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

Flow $q$ (veh/h)

Density $k$ (veh/km)
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
Stochasticity in local data

- Macroscopic fundamental diagram
- "Average" fundamental diagram for an area

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

<table>
<thead>
<tr>
<th>Perimeter control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

Fixed time traffic lights
Volume based (previous cycle)
SCATS-like systems (upstream detection)
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