French Institute
of Science and Technology
for Transport, Development
and Networks

Microscopic traffic models: are the recommendations for correct calibration applicable in stochastic cases?

Christine BUiSSON,
LICIT (ENTPE/IFSTTAR)
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IFSTTAR

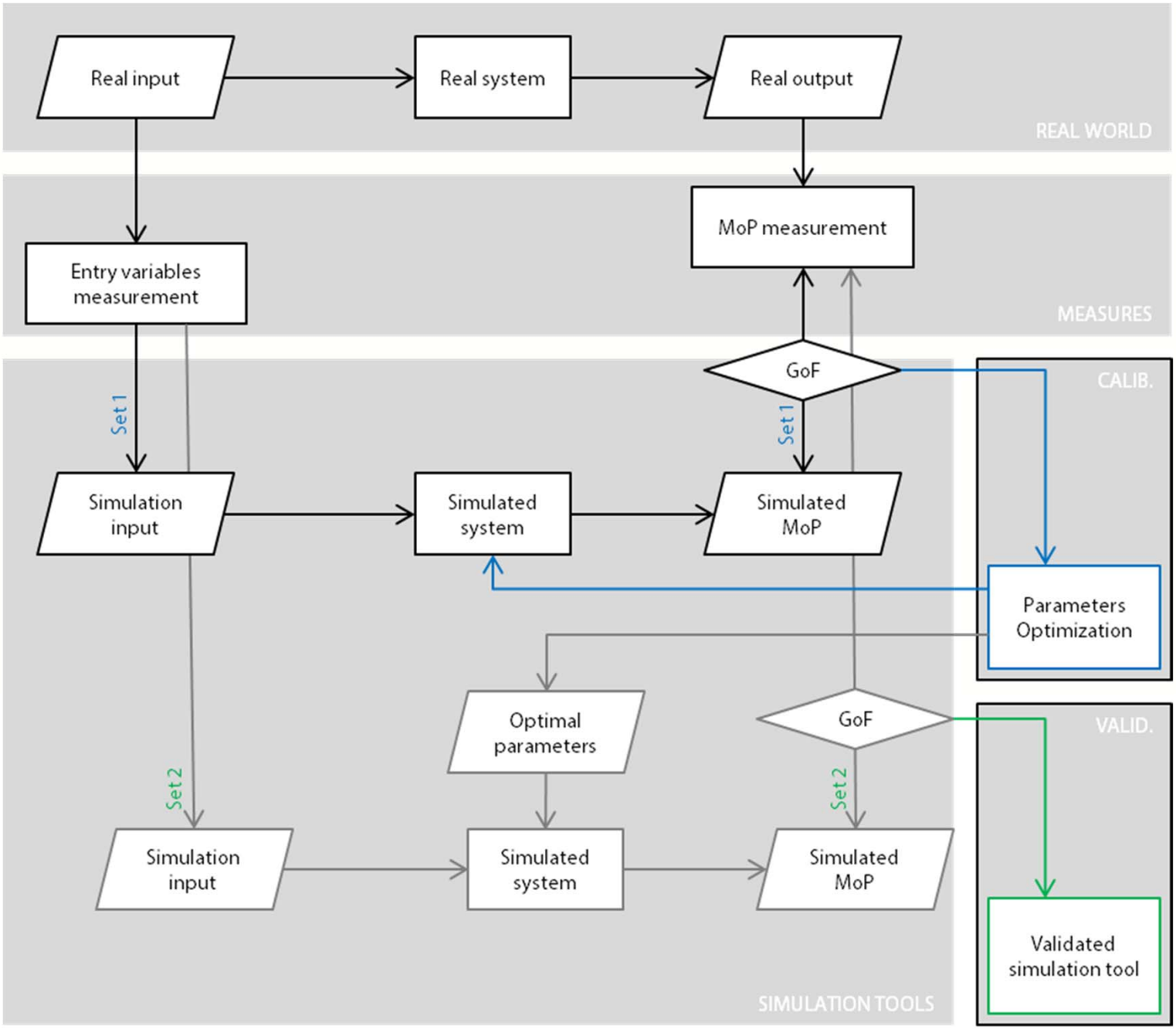
Main objectives

- List questions about
  - Calibration and validation in case of influent stochastic components of the modelling

- Present
  - Some research directions to answer them
  - A European project to make progress in this direction

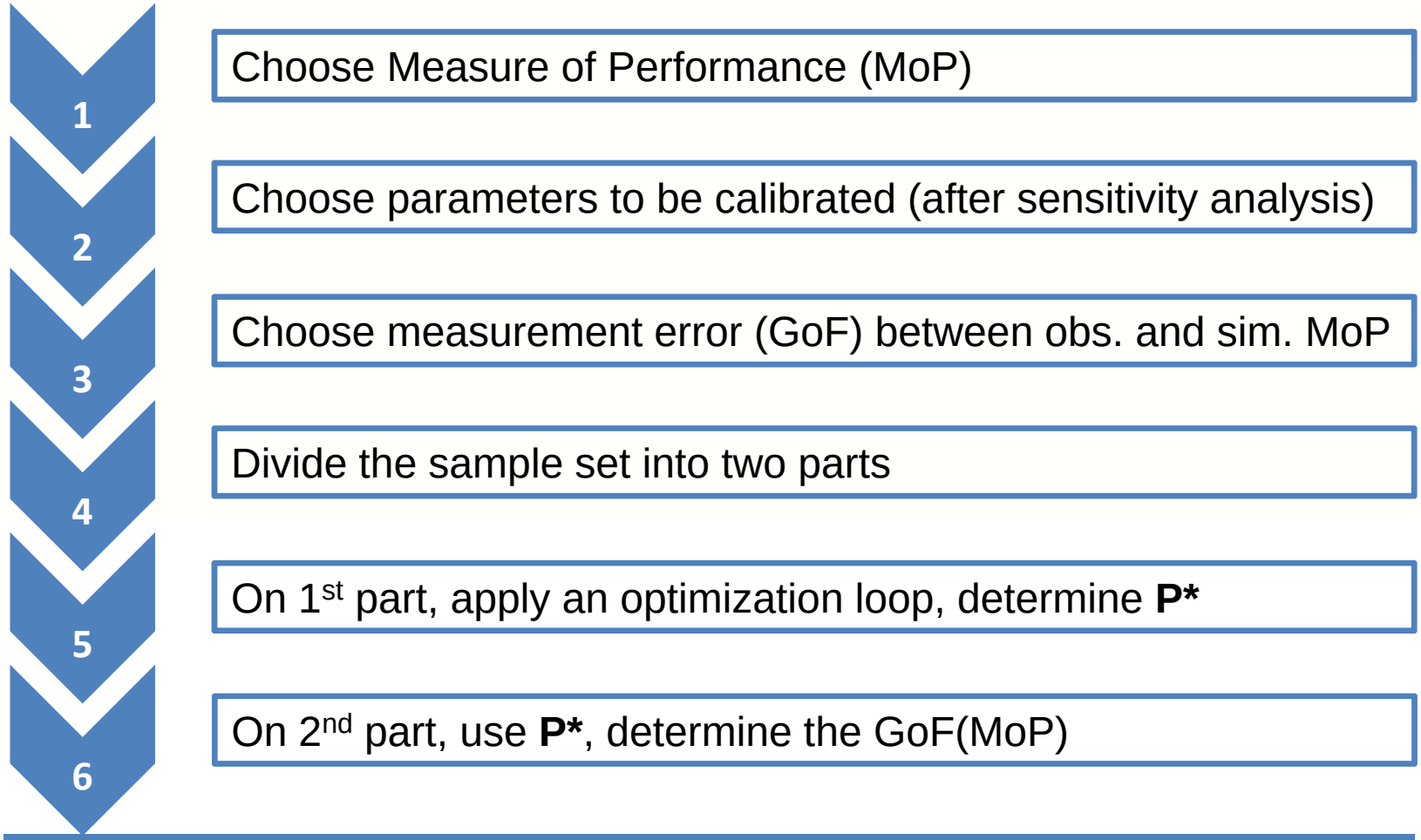
Part 1: list questions

- What are “the recommendations for correct calibration and validation”?
- How many types of randomness are they?
- Where does randomness lies in the modelling process?
- How was this question faced in literature recently
- List the questions (at least, a part of them)



From: Daamen et al, 2015

State of the art recommendations



What said Peter about this in his presentation, last TRB?

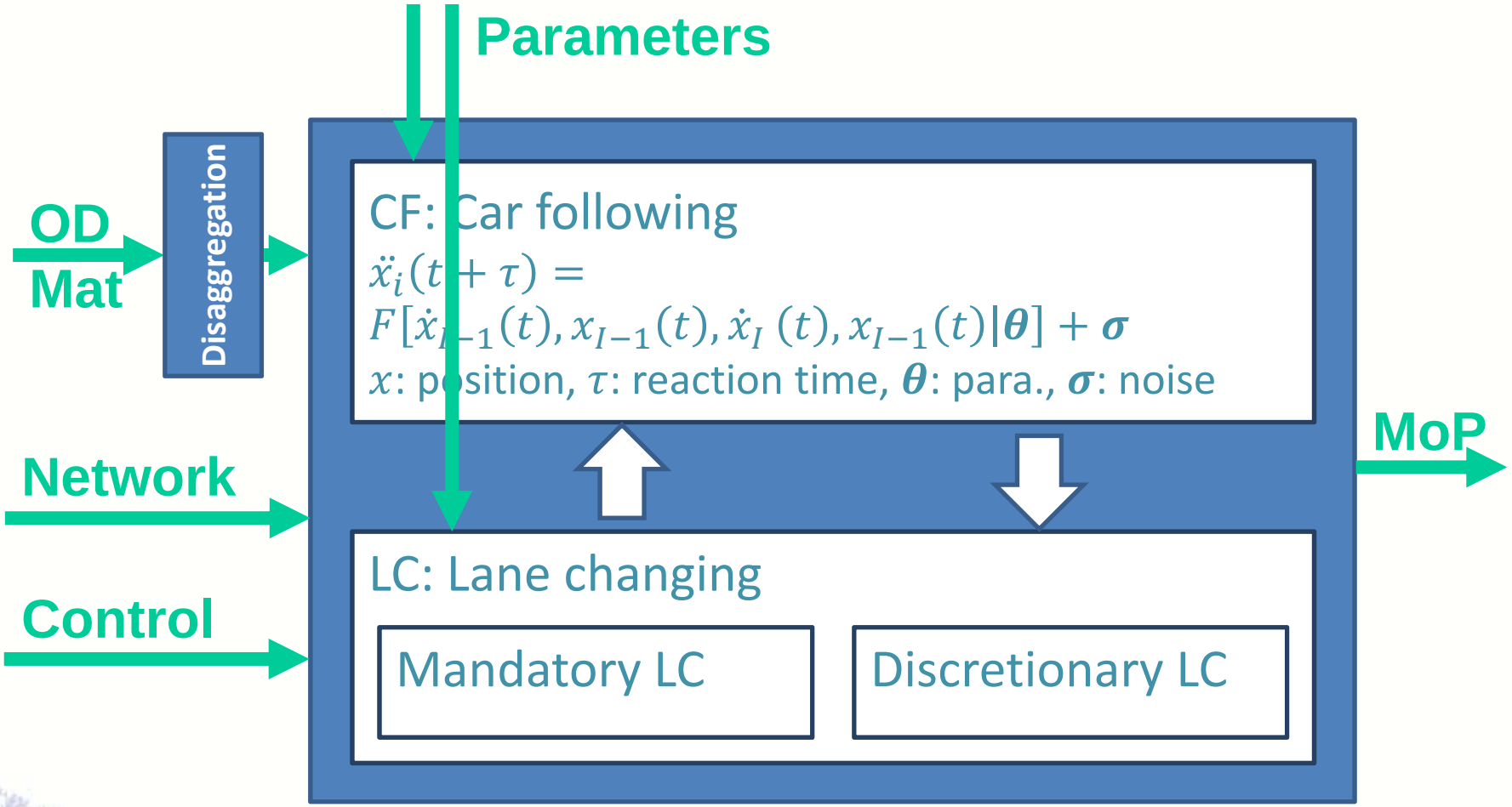
“Randomness

- Ignore philosophy and use the following (hopefully) useful description:
- What is beyond our observation/ consideration shines up as stochasticity
- Stochasticity can be:
  - Measurement errors
    (they are the simplest to deal with)
  - Parametrization errors
  - Modelling errors
  - ??”

From: Wagner et al, 2016

Various types of randomness in microscopic models

- Randomness is used in the vocabulary or is present in:
  1. Variability of the input variables or error in their measurements
  2. Disaggregation of global variables (input flow) into individual ones (entry instant)
  3. Individual parameters distribution
  4. Random term in the model equation/ behavior



For an experimental evidence of $\boldsymbol{\sigma}$ see Jiang et al, 2014

1. Variability of the input variables or error in their measurements
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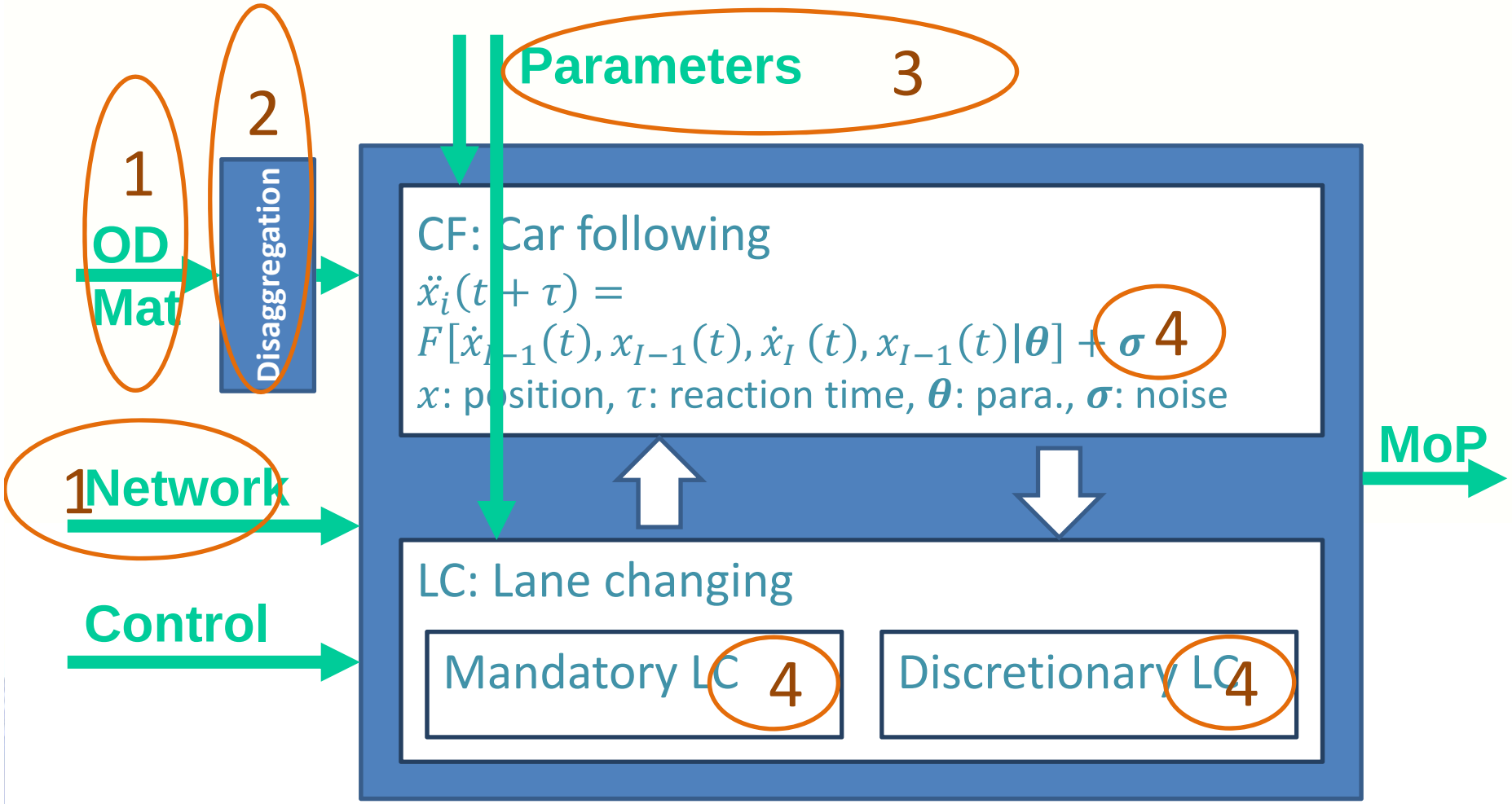
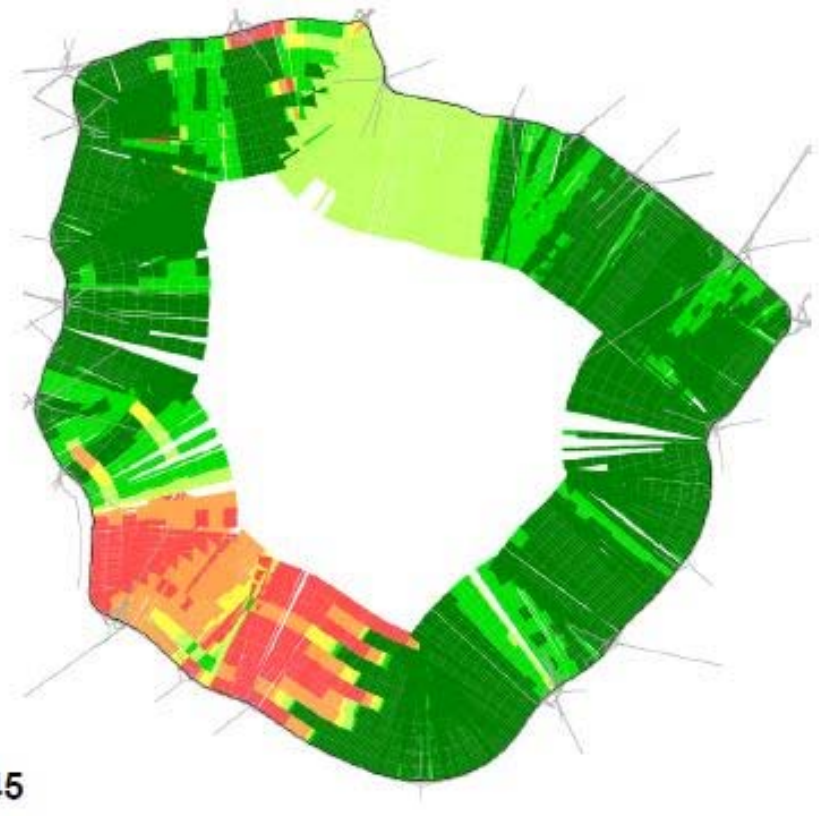


1: Variability of the input variables or error in their measurements

- Usually through a comparison of
  - Simulated MoP distributions
  - Observed MoP distributions
- Randomness of types 1,2 and 3 are fused together



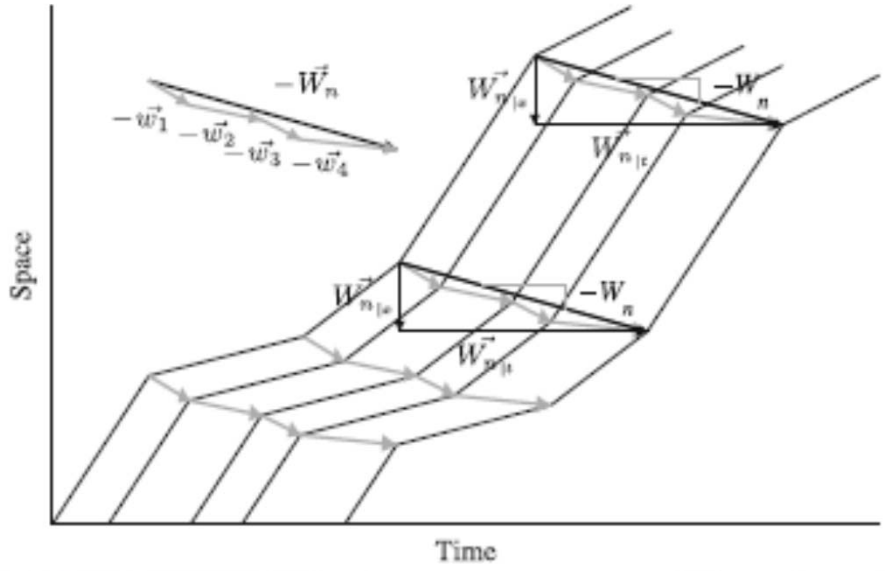
From: CEREMA IFSTTAR 2015

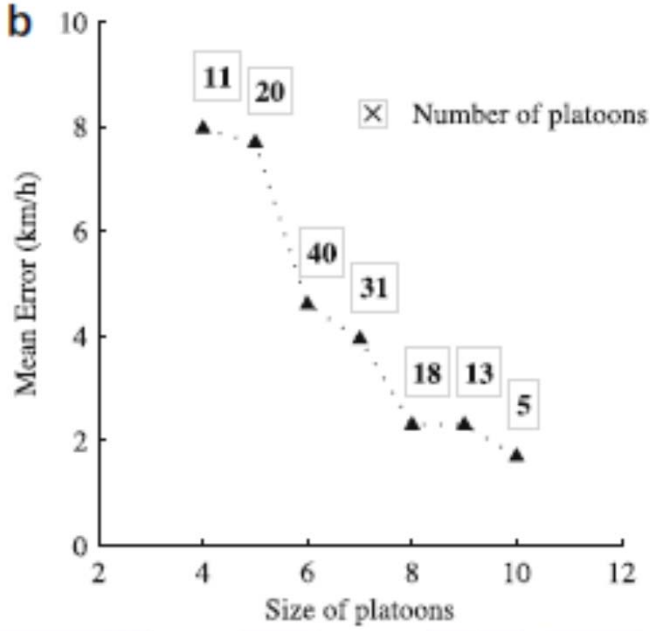
2: Disaggregation of global variables into individual ones

- A consistency check is made inside the simulation tools, but no specific studies

3: Individual parameters distribution of CF model

- In the case of Newell's model, it has been found that the parameters distribution effect vanishes if the number of drivers is sufficient





Chiabaut et al, 2010

3: Individual parameters distribution of CF model (cont.)

- Observation of individual trajectories reveals:
  - Parameters are distributed
  - And models also!
    - See S. Ossen 2008 work about CF
    - See M. Keyvan-Ekbatani, V. Knoop, W. Daamen, 2015, about LC
- There is no rules (until yet) to define
  - The parameters distribution
  - And the share ratio between models

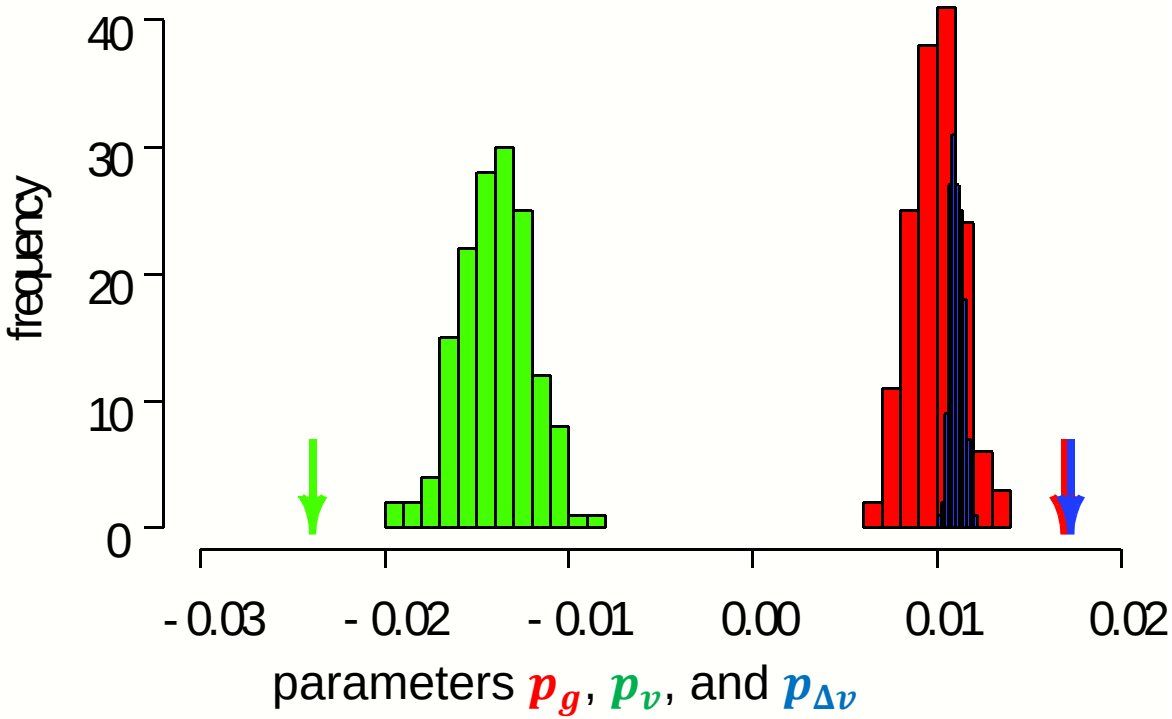
From the observation of macroscopic variables

3: Individual parameters distribution of CF model: where is it important?

- In some cases of traffic characteristics, this randomness is apparently linked to the emergence of (bad) macroscopic behavior:
  - Onset of congestion,
  - Emergence of stop and go waves
- If the simulation objective is
  - Safety or
  - Consumption/pollution

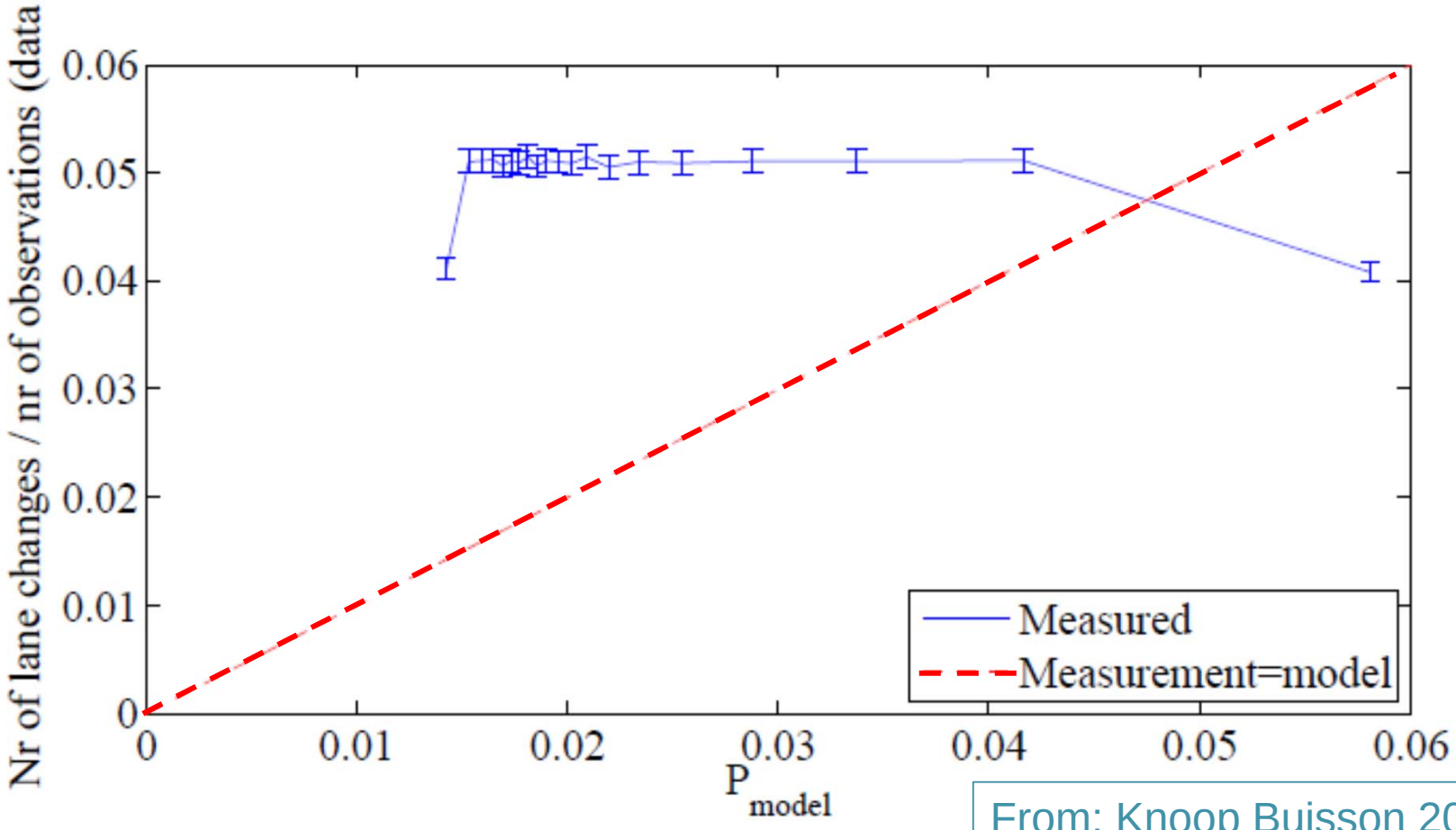
4: Random term in the model equation/ behavior. part 1: CF

- Synthetic trajectories + a state of the art calibration procedure to a CF model with σ
- 100 runs



From: Wagner et al, 2016

4: Random term in the model equation/ behavior. Part 2: LC



From: Knoop Buisson 2014

Figure 8: Microscopic validation results

Conclusions of Part 1: Two (rather simple) questions generated by the application of cal/val to stochastic models

- Can we define a procedure to compare a set of observations to simulation results?
  - Definition of the minimal number of days for a sufficient experimental set?
  - Estimation of the sim. MoP (especially buffer time)?
  - Check randomness of the simulation (capacity?)
- How can we derive parameters distribution from the observation of macroscopic variables?
  - Ideas: fit the shape on microscopic observation and use cal on local macro variables to adjust the terms of this distribution
  - Method never fully tested to the best of my knowledge

Conclusions of Part 1:
Four (much more complicated) questions

- Can we define the traffic assessments projects where a correct reproduction of the 4 stochastic components of micromodels **must** be included?
- (a provocative one)
  Can we trust safety simulation models?
- Can we propose an evolution of the cal/ val procedures to deal with the 4th type of stochasticity?

- Is it not likely that the multiplication of various types of vehicles / users will increase the complexity and thus, the stochasticity of the global transportation system?

Part 2: contribute to the answer

- Some research directions to answer them
- A European project to make progress in this direction

A research path to answer those questions

- Use big data sets to define a determination procedure of the distributions of the macro variables:
  - How many days are needed?
  - What does really “similar input” needs?
  - Can we define homogenized ways of dealing with variability of the real system?
- Use the numerous datasets combining individual and collective variables to answer the second (rather easy) question
- **For the four more complicated questions: Look into other disciplines/ application fields to understand what are their approaches**

First collective step into this path

- Publicly available datasets
- Publicly available simulation tools
- Publicly available papers

- Let’s open science!

An European project

- Propose an ITN (= PhD + summer schools)
- Research objective:

Reliable cities in increasing complexity

Thank you very much!

- References cited explicitly in the presentation

(but this is an evolving subject and many recent papers could have been cited)

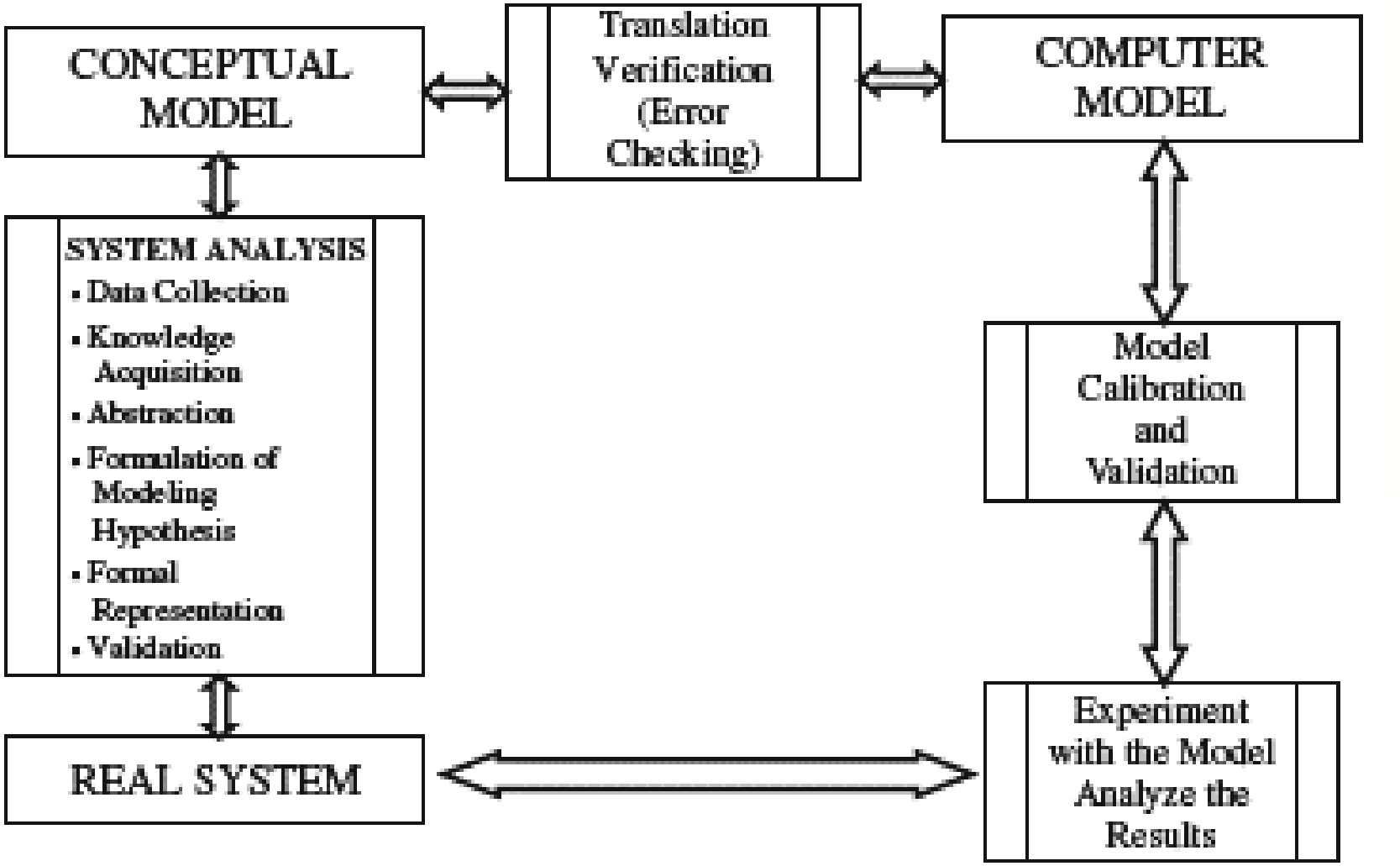
- Daamen, Buisson, Hoogendoorn, Ed. (2015) Traffic Simulation and Data: Validation Methods and Applications, Taylor and Francis.
- Wagner, Buisson, Nipold, (2016) Challenges in applying calibration methods to traffic models. 95rd Transportation Research Board Meeting, Washington D.C (USA), 2014 , paper n°16-1110.
- **Jiang, Hu, Zhang, Gao, Jia, Wu, Wang, Yang, (2014) Traffic experiments reveals the nature of car-following, Plos One, April, 4.**
- Chiabaut, Leclercq, Buisson (2010), From Heterogenous drivers to macroscopic patterns, in congestion, Transportation Research Part B, 44, 299-308.
- S. Ossen PhD manuscript (sorry for the title)
- Keyvan-Ekbatani, Knoop, Daamen, (2015) categorisation of the lane change decision process on freeways, Transportation Research Part C
- Knoop, Buisson, (2015) Calibration and validation of probabilistic discretionary lane-change models, Intelligent Transportation Systems, IEEE Transactions, 16 (2), 834-843

- For good review papers (LC and CF) read Zuduo Zheng Tr-B and TR-C:

Annexes

Modelling loop

From: Barcello, 2010



3: Individual parameters distribution of CF model (cont.)