

Preferred citation style

Axhausen, K.W. (2009) Demand and user behaviour: Suggestions for a research agenda, presentation at *Transport and Crowd Management Workshop 2010*, Jeddah, May 2010.

Demand and user behaviour: Suggestions for a research agenda

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May 2010

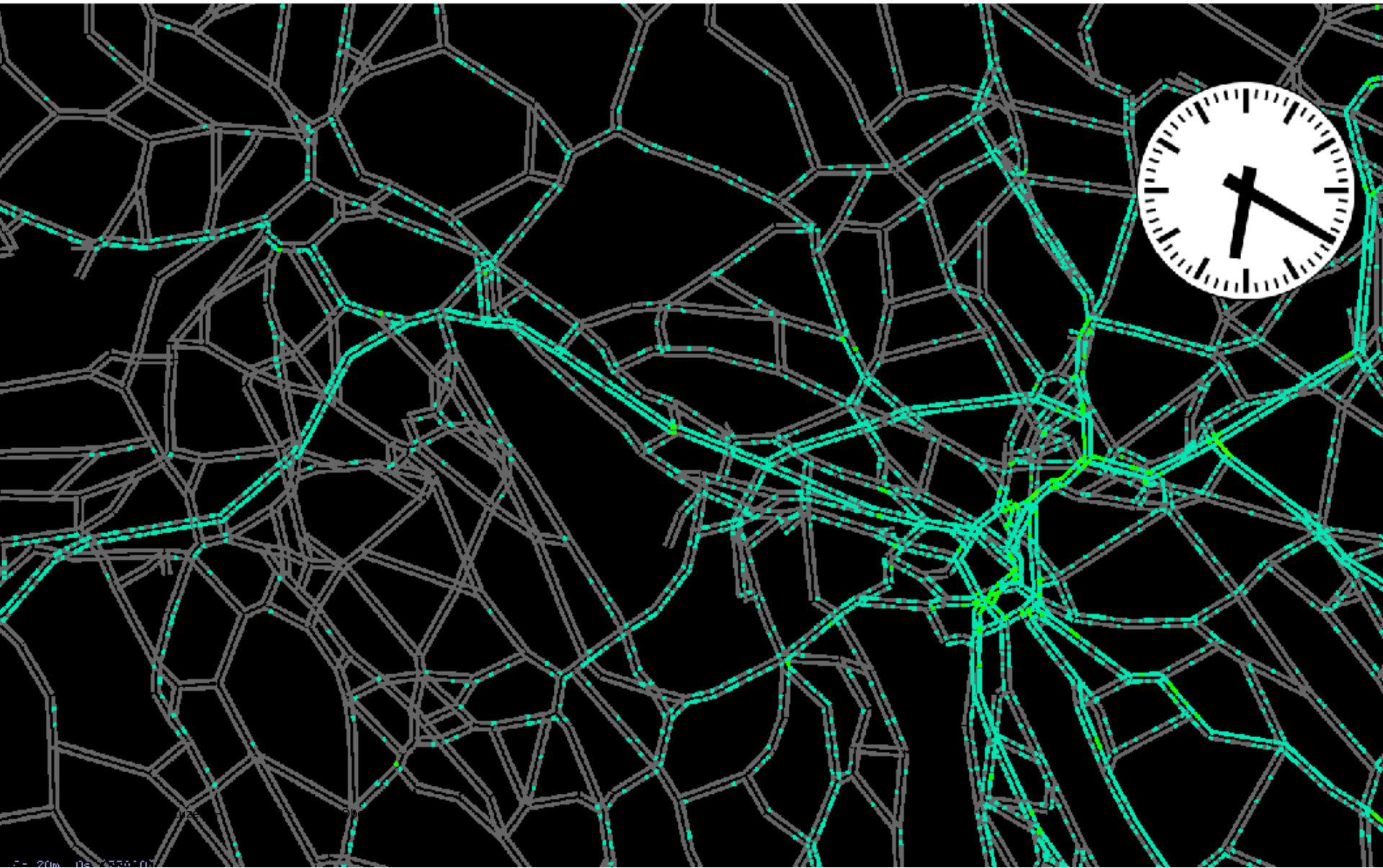
 Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Starting point

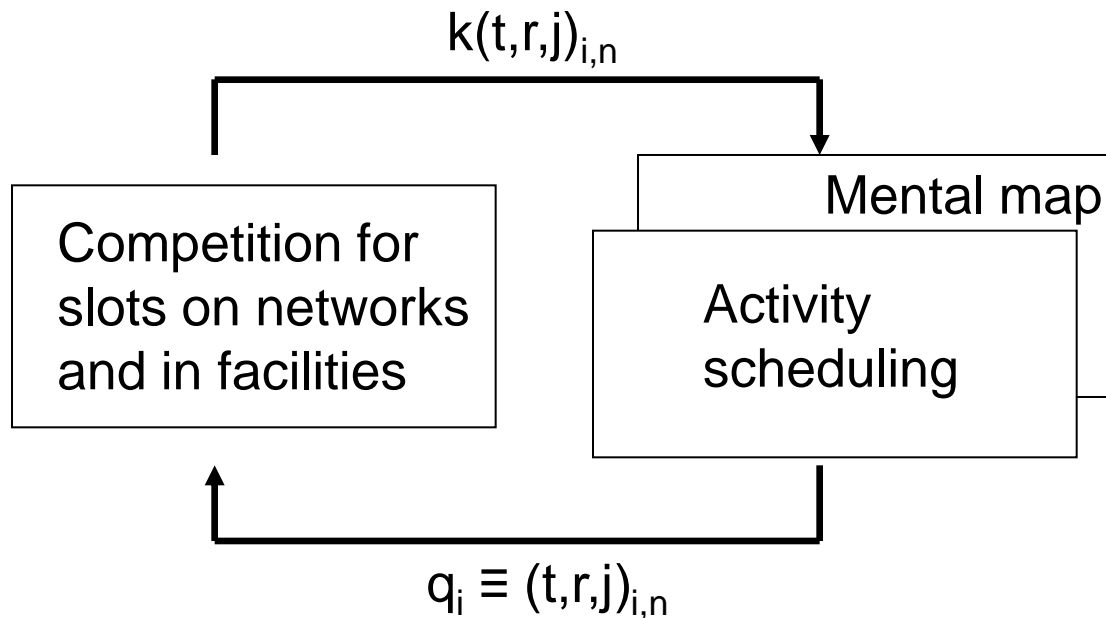
A peak hour in Zürich (modelled with MATSim)



Activity scheduling

- Number and type of activities
- Sequence of activities
 - Start and duration of activity
 - Composition of the group undertaking the activity
 - Expenditure division
 - Location of the activity
- Movement between sequential locations
 - Location of access and egress from the mean of transport
 - Parking type and location
 - Vehicle/means of transport
 - Route/service
 - Group travelling together
 - Expenditure division

Learning approach of the generic one-day transport model

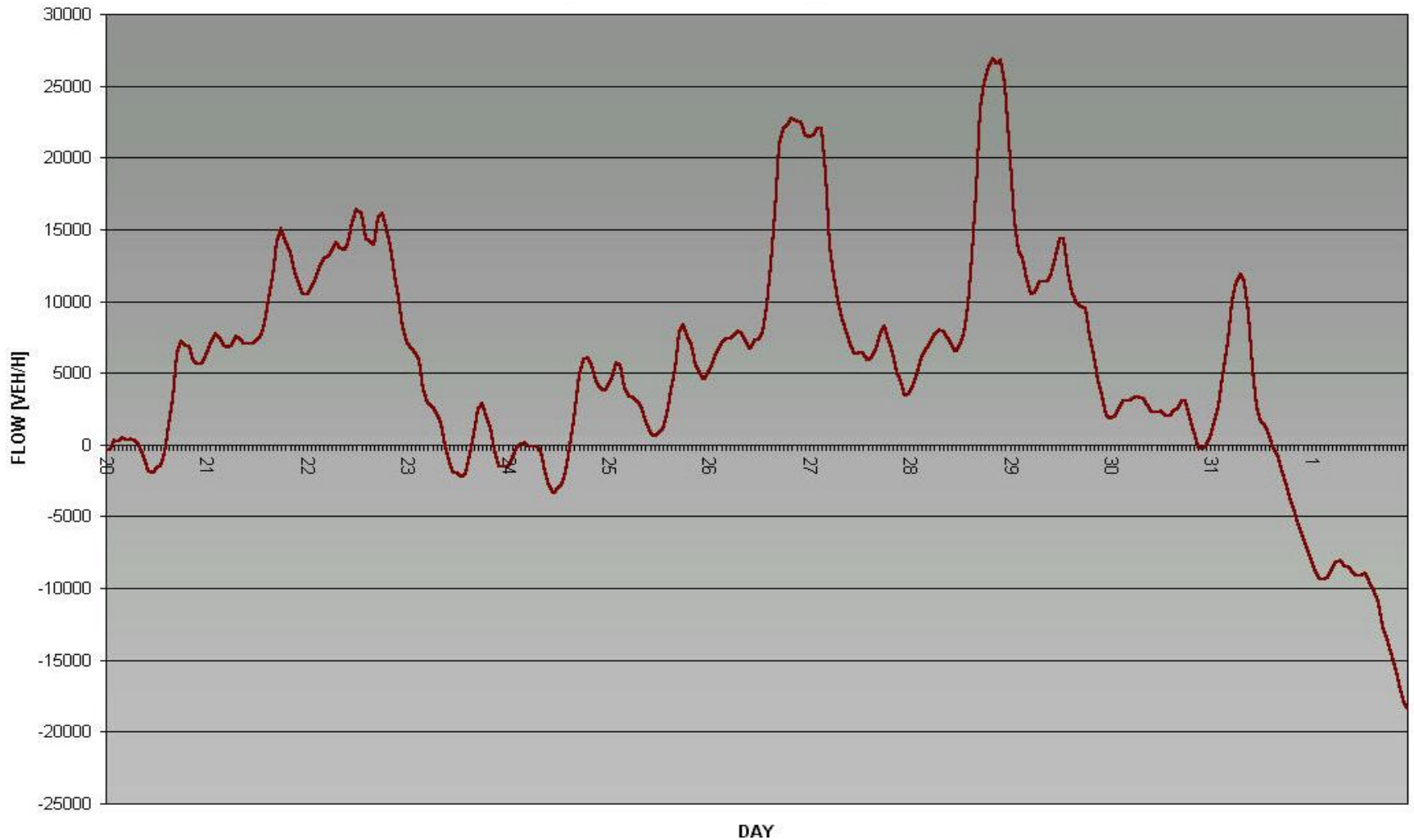


Relevant individual long(er) term choices

- Social network geography
- Social commitments
- Amount and type(s) of occupation
 - Work location(s)
 - School location
 - Home location
 - Mobility tools
 - Discount cards
 - Season tickets
 - Vehicles (by body type, fuel, energy efficiency)

Makkah: External cordon – Accumulated balance

Ramadan



Challenge 1: the medium term “project”

- Meaningful sets of coherent activities over multiple days:
 - Pilgrimage, e.g. Hajj, but others as well
 - Vacation
 - Conference

 - Work assignment abroad

 - Courses, like learning to sail, fly, etc.
 - Renovating a house or apartment

Challenge 2: Dynamics of the year

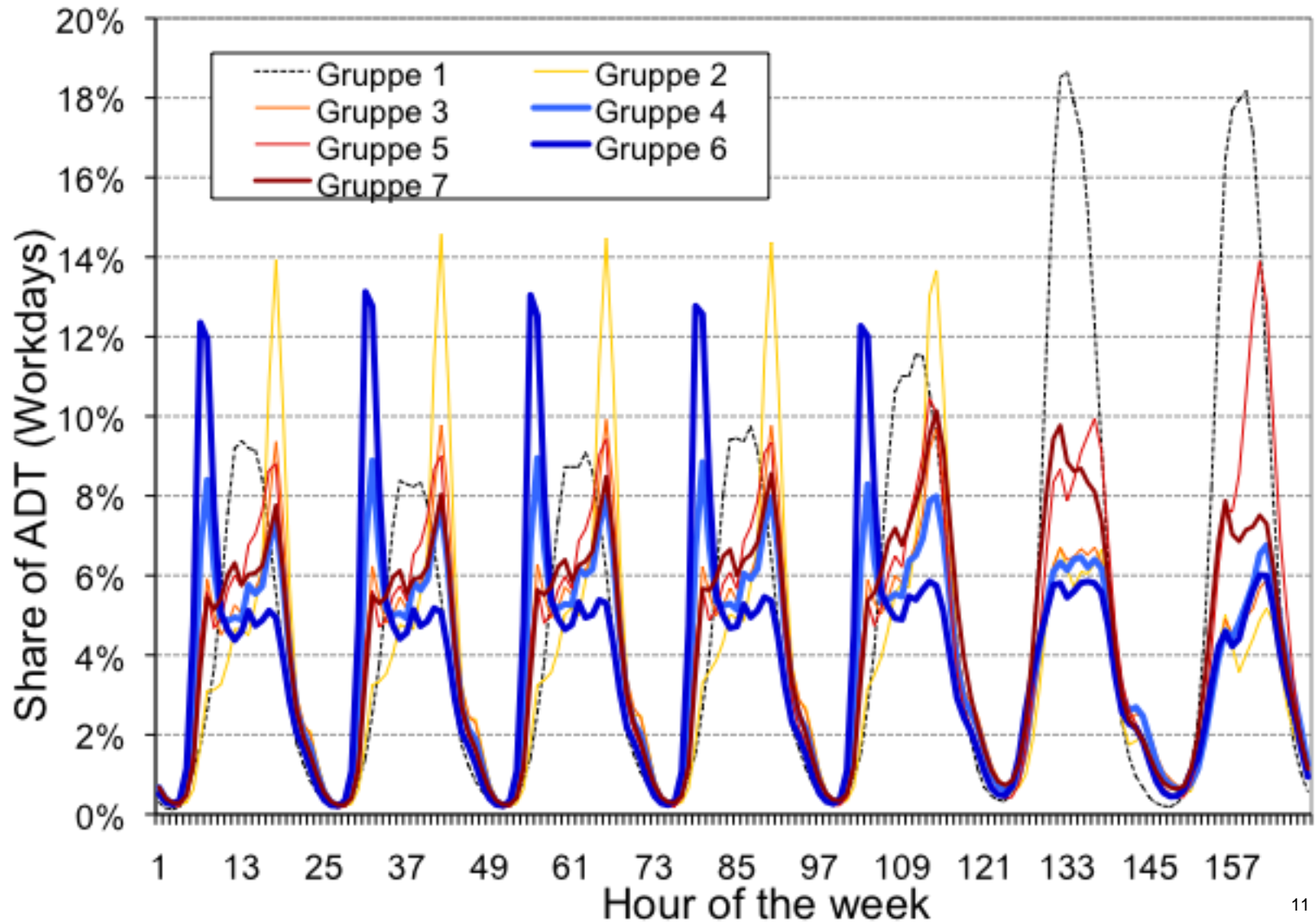
The combination of

- Weekly rhythms
- Annual rhythms

Overlaid with

- Recurring, but moving events
- One – off events

An example weekly rhythms: Swiss inter-urban traffic



Challenge 3: Scheduling the year(s)

Understanding the

- Trade-offs across medium-term time-horizons
- Coordination within the social networks

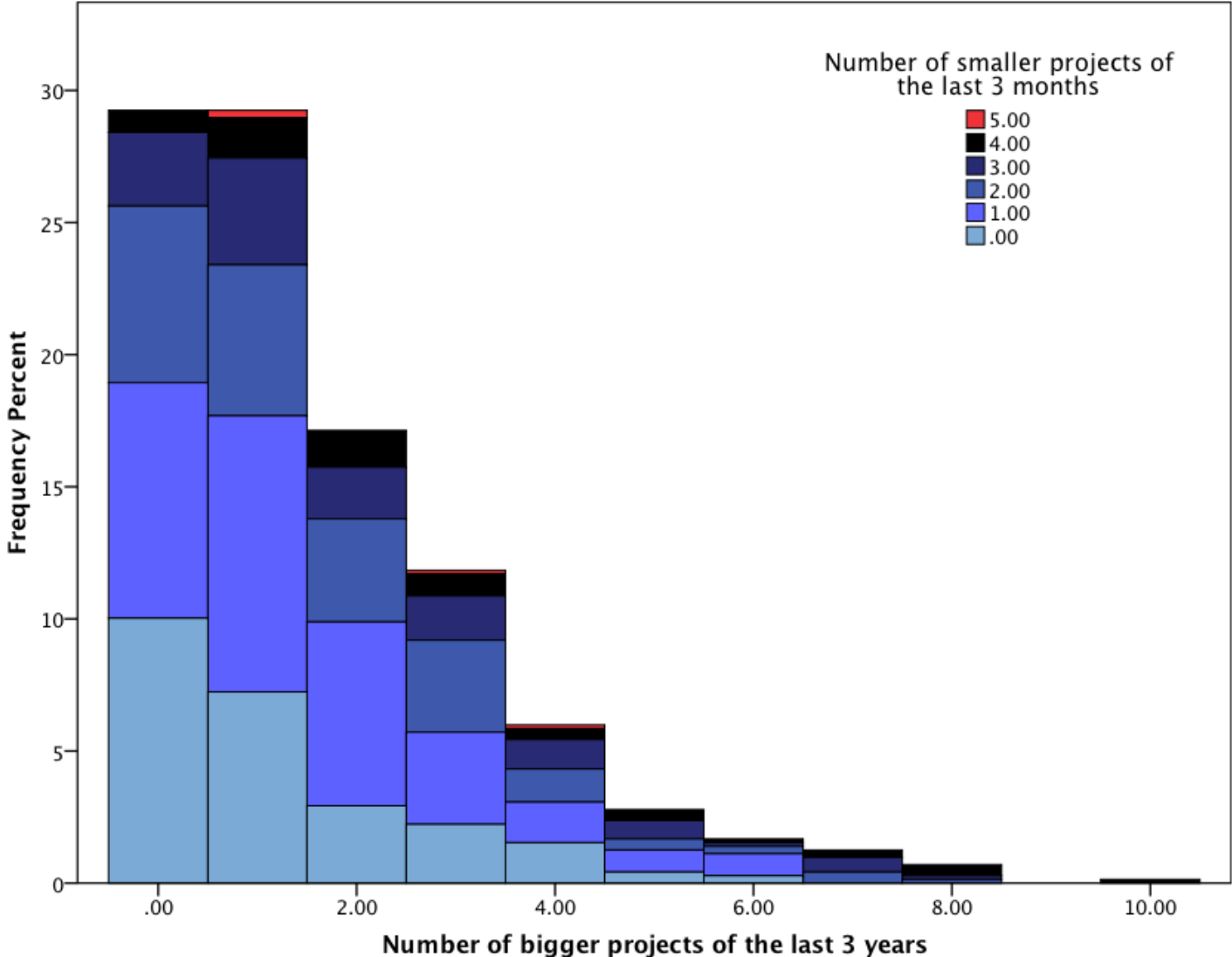
And their integration with

- Expected and planned income streams (and therefore saving and investment behaviour)
- Time use expectation over the longer term

New questions: Measurement

- How to observe “projects” ?
- How to observe longer term ambitions ?
- How to observe social networks ?

Asking for projects: Univox 2009 in Switzerland



New questions: Choice modelling

Understanding the

- Choice sets
 - Medium term at high resolution
 - Longer term: Permissible options;
- Strategic behaviour (to open up alternatives)
- Household interactions
- Social network dynamics

New questions: Which simulation ?

- Path-dependent or equilibrium ?
 - Open ended simulation of the system
- Social learning mechanisms ?
- Creation of alternatives ?
 - Services
 - Infrastructure
- Link with real time control

A possible focus ?

- Research on medium – term projects
- Research on open-ended simulations
- Research on dynamic equilibria

More information

www.ivt.ethz.ch

www.matsim.org

Reference

Makkah Western Gateway Transport and Traffic Study (Without date) Task 2.6 – 2.7: Makkah Transport Modeling Study – Results, IBI Group, DMJM Harris

Annex: MATSim today - A brief summary

MATSim: A GNU public licence software project

Main partners

- TU Berlin (Prof. Nagel)
- ETH Zürich
- Axon Active (Dr. Balmer, Rieser)

Coordination via:

- User meeting
- Developer meeting

Help for new users

- Tutorial (e.g. Mai 2010)
- www.matsim.org

MATSim evolutionary process

Read scenario

Generate initial demand (schedules)

Do until convergence

- Select schedule to execute with a biased random approach

- Execute schedules (traffic flow simulation)

- Score all schedules

- Add a new schedule to a random subset of the agents

- Delete worst schedule, if necessary

Current Vickrey-type utility function

$$U_{plan} = \sum_{i=1}^n U_{act,i} + \sum_{i=2}^n U_{trav,i-1,i}$$

$$U_{act,i} = U_{dur,i} + U_{late.ar,i}$$

2009 MATSim: Initial demand

Population: Census-based (sample); Through traffic from surveys

- **Number, type, sequence and duration of activities:**
 - Conditional random draw from observed categorised MZ 2000-2005 distributions by person type
- **Location of work/school activity:**
 - Census commuter matrix
- **Location of secondary activities:**
 - Random constrained selection or
 - Capacity-constrained MNL within a time-space prism
- **Mode choice:**
 - MZ-based subtour MNL
- **Route choice:**
 - Improved A* shortest path

Capacity constrained MNL with time-space prism

Based on PPA-
Algorithm Scott, 2006

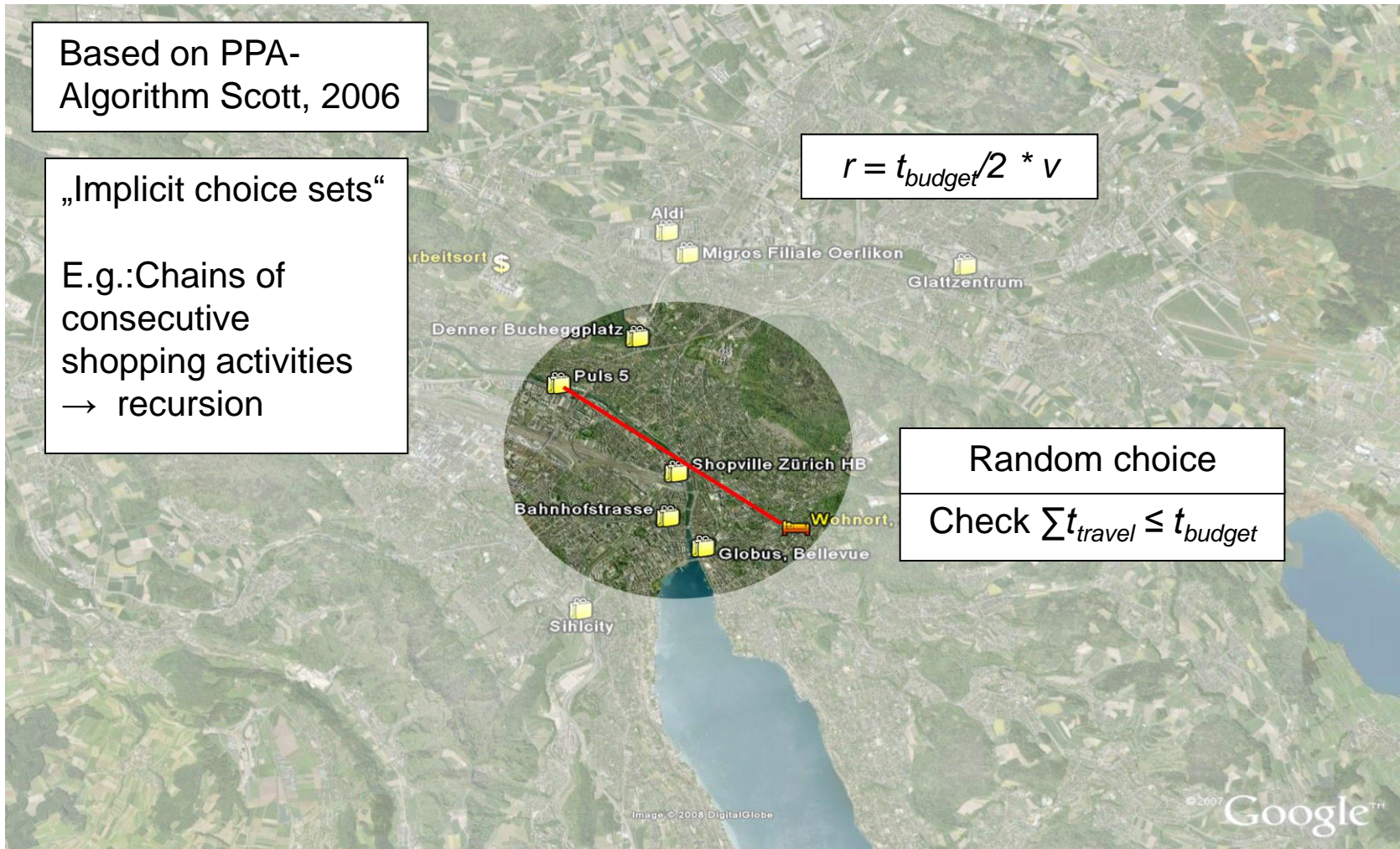
„Implicit choice sets“

E.g.: Chains of
consecutive
shopping activities
→ recursion

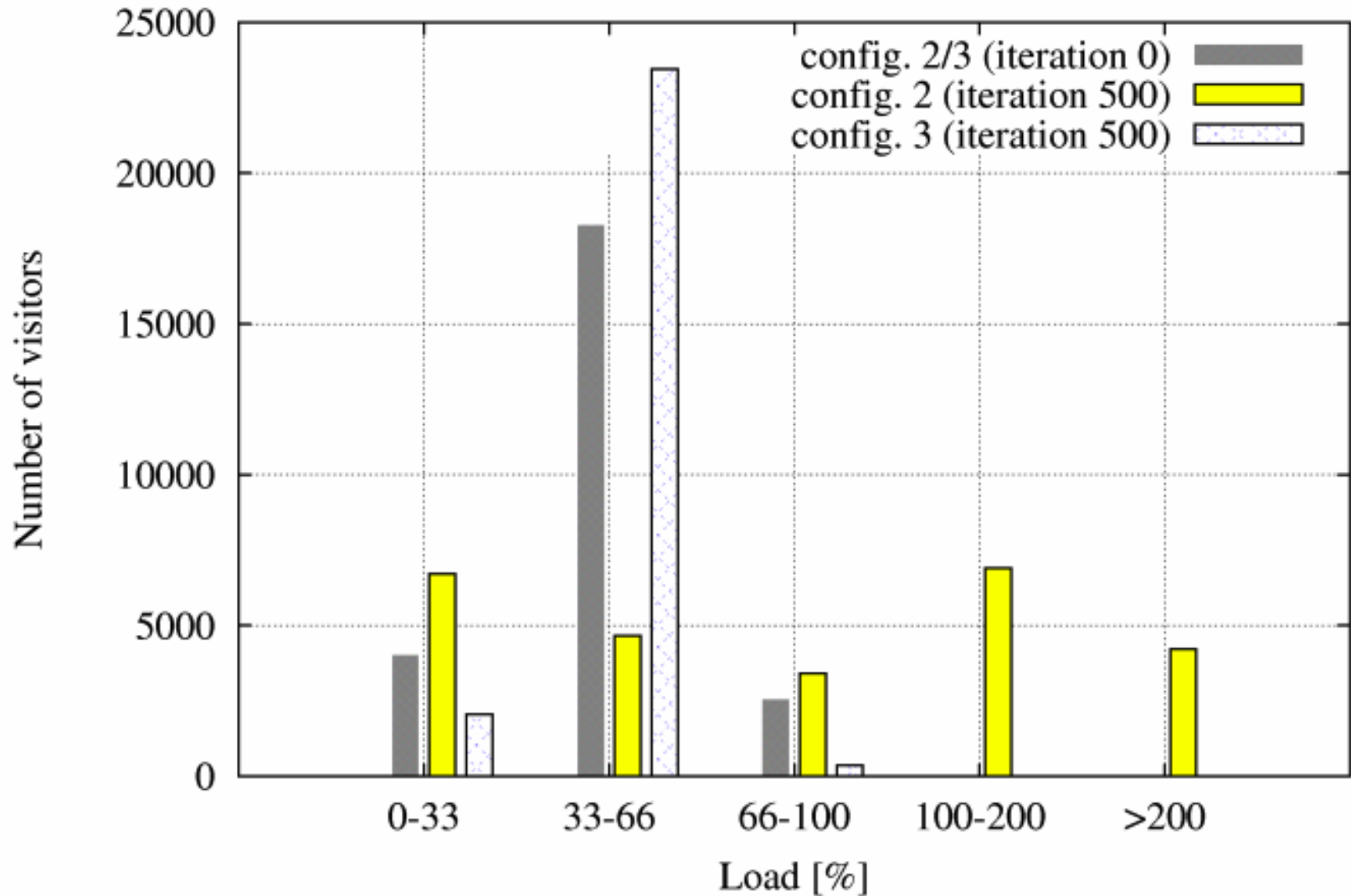
$$r = t_{budget} / 2 * v$$

Random choice

Check $\sum t_{travel} \leq t_{budget}$

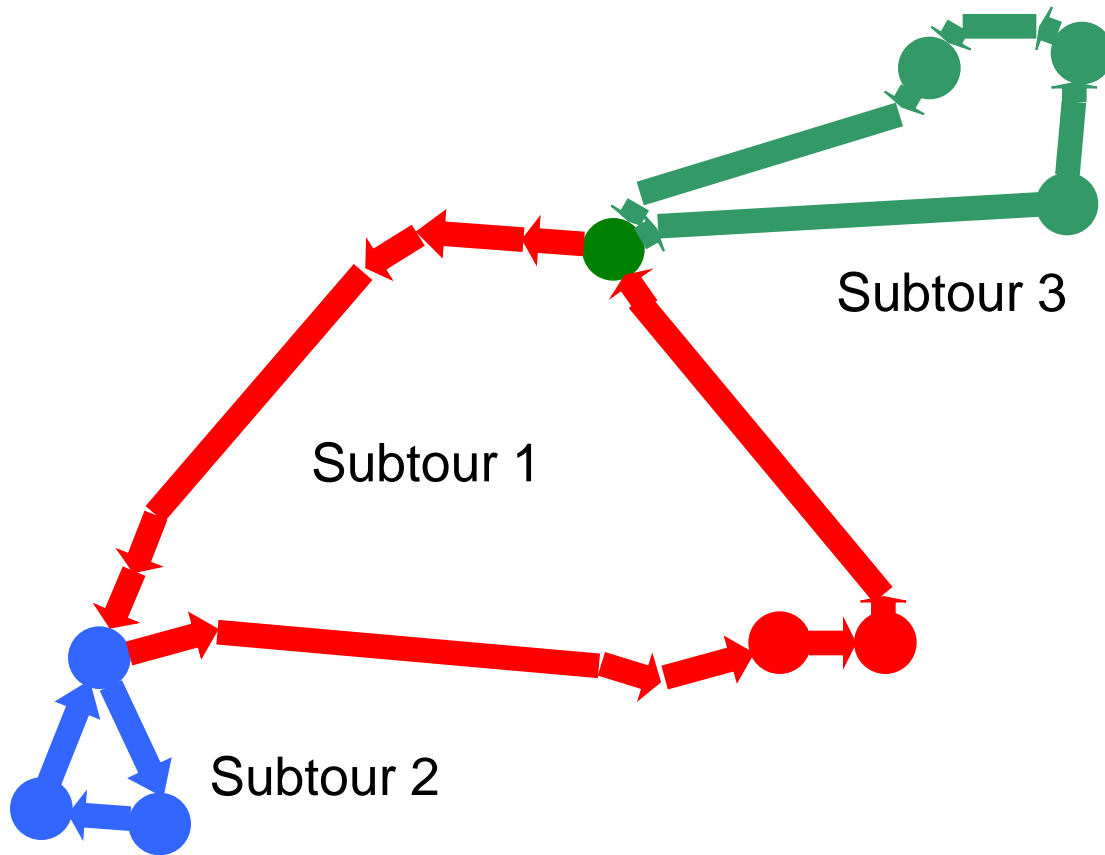


Capacity constrained MNL with time-space prism



Config 2/3 without/with capacity restraint

Mode choice: Subtour



2009 MATSim configuration: Iteration

- Number and type of activities
- Sequence of activities
 - **Start and duration of activity**
 - Random mutation
 - Planomat: GA optimiser
 - Composition of the group undertaking the activity
 - Expenditure division
 - **Location of the activity**
 - Location of access and egress from the mean of transport
 - Parking type
 - **Vehicle/means of transport**
 - **Route/service**
 - Group travelling together
 - Expenditure division

2009 MATSim: Traffic flow simulation

- Disaggregate simulation of car traffic
 - Detailed signal control
 - Detailed parking facilities
 - Detailed recharging facilities for electric vehicles
- Disaggregate simulation of public transport
- Disaggregate simulation of cyclists
- Disaggregate simulation of pedestrians

Java - queue-based traffic flow simulations

Approach	Number of cores	Signals	Public Transport
Event	Parallel	No	Pseudo
Event	Parallel	No	Zonal travel time matrices with transit stops
Event	Single	No	Pseudo
Time step	Single	No	No
Time step	Single	No	Pseudo
Time step	Single	No	Micro (driver; passengers)
Time step	Single	Yes	No

Modelling Switzerland 2009

2009 MATSim Switzerland: Configuration

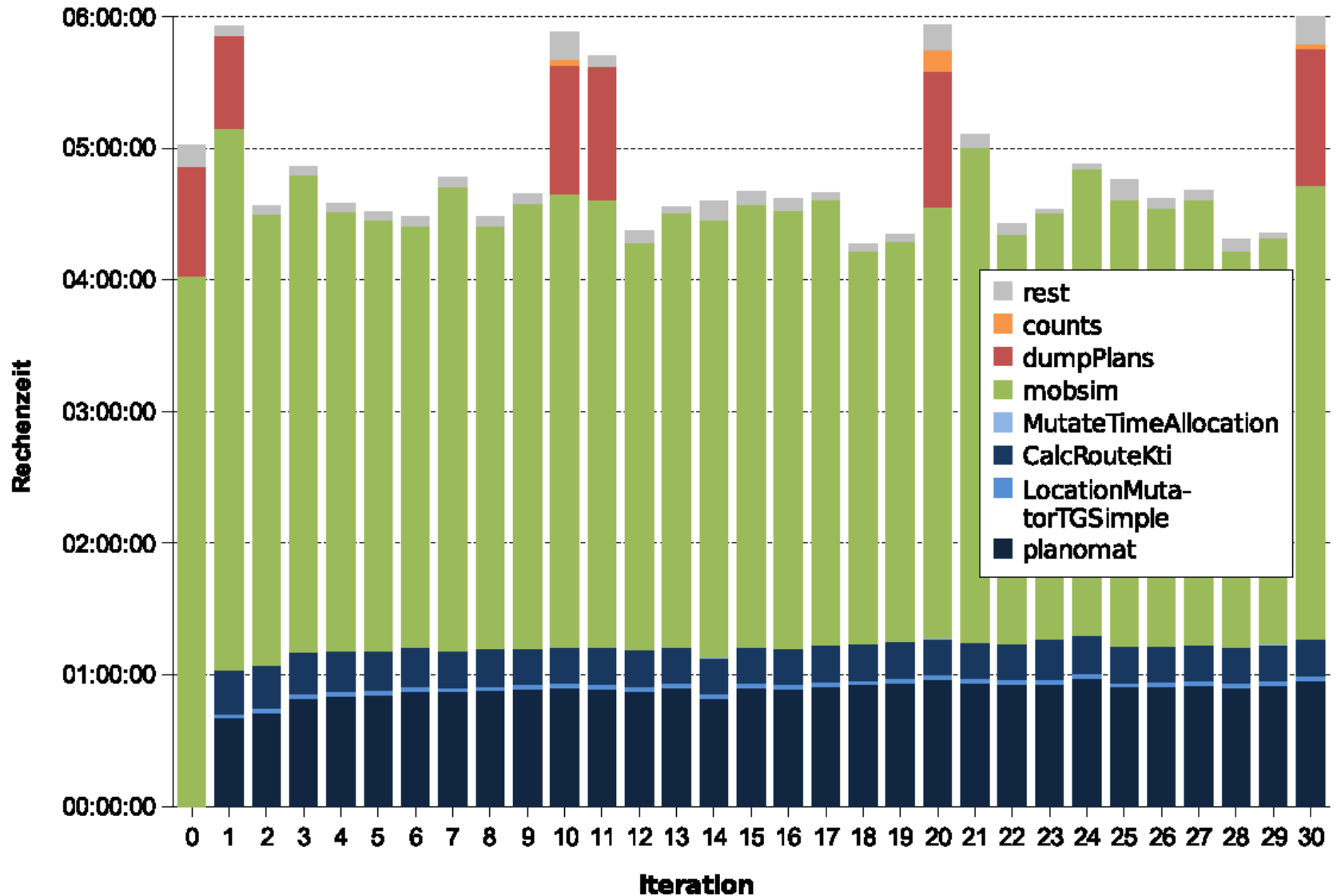
During the iterations:

- Optimisation of start time and duration of the activities
- Random location of the activity (with capacity constraint)
- Vehicle/means of transport at sub-tour level
- Optimal routes
- Event-oriented queue-based traffic flow simulation

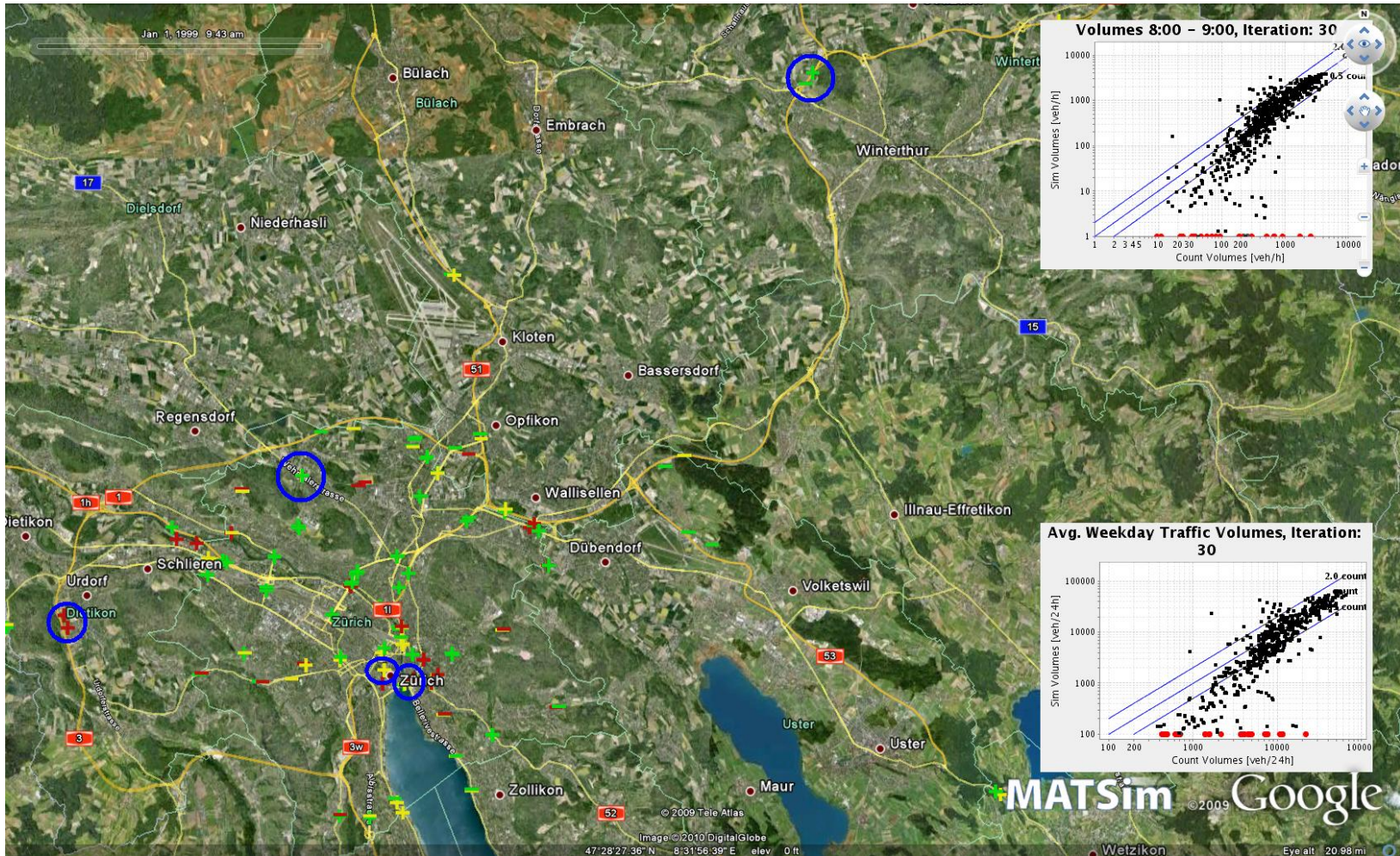
For a search space of:

- $6.0 * 10^6$ agents with 11 activity types
- $1.6 * 10^6$ facilities
- $0.8 * 10^6$ links
- $24 * 60 * 60$ seconds

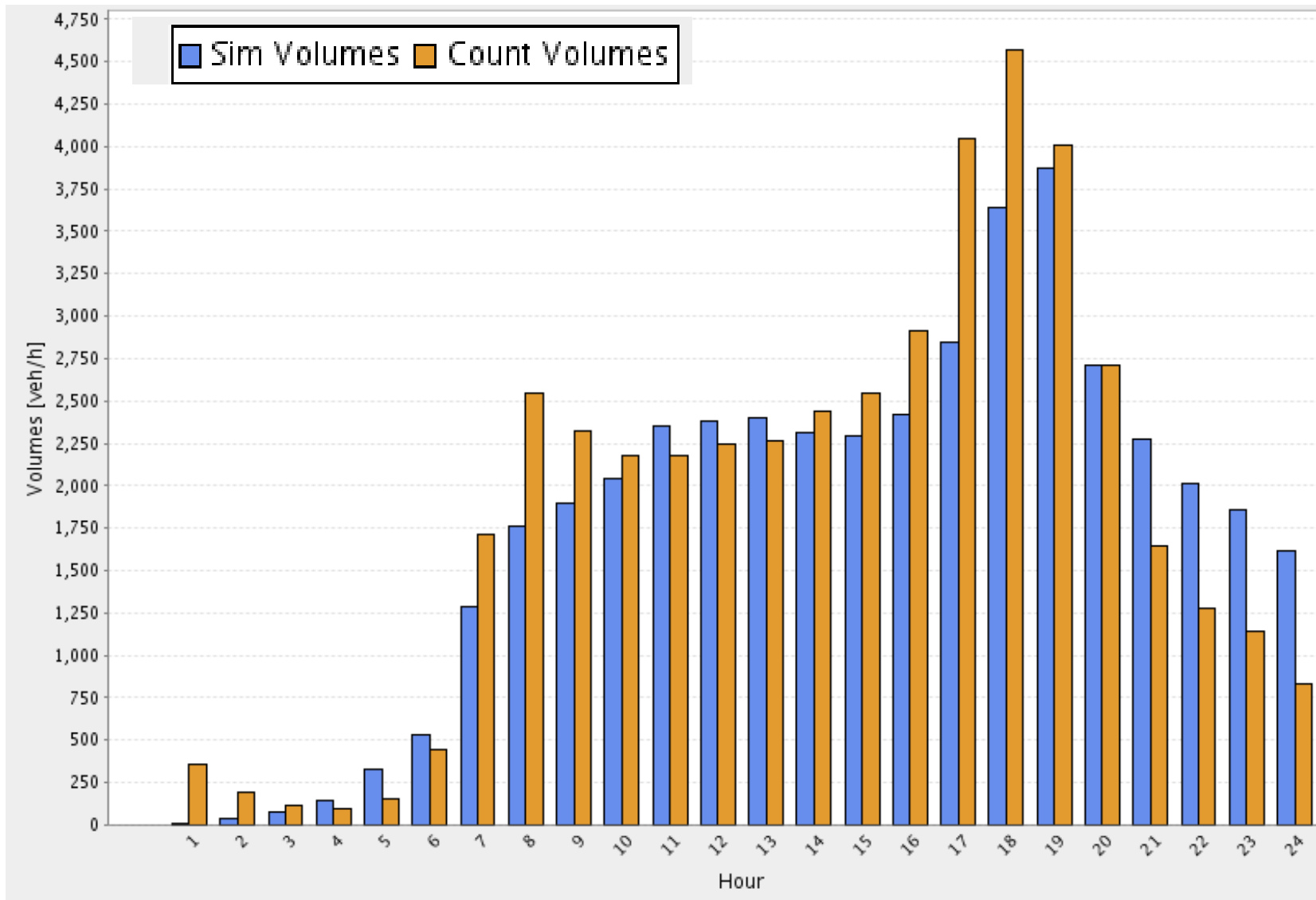
2009 MATSim Switzerland: Computing time



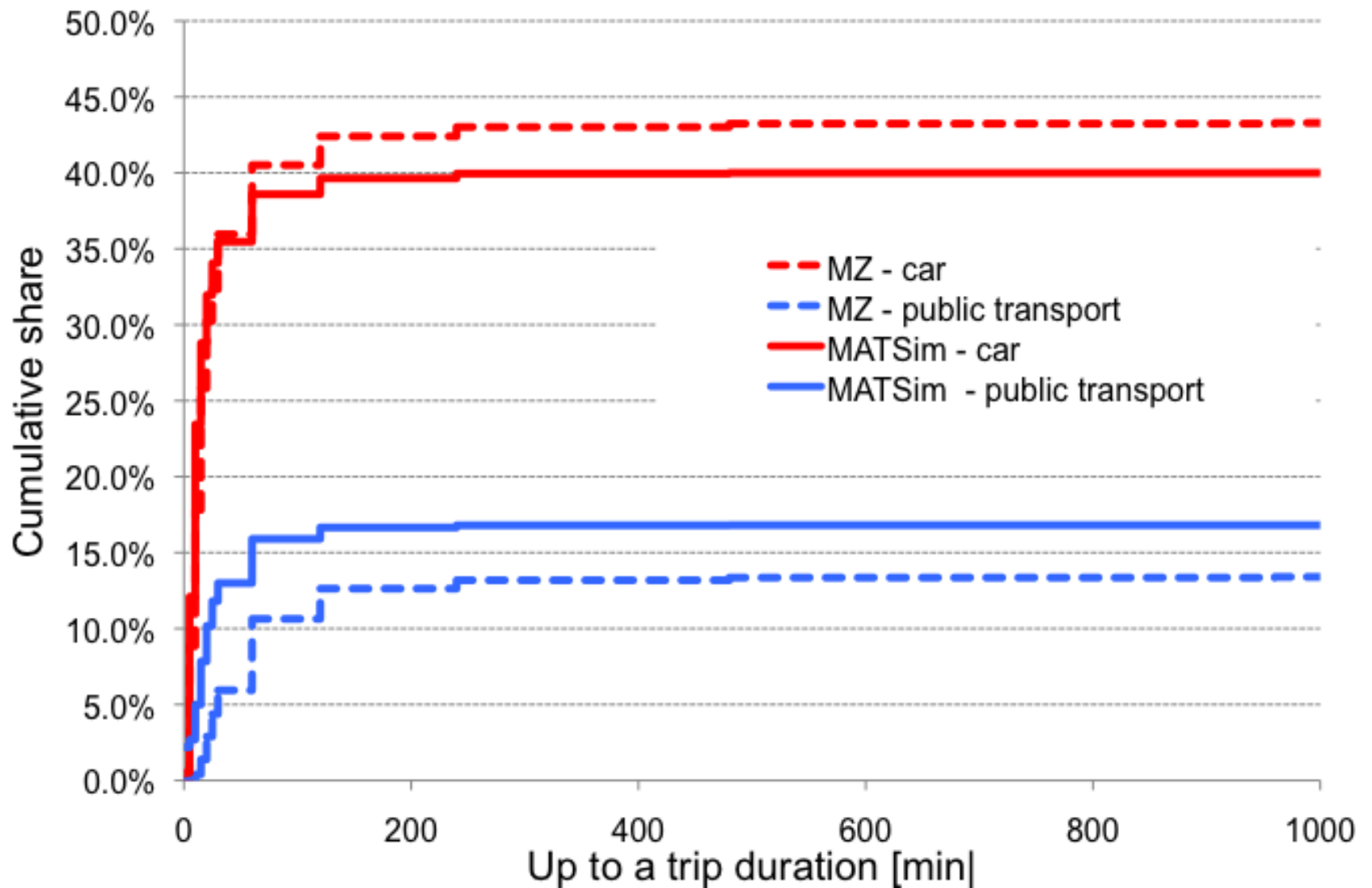
Quality of the results: Overall counts



Quality of the results: A1 at Winterthur (no transit traffic)



Quality of the results: 2 of 5 modes



- Michael Balmer
- David Charypar
- Francesco Ciari
- ChristophDobler
- Matthias Feil
- Jeremy K. Hackney
- Andreas Horni
- Konrad Meister
- Nicolas Lefebvre
- Rashid Waraich