1-C-06

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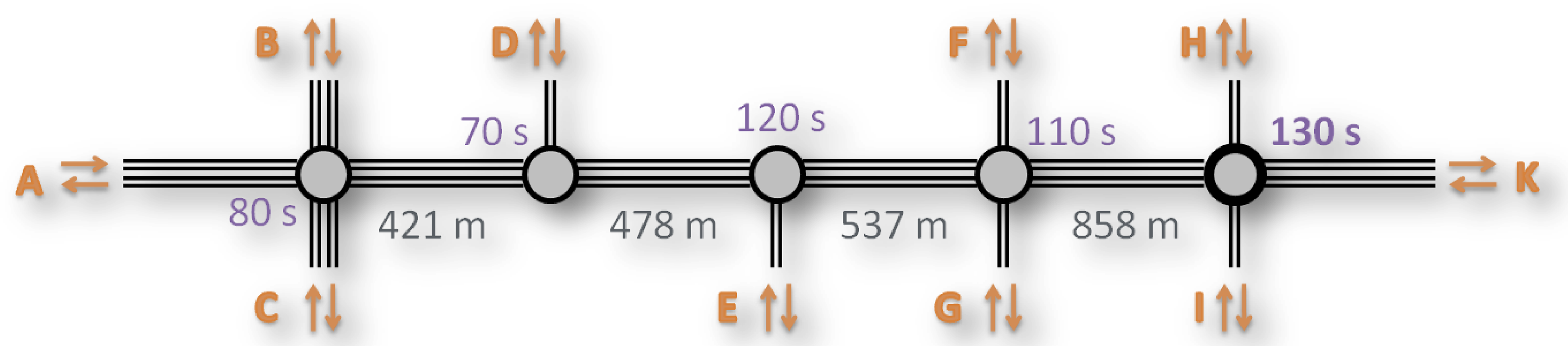
A methodology for the simulation based Assessment of Coordination Strategies using Particle Swarm Optimization

The Problem

- Signal coordination
  - can aim at very different objectives.
  - can be realised in different ways.
- How can we compare strategies and determine the best solution for a given set of objectives and traffic conditions?



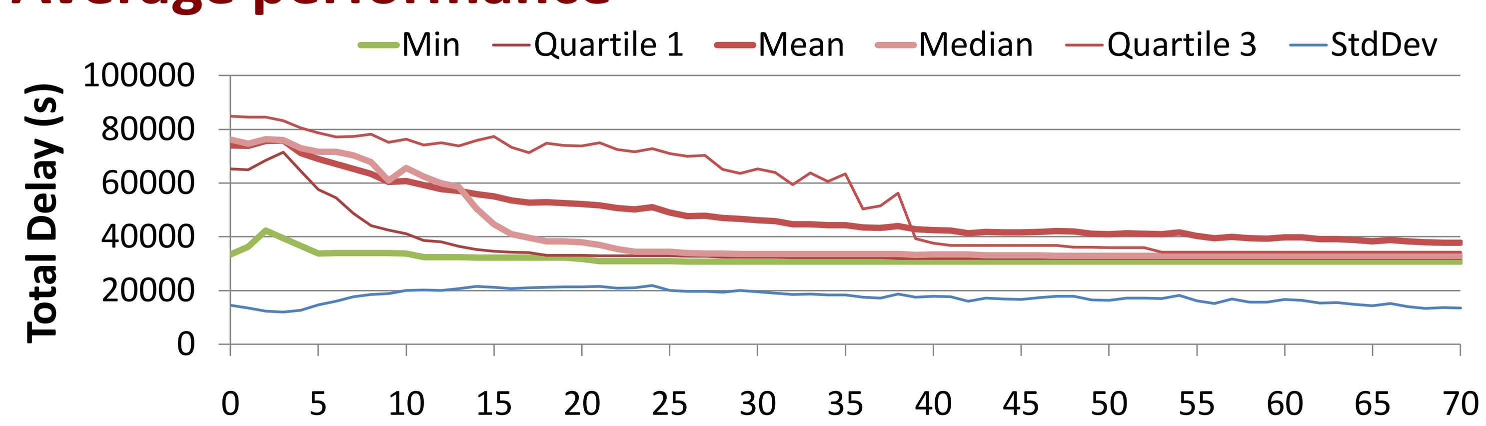
The Objective

Provide a platform for a flexible and general assessment of signal coordination strategies. with reference to a benchmark solution.

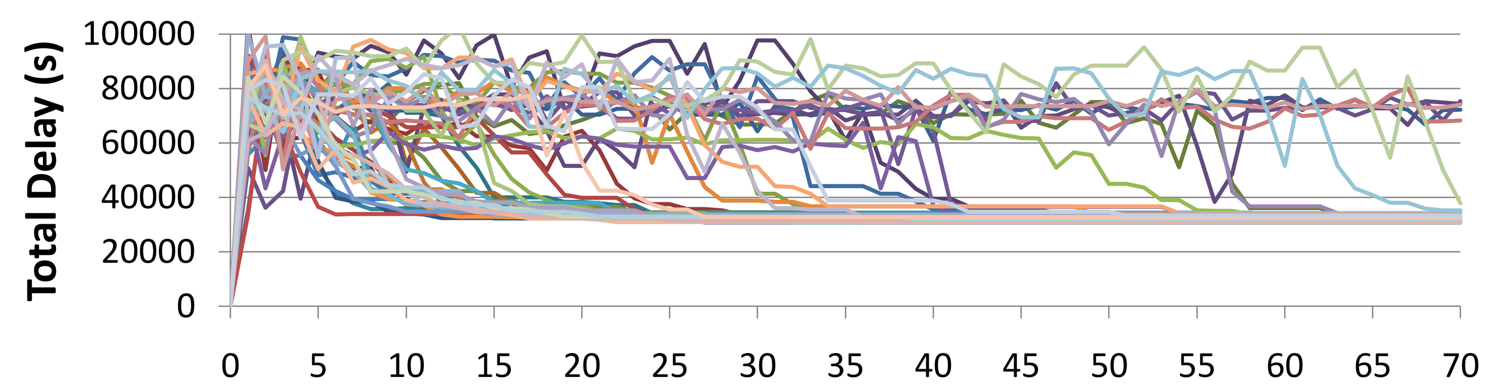
Research questions

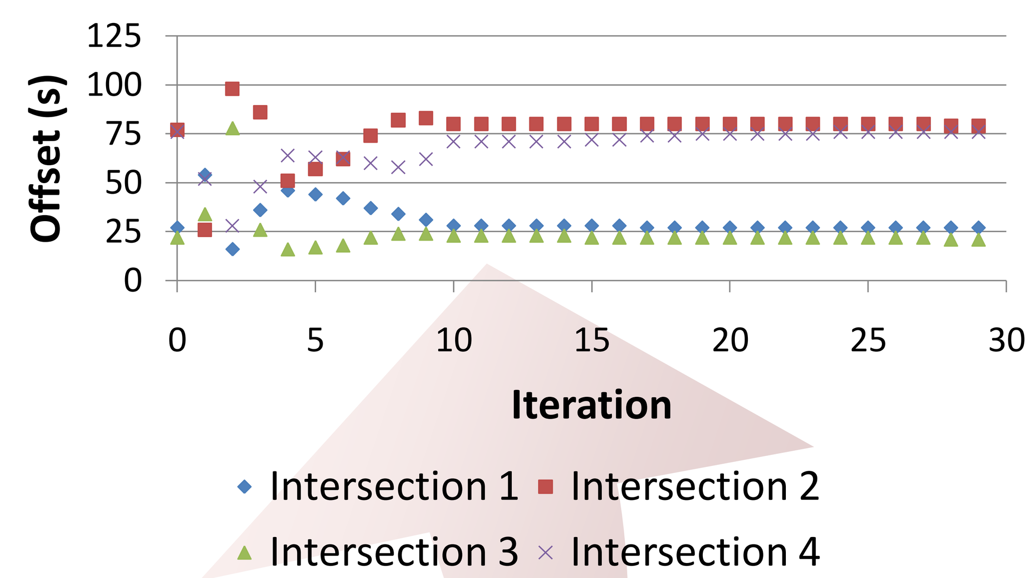
- How is “best” (in best coordination strategy) defined?
- How sensitive are strategies to changed demand?
- What if the data supply is unreliable or insufficient?
- What happens, if priorities change?

Average performance



Performance of individual particles



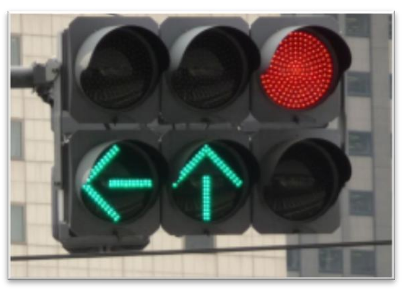


The Solution

true performance

Traffic Flow Simulation

Calculates performance for given signal programs and traffic situation



Signal Programs

Performance Indicators

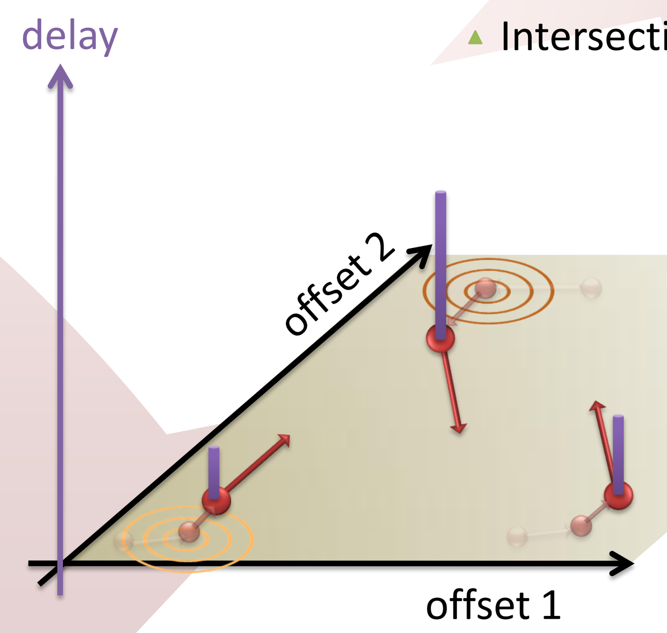
best solution (benchmark)

Signal Program Optimisation Tool

Optimises signal programs according to performance indicators

Example evaluation

Strategy	Cycle time	Offset 1	Offset 2	Offset 3	Offset 4	Delay
Manual →		28 s	55 s	0 s	55 s	25.5 s
Manual ←	110 s	82 s	55 s	0 s	55 s	26.1 s
Optimum		56 s	56 s	109 s	51 s	25.5 s



$$\vec{x}_i = \begin{pmatrix} o_1 \\ o_2 \end{pmatrix}$$

$$f_i = d$$

Conclusion and Outlook

- PSO is a suitable tool for optimisation problems in the context of signal control.
- The developed framework promises valuable insight into the performance of signal coordination strategies.
- The modular structure of the software (C++) facilitates adaption to different simulation tools.
- The assessment platform still has to be applied to different scenarios (network layout, traffic demand, strategies, …).

Particle Swarm Optimisation

Convergence PSO

$$v_i(t+1) = \chi\left[\bar{v}_j(t) + \phi_1\left(\bar{y}_j(t) - \bar{x}_j\right) + \phi_1\left(\hat{\bar{y}}(t) - \bar{x}_j(t)\right)\right]$$

Constriction Factor

$$\chi = \frac{2\kappa}{\left|2-\phi-\sqrt{\phi(\phi-4)}\right|}$$

$$\phi = \phi_1 + \phi_2$$

Cognitive and social factors

$$\phi_i = c_i\, r_i$$

c_1: cognitive factor (particle best)
c_2: social factor (swarm best)
r_i: random influence

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