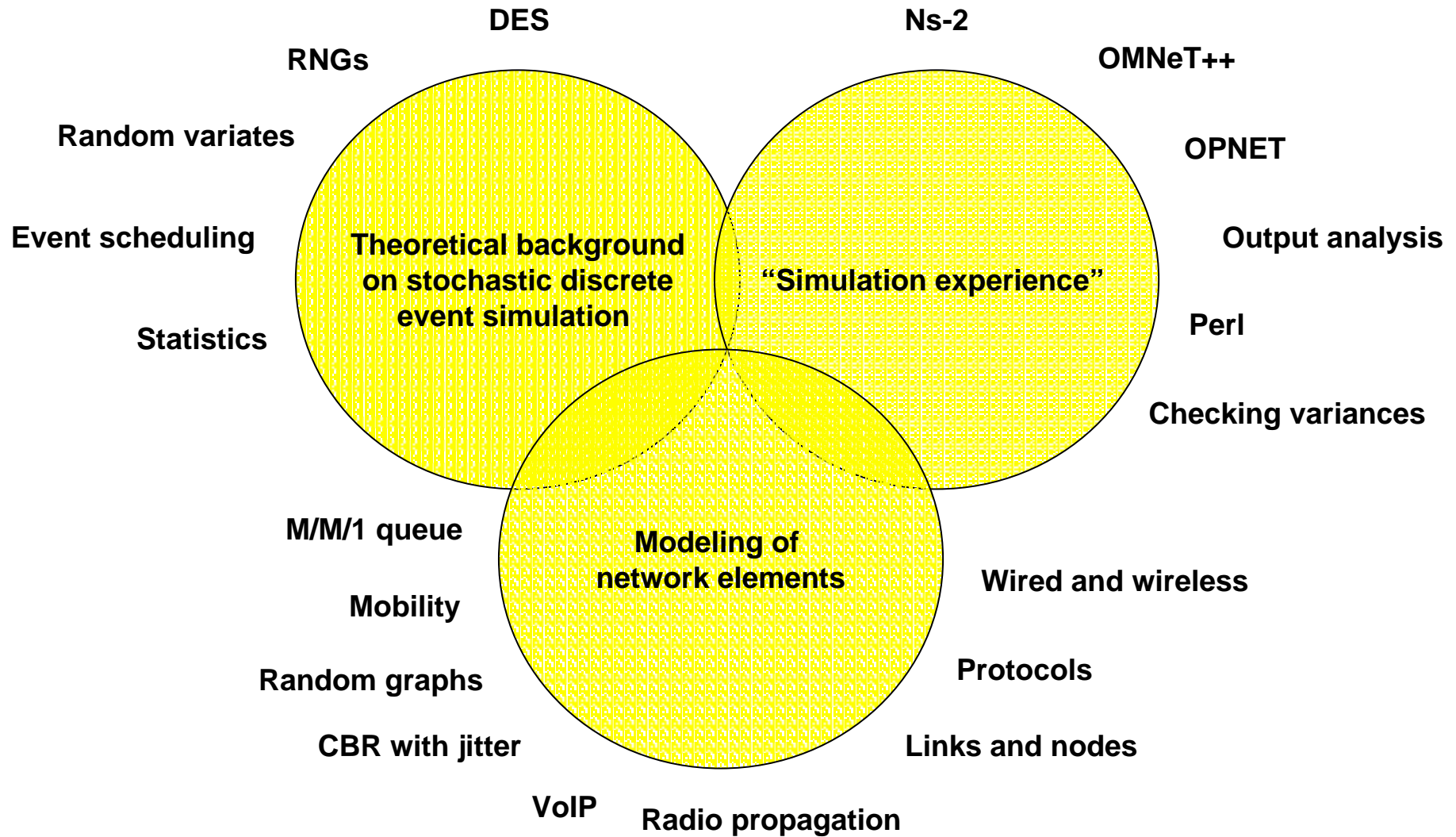# Simulation lifecycle

Holger Füßler

Lecture overview

» **Retrospection**

– **Tour d'horizon**

– **Simulation life-cycle (recap from another perspective)**

Retrospection

DES   Ns-2

RNGs   OMNeT++

Random variates   OPNET

Event scheduling   **Theoretical background**   Output analysis
                   on stochastic discrete   **"Simulation experience"**
                   event simulation

Statistics   Perl

                                            Checking variances

M/M/1 queue   **Modeling of**
                   network elements

Mobility   Wired and wireless

Random graphs   Protocols

CBR with jitter   Links and nodes

           VoIP   Radio propagation

Simulation life-cycle

Generic

Example

» **Communicated problem**

» **Formulated problem**

Understanding the problem
(extremely important, not
exclusively related to simulation ☺)

» **Wireless multi-hop
communication between
vehicles to increase safety and
comfort**

» **Routing/Forwarding in a highly
dynamic mobile ad hoc network:
which protocol/protocol class is
optimal?**

– **Topology-based: AODV, DSR**

– **Position-based: GPSR, …**

Simulation literacy:

**How was the study
performed?**

Do I trust the results?

Simulation life-cycle

» **Proposed solution technique: simulation**

» **System and objectives definition**

» **Why?**
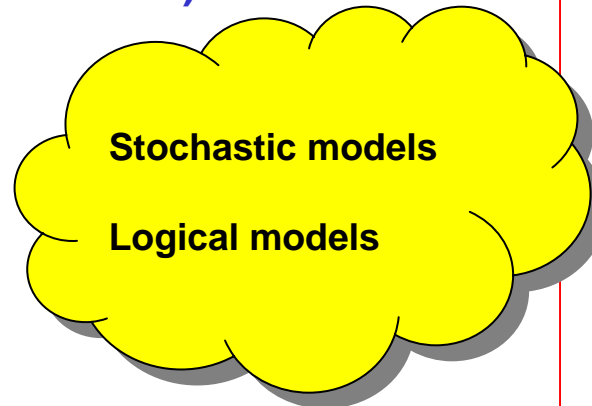 – **Scalability**
  – **Ease of experimentation**

Simulation as a tool

» **System: vehicles equipped with radio hardware and computing facility**
  – **Need realistic movement patterns**
    • **Highways**
    • **Cities**
  – **Need realistic DLC/MAC modeling**

  – **Protocols under evaluation: …**
  – **Performance measures:**
    • **Packet delivery ratio**
    • **Delay**
    • **Overhead/costs**

Simulation life-cycle

» **Conceptual, communicative model (selection)**

> **Stochastic models**
>
> **Logical models**

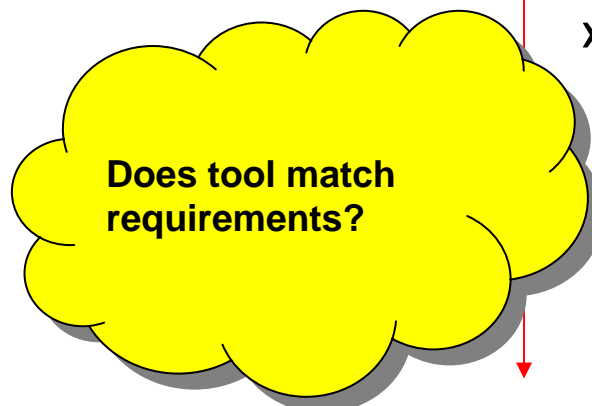» **Selection of tools**

> **Does tool match requirements?**

» **A: Modeling vehicular traffic**
 – **There exists a whole world of models; which one is appropriate?**
 – **Selection of 'driver-behavior models'**
 – **Our criterion: realism**

» **B: Networking aspects**
 – **Driven by network layer models**
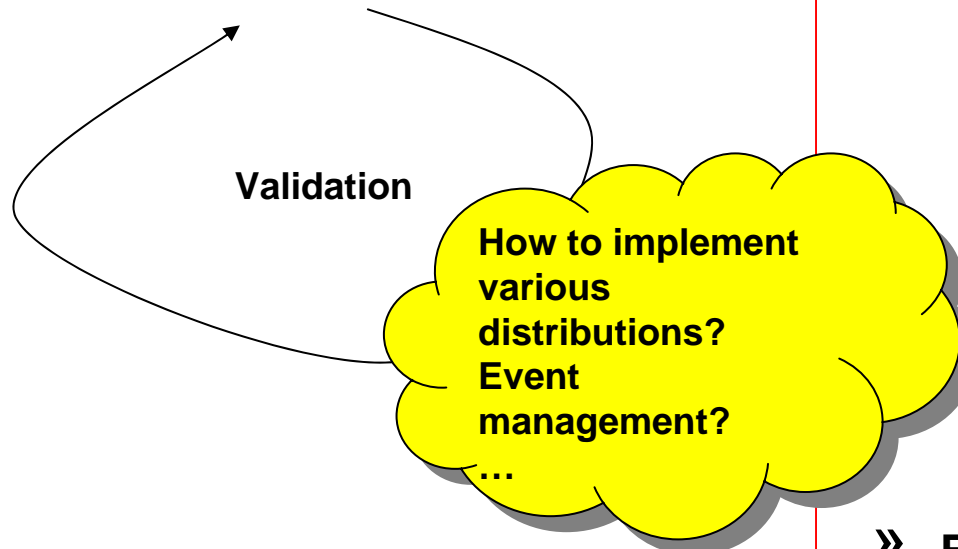 – **How to model data traffic/applications?**

» **A: FARSI, a DaimlerChrylser simulator for vehicle movements**

» **B:**
 – **Which one has already most of the required functionality?**
 – **What about the RNG?**
 – **Efficient event management?**
 – **Selection of ns-2**

Simulation life-cycle

» **Programmed model**

Validation

> **How to implement various distributions? Event management? …**

» **Experimental model**

> **What should be measured? How do I get results I believe in?**

– **Generated and validated vehicular movement patterns**
– **Implemented position-based routing approach (and location service)**
– **Enhanced ns-2 to cope with our scenarios …**
– **Tcl scripts …**
– **Run time efficiency!**
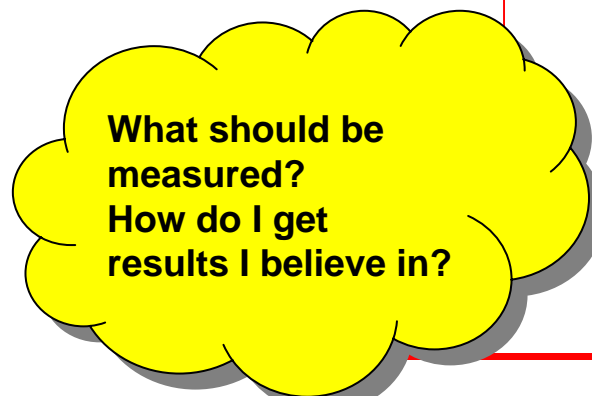
» **Experimental design**

– **Factors?**
– **Responses?**
– **Third variables?**

– **Scripts**
– **Statistics**

Simulation life-cycle

» **Simulation results**

– **Decision**
– **Re-definition**
  • **Start again**

**Improve models,
Improve code**
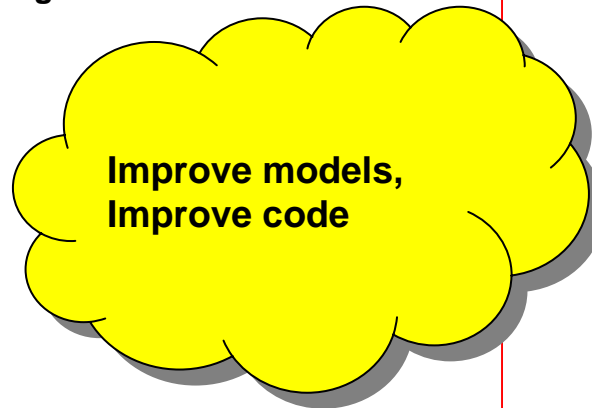
» **Simulation results:**

– **Position-based routing clearly has advantages over topology-based approaches (decision)**
– **But: real-world measurements show some problems with radio fluctuations**
– **Re-definition**

Simulation life-cycle

Nance/Balci model 1987

Simulation life-cycle New Network Protocol (U Mannheim)

1. **Define Problem**

2. **Specify Approach**

3. **Implement Basic Version + Select Startup Parameter Space**

4. **Simulate; Debug; Evaluate; Understand**

5. **Develop Modifications / Improvements**

- **Increase Model Granularity**
- **Adapt Parameter Space**

6. **Simulate with final Parameter Space and statistical Significance**

7. **Evaluate; Understand**

8. **Document Result**

Define the Parameter Space

» **Identify „Environmental Factors"**

    – **e.g. Mobility**

    – **e.g. Node Energy Level**

» **Identify „Problem Factors"**

    – **e.g. Traffic Load the Protocol has to handle**

» **Identify Protocols**

    – **Identify Protocol Parameters per protocol**

Problem: "Parameter Space Explosion"

» **Every varying parameter adds one dimension to parameter space**

    (if k parameters exist, each with n values, n^k combinations have to be simulated. Problem: Simulation Time)

» **Starting Point: 2^k factorial design:**

  – **select for every parameter a high/low or on/off value**

  – **simulate all (2^k simulations)**

  – **after evaluation reduce the number of parameters to the ones that are interesting and maybe extend parameter values**

» **During Simulation Lifecycle:**

  – **refine n and k**

  – **increase statistical significance**

Last Words

» **Hope you have some more tools in your toolbox.**

» **Lots of thanks for having me as a lecturer.**

» **Good Luck to those taking the exam.**

» **„Nice Holiday" to those who are not.**