EDA group

Department of Control and Computer Engineering
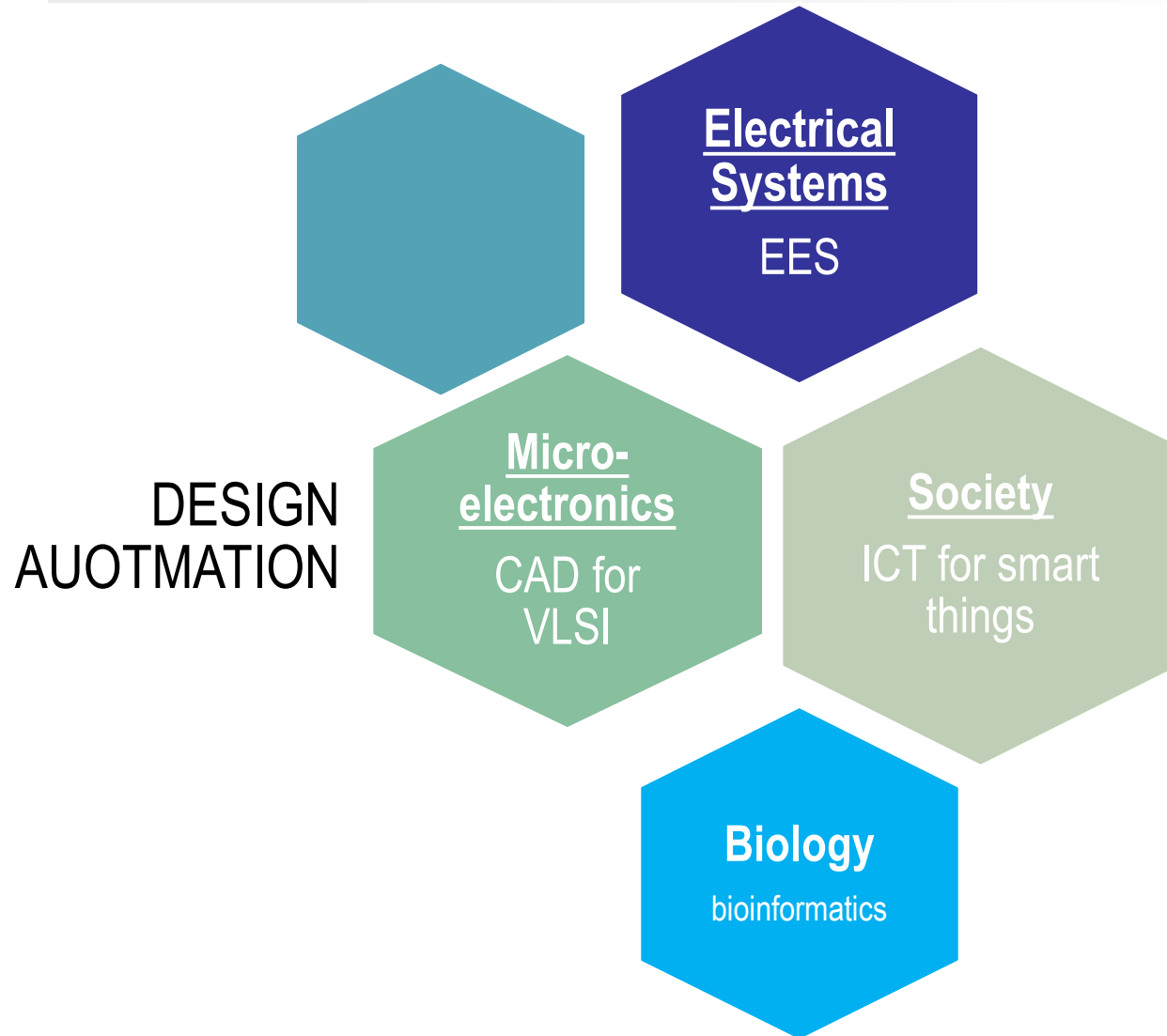
the EDA group
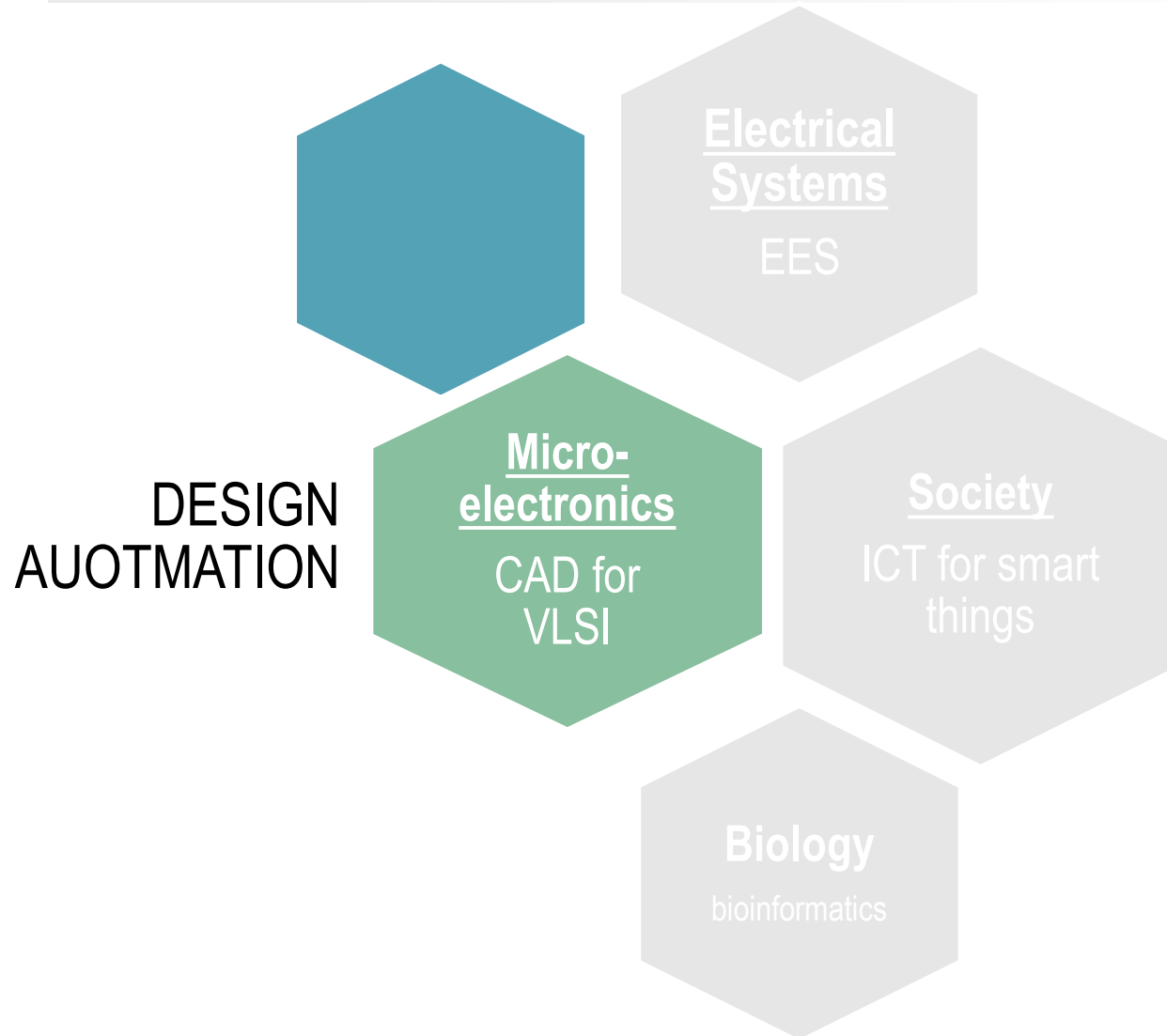
EDA = Electronic **D**esign **A**utomation

- 9 Faculty members
- 4 post-docs
- > 10 Ph.D. students

Research areas

Electrical Systems
EES

DESIGN
AUOTMATION

Micro-electronics
CAD for VLSI

Society
ICT for smart things

Biology
bioinformatics

Research area

DESIGN
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CAD for VLSI

- ## EDA for energy-efficient systems
  - ### Leakage management in DSM designs
    - Power-gating of standard-cell designs and memories
  - ### Energy-efficient chip multicore
    - Energy-efficient memory sub-system design
    - Technology implications of voltage/frequency scaling

- ## EDA for "indirect metrics"
  - ### Thermal-aware design & architectures
    - Adaptive compensation of thermal gradients
    - Leakage/Thermal-aware co-synthesis
    - Thermal-aware design of clock trees
  - ### Variation-tolerant design techniques
    - Latency/skew control
    - Use of power management knobs (power gating) to compensate variations
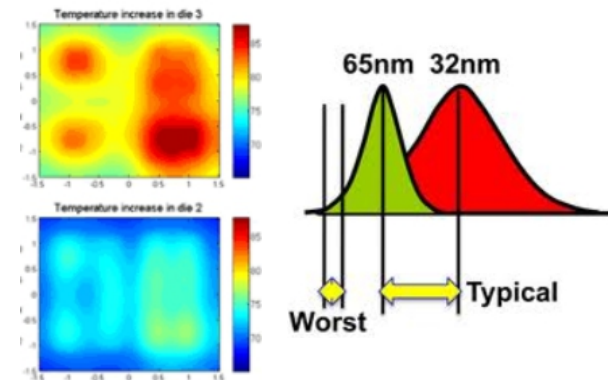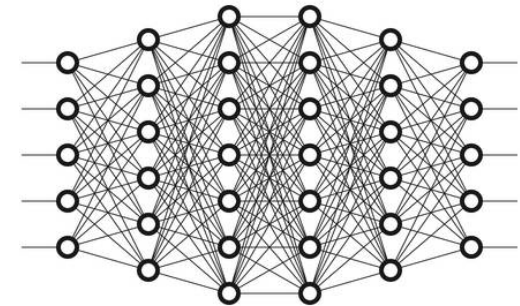
CAD for VLSI (II)

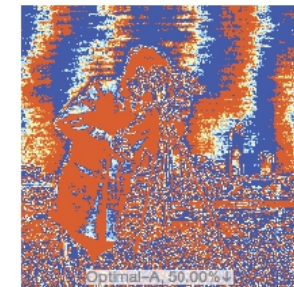- **Approximations for edge-devices**
  - **Computation**
    - **Brain-inspired arithmetic**
    - **Complexity-driven scaling techniques**
    - **Architectural and circuit-level techniques for adaptive accuracy/energy scaling**

  - **Data**
    - **HW-aware data manipulation**
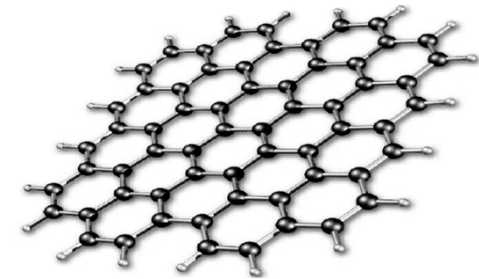   **e.g. image manipulations for OLEDs**

CAD for VLSI (III)
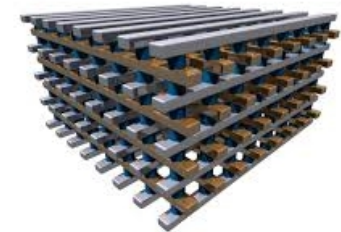
- ## CAD for beyond-CMOS technologies
  - **Graphene devices**
    - Adiabatic computing with ambipolar resistive devices
    - Delay and power modeling of devices based on p-n junctions based on polarized graphene
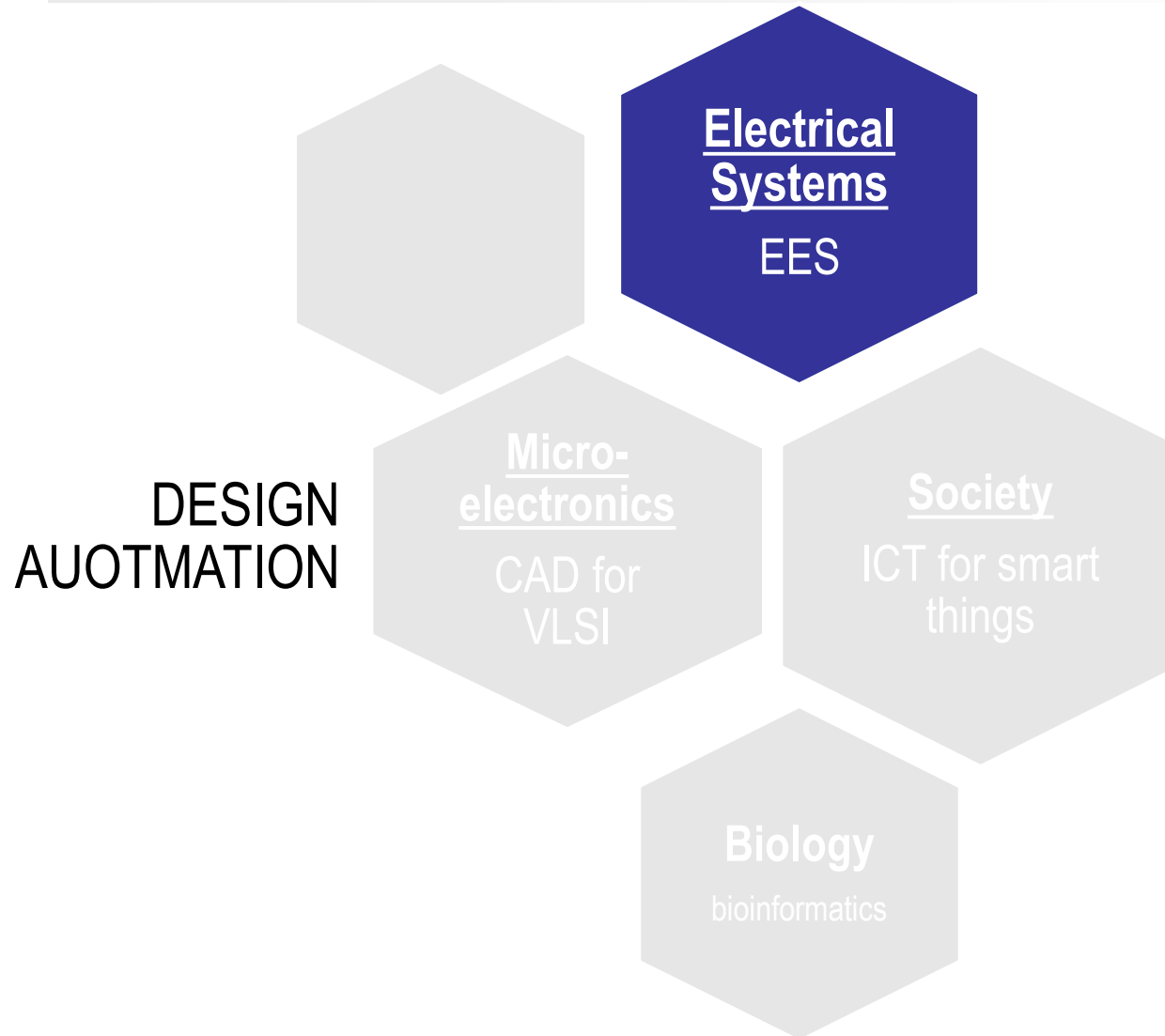   - Automated synthesis techniques for re-configurable gates based on these devices

  - **Computing-in Memory**
    - Algorithms for data-analytics in-memory
    - Logic Synthesis & Mapping for logic-in-Memory

Research area

DESIGN AUOTMATION

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CAD for electrical energy systems

- ## CAD for electrical energy systems (EES)
 - **Battery modeling**
    - Battery metamodeling from datasheet
    - Battery modeling of inter-cycle effects (capacity fade, aging, etc.)
    - Macromodels for battery charge
  - **Hybrid EESs**
    - Optimal charge allocation/distribution/ /recycling policies
    - Interaction of charge distribution and power management
    - Thermal management of energy storage devices
  - **Smart battery chargers**
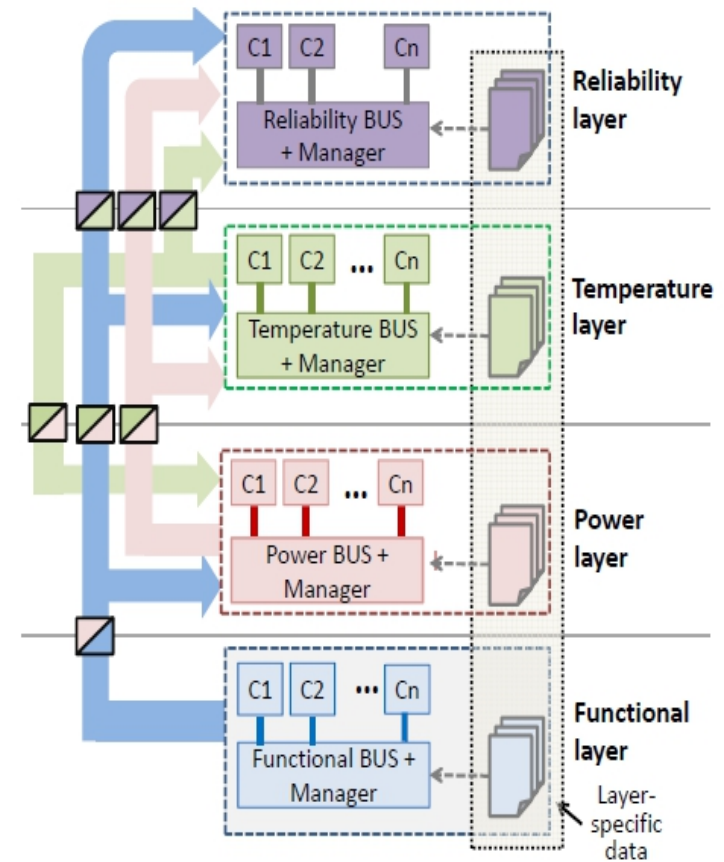   - Non-standard algorithms/policies for fast charge
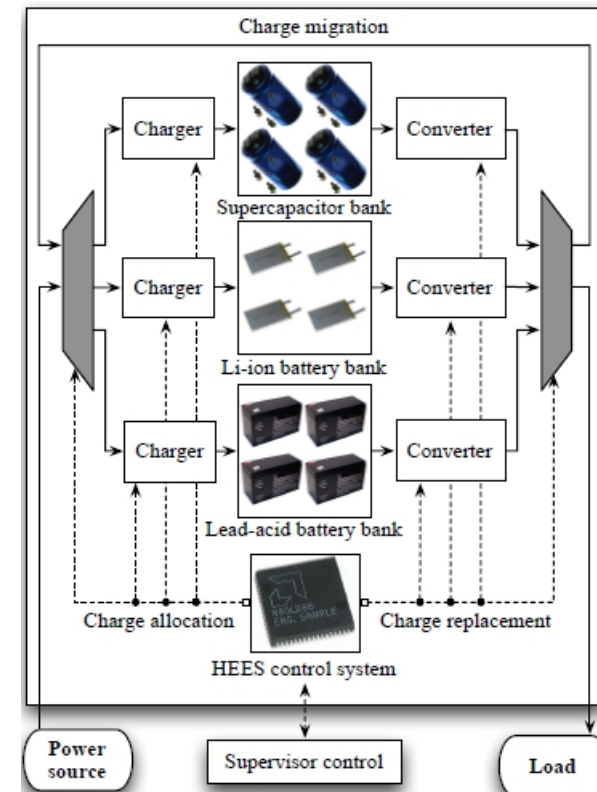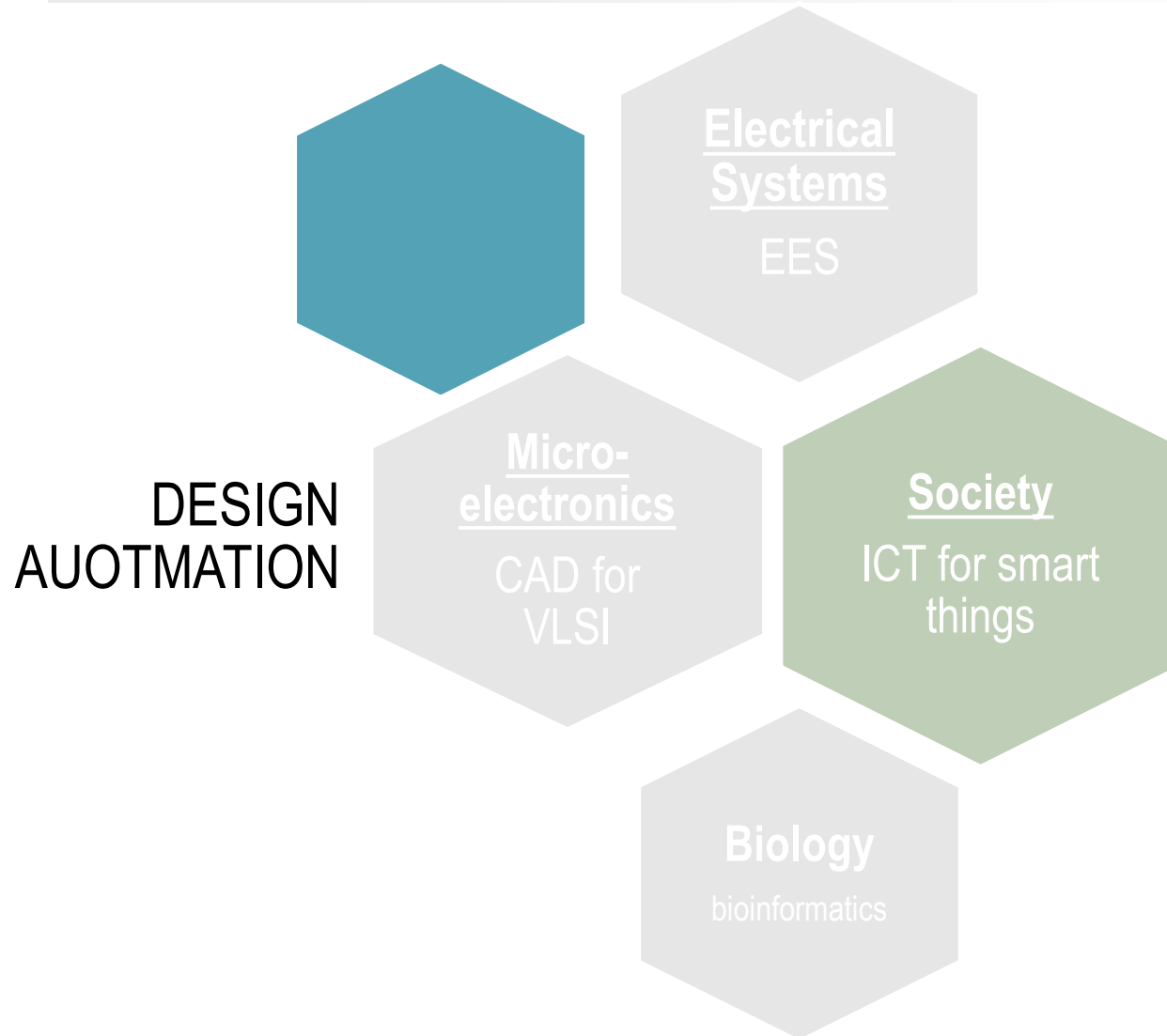
CAD for electrical energy systems

- ## CAD for electrical energy systems (EES)

  - **General Cyber-Physical Energy Systems**
  - Open-source, extensible SystemC/AMS+IP-XACT simulation framework
  - Implementation of smart policies
  - Extension to extra-functional properties
    - **Aging**
    - **Temperature**
    - **Operational cost**

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CAD for Smart-Things & App

- Cross-domain application of EDA methods to
  - **Smart cities**
  - **Smart fabs**

CAD for Smart-Society: Cities

To design and deploy sensing technologies for energy efficient...

- **Energy efficient** wireless sensor networks
- **Middleware** for heterogeneous energy data integration
- Web-services-oriented software infrastructure for **interoperability** of
  - Sensor data
  - Building models
  - District/network models
- Visualization techniques using A/R, V/R to enable **Ambient Energy Intelligence**.

CAD for Smart-Society: Fabs

- Smart Manufacturing:
  - Minimization of resources in production lines
  - Improvement of product quality through optimization of process parameter
  - Reduction of defects (e.g. porosities) in the final product

- Technologies:
  - Analysis of process parameter and characterization
  - Casting process modeling using machine learning (black box modelling)
  - Heuristic parameter optimization
  - Integration of the black-box model in a simulation and visualization engine

Funded research

- JU ENIAC
  - ~~MOTORBRAIN~~
  - ~~ERG~~
  - ~~E2SG~~
  - ~~IDEAS~~

- JU ARTEMIS
  - ~~IOE~~
  - ~~VETESS~~
  - ~~DEMANESS~~
  - ARROWHEAD

- FP7/FET
  - ~~SMAC (IP)~~
  - ~~TOUCHMORE (STREP)~~
  - ~~CONTREX (IP)~~
  - TRIBUTE (STREP)
  - DIMMER (STREP)
  - READY4SMARTCITIES (CSA)
  - HUMAN BRAIN PROJECT (FET)
  - ~~LAB4MEMS (KET)~~
  - GRAPHENE (FET)

Legend:
- AUTOMOTIVE
- ENERGY
- SMART CITIES/BUILDING
- TECHNOLOGY/CAD

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CAD for Smart-Society: Cities

To design and deploy sensing technologies for energy efficient...

- Buildings, by management of:
  - Energy consumption of appliances, HVAC, lighting, etc...
  - Comfort level (temperature, humidity, CO2)
- District, by management of:
  - Water temperature (DH), indoor temperature
  - Renewable energy/energy storage
- People, by promoting energy-awareness using:
  - Augmented/virtual reality to expose energy consumption information and suggest green-like actions in the context
  - New business models, win-win billing strategies
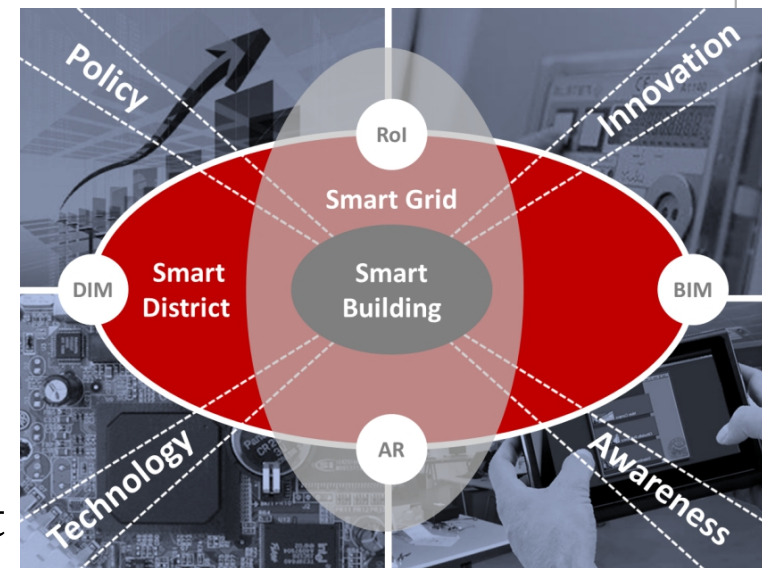
CAD for Smart-Society: Cities

- Objective
  - Design of a ultra low-power device and platform for out-/indoor air quality management

- Technologies:
  - Sensor node assembly-
  - Low power sensing strategies
  - Firmware and SW programming