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Case Studies and Analysis with MATSim

ETH
Eidgenössische Technische Hochschule Zürich
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MATSim
Multi-Agent Transport Simulation

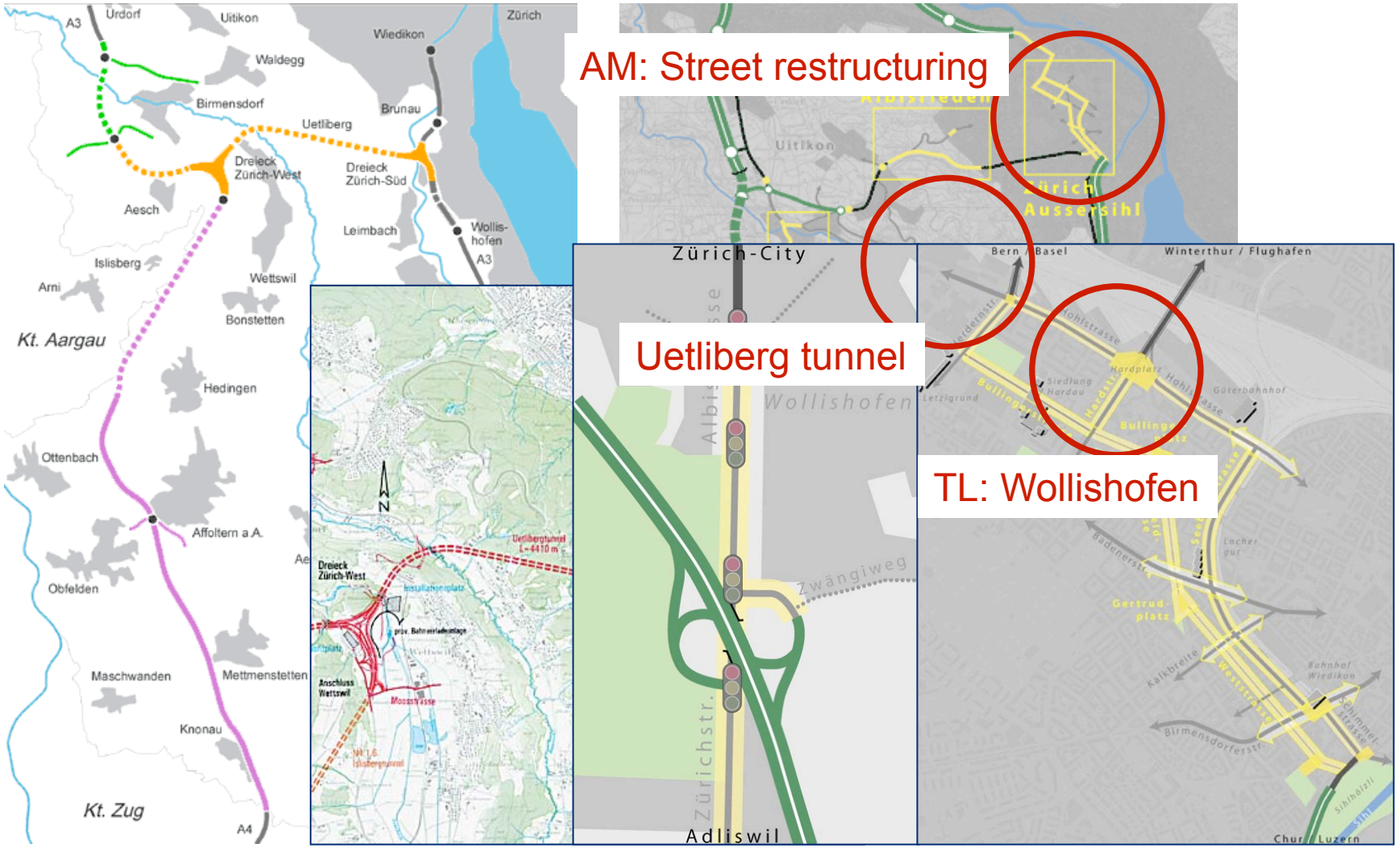
Content

- Target definition & data needs
- Scenario setup (actual state and case studies)
- Calculation of the actual state with MATSim
- Calculation of the case study with MATSim
- Analysis and comparisons (with and without MATSim)
- Discussion

- ➔ [EXAMPLE EQUILNET]

Target Definiton & Data Needs

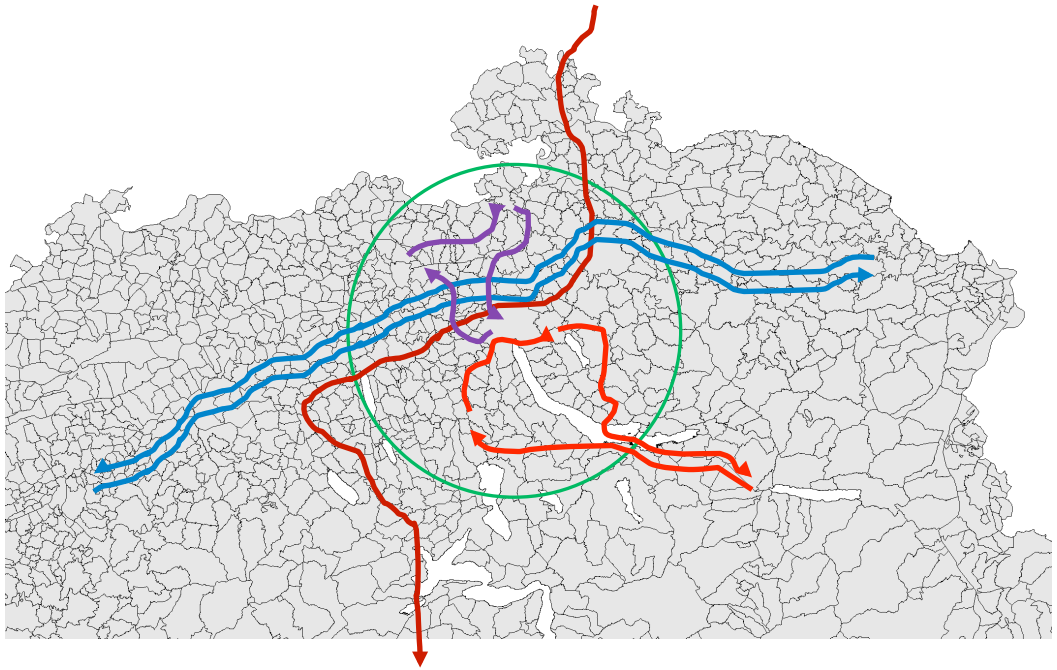
Target Definition & Data Needs
Specify the Region



MATSim
Multi-Agent Transport Simulation

Target Definition & Data Needs
Specify the System Constraints

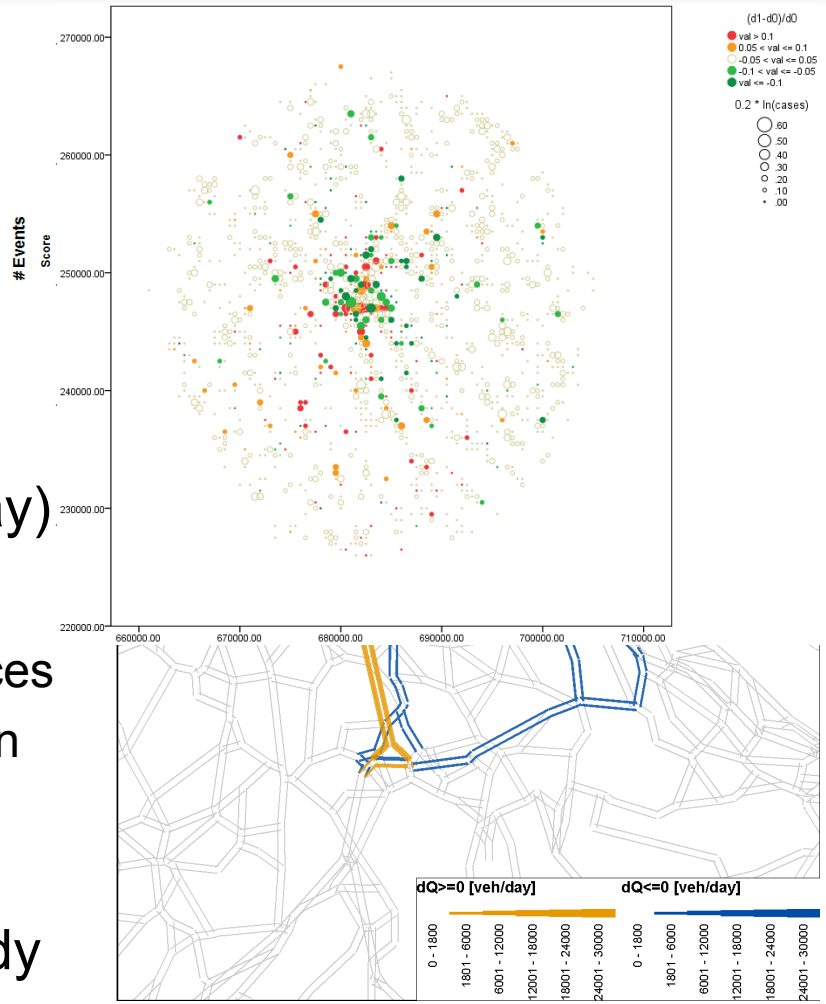
- Region of Interest (infrastructure)
  - Special constraints: Light signals in Zurich city
- Agents of Interest (demand, 24h, typical workday)



MATSim
Multi-Agent Transport Simulation

Target Definition & Data Needs
Specify the Analysis

- Actual state
  - System relaxation
  - Count comparisions (hours, day)
- Actual state & case study
  - Volumes (hours, day, peak hour)
  - „Dynamic spider analysis“ (hours, day)
  - Winner / looser statistics
    - Total utility, trip travel times, trip distances
    - Swiss population set, abroad population set, „route switchers“ & population „Westtangente“
- Comparisons: Actual state vs. case study

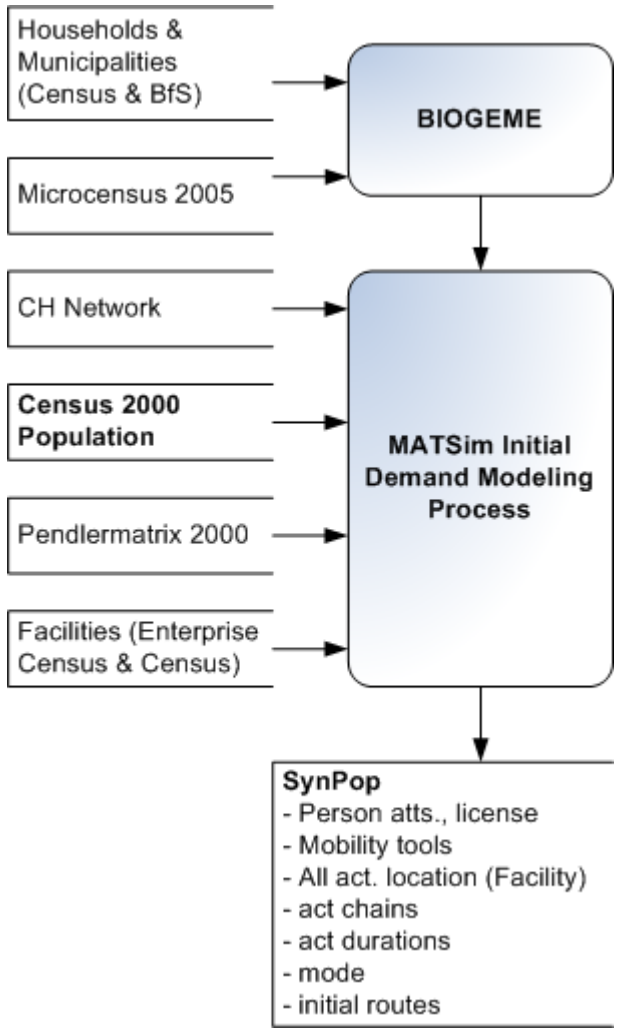


MATSim
Multi-Agent Transport Simulation

Target Definition & Data Needs
Specify the Processes (Init. Demand Modeling)

- Creating initial individual time-dynamic demand based on:
  - Census 2000
  - Micro census 2005
  - Commuter matrices 2000
  - Transit matrices (border crossing traffic)
  - Enterprise census 2000
  - National network model

➔ Agents (demographics) with initial plans



MATSim
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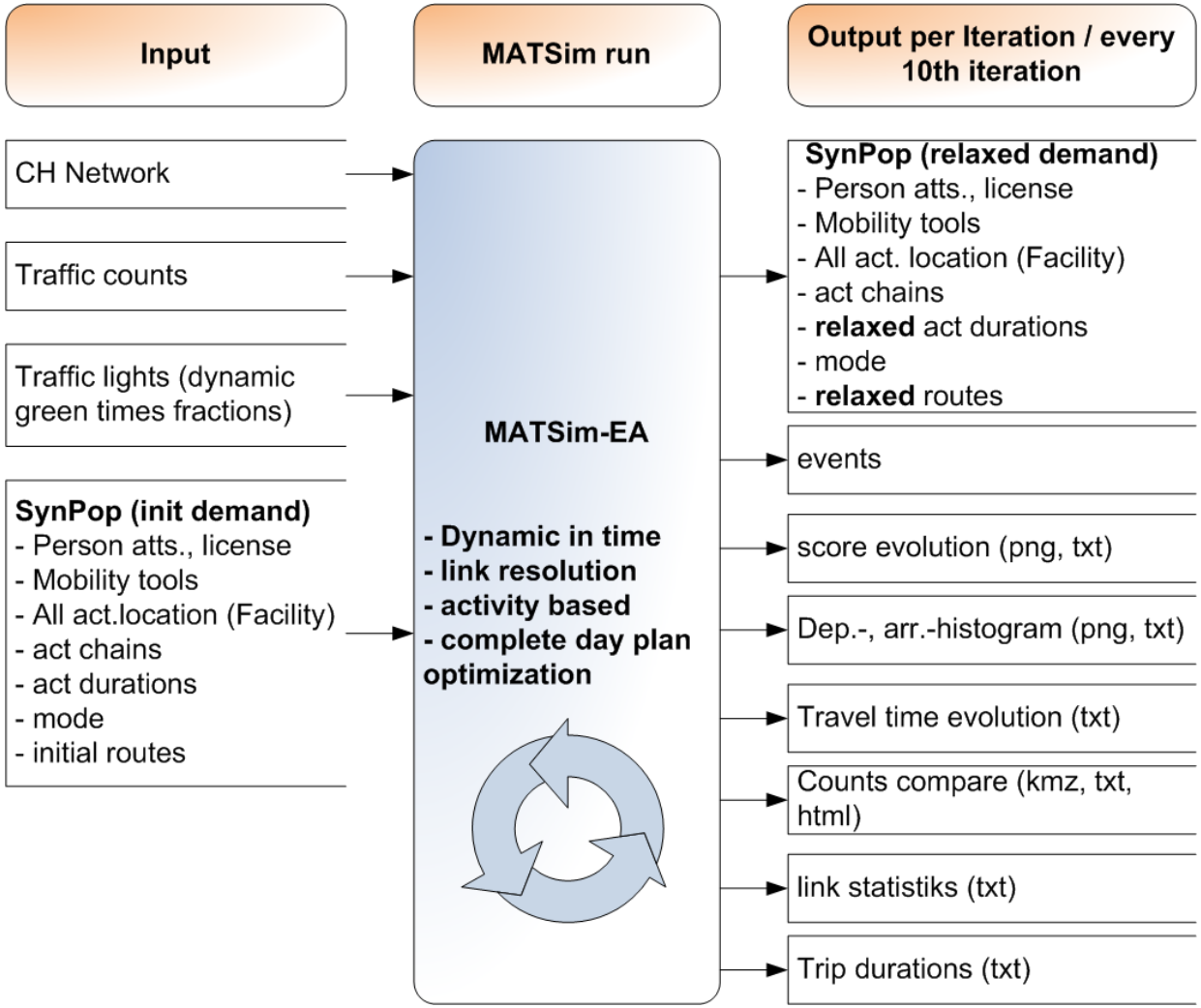
Target Definition & Data Needs
Specify the Processes (Relaxation)



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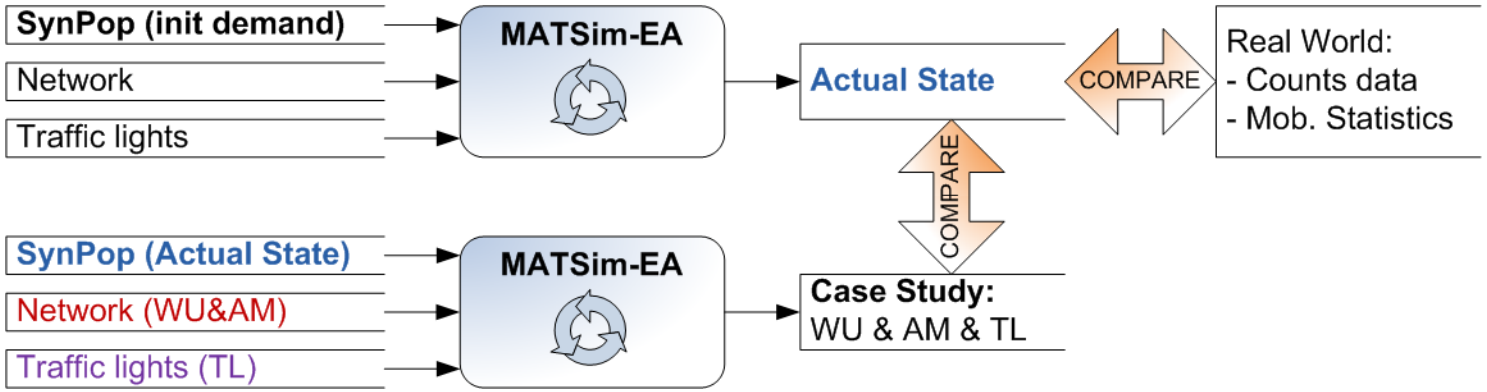
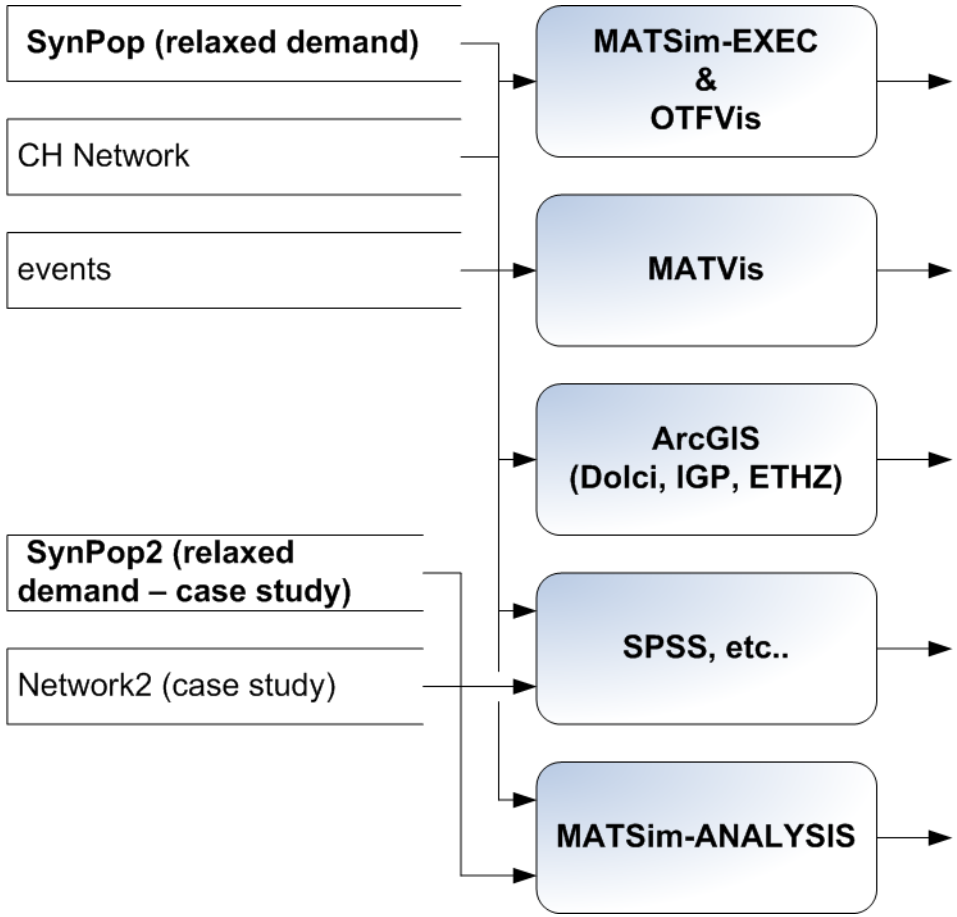
Target Definition & Data Needs
Specify the Processes (Comparisons)



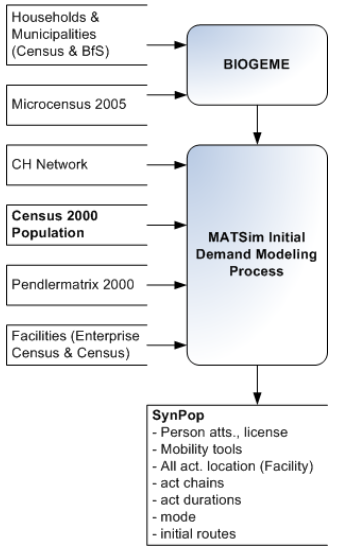
Target Definition & Data Needs
Specify the Processes (Post Process Steps)



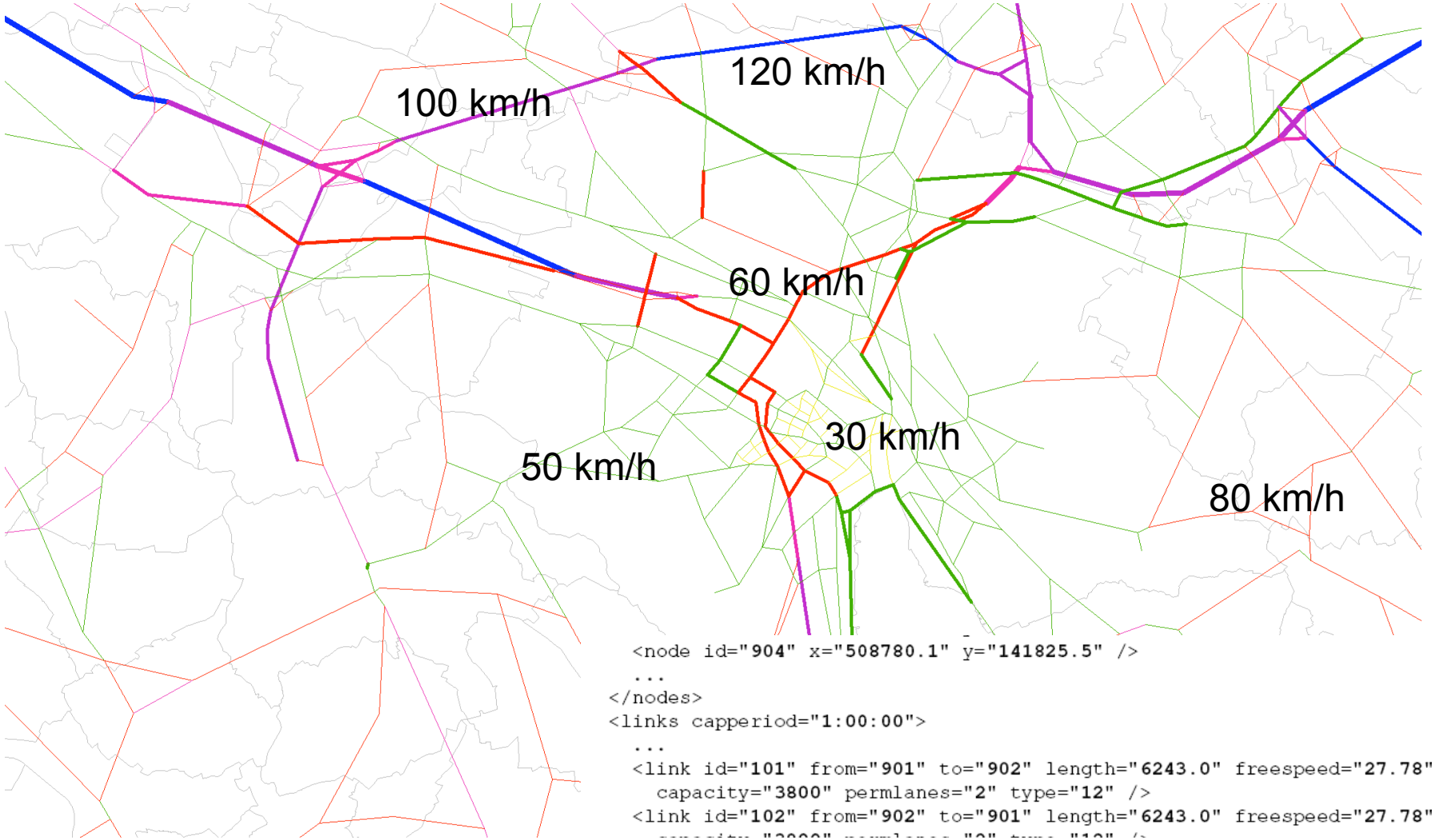
- Tables
- Figures
- Slides
- Movies

MATSim
Multi-Agent Transport Simulation

Scenario setup (actual state and case studies)



Scenario setup (actual state and case studies)
Network (actual state)

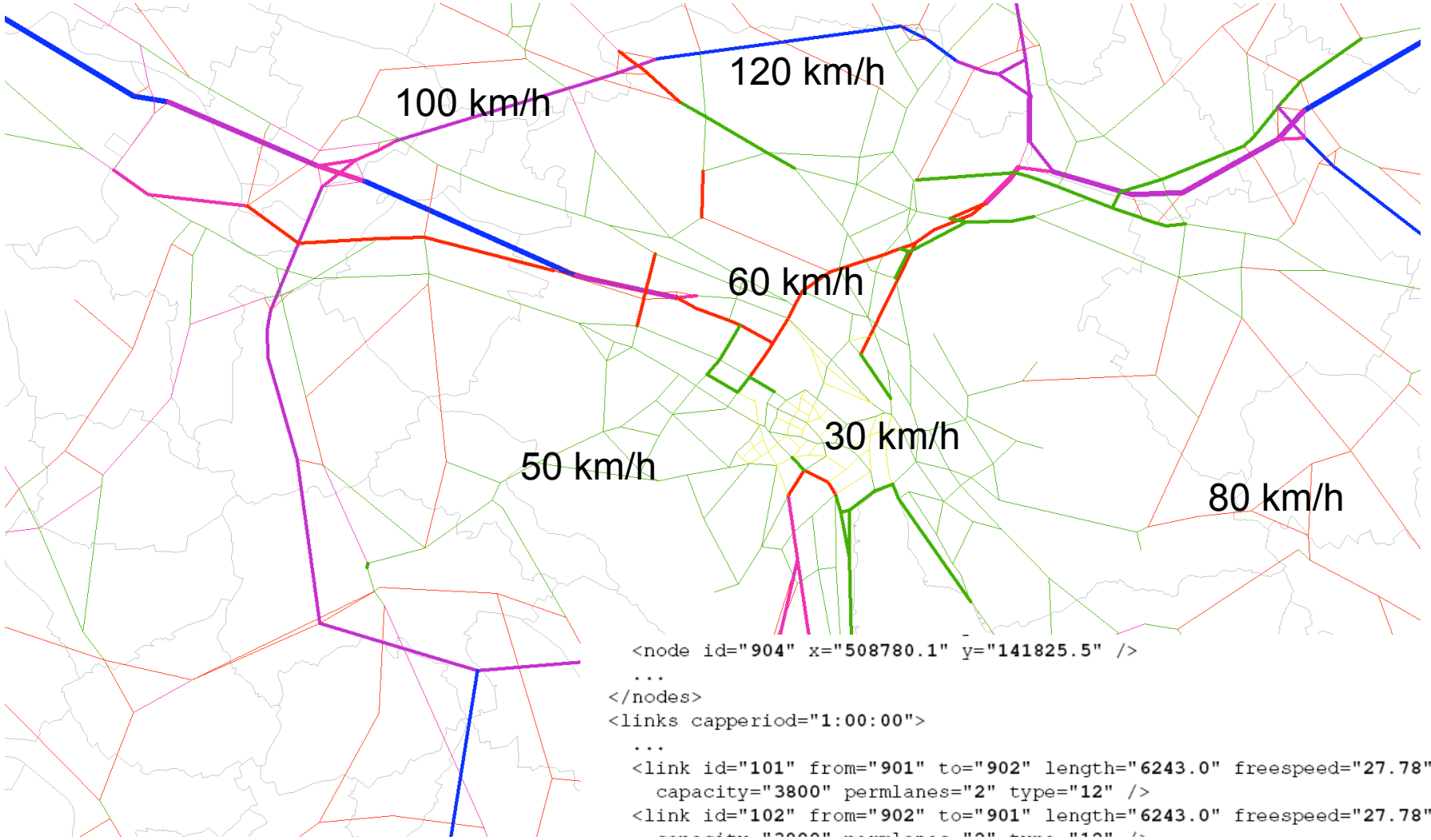



```
  <node id="904" x="508780.1" y="141825.5" />
  ...
</nodes>
<links capperiod="1:00:00">
  ...
  <link id="101" from="901" to="902" length="6243.0" freespeed="27.78"
    capacity="3800" permlanes="2" type="12" />
  <link id="102" from="902" to="901" length="6243.0" freespeed="27.78"
```

colors: free speed, thickness: # lanes

MATSim
Multi-Agent Transport Simulation

Scenario setup (actual state and case studies)
Network (case study)




```
  <node id="904" x="508780.1" y="141825.5" />
  ...
</nodes>
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    capacity="3800" permlanes="2" type="12" />
  <link id="102" from="902" to="901" length="6243.0" freespeed="27.78"
```
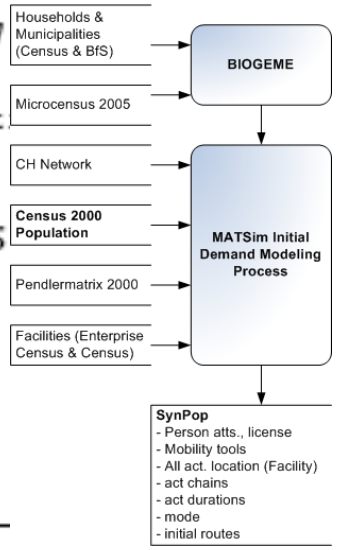

colors: free speed, thickness: # lanes

MATSim
Multi-Agent Transport Simulation

Scenario setup (actual state and case studies)
Initial Demand (plans.xml file)

```
<plans name="example plans">
  ...
  <person id="393241" sex="f" age="27" license="yes" car_avail="always"
    employed="yes">
    <travelcard type="ch-HT">
    <plan>
      <act type="home" link="101" facility="712" start_time="00:00"
        dur="07:00" end_time="07:00" />
      <leg mode="car" dept_time="07:00" trav_time="00:25" arr_time="07:25">
        <route>1932 1933 1934 1947</route>
      </leg>
      <act type="work" link="844" facility="123" start_time="07
        dur="09:00" end_time="16:25" />
      <leg mode="car" dept_time="16:25" trav_time="00:14" arr_t
        <route>1934 1933</route>
      </leg>
      <act type="home" link="101" facility="712" start_time="16
        dur="07:21" end_time="24:00" />
    </plan>
    <plan ...
  </person>
  ...
</plans>
```



MATSim
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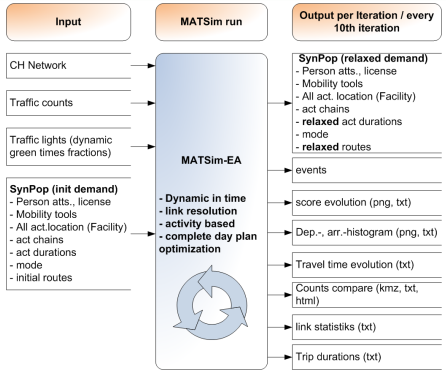
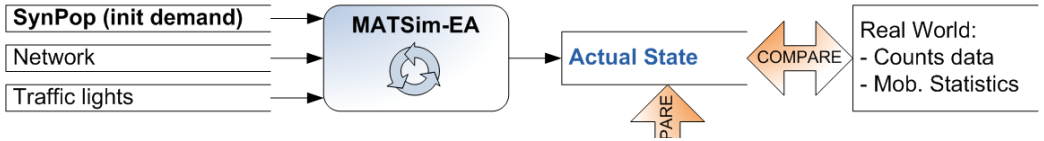
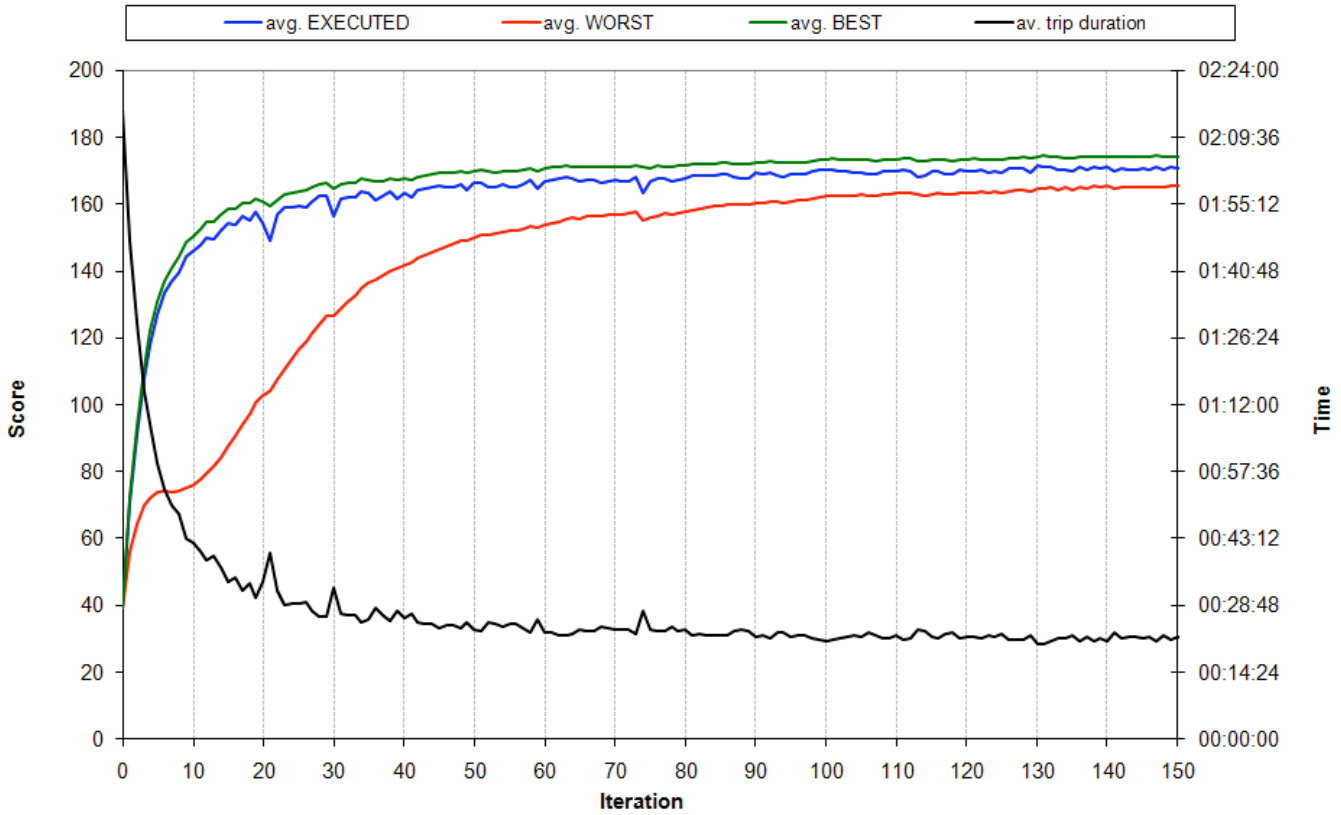


Calculation of the actual state with MATSim



Calculation of the actual state with MATSim
Monitor the run

- score evolution file; Departure and arrival histograms; Trip travel distances; Trip travel times



- ➔ If it does not fit yet, play around with the config parameters

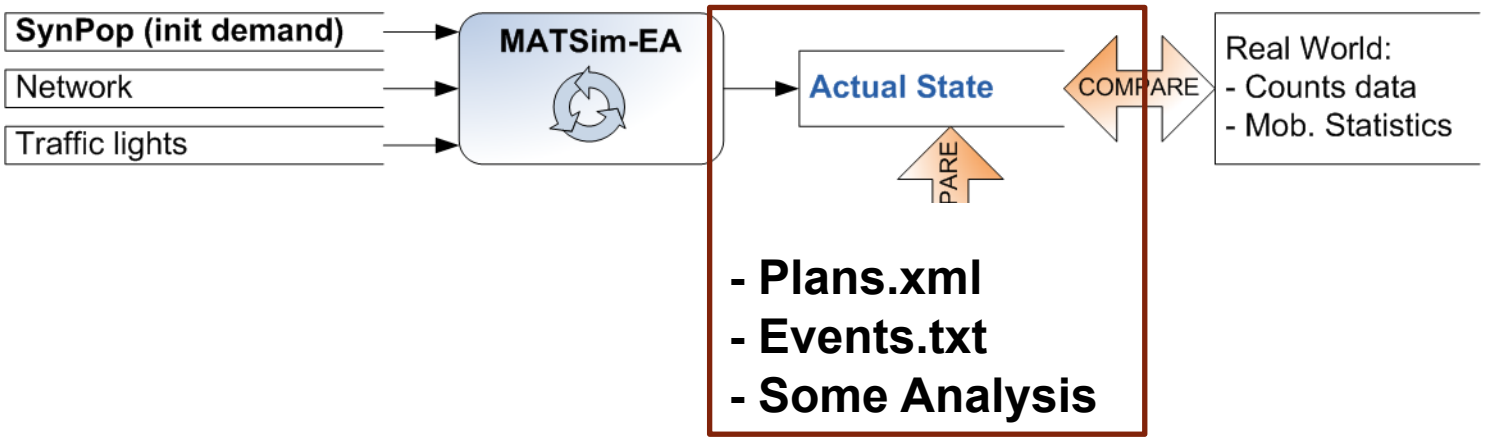
MATSim
Multi-Agent Transport Simulation

Calculation of the actual state with MATSim
Decide when you are done

- Scores do not change much anymore
- Travel times are feasible do not change much anymore
- Travel distances are feasible do not change much anymore
- Histograms are feasible do not change much anymore
- Compare with count stations
- ➔ [EXAMPLE OUTPUT] [HISTO EVOLUTION]
- ➔ A lot of data will be produced. KEEP them as long as you do not know if they are needed, but DELETE everything that is not necessary.
- ➔ Hint: define a large number of Iterations. You can stop the process whenever you want.

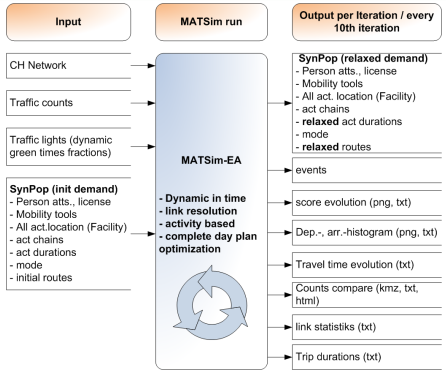
Calculation of the actual state with MATSim
Decide when you are done (2)

- Keep the final iteration. That‘s the solution!!!
- Intermediate iterations do NOT give you additional information. Use only for monitoring the optimization process

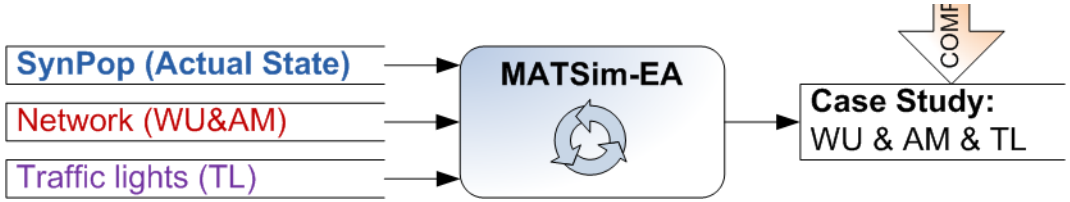


- [EXAMPLE OUTPUT]

MATSim
Multi-Agent Transport Simulation

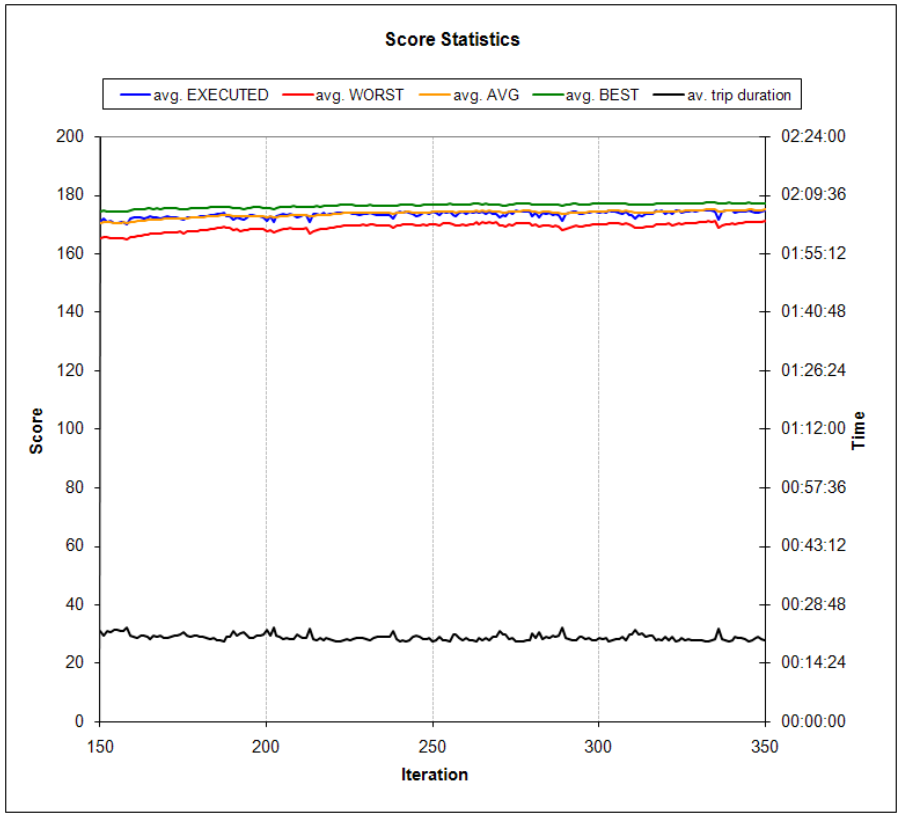


Calculation of the case study with MATSim



Calculation of the case study with MATSim
Monitor the run (again)

- score evolution file; Departure and arrival histograms; Trip travel distances; Trip travel times



- ➔ USE THE SAME CONFIGURATION AS BEFORE

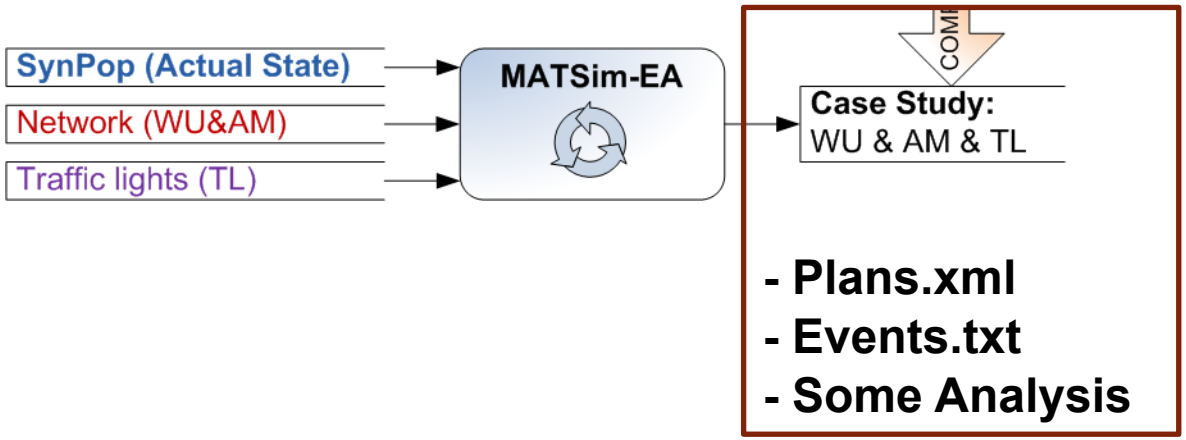
MATSim
Multi-Agent Transport Simulation

Calculation of the case study with MATSim
Decide when you are done

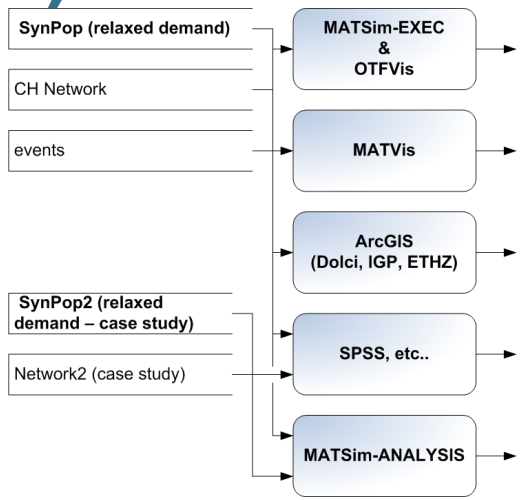
- Scores do not change much anymore
- Travel times do not change much anymore
- Etc...

Calculation of the case study with MATSim
Decide when you are done (2)

- Keep the final iteration. That‘s the solution!!!
- Intermediate iterations do NOT give you additional information. Use only for monitoring the optimization process.



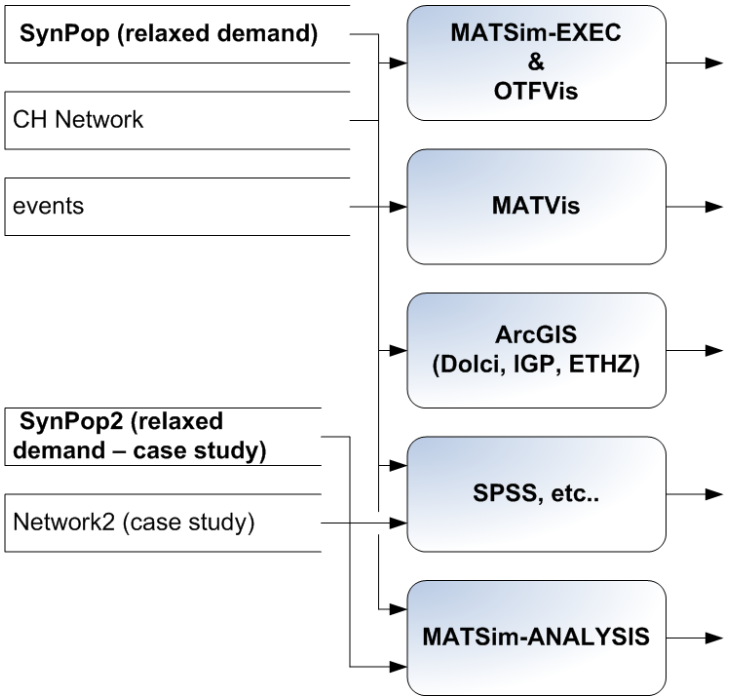
Analysis and comparisons (with and without MATSim)



MATSim
Multi-Agent Transport Simulation

Analysis and comparisons
What do we have now?

- Actual state:
  - Relaxed demand (150.plans.xml.gz)
  - Events (150.events.txt.gz)
  - (current) network.xml.gz
- Case Study:
  - Relaxed demand (240.plans.xml.gz)
  - Events (240.events.txt.gz)
  - (future) network.xml.gz



MATSim
Multi-Agent Transport Simulation

Analysis and comparisons
Events (big but cool)

- Complete, detailed, dynamic agent tracking

Source: Rieser (2008)

- ➔ [EXCEL EXAMPLE]

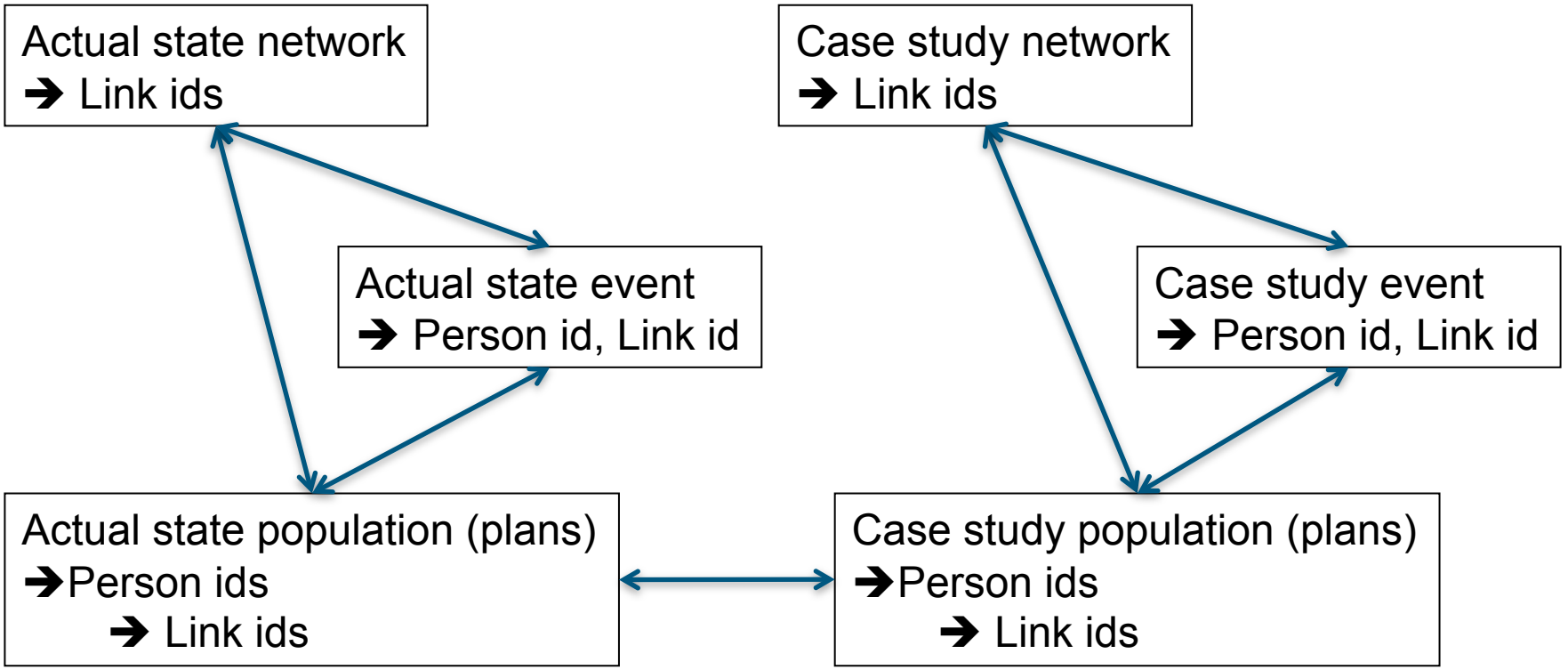
MATSim
Multi-Agent Transport Simulation

Analysis and comparisons
Plans (What kind of synthetic Person is it?)

```
<plans name="example plans">
  ...
  <person id="393241" sex="f" age="27" license="yes" car_avail="always"
    employed="yes">
    <travelcard type="ch-HT">
    <plan>
      <act type="home" link="101" facility="712" start_time="00:00"
        dur="07:00" end_time="07:00" />
      <leg mode="car" dept_time="07:00" trav_time="00:25" arr_time="07:25">
        <route>1932 1933 1934 1947</route>
      </leg>
      <act type="work" link="844" facility="123" start_time="07:25"
        dur="09:00" end_time="16:25" />
      <leg mode="car" dept_time="16:25" trav_time="00:14" arr_time="16:39">
        <route>1934 1933</route>
      </leg>
      <act type="home" link="101" facility="712" start_time="16:39"
        dur="07:21" end_time="24:00" />
    </plan>
    <plan ...
  </person>
  ...
</plans>
```

MATSim
Multi-Agent Transport Simulation

Analysis and comparisons
How is the data connected?



Analysis and comparisons
Network.xml → GIS Shape file

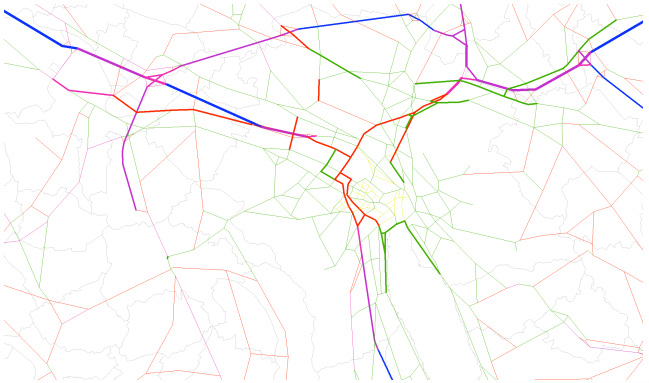
- Version 1 (Write Shapefile directly from MATSim):

```
FeatureGeneratorBuilder builder = new FeatureGeneratorBuilder(network);

builder.setFeatureGeneratorPrototype(LineStringBasedFeatureGenerator.class);

builder.setWidthCalculatorPrototype(LanesBasedWidthCalculator.class);

new Network2ESRIShape(network,outputDir+"/output_links.shp",builder).write();
```

- Version 2 (Write Table for ETGeoWizard):

```
NetworkWriteAsTable nwat = new NetworkWriteAsTable(outputDir);

nwat.run(network);

nwat.close();
```

- ➔ Visualization in ArcGIS
- ➔ [ARCGIS EXAMPLE]



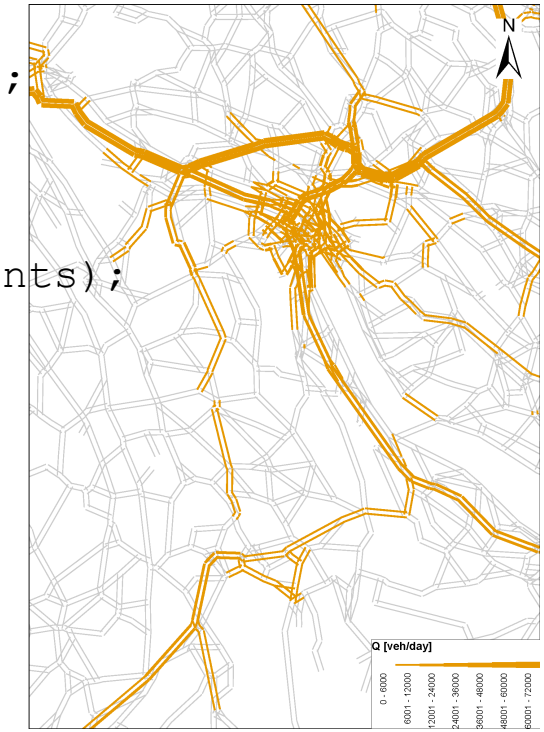
MATSim
Multi-Agent Transport Simulation

Analysis and comparisons
Events ➔ write “Join Tables”

- MATSim events parser and MATSim events handler (in "playground.toronto.example" MATSim JAVA package)

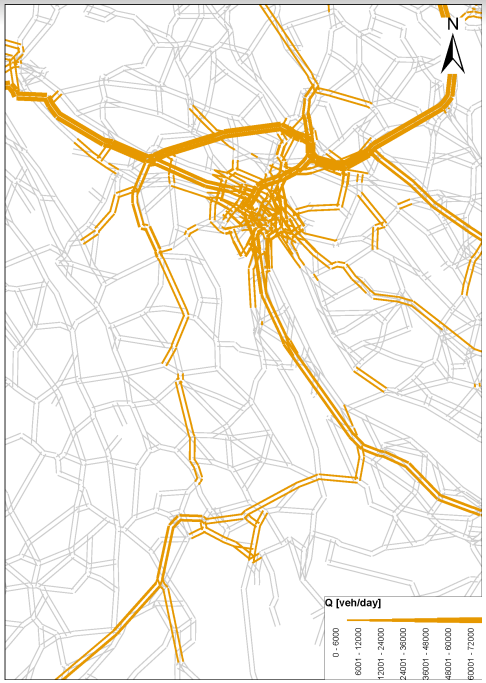
```
Events events = new Events();

DailyLinkVolumeCalc dlvc = new DailyLinkVolumeCalc();

events.addHandler(dlvc);

EventsReaderTXTv1 reader = new EventsReaderTXTv1(events);

reader.readFile("events.txt.gz");

dlvc.writeTable();
```

- ➔ [EXAMPLE]

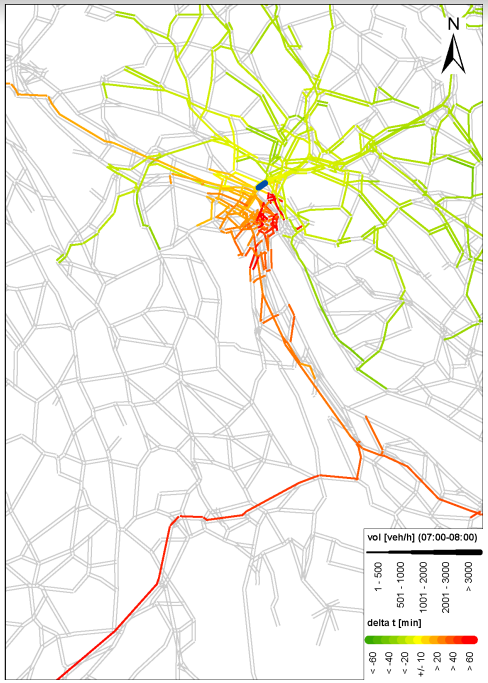


MATSim
Multi-Agent Transport Simulation

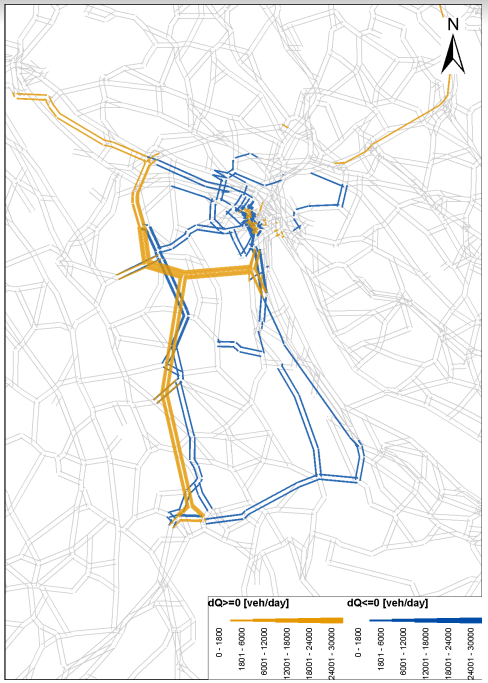
Analysis and comparisons
Network Join Tables Examples



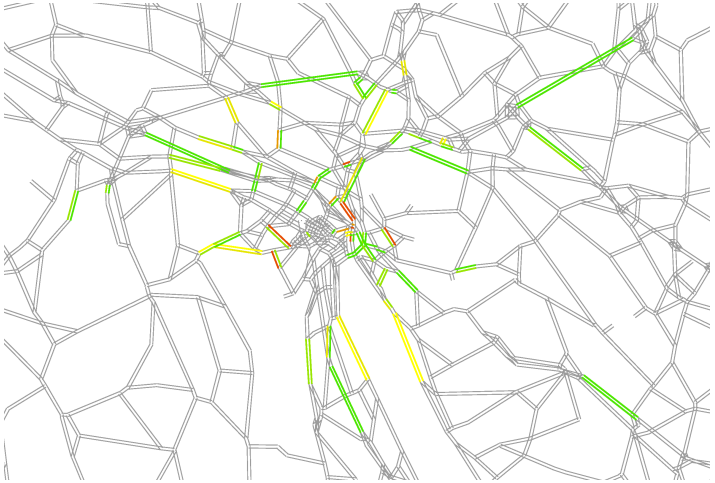
Link volumes



„Spiders“



Link volume comparison



Traffic counts comparison

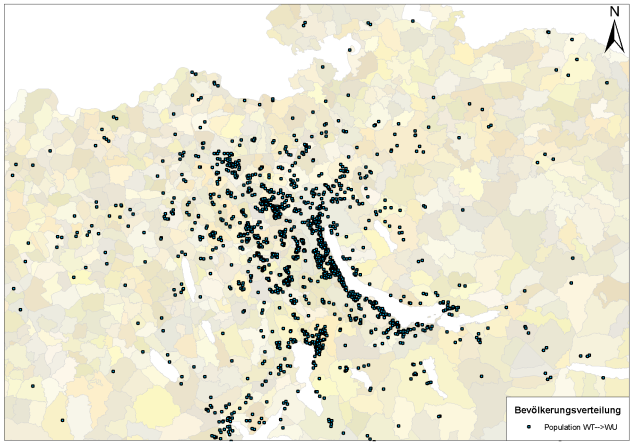
MATSim
Multi-Agent Transport Simulation

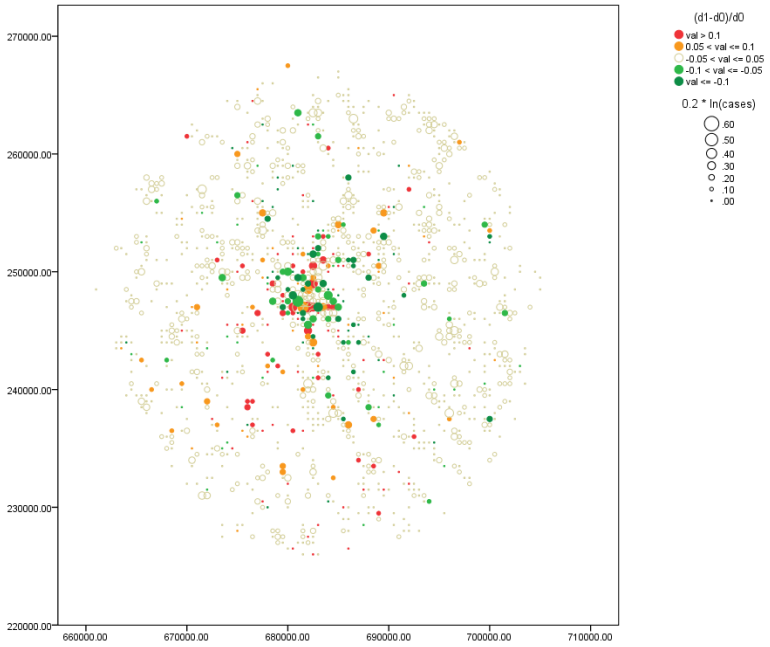
Analysis and comparisons
Person Analysis ➔ Write x,y,attributes-tables

	Ist-Zustand	WU/WT	Veränderung	
Grenzquerende Reisende (~57'600 Personen)				
durchschn. Tagesnutzen	64.84	67.78	104.53 %	▲
durchschn. Wegreisezeit	02:13:14	02:10:04	97.62 %	■
durchschn. Wegdistanz [km]	189.77	189.66	99.94 %	■
Census Bevölkerung (~614'800 Personen)				
durchschn. Tagesnutzen	183.72	184.91	100.65 %	■
durchschn. Wegreisezeit	00:16:22	00:14:41	89.71 %	▲
durchschn. Wegdistanz [km]	12.35	12.34	99.90 %	■
Wechsler WT→WU (~21'300 Personen)				
durchschn. Tagesnutzen	162.86	168.20	103.28 %	▲
durchschn. Wegreisezeit	00:46:18	00:37:56	81.93 %	▲
durchschn. Wegdistanz [km]	41.13	42.59	103.55 %	▼
Anlieger WT (~1'500 Personen)				
durchschn. Tagesnutzen	164.68	164.02	99.61 %	■
durchschn. Wegreisezeit	00:21:54	00:18:38	85.08 %	▲
durchschn. Wegdistanz [km]	8.57	8.45	98.57 %	■

▲: Gewinn von Nutzen; Reduktion von Reisezeit, resp. Reisedistanz
▼: Verlust von Nutzen; Erhöhung von Reisezeit, resp. Reisedistanz
■: Quasi unveränderte Nutzen, Reisezeiten oder Reisedistanzen (±2.5 %)

Statistics





Winners / Loosers

„Route Switchers“

MATSim
Multi-Agent Transport Simulation

Summary / Discussion

Summary / Discussion

- MATSim is truly a large scale, time dynamic, micro-simulation
  - Events delivers a large and very detailed information set.
  - Plans make it possible to connect trips and activities with socio-demographics
  - Network (and facilities) map the outcome to coordinates.
- ➔ Sweet!
- But:
  - Programming is necessary. ➔ More about it Thursday morning
  - Not many standard analysis tools are available already in the MATSim toolkit ➔ Feel free to participate!
  - GIS visualization is not part of MATSim ➔ external software needed

Thanks for your attention!

Questions? Comments?

http://matsim.org/
http://www.ivt.ethz.ch/vpl/publications/reports/ab550.pdf (static)
http://www.ivt.ethz.ch/vpl/publications/reports/ab550a.pdf (interactive)