Fraunhofer

IIS

FRAUNHOFER INSTITUTE FOR INTEGRATED CIRCUITS IIS, DESIGN AUTOMATION DIVISION EAS
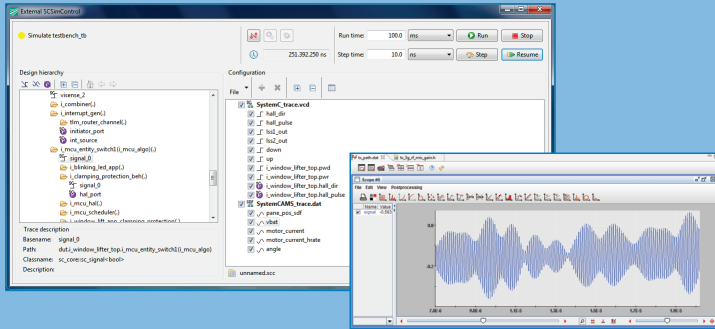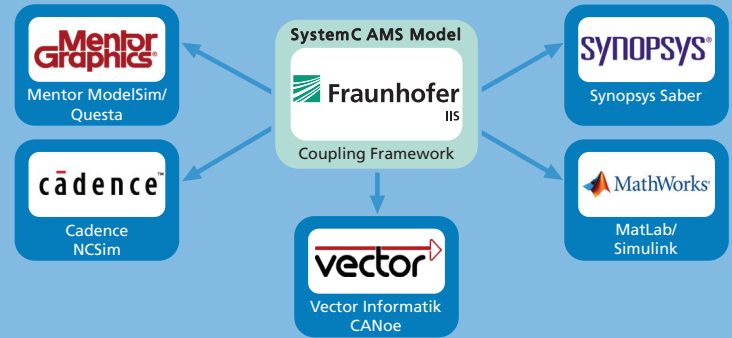**SYSTEM SPECIFICATION   MIXED-SIGNAL SYSTEMS**

Simulation Control, Debugging

- **SCSimCtrl: Advanced Drag'n'Drop Trace Selection, Hierarchy Browsing** and **Simulation Control**
- **Debugging Facilities** in Stand-alone as well as in Coupled Simulation Scenarios

Coupling Framework

SystemC AMS Model

Fraunhofer IIS — Coupling Framework

Mentor ModelSim/ Questa — Cadence NCSim — Vector Informatik CANoe — Synopsys Saber — MatLab/ Simulink

- **Coupling SystemC AMS Simulations** with Tools from Various EDA Vendors
- **IP Protected** Model Exchange
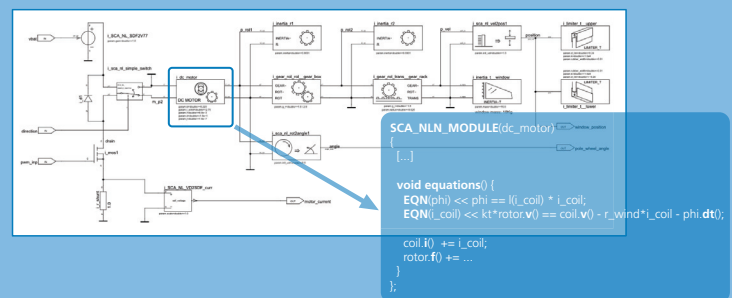- Delivering **Customer Models**

SystemC AMS IDE

SystemC-AMS IDE 3.6.2
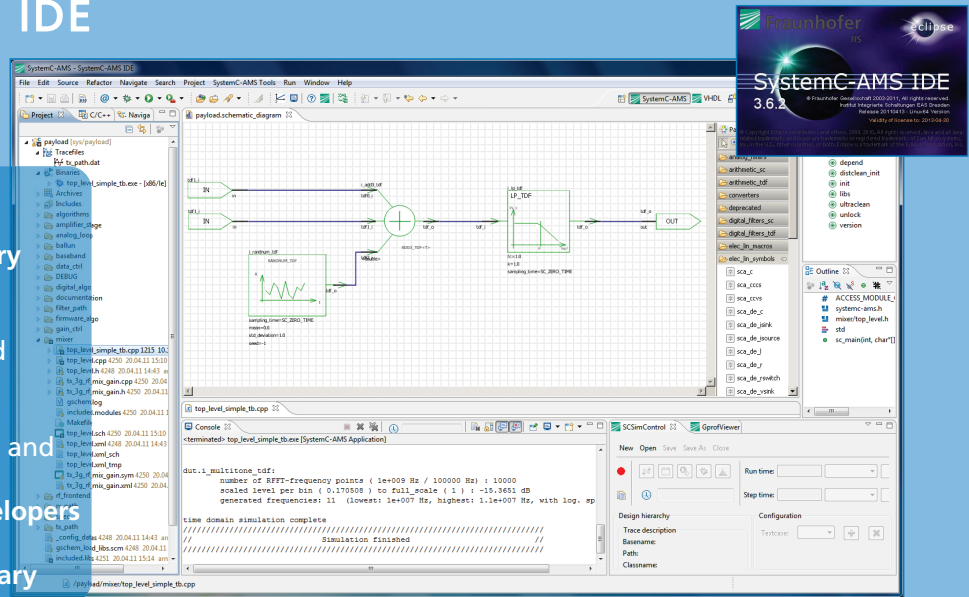
- Powerful Modelling Capabilities
- **Schematic Design Entry**
- **OSCI** Compliant
- Full **TLM 2.0** Support
- SystemC / VHDL Mixed Language Modelling
- Basic Model Libraries
- **Profiling** Performance and Memory Leakages
- **Designed by the Developers of the SystemC AMS Proof-of-Concept Library**

State Chart Editor
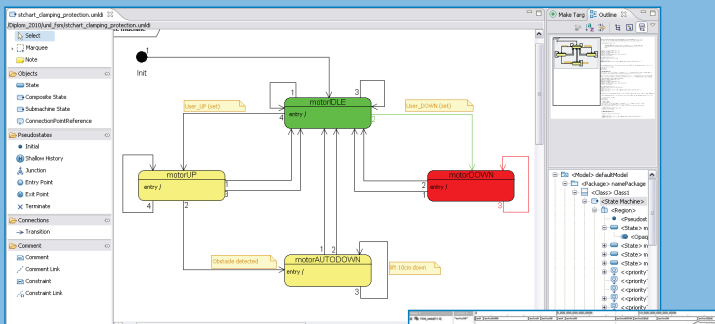
- **UML State Chart Syntax**
- C/ SystemC **Code Generation**
- **Combined** Graphical **State** and **Analogue Tracing**

Extension for Nonlinear Circuits


```
SCA_NLN_MODULE(dc_motor)
{
    [...]

    void equations() {
        EQN(phi) << phi == l(i_coil) * i_coil;
        EQN(i_coil) << kt*rotor.v() == coil.v() - r_wind*i_coil - phi.dt();

        coil.i()  += i_coil;
        rotor.f() += ...
    }
};
```

- **Support for Multiple Physical Domains** such as **electrical, kinematic, thermal**
- Several Quantities Predefined, e.g. **electrical::charge, kinematic::force**
- New Callback Methods, e.g. **sca_module::equations()**

Contact: Thomas Arndt, Karsten Einwich, Thomas Uhle

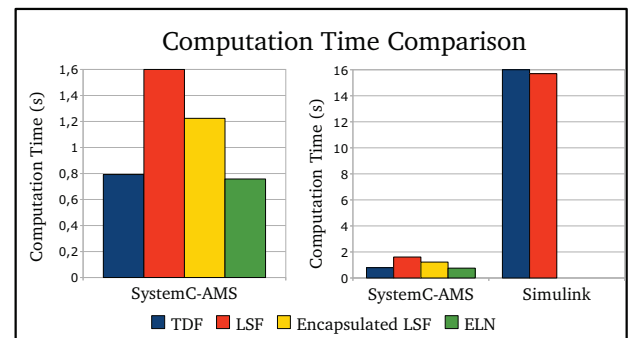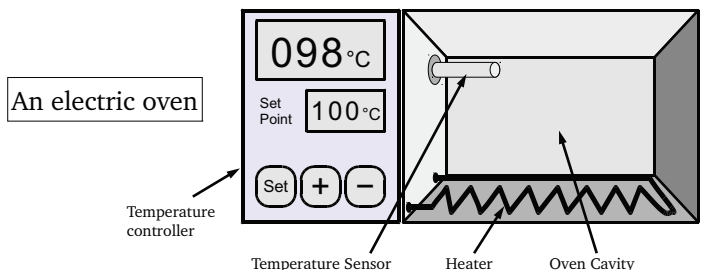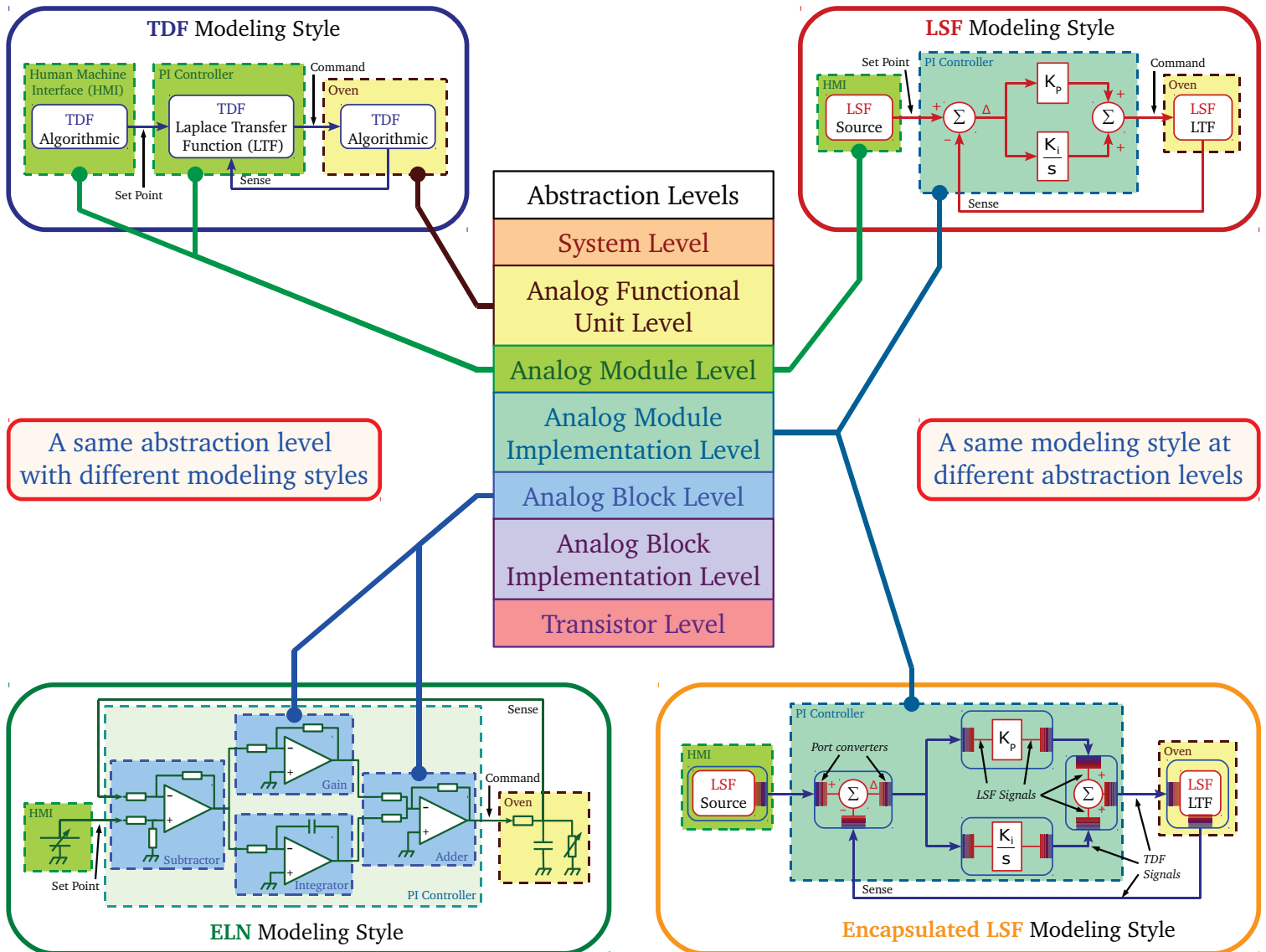**E-Mail:** Karsten.Einwich@eas.iis.fraunhofer.de

Analog Design Abstraction Levels and SystemC-AMS Models of Computation

Franck PAUGNAT, Laurent BOUSQUET, Katell MORIN-ALLORY, Laurent FESQUET
TIMA Laboratory, Grenoble, France
{franck.paugnat, laurent.bousquet, katell.morin-allory, Laurent.Fesquet}@imag.fr

Beyond DREAMS ++

How to help the analog designer to:

- navigate through the abstraction levels and the modeling styles
- choose the most suited modeling style to an abstraction level for best accuracy and computational speed

SystemC-AMS Models of Computation (MoC)		
TDF Timed Data Flow	**LSF** Linear Signal Flow	**ELN** Electrical Linear Network

TDF Modeling Style

Human Machine Interface (HMI) — TDF Algorithmic
Set Point

PI Controller — TDF Laplace Transfer Function (LTF)
Sense

Command

Oven — TDF Algorithmic

LSF Modeling Style

HMI — LSF Source
Set Point

PI Controller
$+$ Σ Δ $-$ K_P Σ $+$ $+$ $\dfrac{K_i}{s}$

Sense

Command

Oven — LSF LTF

Abstraction Levels

- System Level
- Analog Functional Unit Level
- Analog Module Level
- Analog Module Implementation Level
- Analog Block Level
- Analog Block Implementation Level
- Transistor Level

A same abstraction level with different modeling styles

A same modeling style at different abstraction levels

ELN Modeling Style

HMI
Set Point

Subtractor — Gain — Integrator — Adder — PI Controller

Sense
Command
Oven

Encapsulated LSF Modeling Style

HMI — LSF Source

PI Controller
Port converters
$+$ Σ Δ — K_P — LSF Signals — Σ — $\dfrac{K_i}{s}$

Sense
TDF Signals

Oven — LSF LTF

An electric oven

098 °C
Set Point 100 °C
Set + −

Temperature controller

Temperature Sensor — Heater — Oven Cavity

Computation Time Comparison

Computation Time (s): 1,6 / 1,4 / 1,2 / 1 / 0,8 / 0,6 / 0,4 / 0,2 / 0
SystemC-AMS

Computation Time (s): 16 / 14 / 12 / 10 / 8 / 6 / 4 / 2 / 0
SystemC-AMS   Simulink

■ TDF   ■ LSF   ■ Encapsulated LSF   ■ ELN

Franck Paugnat, Laurent Bousquet, Katell Morin-Allory, Laurent Fesquet. "A Performance Comparison Between the SystemC-AMS Models of Computation". EdaWorkshop11, May 2011. Dresden – Germany.

SYCYPHOS - A Framework
for Designing Cyber Physical Systems

Florian Schupfer, Josef Wenninger, Christoph Grimm
Vienna University of Technology, Institute of Computer Technology

Combining distributed computer ('cyber') and physical systems leads to new challenges that are not yet solved, neither by tools nor by methodologies. The methodology handles design issues and provides a (work in progress) tool for the design of cyber physical systems. The tool supports modeling of distributed and heterogeneous systems -- in particular at functional level -- while offering means for power estimation and for analyzing the impact of non-ideal behavior of micro- or nanoelectronic implementations.

PROBLEM

- No joint simulation of network and Hardware/Software design
- Late verification of properties like current consumption, accuracy or reliability

SYCYPHOS

- Common modeling of network and HW/SW components
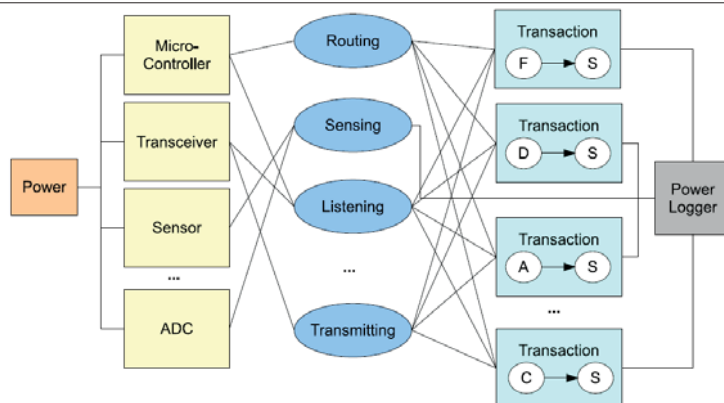- Profiling of accuracy/robustness and power consumption at CPS level

SYCYPHOS - Features

Profiling of:

- Power properties
- Accuracy metrics
- Reliability estimation

Design Methodology

CPS Level:
- Functional Model
- Refine Accuracy, Robustness
- Refine Reliability
- Refine Power Management

Profiling through simulation:
- Estimate & Analyse Accuracy, Robustness
- Estimate & Analyse Current consumption

Embedded System Level:
- Refined Functional Model
- HW/SW Co-Design
- Architectural Model (HW+SW)

Example of a
Cyber Physical System

State of road, Forces Tire-Road, Temperature, Tire pressure — Energy harvester, Sensors, Actuators, ADC, DAC — Coprocessor (e.g. Crypto), Microprocessor, Operating System, Application Software — RF Transceiver, Wake up Receiver, Protocol stack, Wireless In-Car Network

Power Profiling

C3, C2, C1
Bus-connection
RF-connection
CU .. control unit

Micro-Controller, Transceiver, Sensor, ADC
Power
Routing, Sensing, Listening, Transmitting
Transaction F → S
Transaction D → S
Transaction A → S
Transaction C → S
Power Logger

EMBEDDED SYSTEMS · ICT · TU WIEN

TECHNISCHE UNIVERSITÄT WIEN
VIENNA UNIVERSITY OF TECHNOLOGY

SystemC AMS Modeling of a PCR-CE Lab-on-chip For Multithreaded DNA Analysis

Amr Habib, François Pêcheux and Marie-Minerve Louërat

University Pierre et Marie Curie, Computer Science Laboratory LIP6, Paris, France

## Architecture exploration of **heterogeneous Applications**

Model of a bio-compatible heterogeneous system

Lab-on-chip that encompasses several disciplines such as analog, digital, chemical kinetic reactions, optics and embedded software.

Virtual prototype taking as input an initial DNA concentration as well as the expression of the gene as a DNA string

Able to compare the input string to a huge database of reference samples, and this detects mutation and pathologies.

The simulated model can be used as a simulatable specification at a very high level of abstraction and can be seen as the first refinement step towards the design of a complex heterogeneous and bio-compatible system.
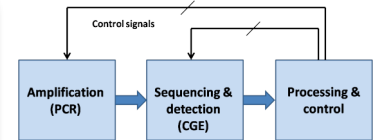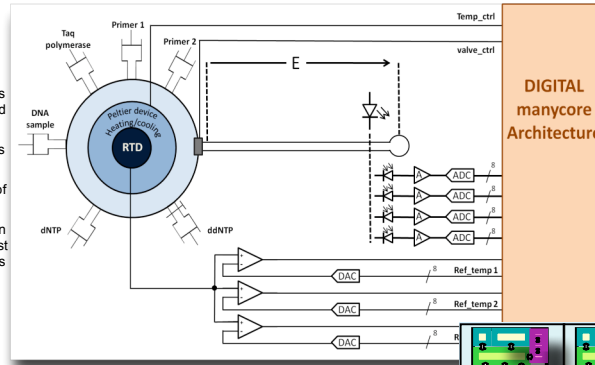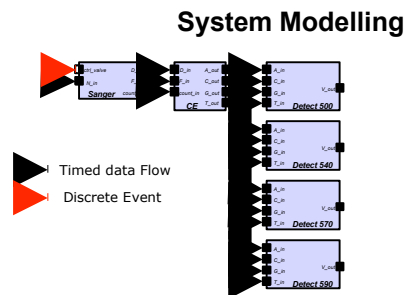
Model composed of three parts :

- DNA amplification by **Polymerase Chain Reaction** (PCR)

- Molecular separation by **Capillary Electrophoresis** (CE) and optical detection of fluorescently labeled molecules

- Automated DNA sequencing on a digital **manycore architecture** running a highly multi-threaded **Smith-Waterman** sequencing algorithm.

System Analysis

- Control temperature
- Control cycle duration
- Signal processing
- Information processing
    - Align DNA sequences
    - Compare acquired sequence with detected sequences
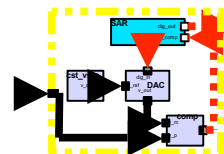   - Search within a database
    - etc …

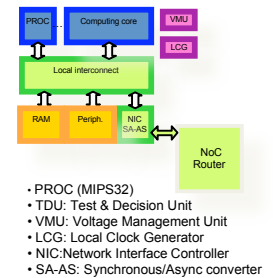## System Modelling

$$(-r_A) = \left(-\frac{da}{dt}\right) = K_d \, a^\alpha$$

Timed data Flow

Discrete Event
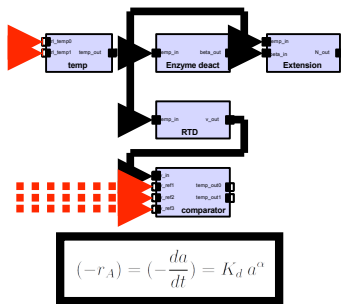
Polymerase Chain Reaction (PCR)

Capillary Electrophoresis (CE)

Optical Detection

- PROC (MIPS32)
- TDU: Test & Decision Unit
- VMU: Voltage Management Unit
- LCG: Local Clock Generator
- NIC:Network Interface Controller
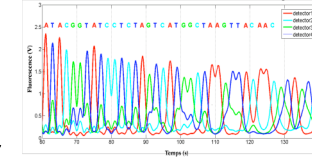- SA-AS: Synchronous/Async converter
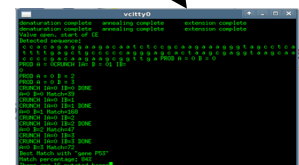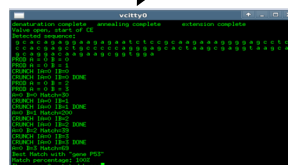
MP SOC Generic Tile
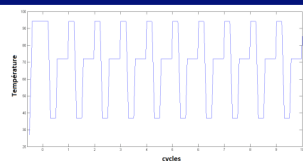
Thermo-Cycling
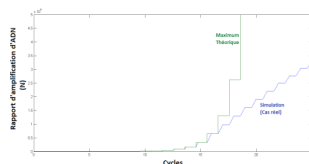
Amplification Ratio of DNA

4 minutes to simulate PCR-CE and 100 samples comparison

Capillary Electrophoresis

Simulation results SystemC AMS (Timed Data Flow) and SystemC

Join the SYSTEMC AMS

Academic Connection Program

Exchanging knowledge for the introduction of the SystemC AMS standard into educational and teaching programs.

Building a network
- Universities
- Research organizations
- Industry

Interested to join this program?

Contact:

Martin Barnasconi, NXP Semiconductors
martin.barnasconi@nxp.com

or

Christoph Grimm, Vienna University of Technology
grimm@ict.tuwien.ac.at

or one of the universities having SystemC AMS already in their curriculum:

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Vienna University of Technology (TU Vienna, TU Wien)
Faculty of Electrical Engineering and Information Technology
Institute of Computer Technology (ICT)
Gußhausstraße 27-29/384, 1040 Wien, Austria
http://www.ict.tuwien.ac.at
Contact person: Christoph Grimm
grimm@ict.tuwien.ac.at

TUDelft Delft University of Technology

Delft University of Technology (TU Delft)
Faculty Electrical Engineering, Mathematics and Computer Science (EWI)
Mekelweg 4, 2628 CD Delft, The Netherlands
http://ens.ewi.tudelft.nl/
Contact person: Rene van Leuken
T.G.R.M.vanLeuken@tudelft.nl

LIP6

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