SMaRT-Online WDN

Online Security Management and Reliability Toolkit for Water Distribution Networks

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PROJET FINANCÉ PAR L'ANR - PROJECT FUNDED BY THE ANR

WP 3
Optimal location of Sensors
Summary and Perspectives

Demonstration event – Dresden the 18th March 2015

Irstea, 3S Consult, VEDIF, CUS, BWB

SmaRT-Online^{WDN} Optimal Sensor Placement

GOALS ARE TWOFOLD

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Sampling Design

6 EARLY-WARNING OBJECTIVES TO OPTIMIZE

1. The average time to detection
2. The fraction of population exposed
3. The detection likelihood
4. The average contaminated network pipe volume ratio
5. The average contaminated network pipe surface ratio
6. The fraction population exposed at risk
7. The installation cost
8. The weighted function

Link with SecurEau 2013 + BWSN 2006

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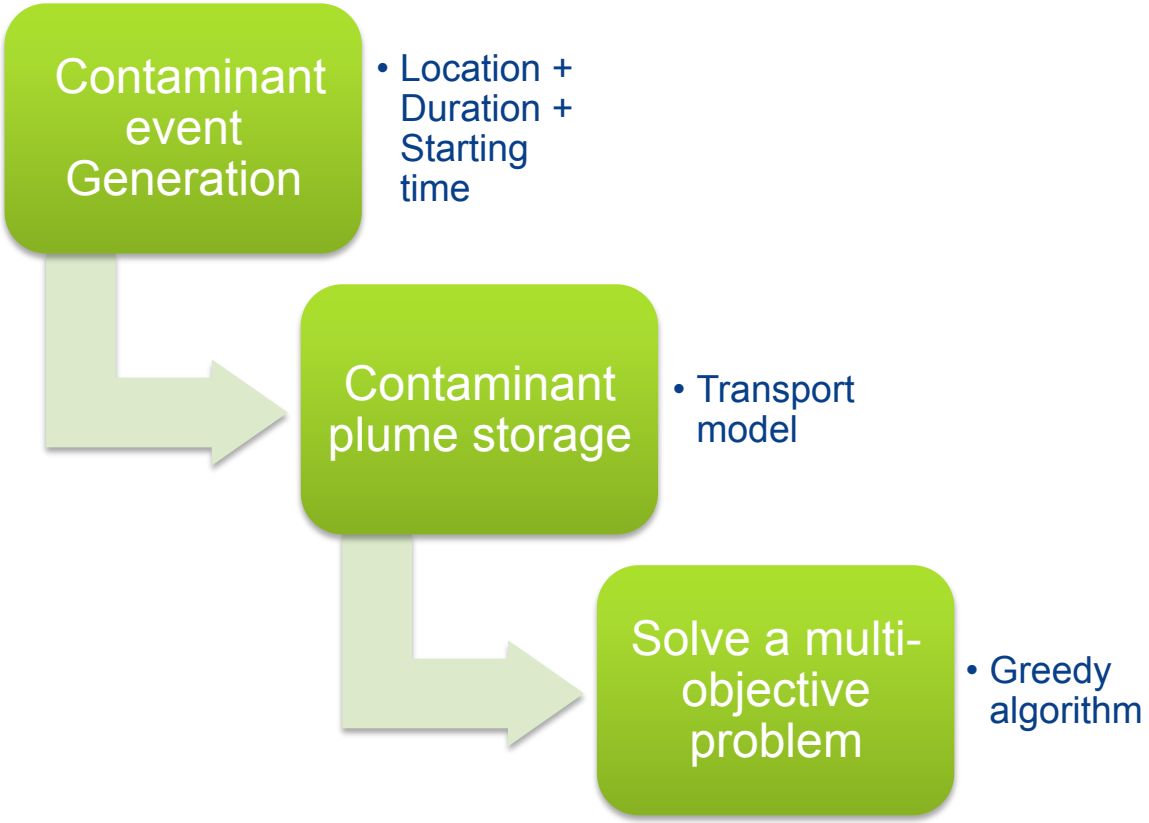
Early-Warning Detection SD

A 3-STEP SOLUTION ALGORITHM WITHIN END-USER SOLUTION



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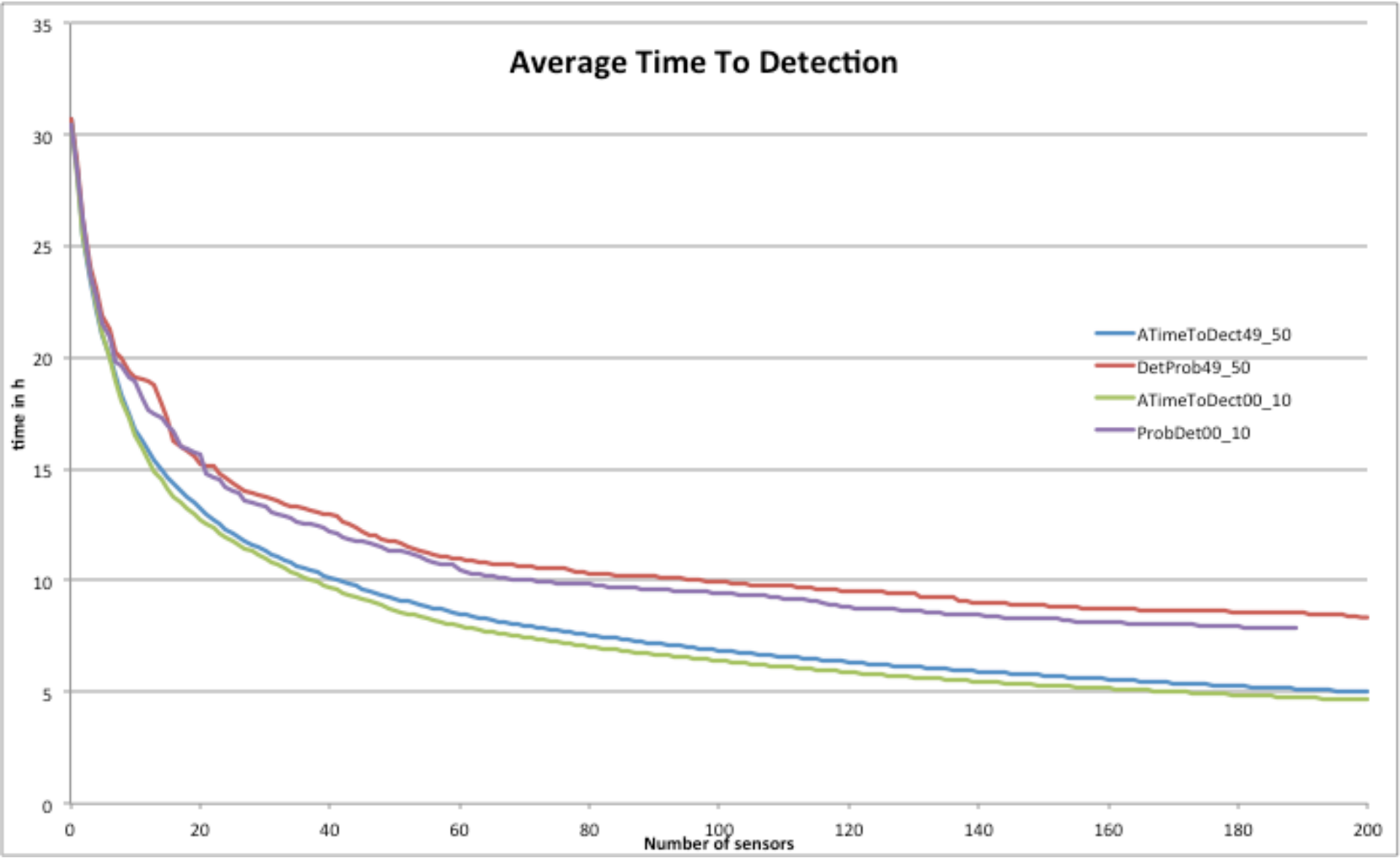
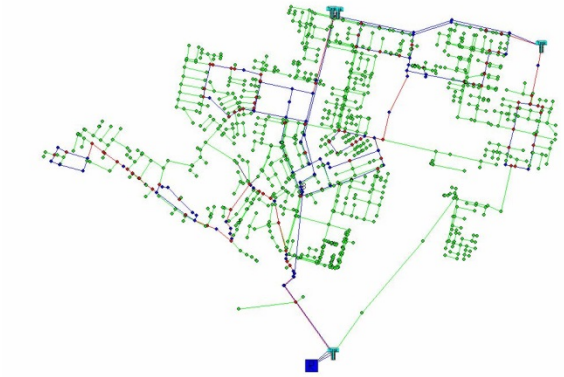

Average Time To Detection
35
30
25
20
15
10
5
0
time in h
0
20
40
60
80
100
120
140
160
180
200
Number of sensors
ATimeToDect49_50
DetProb49_50
ATimeToDect00_10
ProbDet00_10

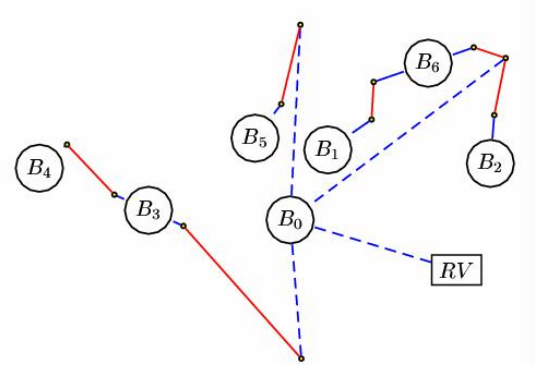
Enhancements for large networks

GRAPH DECOMPOSITION FOR SIMPLIFICATION

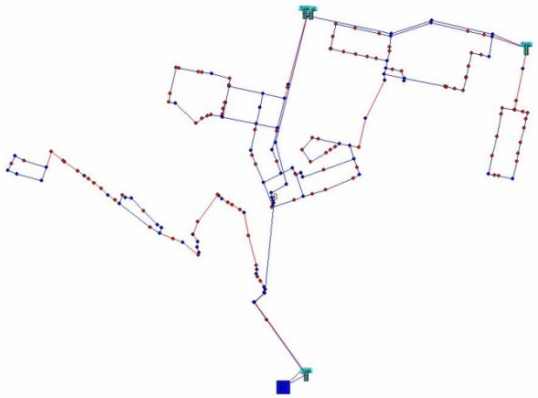


total network graph

forest



block graph tree



2-core

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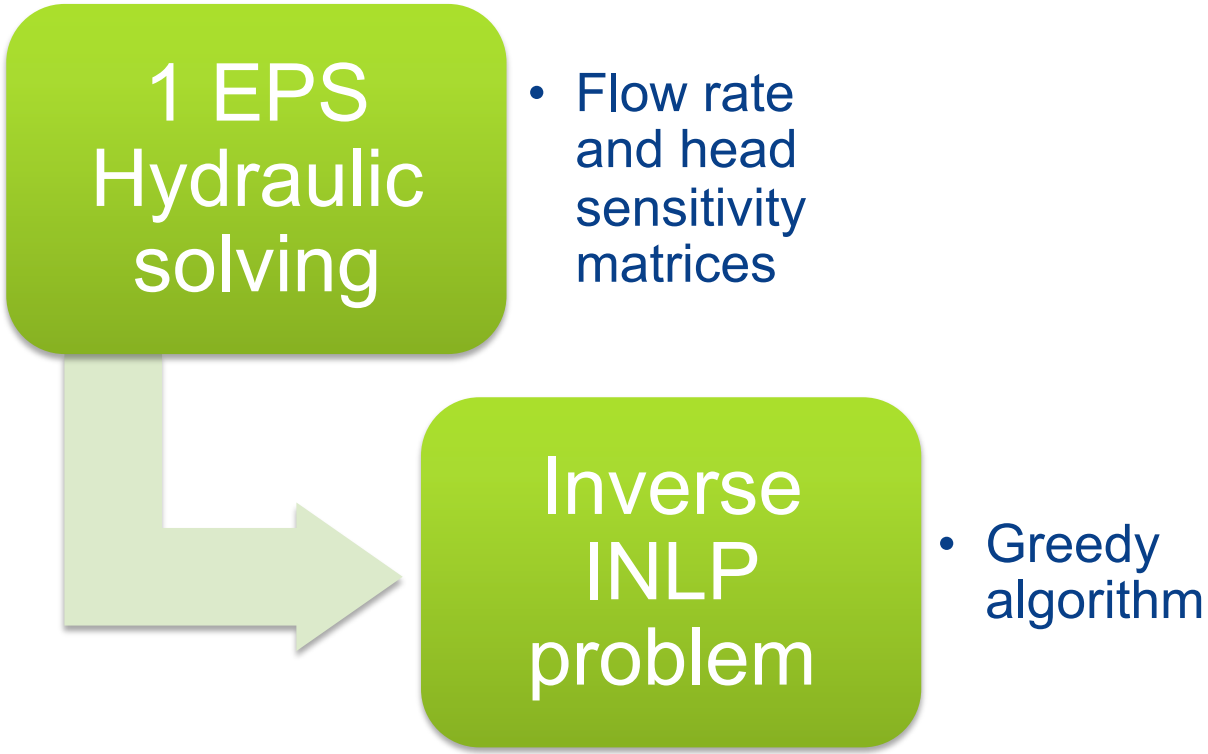
Real-time State Estimation SD

A TWO-STEP SOLUTION



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Real-time State Estimation SD

INLP PROBLEM

We seek for S the Selection matrix such that:

$$\min c(\mathbf{S}) := \left\| \left(\mathbf{SJ} \right)^{+} \right\|_{\infty}$$

$$\text{subject to: } \operatorname{rank}(\mathbf{SJ}) = p$$

Given the uncertainty of potential measurements, we want to minimize the hypercube that contains the parameter confidence region

Close to D-optimality design but no determinant to calculate and an inverse problem of the demand calibration problem

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Investigation and outlook

OPTIMAL LOCATION OF SENSORS

Optimal early-warning detection system

Done for the full SEDIF network (VEDIF) and CUS network

Done for a sub-network of BWB (Hochstadt Ost)

Outlook

Compare the greedy algorithm solution with the one from an conventional method, less rapid but optimal (VEDIF/VERI/Irstea)

Sampling design for real-time State Estimation will be done for CUS.

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Thank you for your attention

Any questions?

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Major findings D3.1

MULTISTAGE FORMULATION

Multi-objective INLP problem

$$\min_{\delta}\left[Z_{\alpha}(\delta) = \frac{1}{\text{Nsimu}} \sum_{j=1}^{\text{Nsimu}} \sum_{i=1}^{N_j - 1} c_{ij}^{\alpha} \right]_{\alpha=1,\cdots,10}^{T}$$

$$\text{subject to: } P \subset \delta \subset F, \; |\delta| = N_s$$

Not a single-stage problem rather a multi-stage problem

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