

# The MFD for traffic control

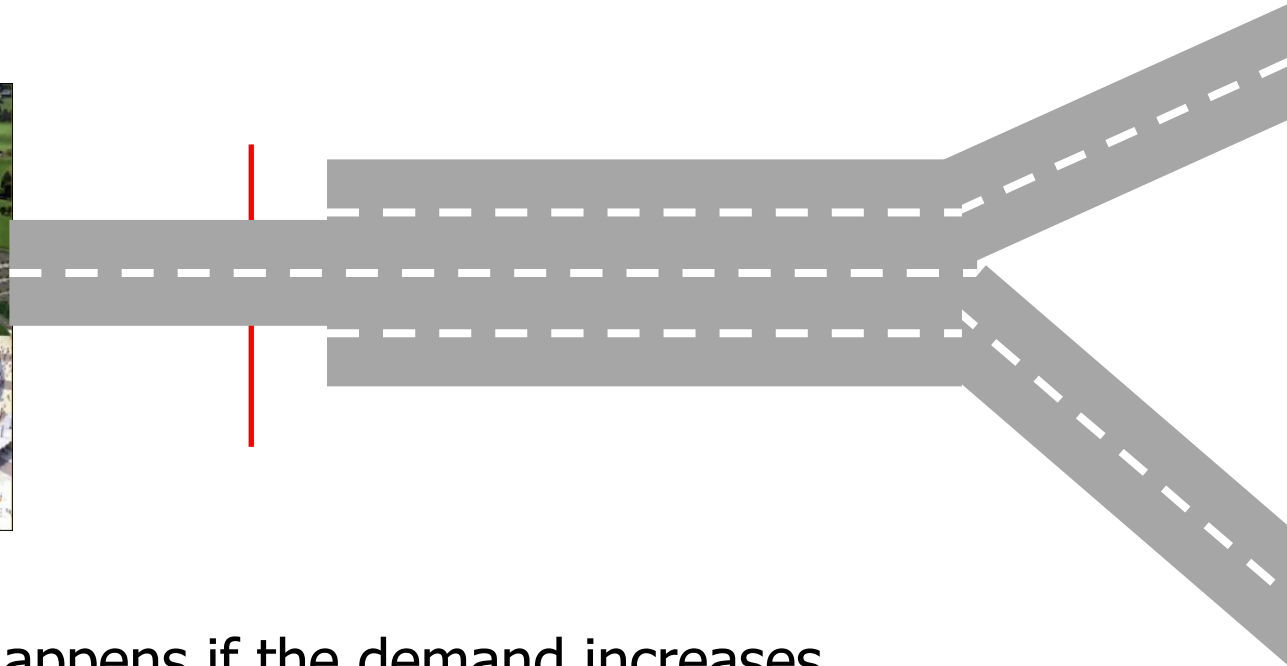
Comparing traffic control schemes

Victor L. Knoop

10 Oct 2019

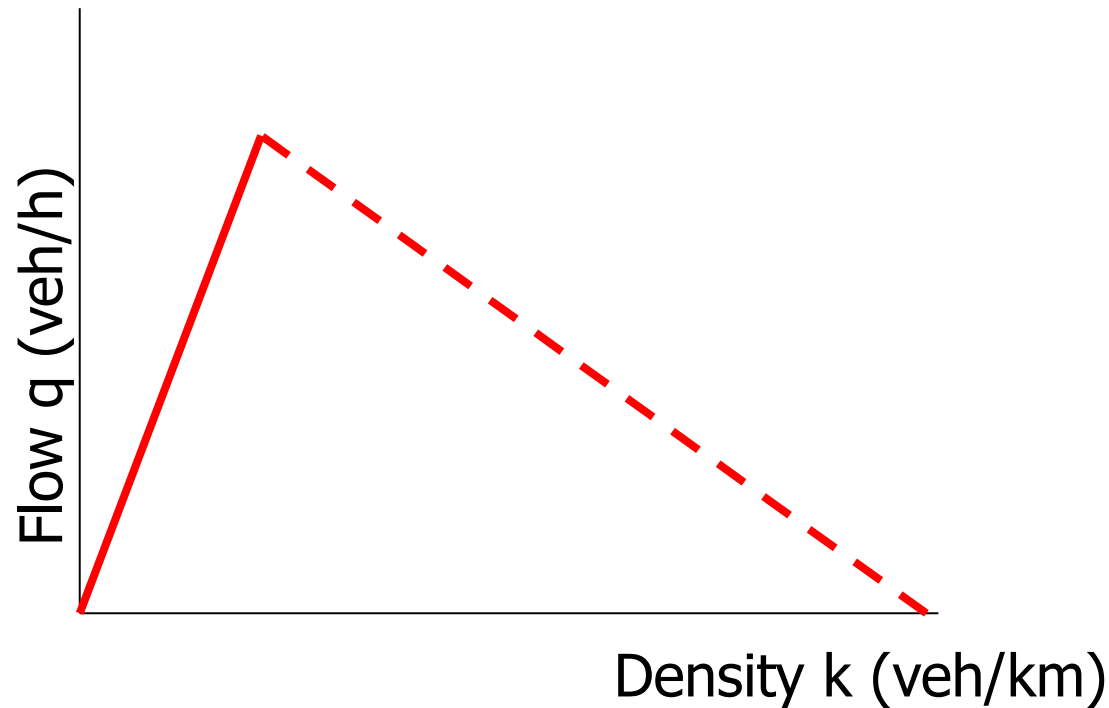
# **Introduction to the MFD**

# Simple road with increasing demand

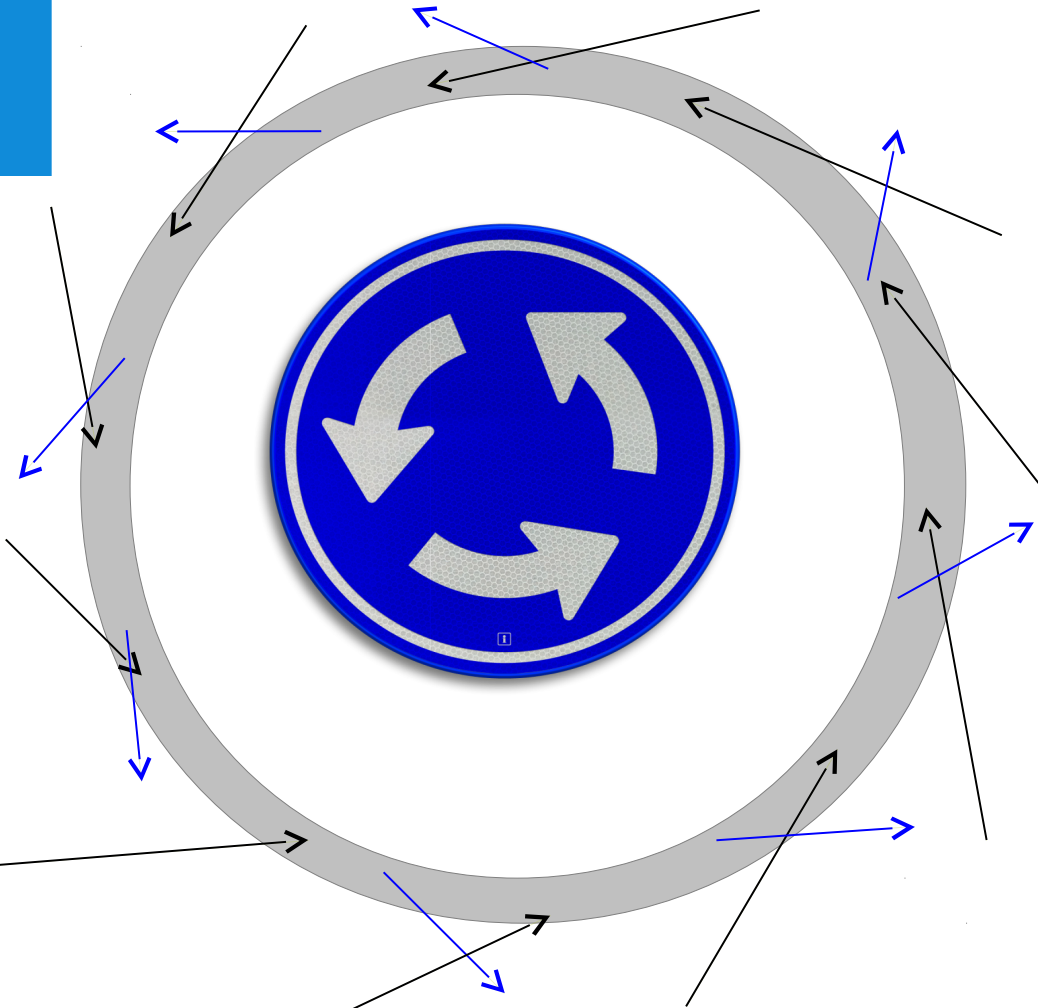


What happens if the demand increases

# Simple road with varying demand



# Not so simple road



- Origins and destinations everywhere
- By increasing input => **congestion**
- **Major difference with road!**

## Scales

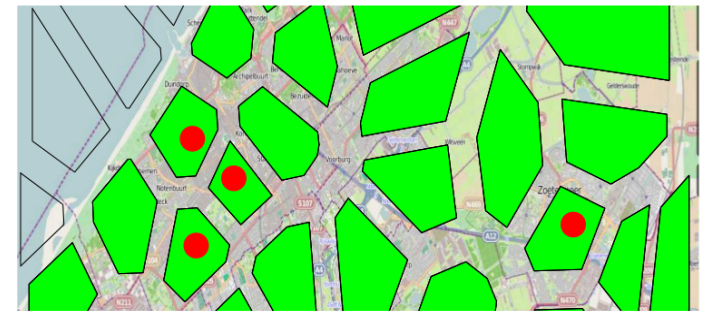
- Microscopic: vehicle level
- Macroscopic: link level
- New level: network level



Vehicle level



Link level

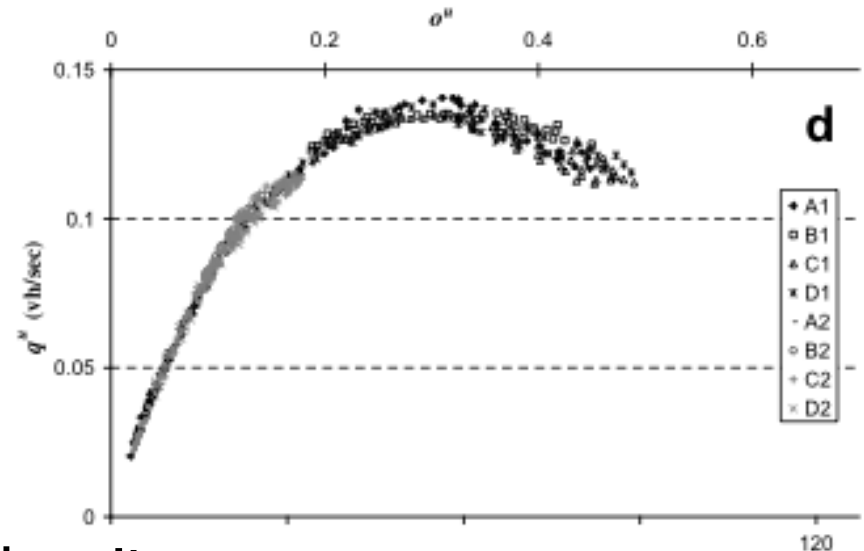
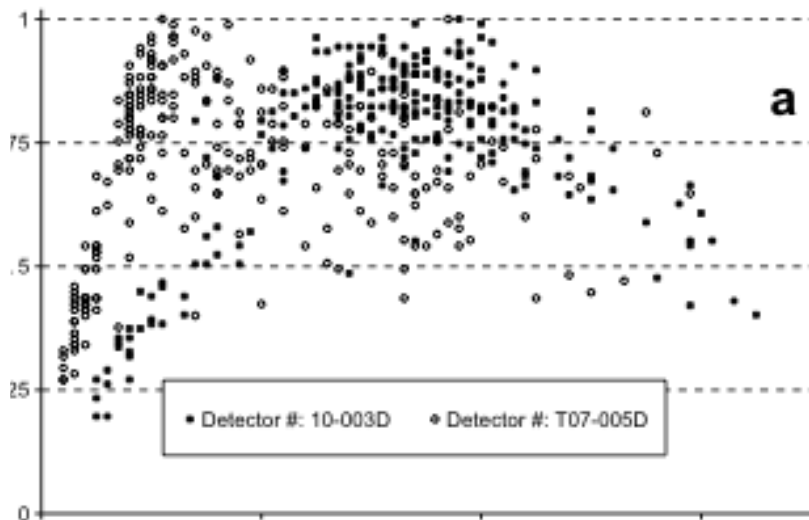


(Sub-)network level

# Stochasticity in local data

- Macroscopic fundamental diagram
- “Average” fundamental diagram for an area

• (Avg.) Flow =>

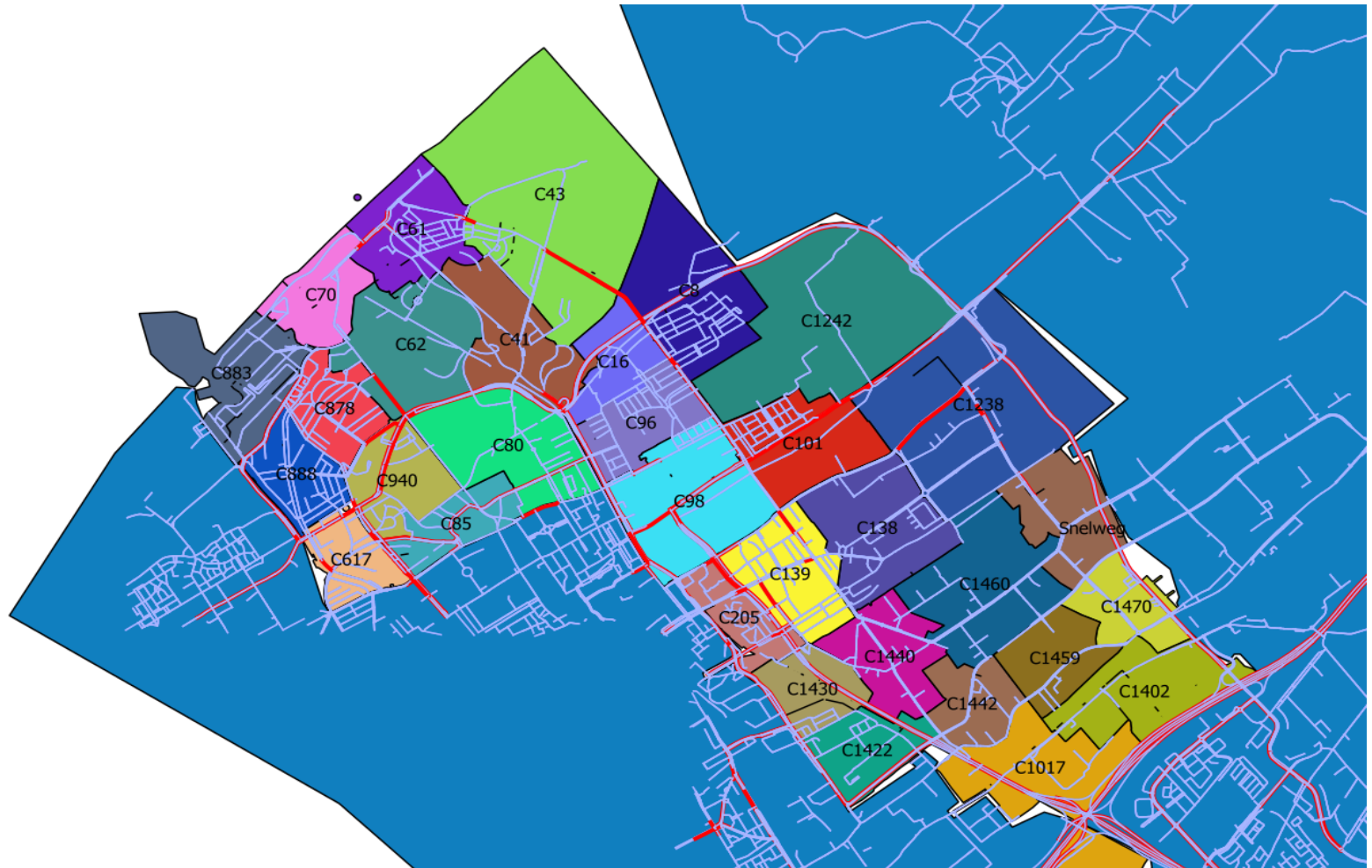


Density

Average density

Fig: (Geroliminis and Daganzo)

# Example from practice: the Hague





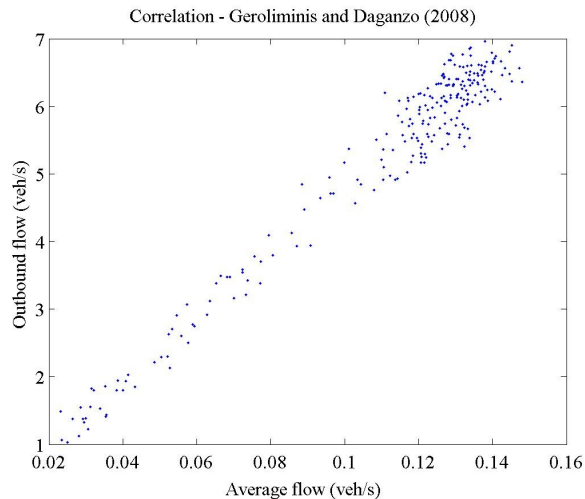
# Randstad area (Mark Sloot)



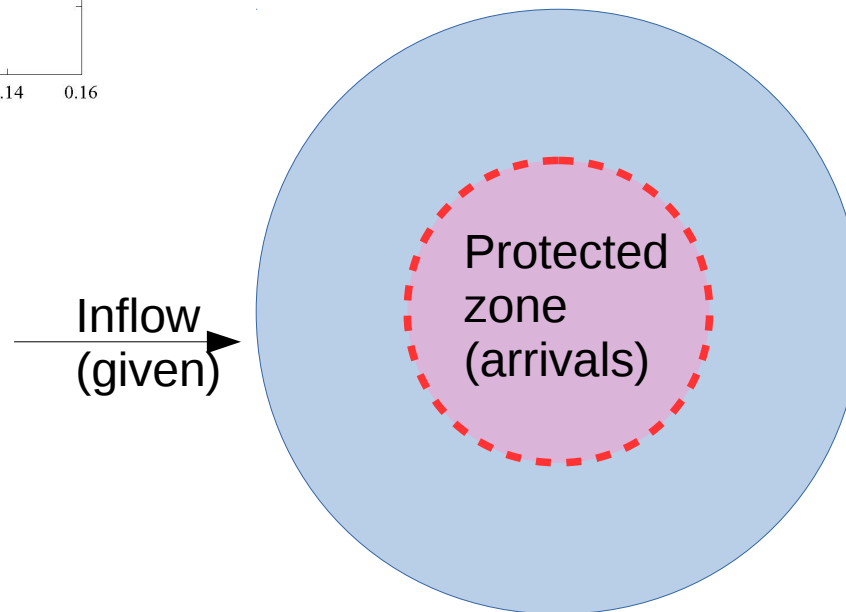
# Name giving

- Macroscopic Fundamental Diagram = Network Fundamental Diagram
- Name giving
  - Average density = *Accumulation*
  - Average (internal) flow = *production*
  - Outflow = *performance*

# Relation performance - production



Minimum delay (given fixed inflow)  
is maximum outflow  
(No longer travel lengths)  
Maximum outflow is top of MFD  
=> Limit accumulation by reducing  
inflow into a protected area of arrivals



# Urban traffic control with MFD

# Paper details

Transportmetrica B (2019)

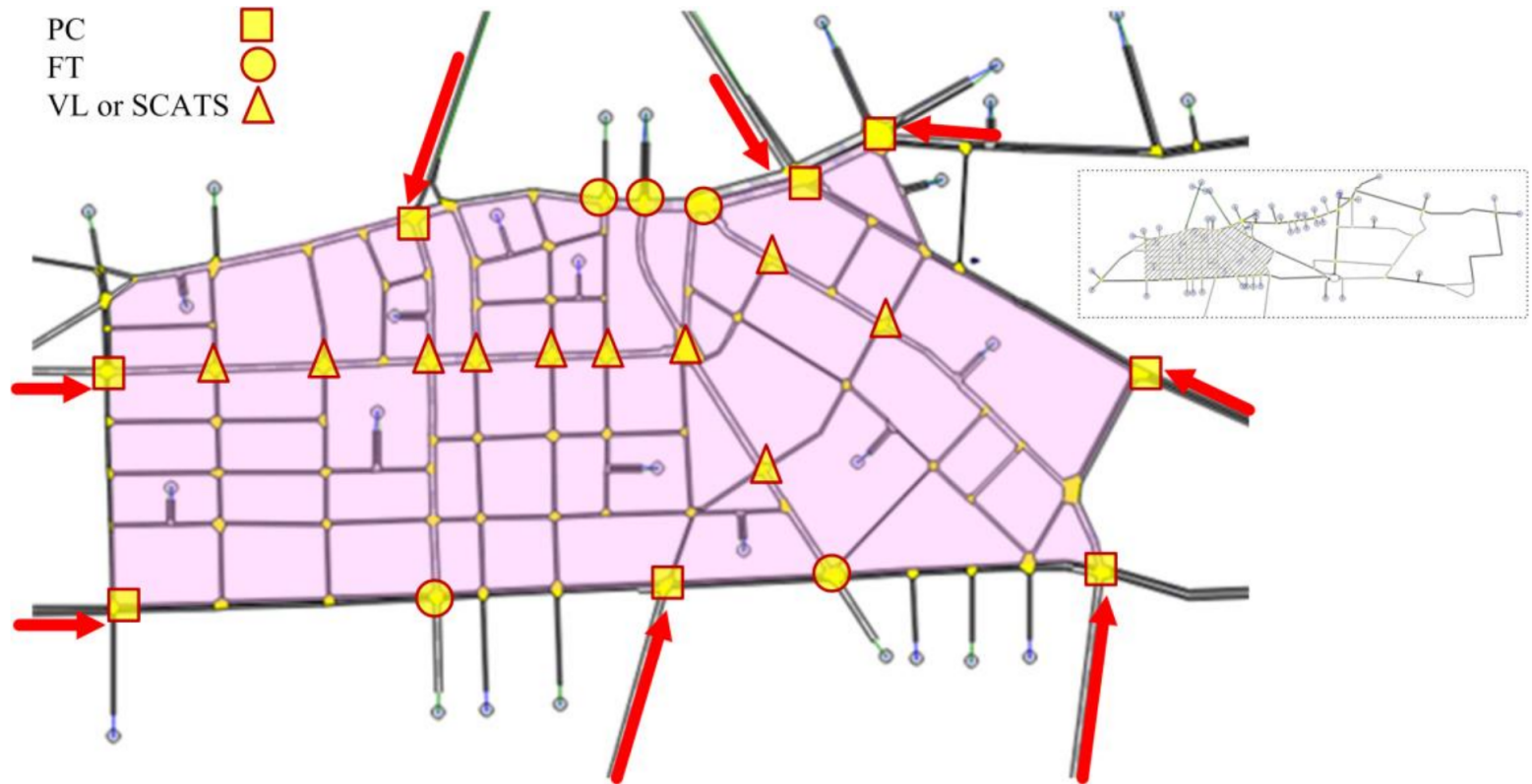
Mehdi Keyvan-Ekbatani., Shirley (X) Gao,  
Vikash Gayah, Victor L. Knoop

Traffic-responsive signals combined with perimeter  
control: investigating the benefit

# Traffic light use?

- 1) Fixed time traffic lights
- 2) Volume based (previous cycle)
- 3) SCATS-like systems (upstream detection)
- 4) Perimeter control

# Combining traffic lights!



# Compare combination control principles

Fixed time traffic lights

Volume based (previous cycle)

SCATS-like systems (upstream detection)

Perimeter control

Yes

No

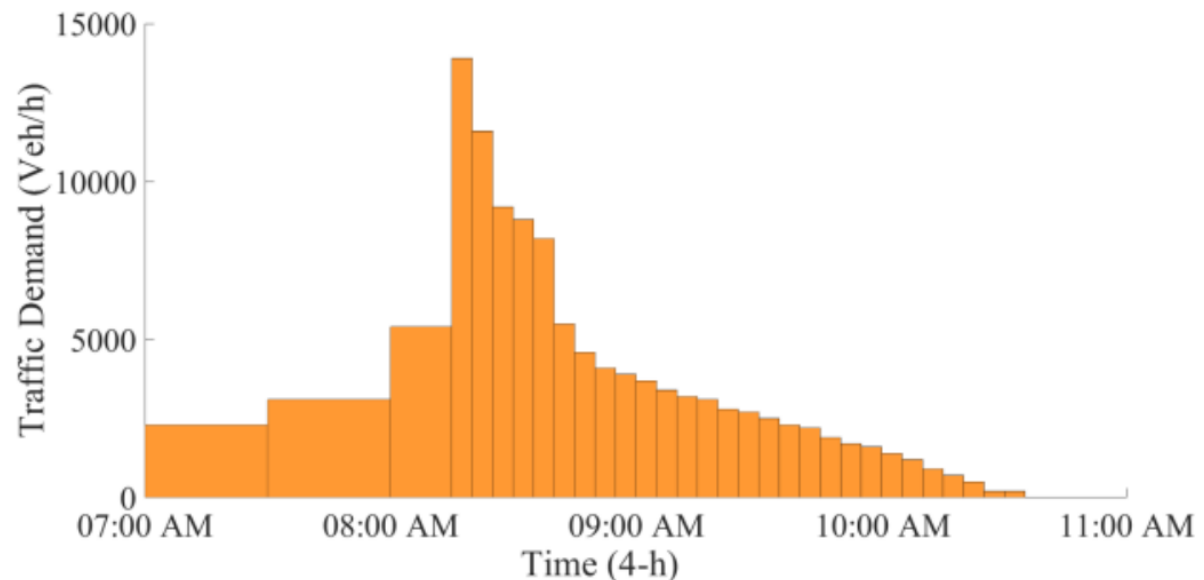



# Simulation set-up

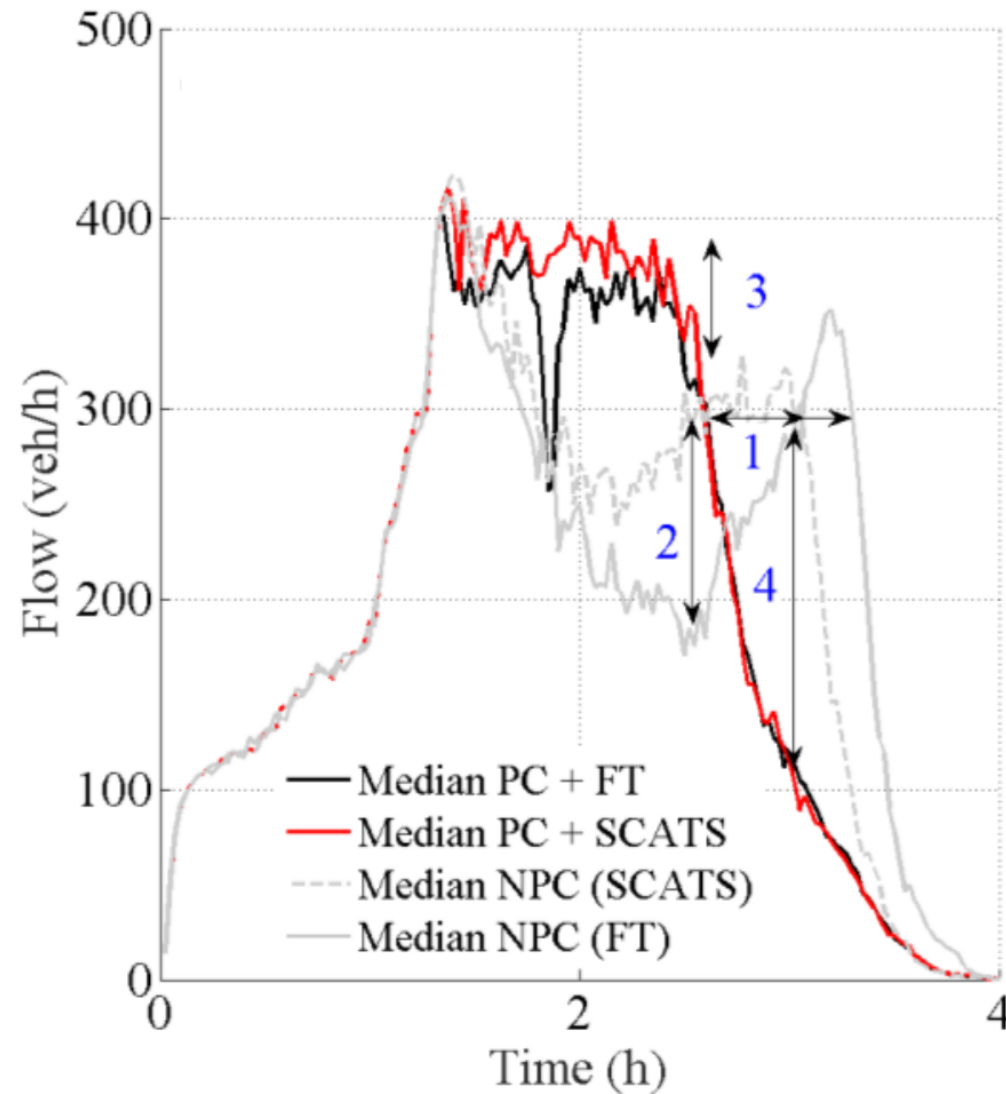
Microscopic traffic simulation (AIMSUN)

Chania network

Realistic demand



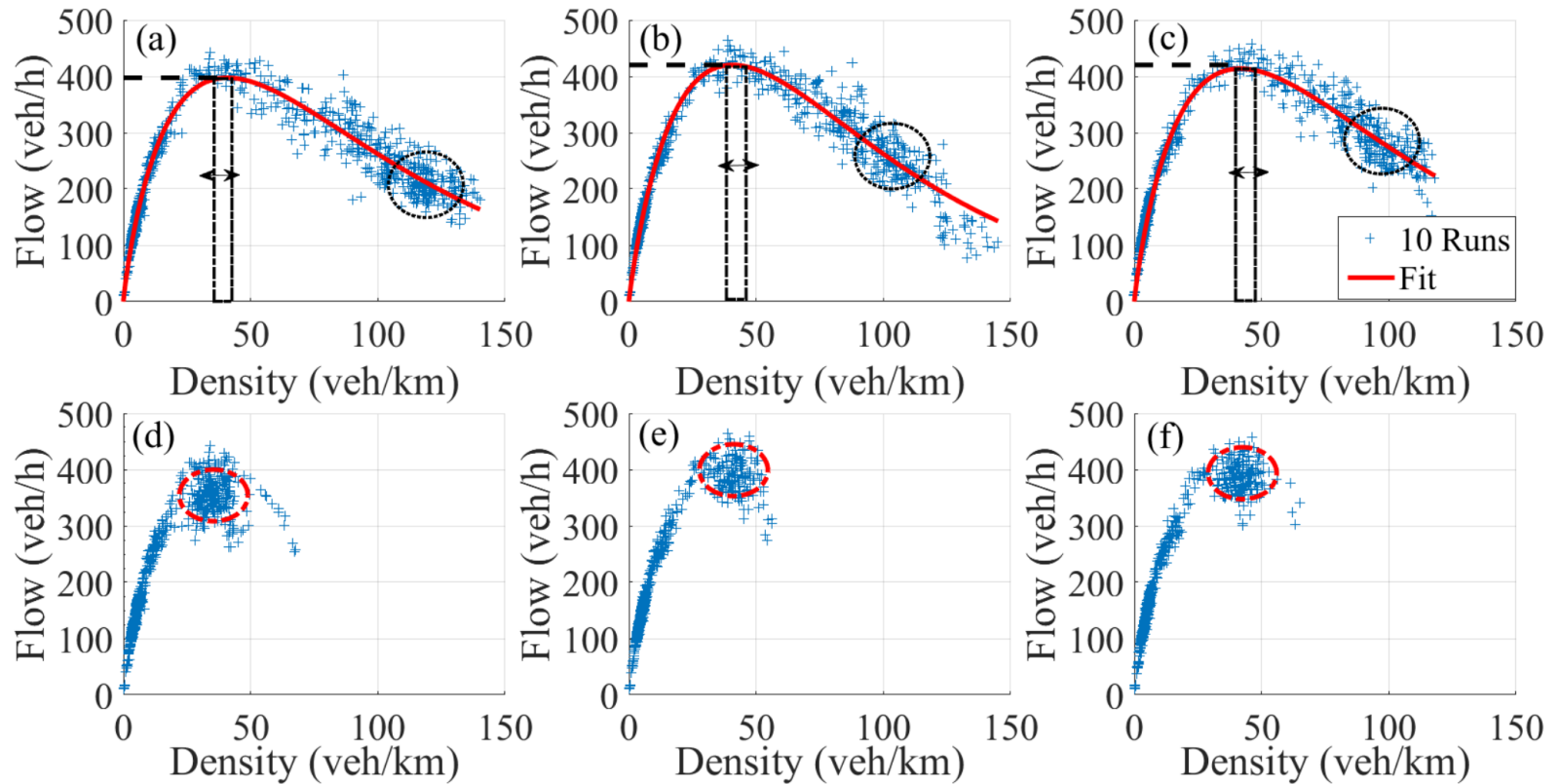
# Resulting flows



# Main findings

1. Perimeter control: congestion dissolves faster & network is empty earlier
2. Internal flow increases with adaptive traffic lights
3. Perimeter + adaptive traffic lights maintains higher flows than only adaptive traffic lights or only perimeter control

# Resulting MFDs



**Figure 7** Loading period MFDs for the NPC (a-c) and PC strategies (d-f): (a) NPC (FT); (b) NPC (VL); (c) NPC (SCATS); (d) PC + FT; (e) PC + VL; (f) PC + SCATS

# Reference

- Keyvan-Ekbatani, M., Gao, X(S), Gayah, V.V., Knoop, V.L.. (2019) Traffic-responsive signals combined with perimeter control: investigating the benefits. Transportmetrica B: Transport Dynamics, Vol. 7, pp. 1402-1425