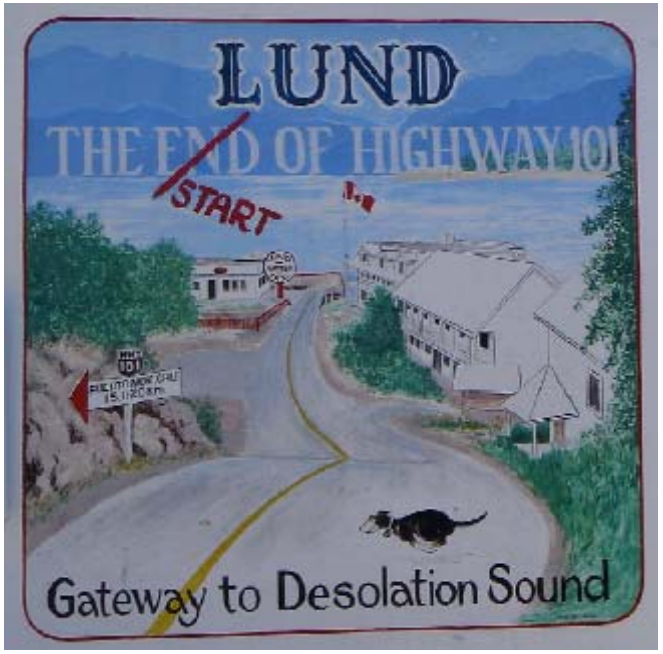
LUND UNIVERSITY

SoS
System Design on Silicon

Welcome to the



Lund Circuit Design Workshop 2010

Welcome and Introduction

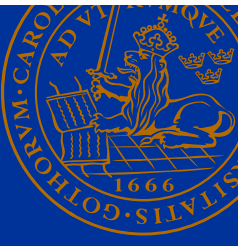
Viktor Öwall

Dept. of Electrical and Information Technology

Lund University, Sweden

viktor.owall@eit.lth.se

Welcome to two exiting days

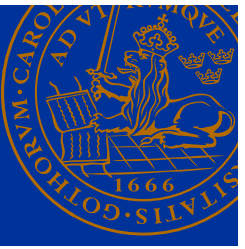


- A Lund University perspective by senior researchers and PhD students
- Invited speakers from academia:
  - Kofi A.A. Makinwa, TU Delft
  - Heiner Linke, Solid State Physics, Lund University
  - Andreas Jansson, ESS Scandinavia
- An industrial perspective:
  - Dag T. Wisland, Novelda AS
  - Lars Risbo, TI Denmark
  - Sami Vilhonen, ST Ericsson Finland
- Social activities including: The Dinner

Some Logistics!

- Today's program is at Grand Hotel including Lunch.
- Dinner in the Main Building of Lund University.
- Tomorrows programs is at the Faculty of Engineering, Lund University.

Some Logistics!



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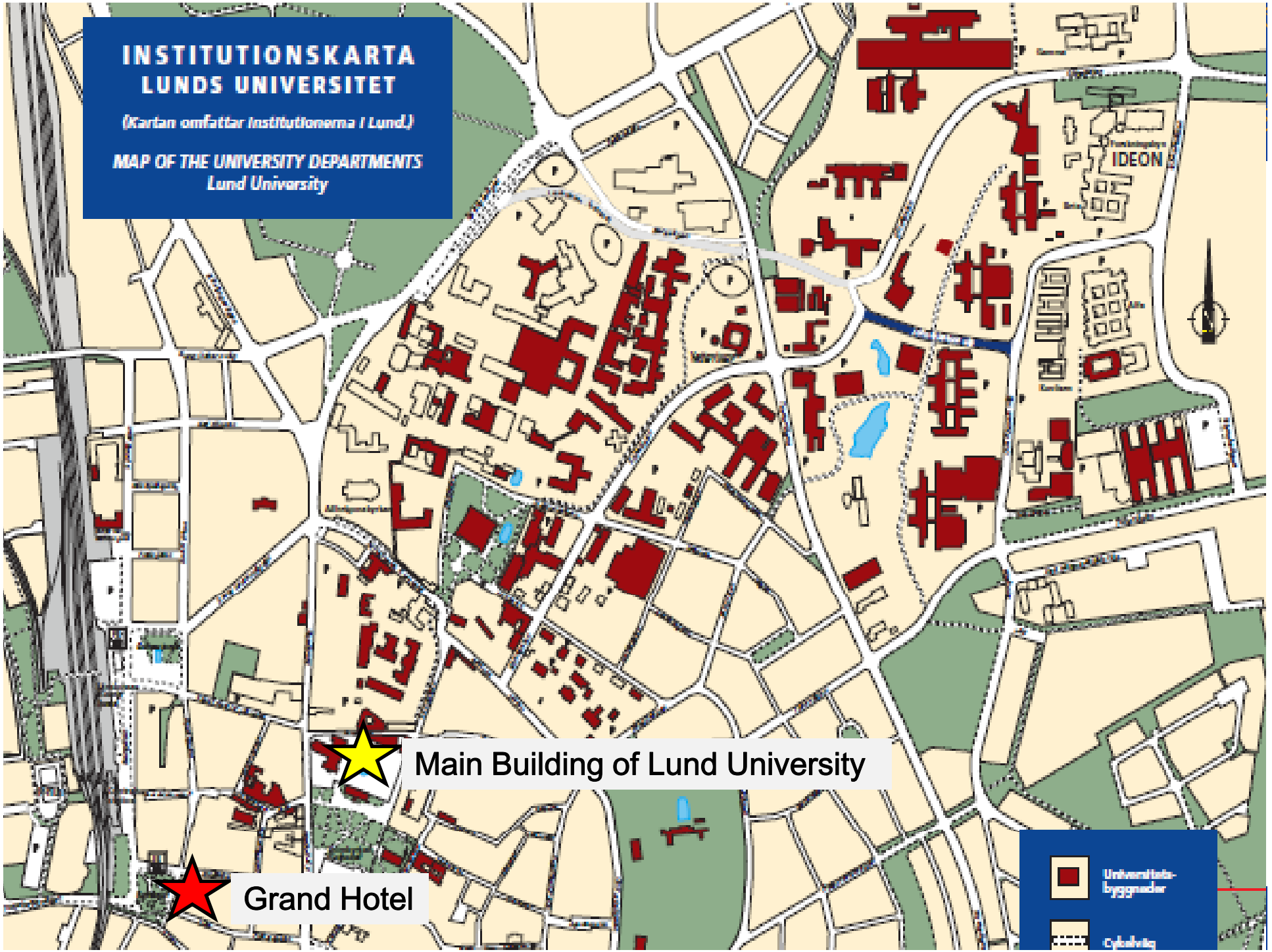
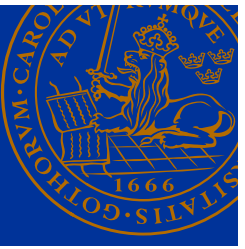

INSTITUTIONSKARTA
LUNDS UNIVERSITET
(Kartan omfattar institutionerna i Lund.)
MAP OF THE UNIVERSITY DEPARTMENTS
Lund University
IDEON
Main Building of Lund University
Grand Hotel

Dinner : Main Building of Lund University

Some Logistics!



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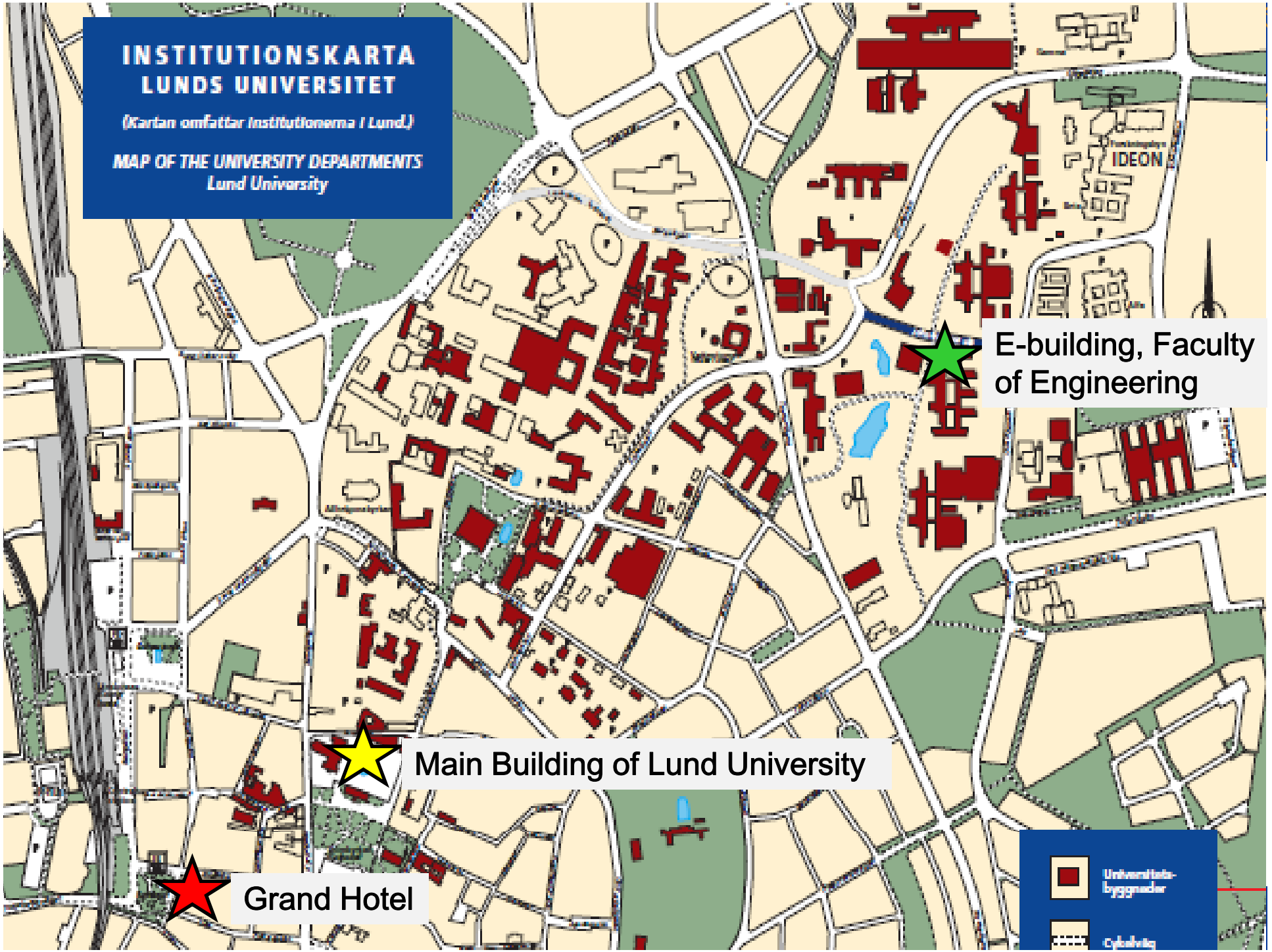
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MAP OF THE UNIVERSITY DEPARTMENTS
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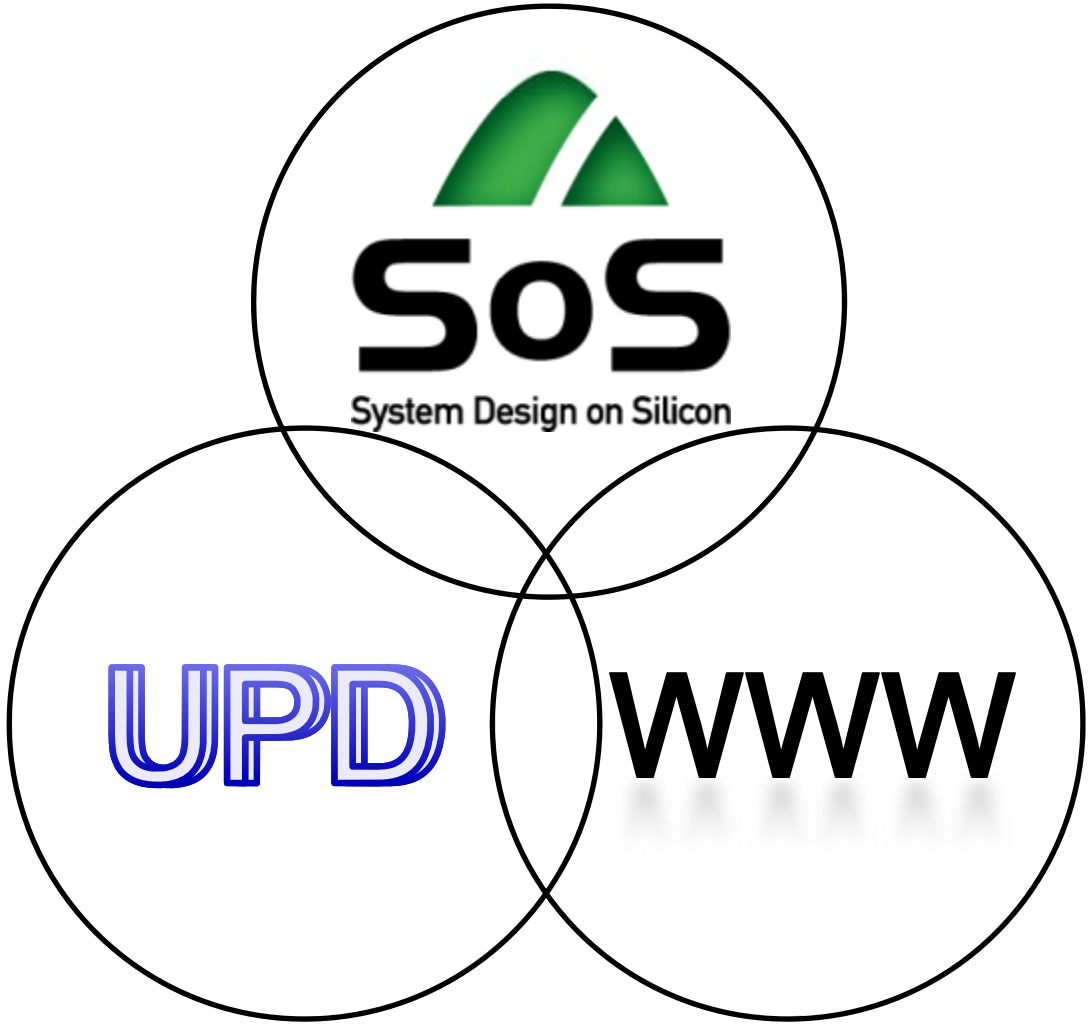
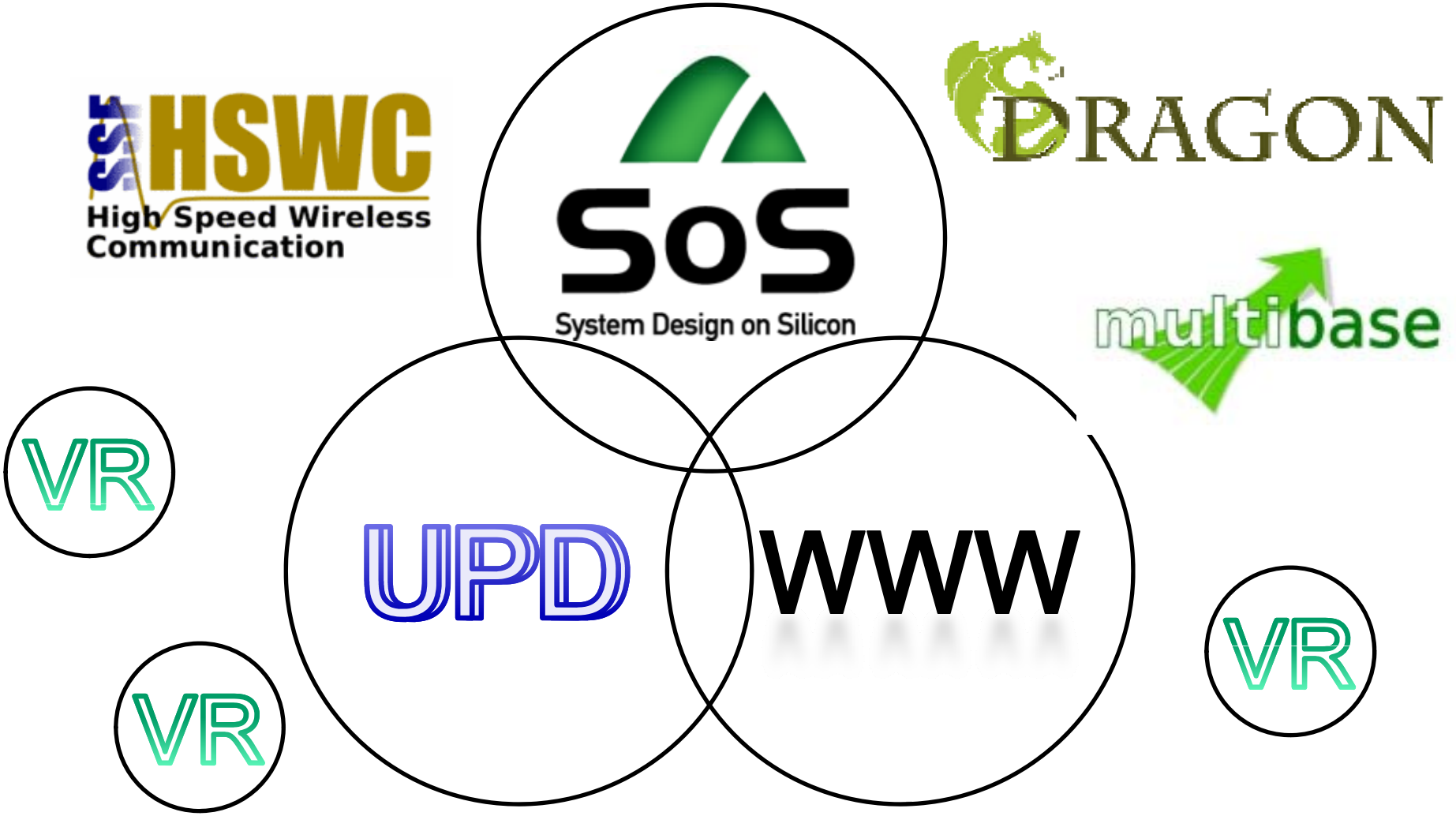
E-building, Faculty of Engineering
Main Building of Lund University
Grand Hotel

E-building: faculty of Engineering

The hosts



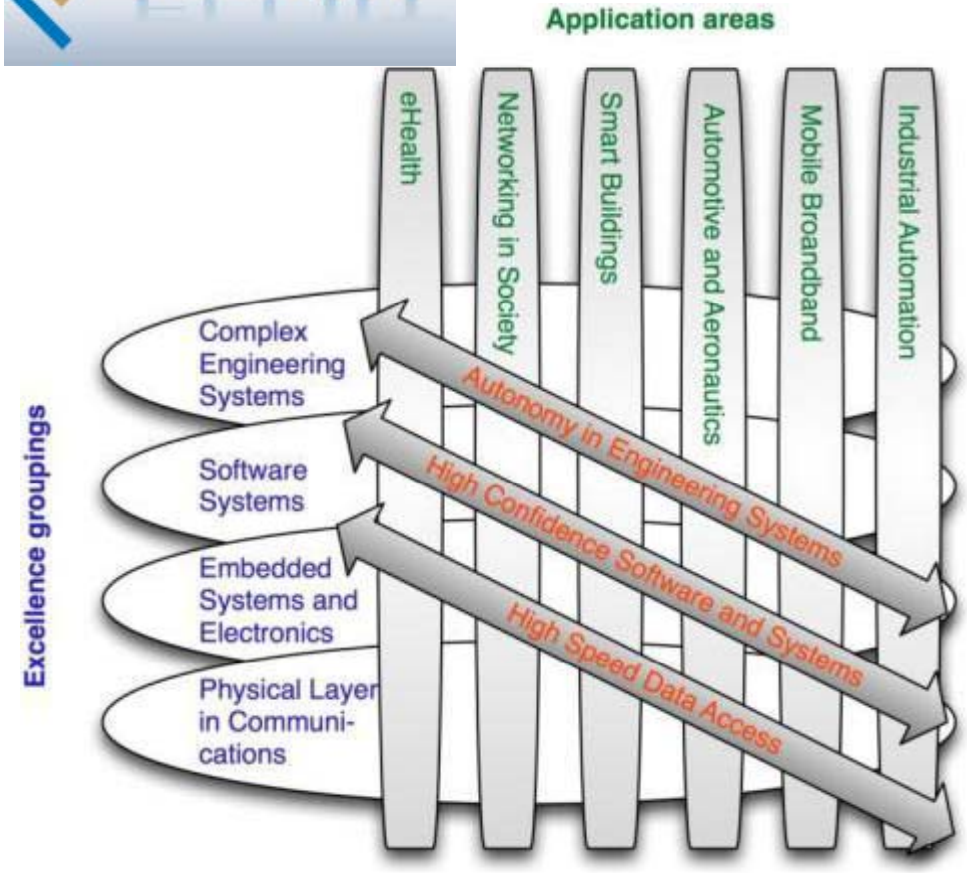
Funding and Initiatives



Strategic Research Funds: ELLIIT

ELLIIT is a network organization for Information and Communication Technology (ICT) which has been created to support and enhance an internationally acknowledged research environment in these areas. It is organized within the Swedish government's strategic research support initiative.

Strategic Research Funds: ELLIIT



ELLIIT:

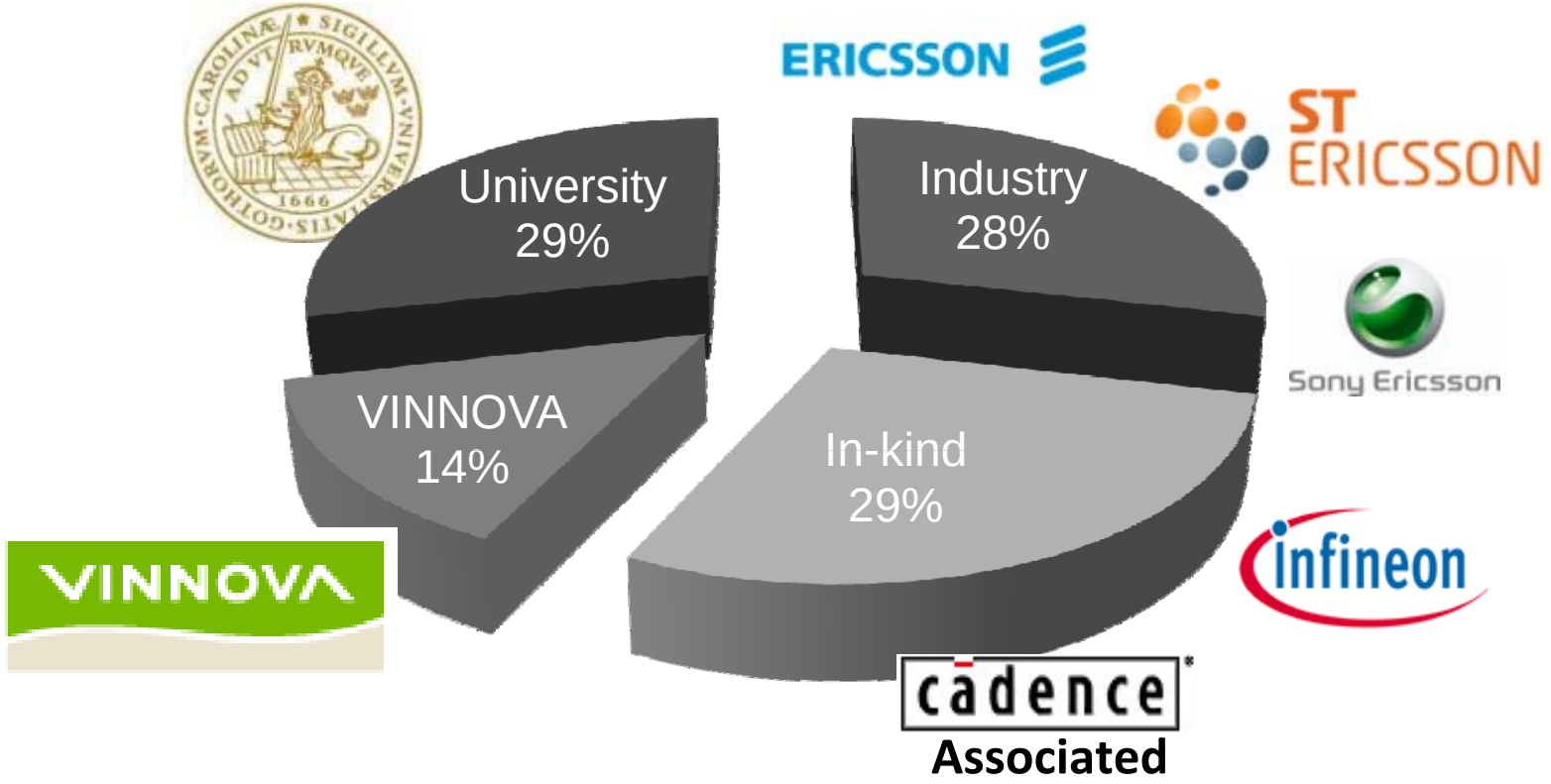
1. is headed by Lennrt Ljung from Linköping University. Co-director John B. Anderson Lund University.
2. partners are at Linköping, Lund, Halmstad and Blekinge,.
3. covers ”all” aspects of ICT.
4. embedded systems and Circuit Design is an important part of the initiative.

VINNOVA Industrial Excellence Center in

SoS
System Design on Silicon

has the vision to be a world class research facility for the development of system solutions on silicon for wireless communication devices that ensure the competitiveness of the participating companies.

VINNOVA Industrial Excellence Center in System Design on Silicon



Budget approximately 14.5MSEK/year including in-kind.
Ongoing discussions with several other companies.

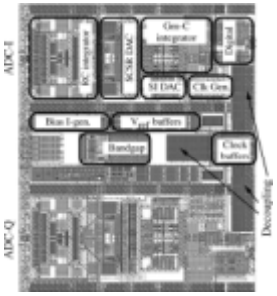
Some Results

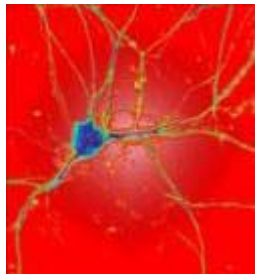
Academic output:

- **Six PhD degrees.**
- **16 journal papers (primarily in IEEE journals).**
- **28 papers at international peer reviewed conferences.**

Some Technology transfers:

- **A novel A/D-converter is currently used by SoS industrial partners. The work was performed by Martin Anderson as a CCCD/SoS PhD student. Martin is now employed at Ericsson Research in Lund.**





- **During our previous center, CCCD, a digital holographic microscope was developed which is now a start-up company.**

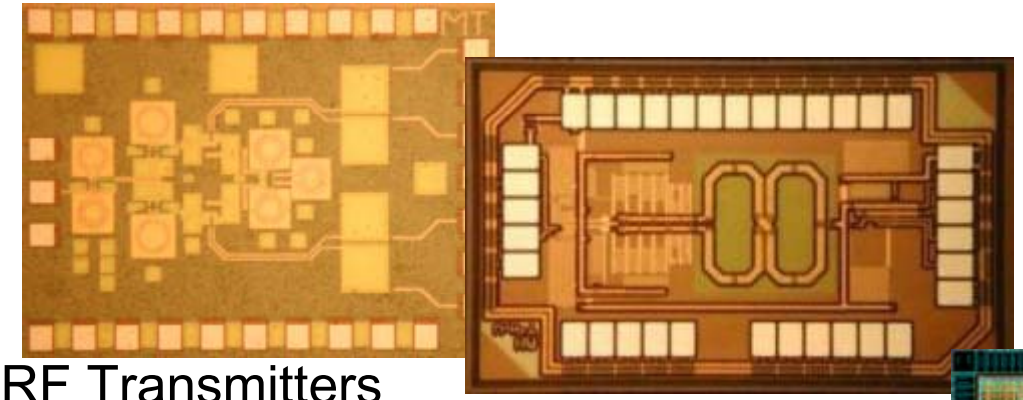
People in SoS

Director: Viktor Öwall, Co-director: Piertro Andreani
Chairman of the Board: Sven Mattisson, Ericsson AB

International Advisory Board

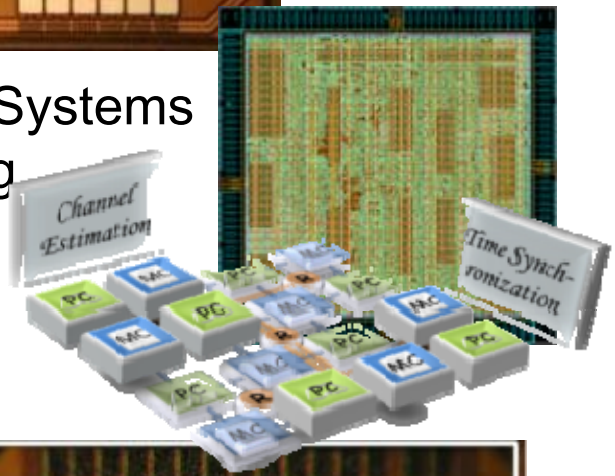
- Professor Jan Rabaey, BWRC, UC Berkeley, USA
- Professor Mike Faulkner, Victoria University, Australia
- Professor Qiuting Huang, ETH, Zürich, Switzerland

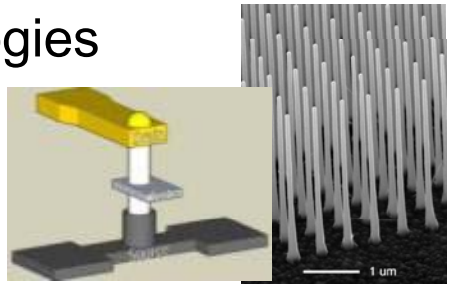
Research projects in SoS

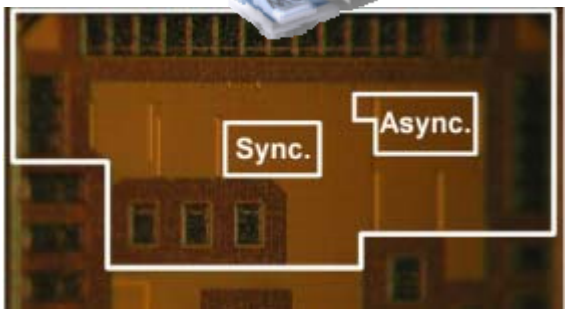


Ongoing projects:

- Switched Mode RF Transmitters
- Microwave and mm-Wave CMOS Circuits and Systems
- Transmitters with adaptive impedance matching
- High-Performance CT Delta-Sigma Modulators
- VCOs and Very-Low-Power Radio Front-ends
- Reconfigurable Computing
- Low Leakage Arithmetic and Architectures
- Future/emerging technologies

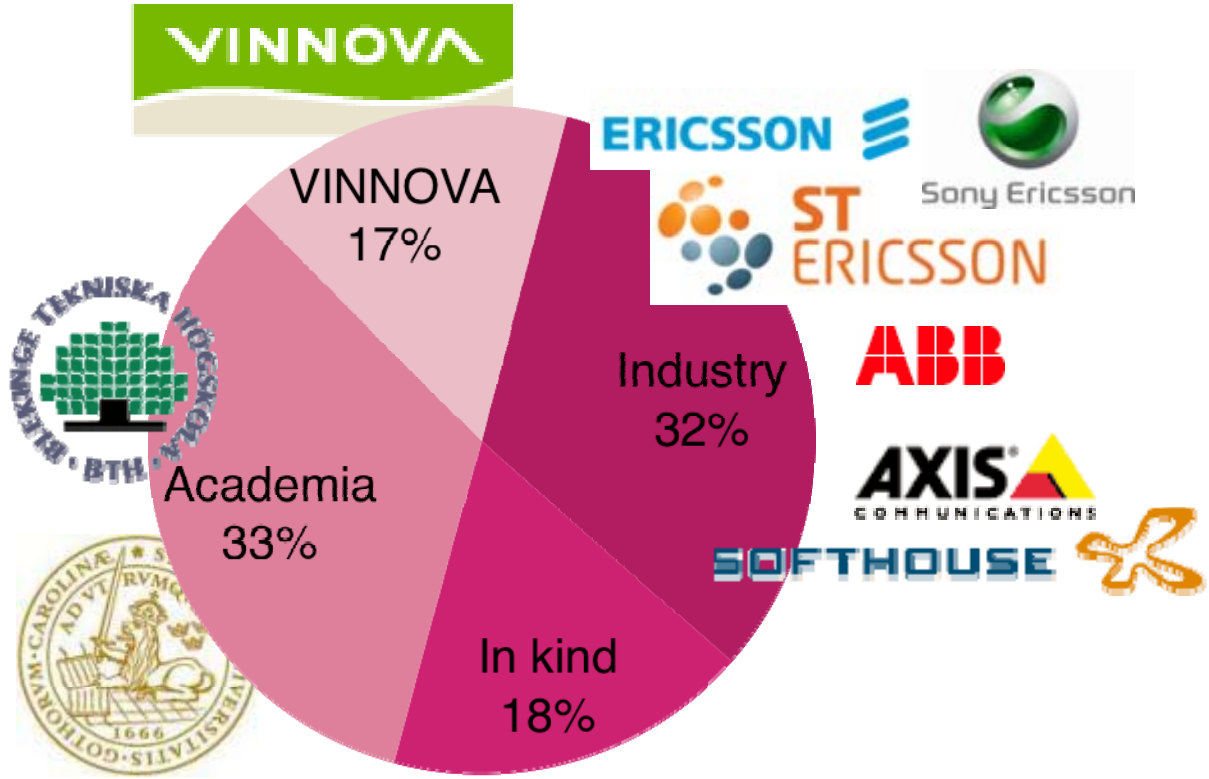






EASE – the sister center

EASE - Embedded Applications Software Engineering



Budget approximately 10.5MSEK/year including in-kind.
Director: Per Runeson, Dept. of Computer Science

Research within EASE

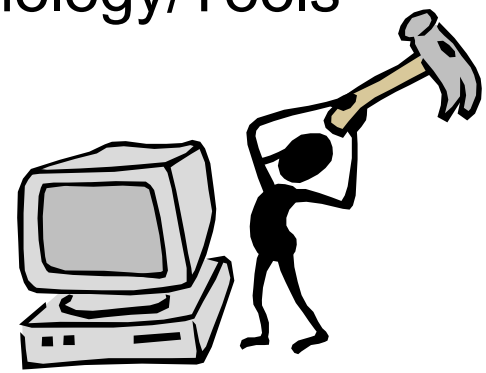
Collaboration with SoS regarding mapping to reconfigurable architectures.

Themes

A: Flexible Software Architectures

B: Parallel Embedded Systems

Technology/Tools



C: Efficient Software Methods (OSS, Agile)

D: Aligning Requirements and Verification

Engineering/People

Mobile Heights

MOBILE HEIGHTS™

Mobile Heights is an industry-driven cluster initiative that gather top companies and universities, as well as regional and national agencies, to finance applied research and innovation in mobile communications business.

Sony Ericsson · ST ERICSSON · TeliaSonera · ERICSSON

LUNDS UNIVERSITET · MALMÖ HÖGSKOLA · SKÅNE

Mobile Heights – The environment

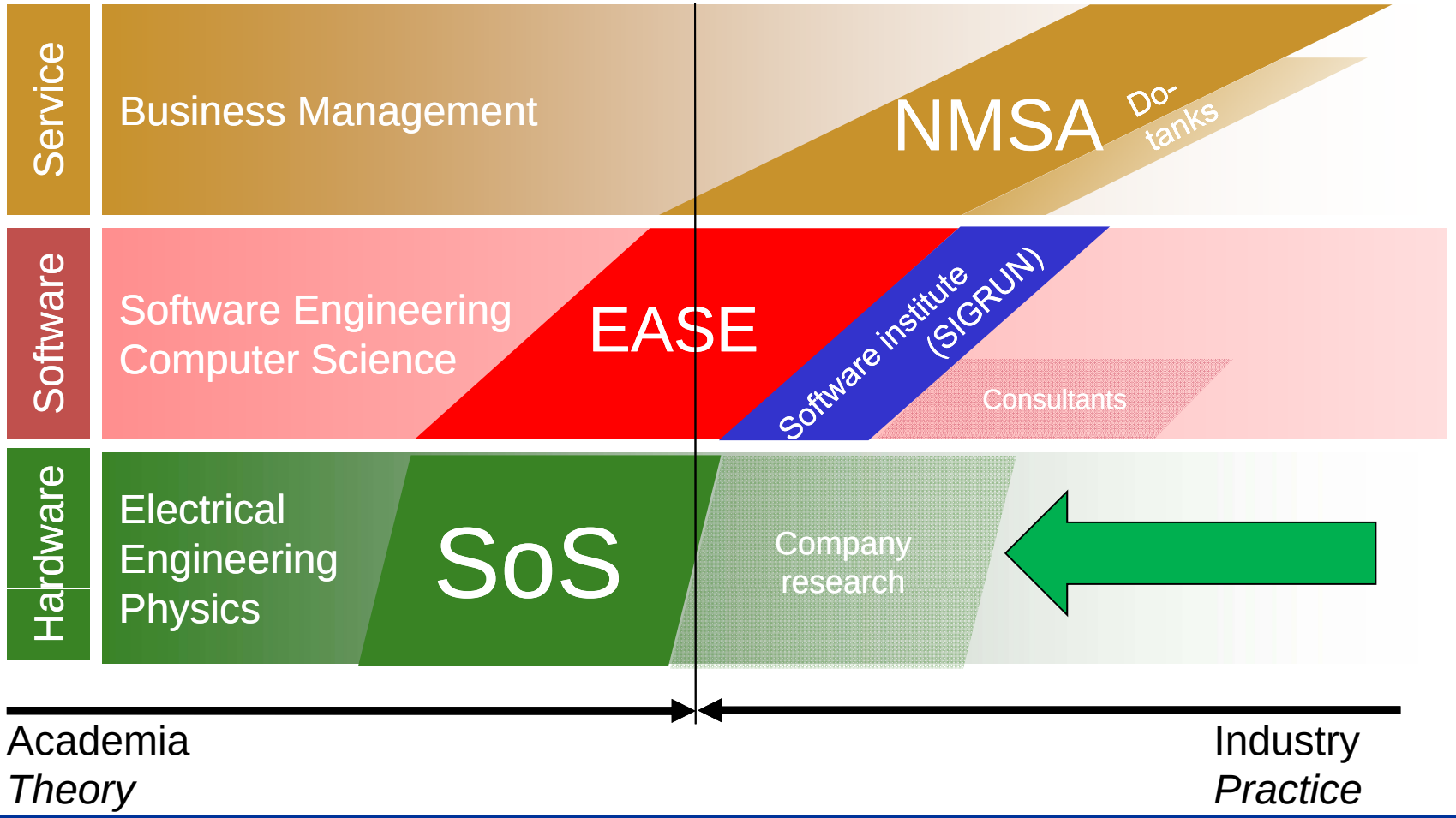
Mobile Heights is located in Southern Sweden, one of Europe's most dense and specialized geography on mobile communications and ICT.

A European mobile handset hotspot!

- 100 000 employees in ICT, 7 000 working in mobile
- 12 000 companies, 2 000 companies in mobile
- 500 public researchers within ICT
- 8 000 students within ICT

Research and innovation

And a business arena to pilot Open Innovation principles:
MHBC – Mobile Heights Business Center



UPD

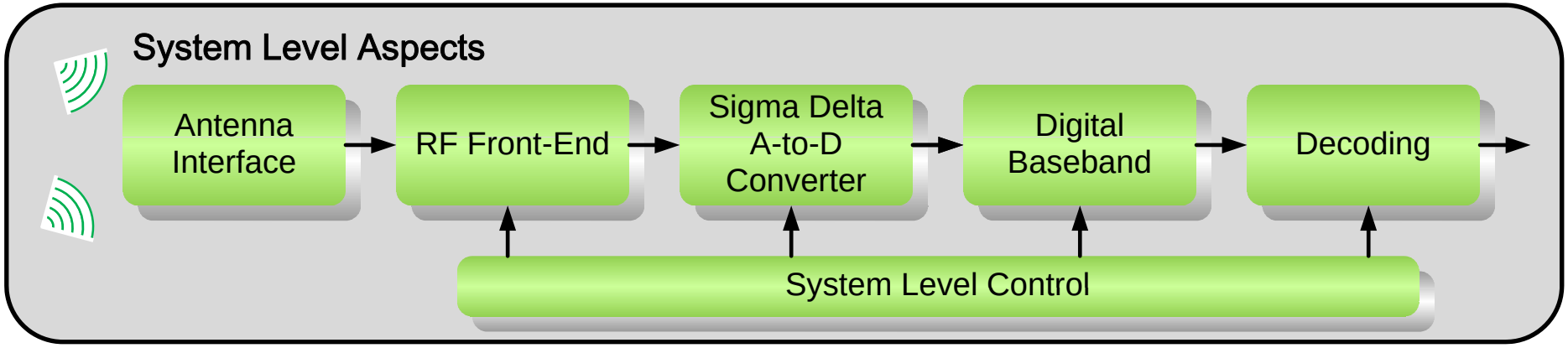
SSF strategic grant in

Wireless Communication for Ultra Portable Devices

UPD: Wireless Communication for Ultra Portable Devices

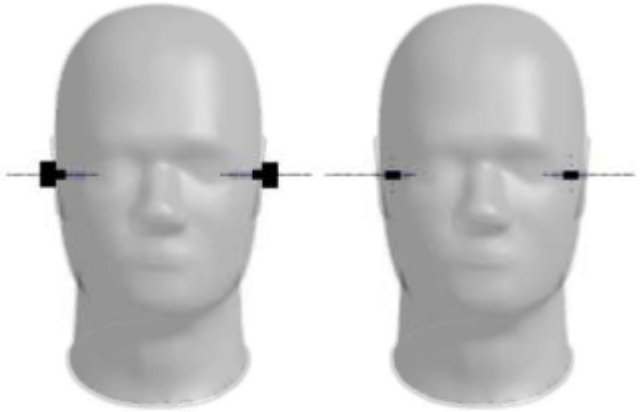
SSF Project granted in summer of 2008.
Main applicant: Henrik Sjöland
Financing: 22.4MSEK over 5 years

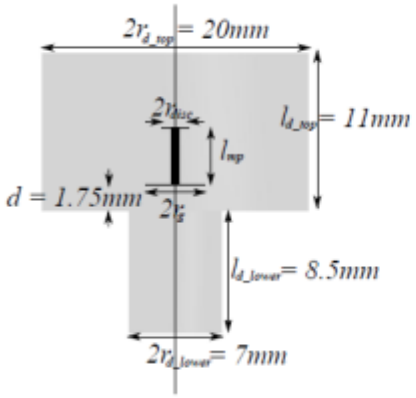
The main goal of this project is to design an ultra compact and low power radio that can be used in devices like hearing aids, medical implants, and remote sensors.

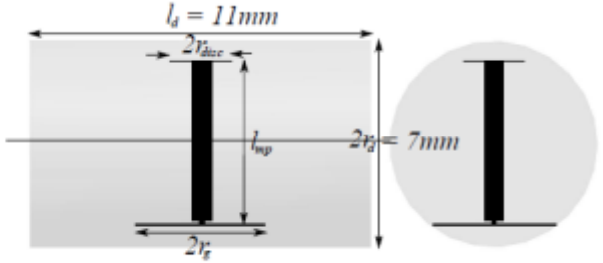


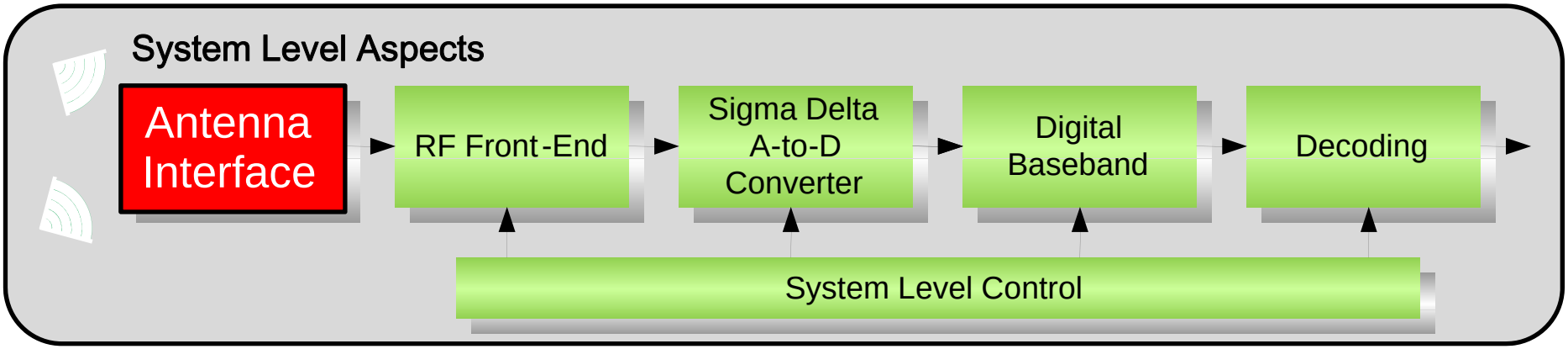
UPD: some results

Antenna Design; In-the-ear and in-the-canal



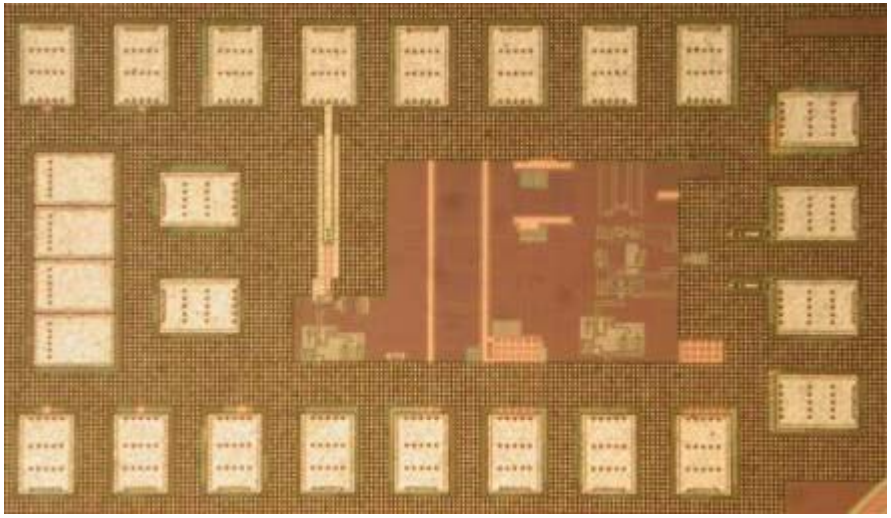


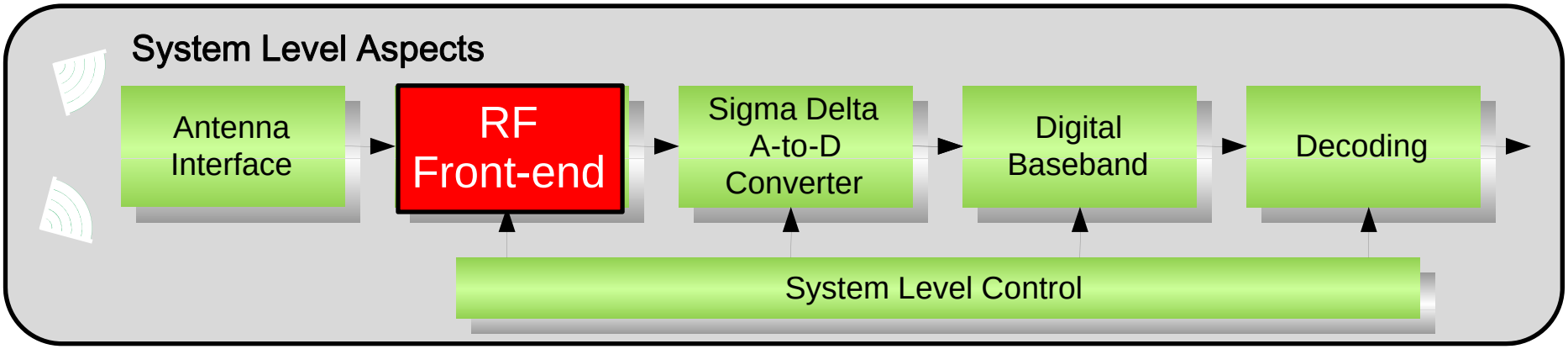




UPD: some results

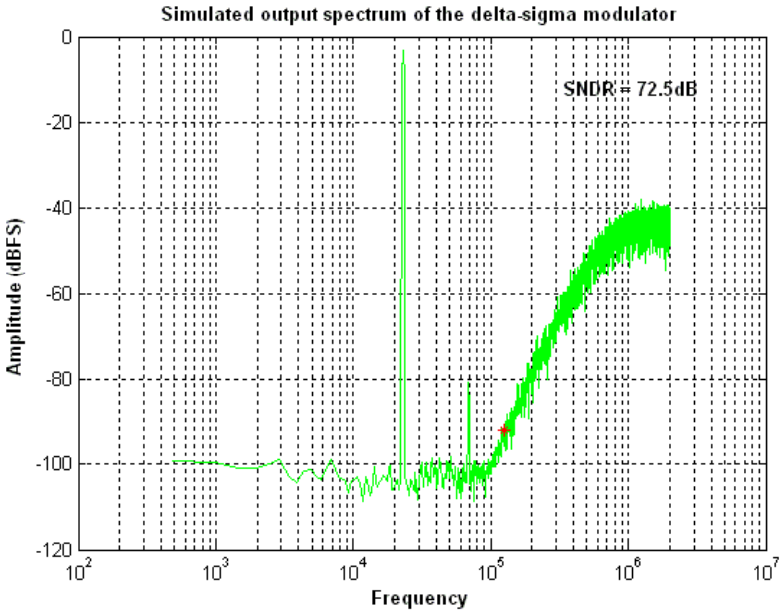
- LNA + frequency divider + mixer
- ST 65nm CMOS
- expected power cons. < 300μW

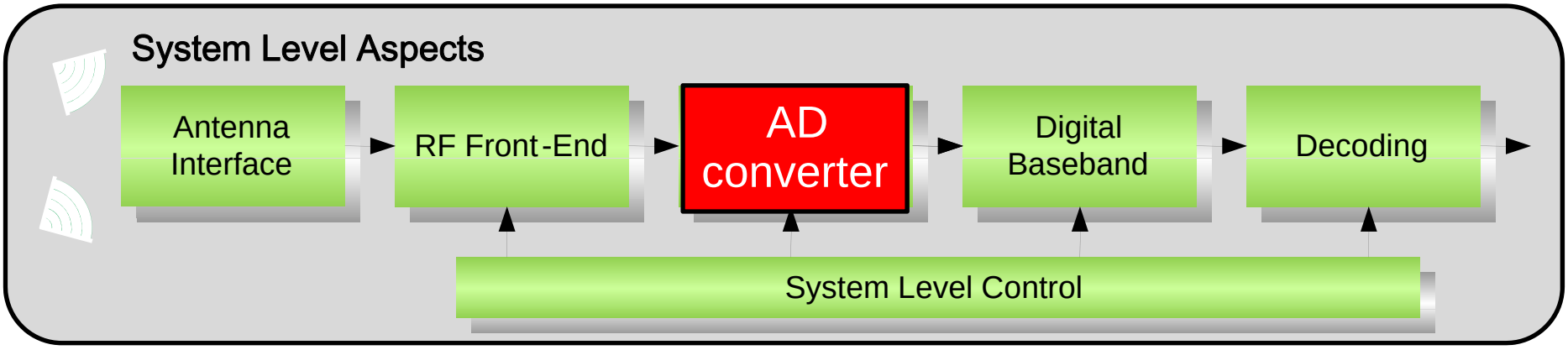




UPD: some results

Simulated spectrum for the output signal from the delta-sigma modulator with SNDR calculated.





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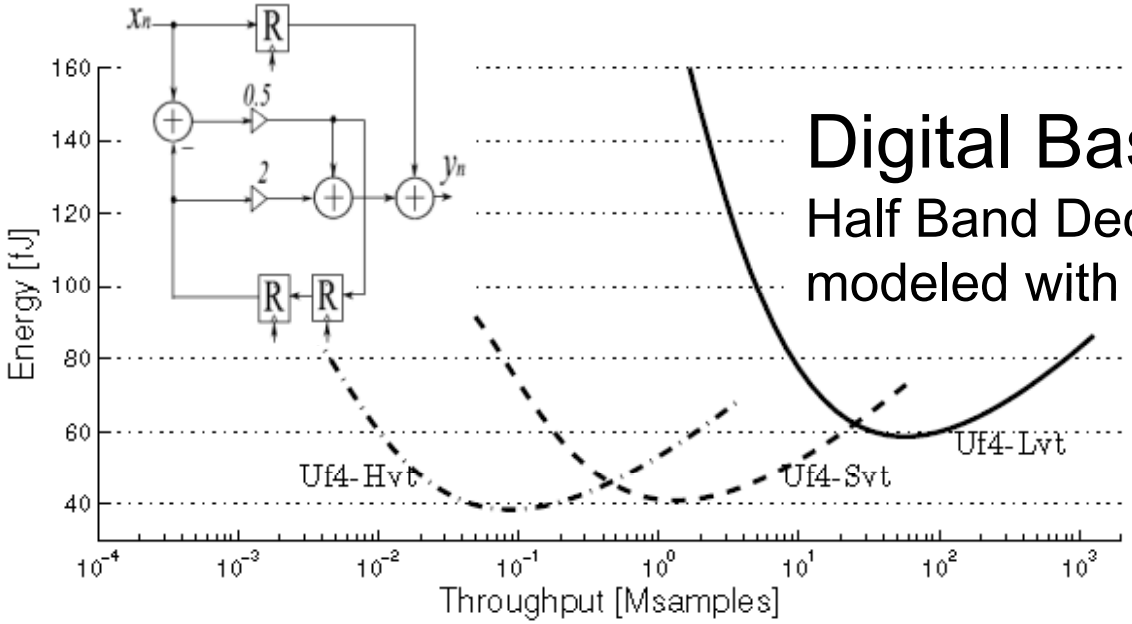
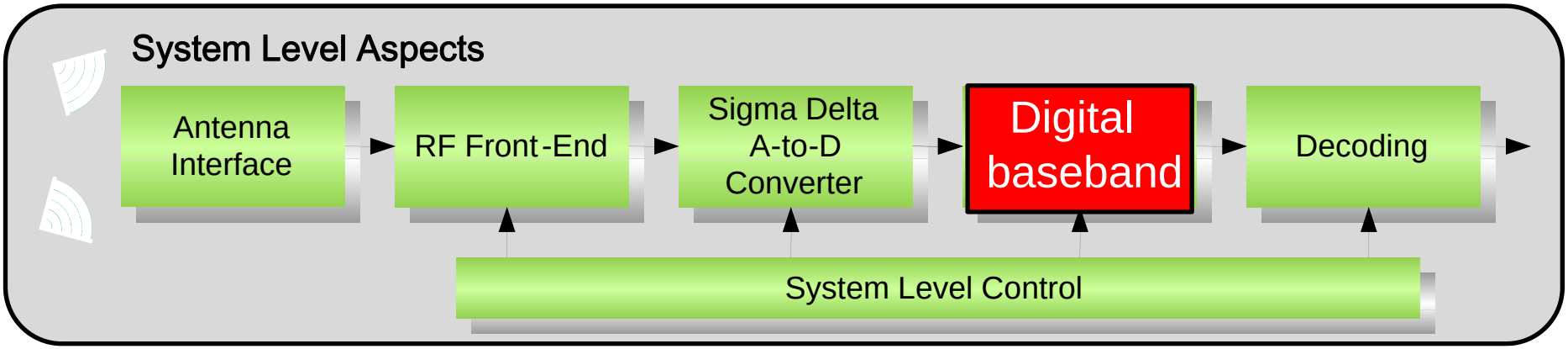


Digital Baseband in Sub-Vt:

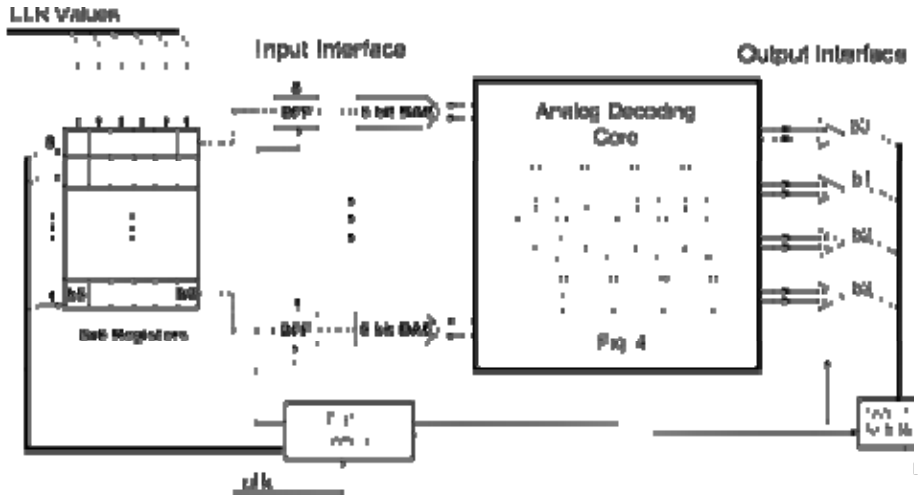
Half Band Decimation Filter Chain, modeled with various architectures.

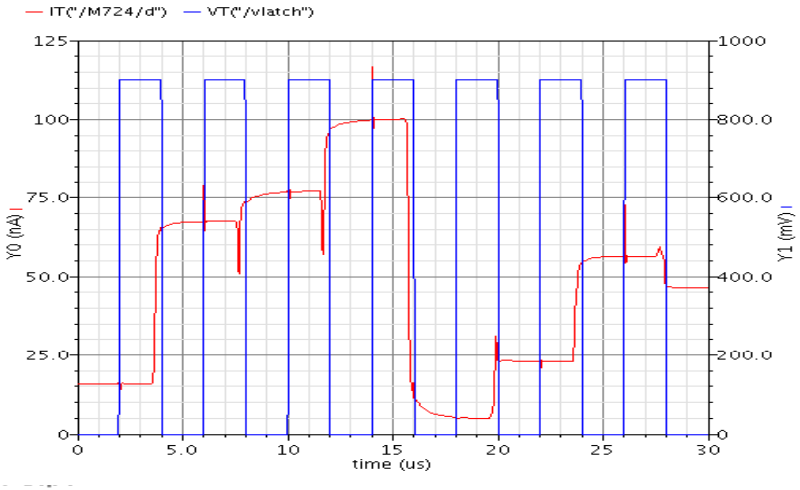


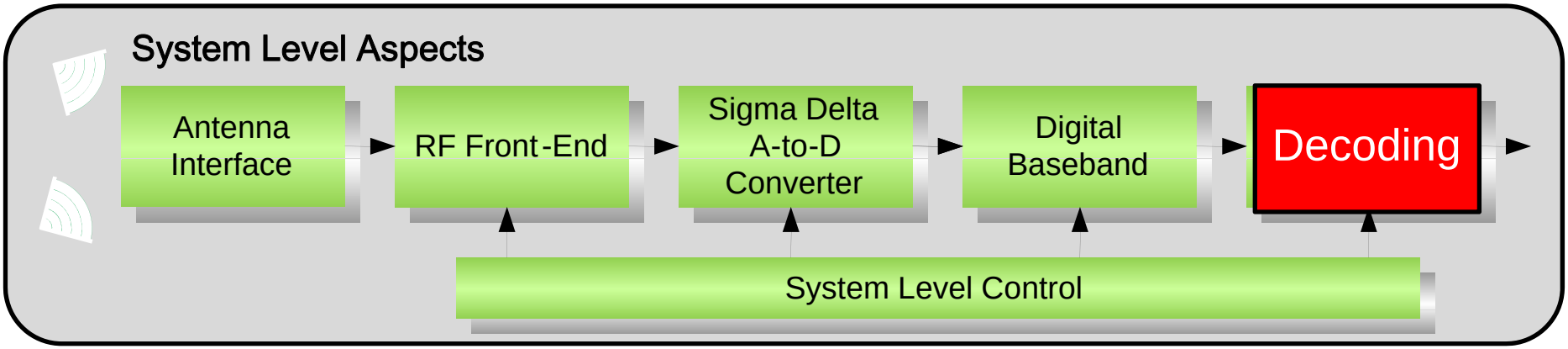
Simulated spectrum for the output signal from the delta-sigma modulator with SNDR calculated

UPD: some results

Analog decoder in a digital environment.

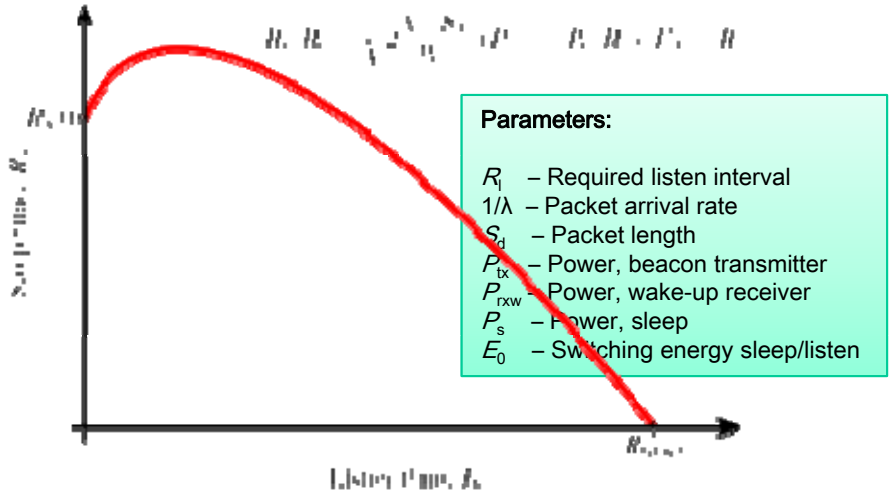


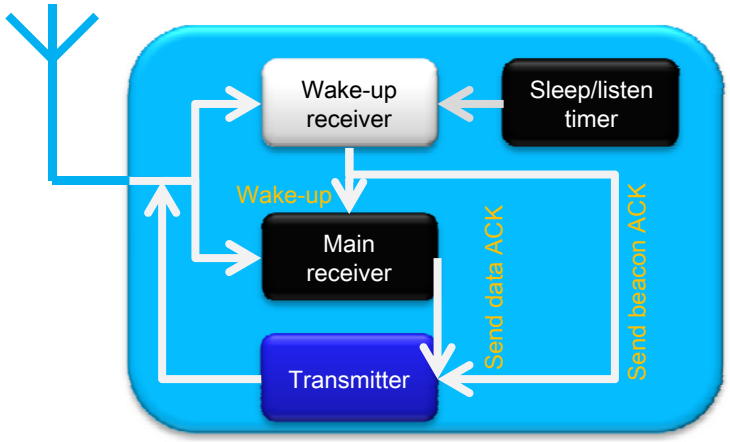


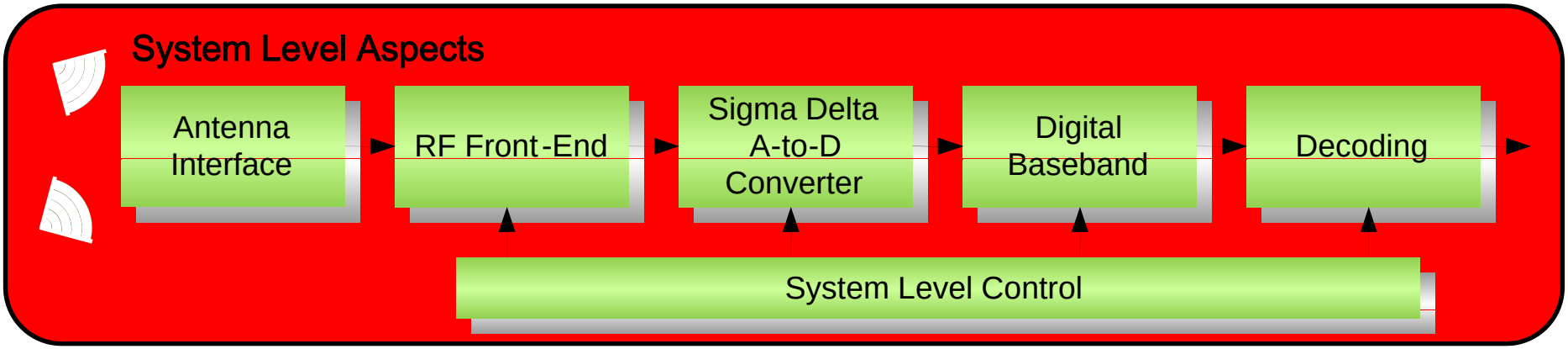


UPD: some results

Finding the minimal total energy/packet







WWW

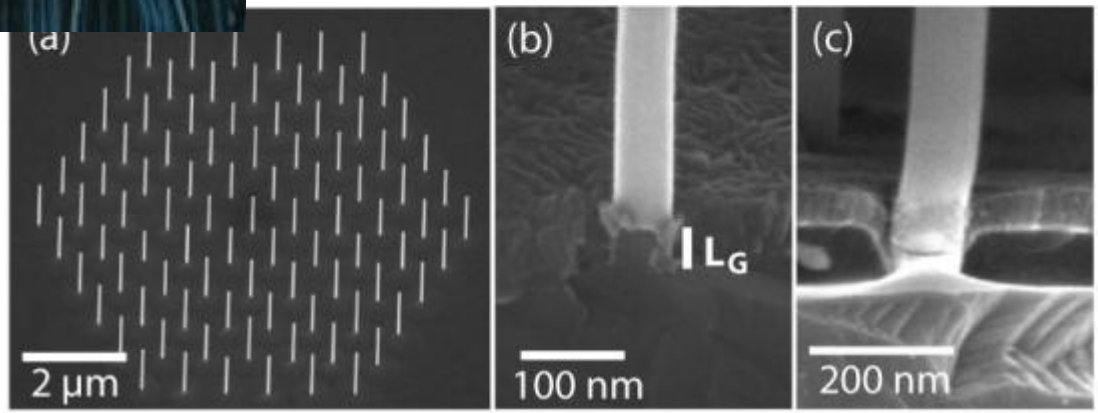
SSF strategic grant in

Wireless with Wires

WWW: Wireless with Wires

SSF Project granted in summer of 2008.
Main applicant: Lars-Erik Wernersson
Financing: 24MSEK over 5 years

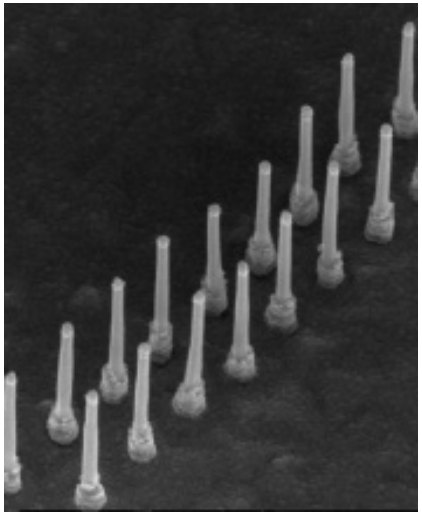
Interdisciplinary research between device physics and circuit design. Transistor and circuits at the end of the ITRS roadmap are considered using nanowire transistors.

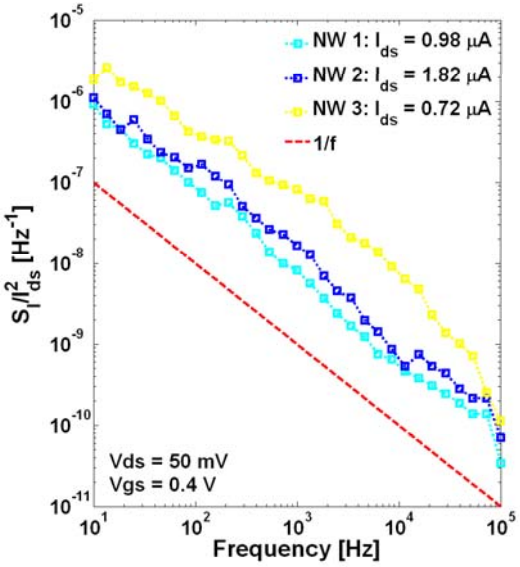


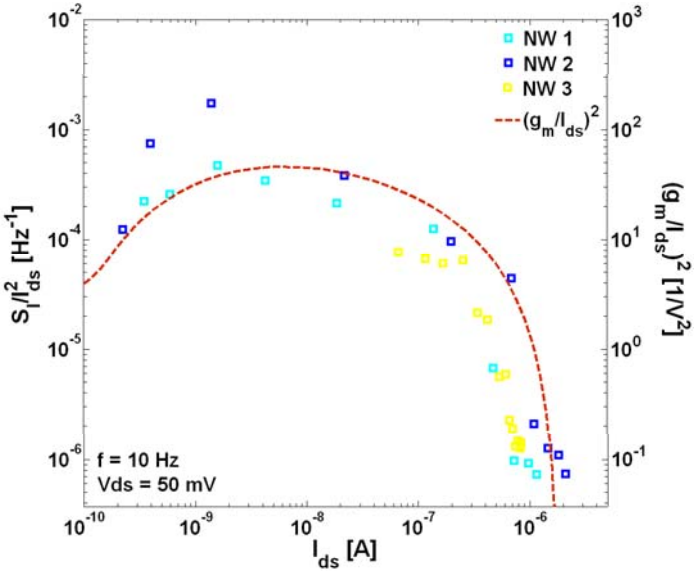
Results: WWW

DC and 1/f-noise performance of 35 nm L_g individual InAs nanowire transistors

First result of noise characteristics for III-V MOSFETs
Correlated number-mobility fluctuation



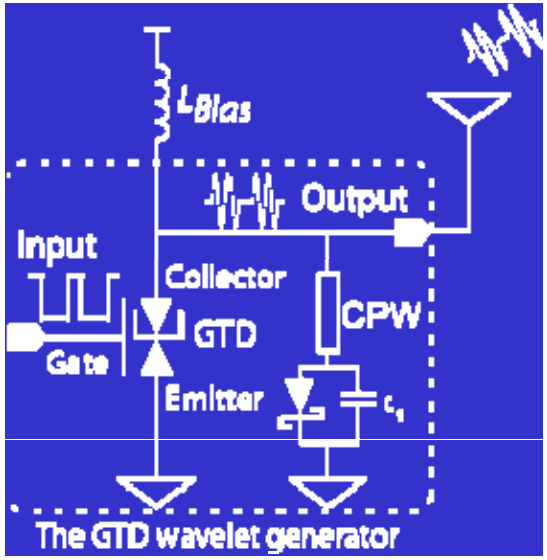


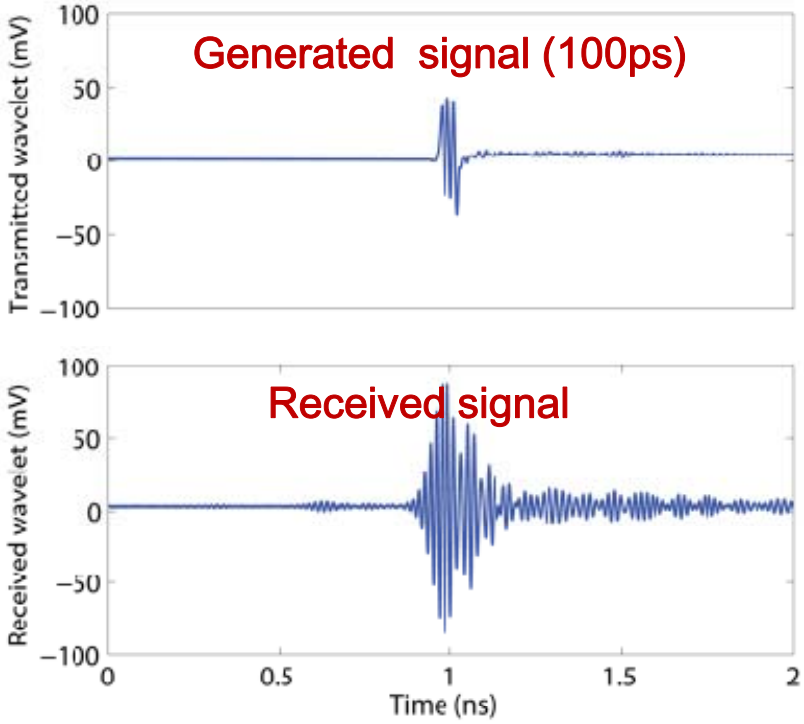


Results: WWW

60 GHz pulse generators in TX-RX configuration over air interface.

12.5 Gbps demonstration!





FP7 STREP Multi-Base

Multibase: January 2008 – April 2011

Scalable Multi-tasking Baseband for Mobile Communications

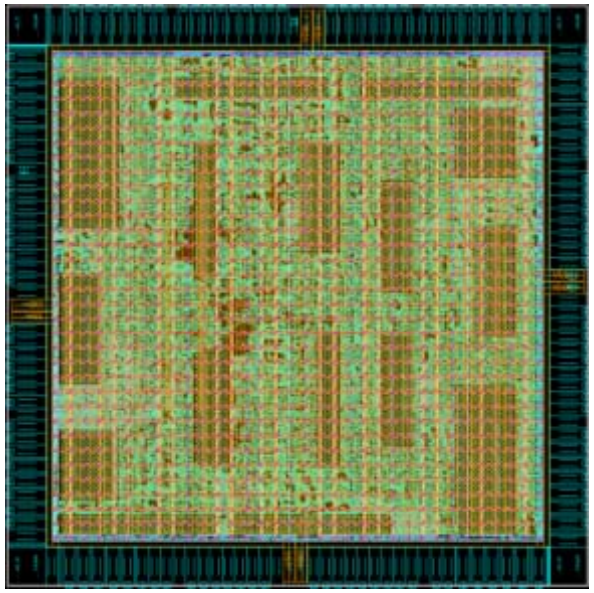
1. Multi-streaming radio (concurrent execution of multiple standards)
2. Scalable programmable/reconfigurable multi-processor technology
3. Algorithm/architecture co-design for maximum energy efficiency

LU Focus: Synch and Channel Estimation, algorithms and architectures.

FP7 STREP Multi-Base

Multibase: January 2008 – April 2011

ERICSSON



imec

Status:

- Complete DFE Rx taped out in June.
- Samples are expected soon.
- Infineon 65nm CMOS
- Chip area 5mm^2
- Core area 3.5mm^2

FP7 STREP DRAGON

Project started in January 2010 for 3 years.

Disruptive Radio Architectures Going Nanoscale

1. Innovative receiver architectures.
2. CMOS power amplifiers that double TX efficiency.
3. Reconfigurable radios with no overhead.
4. Ultimately, new concepts/methodologies pushing the A/D converter closer to the antenna - The holy grail of fully digital radio receivers.

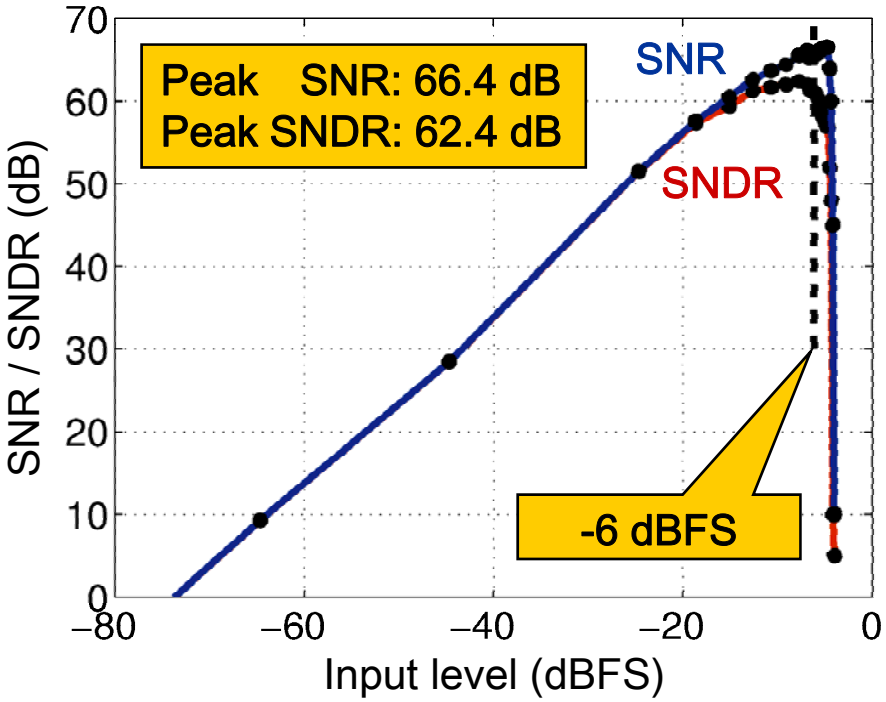
Sven Mattisson
Ericsson

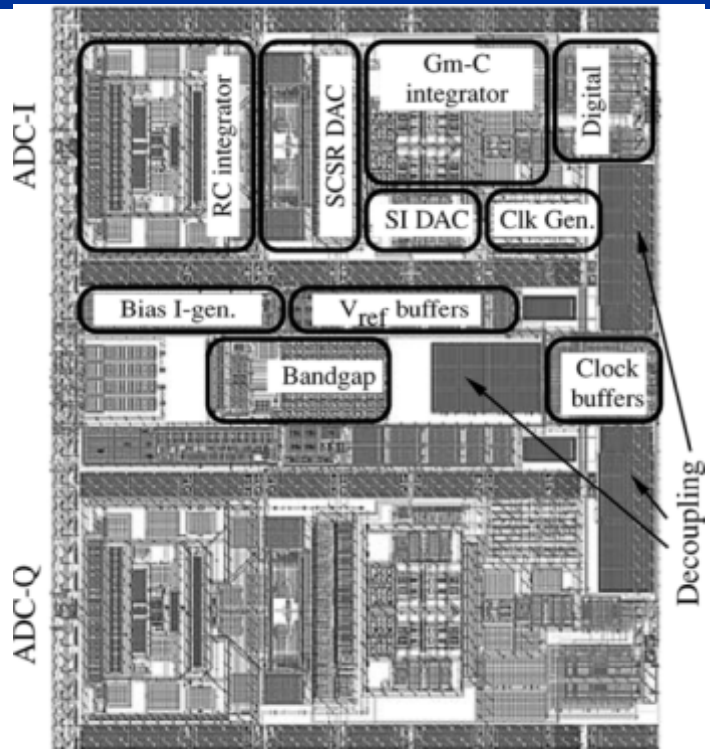
And now to some more achivements!

New Switched-Capacitor Switched-Resistor CT ΔΣ modulator with low jitter sensitivity

Currently being used by SoS industrial partners!

Measured input amplitude sweep

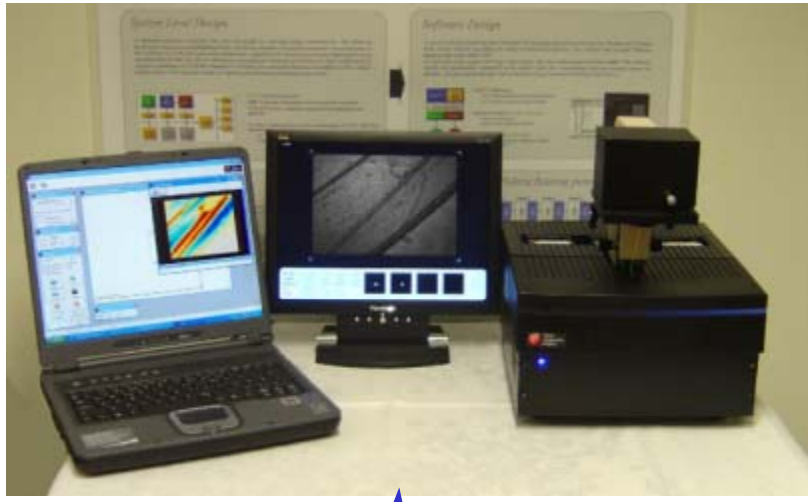




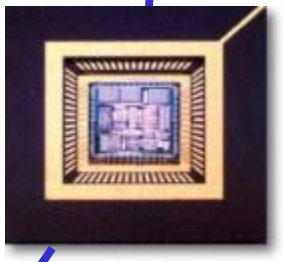
- 1.2 / 1.8V supply
- 90 nm RF-CMOS
- I & Q ΔΣ Modulators
- 0.48 x 0.62 = 0.3 mm²

M. Anderson and L. Sundström, " CT ΔΣ Modulators With Reduced Sensitivity to Clock Jitter through SCSR Feedback", IEEE Journal of Solid-State Circuits, Feb. 2009.

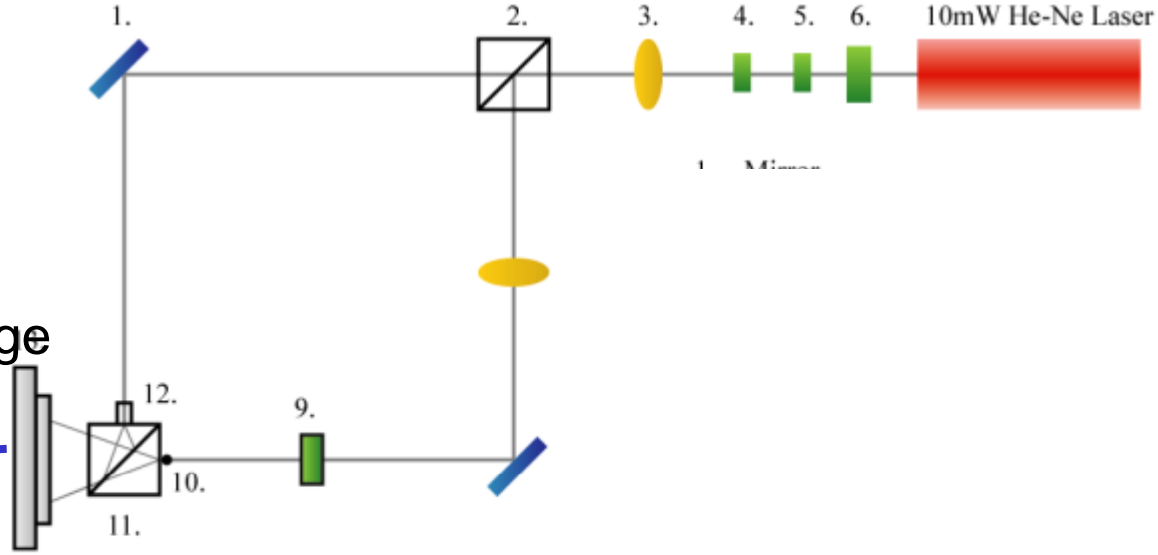
Remember the ”old” Digital Holographic Microscope



2-D FFT accelerator

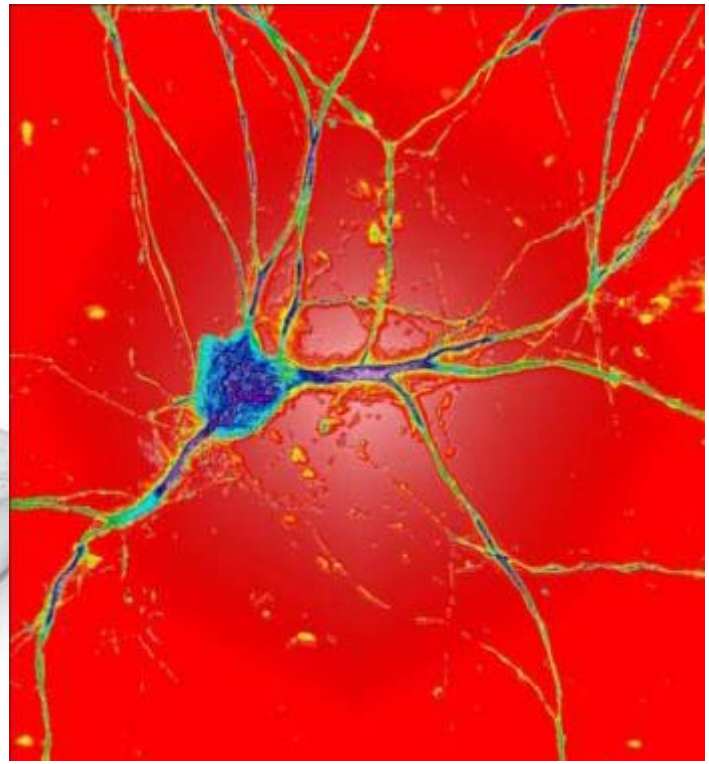


Digital image sensor

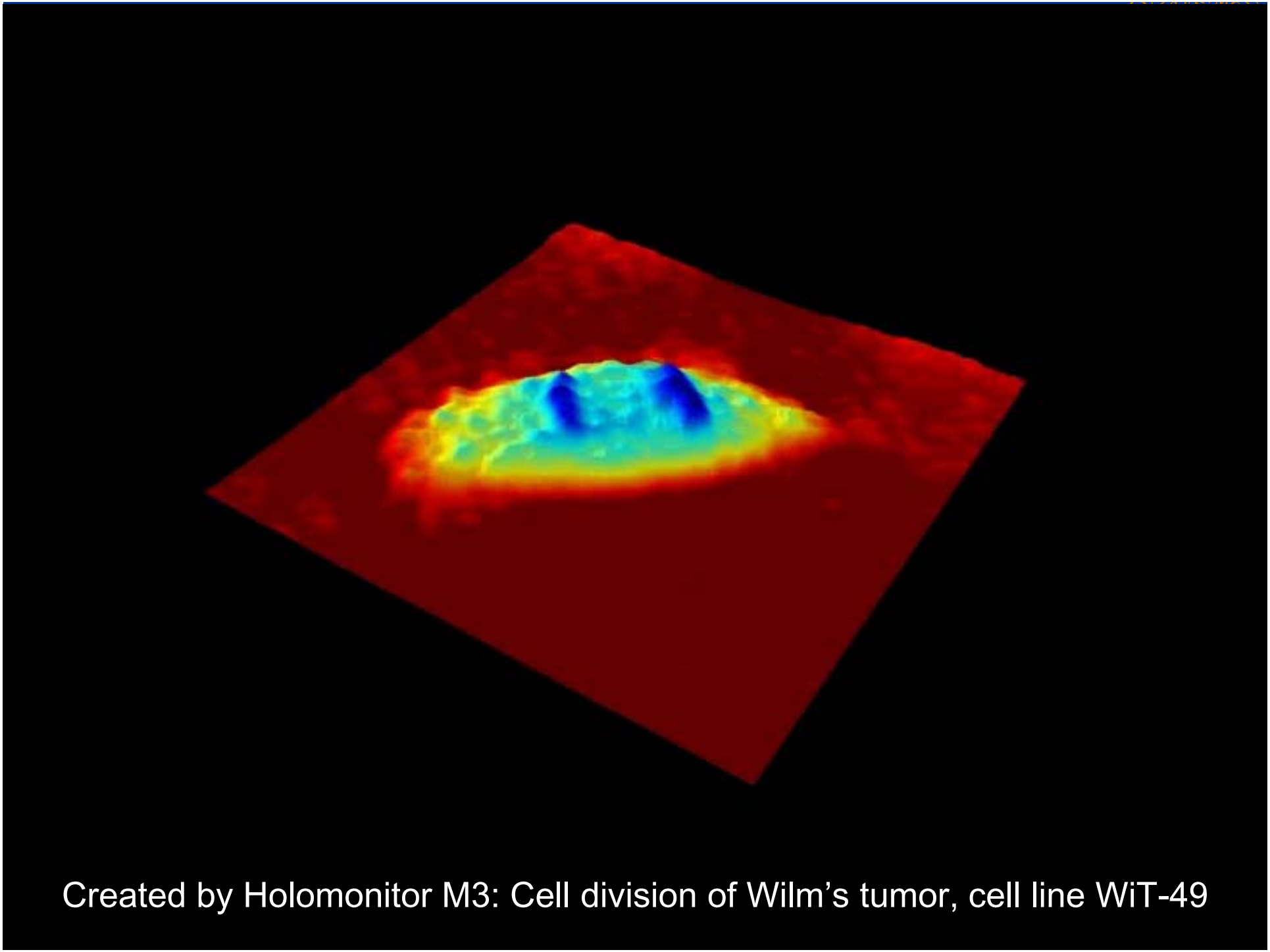


Now a product

www.phiab.org

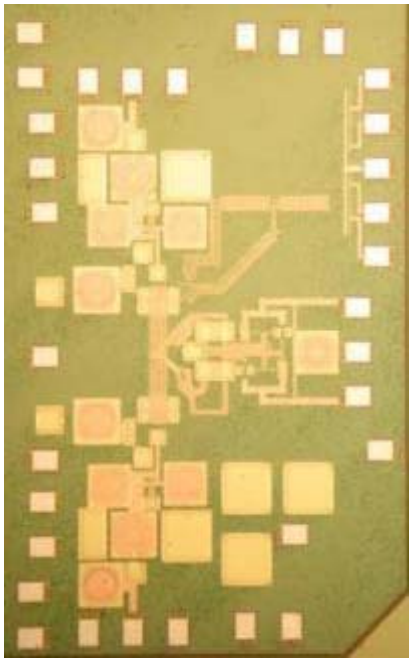


Phase image of a neuron

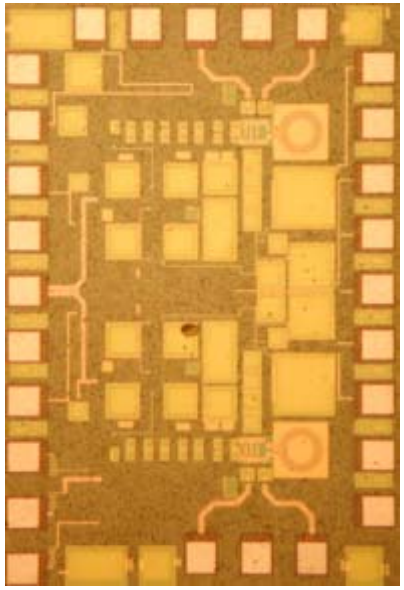


Created by Holomonitor M3: Cell division of Wilm’s tumor, cell line WiT-49

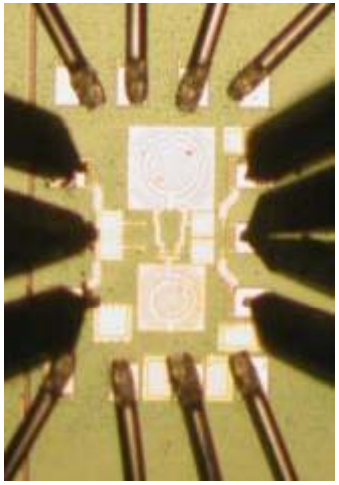
Beamforming: Receiver & Building Blocks



24 GHz receiver
2 channels
Analog baseband
phase rotation
ESSCIRC 2010



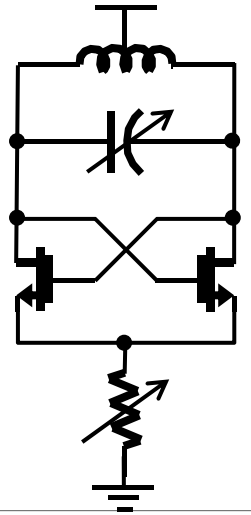
2 PLLs with
digital phase control
APMC Prize 2009

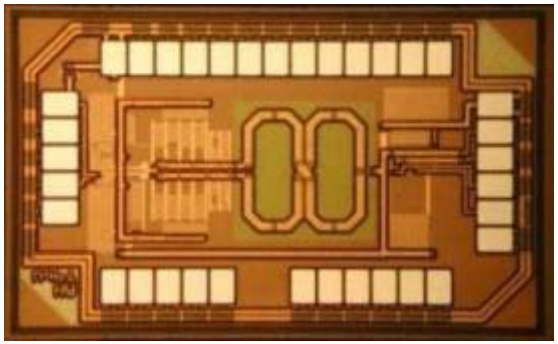


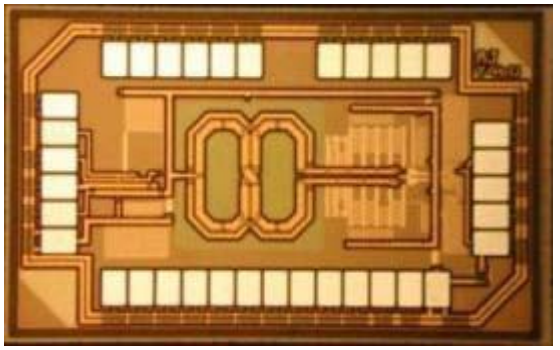
Injection locked
phase shifter
IMS 2010

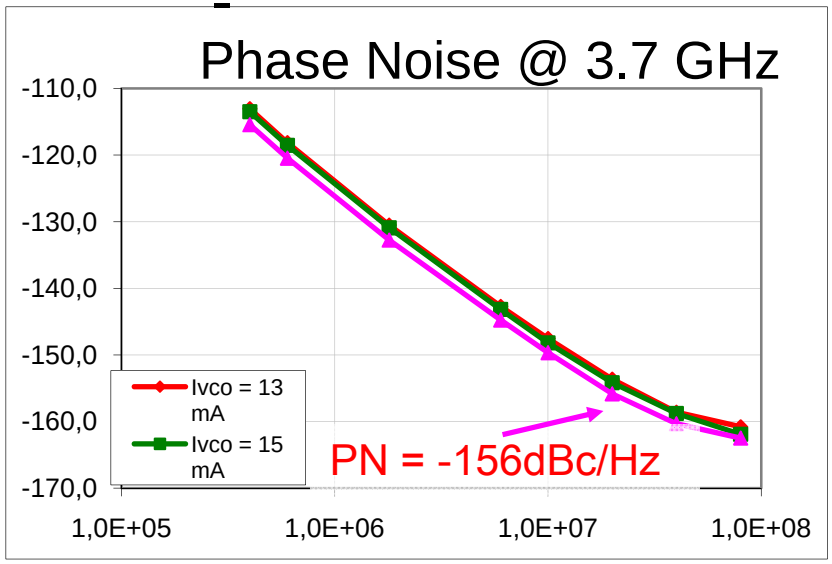
HSWC
High Speed Wireless Communication

A Tx CMOS VCO for WCDMA/EDGE







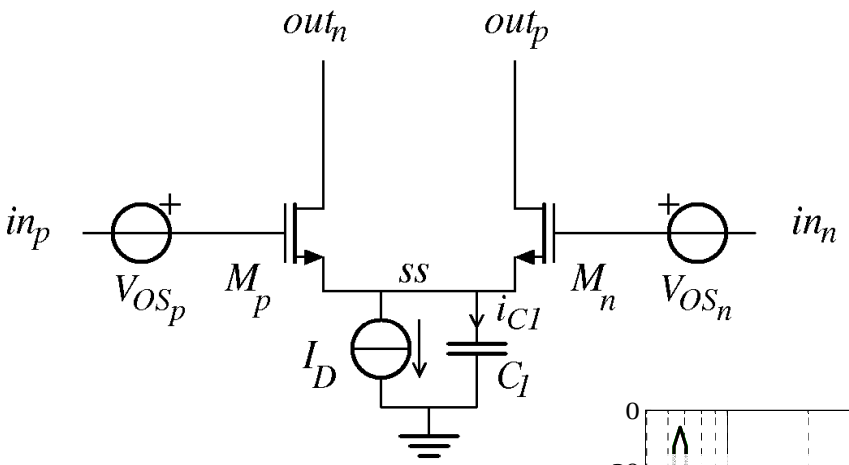


- 2.55GHz < TR < 4.08GHz
- Complies with GSM specs as well as SAW-less WCDMA TX specs

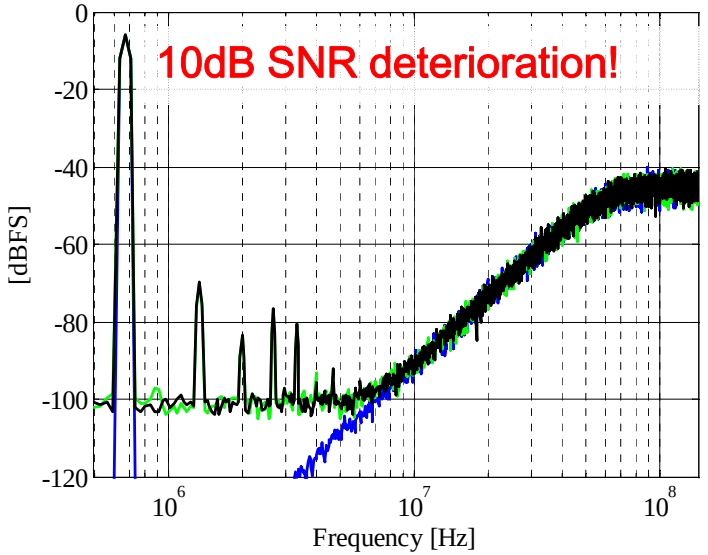
P. Andreani et al “A transmitter CMOS VCO for WCDMA/EDGE”, ESSCIRC 2010

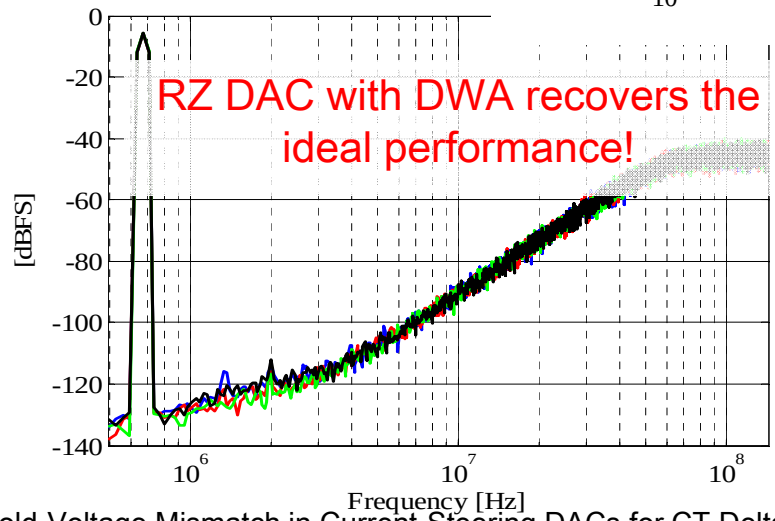
ΔΣ ADC with current-steering DAC

Mismatch between transistors causes nonlinearity!



DAC unit-current cell

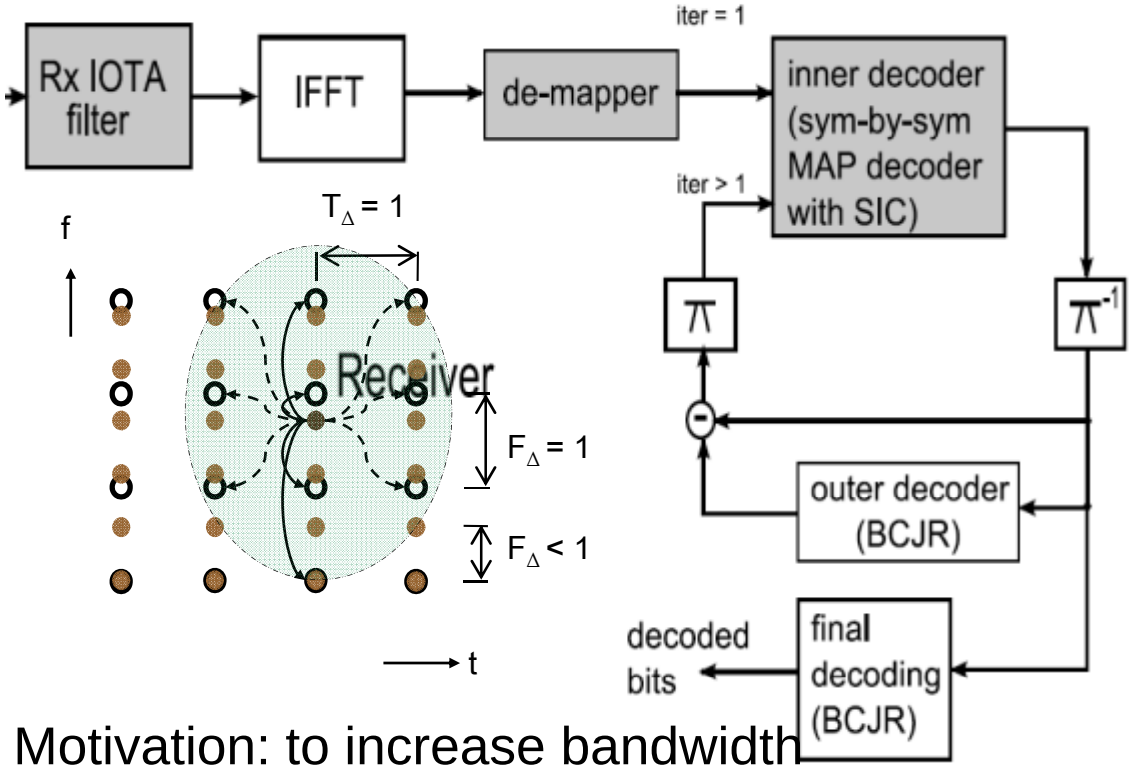


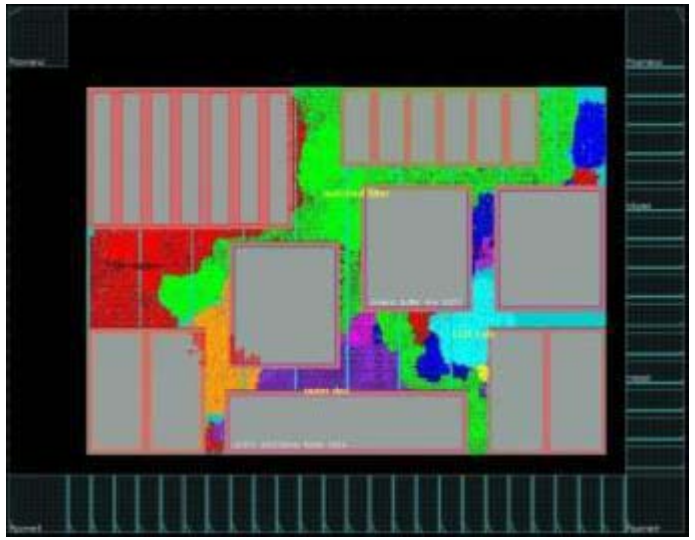


M. Andersson et al “Impact of MOS Threshold-Voltage Mismatch in Current-Steering DACs for CT Delta-Sigma Modulators”, ISCAS 2010

Faster-than-Nyquist (FTN) receiver

FTN iterative receiver





Designed for ST 65nm CMOS
Tape-out in November

Motivation: to increase bandwidth efficiency by compressing in time and/or frequency

HSWC
High Speed Wireless Communication

Thank You and Enjoy!