Organic approaches to traffic control and route guidance

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Agenda

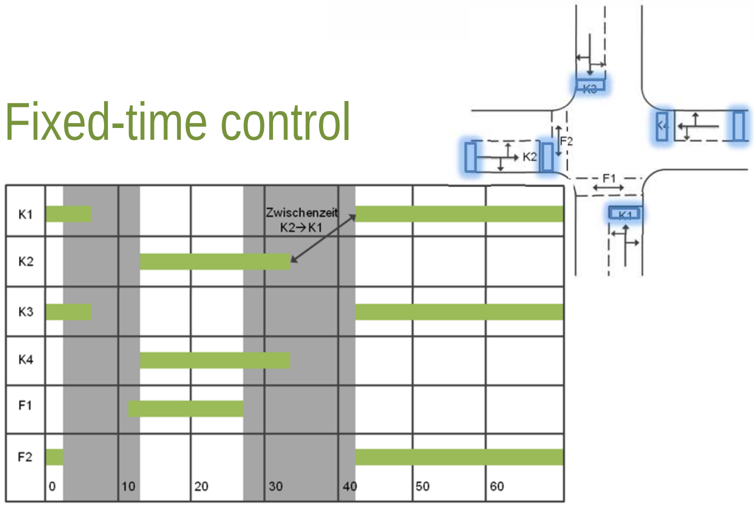
Phase I – Traffic lights at intersections

Phase II – Traffic lights in networks

Phase III – Dynamic Route Guidance

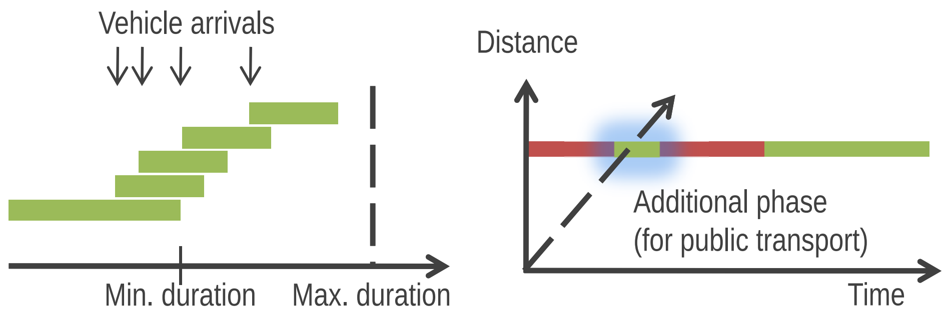
Traffic nodes – State of the art

Fixed-time control



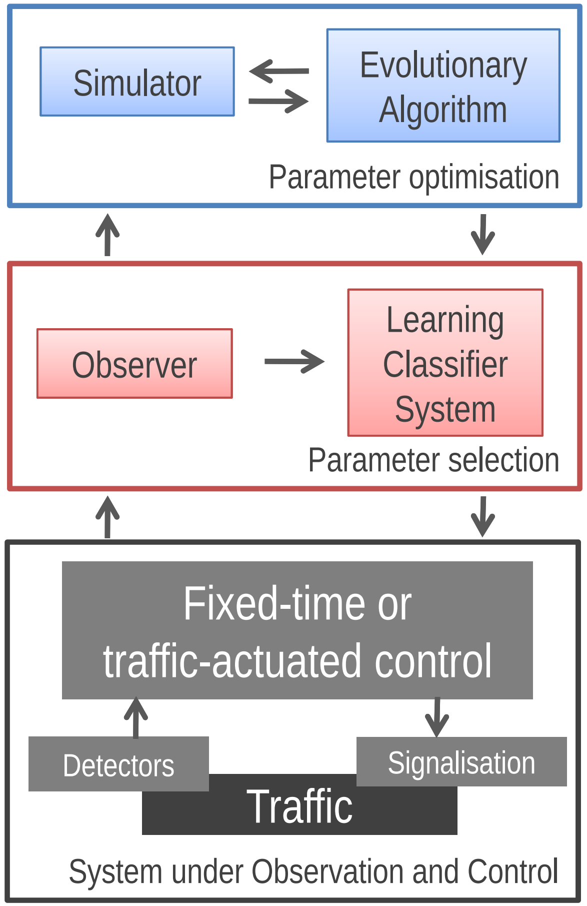
- No traffic-responsive control
- Day-time dependent switching
- Ageing of signal plans[1]: Deterioration of 3% per year w.r.t. delay

Traffic-actuated control

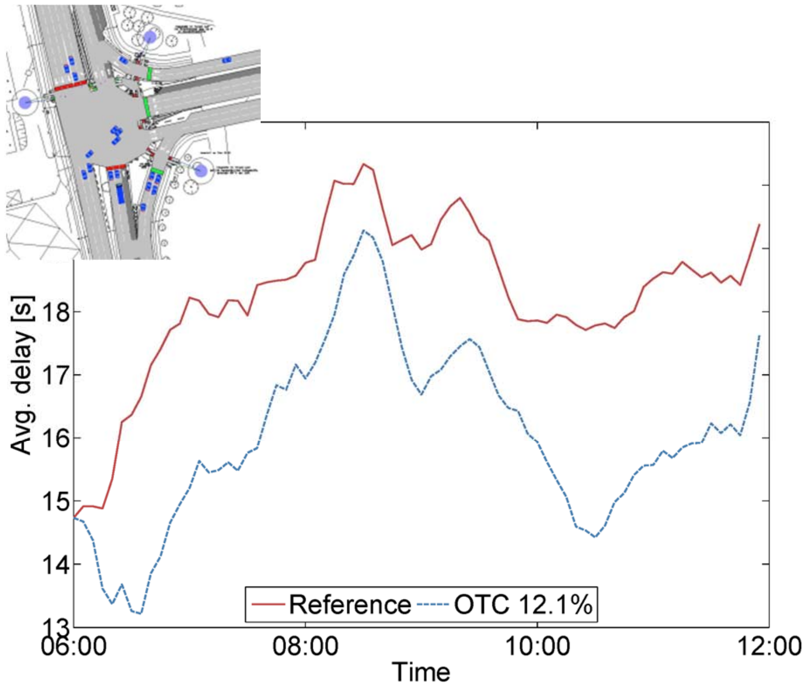


- Predefined logic
- Behaves like fixed-time control at high traffic demands
- No on-line evaluation / optimisation

Organic traffic nodes[2]

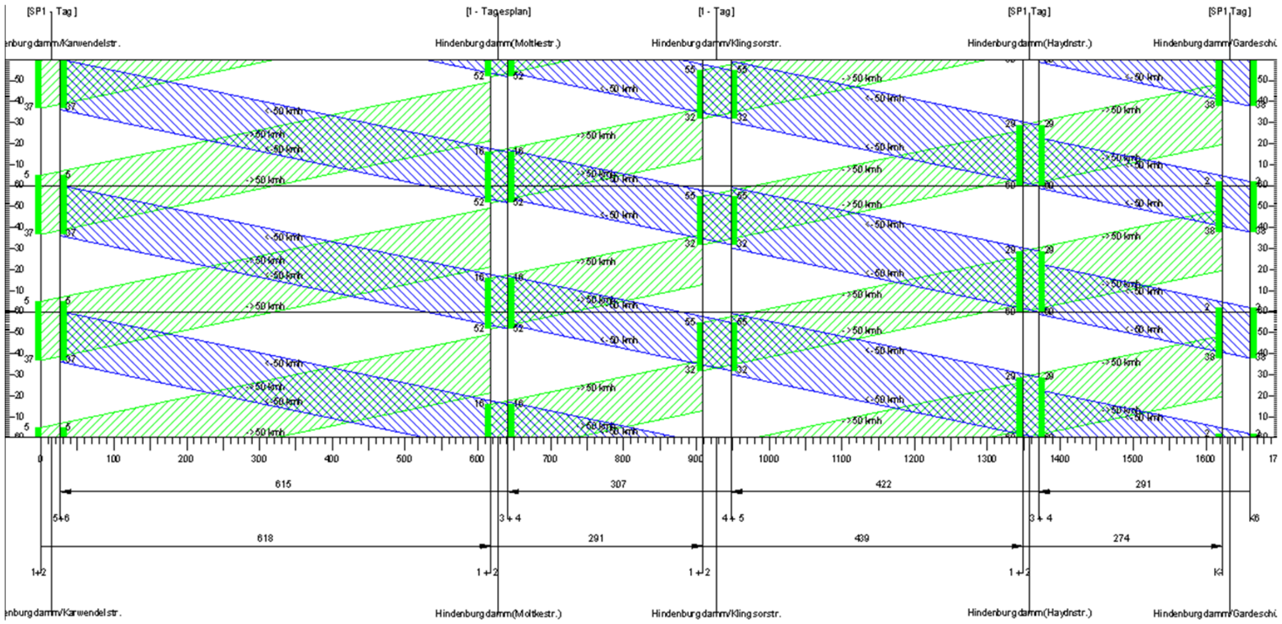


- On-line signal plan optimisation
- Reduced effort for maintenance
- Reduced delays



Traffic networks – State of the art (1/2)

Manual planning



http://www.stadtentwicklung.berlin.de

Computer supported creation of time distance plots

- Not traffic-responsive
- Regular checks / recalculations necessary

Traffic networks – State of the art (2/2)

Adaptive network control systems

SCOOT[3]

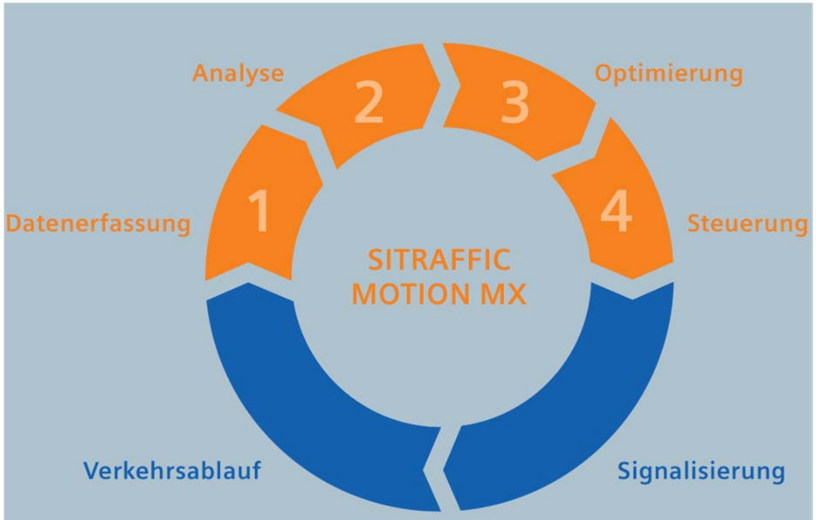
- Centralised optimisation of split, cycle, and offset
- High effort for communication[4,5]
- High susceptibility to failure[5]

OPAC[6]

- Decentralised: Switching policies computed via dynamic programming
- No coordination among neighbouring intersections

MOTION[5]

- Hierarchical system:
  - Network-wide optimisation (frame signal plan)
  - Local traffic-actuated control



http://www.industry.siemens.de

Coordination in organic traffic networks

Decentralised coordination[2]

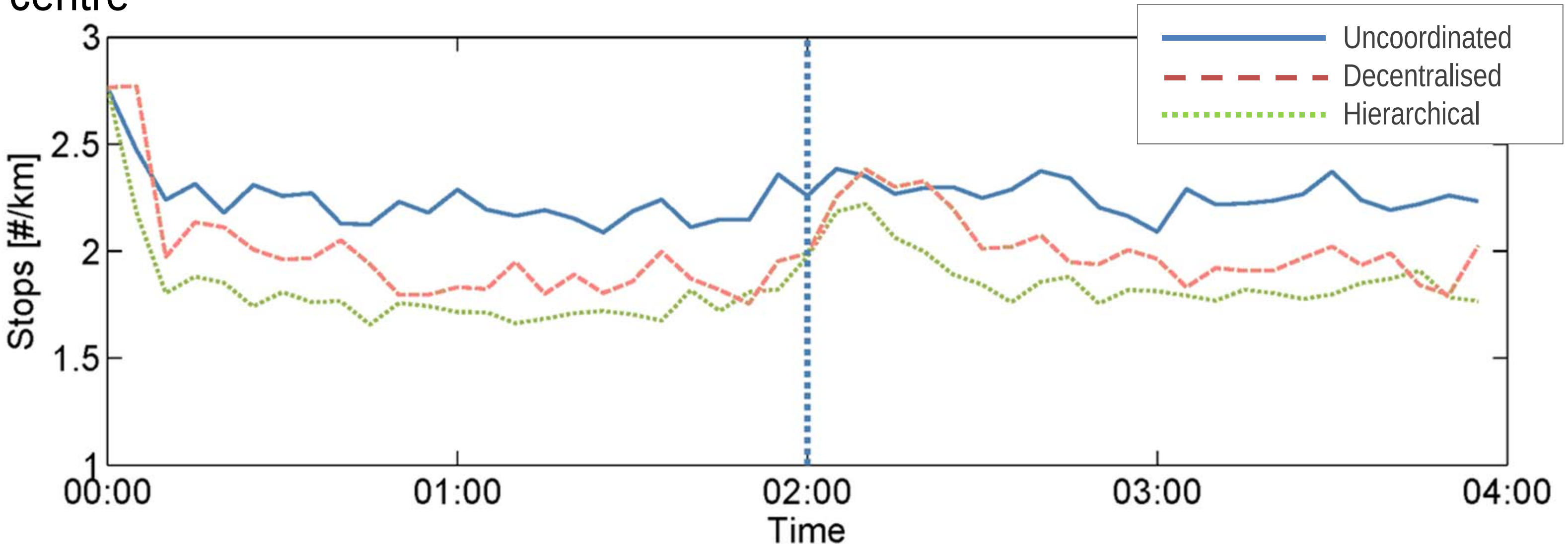
- Local organic intersections
- Decentralised coordination

→ Traffic-responsive coordination
→ Reduced number of stops
→ Avoids drawbacks of a traffic control centre

Hierarchical coordination[7]

- Local organic intersections (i.e., local on-line optimisation)
- Additional Regional Manager supports the coordination

→ Improved handling of special cases



Dynamic Route Guidance (DRG)

State of the art (in cities)

Road users

- Individual navigation systems
- Travel-time database
- User-optimal routes (no network optimum)

Authorities

- Variable Message Signs at selected locations
- Integration of DRG and centralised traffic control systems[8,9]
- Developments are not well documented!

OTC3

Decentralised DRG

- Neighbouring intersections communicate
- Individual recommendations based on
  - Current demands
  - Local information
- Similarities to Internet routing

Hierarchical DRG

- Network-wide traffic prediction
- Incident detection
- Incorporate external goals
- System vs. user optimum

Summary

Phase I – Traffic lights at intersections

- On-line evaluation and optimisation of signal plans

Phase II – Traffic lights in networks

- Traffic-responsive decentralised coordination

Phase III – Dynamic Route Guidance

- Decentralised routing / individual recommendations based on current demands
- Hierarchical routing w.r.t. system optimum

References

[1] M. C. Bell and R. D. Bretherton. Ageing of fixed-time traffic signal plans. In Proc. 2nd IEE Conf. on Road Traffic Control, pages 77-80, 1986.

[2] H. Prothmann, J. Branke, H. Schmeck, S. Tomforde, F. Rochner, J. Hähner, and C. Müller-Schloer. Organic traffic light control for urban road networks. International Journal of Autonomous and Adaptive Communications Systems, 2(3):203-225, 2009.

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[4] J. Mück. BALANCE: Adaptive Lichtsignalsteuerungen für Straßennetze und einzelne Knotenpunkte. In M. Steierwald und S. Martens, Hrsg., *Steuerung kommunaler Verkehrsnetze*, pages 53-66. Akademie für Technikfolgenabschätzung in Baden-Württemberg, 2003.

[5] B. Friedrich. Steuerung von Lichtsignalanlagen: BALANCE – ein neuer Ansatz. *Straßenverkehrstechnik*, 44(7):321–328, 2000

[6] N. H. Gartner. OPAC Strategy for demand-responsive decentralized traffic signal control. In J.-P. Perrin, editor, Control, Computers, Communications in Transportation, pages 241–244, 1989.

[7] S. Tomforde, H. Prothmann, J. Branke, J. Hähner, C. Müller-Schloer, H. Schmeck. Possibilities and Limitations of Decentralised Traffic Control Systems. *Submitted to WCCI 2010.*

[8] N. B. Hounsell, M. McDonald, and R. A. Lambert. The integration of SCOOT and dynamic route guidance. In Proceedings of the IEEE Road Traffic Monitoring Conference, pages 168-172, 1992.

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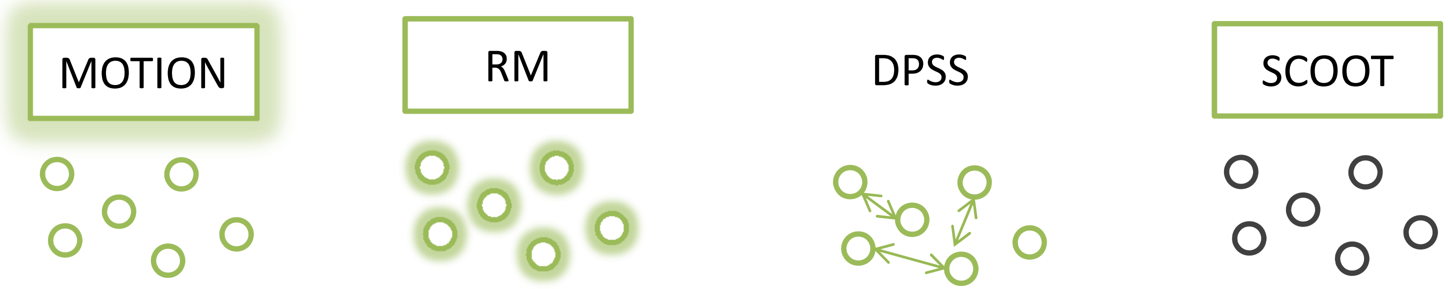
Kritik an zentralen Systemen

"Häufig lassen sich einzelne Signalanlagen aufgrund ihrer Lage schon technisch nicht an eine Zentrale anbinden. In anderen Fällen kann der Aufwand [...] unangemessen sein, weil Verkehrsstörungen lediglich an einzelnen Knotenpunkten auftreten."

J. Mück. BALANCE: Adaptive Lichtsignalsteuerungen für Straßennetze und einzelne Knotenpunkte. In M. Steierwald und S. Martens, Hrsg., *Steuerung kommunaler Verkehrsnetze*, Seiten 53-66. Akademie für Technikfolgenabschätzung in Baden-Württemberg, 2003.

"Die Erfahrung der jüngeren Forschung zeigt, daß verteilte Intelligenz der Komplexität des Verkehrs [...] häufig besser gerecht werden kann. Die Störanfälligkeit eines zentralen Systems sowie der enorme Aufwand, die relevanten Daten [...] zu übertragen, sind weitere Gründe dafür, neue Wege zu effizienteren Systemarchitekturen zu suchen."

B. Friedrich. Steuerung von Lichtsignalanlagen: BALANCE – ein neuer Ansatz. *Straßenverkehrstechnik*, 44(7):321–328, 2000.


MOTION
RM
DPSS
SCOOT