
DTU

Open-Source Chip Design

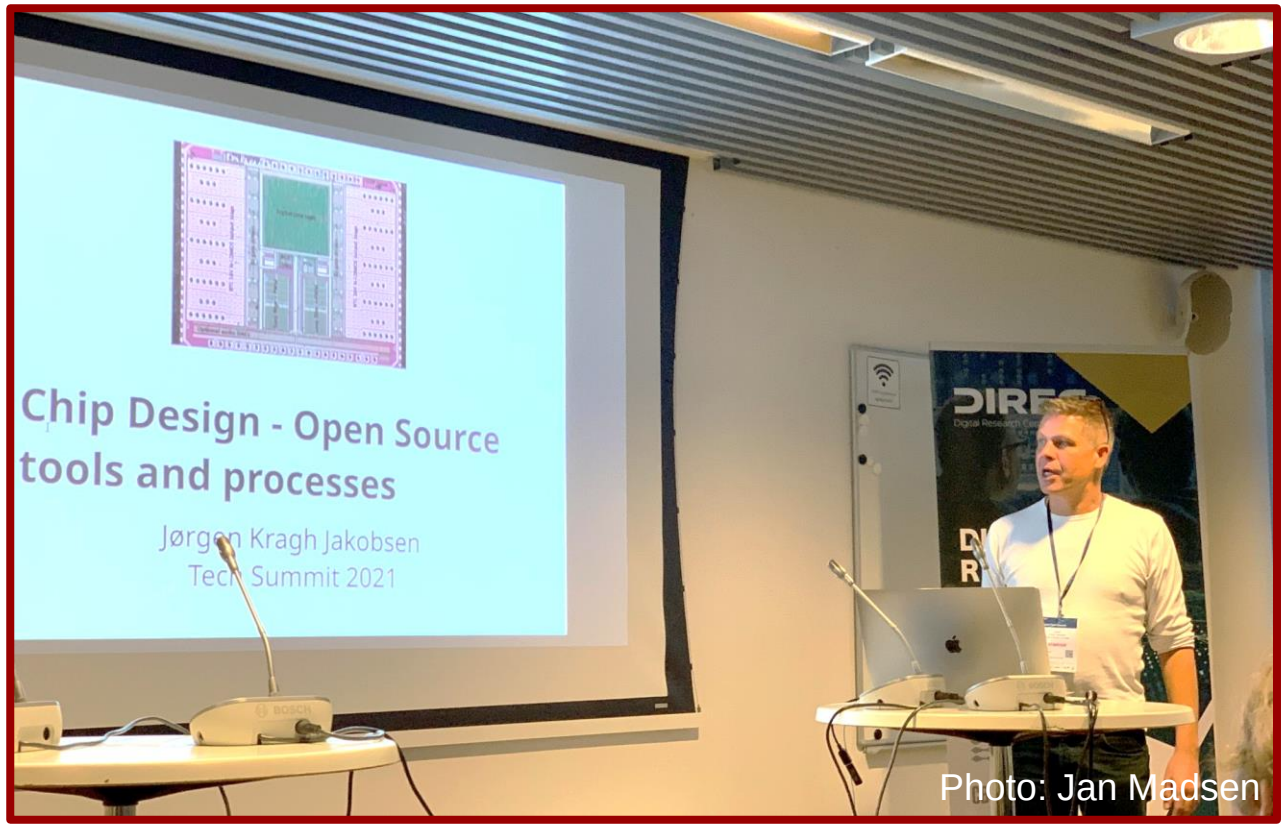
An ‘experimental’ special course at DTU

Luca Pezzarossa
Assistant Professor
DTU Compute

Mads Rumle Nordstrøm
Karl Herman Krause
Syed Anas Alam
Tjark Petersen
Nicolai Dyre Bülow Jespersen
BSc Students in Electro Technology

Motivation

Digital Tech Summit 2021



Jørgen Kragh Jakobsen

IC Works

Martin Schoeberl

Professor

DTU Compute

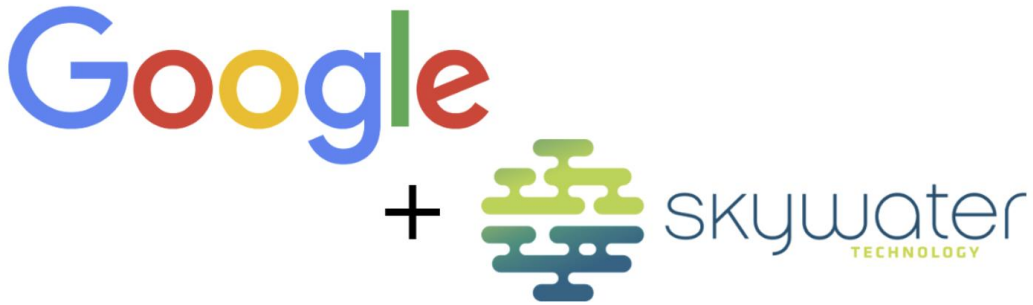
Luca Pezzarossa

Assistant Professor

DTU Compute

Motivation

Open source 130nm Skywater PDK

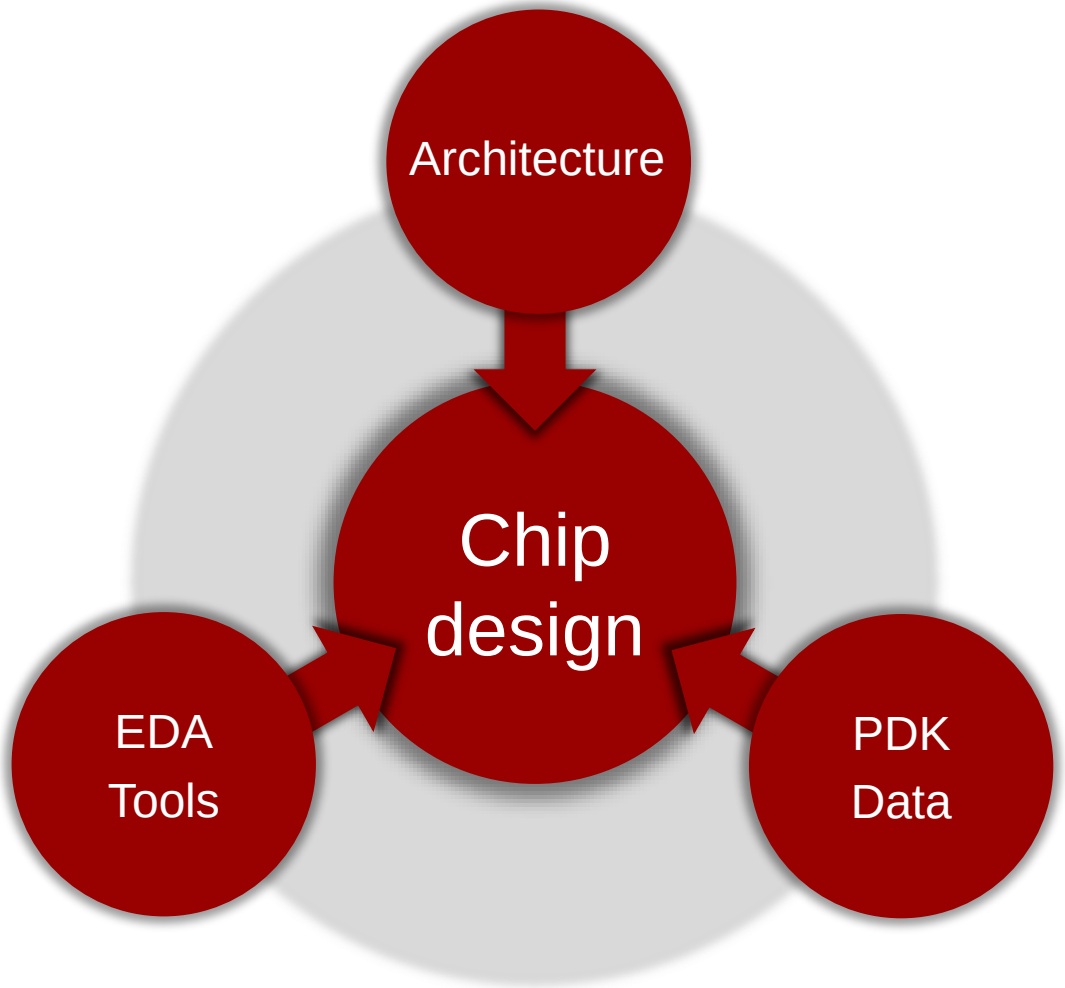


- Full open source toolchain
- From RTL down to the GDS

Open source shuttle program

- Free chip fabrication
- Design has to be open source

The *Open-Source Chip Design* special course



- 13 weeks course - 5 ECTS
- Learning objectives
  - Define precise specifications of a computing system
  - Develop (in Chisel) and test the hardware architecture
  - Use EDA tools and solve related challenges
- 12 students signed up for the course

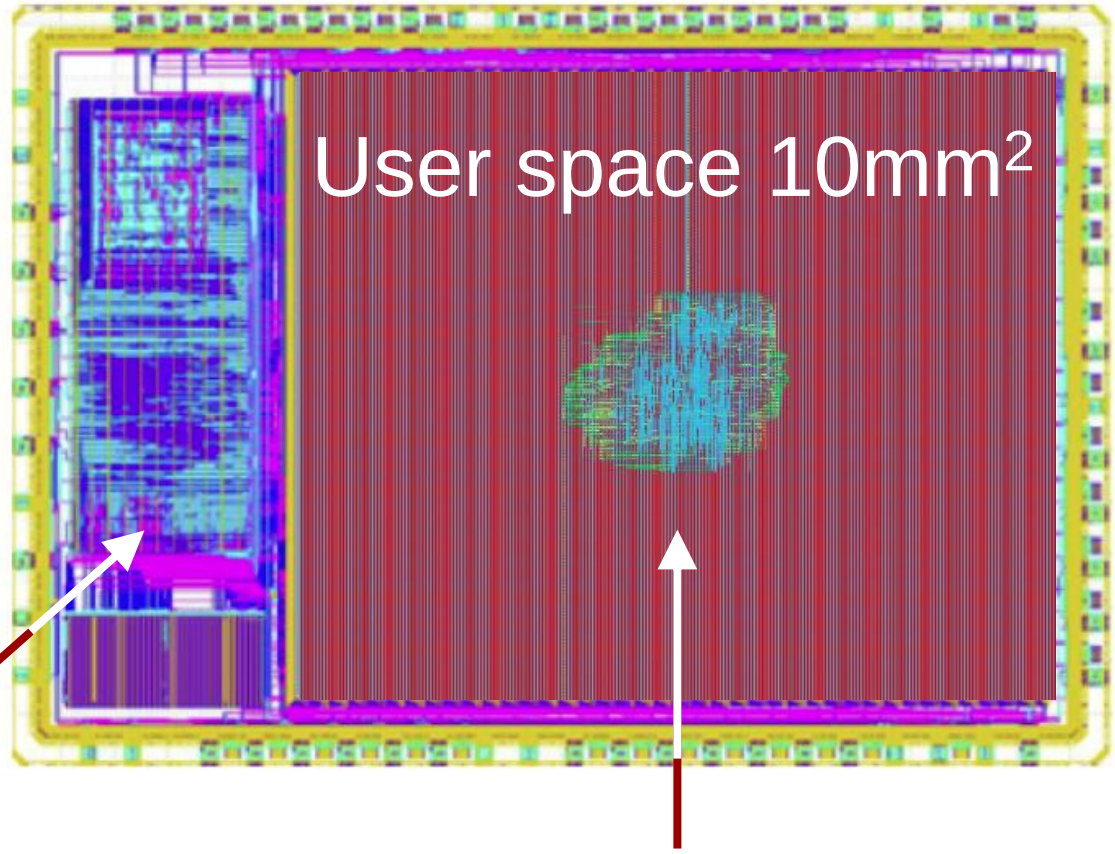
The group

Tjark, Andreas, Simon, Niels, Nicolai, Anas, Karl, Jakob, Mads, Jonas, Jørgen.

Missing: Christa, Ulrik.

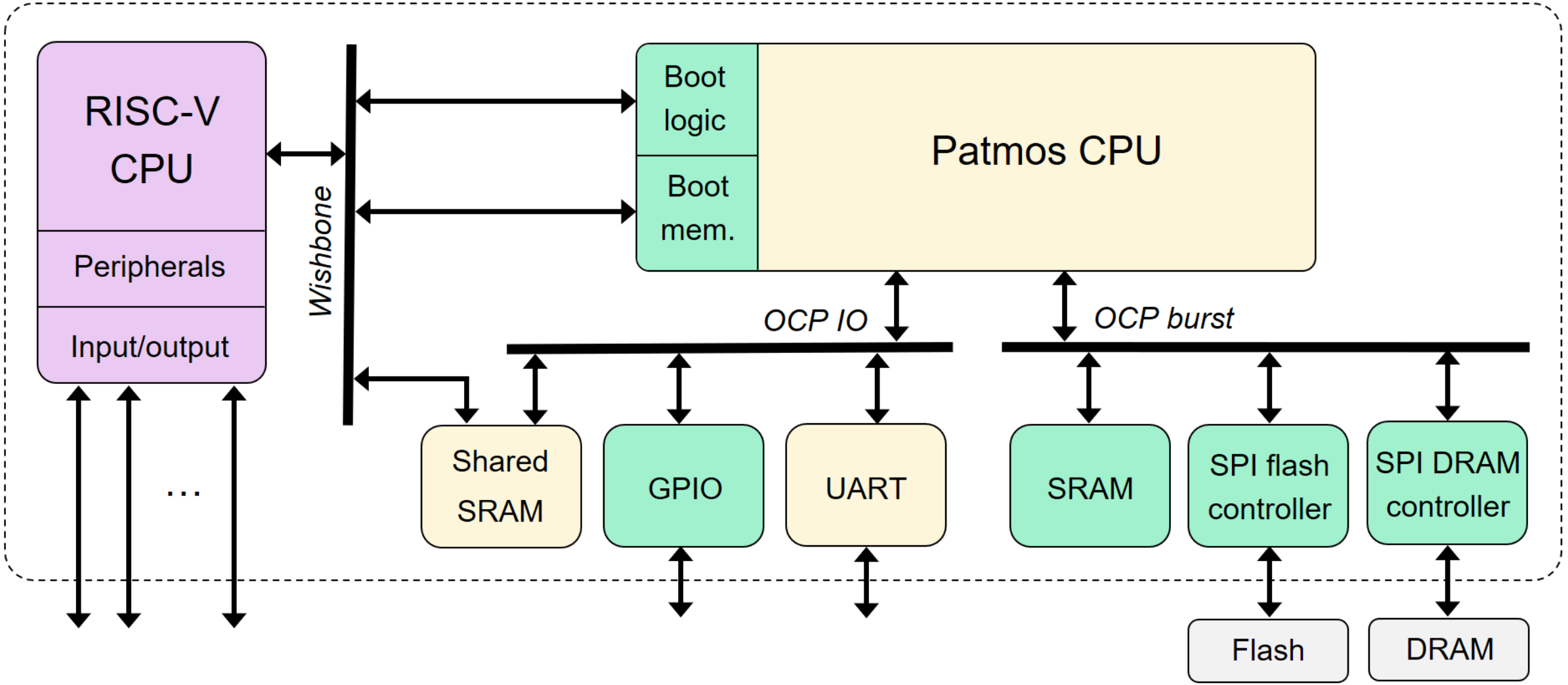
Our architecture

- Based on **caravel**
  - **Pre-made harness**
  - **I/O management**
- Heterogeneous dual core processor



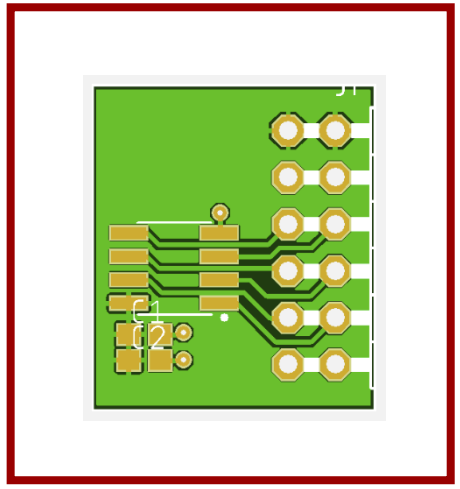
Our architecture

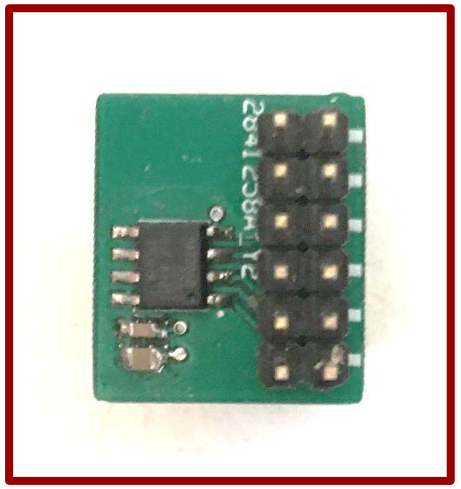
Silicon chip

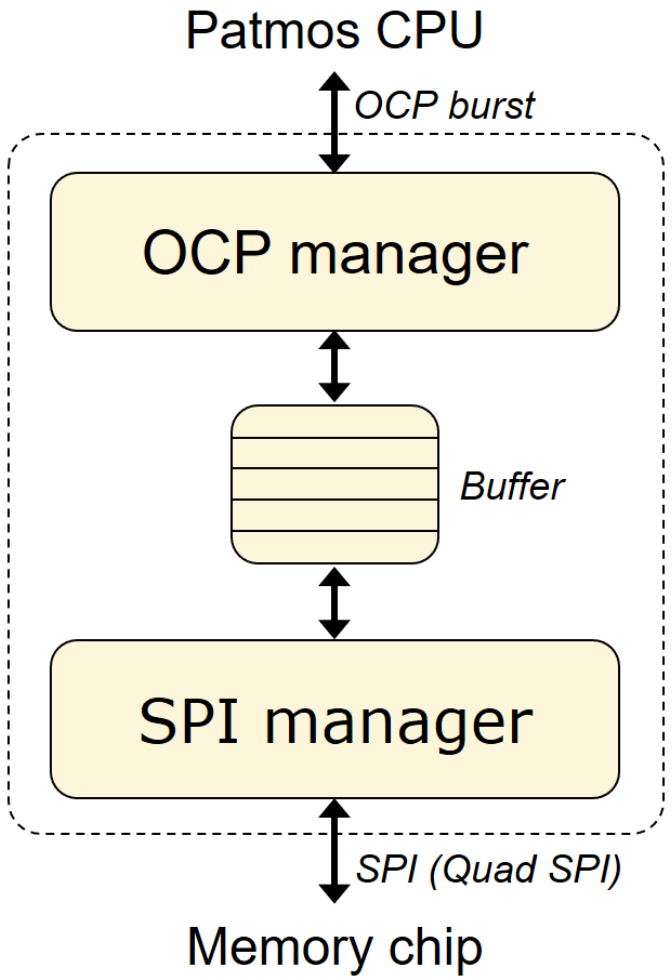


External memories

- 10mm^2 cannot fit large memories
- Off chip DRAM and Flash
- We developed a **memory controller**
- We tested on the real chips

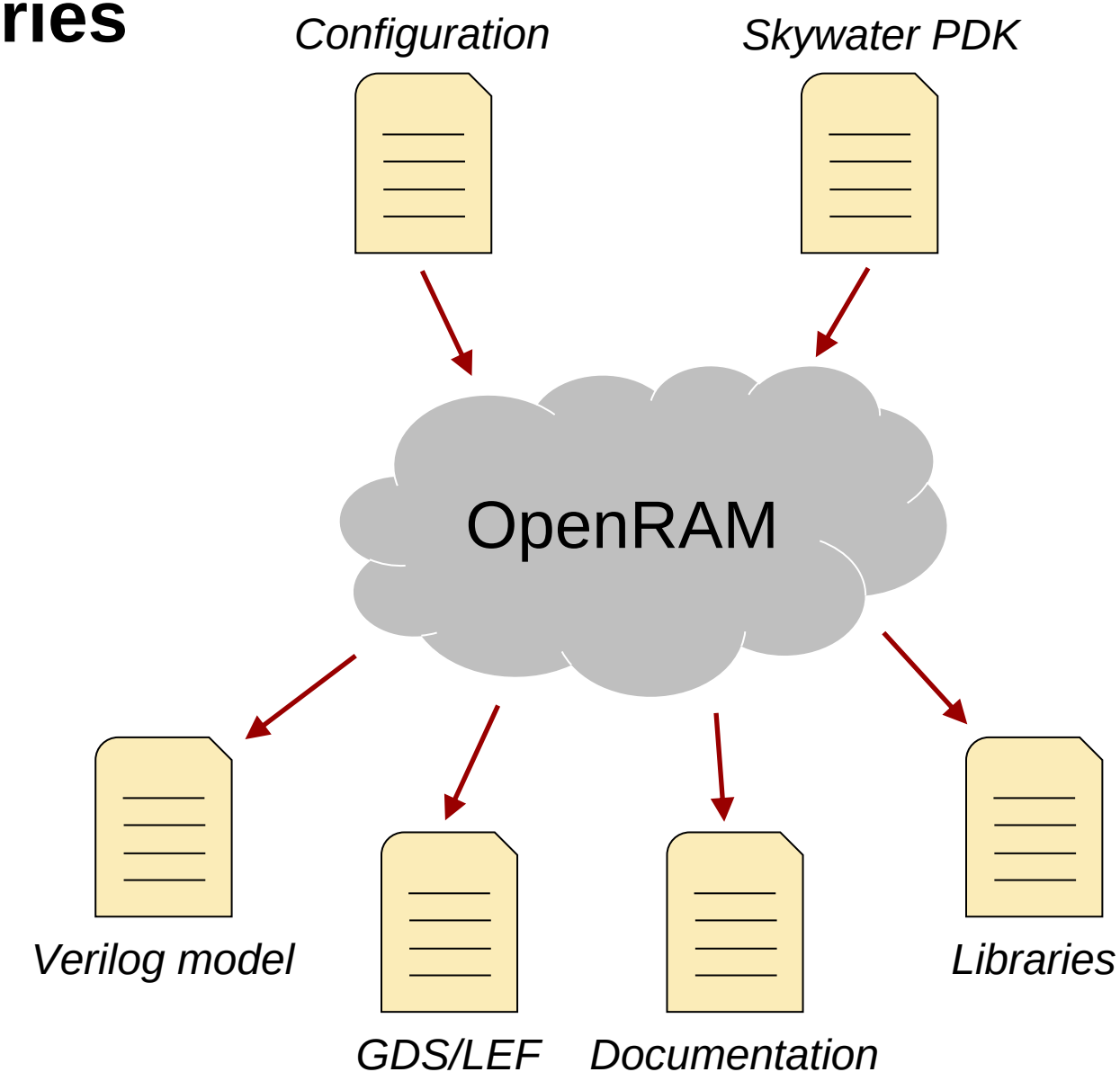






Internal (on-chip) memories

- Memories need to be generated
- We use OpenRAM
  - Precompiled macros
  - Custom memories



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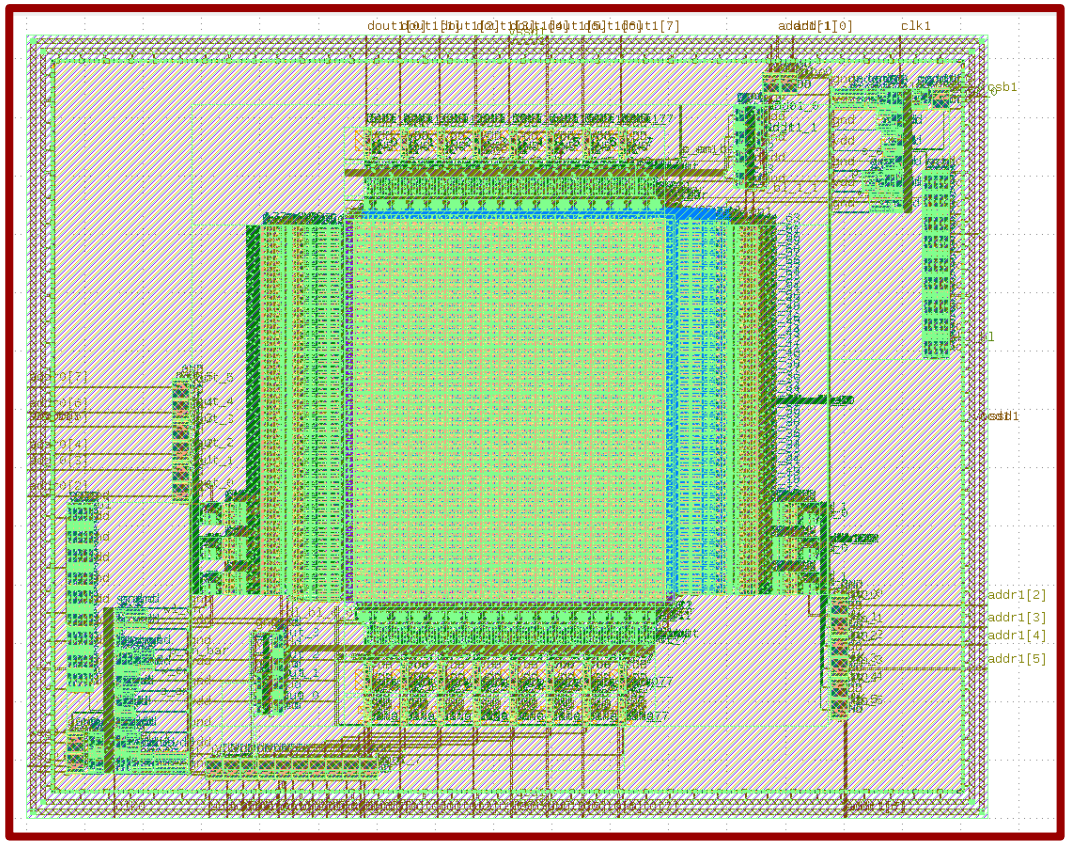
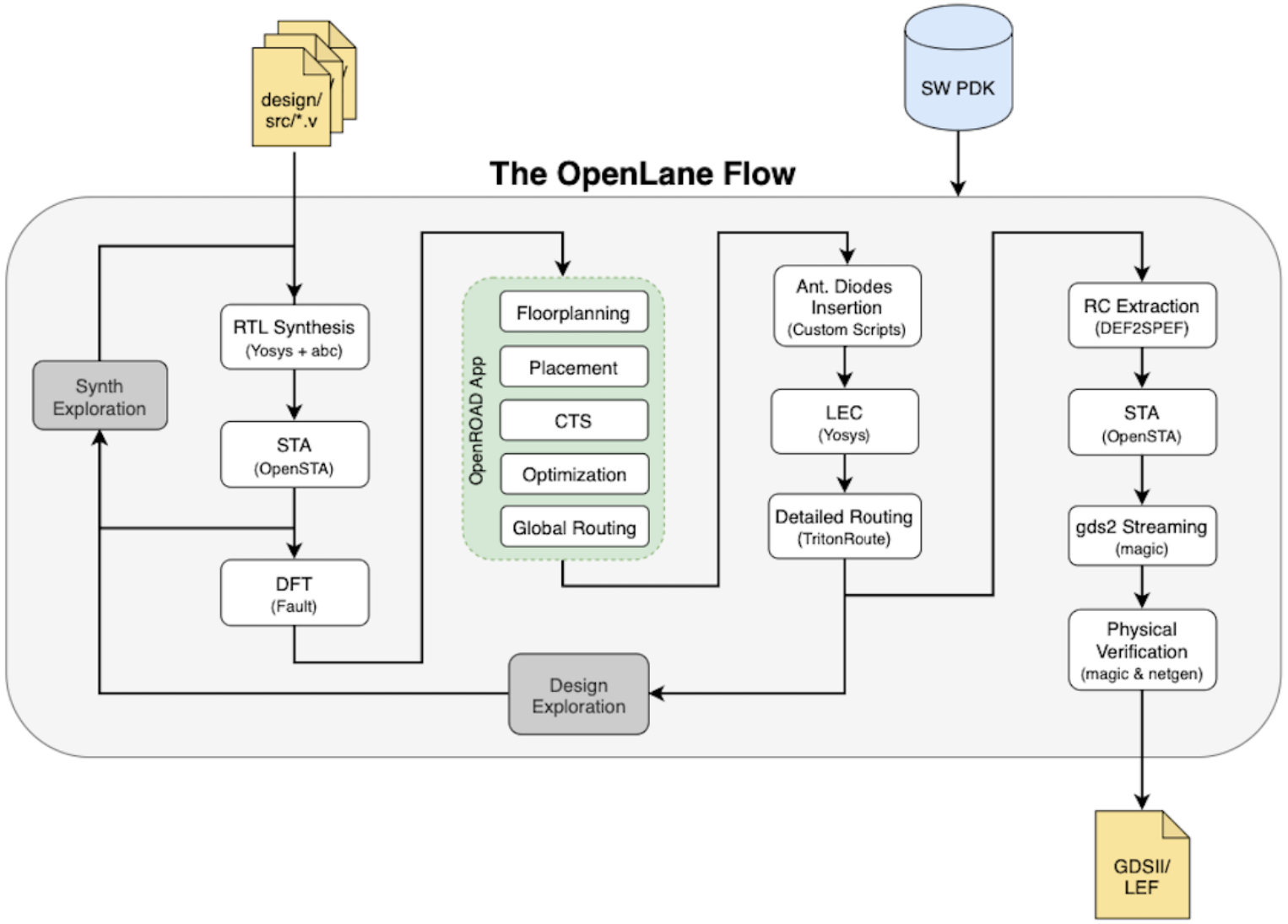
SRAM - sky130 - 1k x 8bit



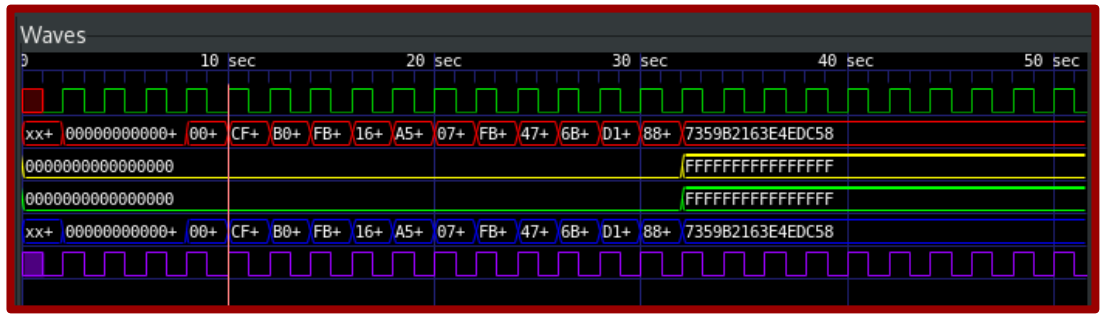
Open source tools and processes

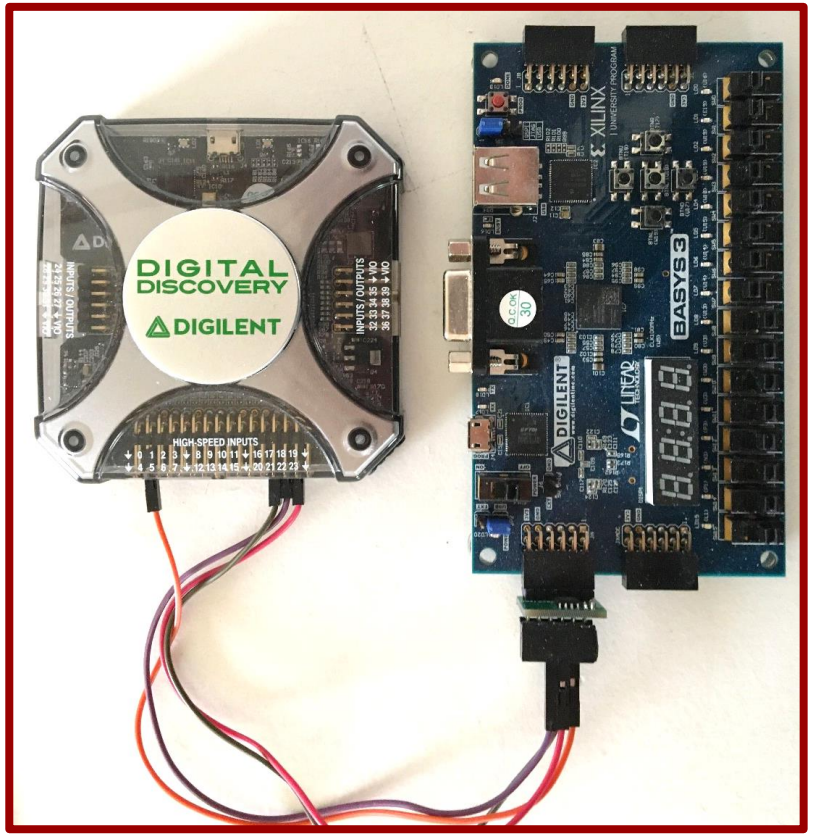


- Series of different tools
  - Yosys for synthesis
  - OpenROAD
  - Others
- Start form our Verilog design
- Finish with the GDS layout files
- Intermediate simulations

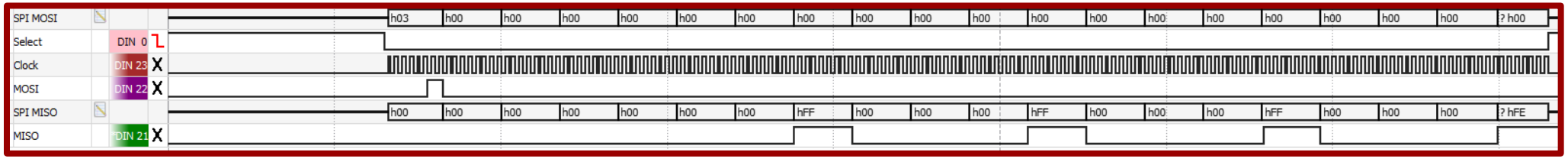
Testing

- Simulation with test-benches
- Simulation running programs

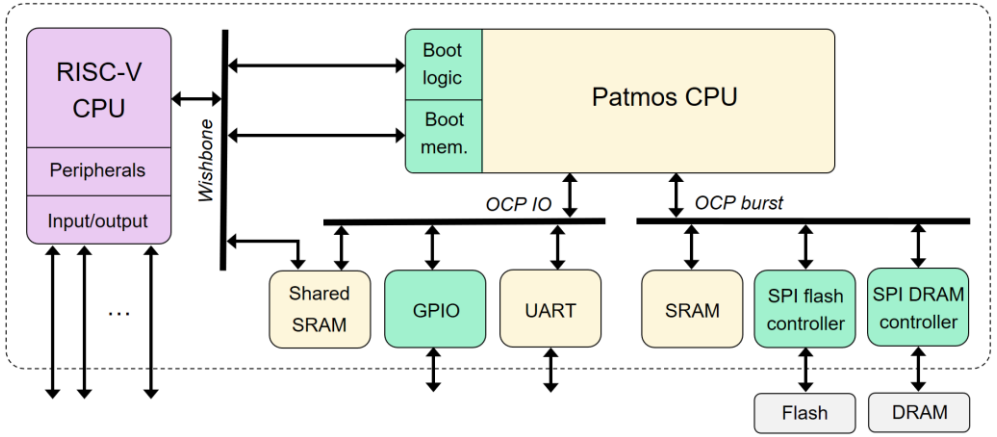




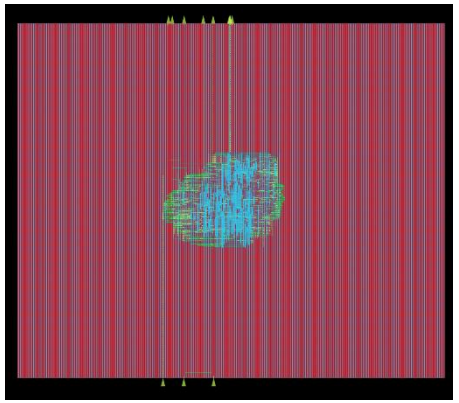
- Test on FPGA + logic analyzer

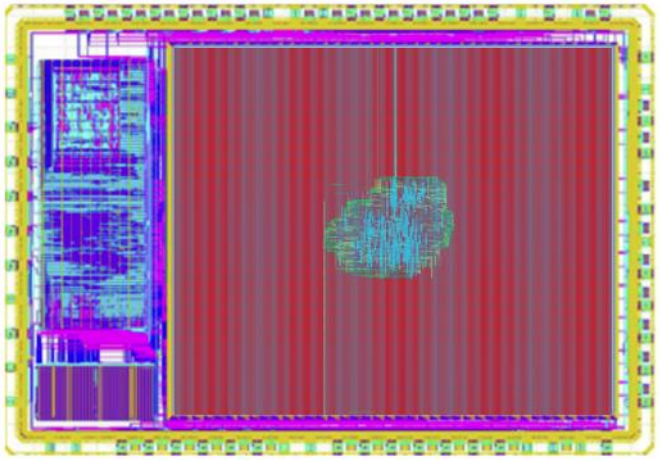


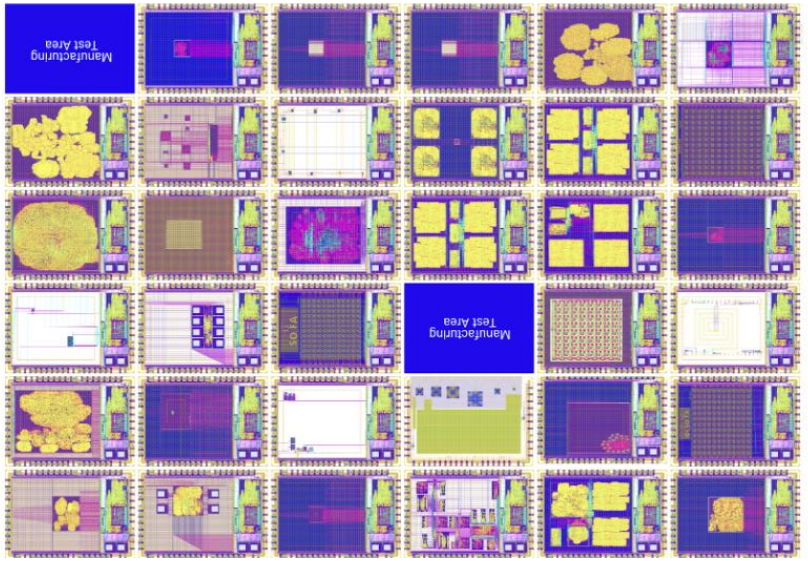
Summary

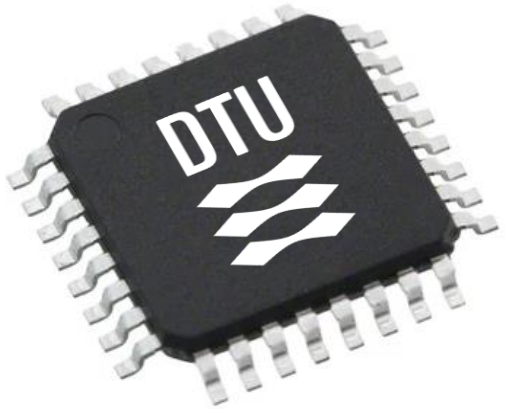


Patmos without memories









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Martin Schoeberl
masca@dtu.dk

Luca Pezzarossa
lpez@dtu.dk

The first open source chip developed at DTU!

https://github.com/os-chip-design


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