CONTROLLING TRAFFIC IN ZÜRICH: A MACROSCOPIC APPROACH

Mónica Menéndez

IVT

ETH Zürich

CICTP

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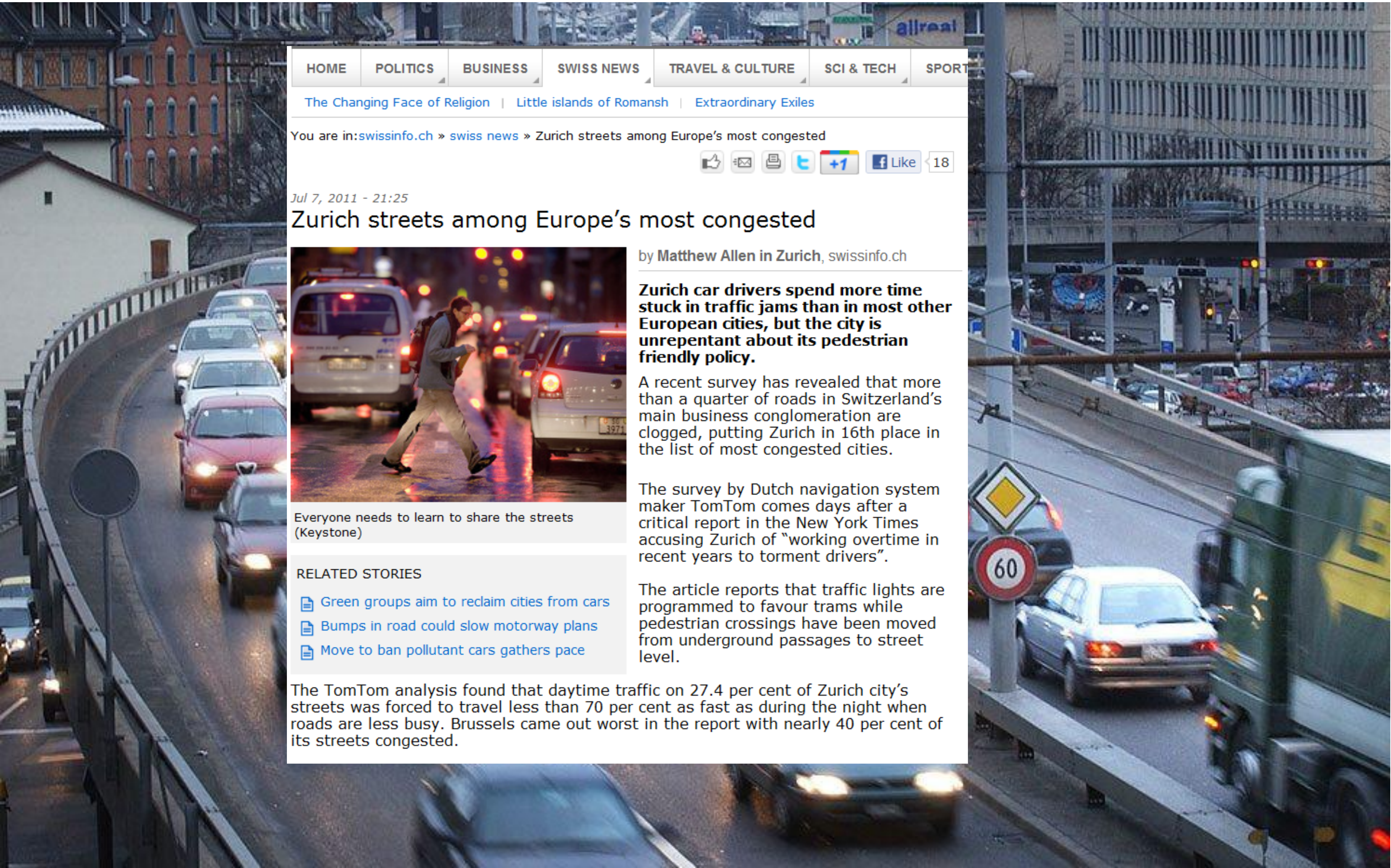
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

Why are we interested in Zürich?



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Zurich streets among Europe's most congested

Everyone needs to learn to share the streets (Keystone)

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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.

Why does congestion happen in Zürich?

Because the capacity of the street network is not able to cope with all the traffic demand

- The city concentrates **many activities** in a small area
- **Commuters**, typically, create the biggest traffic problems
- Normally, the worst scenarios happen on working days in the **morning** and in the **evening peaks**

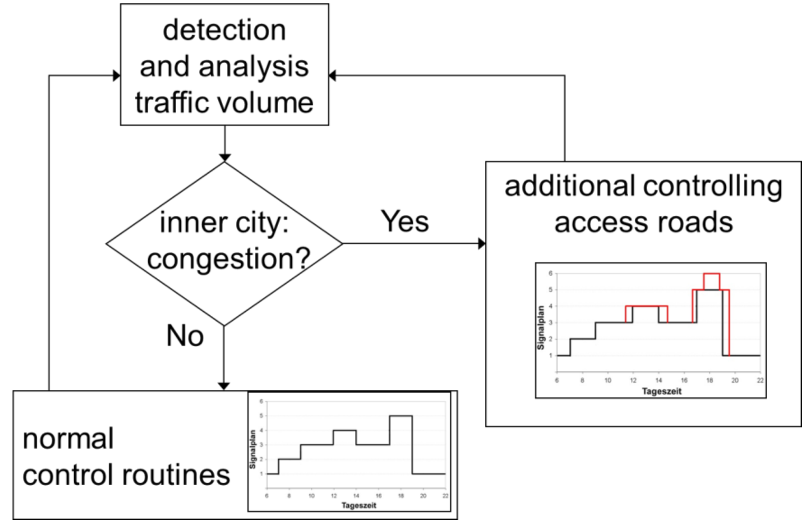
What does the city do about congestion?

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:
  1. It measures the traffic behavior in just a few city streets
  2. It is based on a static and possibly out-of-date demand model (has not been updated since 2007)
  3. 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

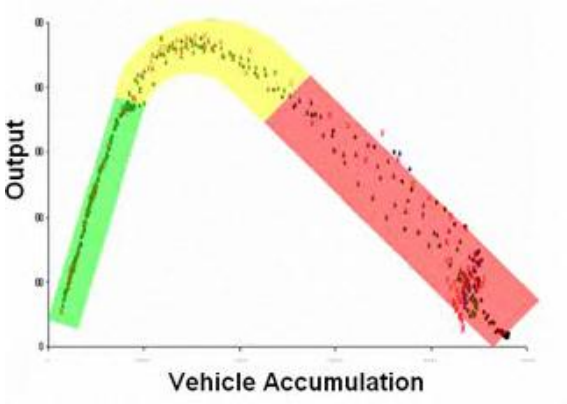
What do we propose?

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 us 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?

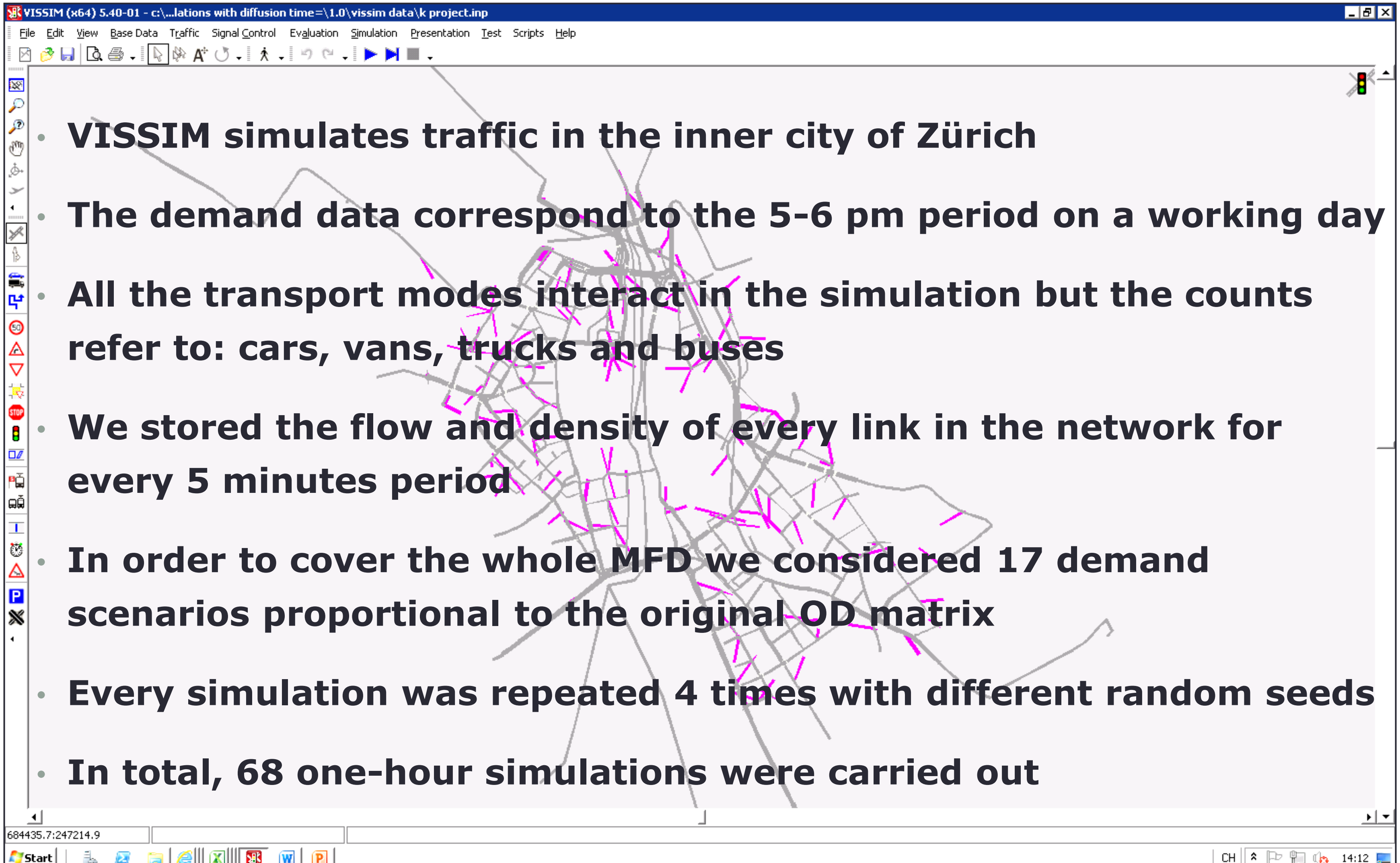
- It could be shown that the traffic states in the links that are measured by *ZüriTraffic* do not necessarily represent the performance of the entire network. The MFD does
- The MFD is independent of the demand patterns, so there is no need to identify demand patterns on a regular basis; and the methodology 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

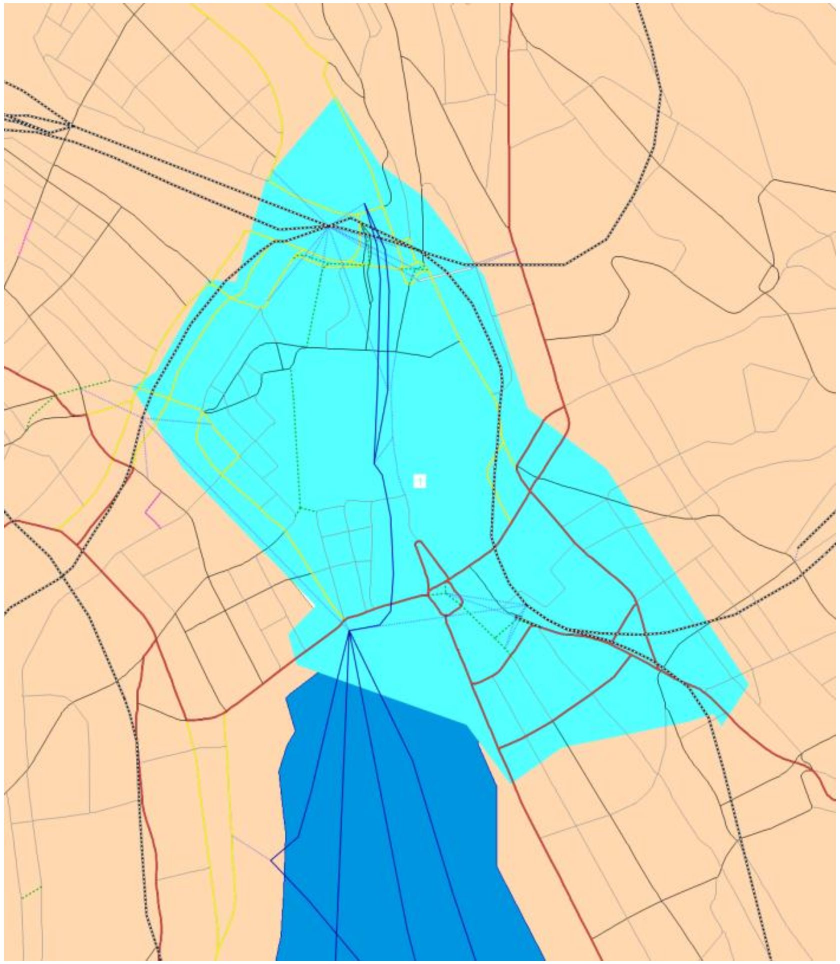
We carried an initial test using VISSIM

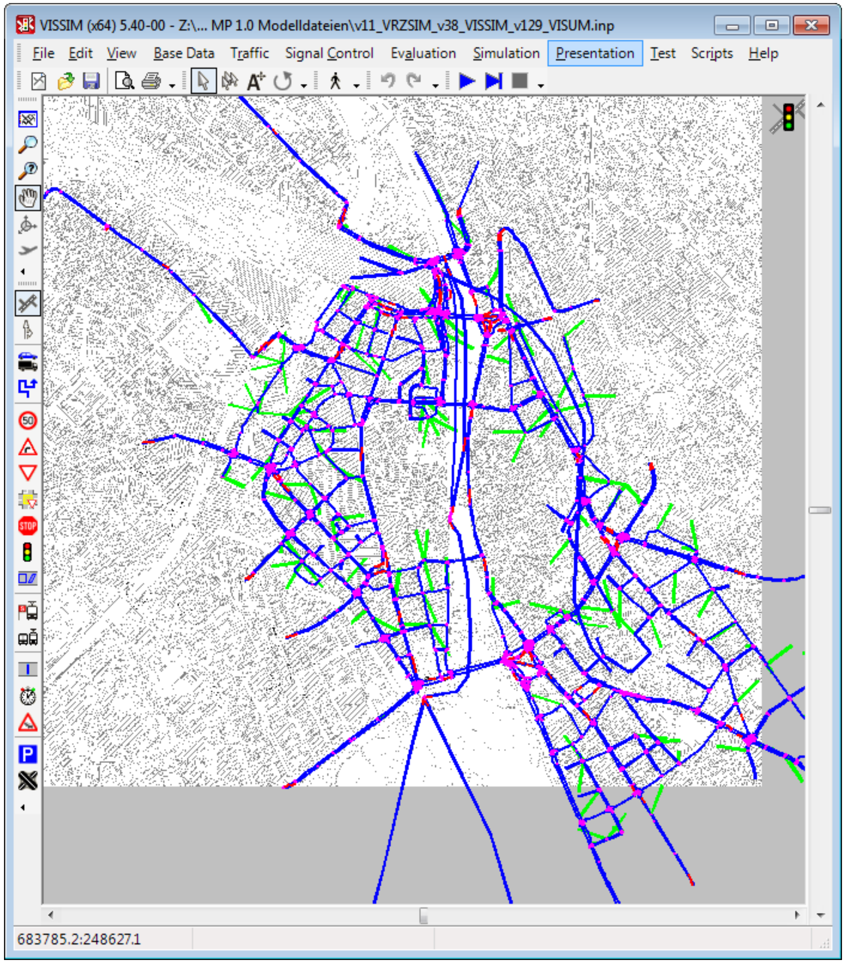
How did we do it using VISSIM?



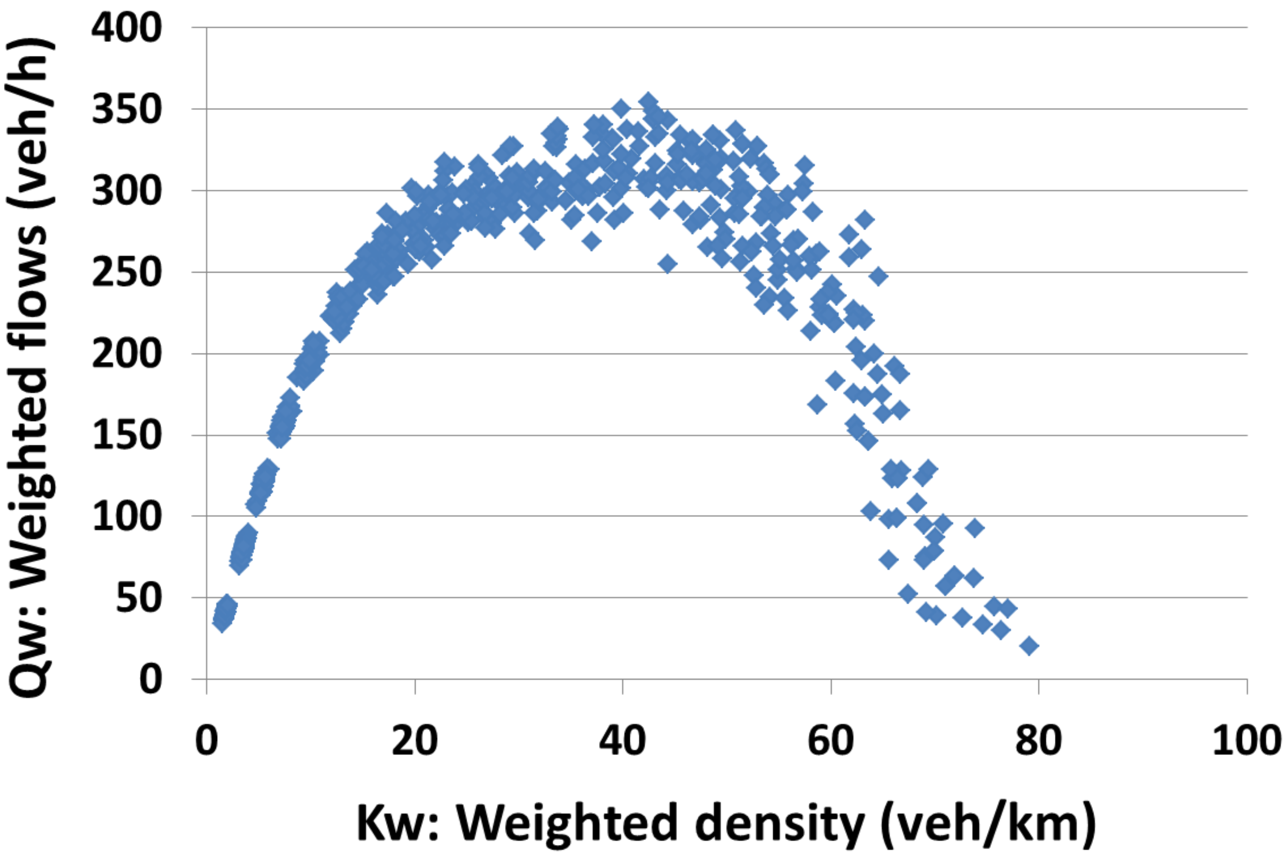
- **VISSIM simulates traffic in the inner city of Zürich**
- **The demand data correspond to the 5-6 pm period on a working day**
- **All the transport modes interact in the simulation but the counts refer to: cars, vans, trucks and buses**
- **We stored the flow and density of every link in the network 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 was the study area?





What did we find?



$$q_w = \frac{\sum_i q_i \cdot l_i}{\sum_i l_i}$$

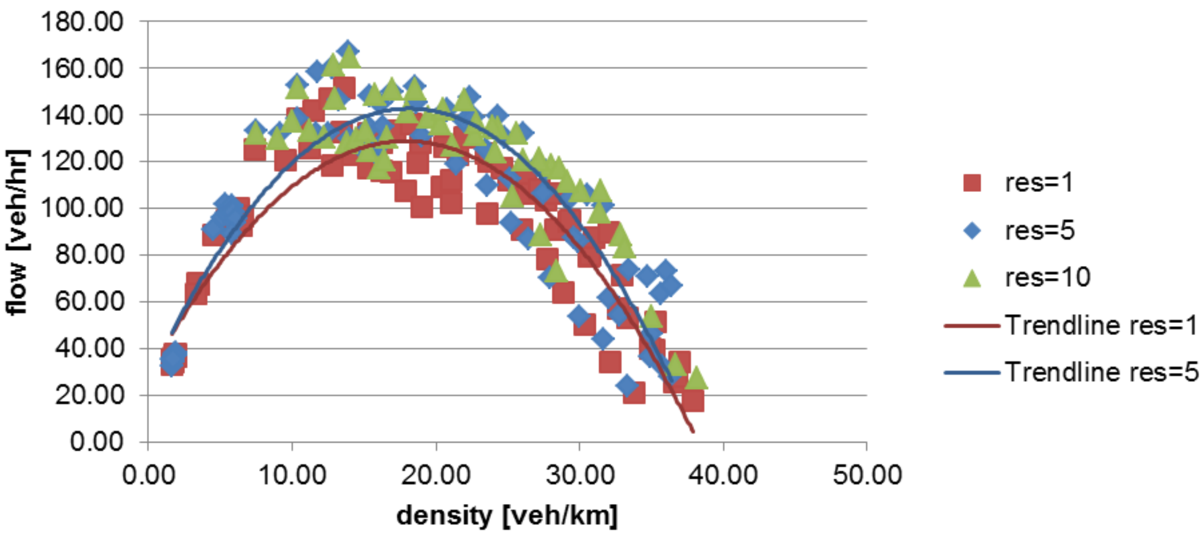
$$k_w = \frac{\sum_i k_i \cdot l_i}{\sum_i l_i}$$

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

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

Which factors are influencing the MFD?

- Non realistic links
- Resolution
- Warm-up time
- VISSIM calibration
- Traffic light scheme
- Demand factors (disappearance rate)



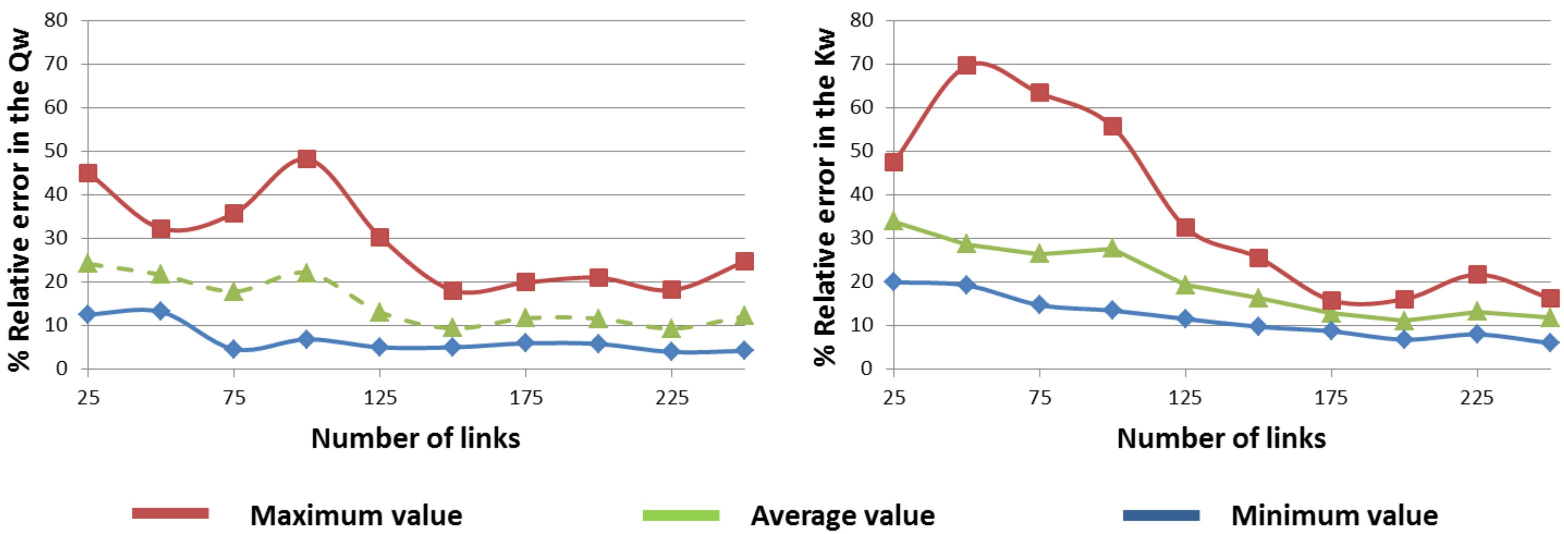
How can we get an even more realistic MFD?

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 of the MFD might be considerable

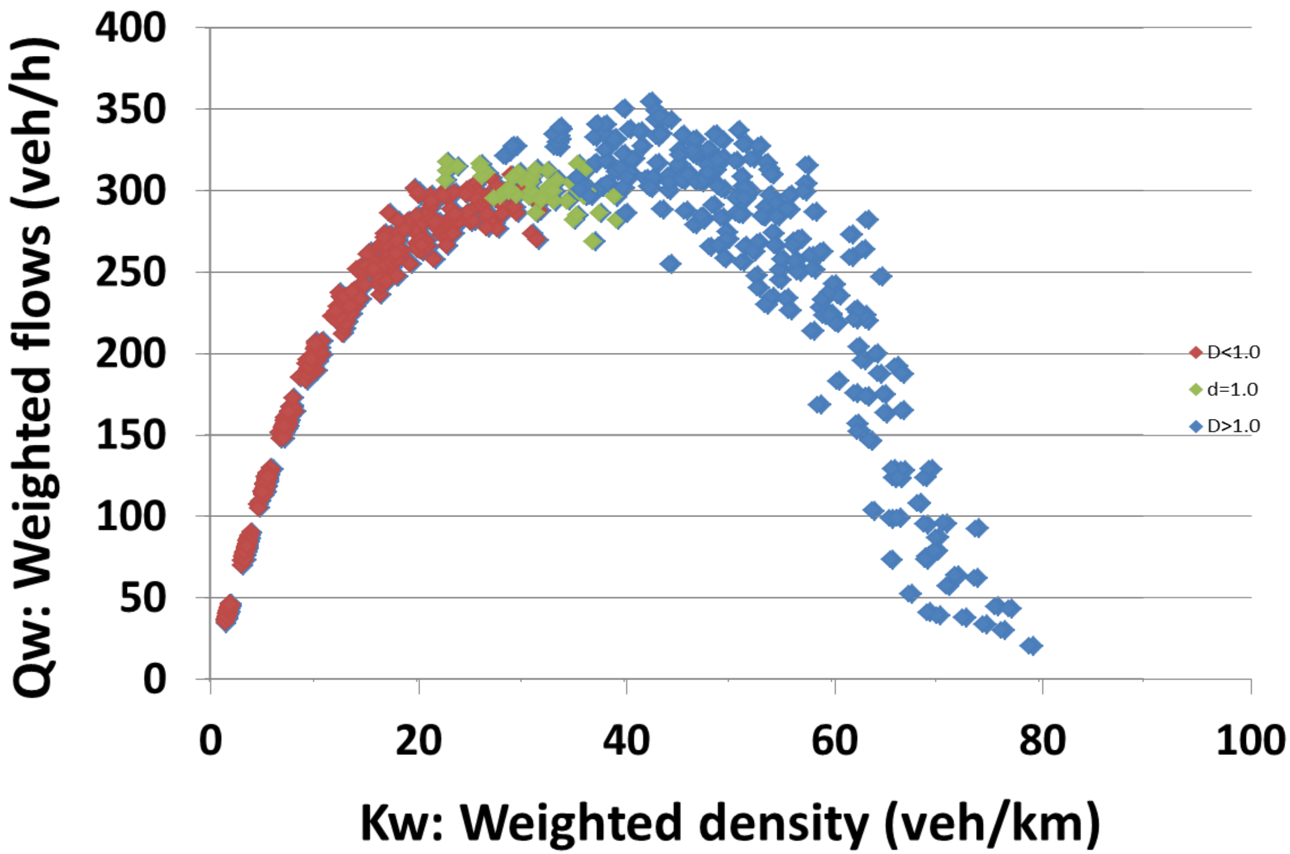
What are our next steps?

- Refine 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)
- Start a new data retrieval program with the City of Zürich, and explore real life control algorithms

Questions?

Backup

What did we find?



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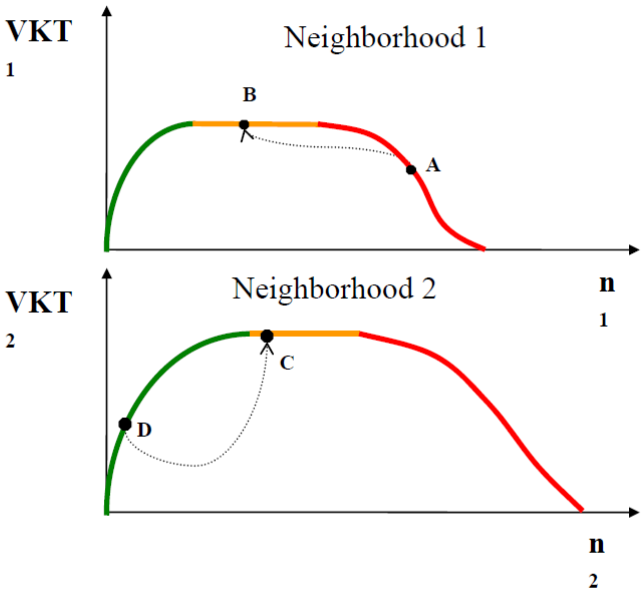
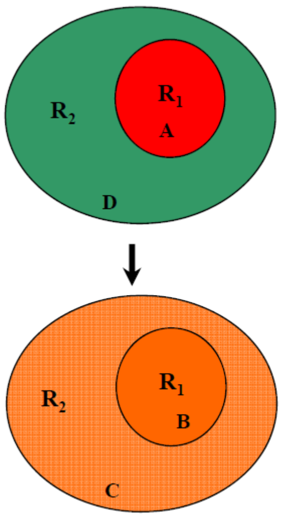
How can we use the MFD?

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





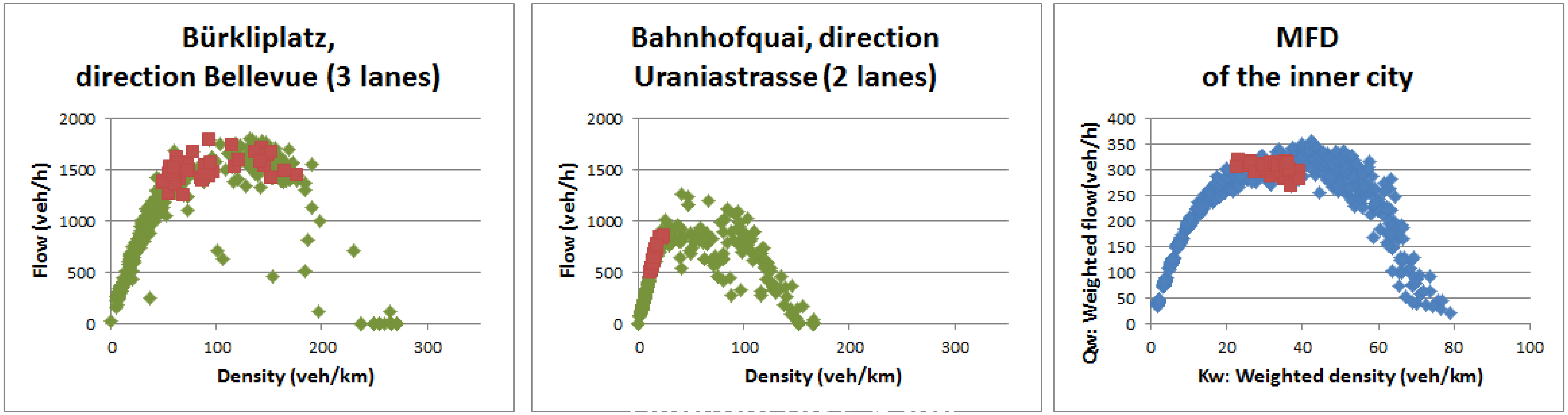
→ **Congested** central area and **uncongested** surroundings

→ Traffic more **homogeneously** distributed

Let's compare it to the adaptive control system!

How similar are the MFD and ZüriTraffic?

We have chosen 2 of the links that are measured by Züritraffic, and we plot their individual fundamental diagrams with the VISSIM simulation data:



- The two links present different shapes and reach congestion at different times

The MFD, in contrast to the ZüriTraffic, might provide a better global view of the system

What are the 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 the demand

How can we address this situation?

- Better and more rational planning of cities and transport systems
- Promotion of more sustainable transport modes
- Pricing strategies
- More efficient operations

What should the city of Zürich do then?

- 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**