Anticipatory Control

Part of the Future of Traffic Management

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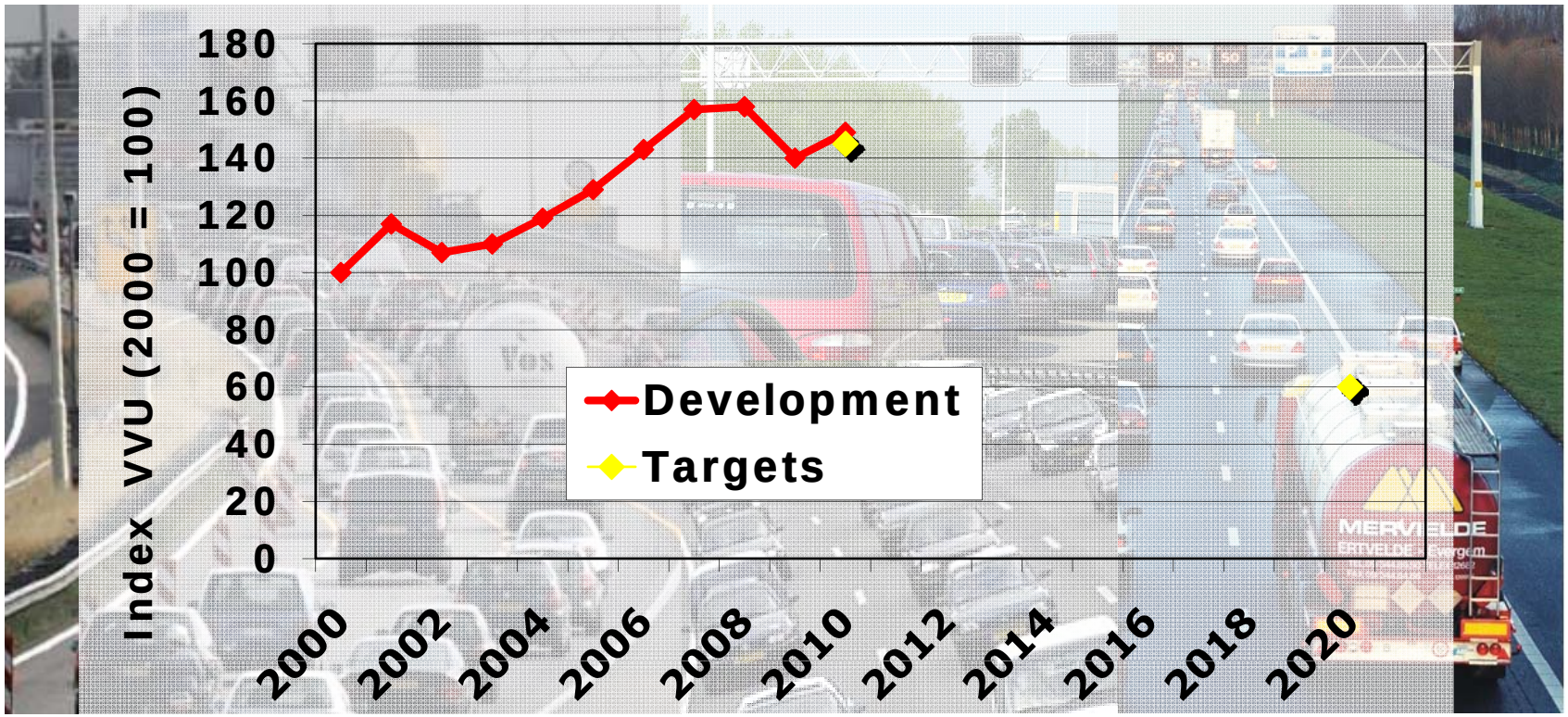
Congestion in The Netherlands

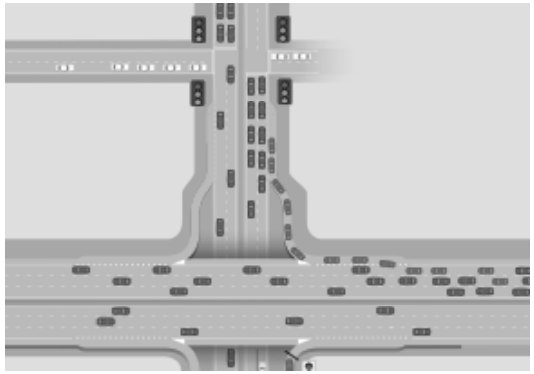
- August 1925: disaster tourism to Borculo (twister)
- May 29th, 1955: to the beach on Whit Monday
- February 8th, 1999: busiest morning peak ever: 975 km.
- November 29th, 2010: busiest evening peak ever: 870 km

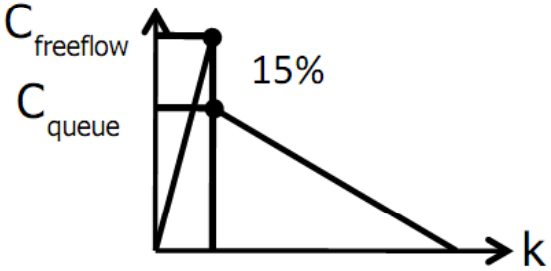
Congestion development

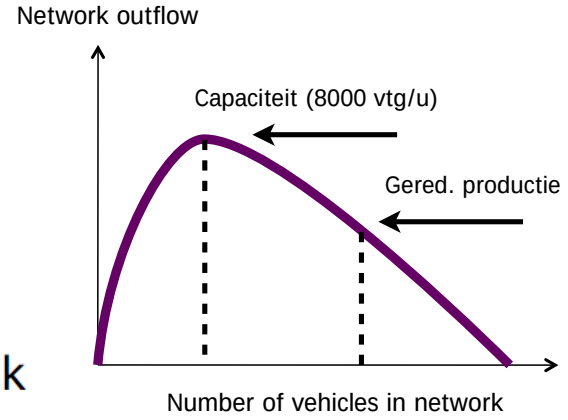


Aspects of congestion

- Balance of traffic demand and capacity
- Blocking back important cause of extra delay
- Capacity drop gives more and longer congestion
- Suboptimal choice behaviour leads to unbalanced distribution







Transport and traffic policy

Building: *"very effective, expensive, long"*

Pricing: "*politically difficult"*

Traffic Management: *"effective, less expensive and quick"*

What should traffic management do?

1. Increase throughput, e.g. postpone congestion, prevent capacity drop or increase capacity
2. Improve distribution of traffic in the network, e.g. give better information or better guidance (incidents and events!)
3. Restrict inflow in (parts of) the network such that amount of traffic is below the critical value
4. Prevent blocking back, e.g. introduce buffers, separate short and long distance traffic, move or redistribute queues

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Perspective traffic management

Perspective traffic management

- Technology: interaction between in-car systems and road side systems is standard practise
- Organisation: mutual cooperation between road authorities, and with knowledge institutes and commercial parties
- Dynamic adaption of traffic demand and capacity: flexible use of infrastructure is possible
- From reactive to anticipatory and integrated traffic management: important role for guidance of traffic in normal and abnormal situations

Traffic signal control

- First traffic light: London, 1868
- Electronic traffic control equipment: USA, 1914
- Large scale implementation in cities: USA, twenties and thirties of 20th century
- First traffic lights in The Netherlands: thirties

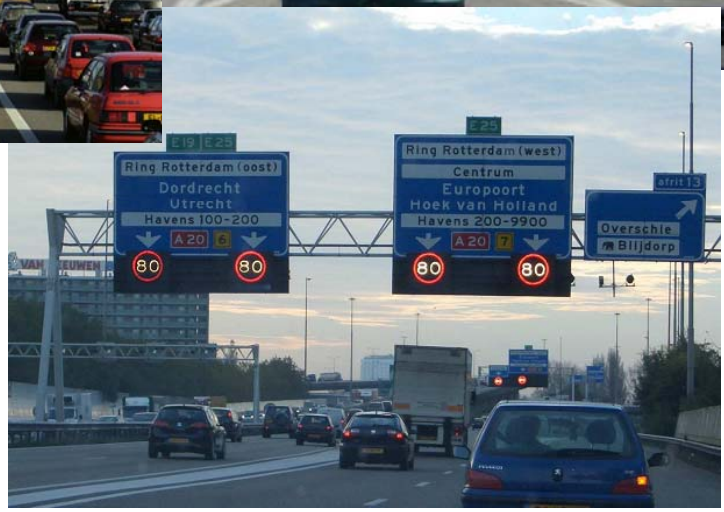
Collectie SA. Foto: A. van Beurden, 1930

Traffic control strategies

- Fixed-time
- Fixed-time but changing during the day (peak periods)
- Variable green times
- In The Netherlands more local control
  - Bicycles
  - Public transport priority
- Control strategies reactive
  - Presence of vehicles
  - Upstream traffic
- Network control strategies: rest of the world

Traffic management measures

- Traffic signal control
- Ramp metering
- Dynamic speed limits
- Tolling
- Information



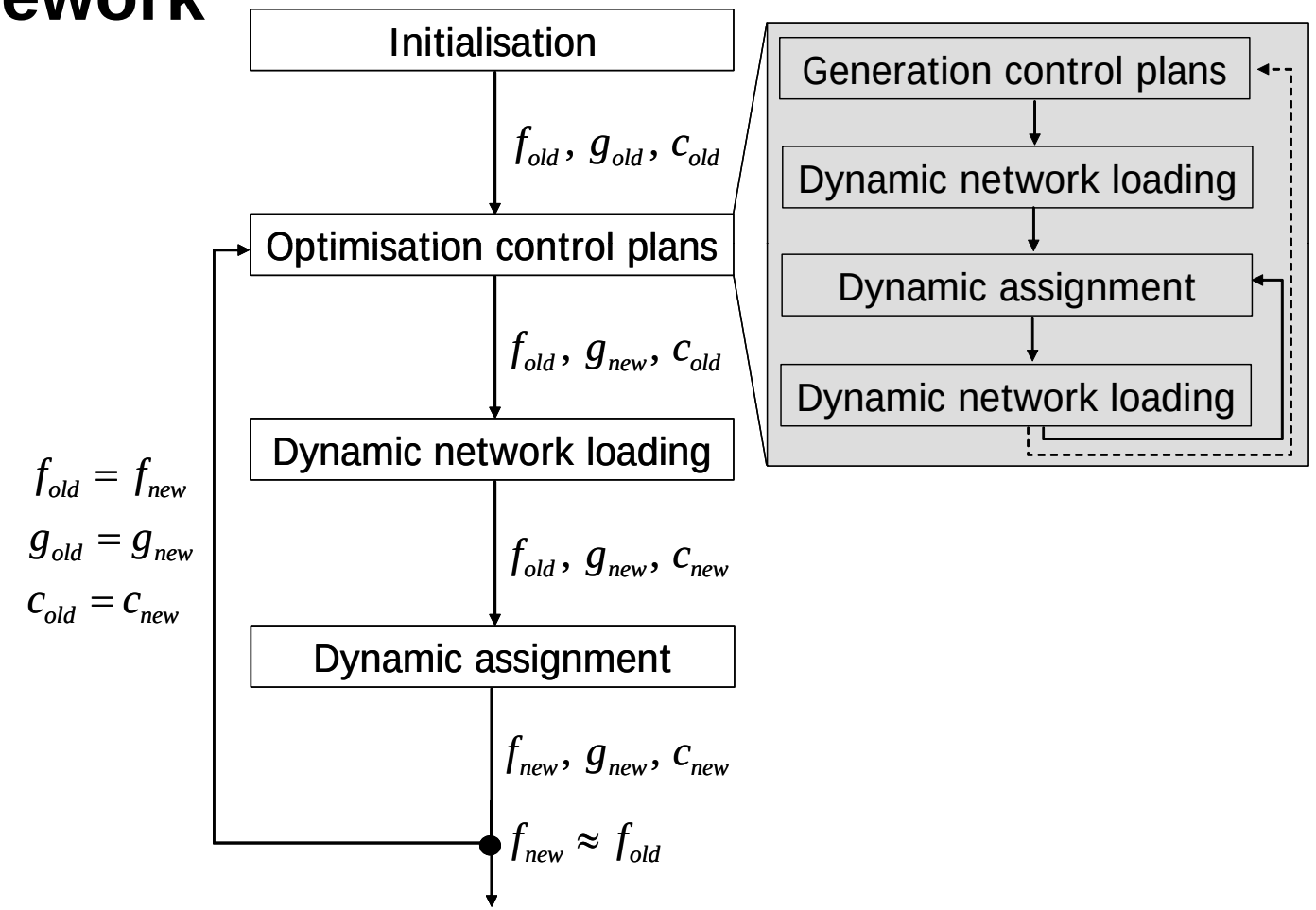
Anticipatory control

- Interaction between road authorities and road users
- Road authorities and road users do not have the same goals
- Manage traffic such that choices of road users are taken into account (in this case: route choice)
- Manage traffic such that different goals of different road authorities are taken into account
- Network approach needed

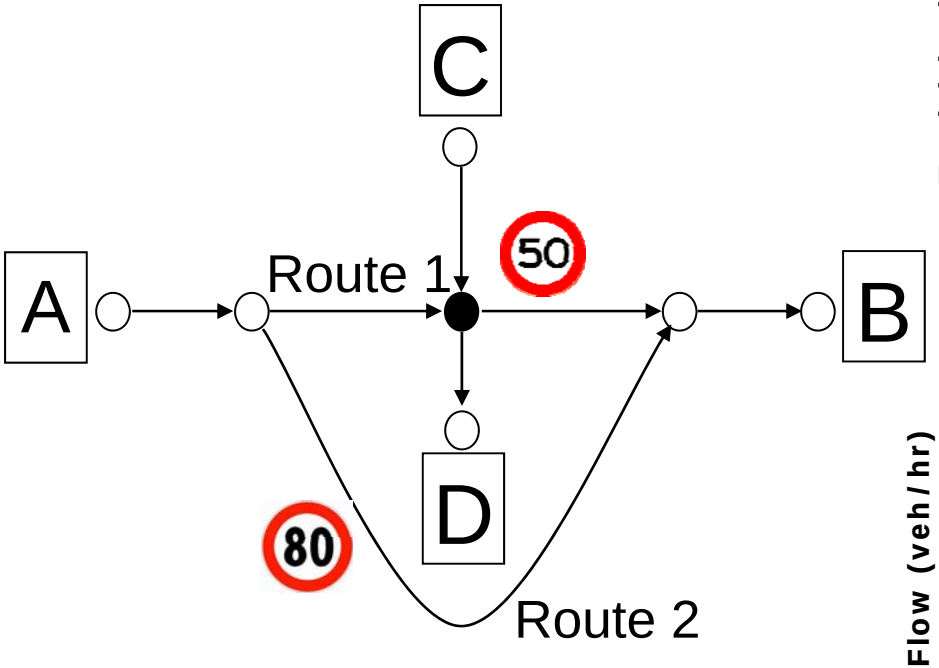
Integrated Control

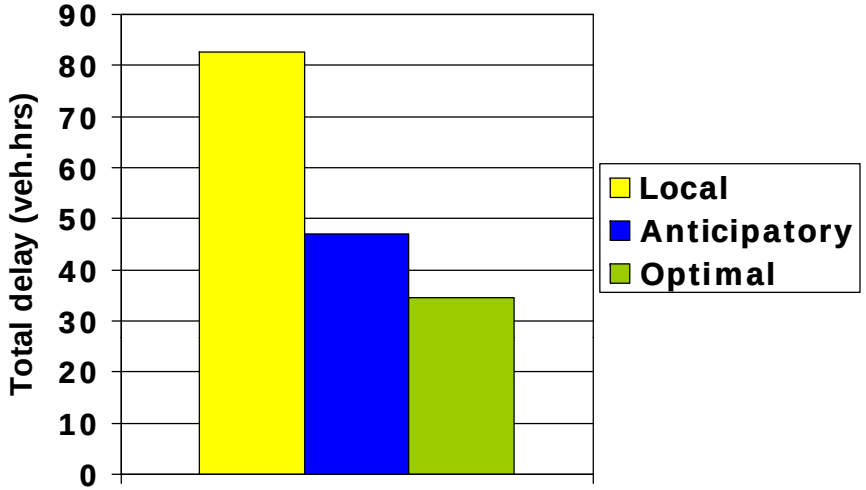
- Different road authorities can have different goals
  - Is cooperation beneficial?
- Coordination of traffic management measures
  - Currently local measures
  - Is coordination of measures better?
- Game theory
  - Interaction between players with their own decisions
  - Gain depends on own decisions and on decisions of the other players
- Strategies
  - React on decision of other players (Nash game)
  - Anticipate on decisions of other players (Stackelberg game)

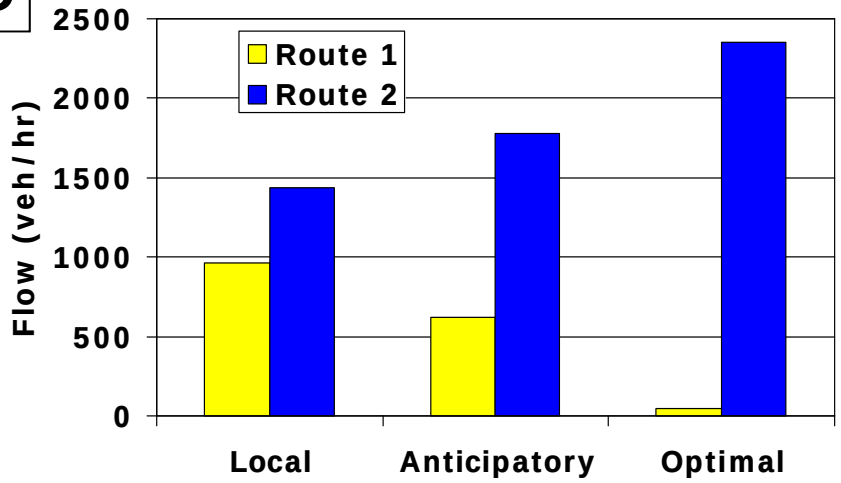
Framework


Initialisation
$f_{old}, g_{old}, c_{old}$
Optimisation control plans
$f_{old}, g_{new}, c_{old}$
Dynamic network loading
$f_{old}, g_{new}, c_{new}$
Dynamic assignment
$f_{new}, g_{new}, c_{new}$
$f_{new} \approx f_{old}$
Generation control plans
Dynamic network loading
Dynamic assignment
Dynamic network loading
$f_{old} = f_{new}$
$g_{old} = g_{new}$
$c_{old} = c_{new}$

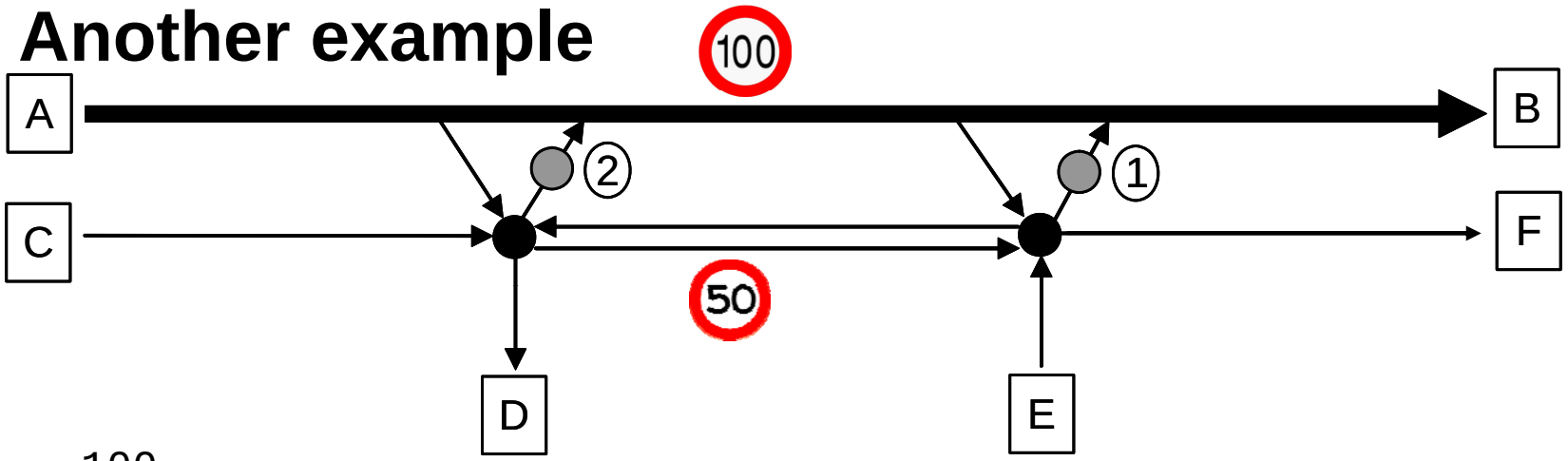
Simple example

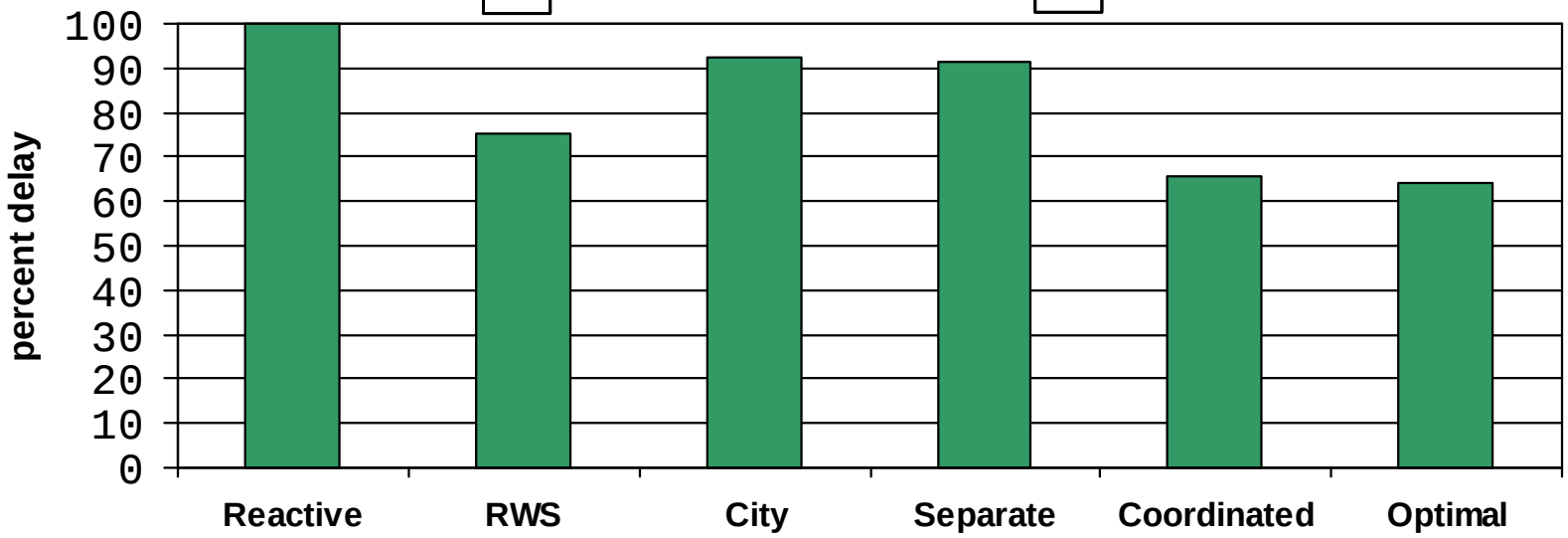




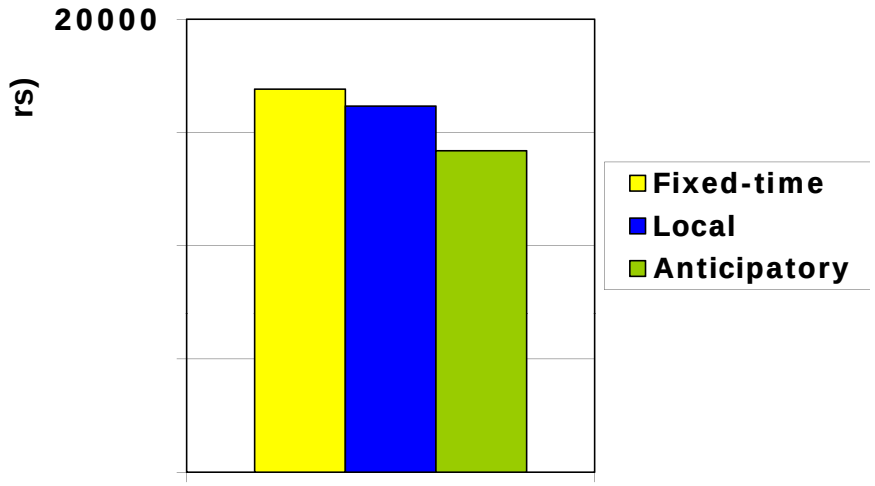


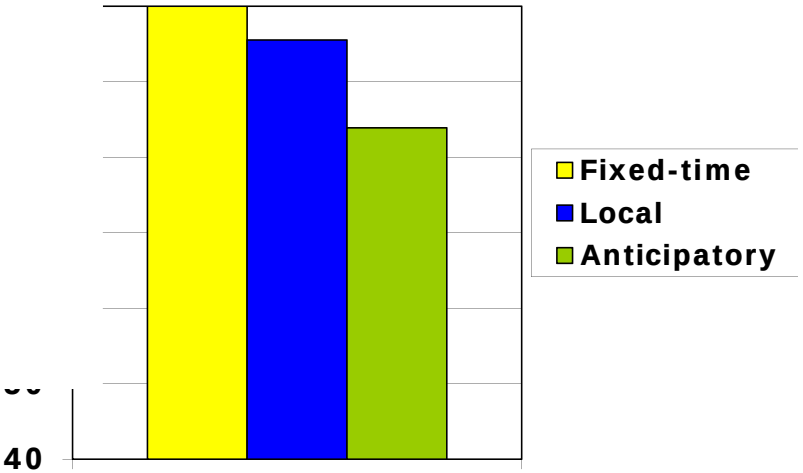
Another example





Larger network





11 signal controlled intersections

Summary

- Congestion is a common phenomenon and it doesn't appear or disappear spontaneously
- Traffic management is an important solution direction
- Anticipatory control is part of the future of traffic management
- Integrated anticipatory control can be profitable for all
- Concept is shown to work for small networks
- Further research has to focus on operational setting

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