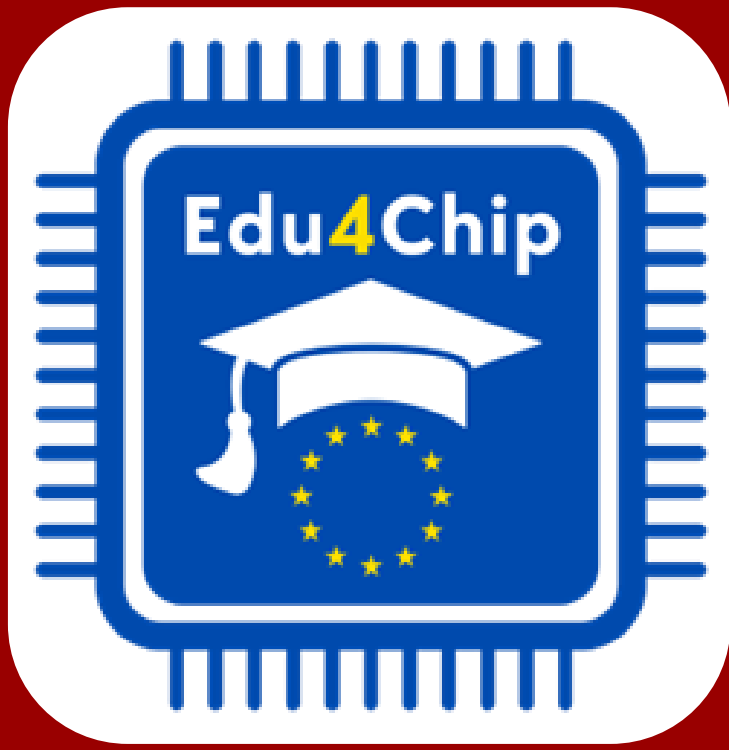

DTU


Edu4Chip

From Theory to Tape-Out: Chip Design Education with Edu4Chip

Matthias Bo Stuart, Luca Pezzarossa
Embedded Systems Engineering
Technical University of Denmark

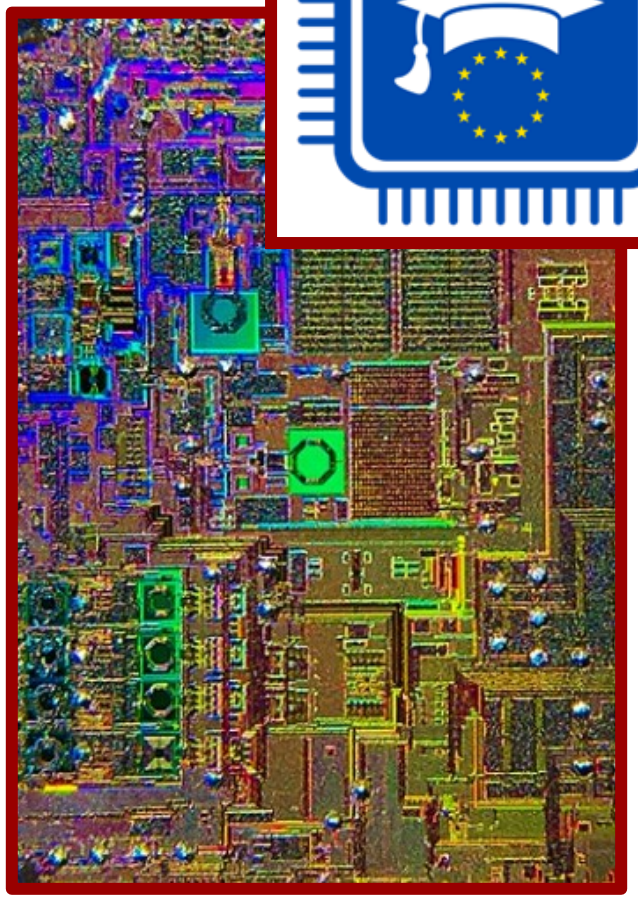
Funded by
the European Union

Who am I?

- MSc (2006), PhD (2010) on Network-on-Chip, DTU
- Postdoc, associate professor (2010-2022) in biomedical engineering
  – Center for Fast Ultrasound Imaging, DTU Electrical Engineering/Health Technology
  – World's largest ultrasound scanner, 320 Virtex-4 FPGAs
- Industry experience (2022–2024)
  – Systems engineer, BK Medical/General Electric/GE HealthCare
- Associate professor at DTU Compute, ESE since March 2024

Overview

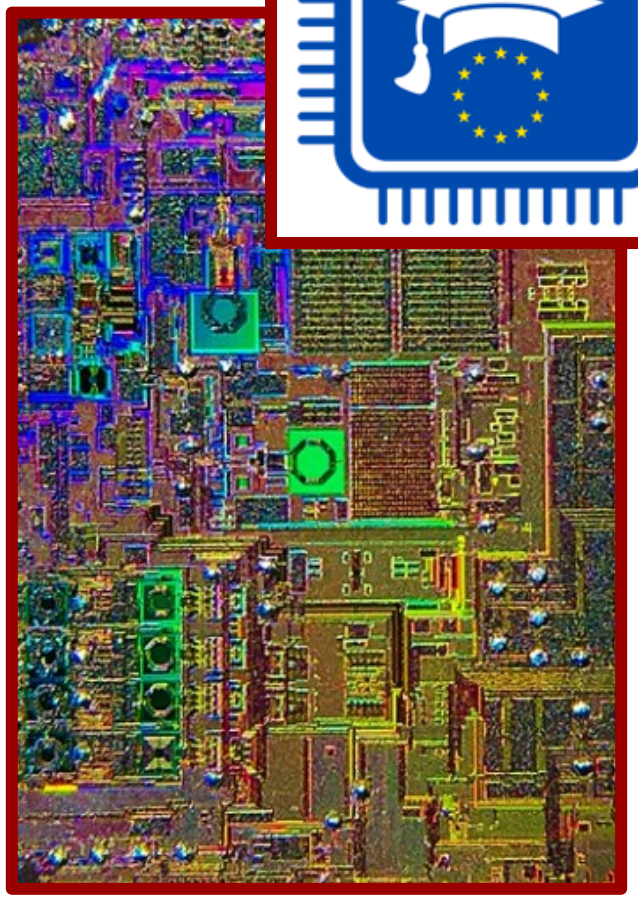
The EU Chips Act aims to promote EU sovereignty in **chip design and manufacturing**



Overview

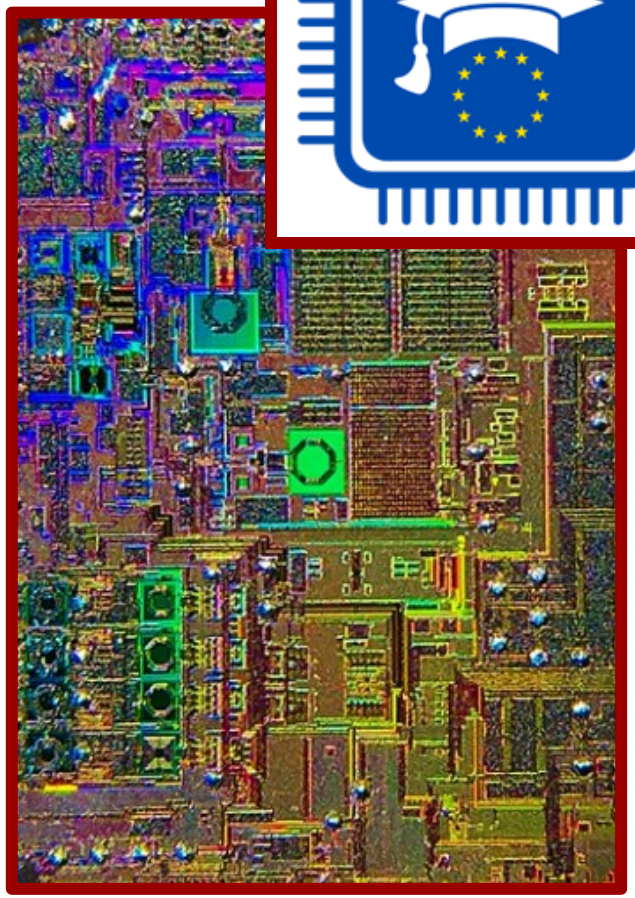
The EU Chips Act aims to promote EU sovereignty in **chip design and manufacturing**

We need **trained skilled professionals**



Overview

- Designing and implementing harmonized MSc programs between universities
- Enabling students to carry out a complete chip design project (from HDL to tape-out to testing)
- Enhancing the chip design capability in Europe by educating skilled engineers



New BSc program in Computer Engineering

- Response to the **EU Chip Act**
- Started fall 2023 at the Technical University of Denmark
- Includes a **chip-design specialization:**
  - Digital electronics theory and projects
  - Computer architecture
  - RISC-V in an FPGA
  - Chip design (using open-source tools)
  - Verification
  - HW/SW codesign
  - …

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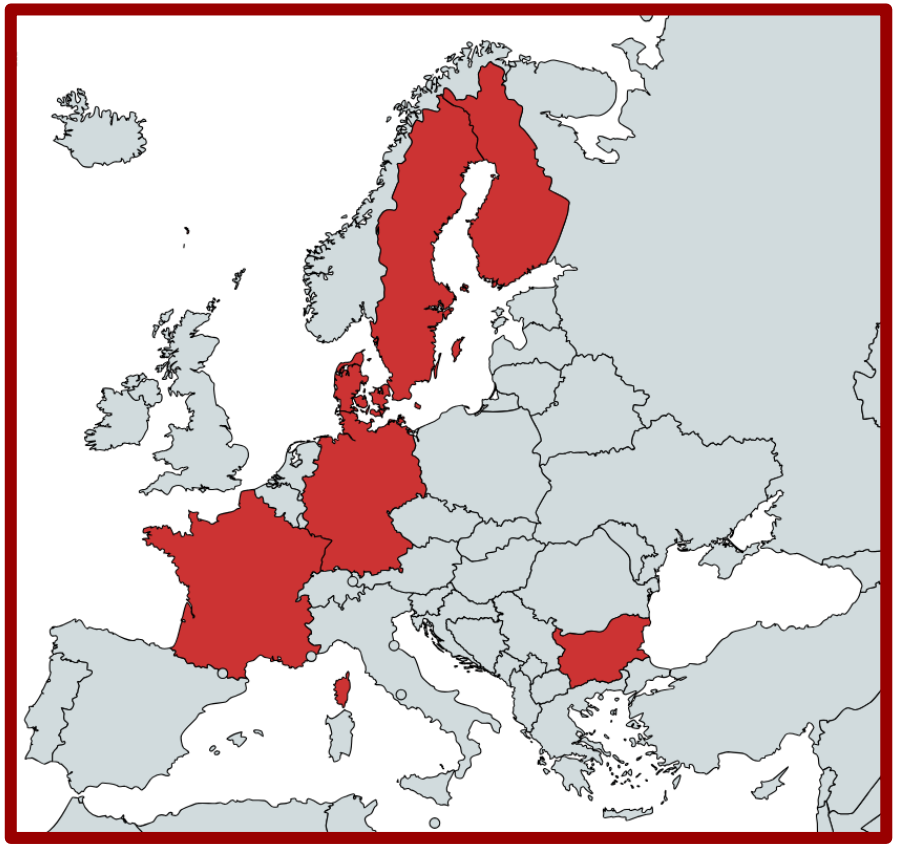
  - …

We already have a MSc including chip design

How can we improve?

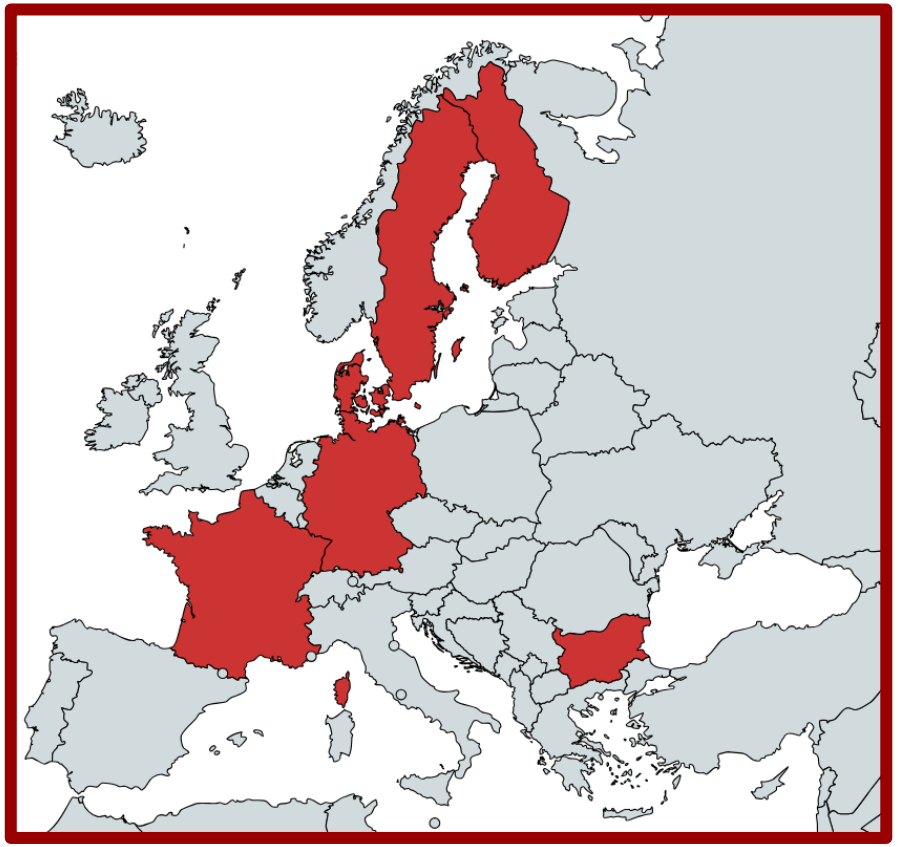
Edu4Chip in a nutshell

- **Universities:**
  - Technical University of Munich - TUM (DE)
  - Technical University of Denmark - DTU (DK)
  - Tampere University - TAU (FI)
  - Royal Institute of Technology - KTH (SE)
  - Mines-Telecom Institute - IMT (FR)
- **Companies:**
  - MINRES Technologies GmbH (DE)
  - Logiqworks Ltd (BU)
  - Syosil ApS (DK)
- **Institutions:**
  - Fraunhofer Institute (DE)



Edu4Chip in a nutshell

- Edu4Chip: Joint Education for Advanced Chip Design in Europe
- Funding from **Digital Europe Programme** (EU DIGITAL-2022-SKILLS-03)
- Period:
  - Started on the 1st of October 2023
  - Ends on the 30th September 2027
- Initial preparation phase + execution phase



Edu4Chip objectives

1

- Strengthen the chip design MSc programs including real tape-out projects

Edu4Chip objectives

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2. Develop common open-source training modules framed around a tape-out project

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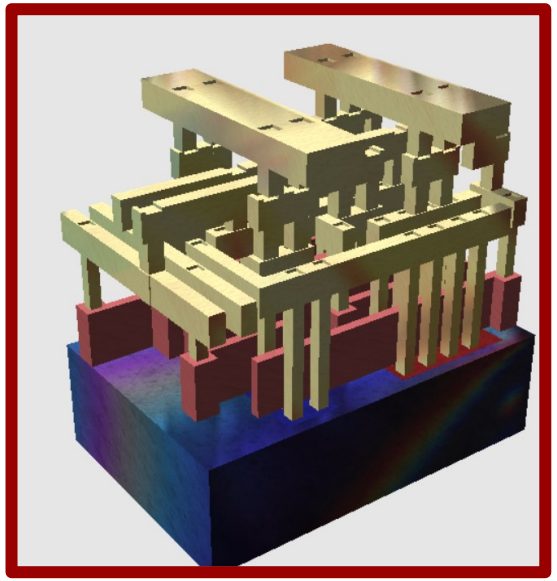
2. • Develop common open-source training modules framed around a tape-out project
3. • Develop common open-source chip template
4. • Allow student mobility between universities and share teaching material

Edu4Chip objectives

1. Strengthen the chip design MSc programs including real tape-out projects
2. Develop common open-source training modules framed around a tape-out project
3. Develop common open-source chip template
4. Allow student mobility between universities and share teaching material
5. Strengthen partnerships with local industry

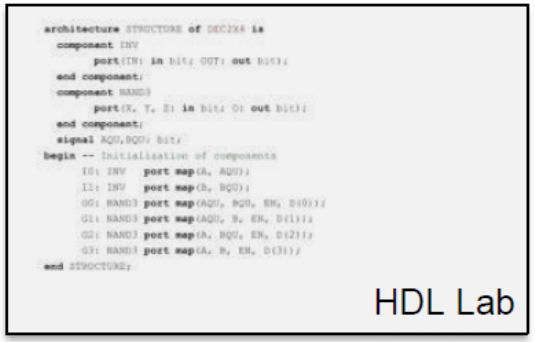
A more practical MSc program

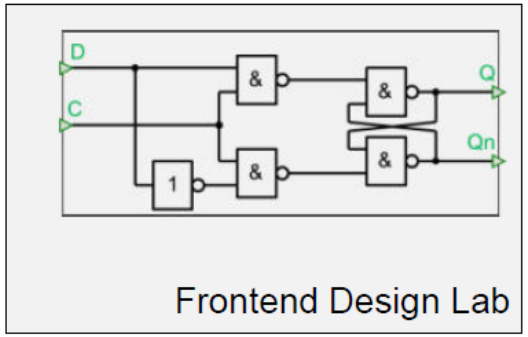
- Unique feature: **Emphasis on practical tape-out projects**
  - Students will experience the entire chip design process, from concept to fabrication and testing
  - Boost student engagement and motivation by working on real chip designs
- Cover digital, analog, and mixed-signal systems
- Enroll and train 150 students per year
- Lifelong Learning Modules:
  - Continuous professional development
  - Transitioning from other fields into chip design

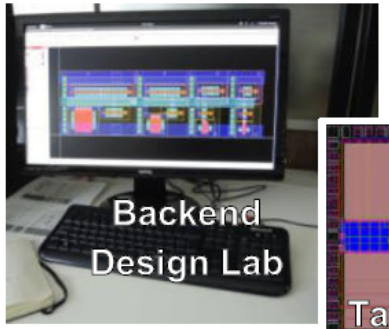


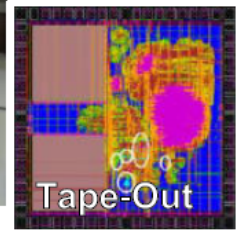
Program outline

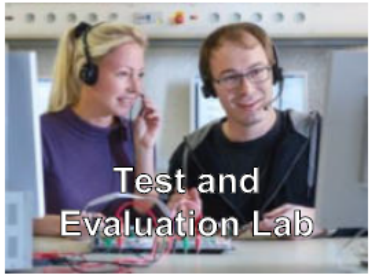
Term 1	Term 2	Term 3	Term 4
Local Modules (existing/new)	Local Modules (existing/new)	Local Modules (existing/new)	Master Thesis Project
Remote Modules (new/existing)	Remote Modules (new/existing)	Remote Modules (new/existing)	
		Research Internship (Industry Partner)	







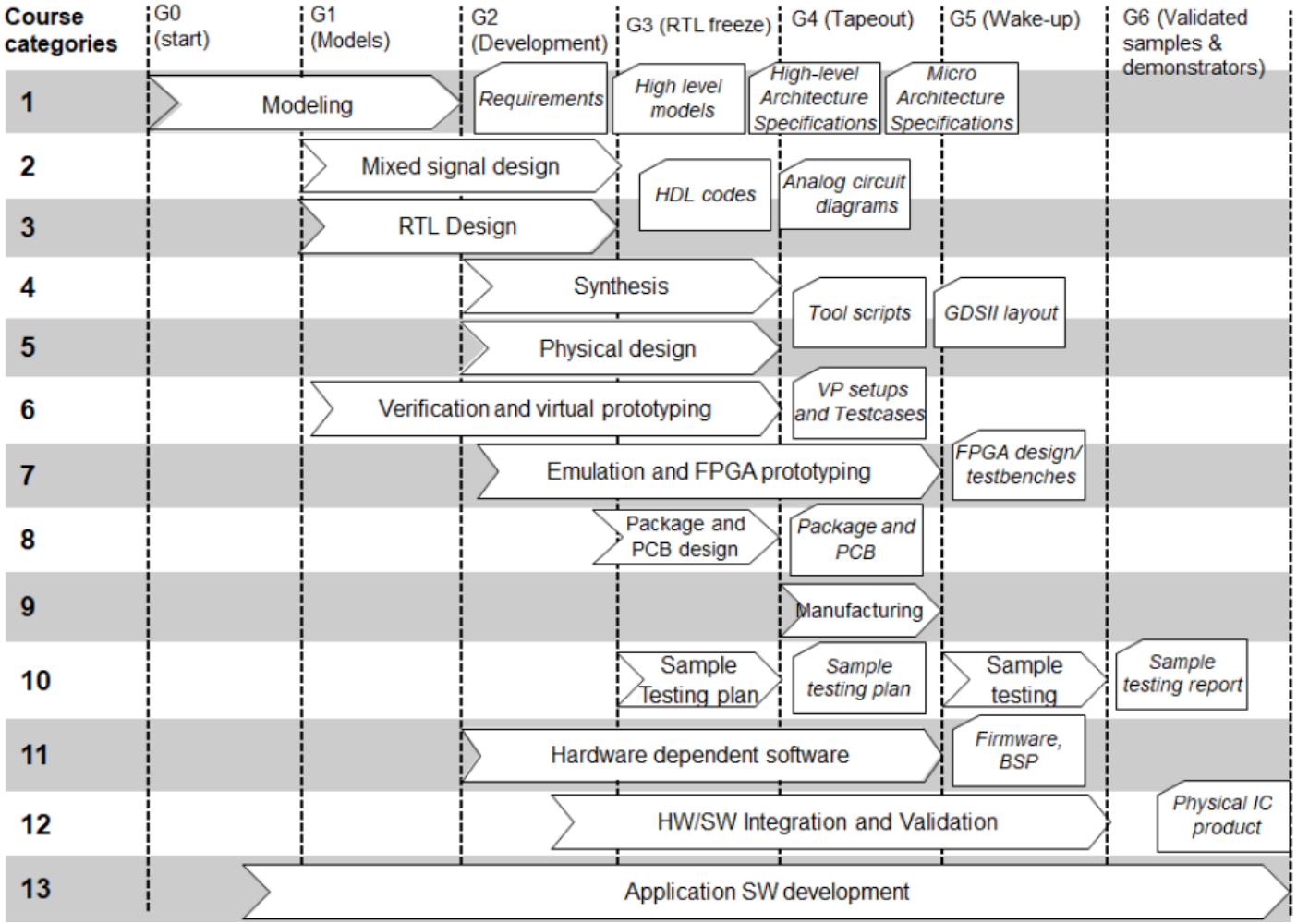




Chip Design Tape-Out Project

Life-long learning modules

Mapping skills to courses



I want to make a chip!

What do I need to know?

Hard for a single university to offer everything

	DTU	IMT	IIS	KTH	LGQW	MNRS	SYO	TAU	TUM
Modelling	+	+	+	+	+	+			+
Mixed Signal Design		+	+		+				+
RTL Design	+	+	+	+		+	+	+	+
Synthesis		+	+	+	+		+	+	+
Physical Design		+	+	+				+	+
Verification & virtual prototyping	+		+		+	+	+	+	
Emulation & FPGA prototyping	+	+				+		+	+
Package and PCB design		+	+					+	
Manufacturing									
Sample testing plan								+	
Hardware dependent software	+				+	+		+	+
HW/SW integration & validation	+				+	+		+	+
Application SW development	+			+	+	+		+	+

- Leverages expertise across all partners
- Inter-university cooperation
- Allow students mobility
  - Physical
  - Virtual

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  - Physical
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Sharing is key!

Sharing allows to have specializing courses

- Testing
- **Agile hardware design**
- Packaging
- FPGA-based emulation
- **Verification**
- **Asynchronous circuits**
- Low-power designs
- High-level synthesis
- **Open-source chip design**

```
def regPipeline[T <: Data](input: T,
    pipeDepth: Int, init: T): T = {
  if (pipeDepth <= 0) {
    val ret = input
    ret
  } else {
    val pipeReg = RegInit(
        VecInit(Seq.fill(pipeDepth)(init)))
    val ret = pipeReg(0)
    pipeReg(pipeDepth - 1) := input
    for (i <- 0 until pipeDepth - 1) {
      pipeReg(i) := pipeReg(i + 1)
    }
    ret
  }
}
```

Sharing allows to have specializing courses

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    }
    ret
  }
}
```

Many educational modules will be released to the public

Student mobility between universities

- Harmonized programs facilitate easy transfer between universities
  - Common/shared curriculum across participating universities
  - Share teaching materials and best practices
- Students have a **larger selection of courses**
- Foster strong, long-term partnerships among universities
- Edu4Chip offers travel grants to ensure students (and teachers) exchange

Program concept deliverable

- Deliverable describing the program concept recently published
- Education structure and harmonization
- Challenge: Variations in university education administration in Europe
- Available on https://edu4chip.github.io

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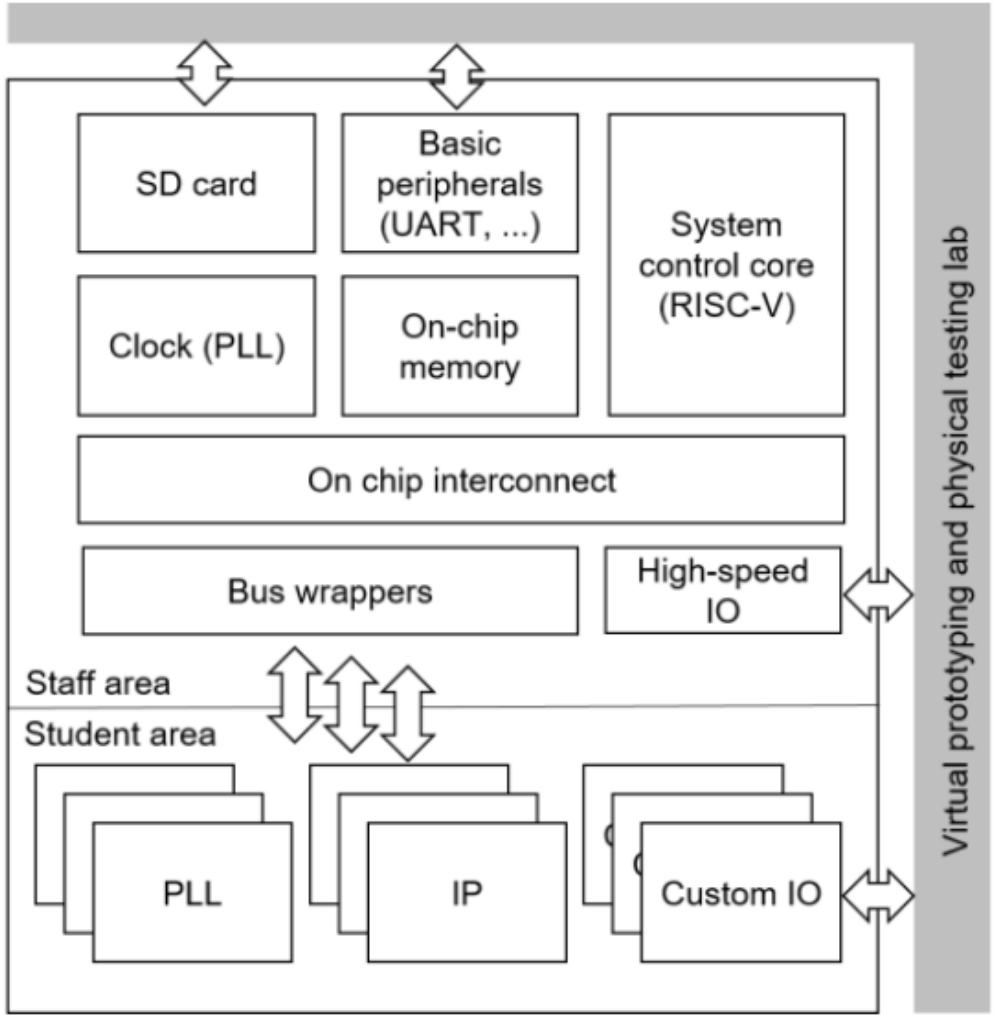
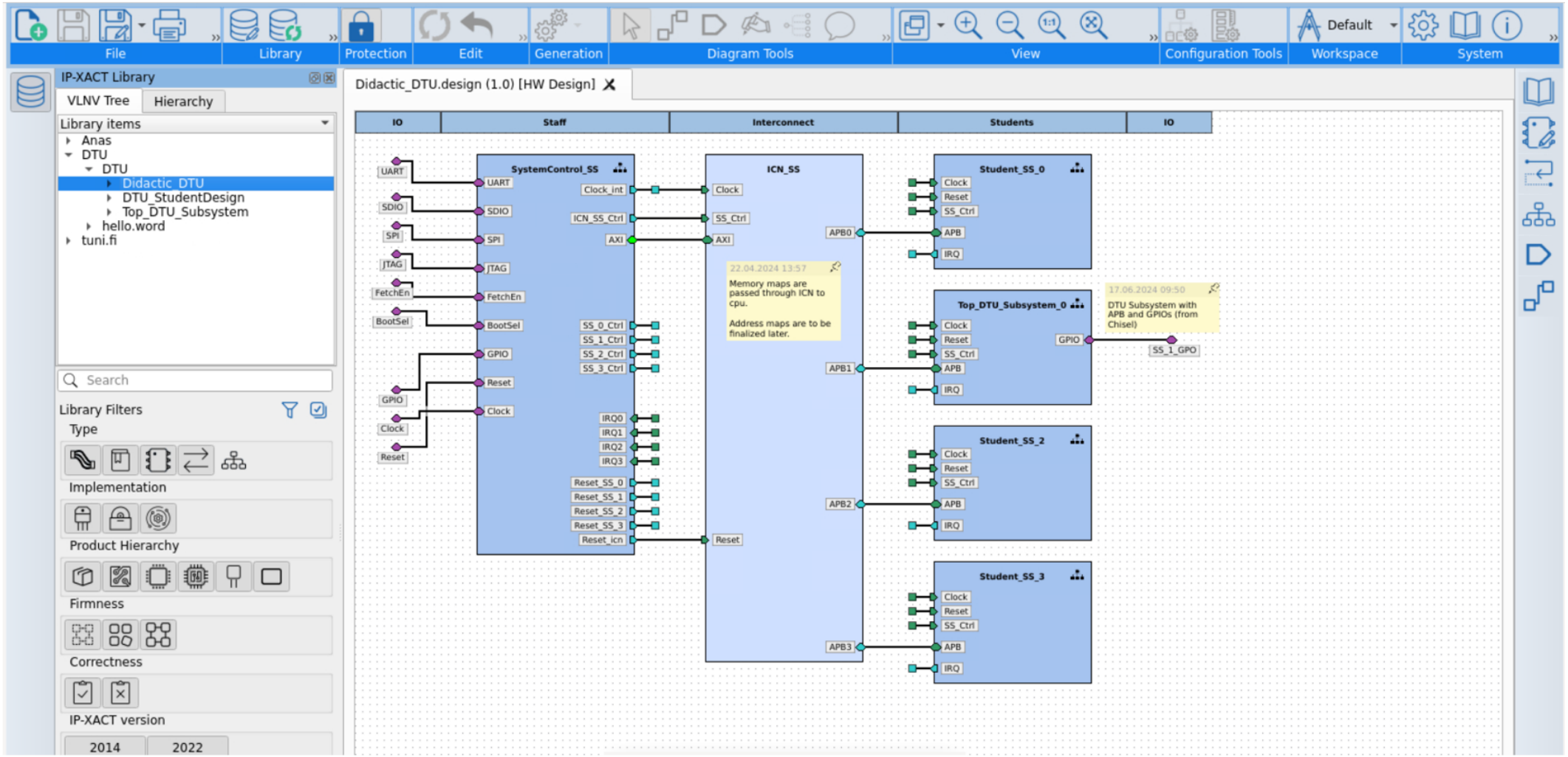
A common open-source chip template

- Joint design template to support student projects tape-out
- Staff area + Student area
- Many student projects per chip
- Edu4Chip offers 1 tape-out per year per partner
- First test tape-out in Spring 2025

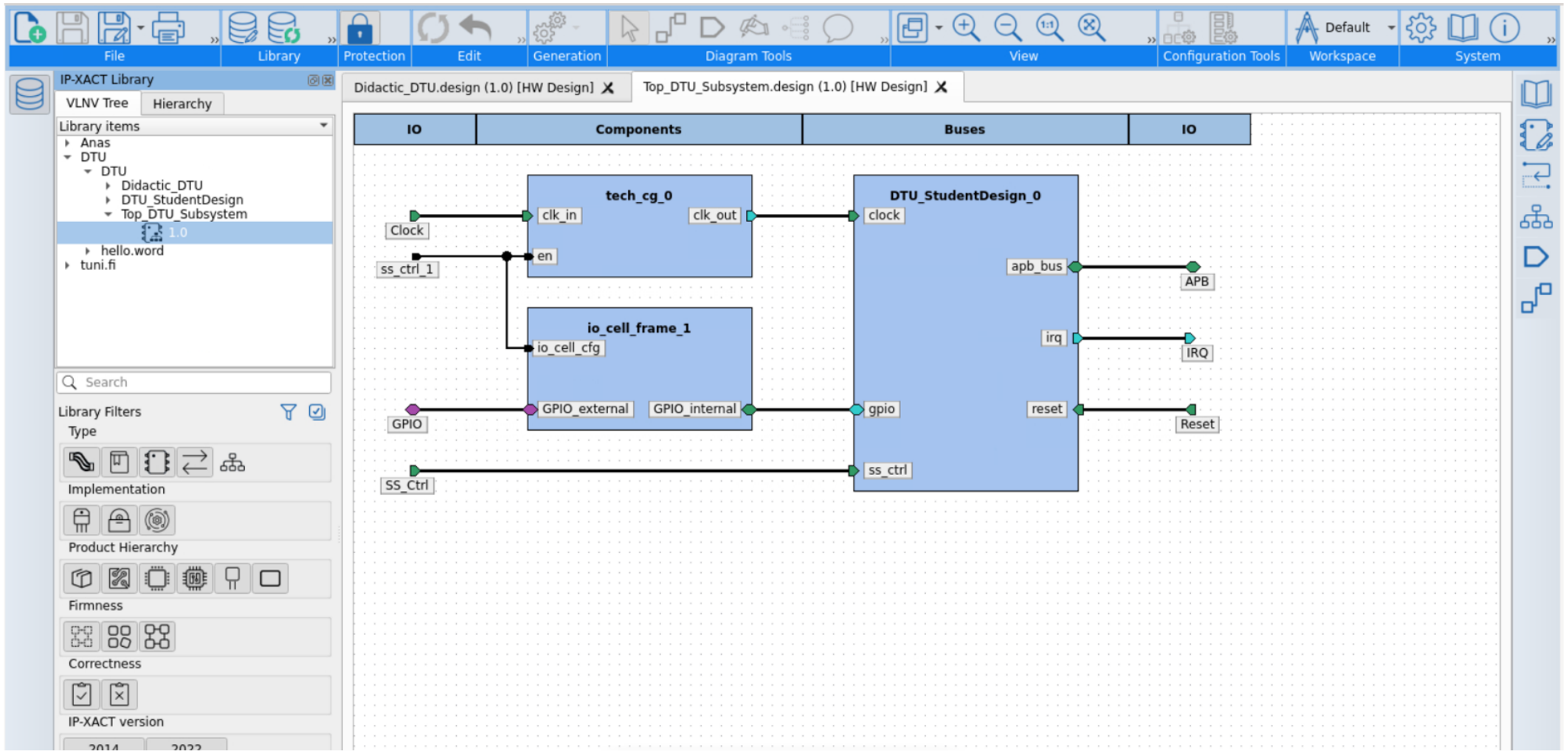


A common open-source chip template



- Modelled with the open source Kactus2 tool from Tampere University (IEEE IP-XACT)

A common open-source chip template



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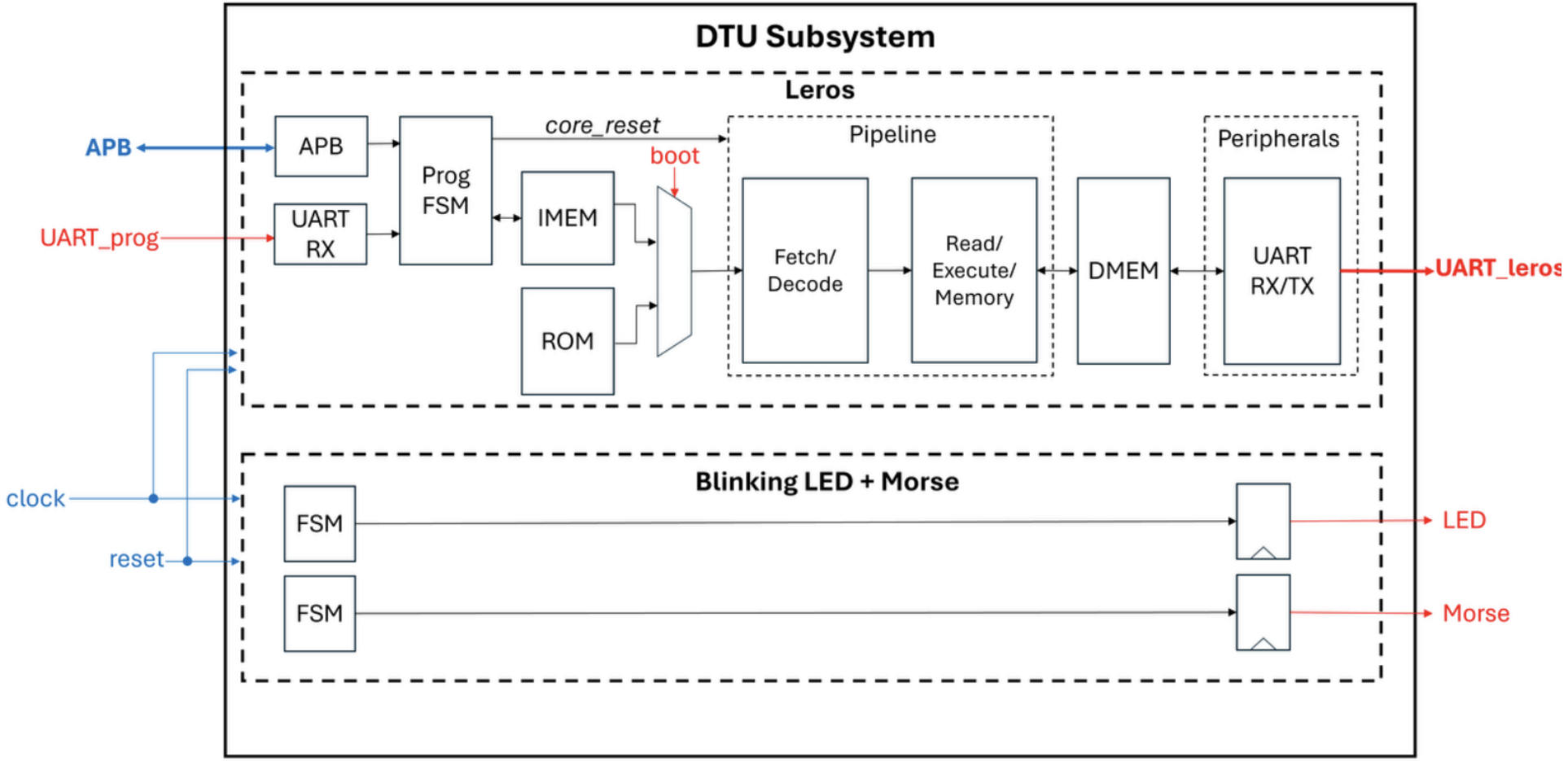
DTU Subsystem for test run

- Leros microprocessor (Martin Schoeberl)
- Preprogrammed ROM and programmable from ”staff area”



EDA toolchains

- **Balanced approach:**
  - Utilize both open-source and commercial EDA tools within the partner universities

- **Commercial tools:**
  - Industry-standard EDA Tools from Cadence, Synopsys, Mentor Graphics, Siemens
  - Students gain hands-on experience with tools used within the industry

- **DTU's open-source tool initiative for education:**
  - Driven by Martin Schoeberl and Luca Pezzarossa
  - Focus on accessible and affordable chip design education
  - No NDAs (and overhead)
  - Open-source tools and PDKs enable education outside the university walls
  - Pilot course: Test course using OpenRoad was very well-received
  - Next: BSc chip design course using TinyTapeout

Summer schools dedicated to chip design

2025
DTU
(Denmark)

2026
IMT
(France)

2027
TAU
(Finland)

- Open to the general public
- Grants available for students
- Promote interest in the field from students

Summer school in 2025

- Organized and held by the Technical University of Denmark in 2025
- From the 18th to the 22nd of August 2025 (Monday to Friday)
- We plan to include a strong focus on open-source chip design

Summary of the outcomes

- Establish harmonized chip design programs at five European universities
- Develop and enhance teaching modules focused on chip design (hands-on tape-outs)
- Release a selection of teaching modules to the public
- Open-source repository for the technical material, tools, and resources (chip template)
- Share reference guidelines and evaluation results to inform and guide similar efforts

From Theory to Tape-Out: Chip Design Education with Edu4Chip

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Web: https://edu4chip.github.io

Project GitHub: https://github.com/edu4chip

Contact:

- Luca Pezzarossa (lpez@dtu.dk)
- Martin Schoeberl (masca@dtu.dk)
- Matthias Bo Stuart (mbst@dtu.dk)

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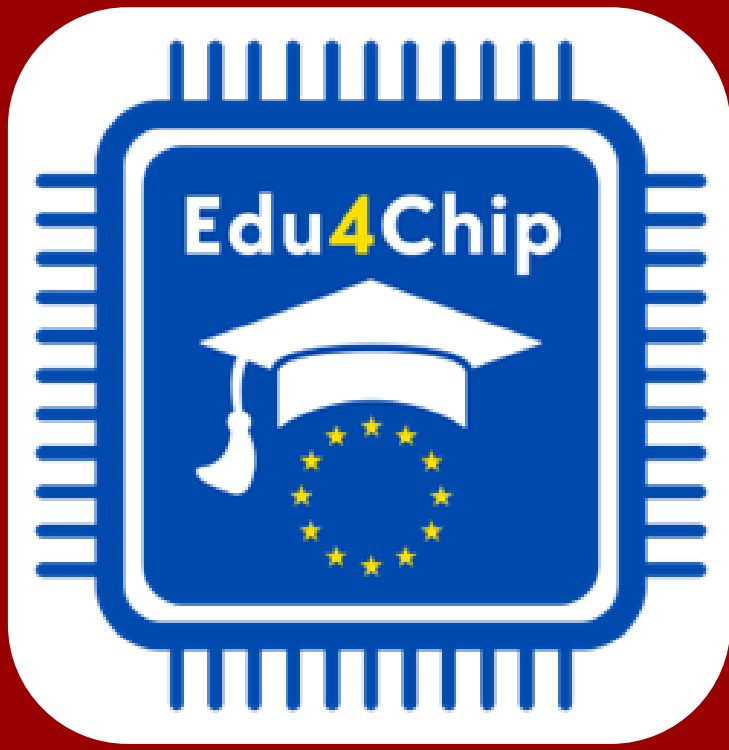
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