Simulation lifecycle

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Lecture overview

» Retrospection
  – Tour d’horizon
  – Simulation life-cycle (recap from another perspective)
Retrospection

Theoretical background on stochastic discrete event simulation

Modeling of network elements

“Simulation experience”

Random variates
Event scheduling
Statistics

RNGs
DES

Ns-2
OMNeT++

OPNET
Output analysis
Perl
Checking variances

M/M/1 queue
Mobility
Random graphs
CBR with jitter

VoIP
Radio propagation

Wired and wireless
Protocols
Links and nodes
Simulation life-cycle

- Communicated problem
- Formulated problem

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

Generic

Example

- 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

» 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

- 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

- 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!

Validation

How to implement various distributions?
Event management?
...

» Experimental model

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

» Experimental design

- Factors?
- Responses?
- Third variables?
- Scripts
- Statistics
Simulation life-cycle

» Simulation results
- Decision
- Re-definition
  • Start again

» 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

Improve models, improve code
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
6. Simulate with final Parameter Space and statistical Significance
7. Evaluate; Understand
8. Document Result

- Increase Model Granularity
- Adapt Parameter Space
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.