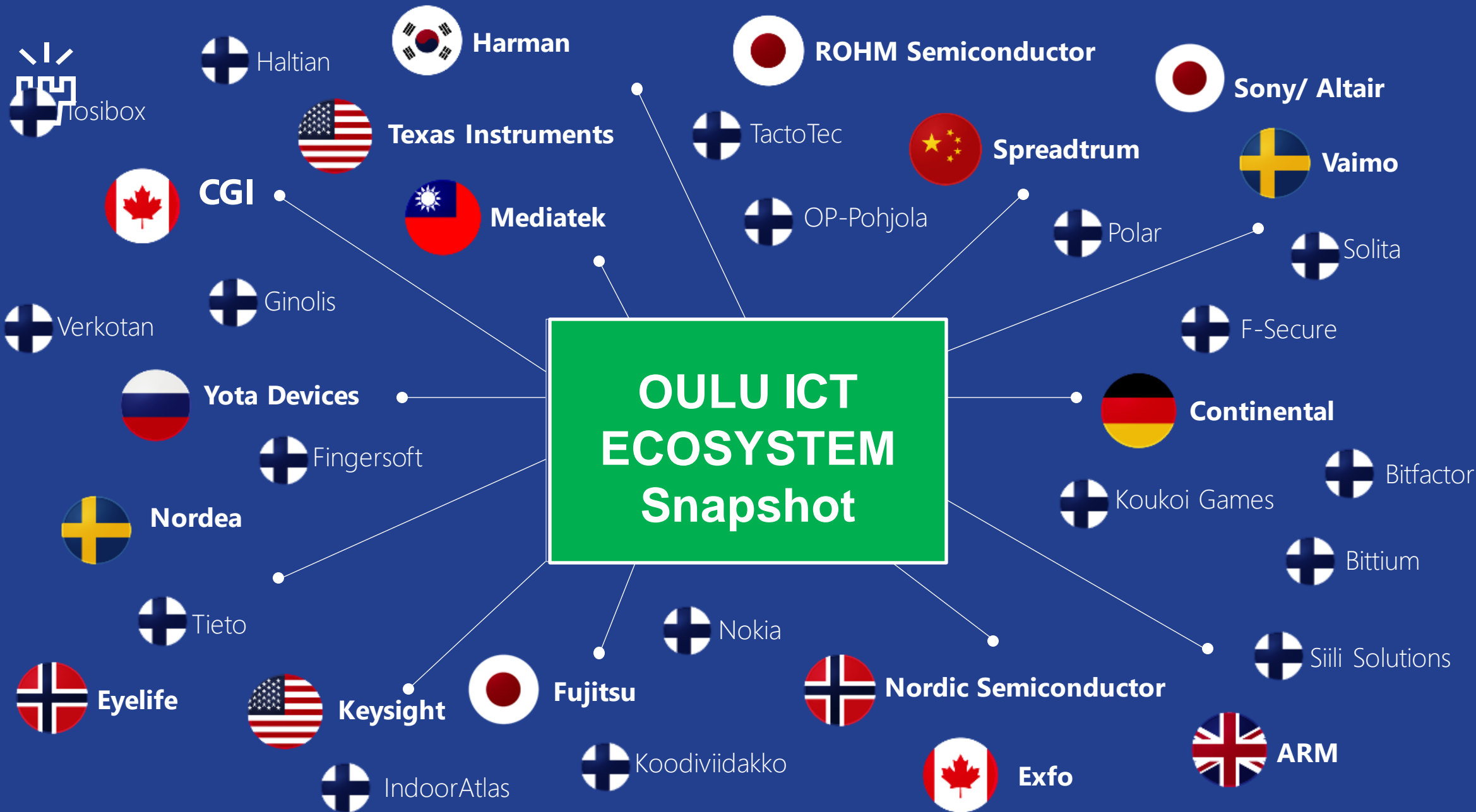




# Introduction of ITEE Faculty and CWC

**Prof. Jari Linatti**  
**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
- 3 700 employees
  - ~ 25 study programmes
- 22 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

**CAS**

**CIRCUITS AND SYSTEMS**  
PROF. TIMO RAHKONEN

**MIC**

**MICROELECTRONICS**  
PROF. HELI JANTUNEN

**OPEM**

**OPTO-ELECTRONICS AND  
MEASUREMENT TECHNIQUES**  
PROF. TAPIO FABRITIUS

**CWC-RT**

**CWC- RADIO TECHNOLOGIES**  
PROF. MARKKU JUNTTI

**CWC-NS**

**CWC - NETWORKS AND SYSTEMS**  
PROF. JARI IINATTI

**ACM**

**APPLIED AND COMPUTATIONAL  
MATHEMATICS**  
PROF. KEIJO RUOTSALAINEN

**CMVS**

**CENTER FOR MACHINE VISION  
AND SIGNAL ANALYSIS**  
PROF. OLLI SILVEN

**BISG**

**BIOMIMETICS AND INTELLIGENT SYSTEMS**  
PROF. JUHA RÖNING

**UBICOMP**

**UBIQUITOUS COMPUTING**  
PROF. TIMO OJALA

**M3S**

**EMPIRICAL SOFTWARE ENGINEERING IN  
SOFTWARE, SYSTEMS AND SERVICES**  
PROF. MARKKU OVO

**OASIS**

**OULU ADVANCED RESEARCH ON SERVICE  
AND INFORMATION SYSTEMS**  
PROF. HARRI OINAS-KUKKONEN

**INTERACT**

**HUMAN COMPUTER INTERACTION AND  
HUMAN-CENTERED DEVELOPMENT**  
PROF. NETTA IIVARI



# ITEE FACULTY

**STRONG ACTOR IN ICT FIELD**

## CRITICAL MASS IN OUR RESEARCH FOCUS AREAS

Ability to execute on very demanding problems  
Multi-disciplinary expertise resulting new innovations

## STRONG PORTFOLIO OF RESEARCH PROJECTS

Well-balanced between fundamental and applied research  
Long R&D tradition with local and international companies

## COMPETENCE CUMULATION

Experienced senior researchers  
Each professor has a seasoned team

## HIGH-QUALITY EDUCATION

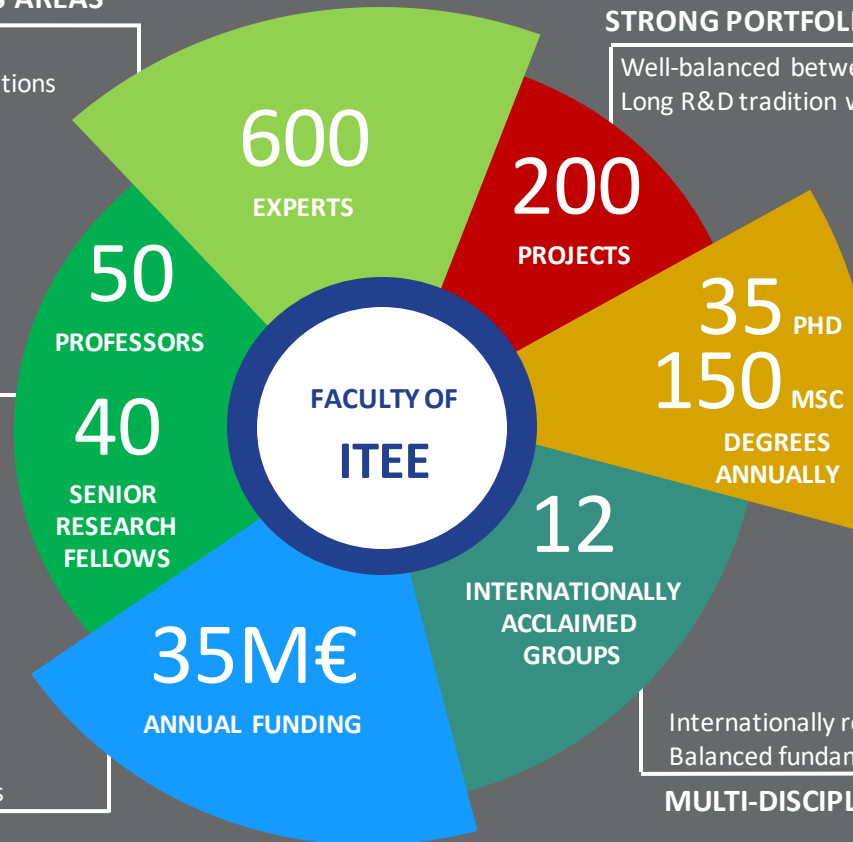
Competent workforce for companies,  
research institutions and public sector

Seasoned in winning funding  
Excellent local and international networks

## OFFERING STABLE ENVIRONMENT

Internationally reviewed and credited research units  
Balanced fundamental and applied research

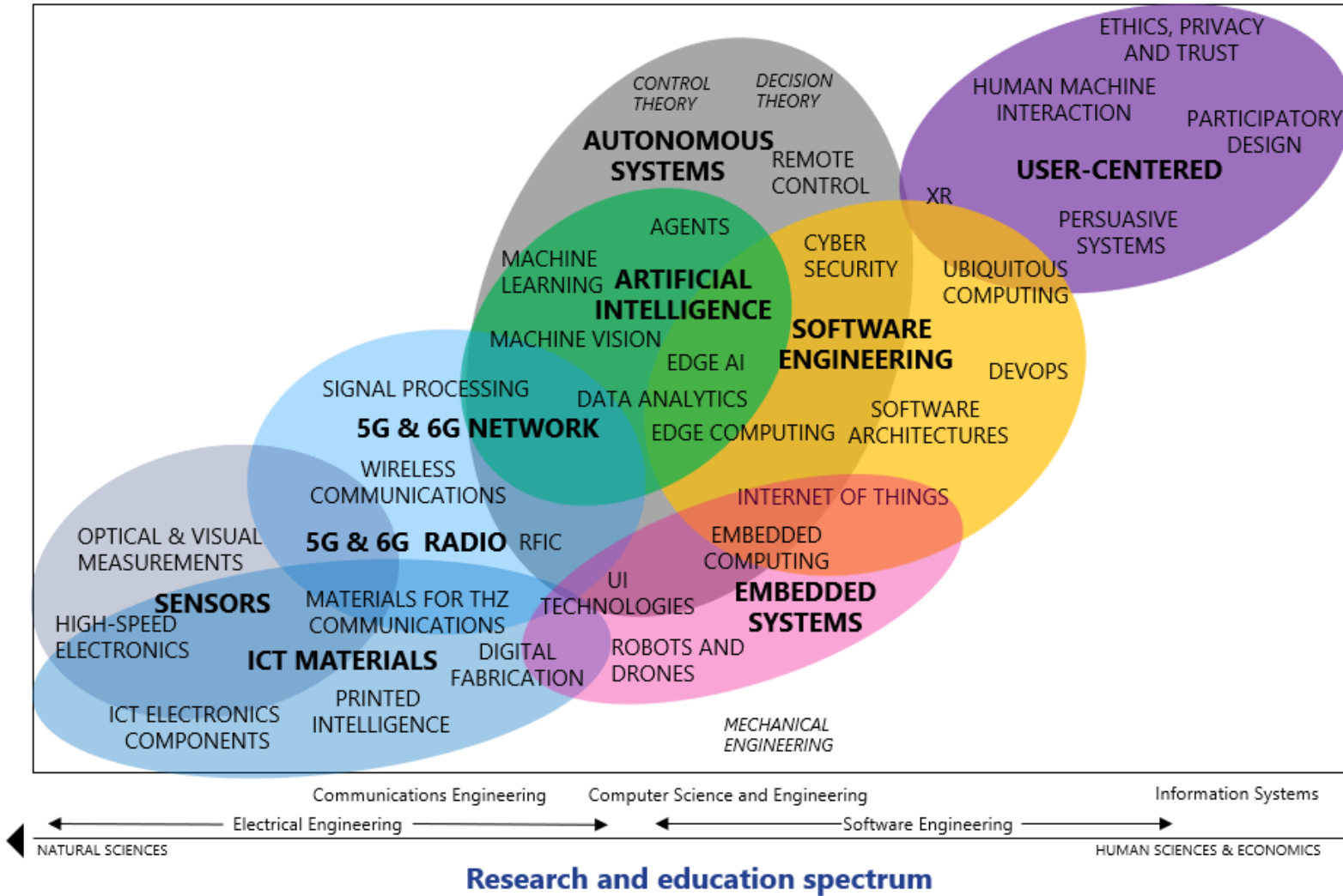
## MULTI-DISCIPLINARY ICT RESEARCH





# ITEE RESEARCH FORMS A SOLUTION CREATION VALUE CHAIN

## BASIC RESEARCH



- 5G and 6G wireless communications
- virtual reality, applications & experiences
- artificial intelligence, including machine vision and exploitation, e.g., in emotion applications and disease analysis
- robotics and its various application areas
- analysis of large amounts of data
- cyber security
- software
- new materials and manufacturing methods of electronics
- engaging human sciences in the development of intelligent technologies.

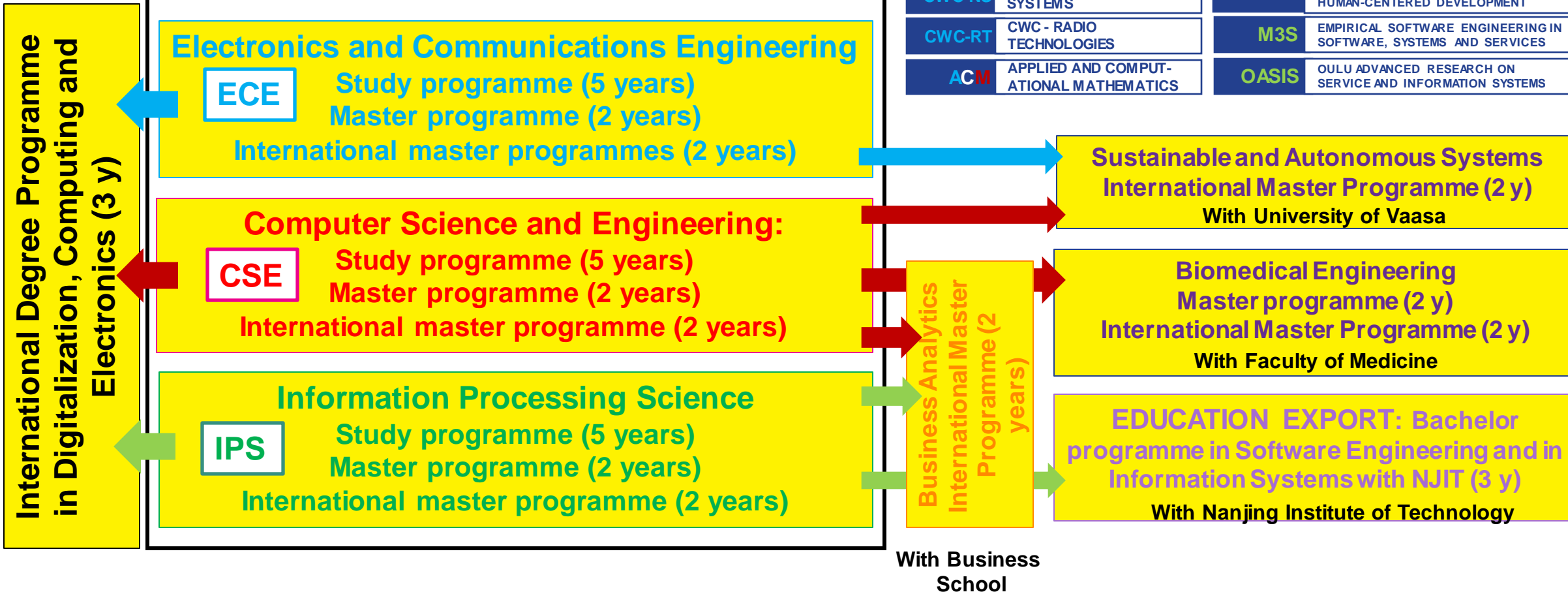


# ITEE Study Programmes - Several

## ITEE Units

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

## Main Disciplines



# ITEE Study Programmes – options and intakes

## FIVE-YEAR PROGRAMS IN FINNISH BACHELOR + MASTER DEGREE

### Computer Science and Engineering (100)

- Applied Computing
- Artificial Intelligence
- Computer Engineering
- Cyber Security (under planning)

CSE

Plus:  
- Open path: 20

### Electronics and Communications Engineering (85)

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

ECE

Plus:  
- Open path: 20

### Information Processing Science (150)

- Information Systems
- Software Engineering

IPS

Plus:  
- Open path: 35

## MASTER'S PROGRAMS, Finnish call

- BME (20+3 via open path, with Faculty of Medicine)
- CSE (20)
- ECE (20)
- IPS (40, of which 10 via open path)

## INTERNATIONAL MASTER'S PROGRAMS

**BA<sup>1)</sup>** Business Analytics (15+15) (+ 20 in Business School)

**BME<sup>2)</sup>** Biomedical Engineering: Signal and Image Processing (30 with Faculty of Medicine)

**CSE<sup>2)</sup>** Computer Science and Engineering (50)

**ELE<sup>2)</sup>** Electronics (30)

**SEIS<sup>2)</sup>** Software Engineering and Information Systems + DD-EMSE (45+15)

**WCE<sup>2)</sup>** Wireless Communications Engineering + 2 DD (30+10)

**SAS<sup>2)</sup>** Sustainable and Autonomous Systems (35) (with UoVaasa)

## INTERNATIONAL BACHELOR PROGRAM

**DICE** International Degree Programme in Digitalization, Computing and Electronics (DICE)<sup>2)</sup> (60)

## EDUCATION EXPORT

Software Engineering with NJIT (100) =>

Software Engineering ( 75) and Information Systems (75)

<sup>1)</sup>Tuition fee: **12 k€**, Scholarships: **60% (for all in 2023)**

<sup>2)</sup>Tuition fee: **10 k€**, Scholarships: **60% (for all in 2023)**





# Key Figures of Centre for Wireless Communications (CWC)

- Founded 1995 as a research programme to improve collaboration between academia and industry.
- Was later merged to the Faculty of ITEE as two research units:
  - CWC – Radio Technologies
  - CWC – Networks and Systems.
- Research and teaching staff: ~ 180, 17 professors:  
10 Full, 3 Associate, 4 Assistant Professors, 2 Profs. of Practice
- Very international staff – majority non-Finns.
- Total funding ~ 10 M€ / year (75% external funding).
  - Distribution: CWC – NS: 35 %, CWC – RT: 65 %



# CWC Approach

## Mission

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

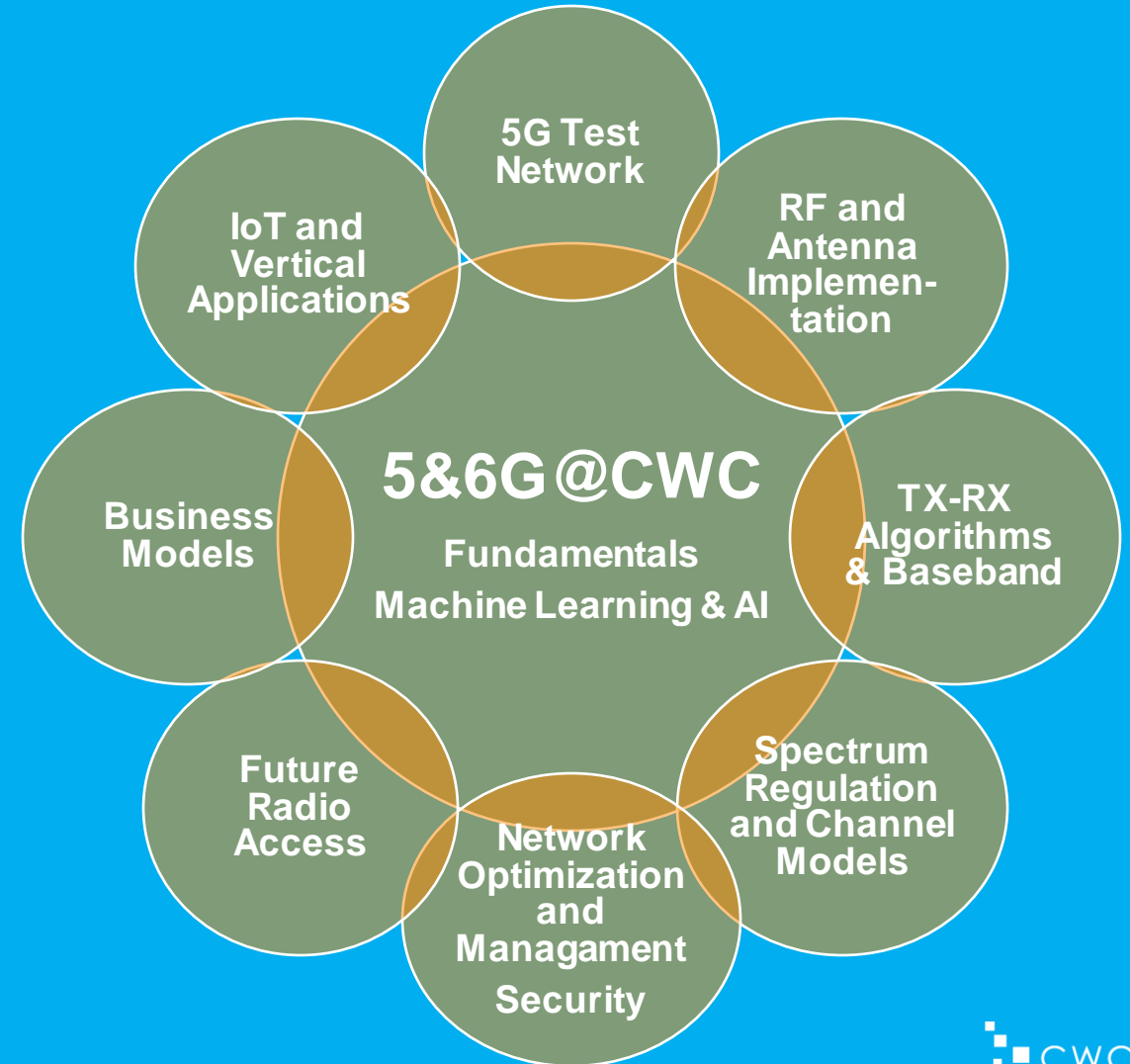
## Objectives

- 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 History and Broader Impact

## CWC-RT and CWC-NS 2015

### Telecommunication Laboratory founded 1985

Tactical Data Link and SDR solutions



### Solmu Technologies

IMT Advanced 4G LTE System Proposals via WINNER Projects



5G NR and System Proposals via METIS Project

### Spread Spectrum Technology Research

### Multicarrier and MIMO Technology Research

### 5G System Research

### (B)5G System & Technology

1986

1990

1997

1999

2007

2014

2017

### Code Division Multiple Access Research

### UWB and WSN Technology Research

First Cognitive network phone call utilising LTE network

5G Test Network



### CWC established 1995

3G standard technology developed in FRAMES project

Proposal for ultrawideband (UWB) IEEE802.15.3a and related ASIC

Nano-IP protocol for wireless sensor network (WSN) and IoT

### KNL Networks -> Telenor 2020

### Sensinode -> ARM 2013

© Centre for Wireless Communications (CWC), University of Oulu





# UOulu and CWC Ranking Performance

## UOulu in Shanghai Ranking



## UOulu in Shanghai Ranking – Telecommunications Eng.

2021: 46  
2020: 51-75  
2019: 48  
2018: 47  
2017: 51-75



Finland

University of Oulu

301–350<sup>th</sup>

World University  
Rankings 2021

201–300<sup>th</sup>

Impact Rankings  
2020

56<sup>th</sup>

Impact Rankings: Decent  
work and economic  
growth 2020



# CWC's Research Groups



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



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



**Intelligent Connectivity & Networks (ICON)**  
Mehdi Bennis & Sumudu Samarakoon



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



**Communications Signal Processing (CSP)**  
Markku Juntti, Antti Tölli, Italo Atzeni



**Network security, trust and privacy (NetSEC)**  
Mika Ylianttila



**Mobile Network Softwarization & Service Customization (MOSAIC)**  
Tarik Taleb



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



**Wireless Medical Communications (WiMeC)**  
Jari Linatti, Matti Hämäläinen, Erkki Harjula

CWC-RT

CWC-NS



# CWC-RT Personnel

## Full Professors

1. Mehdi Bennis: wireless communications, machine learning
2. Markku Juntti: wireless communications, signal processing
3. Matti Latva-aho: wireless communications, 6G
4. Aarno Pärssinen: radio frequency engineering
5. Antti Tölli: wireless communications, signal processing
6. Nandana Rajatheva (pro-term): commun. eng.

## Tenure Track

1. Jack Ping Soh (Associate Professor): radio frequency engineering, antenna technologies (June 2021-)
2. Hirley Alves (Associate Professor): machine-type communications
3. Onel Lopez (Assistant Professor): sustainable communications technologies
4. Italo Atzeni (Assistant Professor), signal processing, low power comms

## Manager Posts

- Dr. Pekka Kyösti, Research Director, radio channel models (also with Keysight)
- Dr. Marko Leinonen: Research Director, RF technologies
- Dr. Juha-Pekka Mäkelä: Laboratory Manager

## Professors of Practice (and Docents)

1. Kari Leppänen (also an entrepreneur)
2. Seppo Yrjölä (also with Nokia)

## Senior Research Fellows (and Docents)

1. Markus Berg, RF engineering, antenna technologies
2. Marian Codreanu, signal processing, information theory (main affiliation with Linköping University)
3. Nurul Huda, wireless communications, URLLC
4. Zaheer Khan, machine learning, FPGA implementations
5. Joonas Kokkonen, THz communications
6. Kari Kärkkäinen, University Lecturers (focus on teaching)
7. Janne Lehtomäki, spectrum sensing, THz wireless
8. Marja Matinmikko-Blue, spectrum management, regulation
9. Diana Osario Moya, physical layer security
10. Pekka Pirinen, wireless networks, 5G and 6G

## Others

- About 20(+) postdoctoral research fellows
- About 60 doctoral and 15 M.Sc. students
- 4 project researchers
- 1 university teacher and 1 executive assistant



# CWC-NS Personnel

- **Professors (4)**
  - Jari Linatti: Communications Theory
  - Marcos Katz: Communications Engineering
  - Ari Pouttu: Dependable Wireless Systems
  - Tarik Taleb: Wireless Communications Networks
- **Tenure Track (3)**
  - Mika Ylianttila (Associate Professor): Security in Wireless Networks
  - Konstantin Mikhaylov (Assistant Professor): Convergent IoT Communications for Vertical Systems
  - Erkki Harjula (Assistant Professor): Wireless System Level Architecture for Future Digital Healthcare
- **Managers (5)**
  - Tuomo Hänninen: Research Manager
  - Olli Liinamaa: Project Manager
  - Esa Posio: Project Manager
  - Hanna Saarela: Development Manager (On leave)
  - Jari Sillanpää: Laboratory Manager
- **University Researchers/University Lecturers (5)**
  - Jussi Haapola (Adjunct Professor)
  - Matti Hämäläinen (Adjunct Professor)
  - Matti Isohookana
  - Harri Saarnisaari (Adjunct Professor)
  - Chafika Benzaid
- **Post-Doctoral Researchers/University Teachers (11)**
  - Timo Bräysy
  - Somayeh Kianpisheh
  - Tanesh Kumar
  - Pawani Porambage (Adjunct Professor)
  - Mazoud Shokmezhad
  - Mariella Särestöniemi (50%) (Adjunct Professor)
  - Johanna Vartiainen (Adjunct Professor)
  - Hao Yu
  - Madhusanka Liyanage (20%) (Adjunct Professor)
  - Pedro Nardelli (20%) (Adjunct Professor)
  - Amir Javadpour
  - Timo Kokkonen
  - Jude Okwuibe (50%)
- **Varying amount of (~30)**
  - Doctoral Students (~20)
  - Project Researchers (~ 5)
  - Trainees (~ 5)





# CWC-RT – Main Research Topics

## Radio Access Techniques

- 6G systems and waveforms
- RAN architecture design and optimization
- AI/ML based waveform design
- Local / micro-operator and licensing
- Secondary radio access utilizing radar bands
- URLLC and application specific optimization

## 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 – Main Research Topics

## Wireless Systems

- Various (new) application areas of wireless communications
- Industry, autonomous mobility, machine-type connectivity in verticals, energy (smart grids)
- Test network for B5G and towards 6G
- Cross-vertical IoT & Light-based IoT (LIoT)

## Critical Communications Systems

- Critical infrastructure communications
- Authorities and tactical communications
- Hybrid commercial-dedicated solutions based on LTE, 5G and B5G
- Communications waveforms and architectures for defence applications

## Wireless Networks (NetSEC & MOSAIC)

- Network architecture design for B5G systems
- Network virtualization, softwarization and slicing
- Network security, trust and privacy
- Edge computing for wireless networks
- Zero-touch cloud management

## Wireless Medical Communications

- System level architecture for healthcare
- WBAN (Wireless Body Area) networks
- 5G for hospitals
- Visible Light Communications (VLC) for medical ICT



**Welcome and Good Luck!**