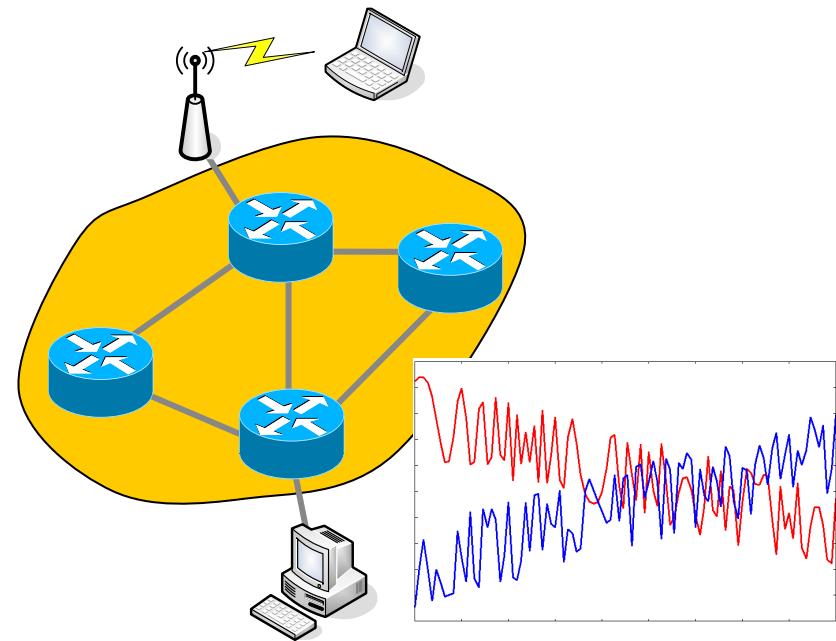


Modeling and Performance Analysis with Simulation

SS 2012

Prof. Dr. Mesut Güneş

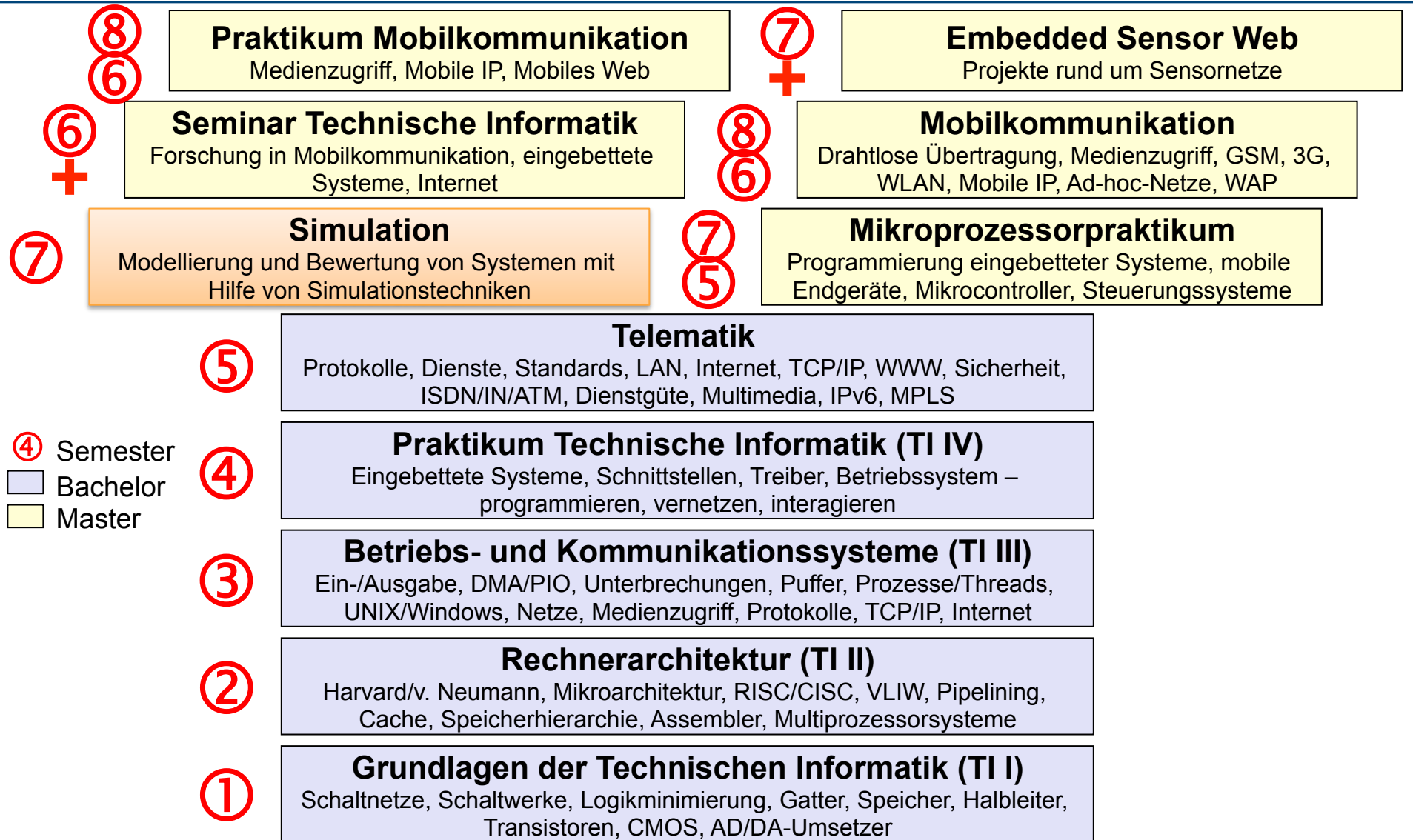
Distributed Embedded Systems
Freie Universität Berlin, Germany
mesut.guenes@fu-berlin.de



Chapter 0

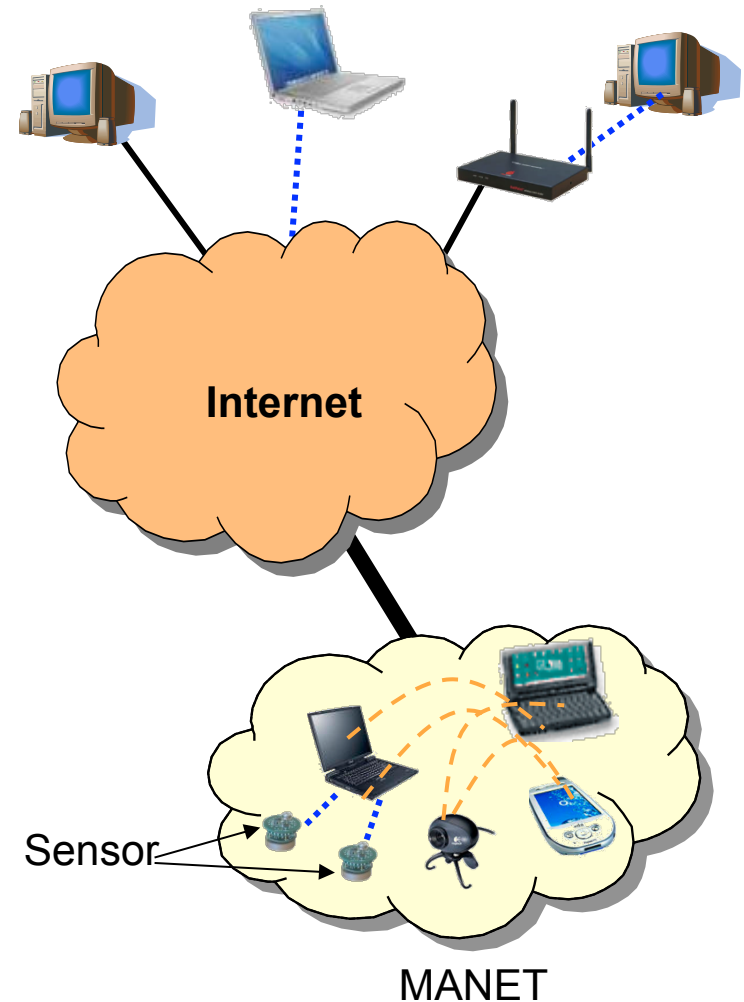
Motivation, why Simulation?, and some organizational issues

Structure/content of CST-Lectures



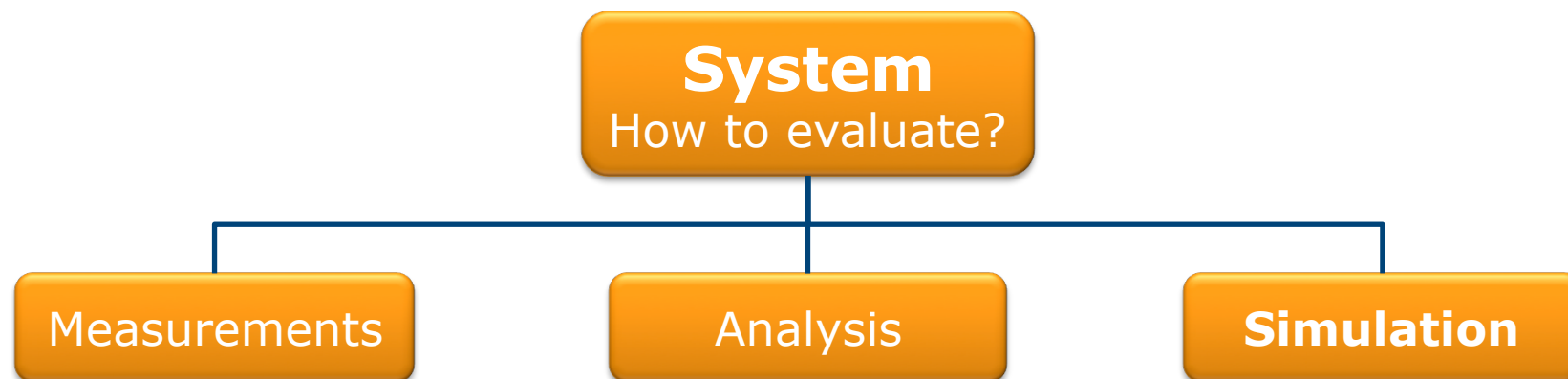
Research topics

- Network architectures and communication protocols
 - Wired networks
 - Local Area Network (LAN)
 - Internet
 - Wireless networks
 - GSM, 3GPP, UMTS, LTE
 - Wireless Local Area Network (WLAN)
 - Mobile Ad-hoc Network (MANET)
 - Wireless Mesh Network (WMN)
 - Wireless Sensor Network (WSN)
 - Protocols
 - HTTP, TCP/UDP, IP
 - IEEE 802.11a,b,g
 - Internet of Things
 - Anytime, Anywhere, Anything



Topics of this course

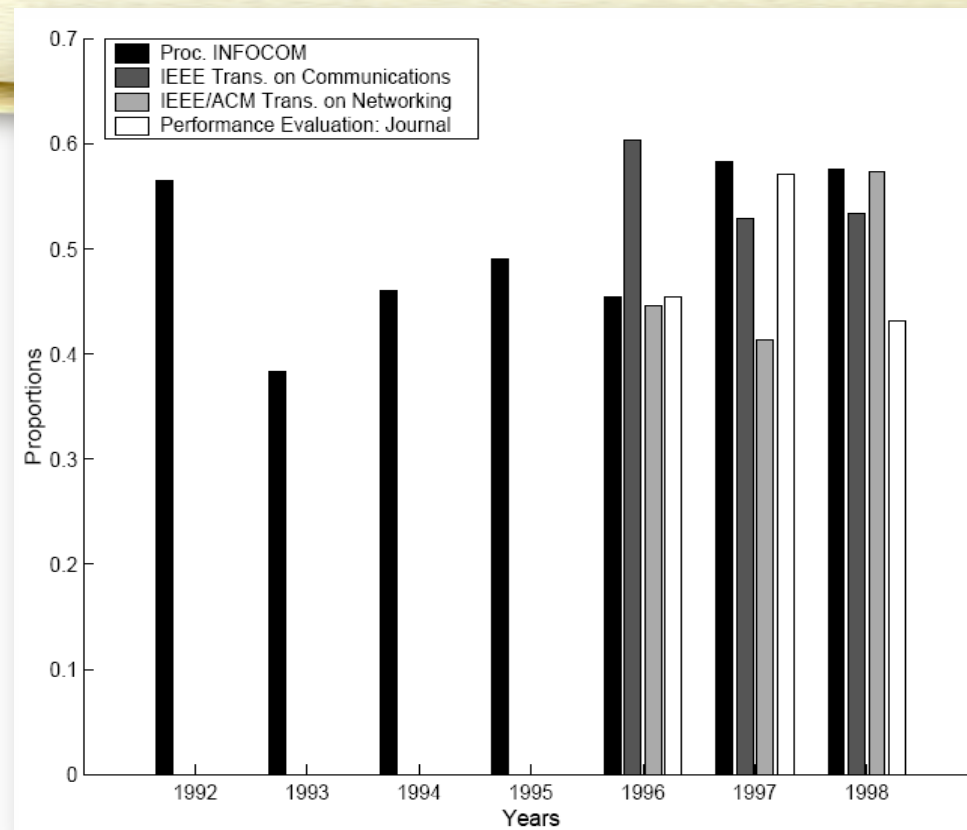
- Given a system, how do you evaluate its performance?



Why a course about simulation?

- *A survey of 2246 research papers on networks (1992-1998)*
- *About **51%** of papers reported results from simulation*

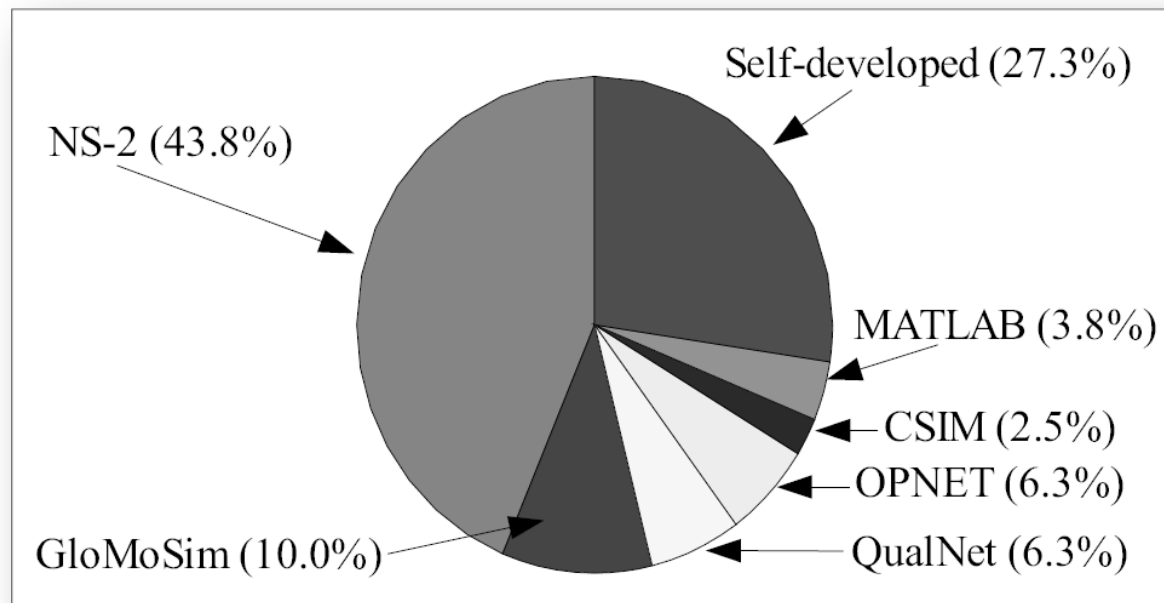
Pawlikowski et al., "On Credibility of Simulation Studies of Telecommunication Networks", IEEE Comms., Jan. 2002.



Why a course about simulation?

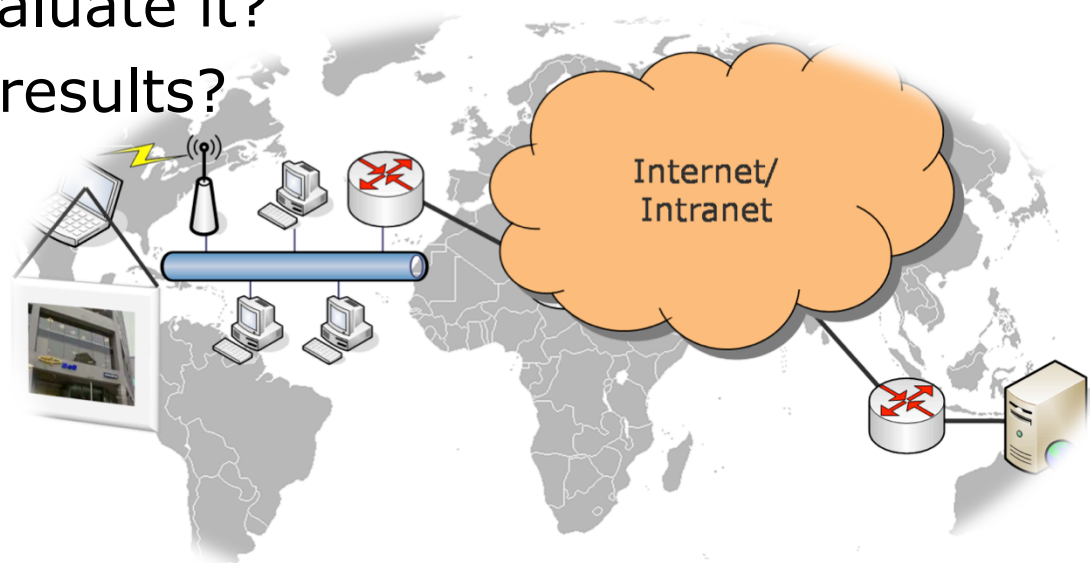
- *Survey of all 151 papers published in Proceedings of the ACM International Symposium on Mobile Ad Hoc Networking and Computing in 2000-2005*
- *About **75.5%** of the papers reported results from simulation*

S. Kurowski et al. "MANET Simulation Studies: The Incredibles", Mobile Computing and Communications Review., no. 4, 2005.



Topics of this course

- What is a system?
- What is a model?
- What is an experiment?
- What is performance and how to measure it?
- On what does performance depend?
- How to build a model?
- How to numerically evaluate it?
- How to interpret such results?



Topics of this course

- At the end of this course, you should ...
 - know about **simulation principles**
 - be able to build **models** of systems
 - be able to identify suitable **performance metrics**
 - be able to **design and implement** simple discrete event simulation programs
 - have some experience with a modern **simulation tool**
 - be able to **design** effective **experiments**
 - be familiar with basic **statistical questions**
 - know how to **evaluate** (simulation) experiment results
 - be aware of **common pitfalls**
- Focus is on practical aspects of implementing a simulator and simulation programs.

Topics of this course

- This course does not deal with/is not a ...
 - mathematical analysis tools for performance evaluation
 - experimental approaches
 - probability and statistics course
 - programming course
 - computer networking course
- However, **all these topics** will be touched or needed in some degree.

Prerequisites

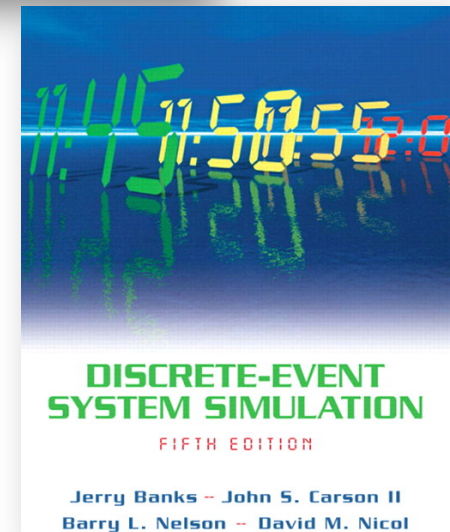
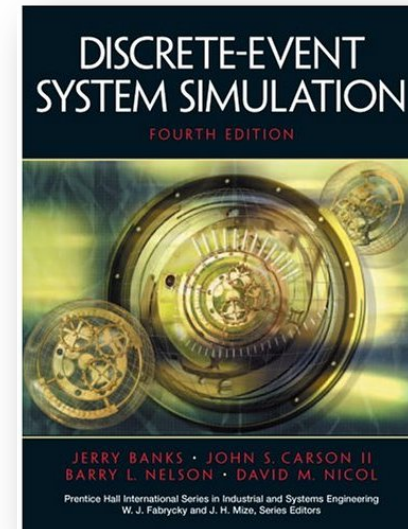
- Basics of probability theory and statistics
- Programming language
 - Python
 - C/C++
 - Java
- Package for statistical computations
 - R
 - Octave
 - Numpy/Scipy
- Spreadsheet tools
 - OpenOffice.Calc
 - MS Excel
- Knowledge about
 - Data communication and computer networks

Contents of the course

Chapter	Topic
1	Introduction to simulation
2	Simulation examples
3	General principles of discrete-event simulations
4	Introduction to network simulators
5	Statistical models in simulations
6	Random-number generation
7	Random-variate generation
8	Queuing models
9	Input modeling
10	Verification and validation of simulation models
11	Output analysis for a single model
12	Comparison and evaluation of alternative system designs
13	Design of experiments

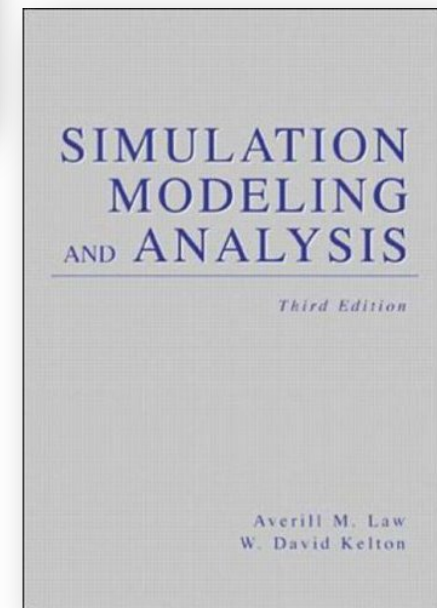
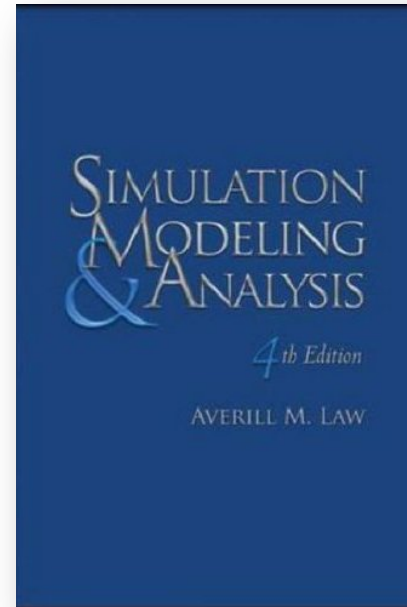
Literature

- Main source of this course:
 - Jerry Banks, John Carson, Barry L. Nelson, David Nicol: ***Discrete-Event System Simulation***, Fourth Edition, 2005, Prentice Hall
 - Fifth Edition, 2010, Prentice Hall
- General book on simulation with applications on
 - Manufacturing
 - Computer systems
 - Communication networks



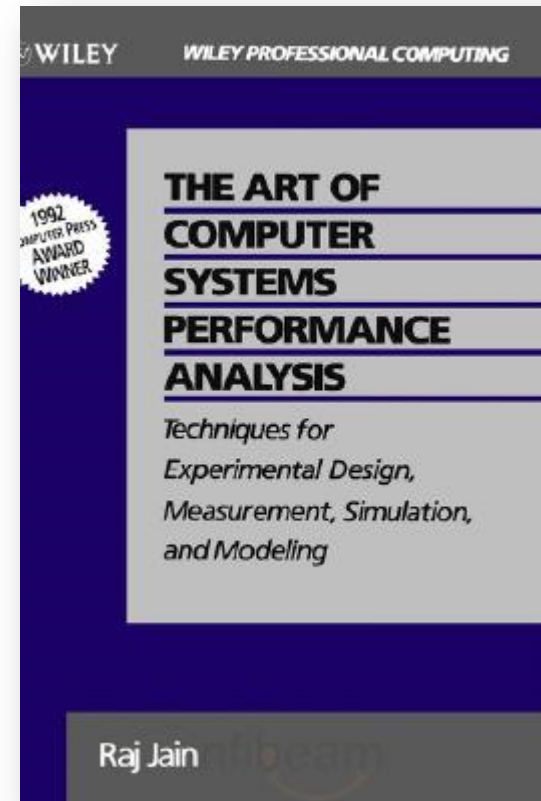
Literature

- Second source of this course:
 - Averill M. Law:
Simulation Modeling and Analysis, 2007,
McGrawHill
- General book on simulation
 - Detailed information about the basics



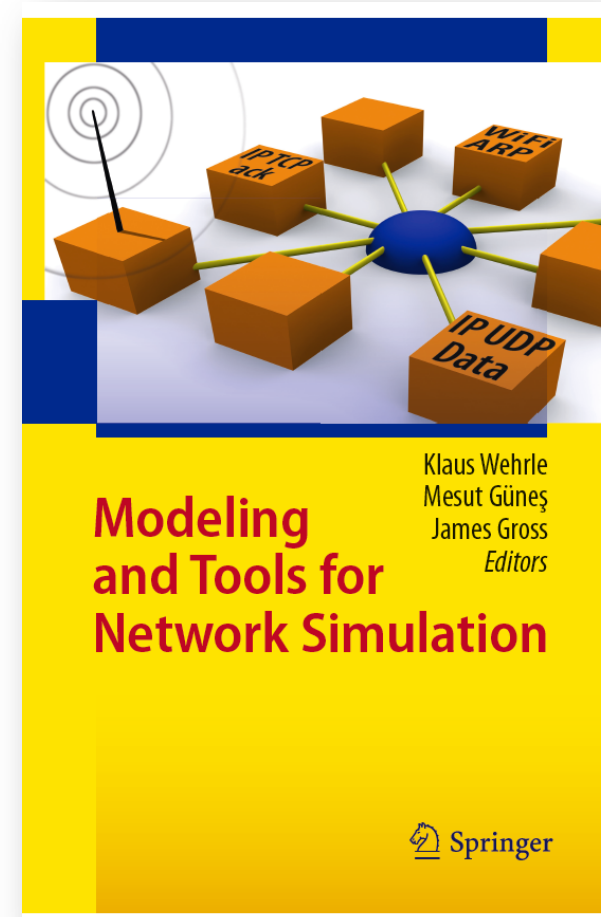
Literature

- Additional source of this course:
 - Raj Jain: ***The Art of Computer Systems Performance Analysis***, 1991, John Wiley & Sons
- General book on performance analysis, deals with
 - Measurements
 - Simulation
 - Queueing theory
 - Experiment design



Literature

- Additional source of this course:
 - Klaus Wehrle, Mesut Güneş, James Gross:
Modeling and Tools for Network Simulation,
2010, Springer, ISBN
978-3-642-12330-6
- Special book on how to model various layers of the ISO/OSI model for networks simulations
- Website



<http://www.springer.com/computer/communication+networks/book/978-3-642-12330-6>

Simulation tool to use ...

The screenshot shows the OMNeT++ website homepage. The browser window has a single tab titled "OMNeT++ Network Simulat..." and the address bar shows "www.omnetpp.org". Below the browser window, the website header features the OMNeT++ logo and a navigation bar with links like "Home", "What is OMNeT++", "Screenshots", "Videos", "License", "How to use this site?", "Commercial edition", "Documentation", "Downloads", "Simulation models", "Wiki", "Mailing list archive", "Publications", and "Get involved!". A "DOWNLOAD" button is prominently displayed. The main content area includes a welcome message, a description of OMNeT++ as an extensible, modular, component-based C++ simulation library, and a list of featured projects including INET, INETMANET, xMIPv6, RedSE, MIXM, MF, and Castalia. A section titled "New users" provides links to a screencast, publications list, tutorials, documentation, and introductory videos. A "New Downloads" section lists recent releases like "iNoC - Network on Chip Simulation Framework" and "OMNeT++ 4.2b1". A "Mailing List" section is also visible at the bottom right.

OMNeT++ Network Simulat... x

www.omnetpp.org

Diese Seite ist auf Englisch Soll sie übersetzt werden? Übersetzen Nein

Optionen x

OMNeT++

Home →

- What is OMNeT++
- Screenshots
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- Commercial edition
- Documentation
- Downloads
- Simulation models
- Wiki
- Mailing list archive
- Publications
- Get involved!

DOWNLOAD

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[Create an account](#)

Welcome to the OMNeT++ Community!

OMNeT++ is an extensible, modular, component-based C++ simulation library and framework, primarily for building network simulators. "Network" is meant in a broader sense that includes wired and wireless communication networks, on-chip networks, queueing networks, and so on. Domain-specific functionality such as support for sensor networks, wireless ad-hoc networks, Internet protocols, performance modeling, photonic networks, etc., is provided by model frameworks, developed as independent projects. OMNeT++ offers an Eclipse-based IDE, a graphical runtime environment, and a host of other tools. There are extensions for real-time simulation, network emulation, alternative programming languages (Java, C#), database integration, SystemC integration, and several other functions.

OMNeT++ is [free](#) for academic and non-profit use, and it is a widely used platform in the global scientific community. Commercial users must obtain a license from [omnest.com](#). [More...](#)

Featured Projects:

       [More...](#)

New users: Watch the [screencast](#) for an introduction into the Simulation IDE, or see in the [publications list](#) what OMNeT++ has been used for. Check out some [tutorials](#), browse the [documentation](#), watch [introductory videos](#), and explore the featured [network simulation](#) projects (click the logos above)!

iNoC - Network on Chip Simulation Framework

Wednesday, 09 March 2011 10:43

NoC simulation is a key for NoC architectures research resulting from the huge incurred cost of VLSI prototypes production using modern manufacturing processes. Although several NoC simulators exist, they are either proprietary or built on non standard infrastructure. iNoC is an open-source implementation of a NoC simulation framework using OMNeT++. The iNoC framework utilizes the OMNeT++ module interface feature to support runtime selection of simulation modules from a library of parametrized components. For example by setting the opCalcType parameter from "XY" to "XY/YX" the simulation change to use a different output port selection algorithm. The models provided support heterogeneous NoC configuration in terms of link capacity and number of VCs. iNoC modules available today implement wormhole switching, with round-robin or winner-takes-all arbitration. Current version of iNoC contains different router implementations: synchronous, asynchronous and a full virtual output queuing (VOQ) with FIFO for each (input VC, output VC and output port) tuple.

Go to the homepage at: <http://webee.technion.ac.il/matrics/software.html> or visit the [model page](#).

OMNeT++ 4.2b1 released

Wednesday, 23 February 2011 00:00

Dear users, we've just released the first beta of OMNeT++ 4.2. Please read the ChangeLog carefully to see what has changed since the 4.1 version. [Download and try it now](#).

[Read more...](#)

New Downloads

- [iNoC - Network on Chip Simulation Framework](#)
- [OMNeT++ 4.2b1 \(source + IDE, tgz\)](#)
- [OMNeT++ 4.2b1 win32 \(source + IDE + MINGW, zip\)](#)
- [mCoA++ Multiple Care of Address Registration for xMIPv6](#)
- [INET-HNRL](#)

Mailing List

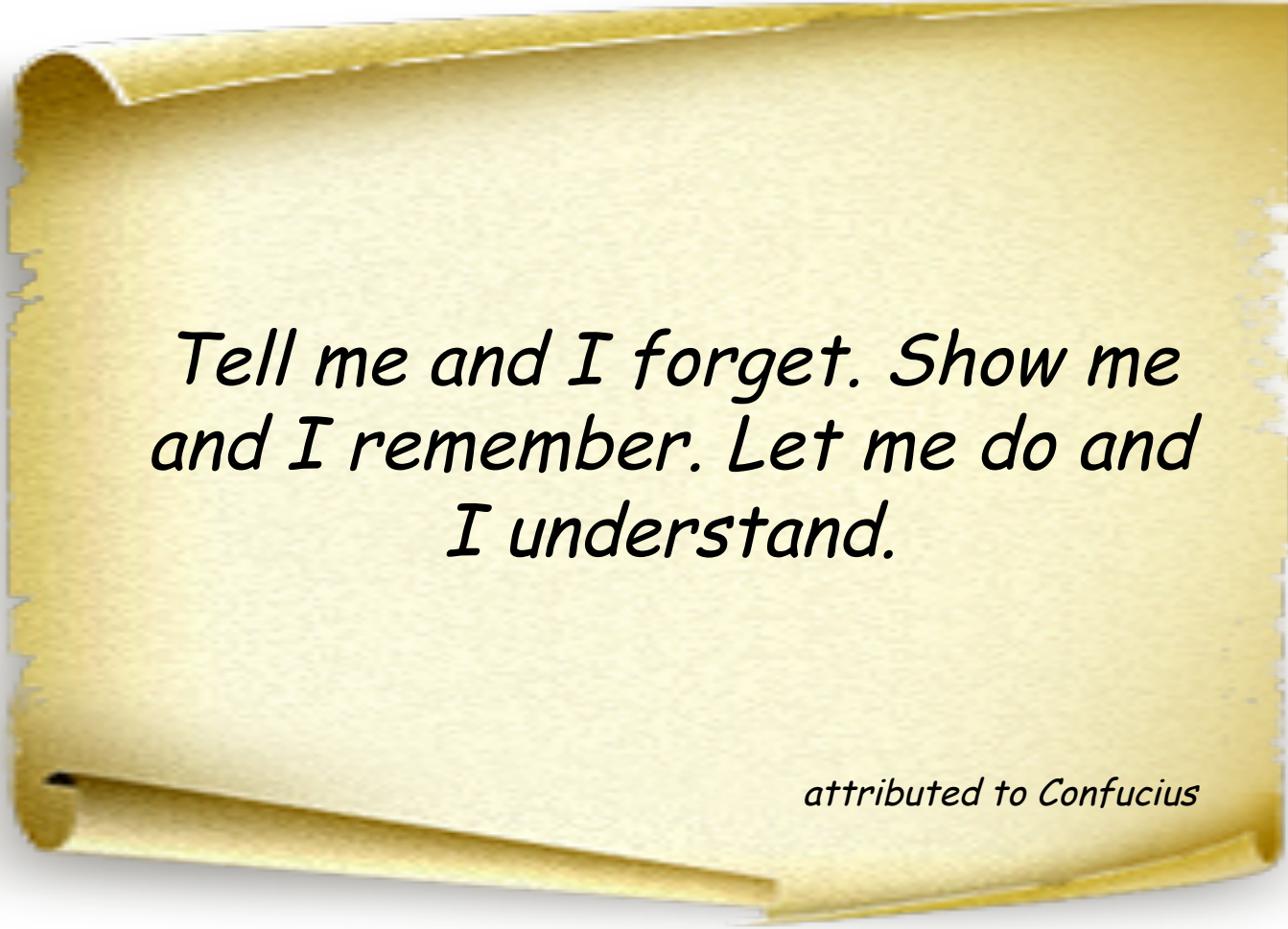
your e-mail address

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- Lecture
 - Friday, 10–12, Takustr. 9, Room SR 049
- Tutorials
 - Thursday, 10–12, Takustr. 9, Room SR 046
- Office hours
 - Prof. Güneş: Tuesday, 15:00-16:00h, Takustr. 9, Room 154
- Homepage of the class
 - News and updates
 - Literature and Materials

Organizational



*Tell me and I forget. Show me
and I remember. Let me do and
I understand.*

attributed to Confucius