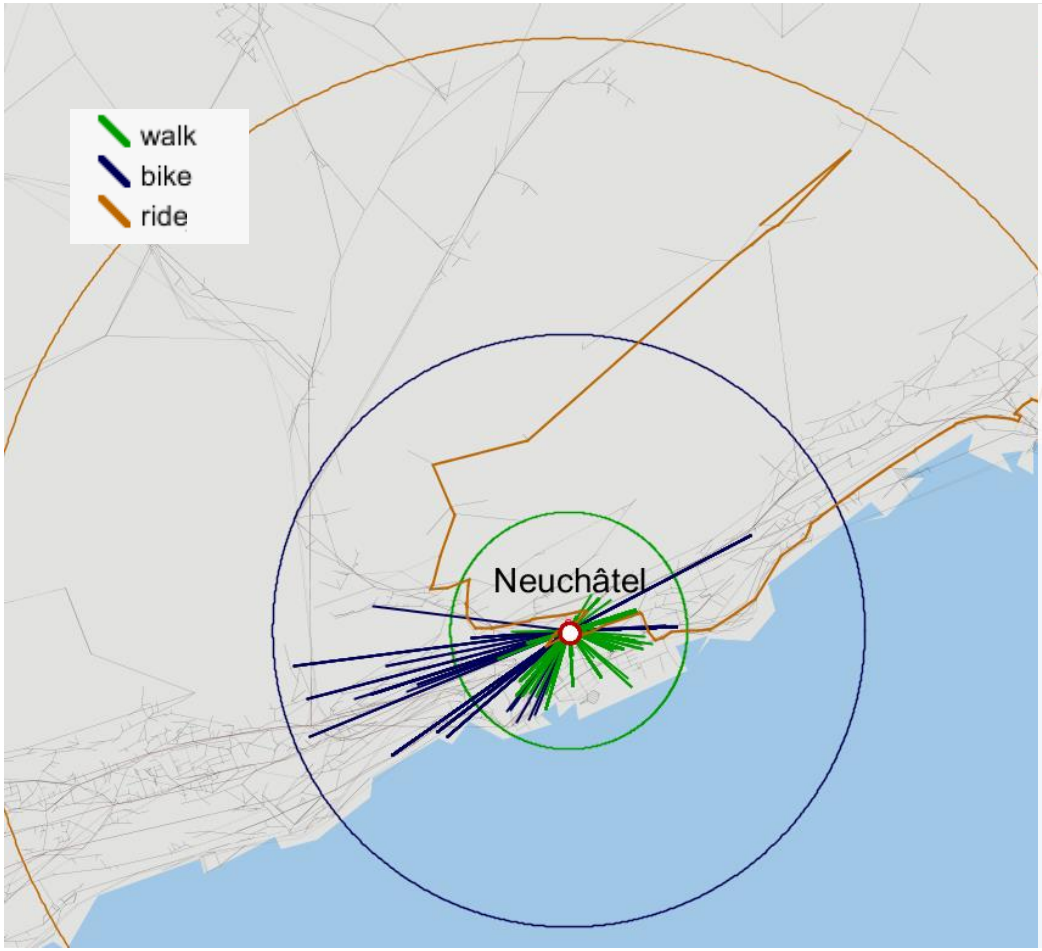


Route choice:



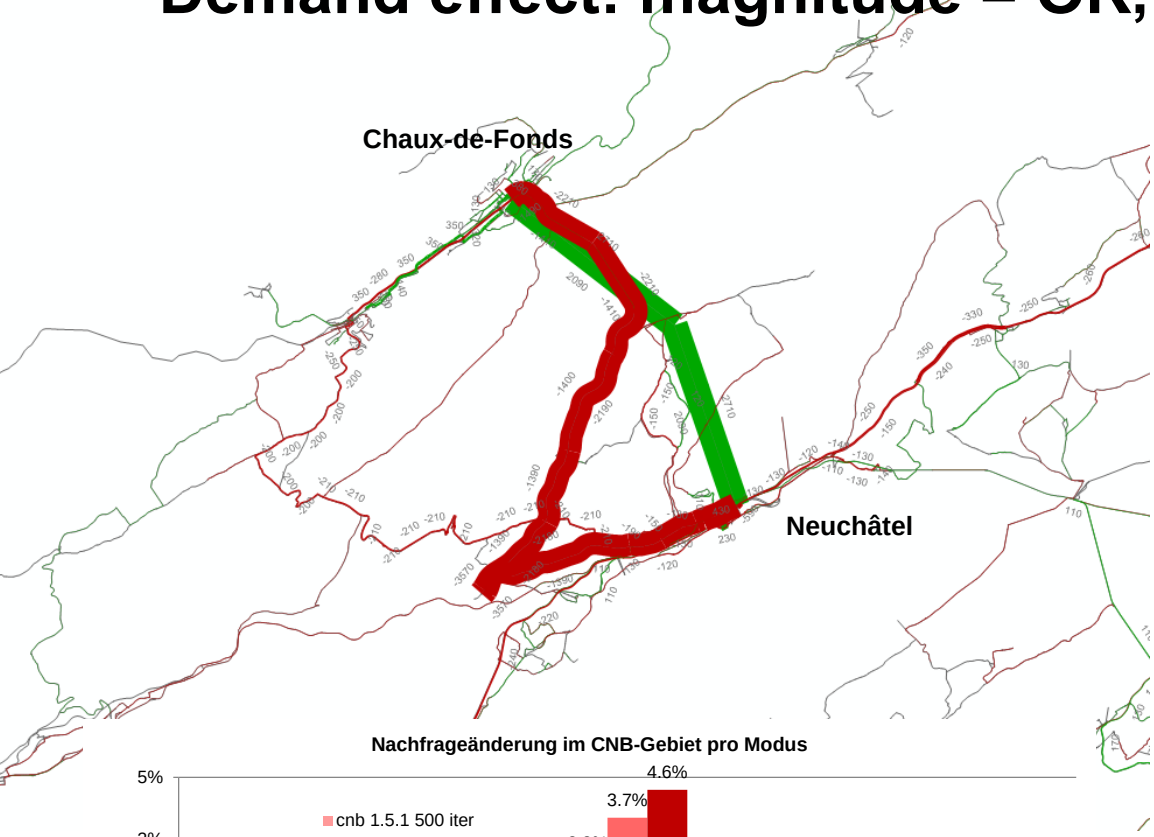
- Case:
  - Rail interruption Neuchâtel - Chaux-de-F.
  - Replacement by buses
- Measured effects:
  - Required bus sizes
  - Shift to other PT lines (route choice)
  - Modal shift to other (motorized) modes

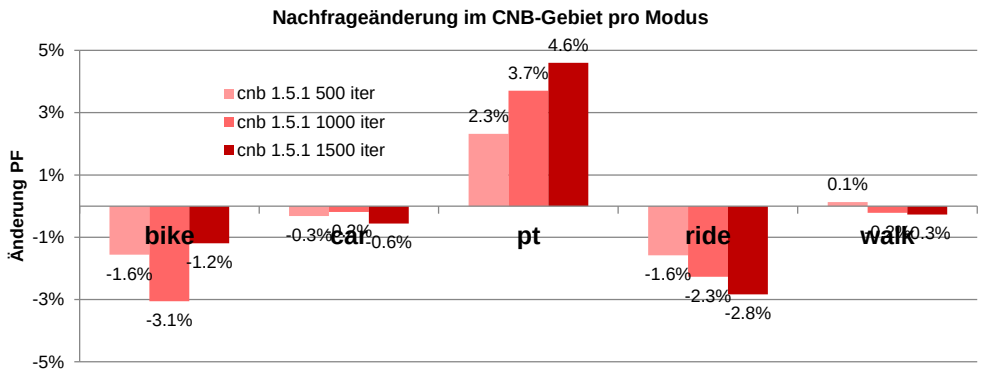
Intermodal access and egress: Making a train station accessible by bike/ride.



- Case:
  - More realistic access and egress to and from train stations
- Measured effects:
  - Modal split in station access (walk, bike, ride and bus)
  - Boarding and alighting counts at stations

Rail service improvement:
Demand effect: magnitude = OK, convergence ≠ OK





- Case:
  - New direct rail connection
  - Travel time cut in half
- Measured effects:
  - Modal split, route choice
  - Train loads, station boardings
- **Unsolved problem: convergence of demand**

Conclusion of the first applications.

- → Convergence is not satisfactory yet
  - Only well converged simulations can serve in the comparison of alternative cases
- → Advanced scenarios with future scenarios of public transport require model further development:
  - intercity bus lines,
  - intermodal rail access,
  - capacity constraints
- → Prediction success and sensitivity: still needs verification
- → We are not at the point yet, where we want to use the MATSim model for serious business cases (but we will get there)

One year with MATSim ...
Where we stand
and where we go from here

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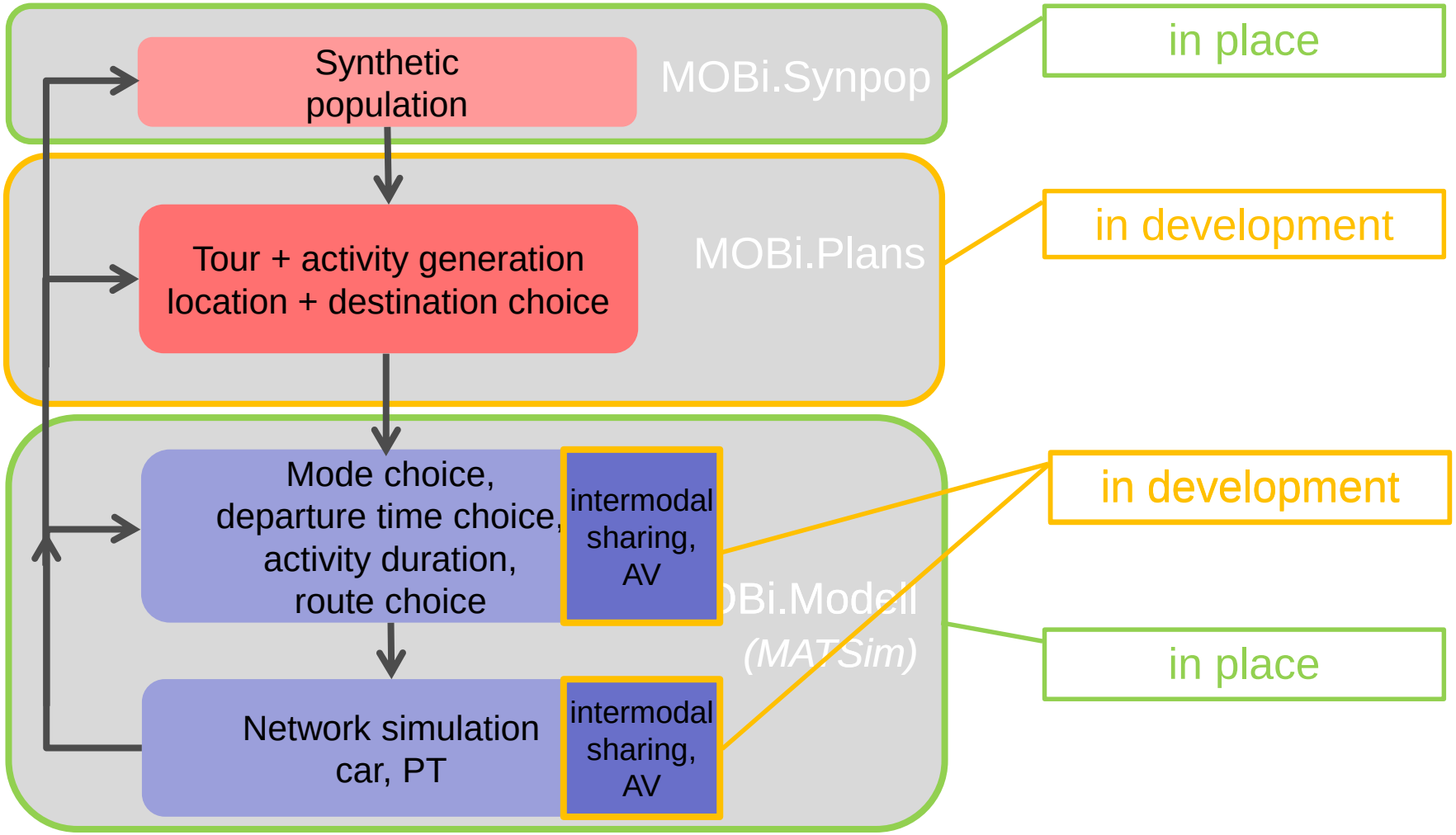
SIMBA MOBi.CH 1.0 : We have calibrated an agent-based simulation on the national scale.

One year with MATSim: What we have achieved.

- → MATSim model on the national scale: calibrated, up and running (syn.pop. and plans from senozon/ETH)
- → Development of
  - an improved public transport model in MATSim (open source)
  - other software features helping to model realistic demand (access times care, person-type diversified scoring , ...)
- → Automation of input data streams for exogenous demand and public transport schedules, both existing and future-forecast
- → Provision of computing power, cloud and local
- → Functional MATSim modeling team
  - know-how in microscopic travel modeling, software development and data science

Next steps of development
Completing the microscopic model chain.



One year with MATSim ...
Lessons learned

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One year with MATSim: Lessons learned

- → Scoring parameters ...
  - ... must be diversified: routing≠plan-scoring, by person type
  - ... can not be copied from a trip-based LOGIT model (not even with the method described in Horni et al 2016)
- → The open source software project is very well done
- → A lot of trial and error ...
  - ... might be avoided for future MATSim starters by best-practice configuration files and better documentation
- → To make MATSim ready for real world transport planning, we need to work on
  - ... calibration, convergence, computation times, and
  - ... access for users that are not programmers

One year with MATSim:
What we like to learn from other users.

- **Convergence** of MATSim simulations
  - ... how to improve it
  - ... and how to handle the lacking convergence in practice

- **Calibration** of travel demand:
  - tipps, tricks, methods

- **Generation of agents' plans** as input to MATSim
  - tours, activities, times of day, destinations

Further information

Acknowledgements

The model, which is presented here, has been built by a team.

The team includes/included:

- Nathalie Frischknecht
- Johannes Lieberherr
- Patrick Manser (presenter, patrick.manser@sbb.ch)
- Denis Métrailler
- Stefan Paschke
- Marcel Rieser
- Wolfgang Scherr (presenter, wolfgang.scherr@sbb.ch)

Visit our open source repositories on github!

https://github.com/SchweizerischeBundesbahnen

- matsim-sbb-extensions: DetPT, SwissRailRaptor
- matsim-sbb: MATSim project for MEMO-P
- matsimba: Python modules for postprocessing

Further reading:

- Wolfgang Scherr, Patrick Bützberger, Nathalie Frischknecht:
  Micro Meets Macro: A Transport Model Architecture Aiming at Forecasting a Passenger Railway's Future.
  http://www.strc.ch/2018/Scherr_EtAl.pdf

- Marcel Rieser, Denis Métrailler, Johannes Lieberherr
  Adding Realism and Efficiency to Public Transportation in MATSim
  http://www.strc.ch/2018/Metrailler_Lieberherr.pdf

Riding trains in Switzerland is fun ...