TRAFFIC CONTROL AND MANAGEMENT STRATEGIES: TODAY AND TOMORROW

SVT

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IVT

ETH Zürich

Traffic Management Research Institute of the Public Security Ministry (TMRI)

August 9th, 2012

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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

Who are we?

ETH Zürich

D-BAUG Eng.

Institute for Transport Planning and Systems (IVT)

Transport Planning	Traffic Engineering (SVT)	Transport Systems
Prof. Axhausen	Dr. Menendez	Prof. Weidmann

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

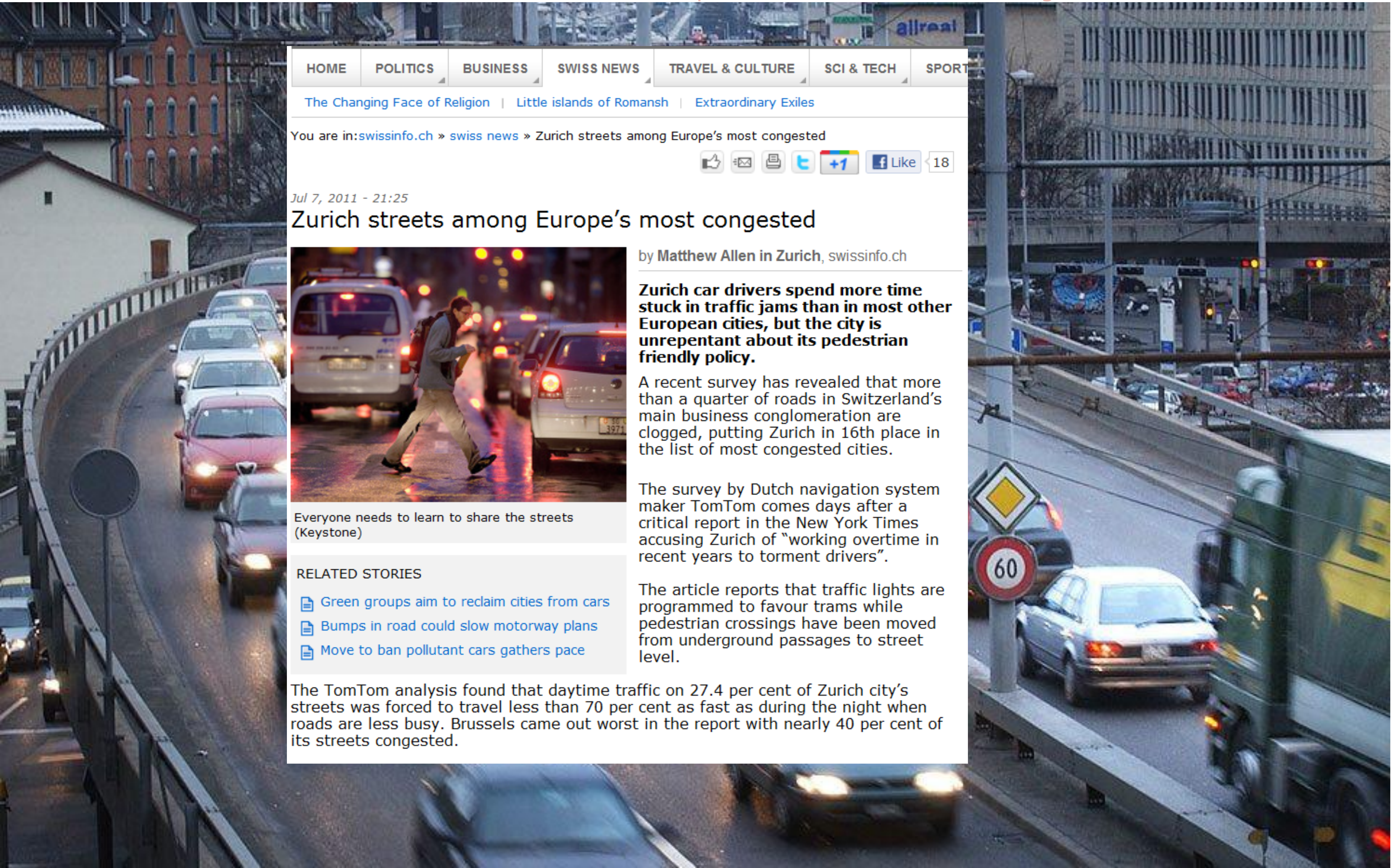
Why am I here?

- Ongoing collaboration with the institute
  - 2 researchers visited us in 2011 (Mr. Pingfan Li and Mr. Aibing Shu)
  - 2 researchers will visit us in 2012 (Ms. Yu Liying and Ms. Shuai Dai)
- Looking to learn more about the institute and traffic management and operations in China
- Interested in sharing experiences and strengthen existing relation
- For more info, check our web page: *http://www.ivt.ethz.ch/svt*

Why do we talk so much about traffic?

Even in Zürich?

SVT



Jul 7, 2011 - 21:25

Zurich streets among Europe's most congested

Everyone needs to learn to share the streets (Keystone)

RELATED STORIES

- Green groups aim to reclaim cities from cars
- Bumps in road could slow motorway plans
- Move to ban pollutant cars gathers pace

by **Matthew Allen in Zurich**, swissinfo.ch

Zurich car drivers spend more time stuck in traffic jams than in most other European cities, but the city is unrepentant about its pedestrian friendly policy.

A recent survey has revealed that more than a quarter of roads in Switzerland's main business conglomeration are clogged, putting Zurich in 16th place in the list of most congested cities.

The survey by Dutch navigation system maker TomTom comes days after a critical report in the New York Times accusing Zurich of "working overtime in recent years to torment drivers".

The article reports that traffic lights are programmed to favour trams while pedestrian crossings have been moved from underground passages to street level.

The TomTom analysis found that daytime traffic on 27.4 per cent of Zurich city's streets was forced to travel less than 70 per cent as fast as during the night when roads are less busy. Brussels came out worst in the report with nearly 40 per cent of its streets congested.

How can that be?

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

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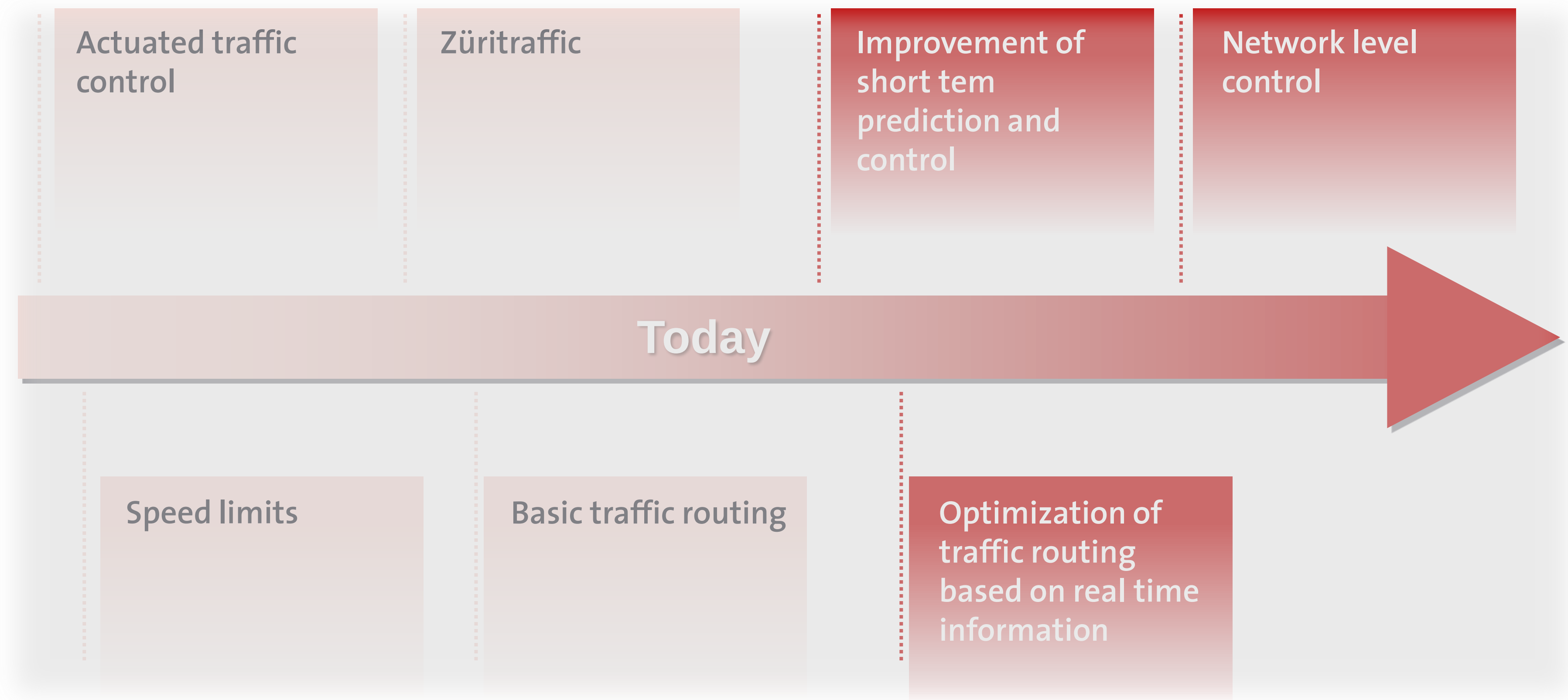
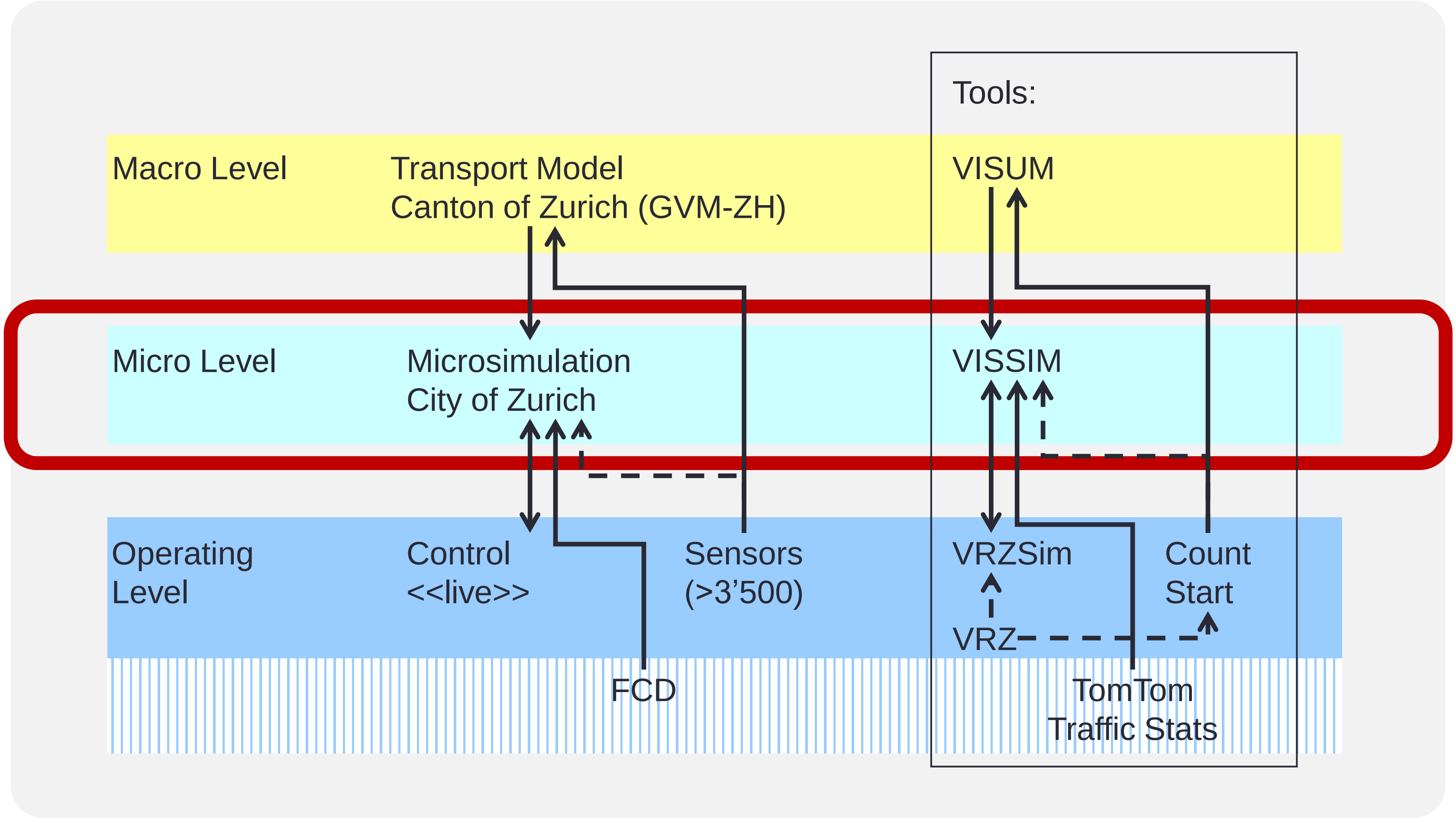
What is the city of Zürich really doing?



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

ZürichLAB

How are they doing it



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

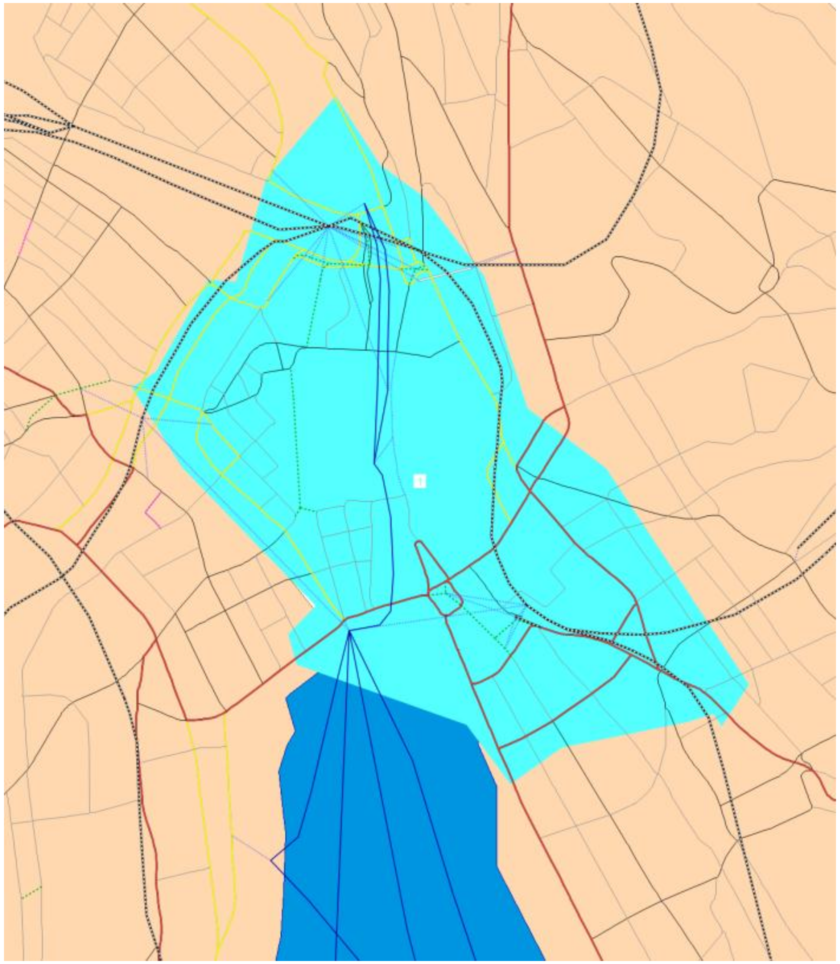
How will they use the simulation?

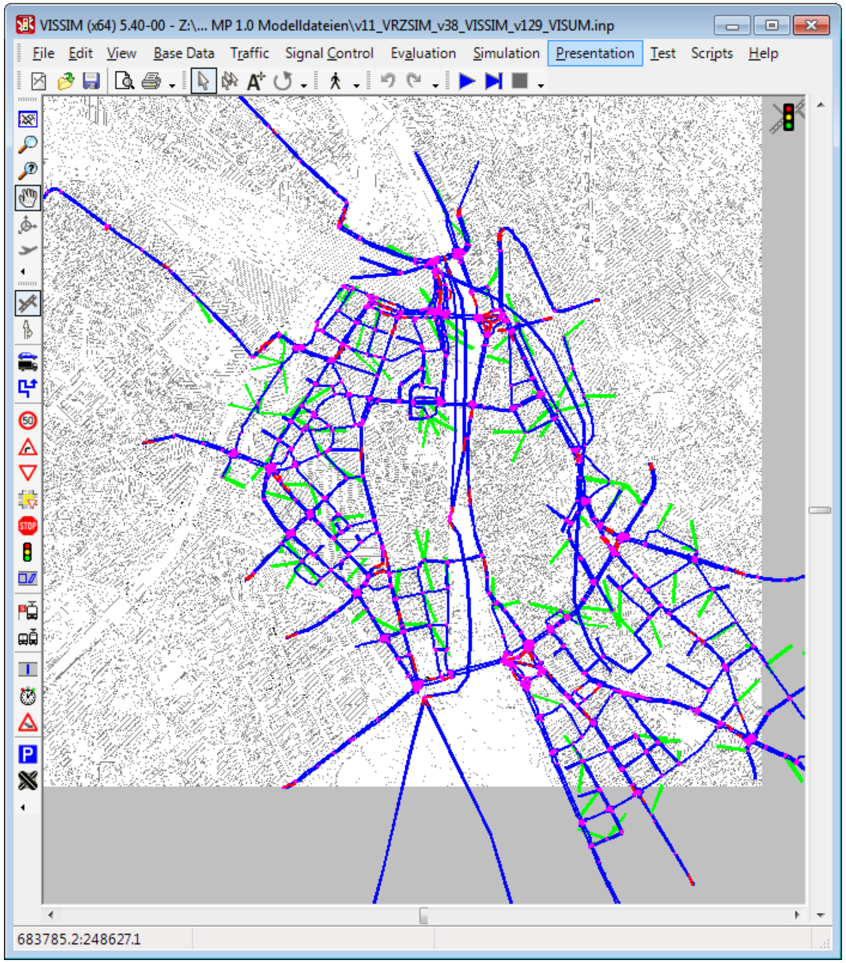
- Development and optimization of traffic control logics and traffic routing
- Analysis and visualisation of the traffic flow, and other traffic impacts
- Operating simulation of Zürich Public Transportation System
- Modeling and testing of multiple traffic management strategies
- Combined use of modeling techniques and real data collection and analysis
- Monitoring and control of the whole network both at specific locations and at an aggregate level

→

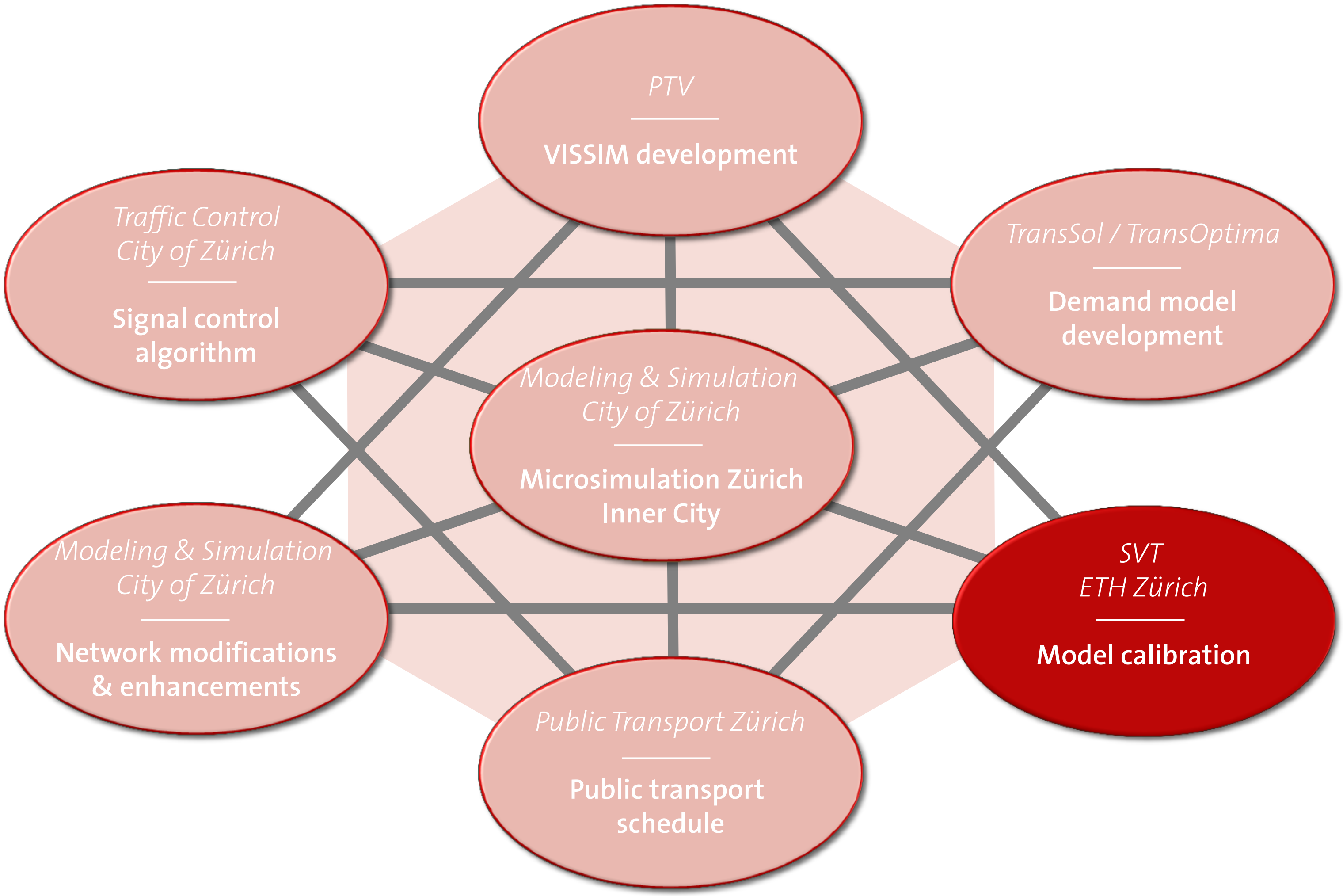
- Current traffic states
- Specific projects / new strategies / transport alternatives
- Construction sites

What is their study area?

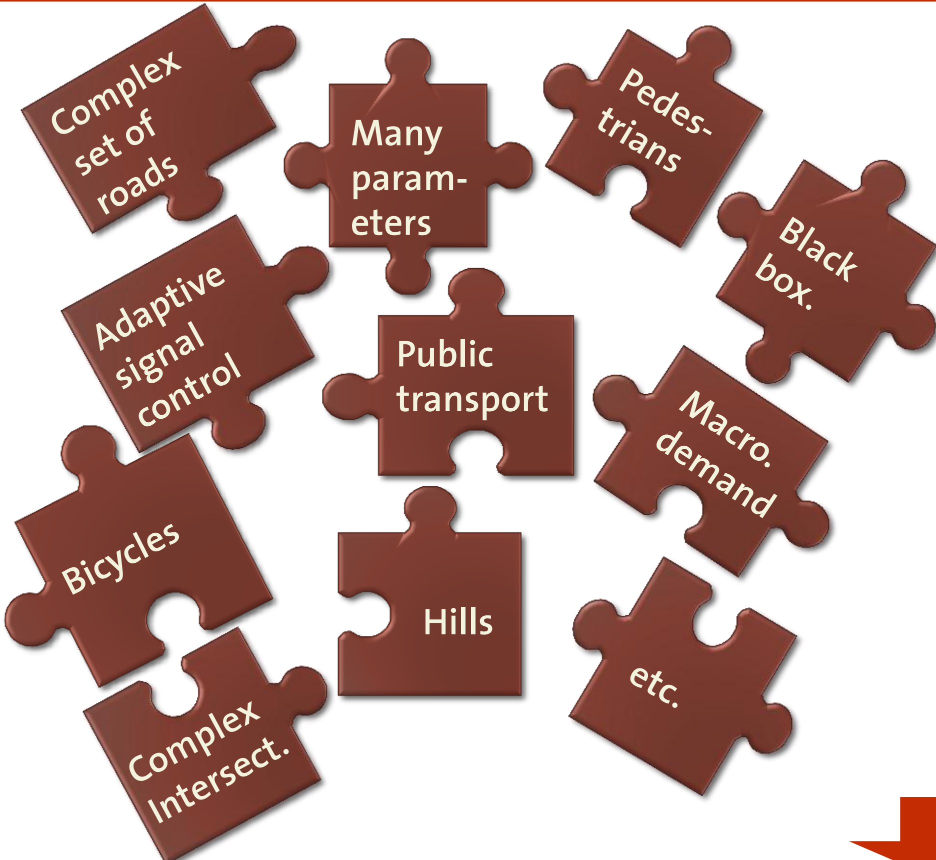


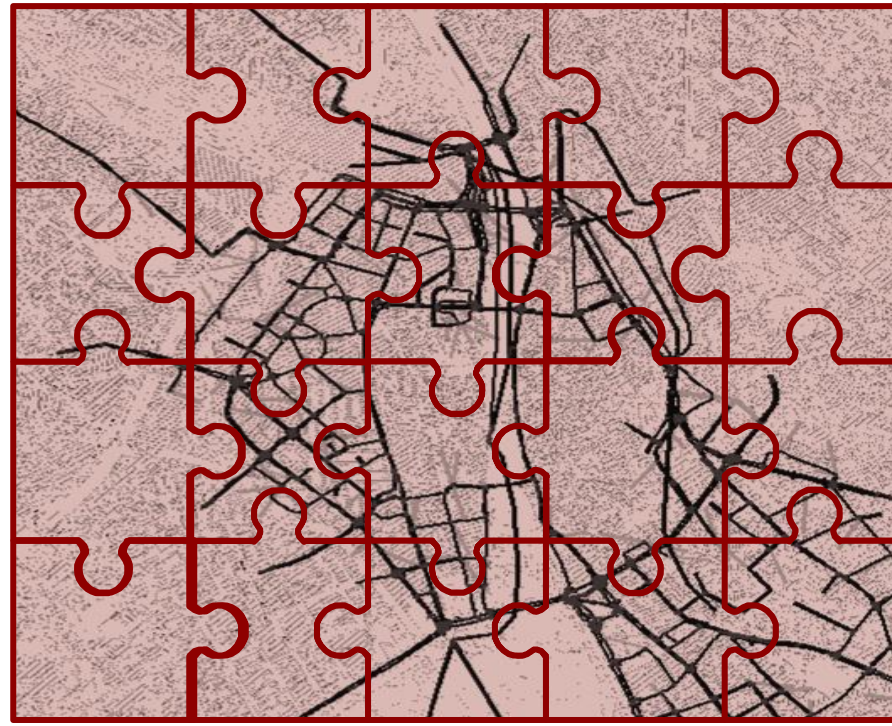


How is the microsimulation being developed?



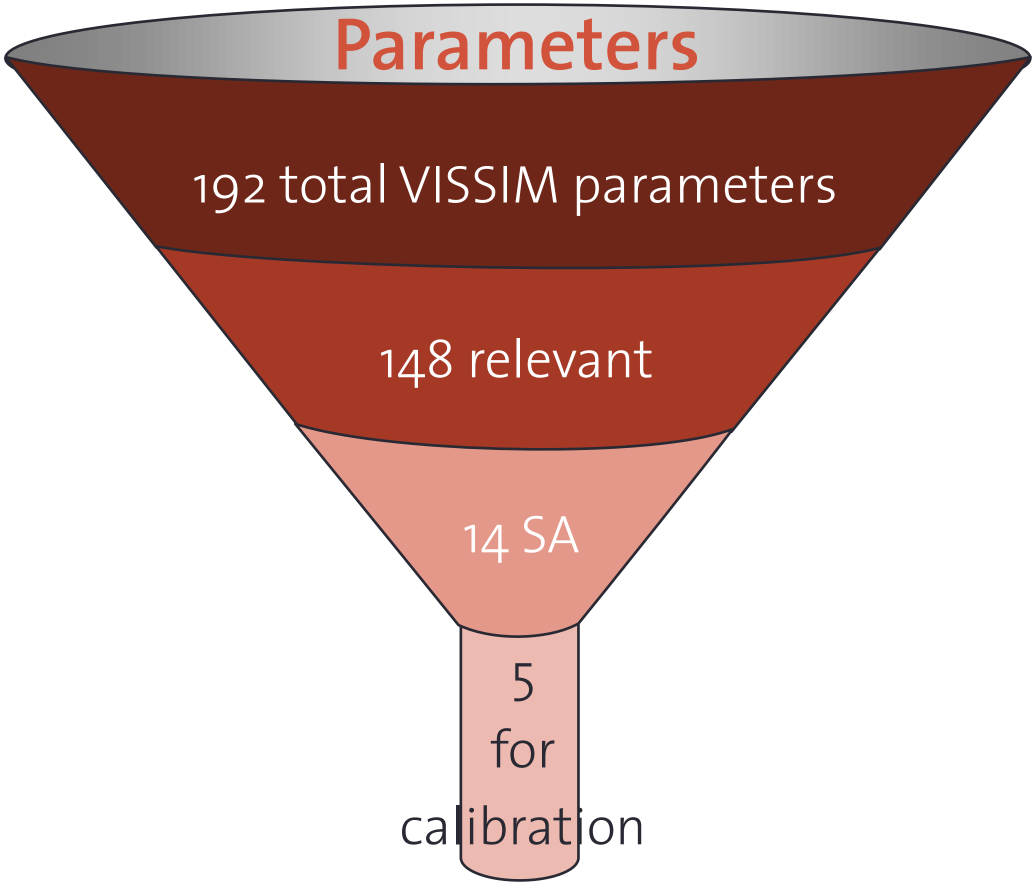
Why is the calibration process so hard?



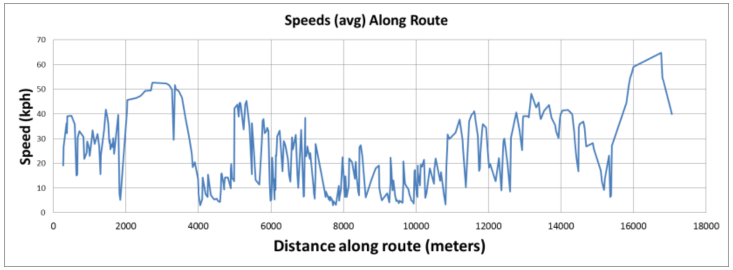


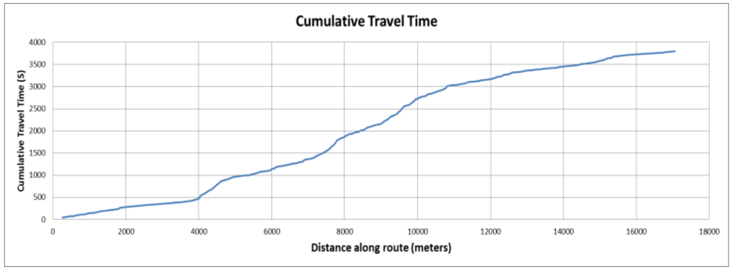
- VISSIM model is complicated, and it behaves like a black box
- Computational cost is very high (> 30 min per simulation run)
  - Cannot use a brute-force approach for the calibration

How did we calibrated the model?



Did we have real data for the calibration?





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

What do we get with VISSIM?

What's the aim of it?

Simulation results should match reality as closely as possible

How can the simulation be used?

- Development and optimization of traffic control logics and traffic routing
- Analysis and visualisation of the traffic flow, and other traffic impacts
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→

- Current traffic states
- Specific projects
- Construction sites

Do we have an example?

Use the simulation to create a

Macroscopic Fundamental Diagram

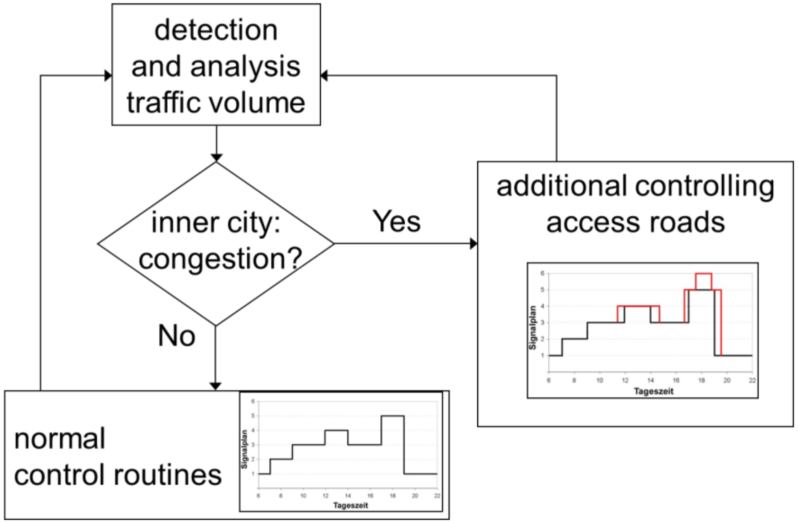
Does this build on any previous strategy?

The city of Zürich employs an already innovative traffic access control system:

ZüriTraffic

How does ZüriTraffic work?

- It measures the **level of service** (LOS) in certain links in the city
- Then detects **LOS changes**
- For given LOS changes, it modifies **traffic signal controls** in the roads accessing the city



Is ZüriTraffic good?

- This system represents a clear step towards more efficient urban operations
- However:
  i. It measures the traffic behavior in just a few city streets
  ii. It is based on a static and possibly out-of-date demand model (has not been updated since 2007)
  iii. It defines only two traffic scenarios, “congested” and “uncongested”, so it cannot adapt flexibly to continuous changes in network performance

A more tailored and dynamic system could bring some benefits

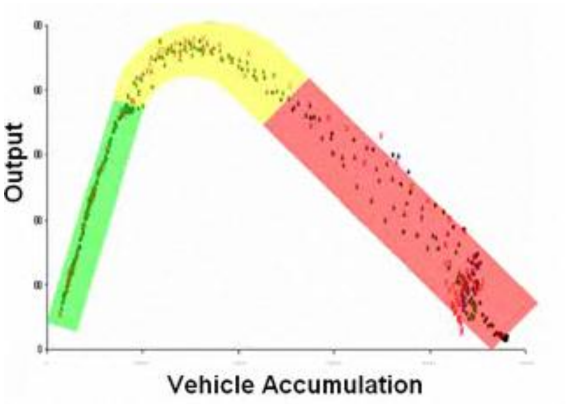
What do we propose?

Use a **Macroscopic Fundamental Diagram (MFD)**

A proper MFD can be used as the basis for an operational scheme for network capacity control

What is an MFD?

- Certain city areas have a relationship between the accumulation of vehicles and the number of trips ended, following a **Macroscopic Fundamental Diagram (MFD)**



- That allows to know (through **monitoring**) how the urban area is **performing**
- If the perimeter of this area is controlled, the **system** can be moved to more **uncongested scenarios**
- The MFD continuously assesses the traffic states within the city and **can adapt easily** to the **capacity** and **traffic requirements**

What are the advantages of using an MFD?

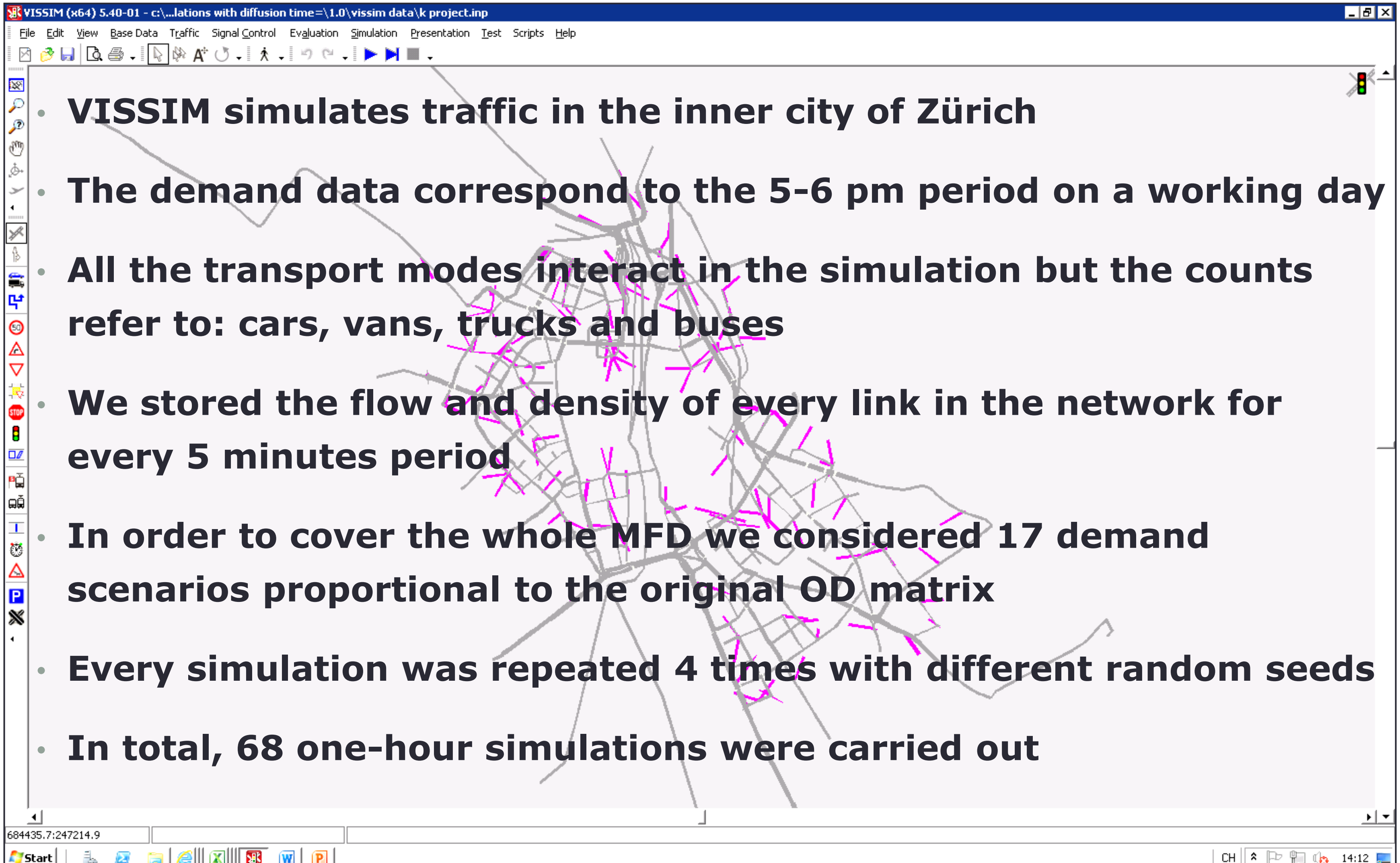
- It could be shown that the traffic states in the links that are measured by *ZüriTraffic* do not necessarily represent the performance of the entire network. The MFD does
- The MFD is independent of the demand patterns, so there is no need to identify demand patterns on a regular basis; and the methodology does not become obsolete as demand patterns change
- The MFD continuously assesses the traffic states within the city and can adapt easily to the capacity and traffic requirements. It can consider a high number of traffic states and the corresponding traffic lights control strategies

How do we create an MFD?

- We need counts and occupancies throughout the city
- Zürich currently has 3,500 loop detectors installed in the city; but the data is not easily available

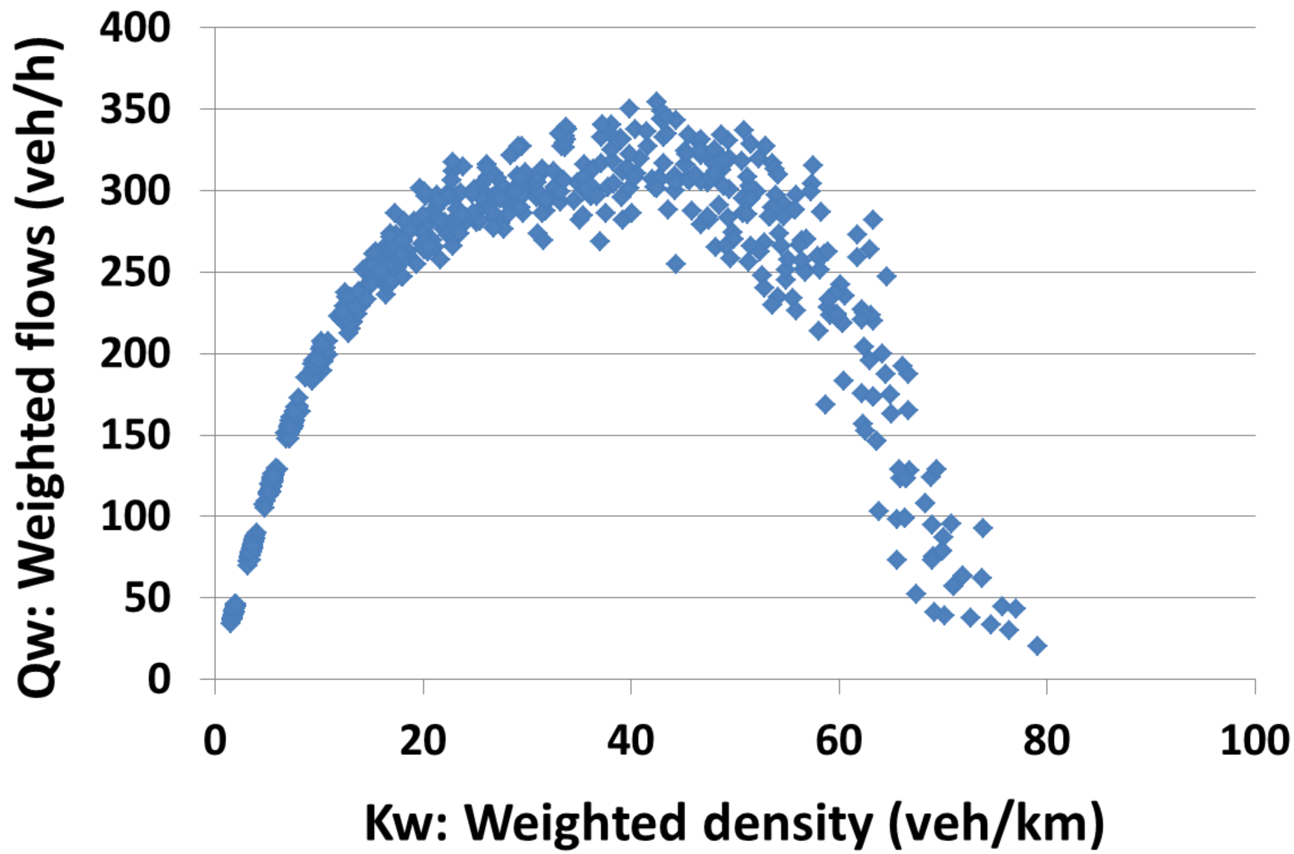
We carried an initial test using VISSIM

How did we do it using VISSIM?



- **VISSIM simulates traffic in the inner city of Zürich**
- **The demand data correspond to the 5-6 pm period on a working day**
- **All the transport modes interact in the simulation but the counts refer to: cars, vans, trucks and buses**
- **We stored the flow and density of every link in the network for every 5 minutes period**
- **In order to cover the whole MFD we considered 17 demand scenarios proportional to the original OD matrix**
- **Every simulation was repeated 4 times with different random seeds**
- **In total, 68 one-hour simulations were carried out**

What did we find?



$$q_w = \sum_i q_i \cdot l_i \Big/ \sum_i l_i$$

$$k_w = \sum_i k_i \cdot l_i \Big/ \sum_i l_i$$

qi: flow of the link
li: length of the link i

ki: density of the link
li: length of the link i

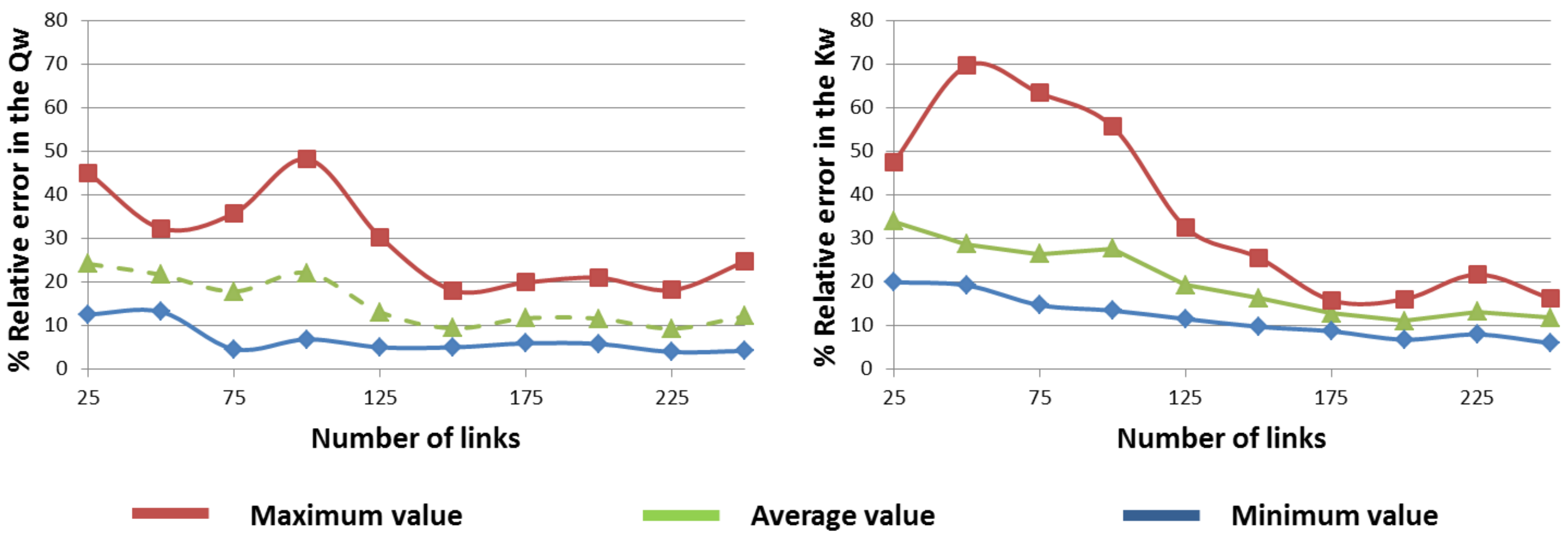
How can we get an even more realistic MFD?

Obtaining the MFD from the microsimulation model presents certain inaccuracies, which could be avoided with real data

- The real data needed to obtain a consistent MFD is provided by traffic measures at loop detectors
- It is necessary that the loop detector network is dense and homogeneous enough so all the network is measured
- The city of Zürich has 3,500 loop detectors, a rather large number for a city of its size

How many detectors would be necessary?

- VISSIM considered 1707 links to build the MFD
- We chose 6 different combinations of 25, 50, 75, 100, 125, 150, 175, 200, 225, and 250 random links…
- …To see how an MFD created with a limited number of detectors could look compared to the one obtained monitoring all links



With less than 10% of the links covered (150 links), the variability might be considerable

What are our next steps?

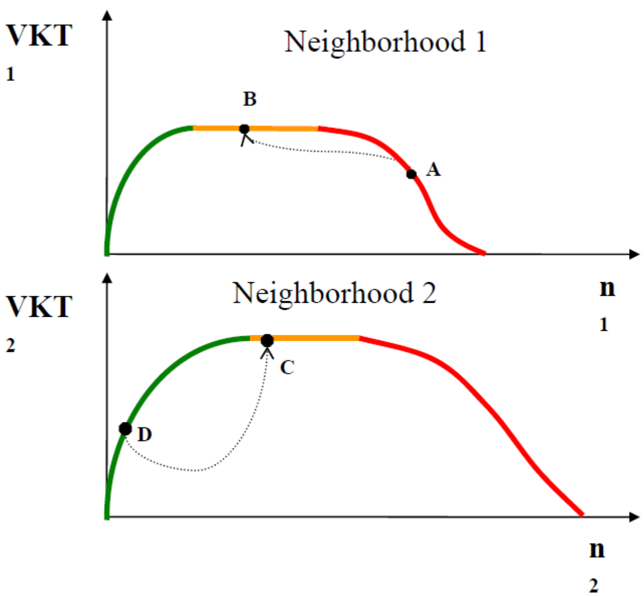
- Refine the MFD based on VISSIM
- Compare simulation results (MFD) with historical loop detector data
- Perform cost-benefit analysis of both existing ZüriTraffic and a possible MFD related strategy
- Further investigate the minimum number of loop detectors required for a proper MFD (placement of detectors according to street hierarchy or location)

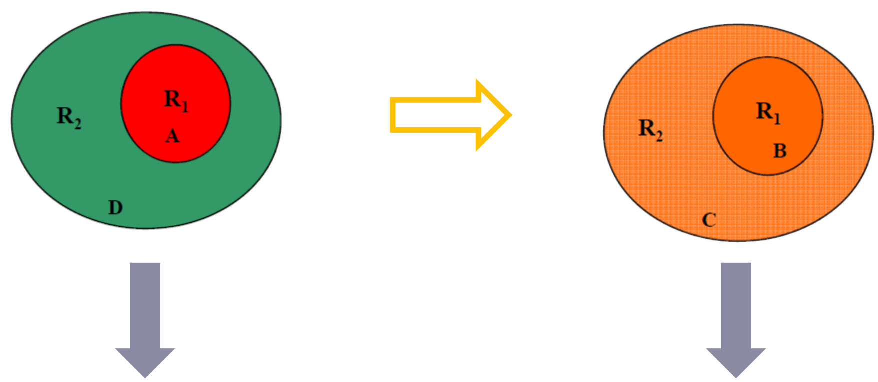
What can the city of Zürich do now?

- The city of **Zürich has 3500 loop detectors**, a rather large number for a city of its size
- The **monitoring** scheme needs very **efficient IT systems** to bring and process the information **at real time**
- With a better data gathering and more focus on the analysis of these data, **innovative traffic management techniques could be applied** (MFD as a ground for the new and improved ZüriTraffic)
- That amount of detectors not only is enough for building an MFD, but if the data was efficiently collected, new traffic management techniques and **cutting edge research could be carried out**

How could they use the MFD?

A Macroscopic perimeter control is a flexible and responsive mechanism to ensure a certain congestion state in the city





Congested central area and **uncongested** surroundings

Traffic more **homogeneously** distributed

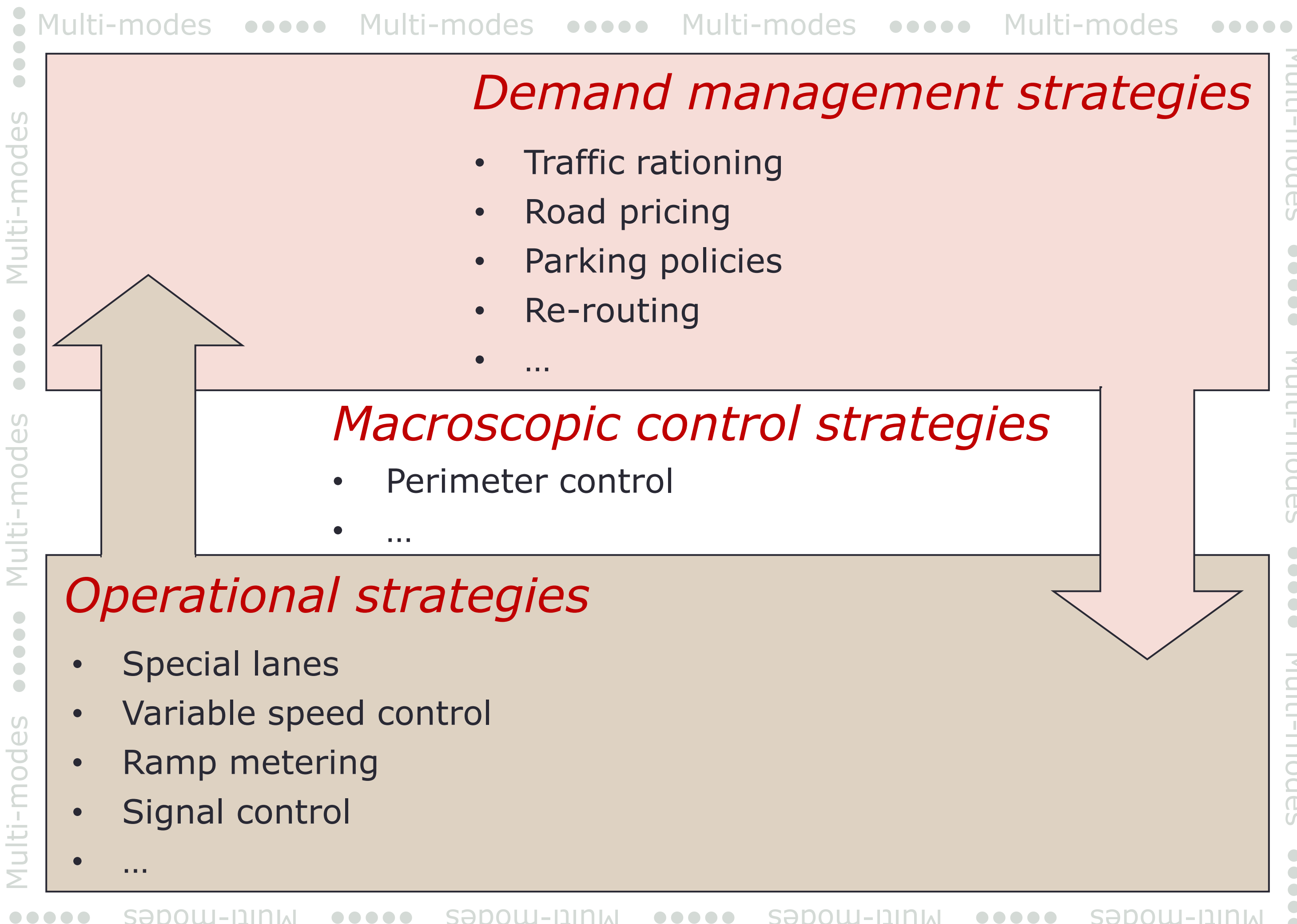
Are there any limitations?

- In the morning, the congestion might be spread to other areas

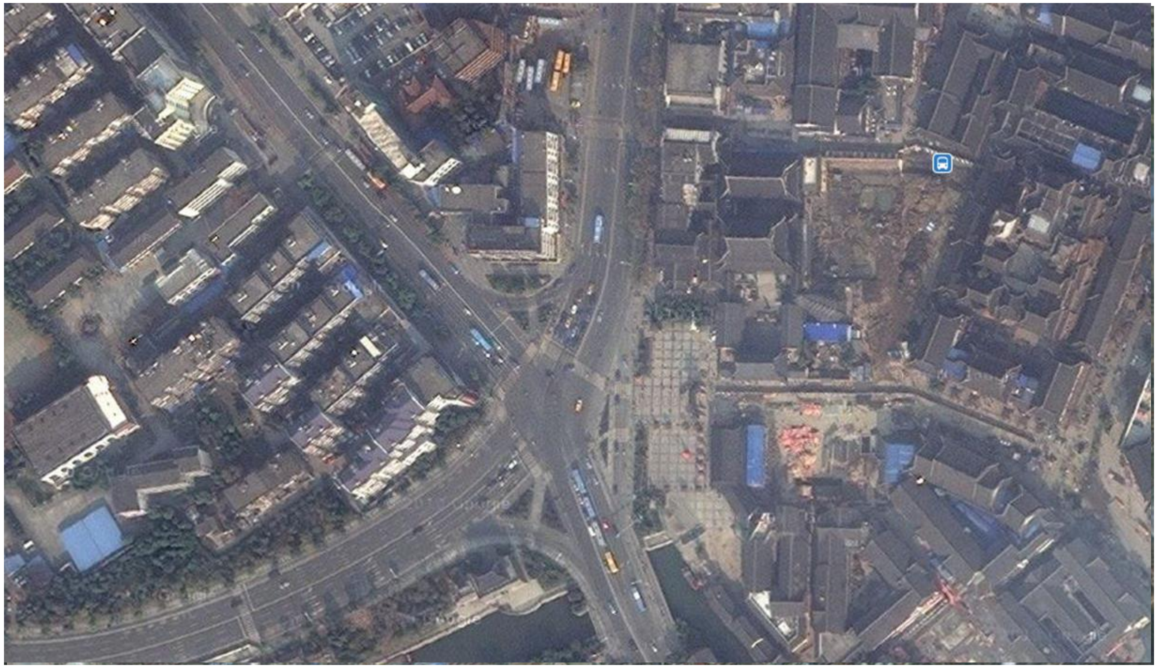
- In the afternoon, the capacity of the system is given by the capacity of the perimeter

To address these issues, you must address both the demand, and the operations of the system

What does that mean?



Could we see a picture?



- Demand management strategies
- Macroscopic traffic control strategies
- Microscopic (more operational) traffic control strategies

What are those strategies again?

Multi-modes ••••• Multi-modes ••••• Multi-modes ••••• Multi-modes •••••

Demand management strategies

- Traffic rationing
- Road pricing
- Parking policies
- Re-routing
- …

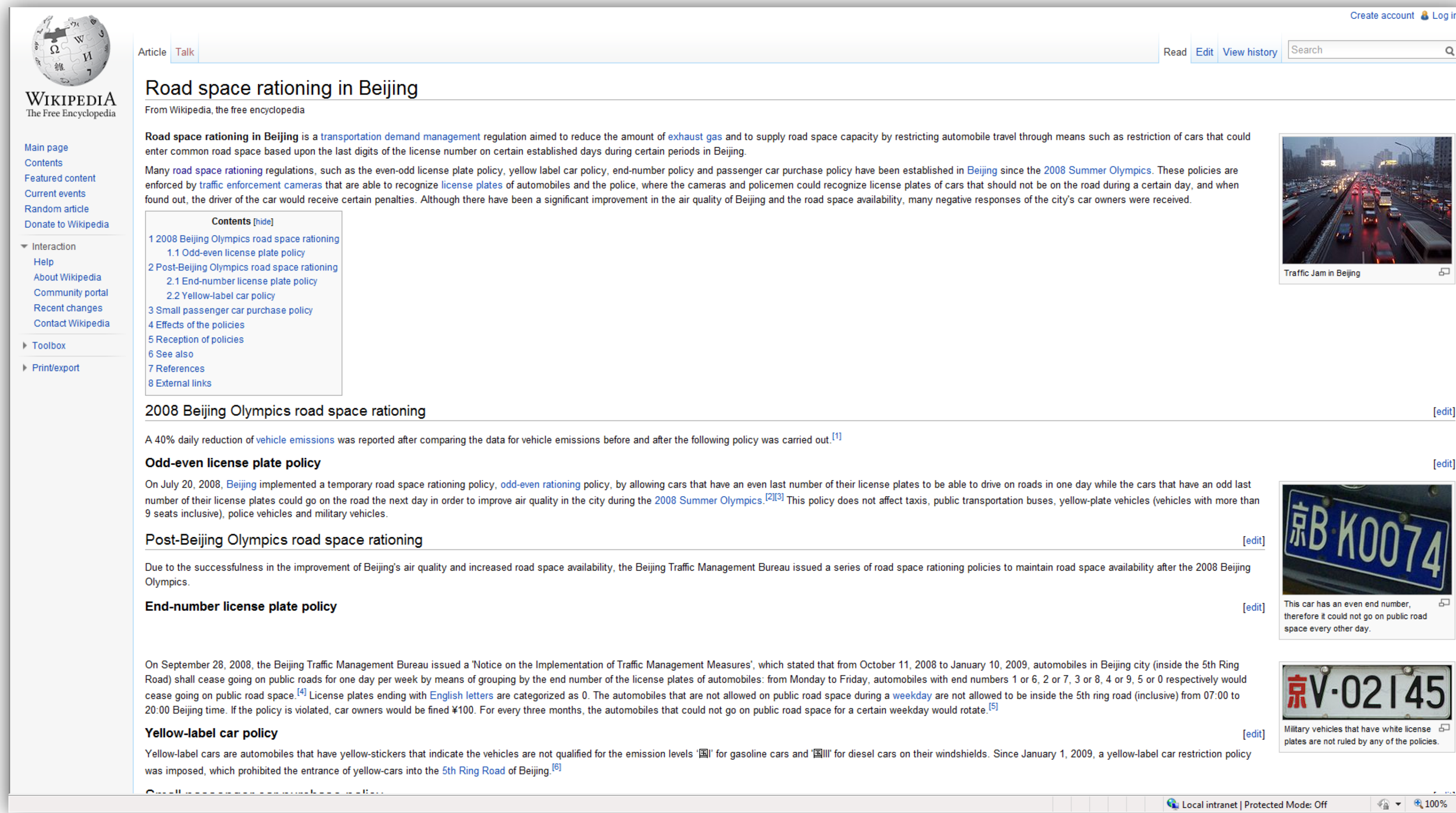
Macroscopic control strategies

- Perimeter control
- …

Operational strategies

- Special lanes
- Variable speed control
- Ramp metering
- Signal control
- …

Stop! You cannot drive today



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Road space rationing in Beijing

From Wikipedia, the free encyclopedia

Road space rationing in Beijing is a transportation demand management regulation aimed to reduce the amount of exhaust gas and to supply road space capacity by restricting automobile travel through means such as restriction of cars that could enter common road space based upon the last digits of the license number on certain established days during certain periods in Beijing.

Many road space rationing regulations, such as the even-odd license plate policy, yellow label car policy, end-number policy and passenger car purchase policy have been established in Beijing since the 2008 Summer Olympics. These policies are enforced by traffic enforcement cameras that are able to recognize license plates of automobiles and the police, where the cameras and policemen could recognize license plates of cars that should not be on the road during a certain day, and when found out, the driver of the car would receive certain penalties. Although there have been a significant improvement in the air quality of Beijing and the road space availability, many negative responses of the city's car owners were received.

Traffic Jam in Beijing

Contents [hide]

2008 Beijing Olympics road space rationing [edit]

A 40% daily reduction of vehicle emissions was reported after comparing the data for vehicle emissions before and after the following policy was carried out.[1]

Odd-even license plate policy [edit]

On July 20, 2008, Beijing implemented a temporary road space rationing policy, odd-even rationing policy, by allowing cars that have an even last number of their license plates to be able to drive on roads in one day while the cars that have an odd last number of their license plates could go on the road the next day in order to improve air quality in the city during the 2008 Summer Olympics.[2][3] This policy does not affect taxis, public transportation buses, yellow-plate vehicles (vehicles with more than 9 seats inclusive), police vehicles and military vehicles.

This car has an even end number, therefore it could not go on public road space every other day.

Post-Beijing Olympics road space rationing [edit]

Due to the successfulness in the improvement of Beijing's air quality and increased road space availability, the Beijing Traffic Management Bureau issued a series of road space rationing policies to maintain road space availability after the 2008 Beijing Olympics.

End-number license plate policy [edit]

On September 28, 2008, the Beijing Traffic Management Bureau issued a 'Notice on the Implementation of Traffic Management Measures', which stated that from October 11, 2008 to January 10, 2009, automobiles in Beijing city (inside the 5th Ring Road) shall cease going on public roads for one day per week by means of grouping by the end number of the license plates of automobiles: from Monday to Friday, automobiles with end numbers 1 or 6, 2 or 7, 3 or 8, 4 or 9, 5 or 0 respectively would cease going on public road space.[4] License plates ending with English letters are categorized as 0. The automobiles that are not allowed on public road space during a weekday are not allowed to be inside the 5th ring road (inclusive) from 07:00 to 20:00 Beijing time. If the policy is violated, car owners would be fined ¥100. For every three months, the automobiles that could not go on public road space for a certain weekday would rotate.[5]

Military vehicles that have white license plates are not ruled by any of the policies.

Yellow-label car policy [edit]

Yellow-label cars are automobiles that have yellow-stickers that indicate the vehicles are not qualified for the emission levels '国I' for gasoline cars and '国III' for diesel cars on their windshields. Since January 1, 2009, a yellow-label car restriction policy was imposed, which prohibited the entrance of yellow-cars into the 5th Ring Road of Beijing.[6]

Local intranet | Protected Mode: Off 100%

No money, no driving

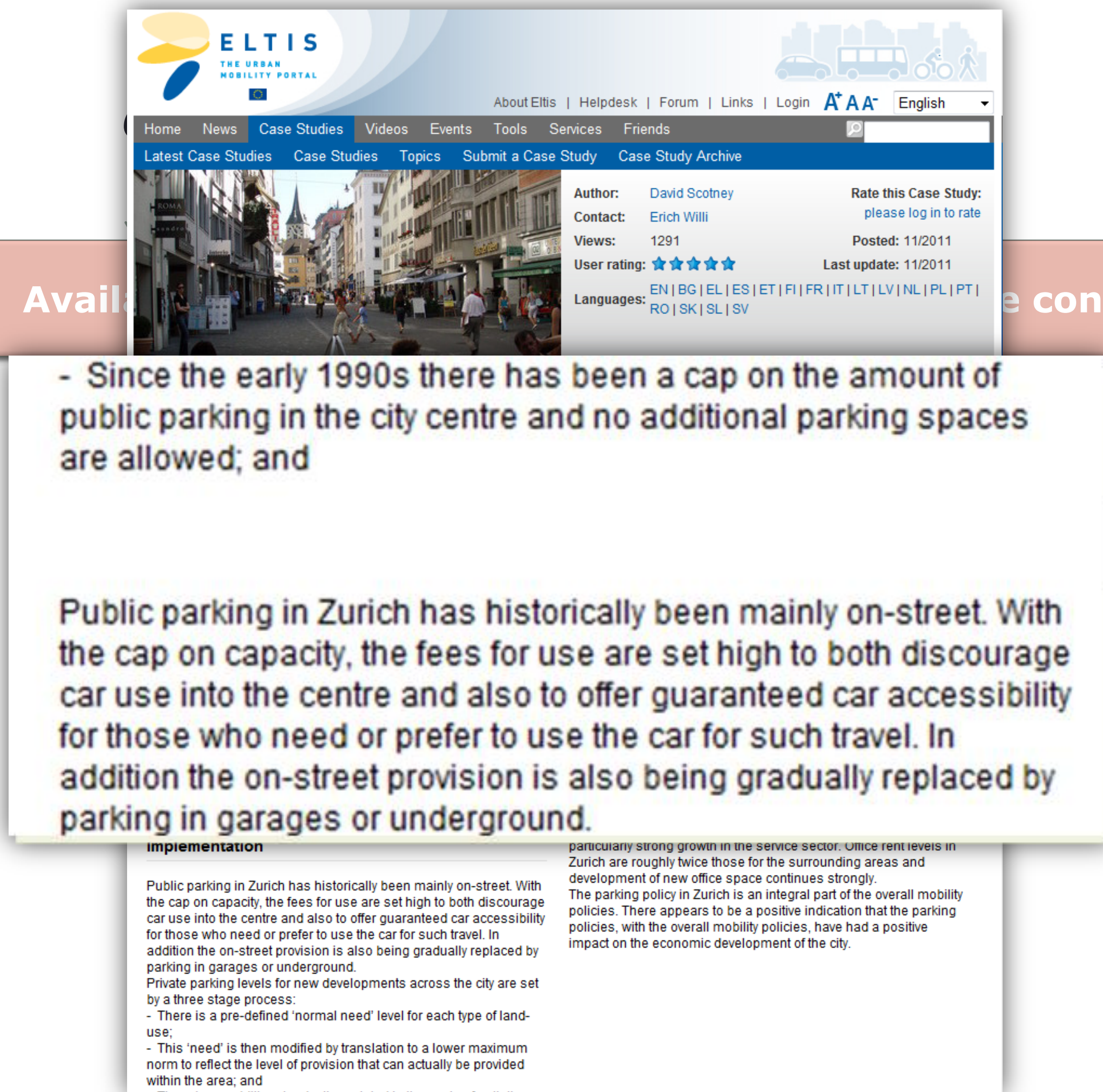
Types of road pricing

- Network fixed pricing
- Zone pricing (fixed or variable)
  - Cordon pricing
  - Area pricing
- Road pricing
  - Traditional tolls
  - Variable pricing
  - HOT (High Occupancy Toll) lanes

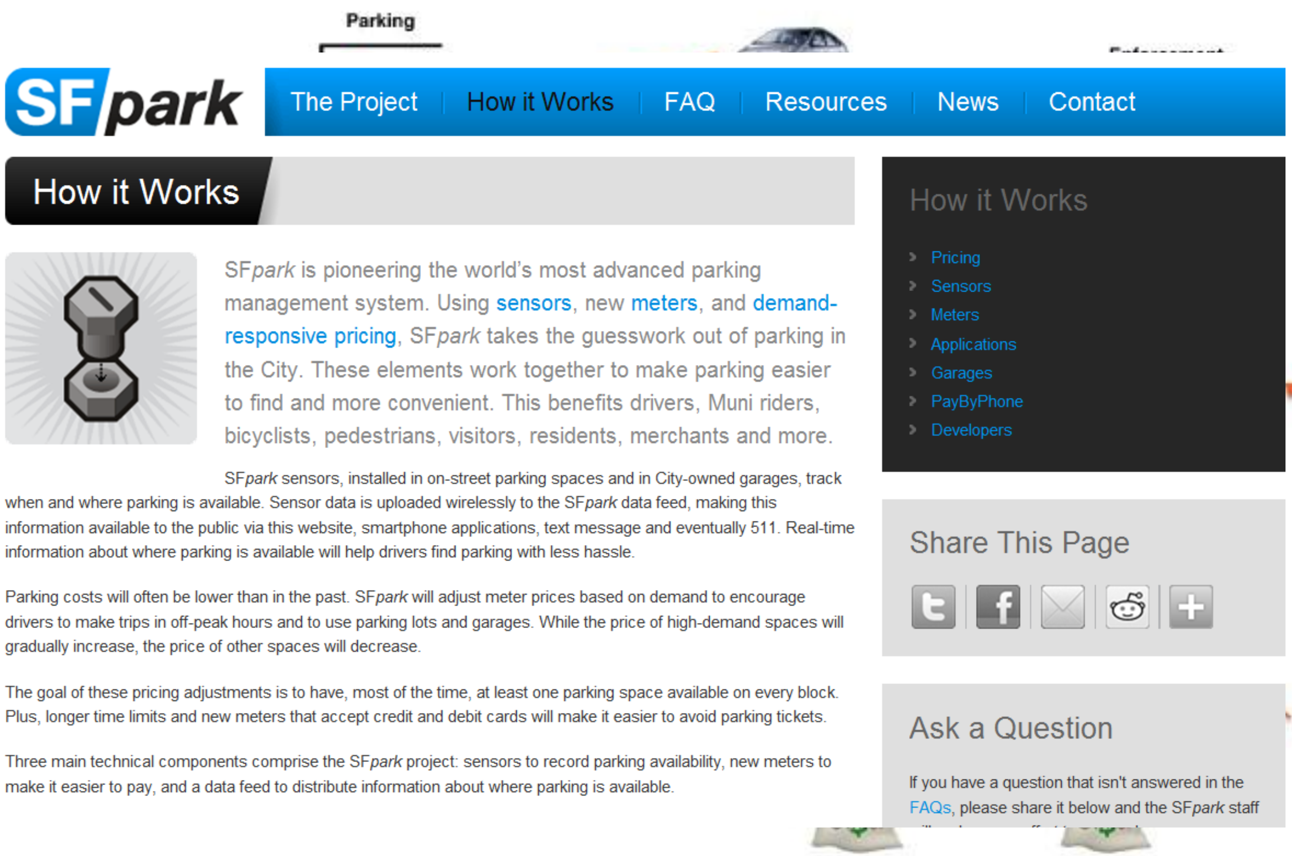
No parking available ☹

Avail

e controls



No parking available ☹


SFpark

The Project | How it Works | FAQ | Resources | News | Contact

How it Works

SF*park* is pioneering the world's most advanced parking management system. Using sensors, new meters, and demand-responsive pricing, SF*park* takes the guesswork out of parking in the City. These elements work together to make parking easier to find and more convenient. This benefits drivers, Muni riders, bicyclists, pedestrians, visitors, residents, merchants and more.

SF*park* sensors, installed in on-street parking spaces and in City-owned garages, track when and where parking is available. Sensor data is uploaded wirelessly to the SF*park* data feed, making this information available to the public via this website, smartphone applications, text message and eventually 511. Real-time information about where parking is available will help drivers find parking with less hassle.

Parking costs will often be lower than in the past. SF*park* will adjust meter prices based on demand to encourage drivers to make trips in off-peak hours and to use parking lots and garages. While the price of high-demand spaces will gradually increase, the price of other spaces will decrease.

The goal of these pricing adjustments is to have, most of the time, at least one parking space available on every block. Plus, longer time limits and new meters that accept credit and debit cards will make it easier to avoid parking tickets.

Three main technical components comprise the SF*park* project: sensors to record parking availability, new meters to make it easier to pay, and a data feed to distribute information about where parking is available.

How it Works

- Pricing
- Sensors
- Meters
- Applications
- Garages
- PayByPhone
- Developers

Share This Page

Ask a Question

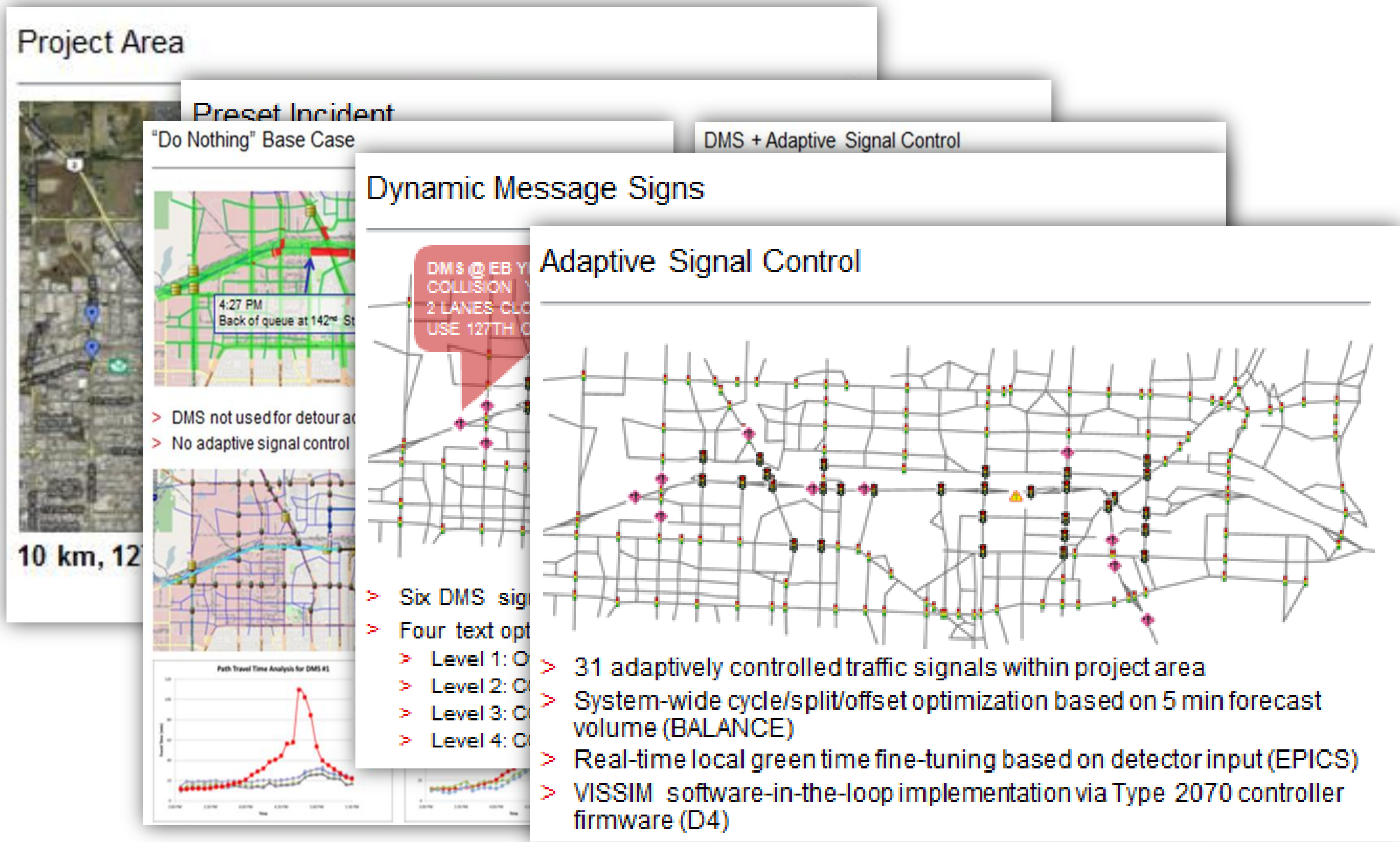
If you have a question that isn't answered in the FAQs, please share it below and the SF*park* staff

Source: www.sparkparking.com

- Pricing (demand responsive pricing)
- Sensors (to track parking availability)
- Meters (accepting different types of payment, incl. credit)
- Computer apps (real time information on cells, text messages, computer maps, variable signs)
- Garages (with variable pricing)
- PayByPhone (add time without returning to meter)
- Developers (free public data feed)

Re-routing

Take that route! This one is not good



Source: PTV

No, this lane is not for you

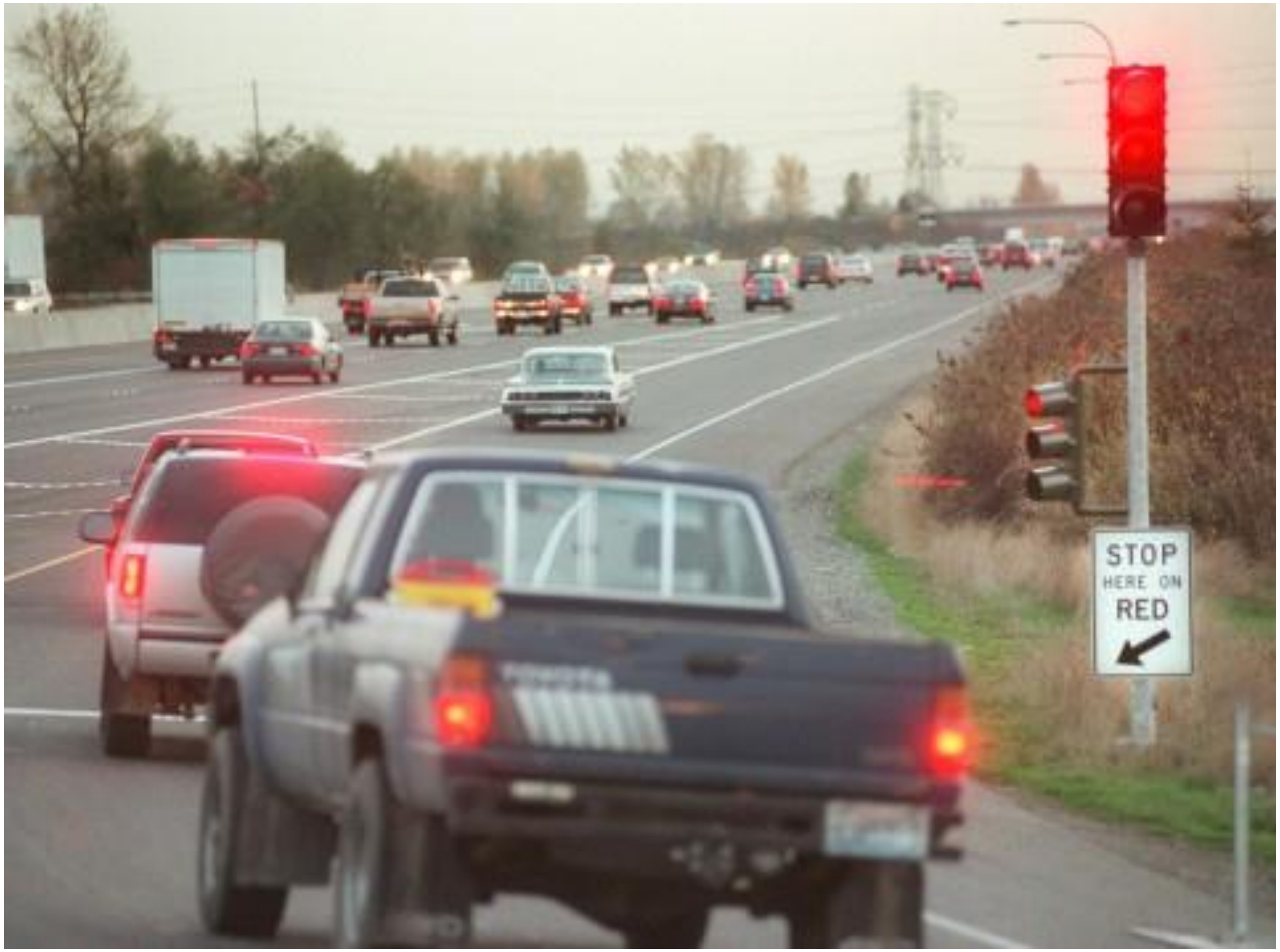
Temporary use of hard shoulder

Bus lanes

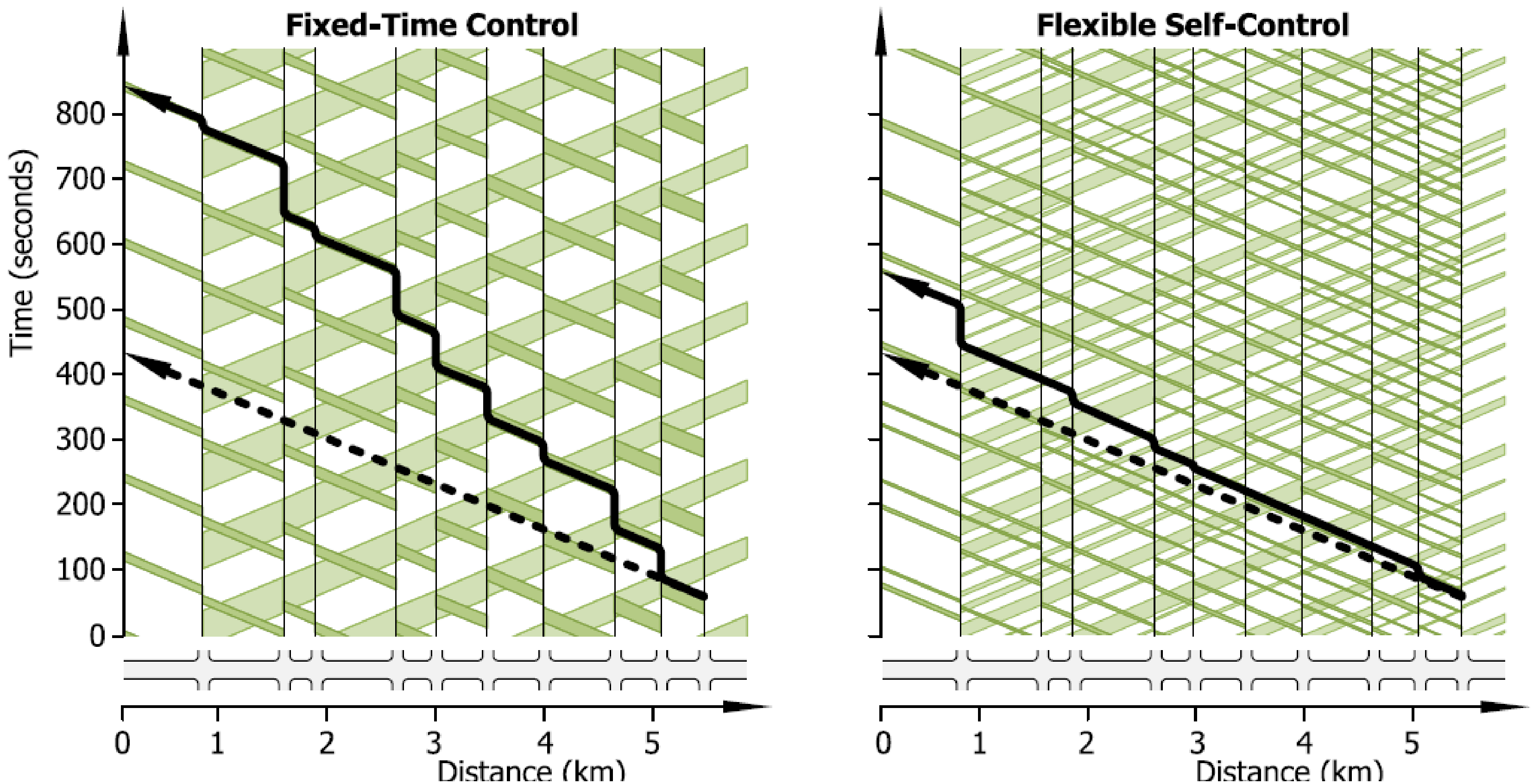
High Occupancy Vehicle (HOV) lanes

Slow down please!

You must stop! The highway is full



You might be able to get more greens



Source: Self-Stabilizing Decentralized Signal Control of Realistic, Saturated Network Traffic (Lämmer & Helbing, 2010)

With so many things, where are we going?

Loop detectors, Video, Car2X communications, etc.

Traffic control center, Simulators, Car smart systems, etc.

In-vehicle navigation systems

Traffic signals

Variable message signs

Lane control signals

What is our emphasis / goal at SVT?

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

Questions?

Backup

Traffic management strategies

- Traffic rationing
- Road pricing (cordon, area, toll roads, toll lanes, …)
- Parking policies
- Dedicated vs. shared lanes (static or dynamic), e.g., buses, HOVs
- Perimeter traffic control
- Signal control
- Ramp metering
- Variable speed control
- Variable message signs
- …

Traffic management tools

- Traditional traffic data collection mechanisms (e.g., loop detectors, video cameras…)
- New traffic data collection technology (e.g., Car2X communications, Bluetooth devices…)
- Simulations (microscopic, mesoscopic, macroscopic)
- Traffic information outlets (variable message signs, navigation devices, smart phones…)
- Traffic control infrastructure (variable signs, traffic signals, ramp meters…)