Introduction of ITEE Faculty and CWC

Prof. Jari Iinatti
Education Dean of ITEE
Head of CWC – Networks and Systems

Prof. Markku Juntti
Head of CWC – Radio Technologies
University of Oulu and Faculties - Eight

Key Figures
• Established in 1958
• Total funding 240 M€
• 8 faculties
• 14 000 students
• 2 900 employees
• ~220 professors
• ~1600 researchers/teaching
• ~ 25 study programmes
• 18 international M.Sc. programs

Eight Faculties
• Oulu Business School
• Biochemistry and Molecular Medicine
• Humanities
• Education
• Science
• Medicine
• Technology
  • Information Technology and Electrical Engineering (ITEE):
    – 12 Research Units
# ITEE Research Units - Twelve

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<td>PROF. KEIJO RUOTSALAINEN</td>
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<td>CMVS</td>
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<td>M3S</td>
<td>EMPIRICAL SOFTWARE ENGINEERING IN SOFTWARE, SYSTEMS AND SERVICES</td>
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<td>HUMAN COMPUTER INTERACTION AND HUMAN-CENTERED DEVELOPMENT</td>
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ITEE Study Programmes - Several

**Main Disciplines**

**Electronics and Communications Engineering**
- Study programme (5 years)
- Master programme (2 years)
- International master programmes (2 years)

**Computer Science and Engineering:**
- Study programme (5 years)
- Master programme (2 years)
- International master programme (2 years)

**Information Processing Science**
- Study programme (5 years)
- Master programme (2 years)
- International master programme (2 years)

**ITEE Units**

- **CAS**: CIRCUITS AND SYSTEMS
- **Bios**: BIOMIMETICS AND INTELLIGENT SYSTEMS
- **Mic**: MICROELECTRONICS
- **CMVS**: CENTER FOR MACHINE VISION AND SIGNAL ANALYSIS
- **OPEM**: OPTO-ELECTRONICS AND MEASUREMENT TECHNIQUES
- **UBICOMP**: UBIQUITOUS COMPUTING
- **CWC-NS**: CWC - NETWORKS AND SYSTEMS
- **INTERACT**: HUMAN COMPUTER INTERACTION AND HUMAN-CENTERED DEVELOPMENT
- **CWC-RT**: CWC - RADIO TECHNOLOGIES
- **M3S**: EMPIRICAL SOFTWARE ENGINEERING IN SOFTWARE, SYSTEMS AND SERVICES
- **AC**: APPLIED AND COMPUTATIONAL MATHEMATICS
- **OASIS**: OULU ADVANCED RESEARCH ON SERVICE AND INFORMATION SYSTEMS

**Business Analytics**
- International Master Programme (2 years)

**Biomedical Engineering**
- Master programme (2 y)
- International Master Programme (2 y)

With Faculty of Medicine

**EDUCATION EXPORT**: Bachelor programme in Software Engineering with NJIT (3 y)

With Nanjing Institute of Technology

With Business School
ITEE Study Programmes

FIVE-YEAR PROGRAMS IN FINNISH
BACHELOR + MASTER DEGREE

Computer Science and Engineering (120)
- Applied Computing
- Artificial Intelligence
- Computer Engineering

Electronics and Communications Engineering (105)
- Electronics Design
- Electronics, Materials and Components
- Communications Engineering
- Photonics and Measuring Technology
- RF Engineering

Information Processing Science (185)
- Information Systems
- Software Engineering

MASTER’S PROGRAMS, Finnish call
- BME (23, with Faculty of Medicine)
- CSE (20)
- ECE (20)
- IPS (40)

INTERNATIONAL MASTER’S PROGRAMS

CSE Computer Science and Engineering (50)
BME Biomedical Engineering: Signal and Image Processing (30 with Faculty of Medicine)
BA Business Analytics (15+15) (+ 20 in Business School)
SEIS Software Engineering and Information Systems + DD-EMSE (45+15)
ELE Electronics (30)
WCE Wireless Communications Engineering + 2 DD-programmes (30+10)

INTERNATIONAL BACHELOR PROGRAM

DICE International Degree Programme in Digitalization, Computing and Electronics (DICE) (48)

EDUCATION EXPORT

Software Engineering with NJIT (100 => 100)

Coming: SAS – Sustainable and Autonomous Systems
Key Figures of Centre for Wireless Communications (CWC)

• Founded 1995 as a research programme to improve collaboration between academia and industry.
• Basic operation model for the first 10-years: funding only through competition.
• Was later merged to the Faculty of ITEE as two research units:
  − CWC – Radio Technologies
  − CWC – Networks and Systems
• Research and teaching staff: ~ 200 (13 professors).
• Very international staff – more than half non-Finns.
• Total funding ~ 10 M€ / year (75% external funding).
• CWC – RT: 60 %, CWC – NS: 40 %
CWC Approach

Mission
• Research driven
• Graduates for research or business career
• New technology for real use
• Collaborate globally with companies

Objectives
• Forerunner
• Valued partner for research cooperation
• Research driven training and education
• Fast reacting
  - To the needs expressed by partners
  - Changes in the operation environment
• Interaction with the surrounding community
  - Projects realised with external funding
  - Through long-term national research partners
CWC Key Expertise Areas

- Wireless communications and networking
- Transceiver and radio frequency (RF) technologies
- Radio channels, antennas and propagation
- Optimization, ML, AI and algorithms
- System design, integration, verification and validation
- Wireless applications: industrial internet, medical and health, smart energy grids, security and defense
CWC's Role in Technology Transfer

3G standard technology developed in FRAMES project

Code Division Multiple Access Research

Tactical Data Link and SDR solutions

IMT Advanced 4G LTE System Proposals via WINNER Projects

Spread Spectrum Technology Research

1997

1990

1986

1999

1997

1990

1986

Multicarrier and MIMO Technology Research

Ultra Wideband Technology Research

2007

5G System Research Proposal for IEEE802.15.3a and related ASIC

2014

(B) 5G System & Technology

5G NR and System Proposals via METIS Project

2017

First Cognitive network phone call utilising LTE network

5G Test Network => See: https://www.oulu.fi/6gflagship/

Wireless Connectivity
Ultra-reliable low-latency communications vs. 1 Tbps
Enabling Unmanned Processes

Devices & Circuits
THz communications materials & circuits
Enabling Unlimited Connectivity

Distributed Computing
Mobile edge intelligence
Enabling Time Critical & Trusted Apps

Services & Applications
Multidisciplinary research across verticals
Enabling Disruptive Value Networks

=> See: https://www.oulu.fi/6gflagship/
UOulu in Shanghai Ranking

UOulu in Shanghai Ranking – Telecommunications Eng.
2021: 46
2020: 51-75
2019: 48
2018: 47
2017: 51-75
CWC’s Research Groups

Radio Access Techniques (RAT)
Matti Latva-aho, N. Rajatheva, Hirley Alves, Onel Lopez

Intelligent Connectivity & Networks (ICON)
Mehdi Bennis, Sumudu Samaraskoon

Communications Signal Processing (CSP)
Markku Juntti, Antti Tölli, Janne Lehtomäki

RF Engineering (RFE)
Aarno Pärssinen, Markus Berg, Marko Leinonen, Ping Jack Soh

Wireless Systems (WS)
Ari Pouttu, Marcos Katz, Jussi Haapola, Konstantin Mikhaylov

Critical Communications Systems (CCS)
Harri Posti, Harri Saarnisaari, Tuomo Hänninen

Networking (NET) & Network Security and Softwarization (NSOFT)
Mika Ylianttila, Tarik Taleb

Wireless Medical Communications (WiMeC)
Jari Iinatti, Matti Hämäläinen, Erkki Harjula
CWC-RT Personnel

• Professors:
  - Markku Juntti: Commun. Eng. and Signal Processing
  - Matti Latva-aho: Digital Communications, 6G
  - Aarno Pärlssinen: Radio Frequency Engineering

• Tenure Track:
  - Mehdi Bennis (Associate Professor): Wireless Commun. Eng., Machine Learning
  - Antti Tölli (Associate Professor): Commun. Eng. and Signal Processing
  - Jack Ping Soh (Associate Professor): RF and Antenna Technologies (June 2021-)
  - Onel Lopez (Assistant Professor): Sustainable Commun. Eng.

• Professors of Practice
  - Kari Leppänen (Adjunct Professor)
  - Seppo Yrjölä (Adjunct Professor)

• University Researchers/University Lecturers
  - Italo Atzeni (Adjunct Professor)
  - Markus Berg (Adjunct Professor)
  - Marian Codreanu (Adjunct Professor)
  - Nurul Huda (Adjunct Professor)
  - Zaheer Khan (Adjunct Professor)
  - Kari Kärkkäinen (Adjunct Professor)
  - Janne Lehtomäki (Adjunct Professor)
  - Marja Matinmikko-Blue (Adjunct Professor)

• Manager Posts:
  - Pekka Kyösti, Research Director
  - Marko Leinonen: Research Manager
  - Juha-Pekka Mäkelä: Laboratory Manager
CWC-NS Personnel

- **Professors:**
  - Jari Iinatti: Communications Theory
  - Marcos Katz: Communications Engineering
  - Ari Pouttu: Dependable Wireless Systems
  - Tarik Taleb (30%): Wireless Communications Networks

- **Tenure Track:**
  - Mika Ylianttila (Associate Professor): Security in Wireless Networks
  - Konstantin Mikhailov Convergent IoT Communications for Vertical Systems
  - Erkki Harjula (Assistant Professor): Wireless System Level Architecture for Future Digital Healthcare

- **Manager Posts:**
  - Tuomo Hänninen: Research Manager
  - Harri Posti: Research Manager
  - Olli Liinamaa: Project Manager
  - Esa Posio: Project Manager
  - Hanna Saarela: Development Manager
  - Jari Sillanpää: Laboratory Manager

- **University Researchers/University Lecturers**
  - Jussi Haapola (Adjunct Professor)
  - Matti Hämäläinen (Adjunct Professor)
  - Matti Isohookana
  - Harri Saarnisaari (Adjunct Professor)

- **Post-Doctoral Researchers/University Teachers:**
  - Timo Bräysy
  - Abdelquoddouss Laghrissi
  - Ville Niemelä
  - Johanna Vartiainen
  - Tanesh Kumar
  - Madhusanka Liyanage (20%) (Adjunct Professor)
  - Pedro Nardelli (10%) (Adjunct Professor)

- **Varying amount of**
  - Doctoral Students (y ~25)
  - Project Researchers (~5)
  - Trainees
CWC-RT Research – Key Topics

Radio Access Techniques
• 6G systems and waveforms
• V2X networks
• RAN architecture design and optimization
• Local / micro-operator and licensing
• Secondary radio access utilizing radar bands
• URLLC optimization for different verticals

Intelligent Connectivity & Networks
• URLLC and control
• System design based on rare/extreme events characterization
• Theoretical and algorithmic principles of communications and energy-efficient ML with applications to verticals

Communications Signal Processing
• Beamforming and resource management for massive cell-free MIMO, mmWave and THz
• Reconfigurable intelligent surfaces (RIS)
• Detection, channel estimation and decoding
• Integrated sensing and communications
• Age of information in networks

Radio Frequency Engineering
• MIMO over-the-air (OTA) test beds
• Antenna design
• 5G/6G channel modeling and measurements
• Transceiver architectures and implementation
• RF architectures and IC solutions
• RF lab up to 300GHz range under construction
CWC-NS Research – Key Topics

Wireless Systems
- Various (new) application areas of wireless communications
- Industries, Smart grids, Autonomous mobility, Machine-type connectivity in verticals
- Test network for B5G
- Cross-vertical IoT & Light-based IoT (LIoT)

Critical Communications Systems
- Critical and military communications
- Tactical communications
- Hybrid commercial-dedicated solutions based on LTE, 5G and B5G
- Communications waveforms and architectures for military applications

Wireless Networks
- Network architectures
- Network Functions Virtualization (NFV)
- Mobile Edge Computing (MEC)
- Network softwarization (SDN) and security

Wireless Medical Communications
- 5G for Hospitals
- WBAN (Wireless Body Area) Networks
- System Level Architecture for Healthcare
- Visible light communications (VLC) for medical ICT
Welcome and Good Luck!