Technical program of the First Euro NF Summer School

1. Overview of the area 2 units Monday 9:15-11:00

Dr. Karin Anna Hummel, Austria
Department of Distributed and Multimedia Systems, University of Vienna
http://www.ani.univie.ac.at/~karin/

Multi-hop wireless ad-hoc, sensor, and mesh networks pervade new application areas where temporary, spontaneous, and robust connectivity is needed. In the first part of the lecture, an introduction to these wireless networks will be given reflecting their structural properties as well as performance requirements imposed by typical application domains surveyed for each network type, like smart environments for every day activities based on networked sensor and actuator systems, emergency scenarios, high-speed connectivity in urban areas, and vehicular ad-hoc networks (VANETs).
The addressed wireless networks are often challenged by limited energy source and environmental phenomena, like radio disturbances, weather conditions (e.g., rain), or even fire/heat. Additionally, mobility causes topology changes and increases network dynamics. In the second part of the lecture, the resulting node crash failures, network disruptions, and degradations in throughput will be discussed in terms of their impairments to mainly routing performance and reliable transport. In the third part of the lecture, selected solutions exploiting in particular opportunistic and cooperative behavior, environment-awareness, and mobility will be presented.

2. Basics of queuing theory 3 units Monday 11:15-13:00, 14:15-15:00

Prof. Hans Daduna, Germany
Department of Mathematics, Center of Mathematical Statistics and Stochastic Processes, Hamburg University
http://www.math.uni-hamburg.de/home/daduna/

The module covers the area of queuing theory. Special attention is given to the notions and results connected to the field of the Summer School.

1. Basic queueing systems with exponential servers and with general symmetric servers. Steady state analysis and some fundamental relations.
2. Classical product form networks of the Jackson and Gordon-Newell type. Steady state analysis, fundamental properties and examples for evaluation of performance metrics.
3. BCMP and Kelly networks of symmetric nodes, steady state analysis. Recent developments in product form network theory.

3. Basics of combinatorial optimization 3 units Monday 15:15-18:00

Dr. Arie Koster, UK
Centre for Discrete Mathematics and its Applications (DIMAP) Warwick Business School / Mathematics Institute The University of Warwick Coventry
http://www.warwick.ac.uk/staff/A.M.C.A.Koster/

The module covers the area of combinatorial optimization. We start with defining what makes an optimization problem a combinatorial optimization problem. With a series of examples relevant to networking, we build up experience with modeling complex decisions as combinatorial optimization problems. Moreover, the examples are selected in such a way that the complexity of finding the optimal solution increases. Concepts and methodologies introduced this way are "proof of optimality", (directed) graphs, greedy algorithms, linear programming, integer linear programming, the complexity classes P and NP of decision problems, NP-hardness, approximation algorithms, cutting planes.
Combinatorial optimization problems that will be introduced are minimum spanning tree, maximum flow, minimum cut, min cost flow, vertex coloring, set covering. Applications include frequency assignment, routing in networks, coverage maximization, and interference modeling.

4. Self-organizing networks 8 units Tuesday 9:15-13:00, 14:15-18:00

Prof. Hermann de Meer, Germany
Computer Networks and Computer Communications, University of Passau
http://www.fim.uni-passau.de/en/fim/faculty/chairs/computer-networks-and-communications.html

The module will cover essential principles of self-organization modeling of complex systems. The relation between complex systems and their models will be illustrated. Important concepts such as bifurcations and essential equations such as Lotke-Volterra, the logistic model and their relation to real computer science applications will be motivated. In addition to Cellular Automata, that help to model and illustrate important characteristics of self-organizing systems such as locality of operations and the relation to corresponding, globally emerging effects, many phenomena related to networking will be covered. The most important properties to be investigated are small-world networks, scale-free networks and power-law distributions.

5. Ad hoc networks 4 units Wednesday 8:15-12:00

Prof. Susana Sargento
Institute of Telecommunications, University of Aveiro, Portugal
http://www.av.it.pt/ssargento/

The goal of this module is to provide an overview of research on wireless ad-hoc networks, with special emphasis on their role as enabling technologies for global networking, and addressing performance evaluation issues, through a description of the fundamental principles of wireless ad-hoc networking, the main problems that arise, possible solutions, and theoretical models.
This module will start with a discussion on applications and usage scenarios for ad-hoc networks. Then, it will address the main challenges and significant approaches with respect to medium access control protocols, routing protocols and mobility, QoS and congestion control, security. Some mathematical models will be described to understand the limits of ad-hoc networks.

6. Sensor networks 4 units Thursday 9:15-13:00

Dr. Antonio Grilo, Portugal
INESC-ID, IST, Portugal
http://comp.ist.utl.pt/amg

The goal of this module is to characterize the Wireless Sensor Networks (WSN) and their main applications, identifying their main issues, challenges and corresponding research areas. The module shall focus on WSN protocol and system design perspective, while taking into account related mathematical models of performance analysis. The detailed table of contents shall be the following:

1. Introduction to Wireless Sensor Networks
   - node and network characteristics
   - power consumption models.
2. Medium Access Control in WSNs
   - CSMA/CA protocols
   - TDMA protocols and conflict-free slot allocation.
3. Routing and In-network Processing
   - basic routing protocols
   - data aggregation and directed diffusion
   - distributed storage and consensus.
4. Reliable and Efficient Transport
   - why not TCP: end-to-end vs. hop-by-hop performance
   - transport protocols for WSNs.

7. Meshed networks 4 units Thursday 14:15-18:00

Dr. Mateo Cesana, Italy
Advanced Network Technologies Lab
Dipartimento di Elettronica e Informazione, Politecnico di Milano
http://home.dei.polimi.it/cesana

The purpose of this module is to provide a critical overview of the cutting-edge research in the field of wireless mesh networks which are widely recognized as promising and cost effective solutions for providing wireless connectivity to mobile users. The module will be organized as follows:

1. Wireless Mesh Network Overview (1/2 Unit)
   - application scenarios and enabling technologies
   - main research trends in WMNs.
2. The Capacity of Wireless Mesh networks (1 Unit)
   - dealing with interference, collisions and reuse
   - MAC for WMNs
   - modeling approaches.
3. Optimizing WiFi-Based Wireless Mesh Networks (1 Unit)
   - brief review on classical radio planning
   - mathematical programming approaches to handle wireless devices positioning/configuration, channel assignment and routing in WiFi-based WMNs.
4. Optimizing TDMA-based WMNs (1 Unit)
   - jointly scheduling/routing optimization models
   - heuristic approaches.
5. Case study of Wireless Mesh Platform (1/2 unit)
   - challenges when dealing with real implementation.

8. Mathematical modeling and exercises 4 units Friday 9:15-13:00

Dr. Di Yuan, Sweden
http://www.itn.liu.se/~diyua

This module is intended to provide knowledge and training in applying mathematical modeling and computer software to combinatorial optimization problems, focusing on some selected problems arising in performance optimization of wireless ad hoc and mesh networks. The module consists of lecture presentation, discussions, exercises, and hands-on assignments of combining a modeling language and an optimization solver for problem solution. Contents is as follows:

1. Introduction to optimization modeling language and solver.
2. Basics of using AMPL and CPLEX.
3. Presentation and discussion of some selected problems in wireless ad hoc and mesh networks.
4. Exercises in using heuristics for problem solutions.
5. Development of linear integer optimization models in AMPL and solution by CPLEX.
6. Comparison between solutions and models.

9. Test in writing 2 units Friday 14:15-16:00

Prof. Michal Pioro, Poland
Institute of Telecommunications, Warsaw University of Technology
http://ztit.tele.pw.edu.pl/en/member.html?name=Pioro&forename=Michal