CEBE IAB Meeting 19.05.2015

Cyberphysical System Design

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Outline

- Research Goals
- Dependable Embedded Many-Core Architectures
- Design Platform for Biomedical Applications
- „Blackbox“-Project: Scalable Bioimpedance Measurement
Nested Health$^2$ Management Concept

Bioengineering

Test, Verification
Design, Diagnosis, Repair
Medical equipments, ICT
System Health

Engineering knowledge
Medical knowledge

DOCTOR
PATIENT

Patient’s Health
CEBE Design Cooperation Goals:

**Goals: Contributions of Embedded System Design Research:**

- Provision of methods, components and services for system health monitoring and fault tolerance (intellectual property)
- Fast Concept Evaluation and Feasibility analysis for new project ideas
- Provision of research environment and infrastructure for system prototyping
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**Competence fields:**
Design and test of embedded systems
1 – Verification and diagnosis
2 – Testing and reliability
3 – Dependable system design
Electronics and signal processing
4 – Signals and signal processing
5 – Semiconductor technology
Biomedical engineering
6 – Brain studies
7 – Diagnostics of cardiovascular diseases
8 – Biofluid optics

**Coperation projects:**
P1 – Application specific processors
P2 – Verification, test and fault diagnosis
P3 – Cardiovascular diagnostics
P4 – Evaluation of mental disorders using EAG analyzer
P5 – Reliable monitoring of dialysis
P6 – Embedded instrumentation platform for board testing
P7 – Semiconductor devices
P8 – Embedded system design platform

**CEBE Competences and Projects Flow**

**Application examples:**
P1 – QUADRA®, Pacemakers
P3 – Smart optical cardiovascular sensor
P4 – EEG analyzer
P5 – Diasens, Optofluid Dialysis Sensor
P6 – BERT tester (CERN), Embedded test instruments
Dependable NoC Architecture

Research results:

- Adaptive 3D Routing
- Fault-tolerance concept for any amount of defect routing segments in the NoC


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Ambient Assisting Technologies

Internet Gateway

Local Data Concentrator

eHealth Middleware
Design Method: IP-based + Virtual Prototyping

- Engineering knowledge
- Medical knowledge

System Model

IP / Templates

Components, Architectures, Networks, Services

Virtual Prototyping

Distributed ES
Generic Platform Architecture

Medical Services

Smart In-house infrastructure

Smart Personal Environment.

Data Services

- Uplink Communication
- Local Communication
- Local User Interface
- Data Processing
- Memory
- Power Supply

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Generic Platform Architecture

Medical Services

Data Services

Structure Instantiation for Bioimpedance Application

Smart In-house infrastructure

Smart Personal Environment.
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The „Blackbox“ Project:
Scalable Bioimpedance Measurement

Seebeck Institute

- Bioimpedance know-how
- DSP/signal proc. know-how
- First bioimpedance measurement implementations

Paul Annus
Yannick Le Moullec & team
Marko Reidla
Alar Kuusik (Eliko)
Raul Land

ATI:

- Platform concept
- Test and Dependability concepts and models
- Networking know-how

Thomas Hollstein
Uljana Reinsalu
Priit Ruberg
Karl Janson

Scalable and Networked Bioimpedance Measurement System „Blackbox Project“
(final CEBE demonstrator and flexible front-end for e-health applications)
The „Blackbox“ Architecture

Signal Processing „Black Box“
(DSP, FPGA, ASIC, ...)

Power Supply Module (opt.: with energy harvesting)

Scalable Usage Scenario

Signal Processing "Black Box" (DSP, FPGA, ASIC, ...)
Concluding Remarks

Results:

✓ Methods for Design and Deployment of Fault-tolerant Many-Core Architectures
✓ Design Platform/Templates and IP-based concept
✓ „Blackbox“-Project: Joint Seebeck/ATI platform: scalable Bioimpedance Measurement >> final demonstrator in integration phase

Future Research based on Design Platform Concept:
✓ Future Research: Methods and Tools for Fast Virtual Prototyping

Thank you!