Data fusion for traffic flow estimation at intersections

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Outline

Part I Motivation and idea

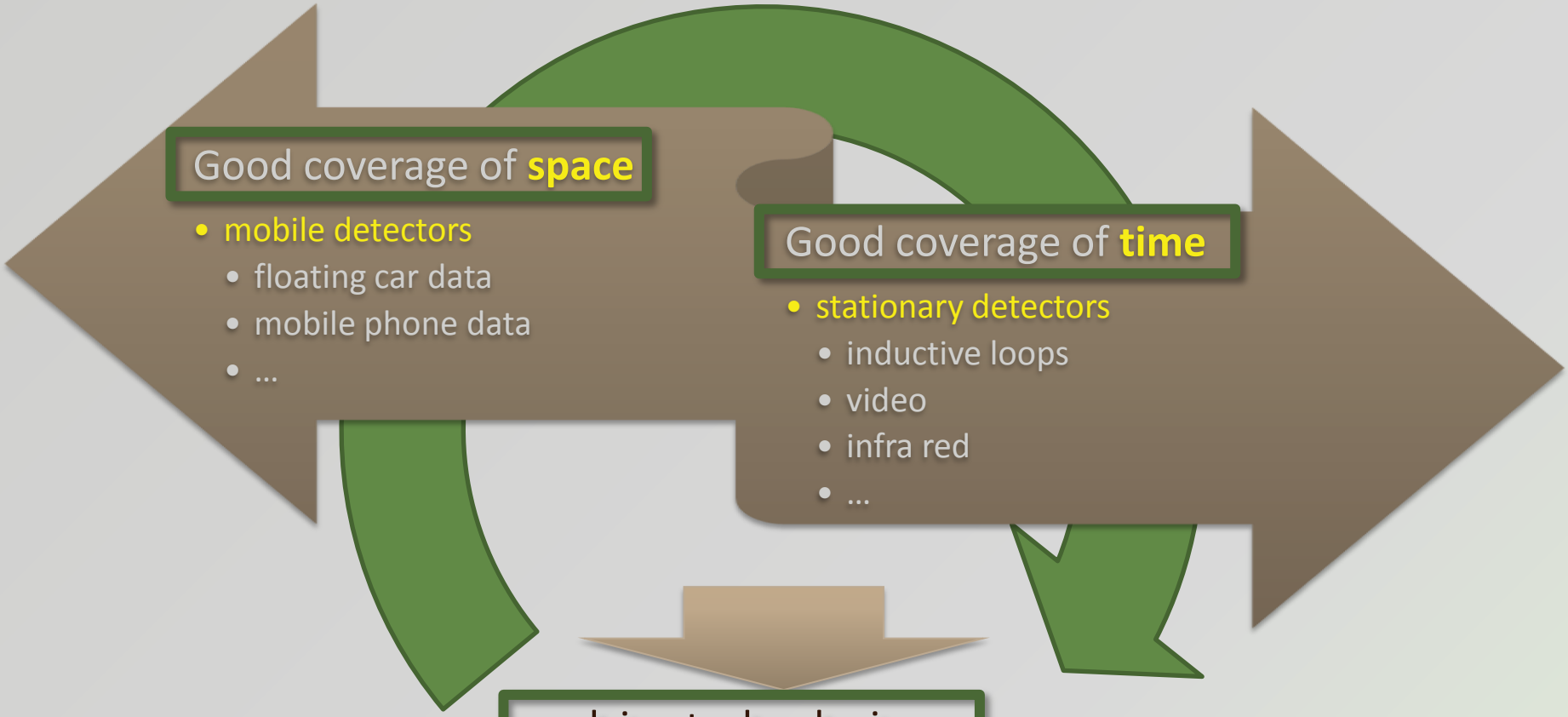
Part II Data Fusion Concept

Part III Application and Discussion

Part I

Motivation and idea

Why data fusion?



The application

- Mobile and stationary detectors have been fused before.
- But not at intersection level.

- The story about the importance of signalised intersections in urban networks.

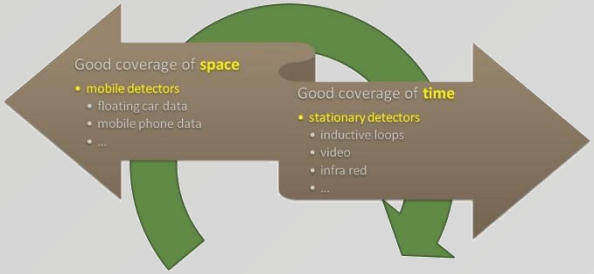
- Signal control is based on turning ratios ever since.

- But who knows the turning ratios?

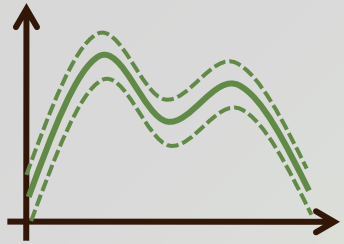
- Soon we will

Data sources for the fusion

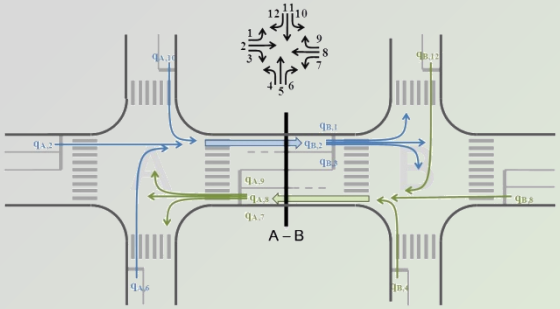
- Mobile detectors
  - Floating Car Data (FCD)
- Stationary detectors
  - e.g. inductive loops



- Historic data
  - used to fill the gaps in time and space

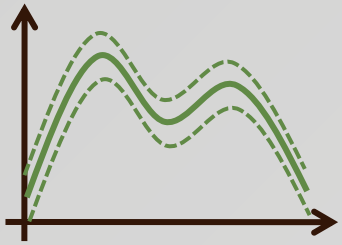


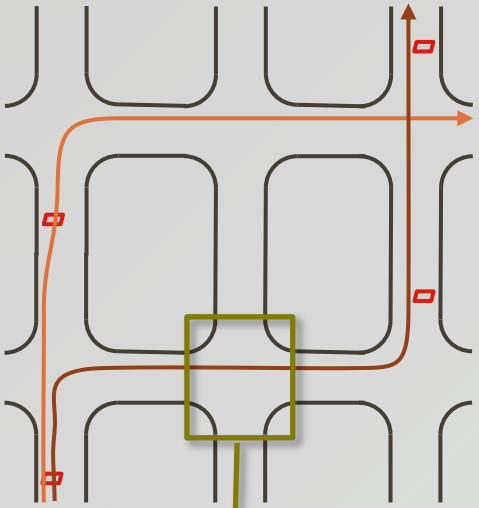
- Network context
  - vehicles do not disappear magically…
  - every simulator uses this information



Data output of the fusion

- Available data
  - Floating Car Data (FCD)
  - detector data
  - historic data
  - network layout



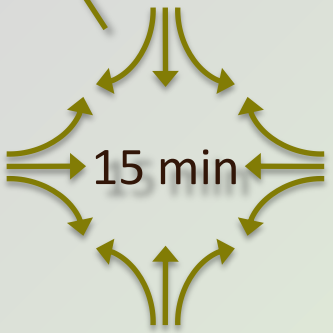


Input

- Desired information
  - OD on intersection level (traffic flow for all movements)
  - resolution 1 h (better 15 min)

q

$[q]$=1 veh/time



Output

Part II

Data Fusion Concept

The concept in a nutshell

- combine as many data sources as are available and seem useful
- bridge the gap of unknown turning volumes at intersections by using Floating Car Data
- use historic data in case no current data is available
- weight the different data sources according to their reliability

Kalman Filter

- estimates true values
- estimates uncertainty of the predicted value
- computes a weighted average of predicted values and measured values
- minimises the error covariance (for white noise)

Kalman Filter

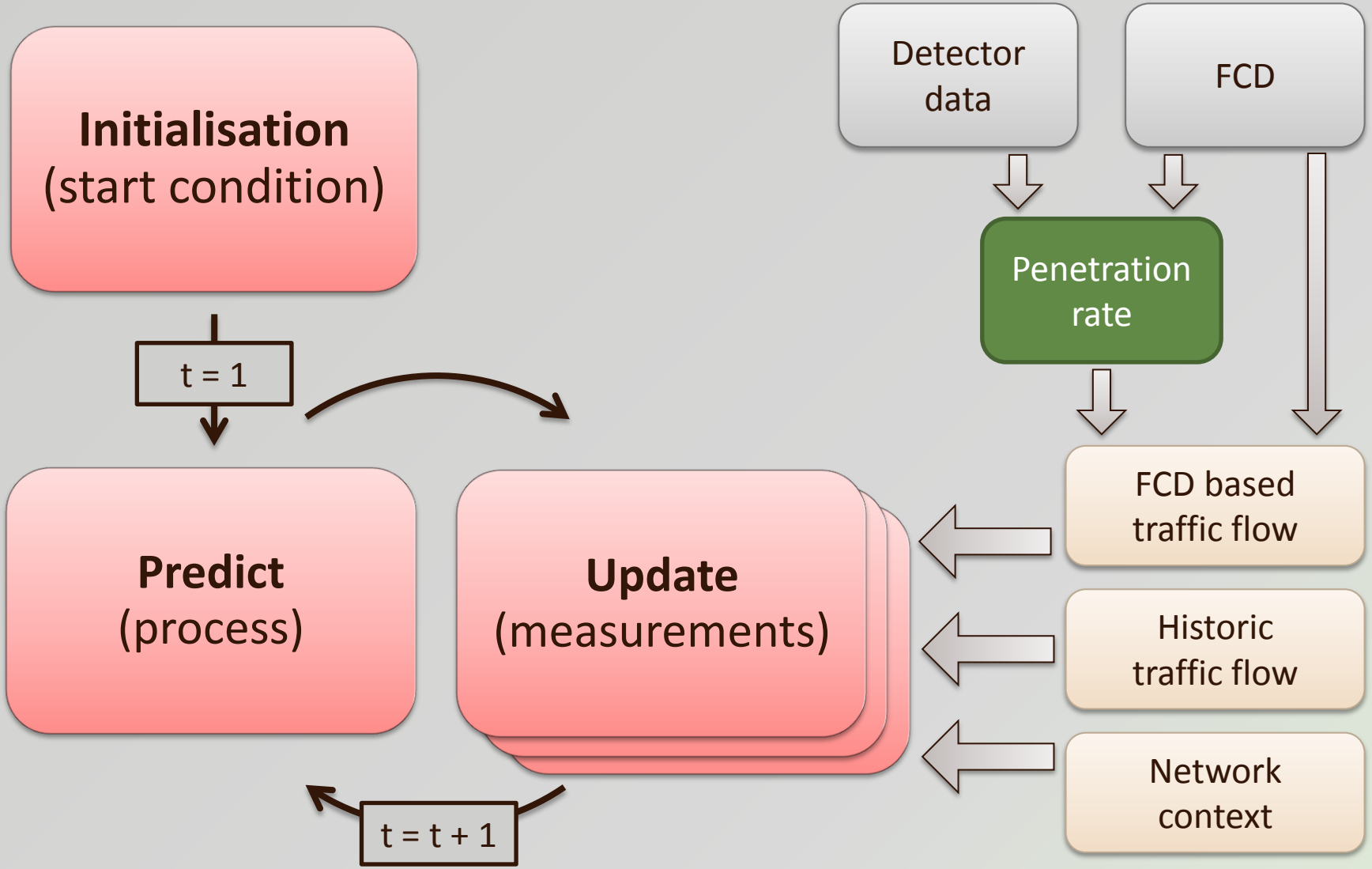
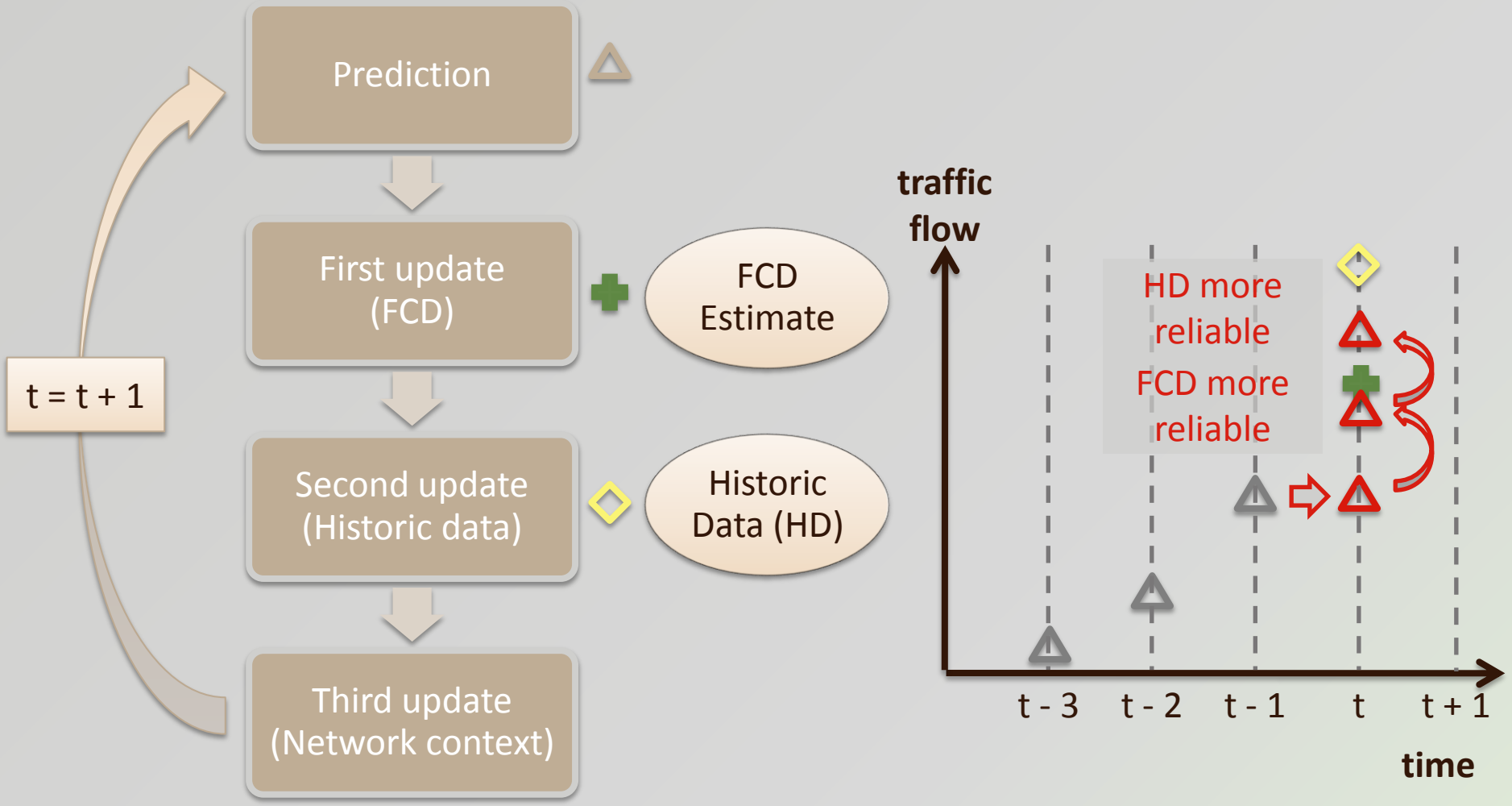
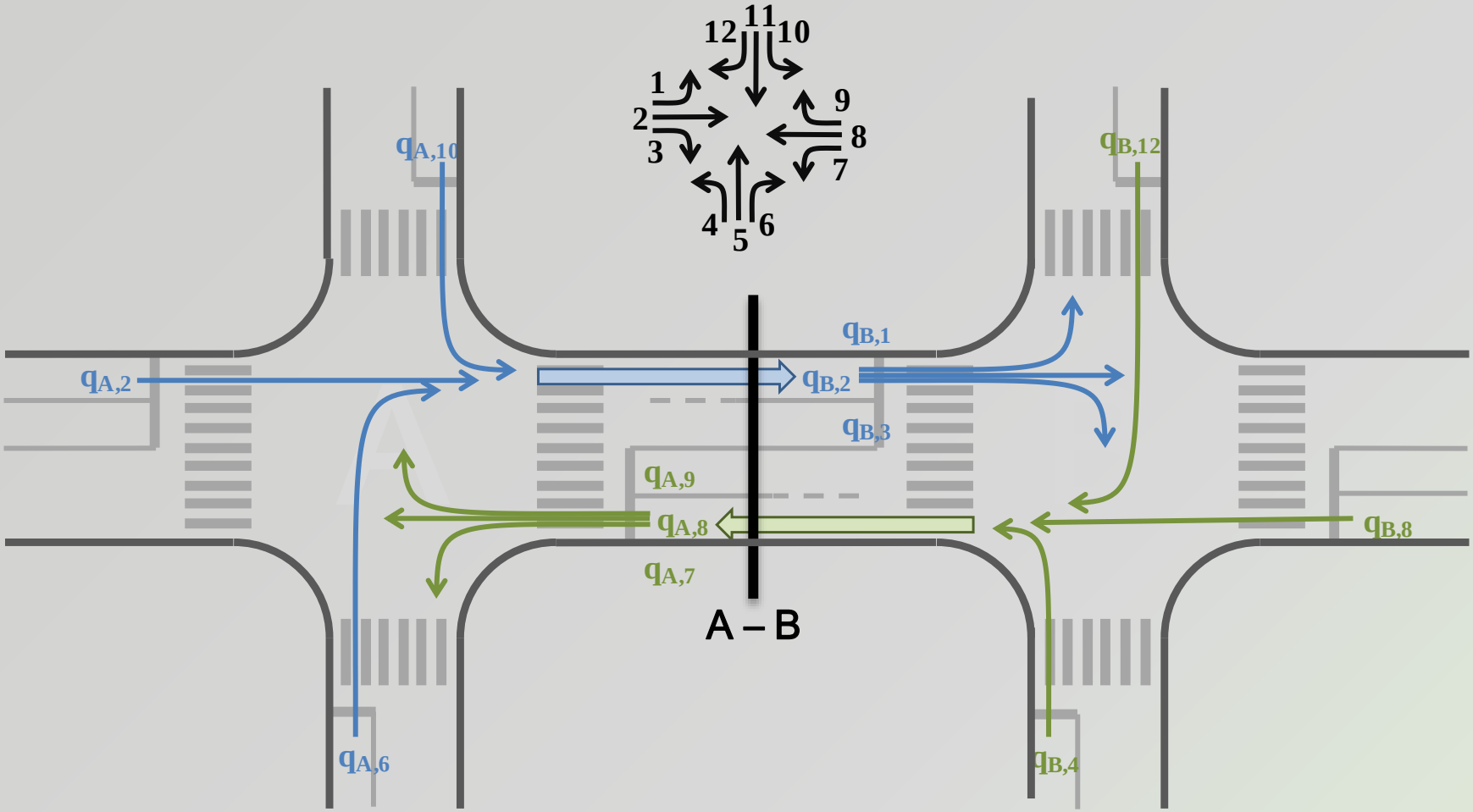


Illustration of Kalman Filter



Network context



Error terms

- Historic data
  - variance of historic data
  - clustering!
- FCD
  - variance of penetration rate
  - detector reliability?
- Network context
  - reliability of estimates from adjacent intersections

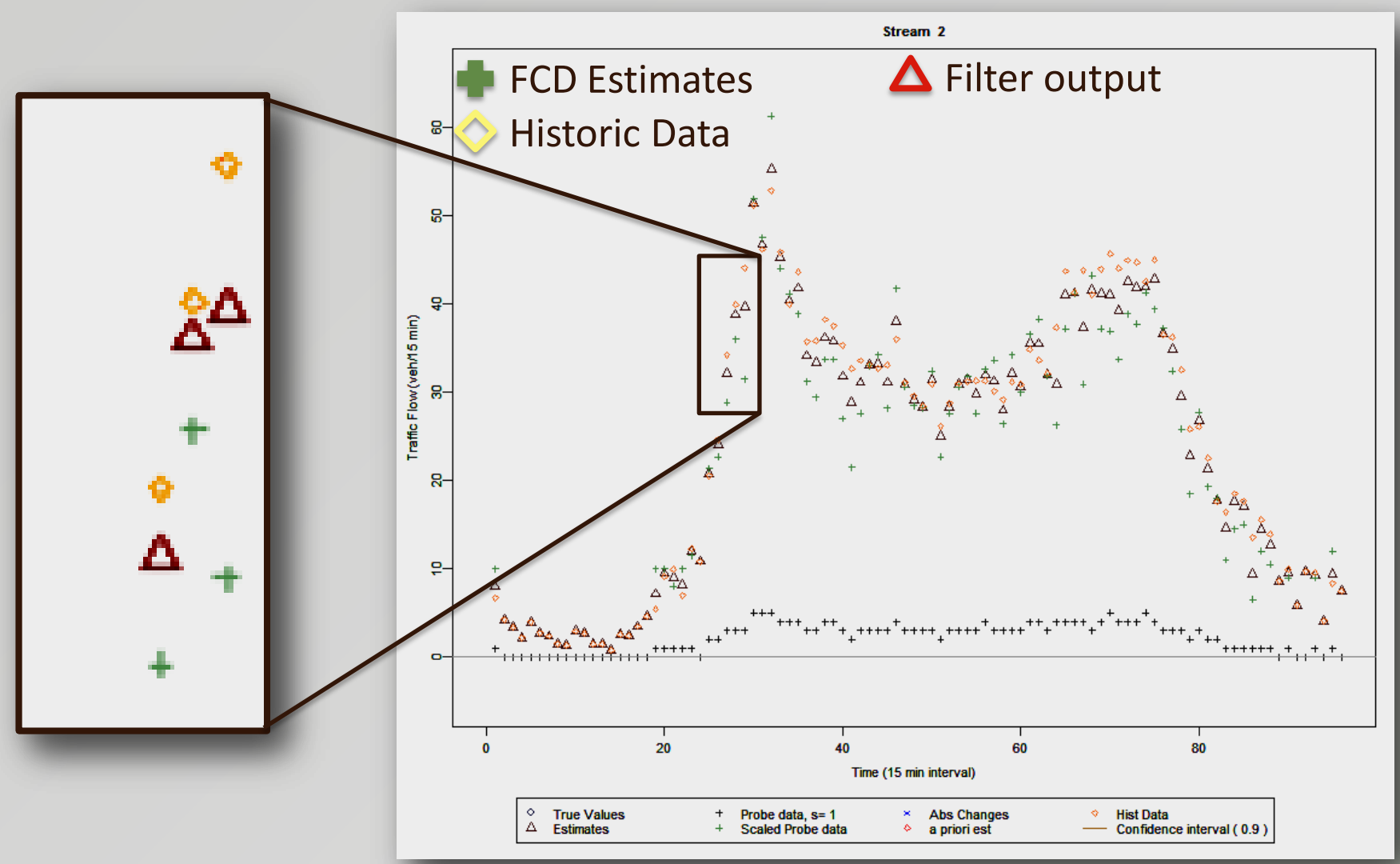
Part III

Application and Discussion

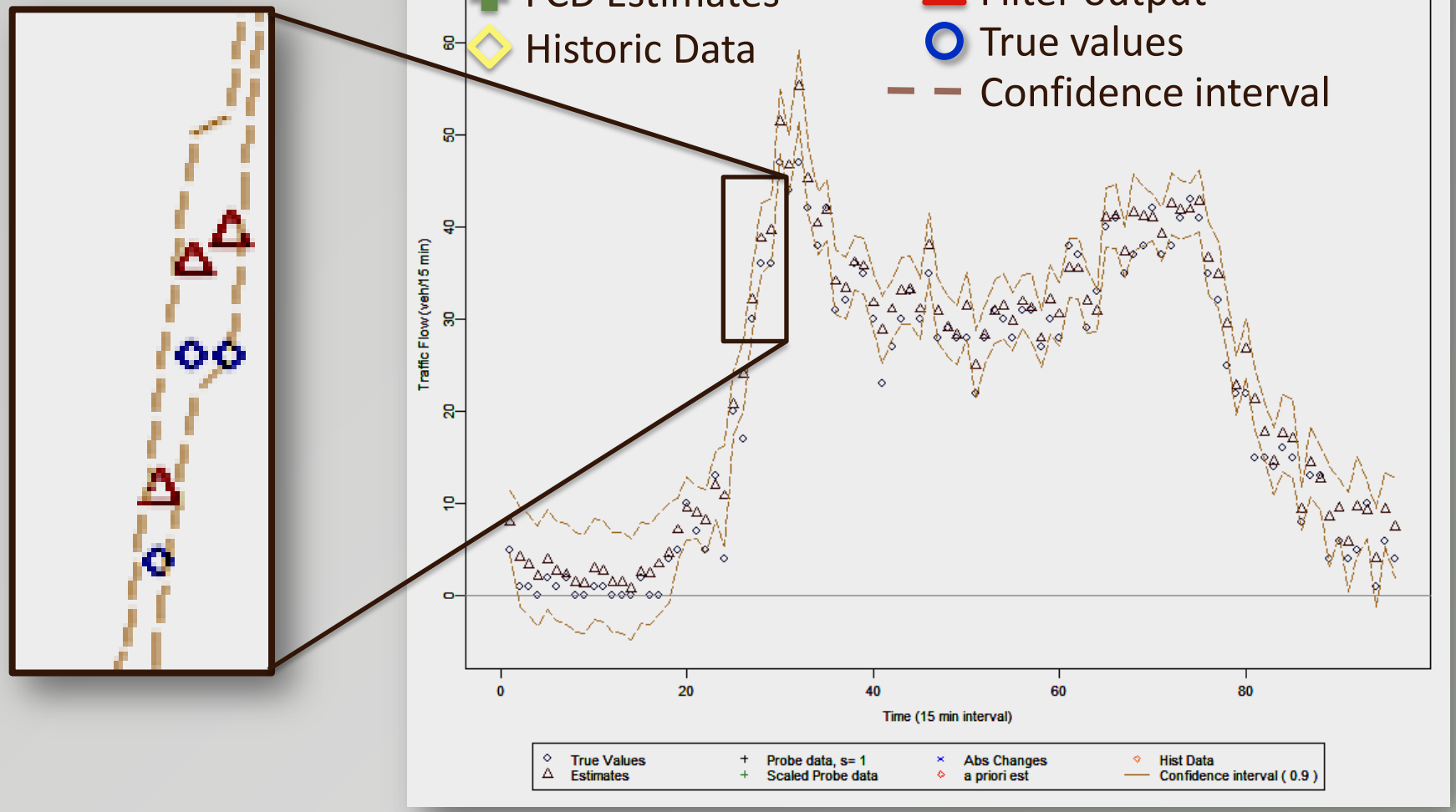
Application overview

- fictitious data
  → true values are known for evaluation
- elasticity tests for different parameters
  - traffic flow variation
  - penetration rate
  - detector reliability
  - representativeness of probe vehicles
- simple two intersection “network”
- Monte Carlo simulation to avoid random results

Application

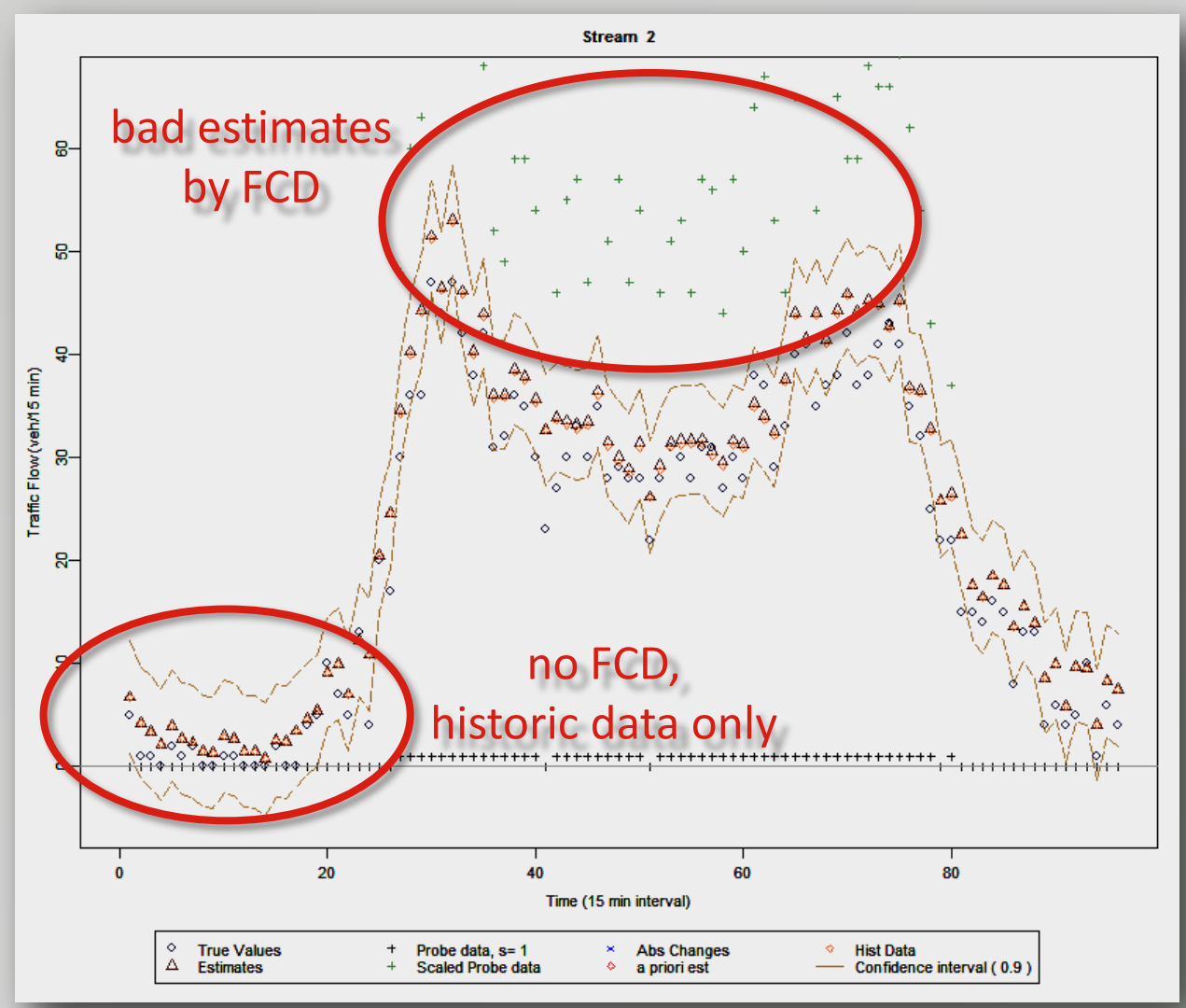


Application



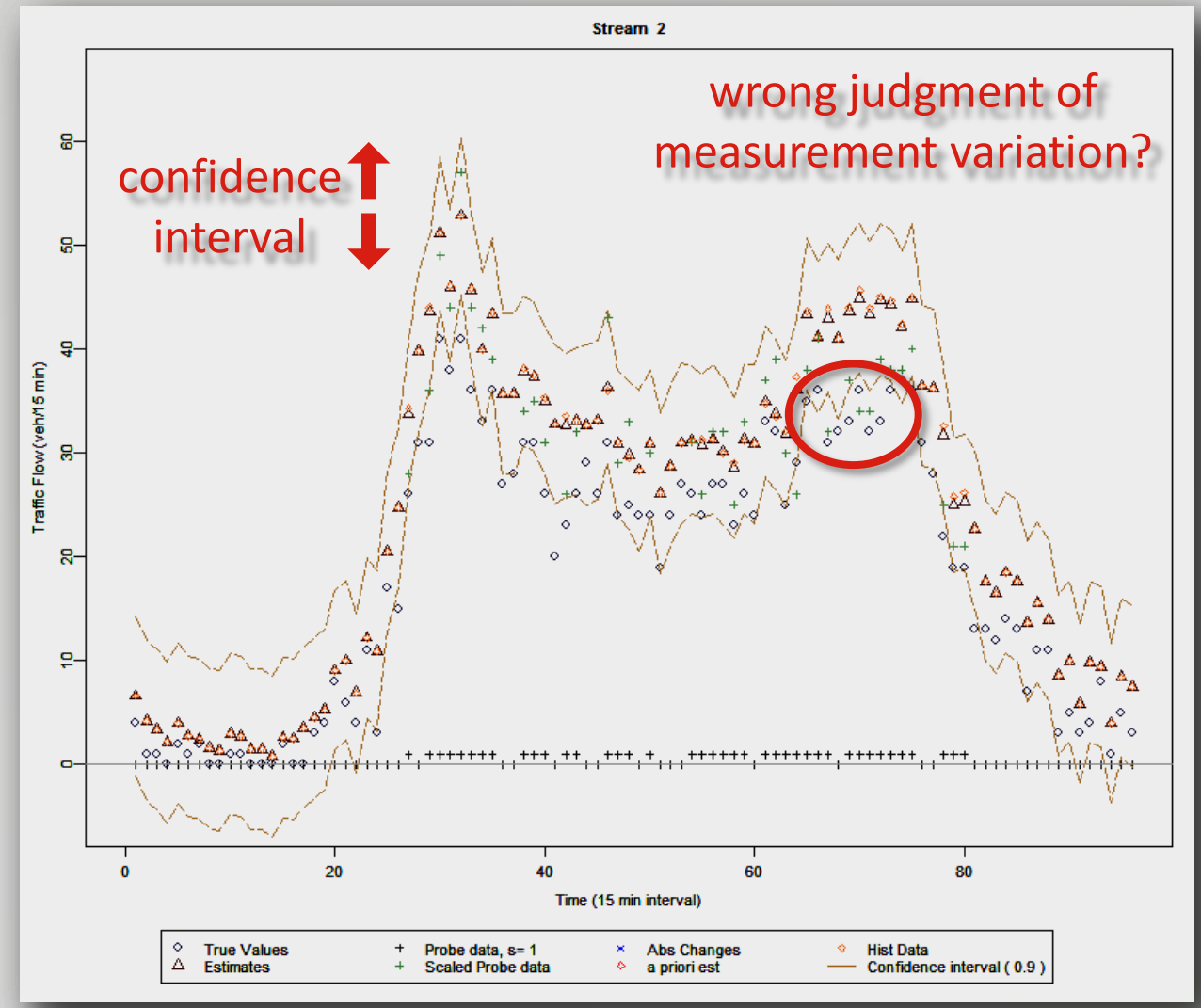
Application

- penetration rate ⬇

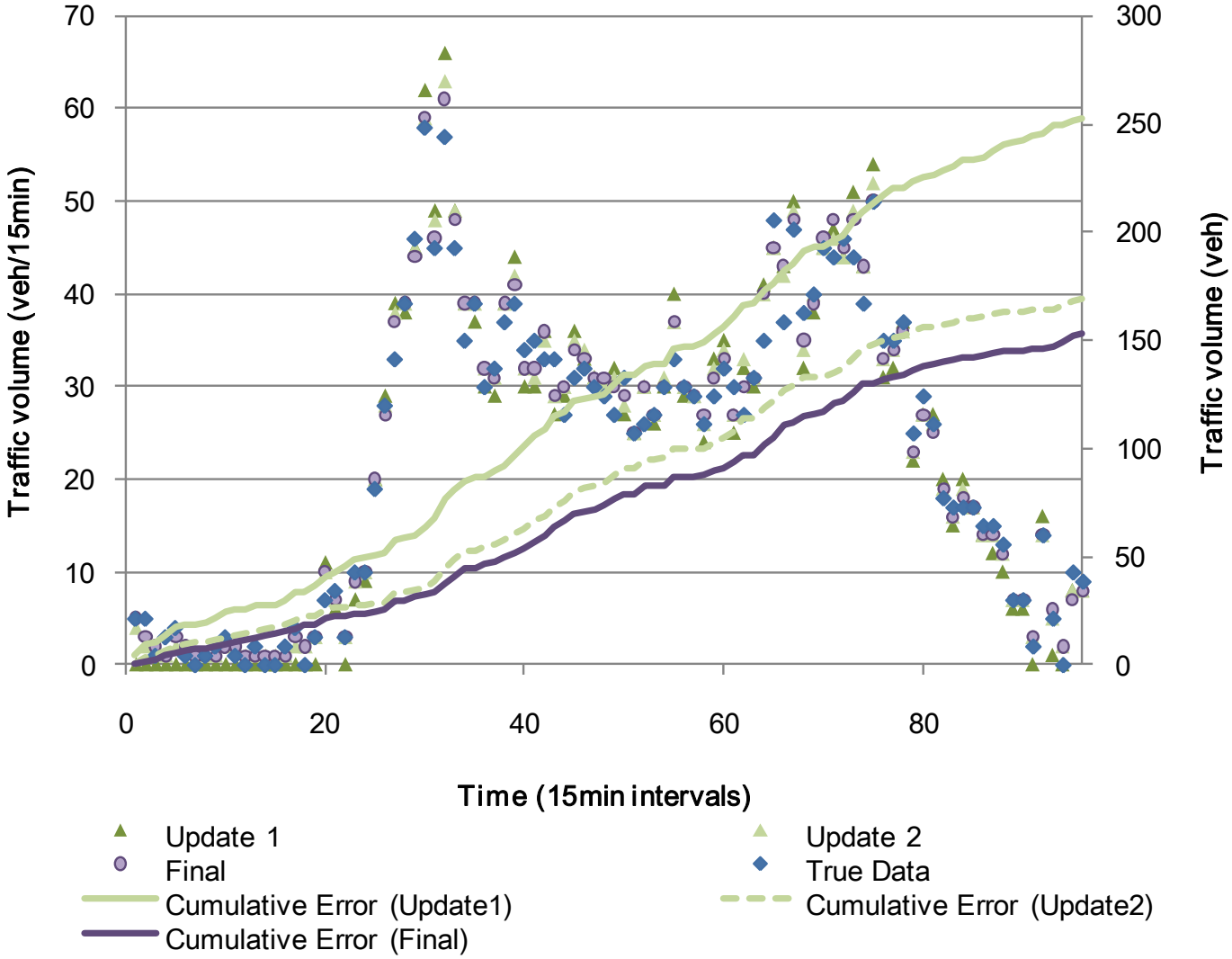


Application

- penetration rate ↓
- flow variation ↑

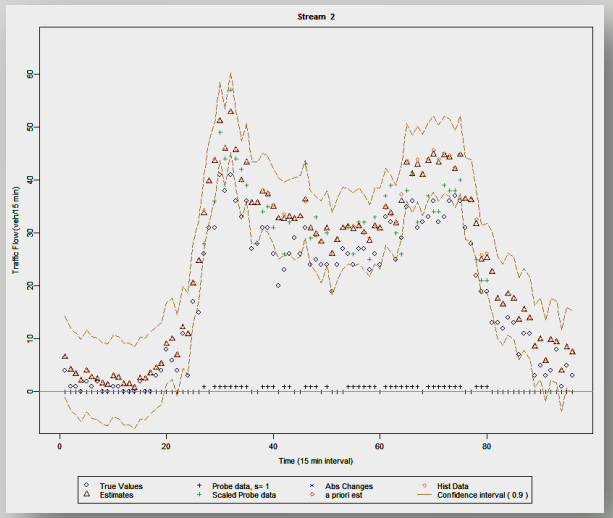


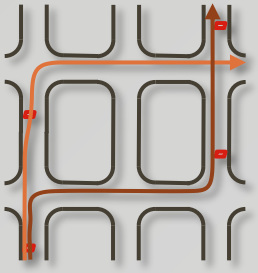
Application



Discussion

- more data sources useful
- how to judge the measurement reliability?
- high penetration rate crucial (> 10 %)
- good clustering technique for historic data required





- combination with flow simulation desirable
- evaluation of real data dito

a promising concept if sufficient FCD is available