WELCOME
to the September 24-25
2018 Lund Circuit Design Workshop

Ove Edfors
Director
Lund University Excellence Center for System Design on Silicon (SoS)
About the workshop
Two days of activities

150+ participants
30+ organizations

Workshop program with

Invited speakers
Senior researchers
Post docs
PhD students
International advisors
SoS board
Thematic sessions

• **Day 1** - Monday September 24
  – Session 1: Emerging Circuits and Systems
  – Session 2: Application Specific Processors
  – Session 3: Low-energy circuits

• **Day 2** - Tuesday September 25
  – Session 4: Computing and communication
  – New Competence Center for Connected Systems
Invited speakers

- **Lorenzo Ciampolini**, CEA LETI – LISAN, FR
  *Advanced memory solutions for emerging circuits and systems*

- **Marcus Binning**, Cadence, UK
  *Close to the Edge – How Neural Network inferencing is migrating to specialised DSPs in State of the Art SoCs*

- **Frédéric Hasbani & Michael Løngaa**, GN Hearing, DK
  *Technology and design considerations for Ultra-Low Power audio DSP*

- **Nafiseh Mazloum**, Sony Mobile Communications, SE
  *Cellular IoT Devices*

- **Jan Rabaey**, UC Berkeley, US
  *Adventures in High Dimensions*
SoS Board

Sven Mattisson, Chairman
Ericsson

Andrea Cathelin
STM

Franz Dielacher
Infineon

Peter Karlsson
Sony

Anton Klotz
Cadence

Karl-Erik Årzén
LTH

Peter Olanders
Ericsson

Per Runeson
CS, LTH
SoS International Advisors

Mike Faulkner
Victoria University
Australia

Qiuting Huang
ETH
Switzerland

Jan Rabaey
UC Berkeley
California
Some logistics

- Day 1 activities at Grand Hotel, including lunch

- Day 1 workshop dinner at Hypoteket
  Dinner starts at 19.00

- Day 2 activities in the E-building, Faculty of Engineering, LU
  Coffee and posters at 09.00

ALL THREE LOCATIONS ON THE MAP AT THE END OF THE PRINTED PROGRAM
Lund map – The tree important locations

- E-huset
- Faculty of Engineering
- Hypoteket
- Grand Hotel
Hypoteket

TONIGHT AT 19.00
Across the street from Lund cathedral
E-building, Faculty of Engineering

TOMORROW AT 09.00
Excellence Center in System Design on Silicon
Director and co-director

- **Ove Edfors**
  Director
  Focus on higher level system design

- **Joachim Rodrigues**
  Co-director
  Focus on circuit design
Guest professor

- **Liesbet Van der Perre**, KU Leuven
  Appointed part-time Lise Meitner Guest Professor at Lund University
  for a period of three years

Holds a workshop on

**IoT with a soft touch**

directly after this workshop.
... SoS associated people

Senior Researchers

PostDocs

PhD Students
A selection of SoS related projects active in 2017/2018
MaMi in new 5G frequency bands

2.1 MSEK over two years: August 2016 to July 2018

EIT: Liang Liu, Fredrik Tufvesson, Ove Edfors

Project Partner: Sony Mobile Communications
High-Speed A/D Converters for 5G

3.5 MSEK over two years: Sept. 2017 to Aug. 2019
EIT: Pietro Andreani
Project Partner: Ericsson Research
mmWave Smart Beamforming MaMi

2.04 MSEK over two years: September 2018 to June 2020

EIT: MinKeun Chung, Liang Liu, Fredrik Tufvesson, Ove Edfors

Project Partner: Sony Mobile Communications
Extremely Wideband Digital Receivers

2.5 MSEK over two years: September 2018 to June 2020

EIT: Henrik Sjöland, Pietro Andreani

Project Partner: Ericsson, SAAB
Digital Predistortion PA for NB-IoT

2 MSEK over two years: September 2018 to June 2020

EIT: Henrik Sjöland, Joachim Rodrigues

Project Partners: ARM, Xenergic
5G lab equipment

1.2 MSEK over 5 years (LTH)
200 kSEK (Crafoord)

Fredrik Tufvesson

The Crafoord Foundation
ESTABLISHED BY HOLGER CRAFOORD IN 1980
28 GHz MIMO Channel Sounder

Fredrik Tufvesson
Distributed Dense MaMi Networks

375 kUSD over three years: May 2016 to Apr 2019

EIT: Liang Liu, Ove Edfors

Project Partner: SRC/Intel
3D-MUSE

3.8 MEUR over two years (400 kEUR to Lund)

Lund representative: Joachim Rodrigues
Ultra Low Voltage SRAM Architectures

3.2 MSEK over four years

PI: Joachim Rodrigues
MaMi through tight device cooperation

3.2 MSEK over four years

PI: Ove Edfors
EIT long term massive MIMO cooperation with Ericsson

Ericsson goes Massive with Lund University

Mar 8, 2018
Today, Ericsson and Lund University are happy to announce a multi-year collaboration agreement regarding research and development in key technologies for mobile communication systems, mainly Massive MIMO technologies and applications.

A result of the successful research within SoS and the strategic research area ELLIIT.
Publication high-lights
An Area-Efficient On-Chip Memory System for Massive MIMO Using Channel Data Compression
Yangxunui Liu, Member, IEEE, Liang Liu, Member, IEEE, Ove Edfors, Senior Member, IEEE, and Viktor Owall, Member, IEEE

Compressed Level Crossing Sampling for Ultra-Low Power IoT Devices
Jun Zhou, Student Member, IEEE, Amir Tofighi Zavareh, Robin Gupta, Liang Liu, Zhongfeng Wang, Fellow, IEEE, Brian M. Sadler, Fellow, IEEE, Jose Silva-Martinez, Fellow, IEEE, and Sebastian Hoyos, Senior Member, IEEE

A 128kb 7T SRAM Using a Single-Cycle Boosting Mechanism in 28-nm FD–SOI
Babak Mohammadi, Member, IEEE, Oskar Andersson, Member, IEEE, Joseph Nguyen, Student Member, IEEE, Lorenzo Ciampolini, Member, IEEE, Andrea Catinelli, Senior Member, IEEE, and Joachim Neves Rodrigues, Senior Member, IEEE

On the Remarkable Performance of the Series-Resonance CMOS Oscillator
Fedderico Pepe, Andrea Bevilacqua, Senior Member, IEEE, and Pietro Andreani

A General Theory of Phase Noise in Transconductor-Based Harmonic Oscillators
Fedderico Pepe and Pietro Andreani

To appear:
M. Adbulaziz, E. Klumperink, B. Nauta, H. Sjöland, “Improving Receiver Close-in Blocker Tolerance by Base-band Gm-C Notch-Filtering”, accepted to IEEE TCAS-I
Architecture Design of a Memory Subsystem for Massive MIMO Baseband Processing

Yangxurui Liu, Liang Liu, and Viktor Öwall
Elsevier Integration: the VLSI journal

A 70 pJ/b configurable 64-QAM soft MIMO detector

Mahdi Shabany\textsuperscript{a,}\textsuperscript{*}, Dimpesh Patel\textsuperscript{b}, Mario Milicevic\textsuperscript{b}, Mojtaba Mahdavi\textsuperscript{c}, P. Glenn Gulak\textsuperscript{b}

Clustered checkpointing: Maximizing the level of confidence for non-equidistant checkpointing

Dimitar Nikolov\textsuperscript{a}, Erik Larsson

Department of Electrical and Information Technology, Lund University, Lund 22100, Sweden
A 2.8–3.8-GHz Low-Spur DTC-Based DPLL
With a Class-D DCO in 65-nm CMOS
Ahmed Mahmoud, Pietro Andreani, and Federico Pepe

Two mm-Wave VCOs in 28-nm
UTBB FD-SOI CMOS
Therese Forsberg, Student Member, IEEE, Johan Wernehag, Member, IEEE, Anders Nejdel, Member, IEEE,
Henrik Sjöland, Senior Member, IEEE, and Markus Törnänen, Senior Member, IEEE
To appear:

Staffan Ek, Tony Pählsson, Christian Elgaard, Anders Carlsson, Member, IEEE, Andreas Axholt, Anna-Karin Stenman, Member, IEEE, Lars Sundström, Member, IEEE, and Henrik Sjöland, Senior Member, IEEE
13.6 A 1.8G b/s 70.6pJ/b 128×16 Link-Adaptive Near-Optimal Massive MIMO Detector in 28nm UTBB-FDSOI
Wei Tang1, Hemanth Prabhu2, Liang Liu2, Viktor Öwall3, Zhengya Zhang1
Test of Reconfigurable Modules in Scan Networks

Riocardio Cantoro, Member, IEEE, Farrokh Ghani Zadegan, Member, IEEE, Marco Palena, Member, IEEE, Paolo Pasini, Member, IEEE, Erik Larsson, Senior Member, IEEE, and Matteo Sonza Reorda, Fellow, IEEE

On-Chip Fault Monitoring Using Self-Reconfiguring IEEE 1687 Networks

Farrokh Ghani Zadegan, Student Member, IEEE, Dimitar Nikolov, Member, IEEE, and Erik Larsson, Senior Member, IEEE
Communications and Wireless Communications

IEEE Transactions on Wireless Communications

Massive MIMO Performance—TDD Versus FDD: What Do Measurements Say?
Jose Florides, Student Member, IEEE, Fredrik Rusek, Member, IEEE, Fredrik Tufvesson, Fellow, IEEE, Erik G. Larsson, Fellow, IEEE, and Ove Edfors, Senior Member, IEEE

Nasibeh Seyedi-Madoun, Member, IEEE, and Ove Edfors, Senior Member, IEEE

Reciprocity Calibration for Massive MIMO: Proposal, Modeling, and Validation
Joon Vieira, Fredrik Rusek, Ove Edfors, Member, IEEE, Stefan Malkowsky, Student Member, IEEE, Liang Lin, Member, IEEE, and Fredrik Tufvesson, Fellow, IEEE

IEEE Journal on Selected Areas in Communications

5G: A Tutorial Overview of Standards, Trials, Challenges, Deployment, and Practice
Masood Shafi, Life Fellow, IEEE, Andreas F. Molisch, Fellow, IEEE, Peter J. Smith, Fellow, IEEE, Thomas H. Elgin, Member, IEEE, Peiying Zhu, Senior Member, IEEE, Prasun De Silva, Member, IEEE, Fredrik Tufvesson, Fellow, IEEE, Ammar Baniabdelmalek, Senior Member, IEEE, and Gerhard Ungerer, Senior Member, IEEE

Performance Characterization of a Real-Time Massive MIMO System With LOS Mobile Channels
Paul Harris, Student Member, IEEE, Stefan Malkowsky, Student Member, IEEE, Joon Vieira, Erik Bergström, Fredrik Tufvesson, Fellow, IEEE, Wael Boukley Hasan, Student Member, IEEE, Liang Lin, Member, IEEE, Mark Beach, Member, IEEE, Simon Armour, and Ove Edfors, Member, IEEE

IEEE Wireless Communications Letters

Achievable Rates and Training Overheads for a Measured LOS Massive MIMO Channel
Paul Harris, Wael Boukley Hasan, Liang Lin, Stefan Malkowsky, Mark Beach, Simon Armour, Fredrik Tufvesson, and Ove Edfors

IEEE Transactions on Communications

Optimal Channel Shortener Design for Reduced-State Soft-Output Viterbi Equalizer in Single-Carrier Systems
Sha Hu, Harald KriG, Qingzhi Huang, Fellow, IEEE, and Fredrik Rusek
Antennas and Propagation

IEEE Transactions on Antennas and Propagation

Communication
Radiative MRI Coil Design Using Parasitic Scatterers: MRI Yagi
Juan D. Sánchez-Heredia, Johan Avendi, Adnan Bibic, and Buon Kiong Lau

IEEE Transactions on Antennas and Propagation
Communication
Design of Closely Packed Pattern Reconfigurable Antenna Array for MIMO Terminals
Hui Li, Buon Kiong Lau, and Sailing He

IEEE Transactions on Antennas and Propagation
Communication
Analysis and Estimation of MIMO-SAR for Multi-antenna Mobile Handsets
Hui Li, Apostolos Tsiaras, and Buon Kiong Lau

IEEE Antennas and Wireless Propagation Letters

Dynamic Channel Model With Overhead Line Poles for High-Speed Railway Communications
Lai Zhou, Zhi Yang, Fengyu Luan, Andreas F. Molisch, Fellow, IEEE, Fredrik Tufvesson, Fellow, IEEE, and Shidong Zhou, Member, IEEE

Measurement-Based Multiple-Scattering Model of Small-Scale Fading in High-Speed Railway Cutting Scenarios
Bei Zhang, Student Member, IEEE, Zhongbai Zhong, Senior Member, IEEE, Ruisi He, Member, IEEE, Fredrik Tufvesson, Fellow, IEEE, and Bo Ai, Senior Member, IEEE

On Characteristic Eigenvalues of Complex Media in Surface Integral Formulations
Zachary Miers, Member, IEEE, and Buon Kiong Lau, Senior Member, IEEE
Signal processing

IEEE Transactions on Signal Processing

Efficient DSP and Circuit Architectures for Massive MIMO: State of the Art and Future Directions
Liesbet Van der Perre, Liang Liu, and Erik G. Larsson, Fellow, IEEE

Beyond Massive MIMO: The Potential of Data Transmission With Large Intelligent Surfaces
Sha Hu, Member, IEEE, Fredrik Rusek, Member, IEEE, and Ove Edfors, Senior Member, IEEE

IEEE Journal of Selected Topics in Signal Processing

A Soft-Output MIMO Detector With Achievable Information Rate based Partial Marginalization
Sha Hu and Fredrik Rusek

Beyond Massive MIMO: The Potential of Positioning With Large Intelligent Surfaces
Sha Hu, Fredrik Rusek, and Ove Edfors

Digital Predistortion for Hybrid MIMO Transmitters
Mahmoud Abdelaziz, Member, IEEE, Lauri Antila, Member, IEEE, Alberto Brihuega, Student Member, IEEE, Fredrik Tufvesson, Fellow, IEEE, and Mikko Valkama, Senior Member, IEEE
Vehicular Communication Channels

IEEE Transactions on Vehicular Technology

Estimating the Cross-Correlation Properties of Large-Scale Parameters in Multilink Distributed Antenna Systems: Synchronous Measurements Versus Repeated Measurements

Ghassan Dahman, *Member, IEEE*, Jose Floridelis, *Student Member, IEEE*, and Fredrik Tufvesson, *Fellow, IEEE*

A Measurement-Based Multilink Shadowing Model for V2V Network Simulations of Highway Scenarios

Mikael G. Nilsson *, Member, IEEE*, Carl Gustafson, Member, IEEE*, Taimoor Abbas, Member, IEEE*, and Fredrik Tufvesson, Fellow, IEEE*

Measurement-Based Wideband Analysis of Dynamic Multipath Propagation in Vehicular Communication Scenarios

Kim Mahler, Wilhelm Keusgen, Fredrik Tufvesson, Thomas Zemen, Senior Member, IEEE*, and Giuseppe Caire, Fellow, IEEE
Recent PhD graduates
Yangxurui Liu

Efficient Processing and Storage for Massive MIMO Digital Baseband

Yangxurui Liu

Lund University

Doctoral Thesis
Electrical Engineering
Lund, March 2018

Exchange PhD student from China

Supervisor: Viktor Öwall
Mikael Nilsson

Verification of wireless communication performance and robustness for automotive applications

Mikael Nilsson

Industrial PhD student

Supervisor: Fredrik Tufvesson

Lund 2018
Babak Mohammadi

Ultra-low Power Design Approaches in Memories and Assist Techniques

Babak Mohammadi

EIT PhD student

Supervisor: Joachim Rodrigues
Hu Sha

Channel Shortening in Wireless Communication

EIT PhD student

Supervisor: Fredrik Rusek
Joao Vieira

Algorithms and Proofs of Concept for Massive MIMO Systems

João Vieira

EIT PhD student

Supervisor: Fredrik Tufvesson

Lund 2017
Elevations, rankings and awards
IEEE Fellow Grade Elevations

Fredrik Tufvesson

for contributions to measurement and modeling of wireless propagation channels

Pietro Andreani

for contributions to CMOS integrated voltage-controlled oscillators
## Shanghai Ranking

### Electrical and Electronic Engineering

#### 2017

<table>
<thead>
<tr>
<th>World Rank</th>
<th>Institution</th>
<th>Country/Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>University of California, Berkeley</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Stanford University</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Massachusetts Institute of Technology (MIT)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>University of Illinois at Urbana-Champaign</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Georgia Institute of Technology</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Nanyang Technological University</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Tsinghua University</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>University of Michigan-Ann Arbor</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>The University of Texas at Austin</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>National University of Singapore</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Harvard University</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Purdue University, West Lafayette</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Rutgers, The State University of New Jersey - New Brunswick</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Princeton University</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>University of California, Santa Barbara</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Swiss Federal Institute of Technology Zurich</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Carnegie Mellon University</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>University of Maryland, College Park</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Zhejiang University</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Lund University</td>
<td></td>
</tr>
</tbody>
</table>

#### 2018

<table>
<thead>
<tr>
<th>World Rank</th>
<th>Institution</th>
<th>Country/Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Massachusetts Institute of Technology (MIT)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Stanford University</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>University of California, Berkeley</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Georgia Institute of Technology</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>University of Illinois at Urbana-Champaign</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Princeton University</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>University of California, Santa Barbara</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Rutgers, The State University of New Jersey - New Brunswick</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Harvard University</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>North Carolina State University - Raleigh</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Swiss Federal Institute of Technology Zurich</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Nanyang Technological University</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>University of Michigan-Ann Arbor</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Auburn University</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>University of California, San Diego</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>University of California, Los Angeles</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Lund University</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Texas A&amp;M University</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Carnegie Mellon University</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>The University of Texas at Austin</td>
<td></td>
</tr>
</tbody>
</table>
Paper awards

2018 IEEE Edge conference Best Paper Award

Towards Mission-Critical Control at the Edge and Over 5G

Per Skarin*,†‡, William Tärneberg*,§, Karl-Erik Årzen†, and Maria Kihl§

2018 IEEE Communications Society Best Tutorial Paper Award

Massive MIMO for Next Generation Wireless Systems

Erik G. Larsson, ISY, Linköping University, Sweden
Ove Edfors and Fredrik Tufvesson, Lund University, Sweden
Thomas L. Marzetta, Bell Labs, Alcatel-Lucent, United States

Joao was awarded the Sparbanksstiftelsen Färs & Frosta 100 000 SEK prize for best doctoral thesis at the Faculty of Engineering, Lund University.
Liang Liu received the 40 000 SEK Göran Lind Prize from the Royal Physiographic Society of Lund for his contributions to massive MIMO.
Future of SoS
System Design on Silicon → Connected Systems

• The System Design on Silicon center will broaden its field of activities, covering many aspects from materials and devices to high-level system design and applications.

• To reflect the new focus the name will be changed to Connected Systems.

• In this process we are looking for new partner companies.

• More information about this tomorrow at 11.15 – 11.45.
Next year's workshop

- The successful tradition of annual workshops will continue

- Next year's workshop will be held

  **Thursday-Friday September 19-20, 2019,**

  the days before the ESSCIRC/ESSDERC conference.
Let's return to this year's workshop
Session 1: Emerging Circuits and Systems

**MONDAY**

10.30-11.15

**Invited Presentation: Advanced memory solutions for emerging circuits and systems**
LORENZO CIAMPOLINI, CEA LETI – LISAN, FR

11.15-11.45

**3D stackable circuits and memory**
KARL-MAGNUS PERSSON, EIT, LUND UNIVERSITY

11.45-12.00

**A 26GHz 22.2dBm Variable Gain Power Amplifier in 28nm FD-SOI CMOS for 5G Antenna Arrays**
CHRISTIAN ELGAARD, ERICSSON + EIT, LUND UNIVERSITY

12.00-13.15

*Lunch*
Session 2: Application Specific Processors

**MONDAY**

13.15-14.00  Invited Presentation: Close to the Edge – How Neural Network inferencing is migrating to specialised DSPs in State of the Art SoCs
MARCUS BINNING, CADENCE, UK

14.00-14.15  An ASIP for massive MIMO with full compiler support
STEFFEN MALKOWSKY, EIT, LUND UNIVERSITY

14.15-14.30  SoC implementation in ST 28nm FD-SOI for distributed MIMO systems
HEMANTH PRABHU, EIT, LUND UNIVERSITY (XENERGIC)

14.30-14.45  Tuesday-poster pitches
POSTER PRESENTERS, EIT, LUND UNIVERSITY

14.45-15.15  Coffee
**Session 3: Low-energy Circuits**

**MONDAY**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.15-16.00</td>
<td>Invited Presentation: Technology and design considerations for Ultra-Low Power audio DSP</td>
</tr>
<tr>
<td></td>
<td>FRÉDÉRIC HASBANI &amp; MICHAEL LØNGAAN, GN HEARING, DK</td>
</tr>
<tr>
<td>16.00-16.15</td>
<td>Energy efficient analog front ends: Scaling laws and applications</td>
</tr>
<tr>
<td></td>
<td>MURIS SARAJLIC, EIT, LUND UNIVERSITY</td>
</tr>
<tr>
<td>16.15-16.30</td>
<td>Human Body IoT- Connected as needed</td>
</tr>
<tr>
<td></td>
<td>ALI ZAHER, EIT, LUND UNIVERSITY</td>
</tr>
<tr>
<td>16.30-17.00</td>
<td>Invited Presentation: Cellular IoT Devices</td>
</tr>
<tr>
<td></td>
<td>NAFISEH MAZLOUM, SONY MOBILE COMMUNICATIONS, LUND</td>
</tr>
<tr>
<td>19.00-</td>
<td>Dinner at Hypoteket</td>
</tr>
</tbody>
</table>
## Session 4: Computing and Communication

### TUESDAY

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>09.00-09.30</td>
<td>Coffee with Poster Session</td>
</tr>
<tr>
<td>09.30-10.15</td>
<td>Invited Presentation: Adventures in High Dimensions</td>
</tr>
<tr>
<td></td>
<td>JAN RABAЕY, UC BERKELEY, US</td>
</tr>
<tr>
<td>10.15-10.30</td>
<td>Multi-antenna terminals in Massive MIMO</td>
</tr>
<tr>
<td></td>
<td>ERIK BENGTSSON, SONY MOBILE COMMUNICATIONS + EIT, LUND UNIVERSITY</td>
</tr>
<tr>
<td>10.30-10.45</td>
<td>Mission Critical Control at the Edge and over 5G</td>
</tr>
<tr>
<td></td>
<td>PER SKÄRIN, ERİCSSON + AUTOMATIC CONTROL, LUND UNIVERSITY</td>
</tr>
<tr>
<td>10.45-11.15</td>
<td>Coffee with Poster Session</td>
</tr>
</tbody>
</table>
New Directions and Closing

TUESDAY

11.15-11.45  New Competence Center for Connected Systems  
OVE EDFORS, EIT, LUND UNIVERSITY

11.45-12.00  Closing Remarks  
SVEN MATTISSON, ERICSSON, CHAIRMAN OF THE SOS BOARD

12.00-13.30  Lunch and continued poster session