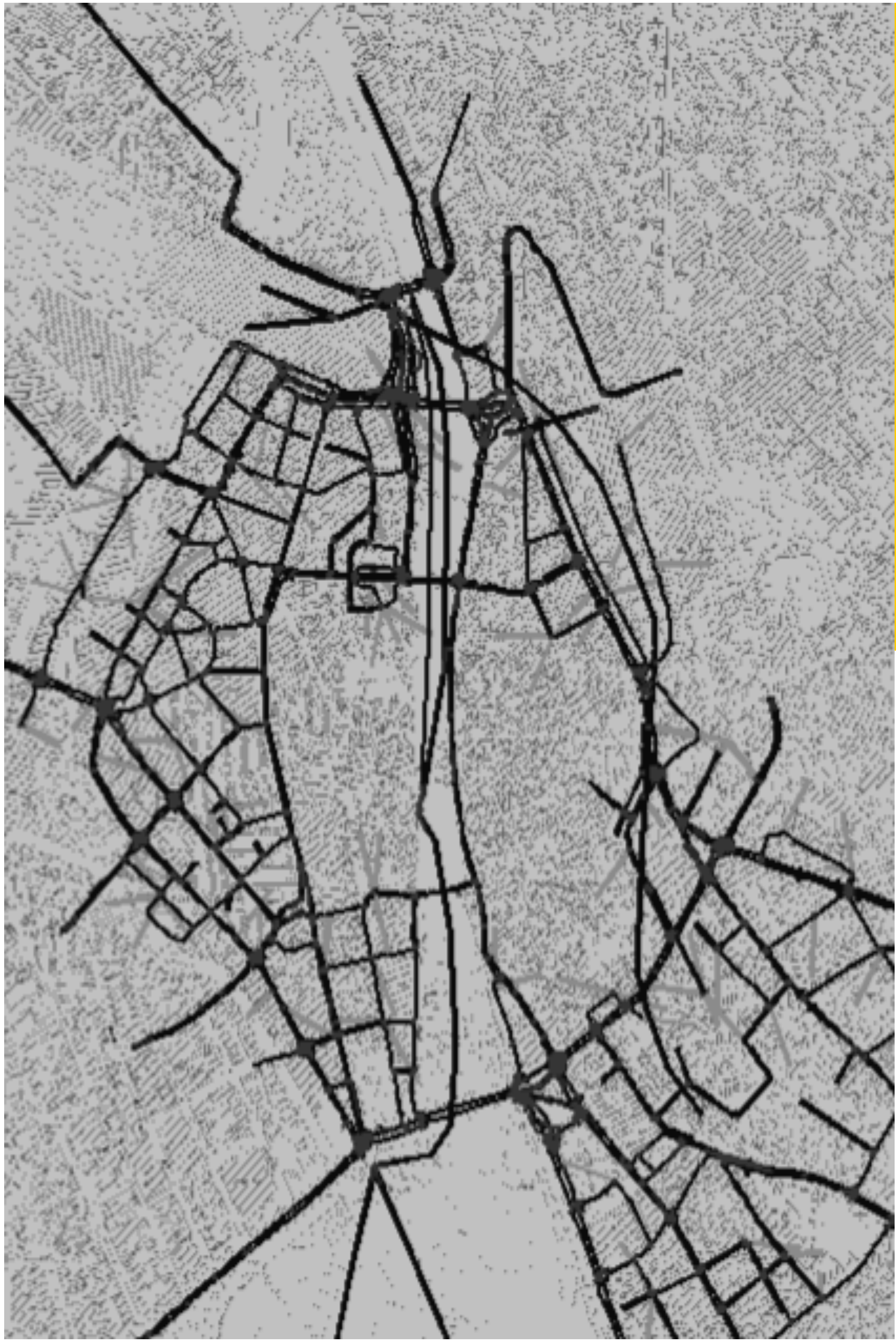


Using VISSIM to model traffic in the city of Zürich

Monica Menendez

Qiao Ge

Traffic Engineering (SVT) group

IVT
Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

What does the Strassenverkehrstechnik (Traffic Engineering) group do?

- Develop **models to better replicate real traffic conditions**, improve the understanding of traffic phenomena, and contribute to a better definition of the role of cars in cities, while assessing their external costs and impacts
- Understand and quantifying how different **technologies and management strategies influence the performance** of transportation systems, identifying new and efficient methods for using in-vehicle and infrastructure technologies
- Develop innovative solutions to improve traffic performance and reduce congestion both in highways and urban networks, while **optimizing the operations of transportation systems** from a multi-modal perspective

SVT's ultimate goal is to achieve more efficient and sustainable transportation systems mostly from the traffic operations perspective

How is traffic in Zürich?

What is the city of Zürich doing about it?

The New York Times

Environment

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE

To that end, the municipal Traffic Planning Department here in Zurich has been working overtime in recent years to torment drivers. Closely spaced red lights have been added on roads into town, causing delays and angst for commuters. Pedestrian underpasses that once allowed traffic to flow freely across major intersections have been removed. Operators in the city's ever expanding tram system can turn traffic lights in their favor as they approach, forcing cars to halt.

for The New York Times

can turn traffic lights in their favor as they approach.

ELISABETH ROSENTHAL
Published: June 26, 2011

ZURICH — While American cities are synchronizing green lights to improve traffic flow and offering apps to help drivers find parking, many European cities are doing the opposite: creating environments openly hostile to cars. The methods vary, but the mission is clear — to make car use expensive and just plain miserable enough to tilt drivers toward

RECOMMEND
TWITTER
LINKEDIN
COMMENTS (567)

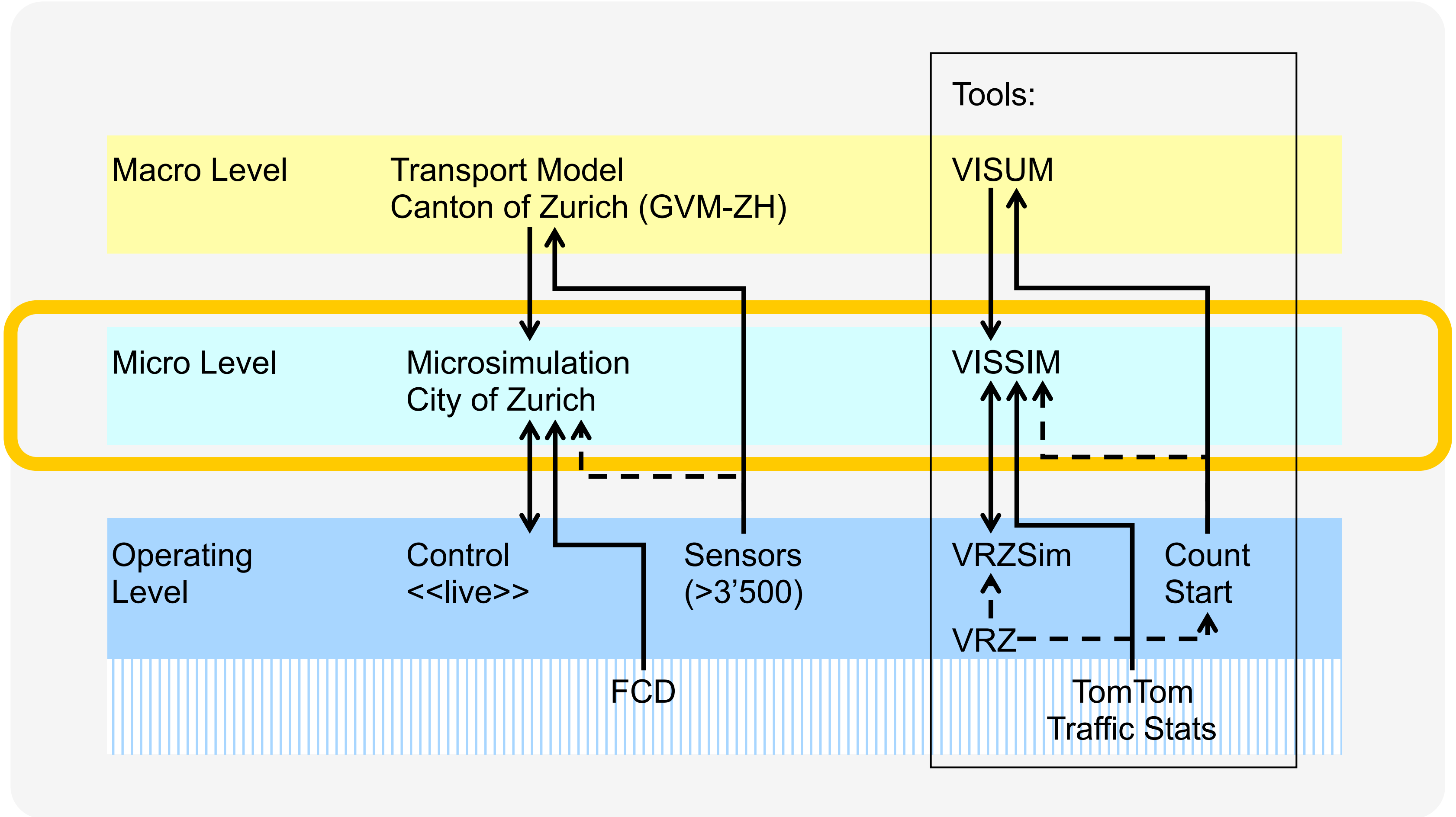
What is the city of Zürich doing about it?

- Actuated traffic control
- Speed limits
- Züritraffic
- Basic traffic routing

Today

- Improvement of short tem prediction and control
- Optimization of traffic routing based on real time information
- Network level control

How? What software is required?



Source: Stadt Zürich, Dienstabteilung Verkehr. Presentation by Christian Heimgartner (2011)

How do they intend to use specifically the microsimulation?

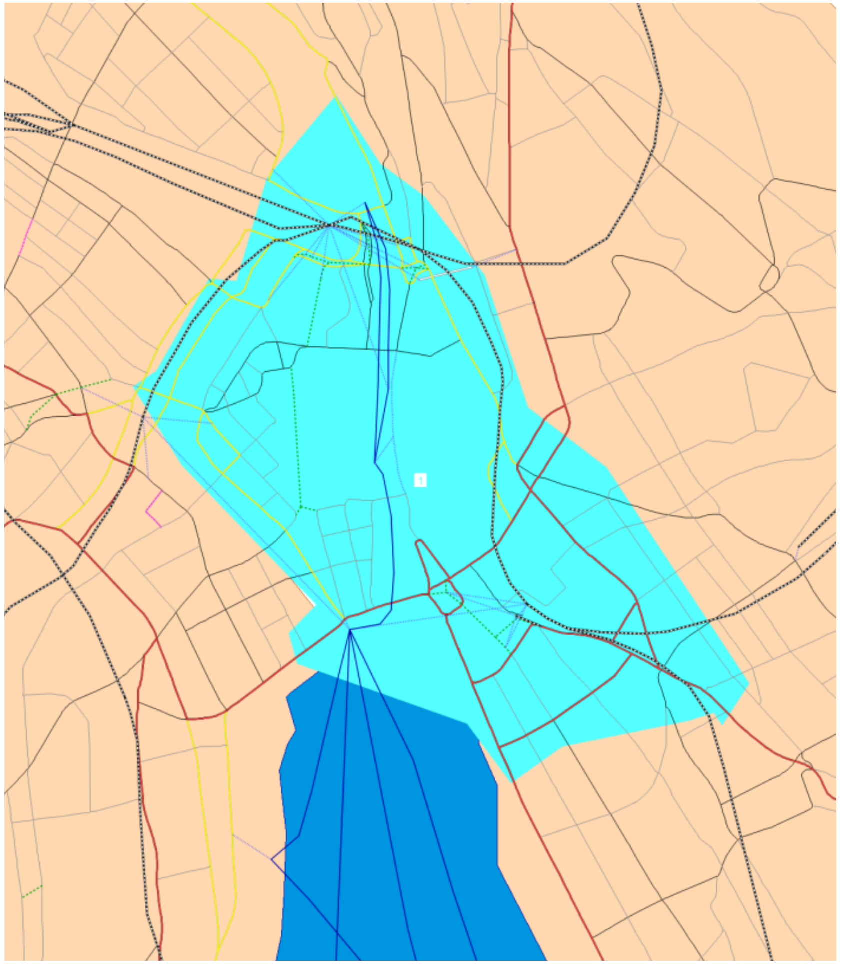
- Development and optimization of traffic control logics and traffic routing
- Analysis and visualisation of the traffic flow
- Analysis and visualisation of other traffic impacts
- Operating simulation of Zürich Public Transportation System

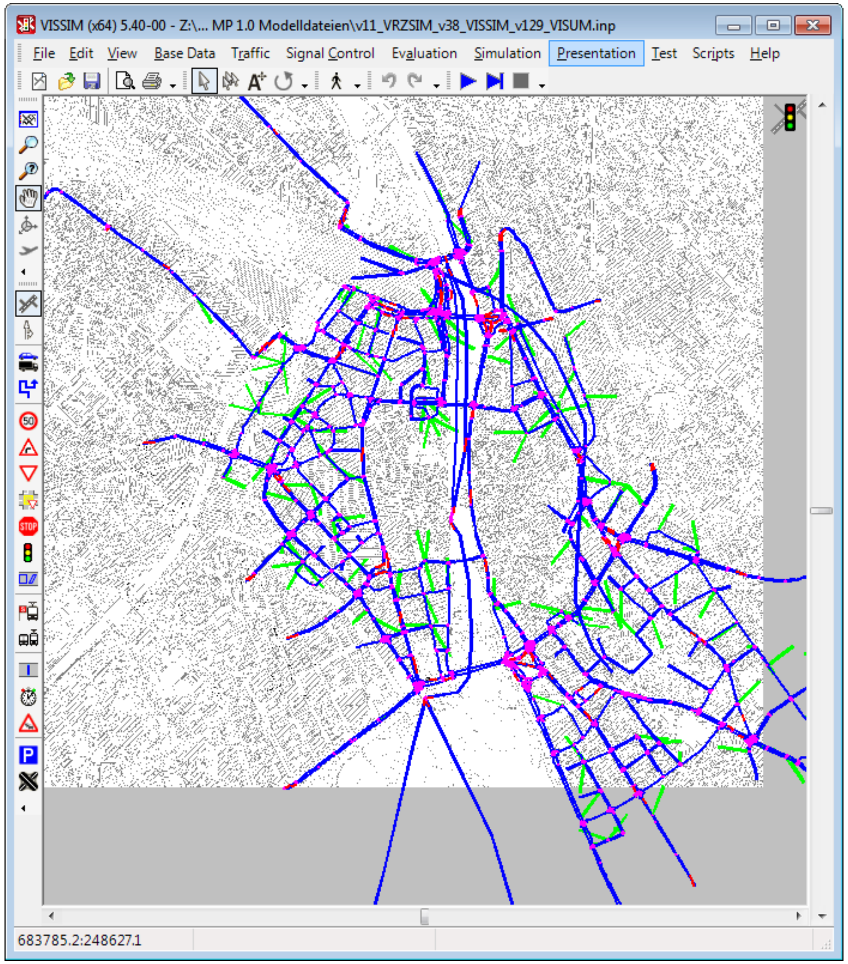
→

- Current traffic states
- Specific projects
- Construction sites

Source: Stadt Zürich, Dienstabteilung Verkehr. Presentation by Christian Heimgartner (2011)

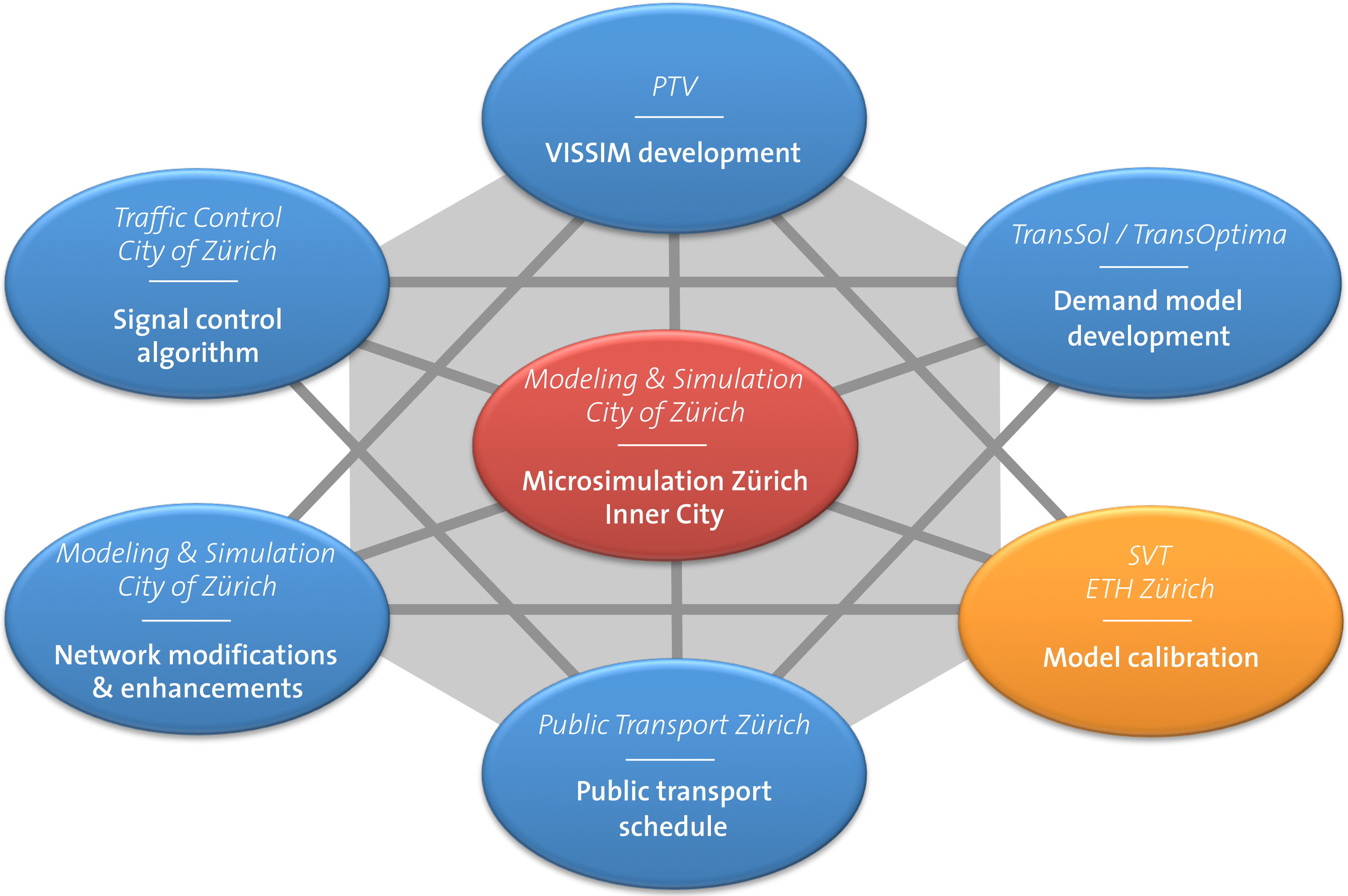
What is the study area?





Source: Stadt Zürich (2011)

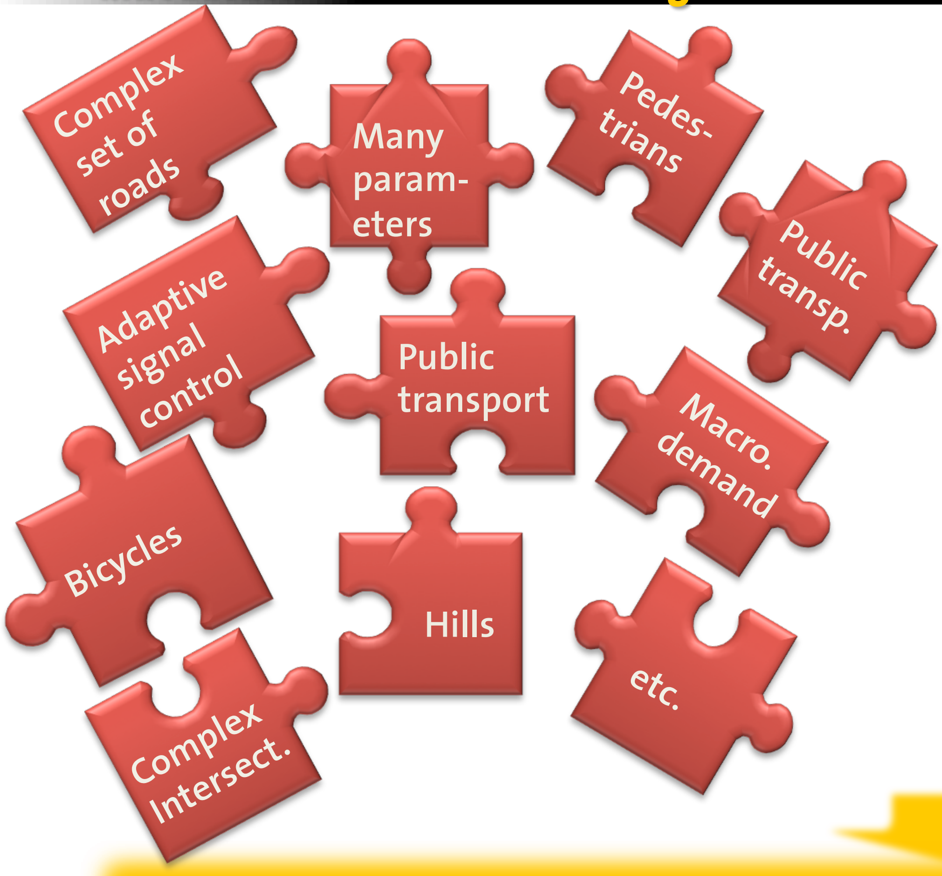
How is the microsimulation being developed?

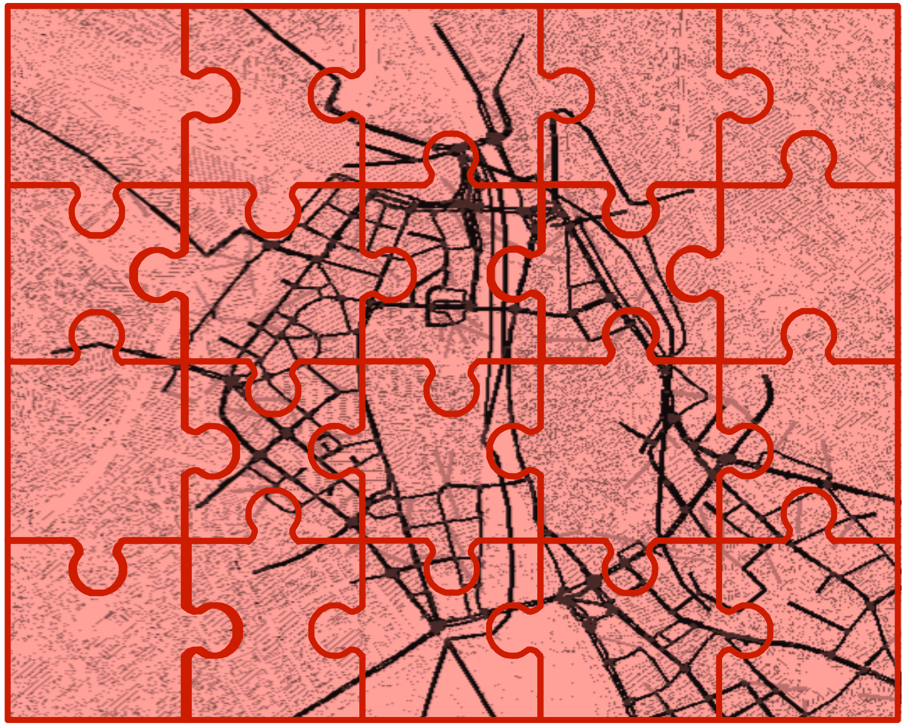


What is the role of the SVT group?

To optimize the calibration process, so the City of Zürich could calibrate the VISSIM model in the most efficient way, tailored to its specific needs and requirements.

What are the challenges of the calibration process?





- VISSIM model is complicated, and it behaves like a black box
- Computational cost is very high (> 30 min per simulation run)
    - Cannot use a brute-force approach for the calibration

How did we go about this project?

- **Phase 1**: investigation of city characteristics and literature review of the calibration procedures
- **Phase 2**: sensitivity analysis to select the most important parameters for calibration
- **Phase 3**: calibration of the model

What did we learn during Phase 1?

Calibration methods & strategy

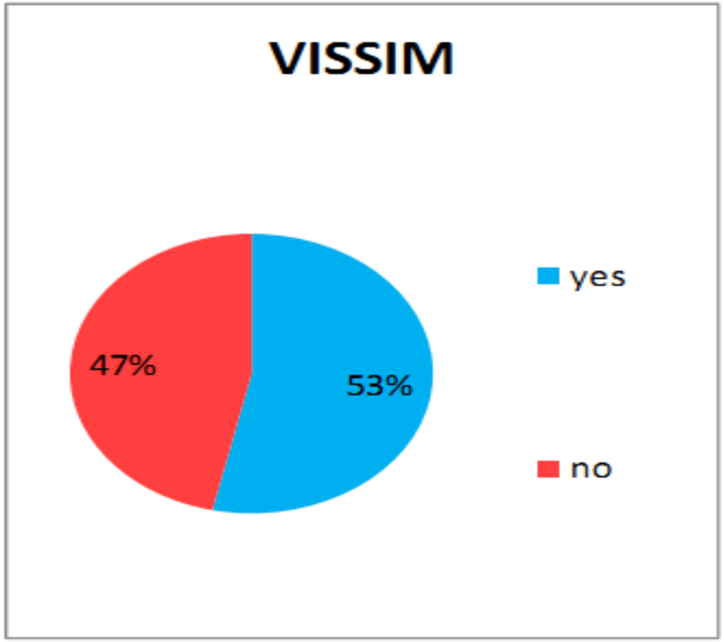
1. Design Manual for Roads and Bridges (UK, 1996)
2. Traffic Modelling Guidelines (UK, 2010)
3. DTO Modelling Guidelines (UK, 2006)
4. Guidelines for the Use of Microsimulation Software (UK, 2007)
5. The Use and Application of Microsimulation Traffic Models (Australia, 2006)
6. Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software (US, 2004)
7. Standard Verification Process for Traffic Flow Simulation Model (Japan, 2002)
8. Hinweise zur mikroskopischen Verkehrsflusssimulation: Grundlagen und Anwendung (Germany, 2006)
9. Best Practices for the Technical Delivery of Long-Term Planning Studies in Canada (Canada, 2008)

VISSIM parameters & calibration

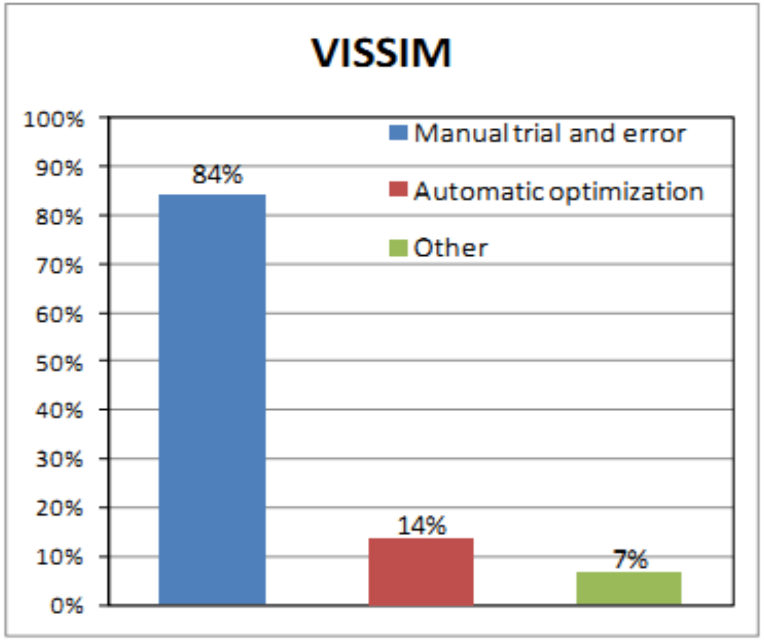
1. VISSIM 5.30-05 User Manual (PTV, 2011)
2. Traffic Modelling Guidelines (TfL, 2010)
3. Calibration of VISSIM to the traffic conditions of Khobar and Dammam, Saudi Arabia (Ahmed, 2005)
4. Calibration of VISSIM for a Congested Freeway (Gomes et al., 2004)
5. Calibration of VISSIM for Bus Rapid Transit Systems in Beijing Using GPS Data (Yu et al., 2006)
6. Calibration of VISSIM for Shanghai Expressway Using Genetic Algorithm (Wu et al., 2005)
7. Microscopic Simulation Model Calibration and Validation Case Study of VISSIM Simulation Model for a Coordinated Actuated Signal System (Park and Schneeberger, 2003)
8. Development and Evaluation of a Calibration and Validation Procedure for Microscopic Simulation Models (Park and Qi, 2004)
9. Developing a Procedure to Identify Parameters for Calibration of a VISSIM Model (Miller, 2009)

Is Zürich alone? What do other cities do?

Use of guidelines/scientific publications in the calibration of traffic simulation programs



Methods applied for calibration of traffic simulation programs



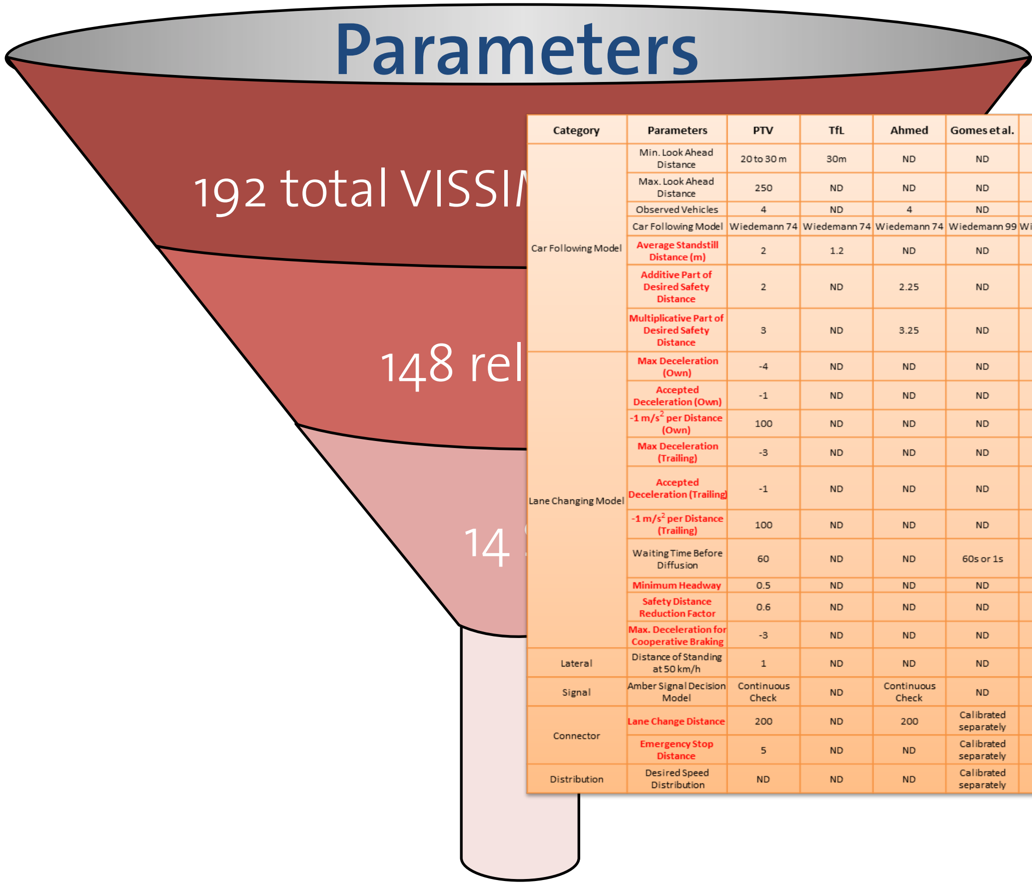
Source: Survey from COST Action TU 0903 - MULTITUDE (2011)

What did we do then?

#	Parameter	Very Important, need calibration	Relevant, use the value from Demand Model and VISSUM output	Relevant, use VISSIM default value	Not relevant
Base Functions and Distributions					
1	Maximum Acceleration			✓	
1.1	Speed range			✓	
1.2	Max value of acceleration			✓	
1.3	Min value of acceleration			✓	
1.4	Mean value of acceleration			✓	
1.5	Distribution curve			✓	
2	Desired Maximum Acceleration			✓	
2.1	Speed range			✓	
2.2	Max value of acceleration			✓	
2.3	Min value of acceleration			✓	
2.4	Mean value of acceleration			✓	
2.5	Distribution curve			✓	
3	Minimum Deceleration			✓	
3.1	Speed range			✓	
3.2	Max value of deceleration			✓	
3.3	Min value of deceleration			✓	
3.4	Mean value of deceleration			✓	
3.5	Distribution curve			✓	
4	Desired Maximum Acceleration			✓	
4.1	Speed range			✓	
4.2	Max value of deceleration			✓	
4.3	Min value of deceleration			✓	
4.4	Mean value of deceleration			✓	
4.5	Distribution curve			✓	

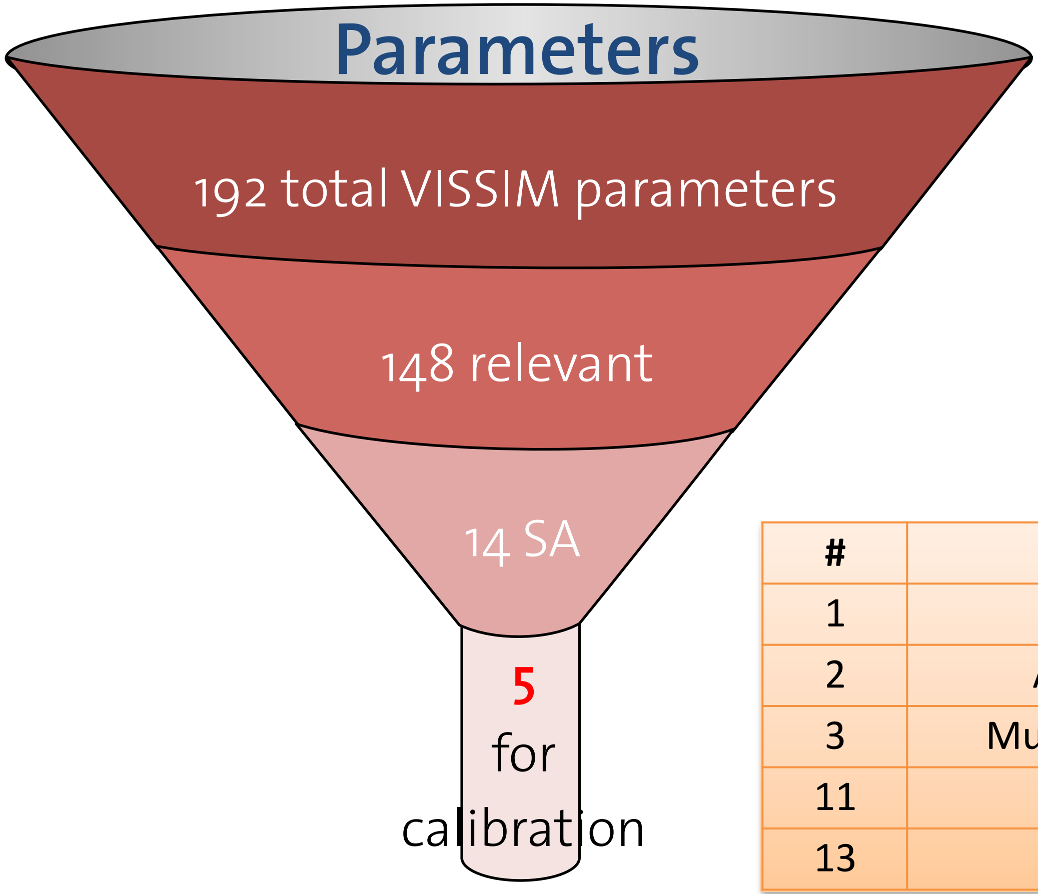
Each parameter was analyzed individually, and categorized according to its relevance within the Zürich model

What were the results?



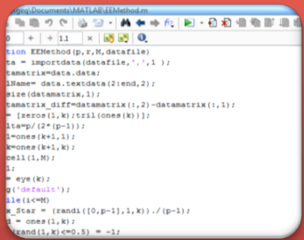
Category	Parameters	PTV	TfL	Ahmed	Gomes et al.	Yu et al.	Wu et al.	Park and Schneeberger	Park and Qi	Miller
Car Following Model	Min. Look Ahead Distance	20 to 30 m	30m	ND	ND	ND	ND	ND	ND	N
	Max. Look Ahead Distance	250	ND	ND	ND	273.7	ND	ND	I	ND
	Observed Vehicles	4	ND	4	ND	ND	ND	1 to 4	I	N
	Car Following Model	Wiedemann 74	Wiedemann 74	Wiedemann 74	Wiedemann 99	Wiedemann 74	Wiedemann 99	Wiedemann 74	Wiedemann 74	Wiedemann 74
	Average Standstill Distance (m)	2	1.2	ND	ND	1.6	ND	1 to 3	I	I
	Additive Part of Desired Safety Distance	2	ND	2.25	ND	4.4	ND	ND	I	I
	Multiplicative Part of Desired Safety Distance	3	ND	3.25	ND	3.72	ND	ND	I	I
Lane Changing Model	Max Deceleration (Own)	-4	ND	ND	ND	-4.4	ND	ND	I	I
	Accepted Deceleration (Own)	-1	ND	ND	ND	-0.3	ND	ND	I	N
	$-1\ m/s^2$ per Distance (Own)	100	ND	ND	ND	78.8	ND	ND	I	N
	Max Deceleration (Trailing)	-3	ND	ND	ND	-4.4	ND	ND	I	I
	Accepted Deceleration (Trailing)	-1	ND	ND	ND	-0.3	ND	ND	I	N
	$-1\ m/s^2$ per Distance (Trailing)	100	ND	ND	ND	78.8	ND	ND	I	N
	Waiting Time Before Diffusion	60	ND	ND	60s or 1s	64.2	90s for peak and 45s for none-peak	20, 40, 60	I	N
	Minimum Headway	0.5	ND	ND	ND	1	ND	0.5 to 7	I	I
	Safety Distance Reduction Factor	0.6	ND	ND	ND	ND	ND	ND	ND	I
	Max. Deceleration for Cooperative Braking	-3	ND	ND	ND	ND	ND	ND	ND	I
Lateral	Distance of Standing at 50 km/h	1	ND	ND	ND	1.9	ND	ND	ND	ND
Signal	Amber Signal Decision Model	Continuous Check	ND	Continuous Check	ND	ND	ND	ND	ND	Continuous Check
Connector	Lane Change Distance	200	ND	200	Calibrated separately	ND	300	150-300m	ND	I
	Emergency Stop Distance	5	ND	ND	Calibrated separately	ND	ND	2-7 m	ND	N
Distribution	Desired Speed Distribution	ND	ND	ND	Calibrated separately	ND	ND	ND	ND	I

How was Phase 2 different from that?



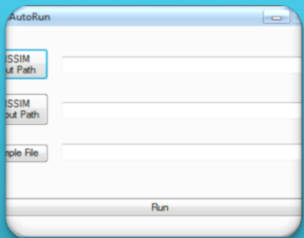
#	Parameters
1	Average Standstill Distance
2	Additive Part of Desired Safety Distance
3	Multiplicative Part of Desired Safety Distance
11	Safety Distance Reduction Factor
13	Lane Change Distance

How did we go from 14 parameters to 5?



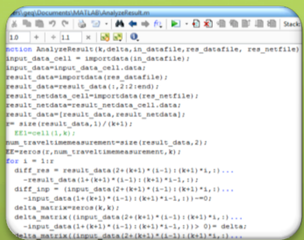
EE Trajectory Generator (MATLAB)

- Input: parameters range (min, max)
- Process: randomly generate EE trajectories
- Output: EE trajectories



Automatic VISSIM Simulator (C#.NET)

- Process: automatically change the parameter values in the VISSIM INP file and run the simulation
- Output: simulation results for each EE trajectory



Analyzer (MATLAB)

- Process: analyze and compare multiple sensitivity measures, e.g. mean, absolute mean and standard variation
- Output: ranking of parameters

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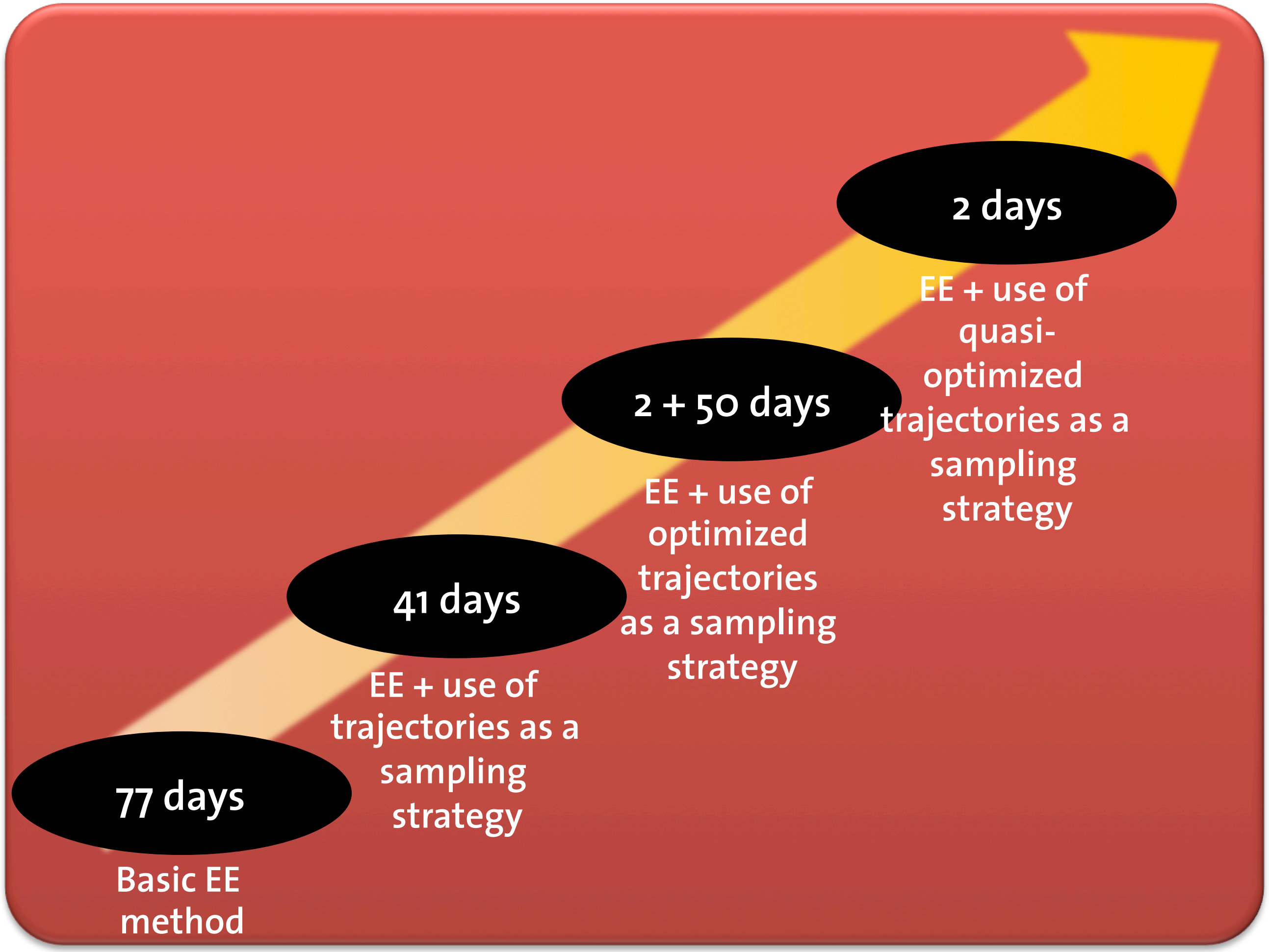

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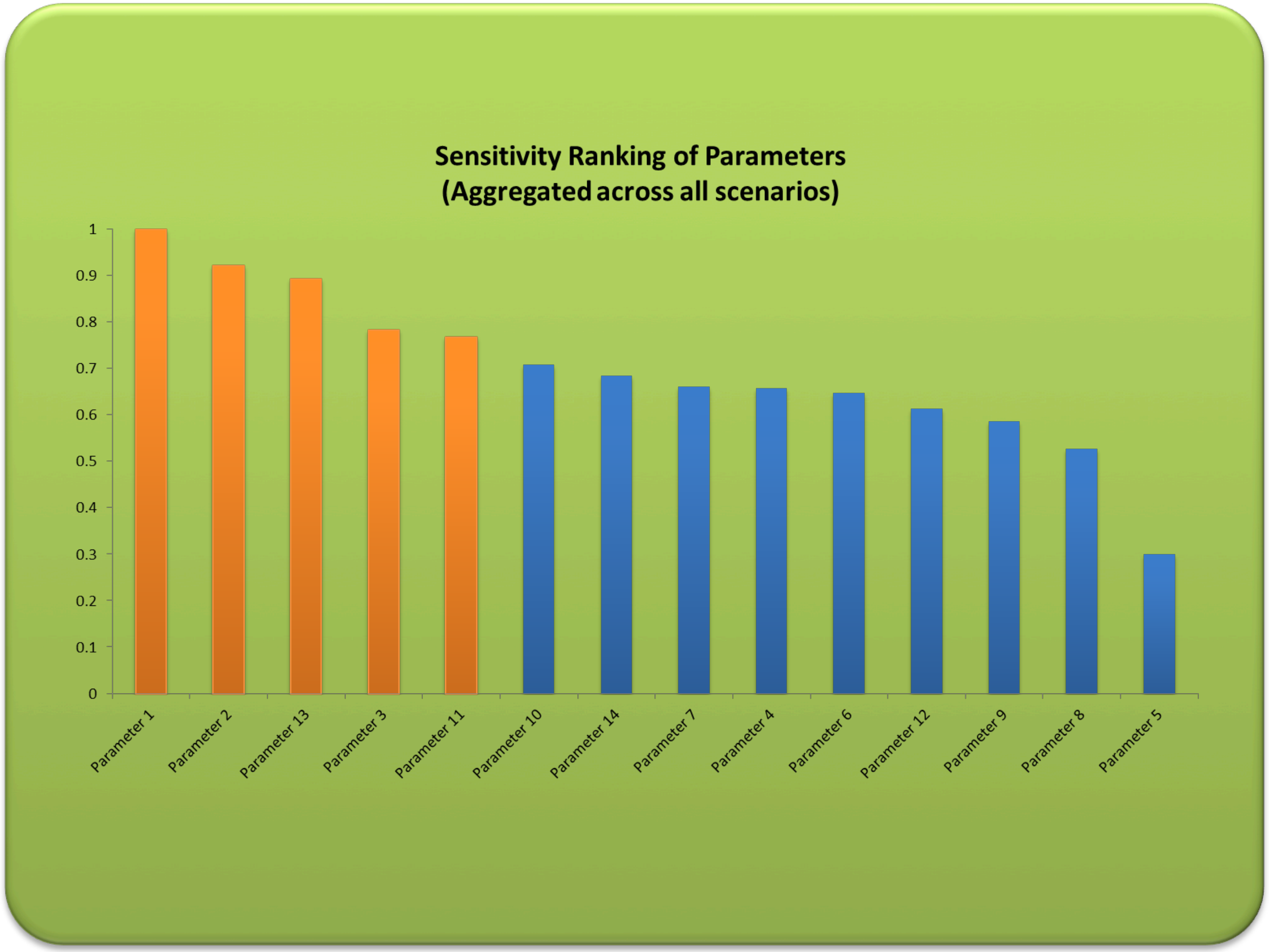
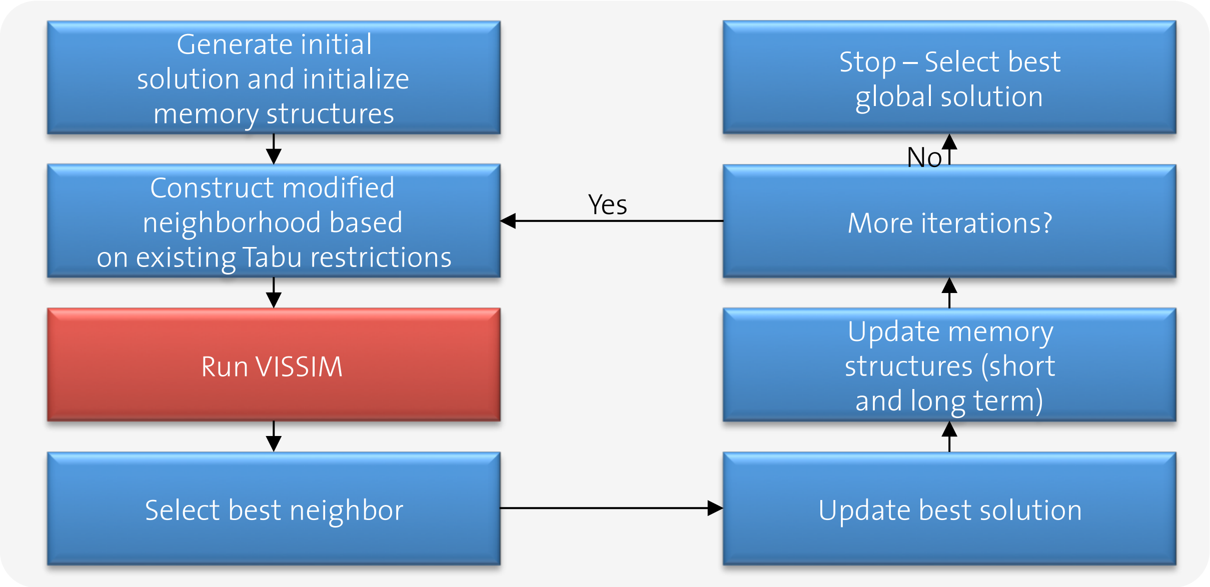


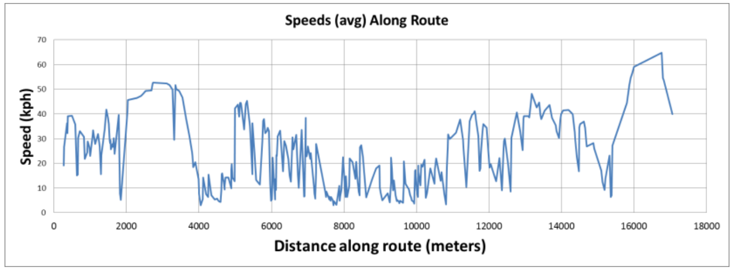
How do we then calibrate those 5 parameters?

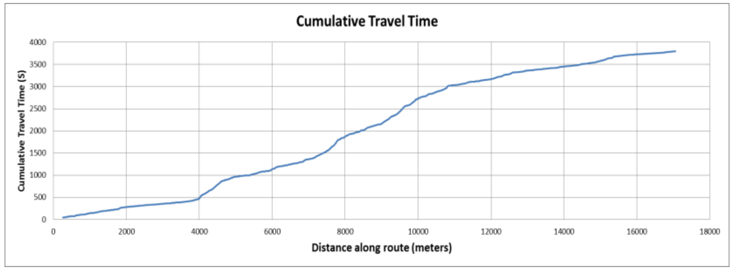
***Tabu Search**: metaheuristic method that guides a local search procedure to explore the solution space beyond local optimality*



Use a Tabu Search algorithm focusing on the five most important parameters

Do we have real data for the calibration?





TomTom provides average speeds and cumulative travel times per route based on GPS data

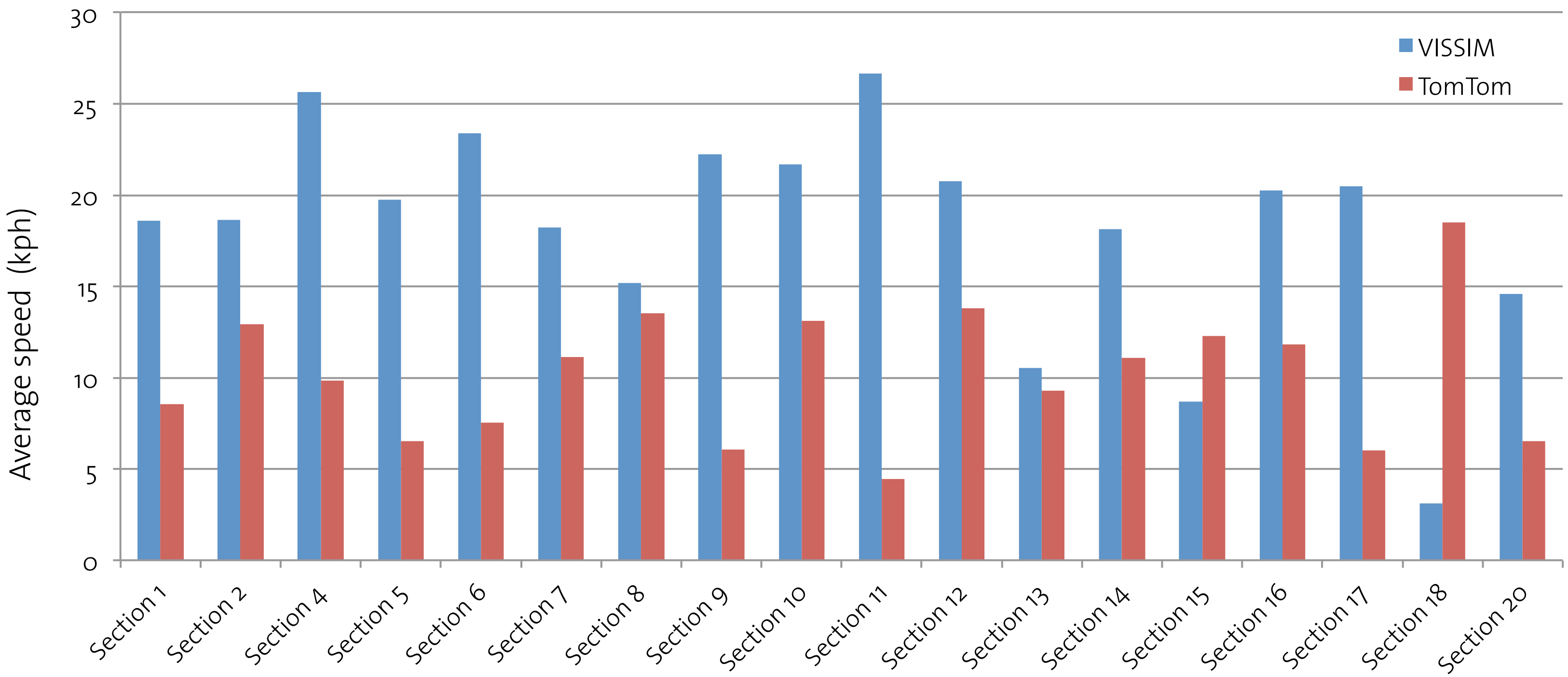
So what did we do?

...We had some extra time to test the model

- Ran 240 simulations
- Further tested the influence of the important parameters
- Used the adaptive signal control algorithms
- Evaluated speeds (and counts) in the network

So what did we do?

What did we observe?



VISSIM consistently over-predicted the speeds in the network

Why?

- Importing a macroscopic demand into a microscopic traffic simulator presents some challenges, e.g., accounting for:
  - Intra-zone demand
  - Parking surge traffic
  - Turning ratios at intersections

- ???

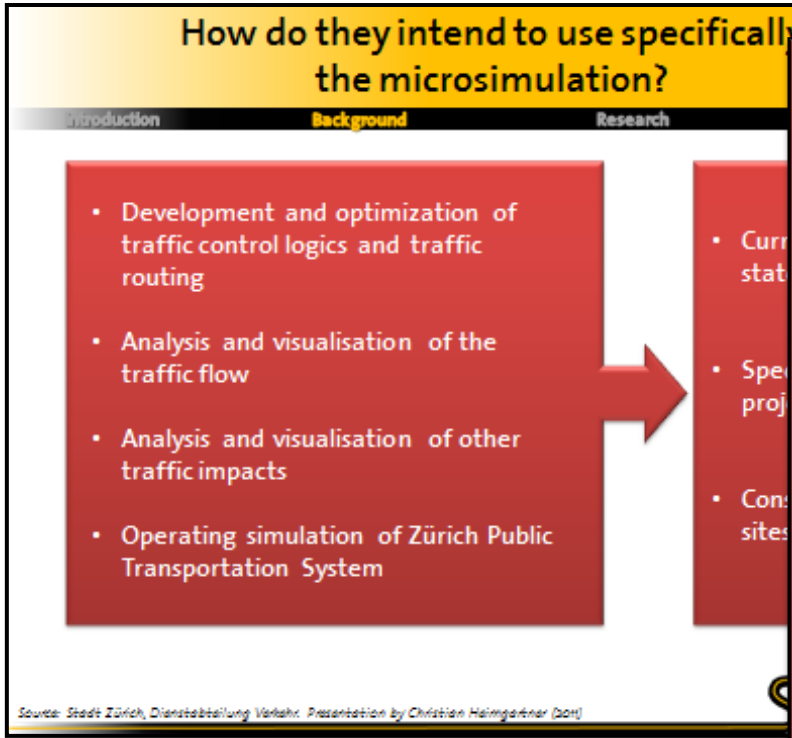
What are the next immediate steps?

- Verify the TomTom data
- Figure out what is driving the large discrepancies in the demand at the microscopic level
- Resume calibration once those issues are solved

Why all this work? Is it really needed?

Simulation results should match reality as closely as possible

Why all this work? Is it really needed?



- Learnings for other cities, and dissemination of best practices in calibration and sensitivity analysis
- Modeling and testing of multiple traffic management strategies
- Monitoring and control of the whole network both at specific locations and at an aggregate level
- Combined use of modeling techniques and real data collection and analysis

The City of Zürich could become a center for research and development in the area of Traffic Operations and Control – *ZürichLAB*

Questions?

Thank you!