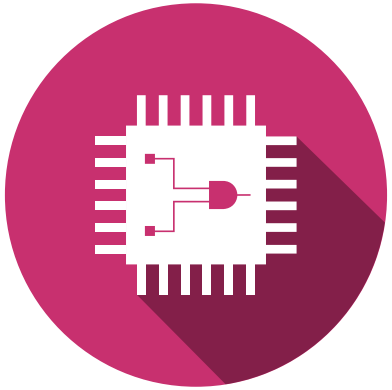
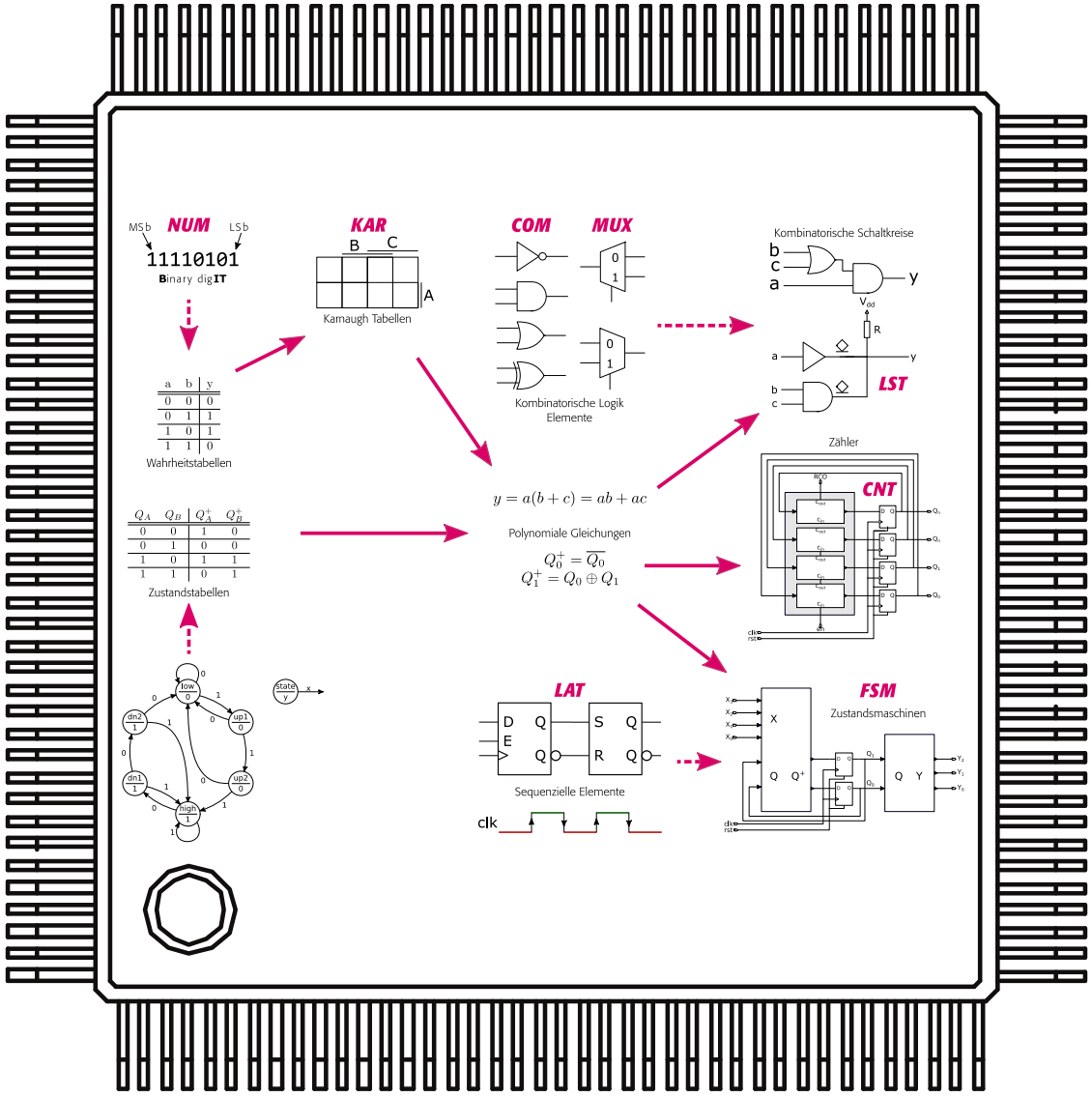
# Advanced Microprocessor Bus Architecture
# Course Embedded Systems (SEm)
# AMBA

Silvan Zahno / François Corthay



Degree program Systems Engineering
Specialization Infotronics – Embedded Systems

# Current content of the topic in the course



# Advanced Microprocessor Bus Architecture (AMBA)

- **General presentation**
- AHB and APB
- AHB-Lite
- EDA tools

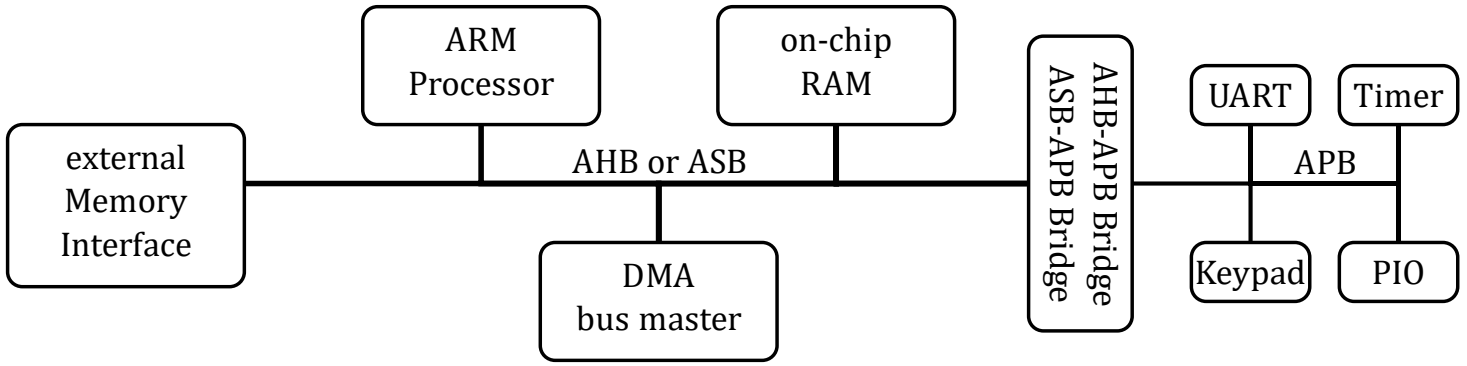
# General presentation

## AMBA Specification

By **A**dvanced **R**ISC **M**achines, Ltd (ARM) from 1996

Bus interfaces:

- **A**dvanced e**X**tensible **I**nterface (AXI)
- **A**dvanced **H**igh-performance **B**us (AHB)
- **A**dvanced **S**ystem **B**us (ASB)
- **A**dvanced **P**eripheral **B**us (APB)



# General Presentation
## Competitors for SoC

- Opencores Wishbone
- Altera Avalon (Altera Nios II)
- IBM CoreConnect (Xilinx Microblaze)

# General Presentation
## VHDL Cores

- By Aeroflex Gaisler (www.gaisler.com)

- Provides GRLib:
  - Library AMBA IP cores (GNU GPL)
  - Additional commercial IP cores
  - At start developed for European Space Agency (ESA)

# Advanced Microprocessor Bus Architecture (AMBA)

- General presentation
- **AHB and APB**
- AHB-Lite
- EDA tools

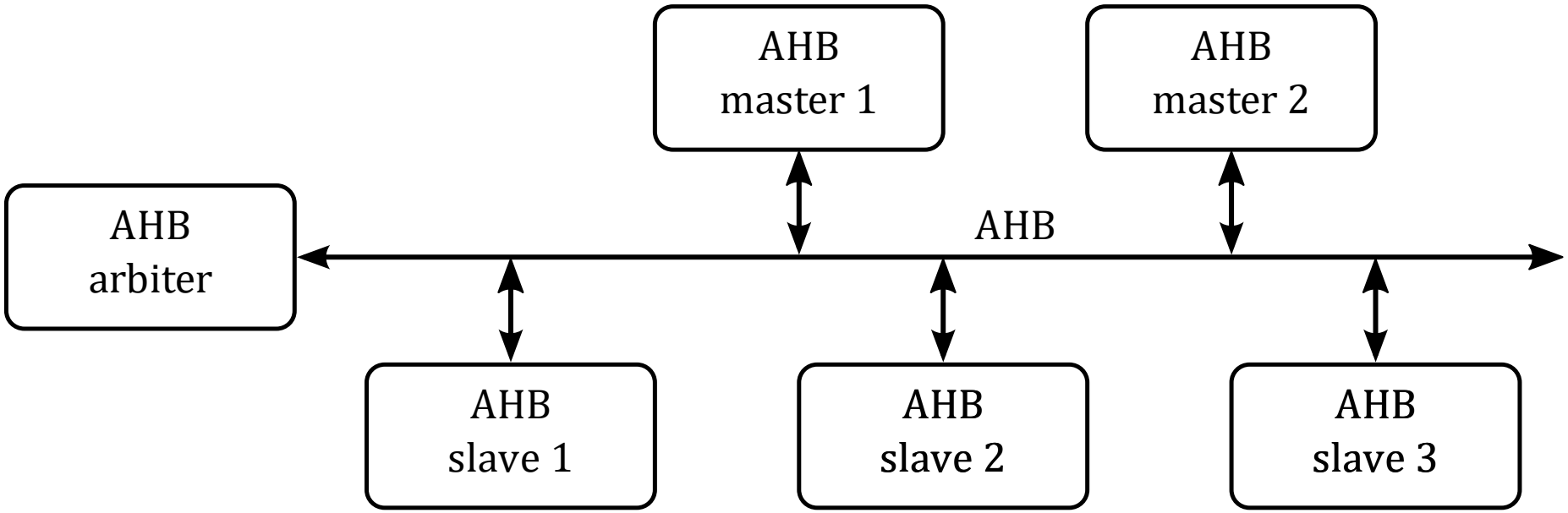
# AHB and APB

## Advanced High-performance Bus (AHB)

- Multi-master
- Bus arbiter
- Unidirectional data busses (in, out)
- Multiplexed busses (no tri-state)

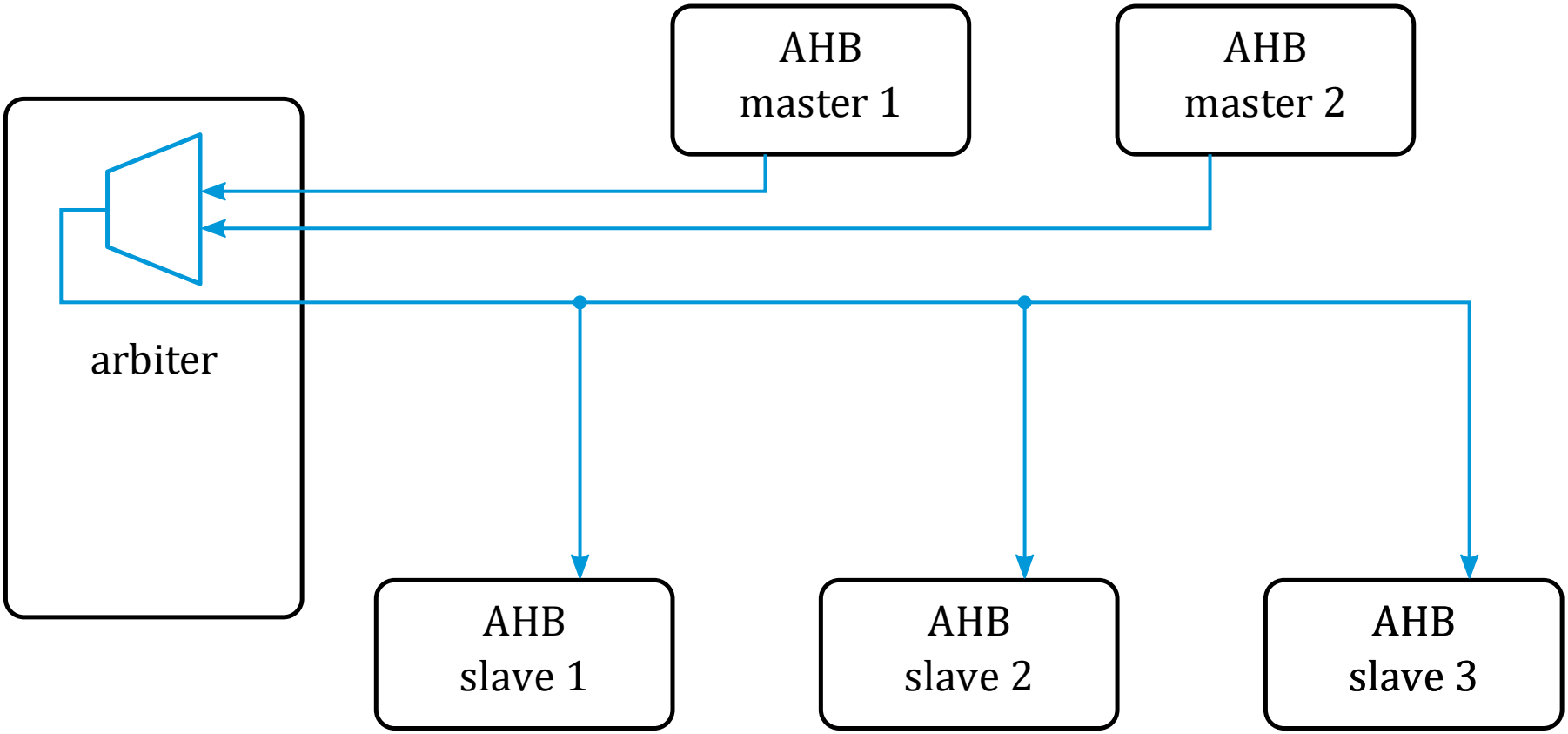
# AHB and APB

## AHB system view



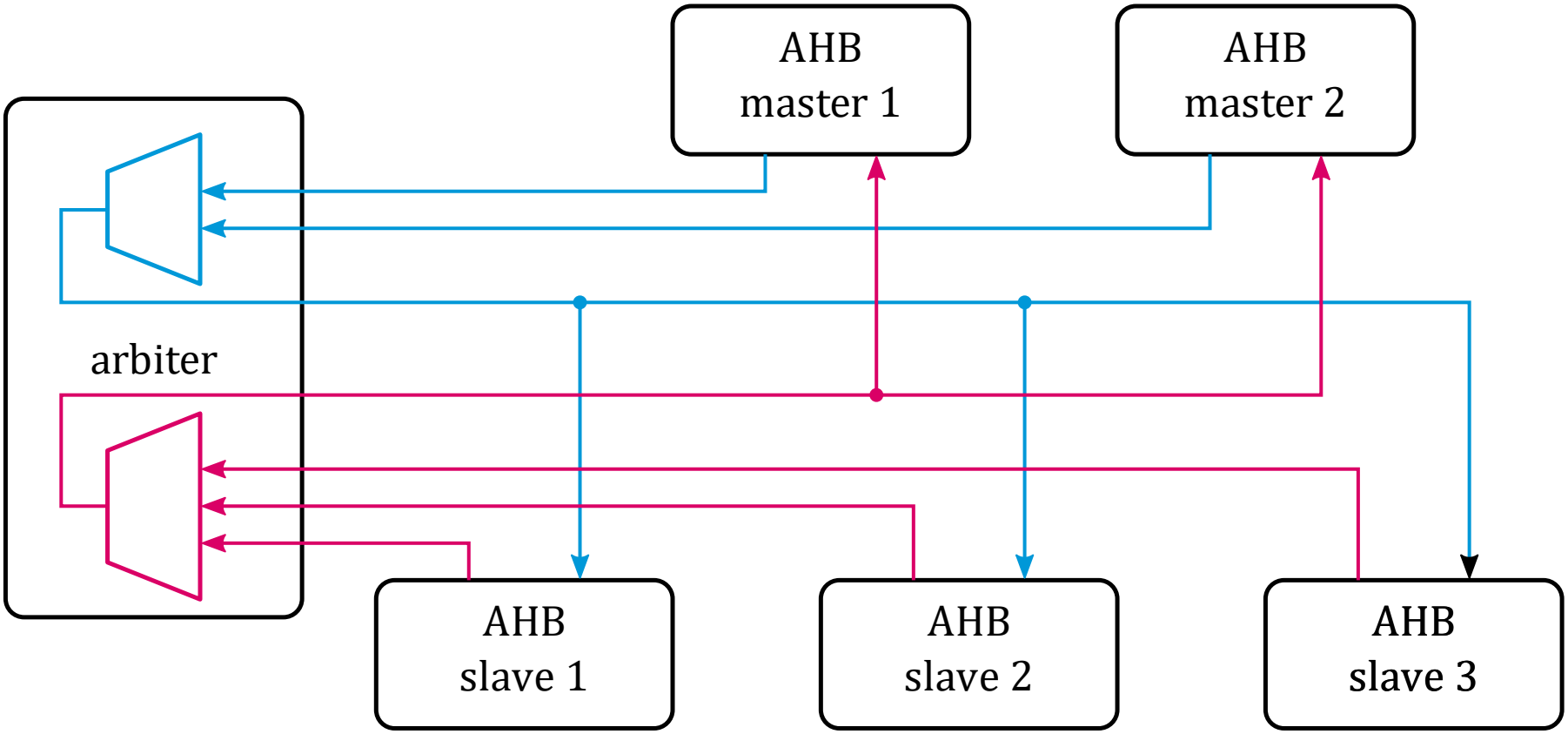
# AHB and APB

## AHB busses



# AHB and APB

## AHB busses



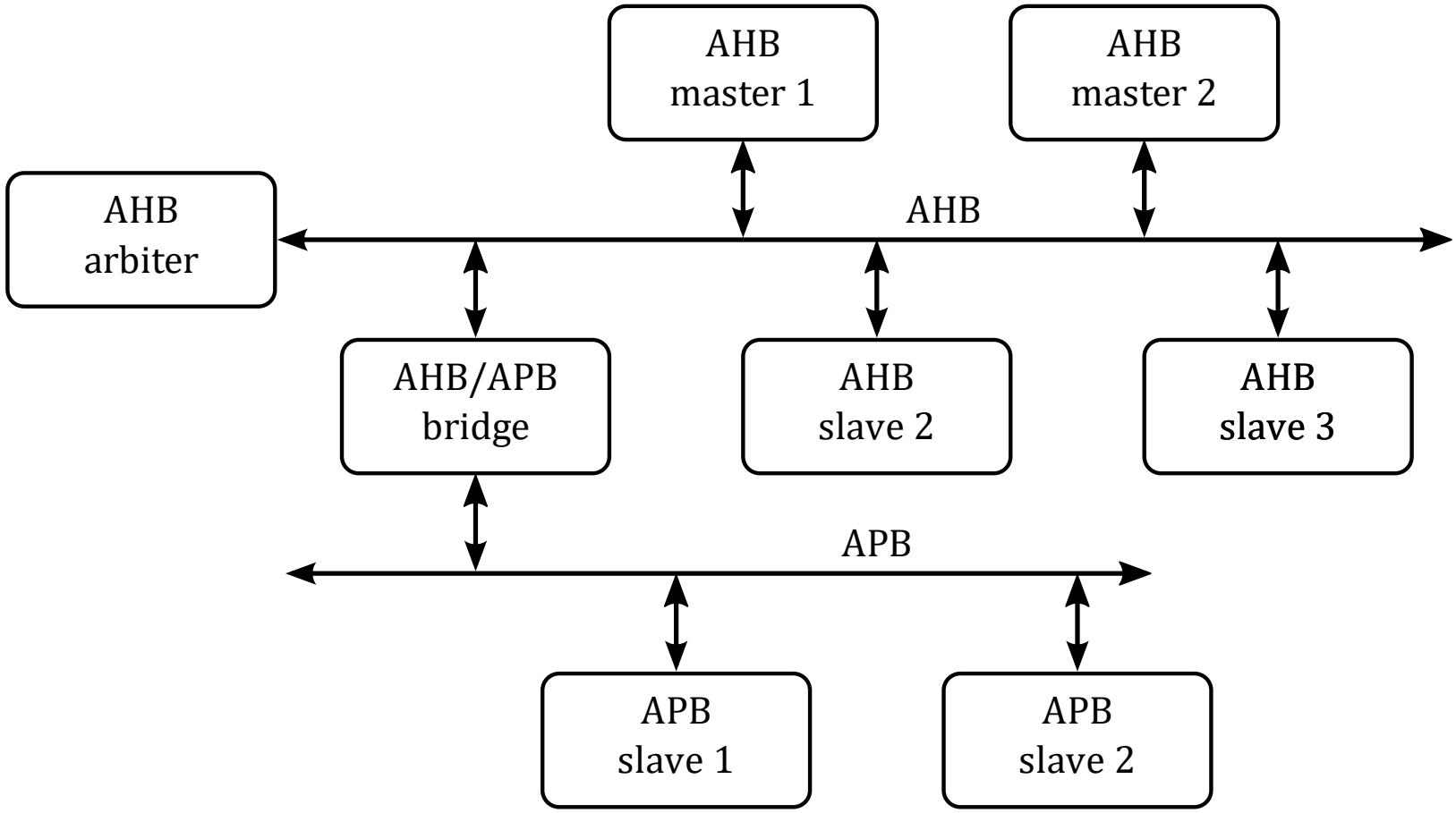
# AHB and APB

## Advanced Peripheral Bus (APB)

- Single-master: the AHB/APB bridge
- Simple access (no bursts, ...)
- Unidirectional data busses (in, out)
- Multiplexed busses (no tri-state)

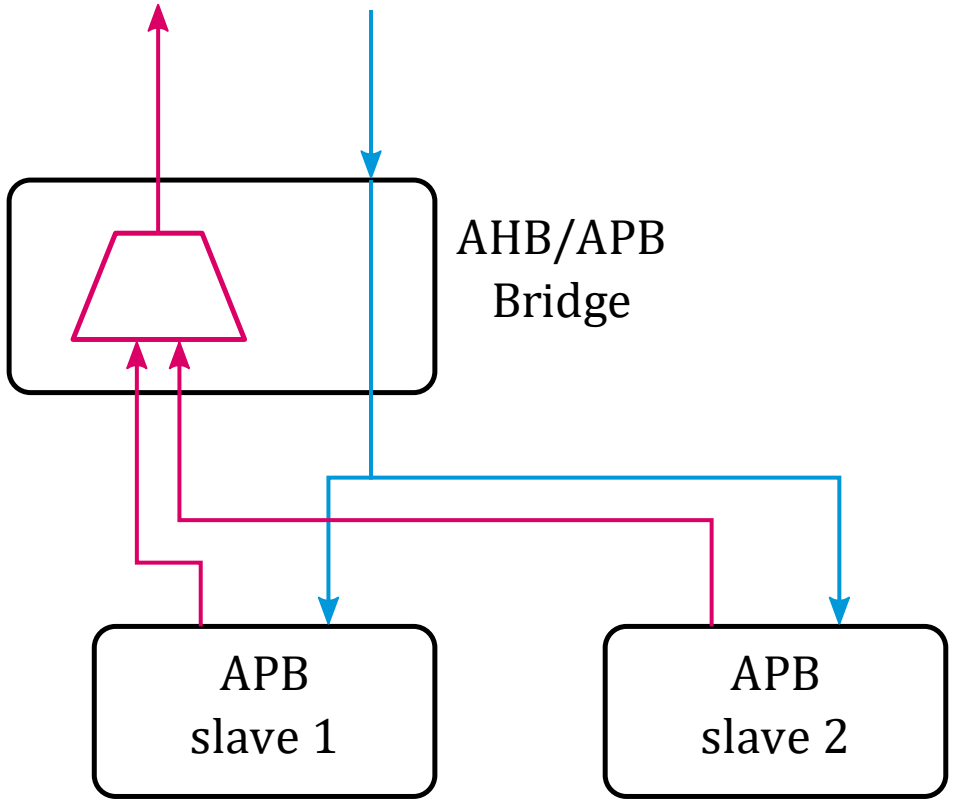
# AHB and APB

## AHB / APB system view



# AHB and APB

## APB busses



# Advanced Microprocessor Bus Architecture (AMBA)

- General presentation
- AHB and APB
- **AHB-Lite**
- EDA tools

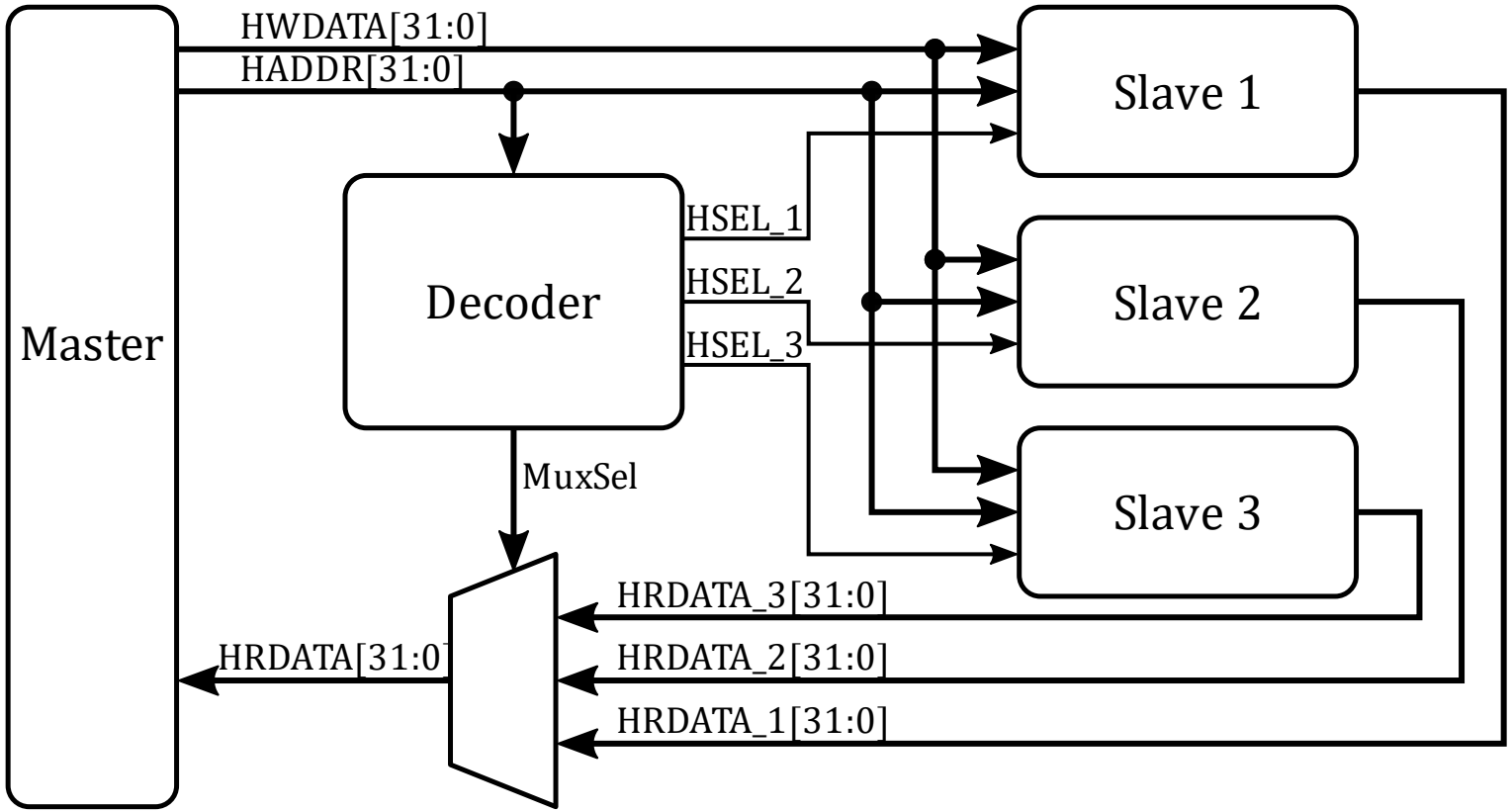
# AHB-Lite

- Single master
- High-speed throughput
- Data is 8, 16, 32, 64, 128, 256, 512, or 1024 bits

- AHB-Lite to APB bridge possible

# AHB-Lite

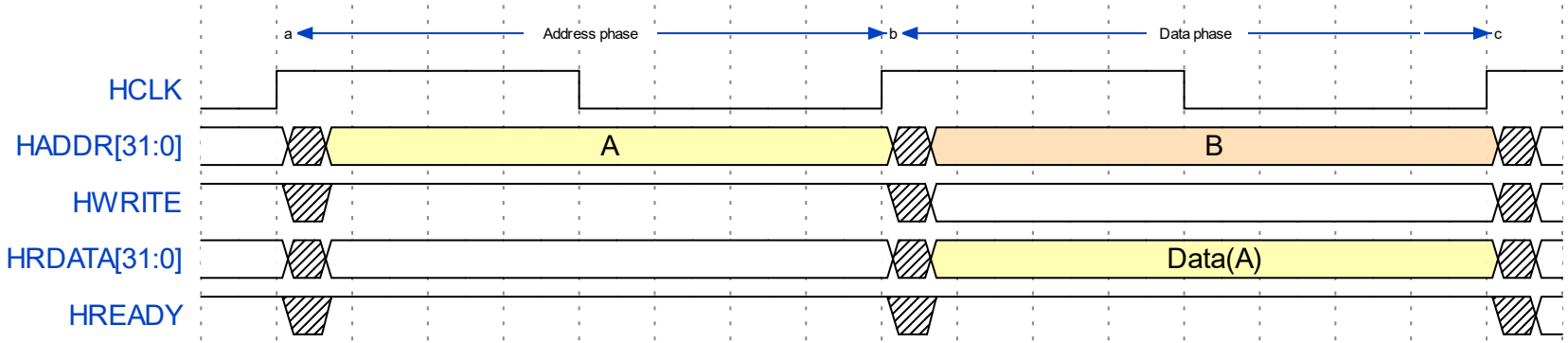
## System view



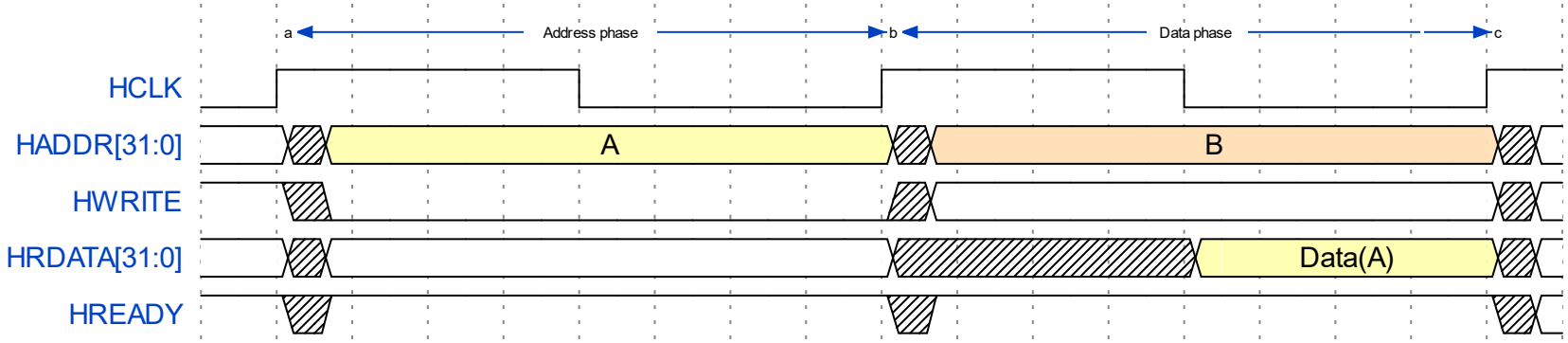
# AHB-Lite

## Read and Write

### Read

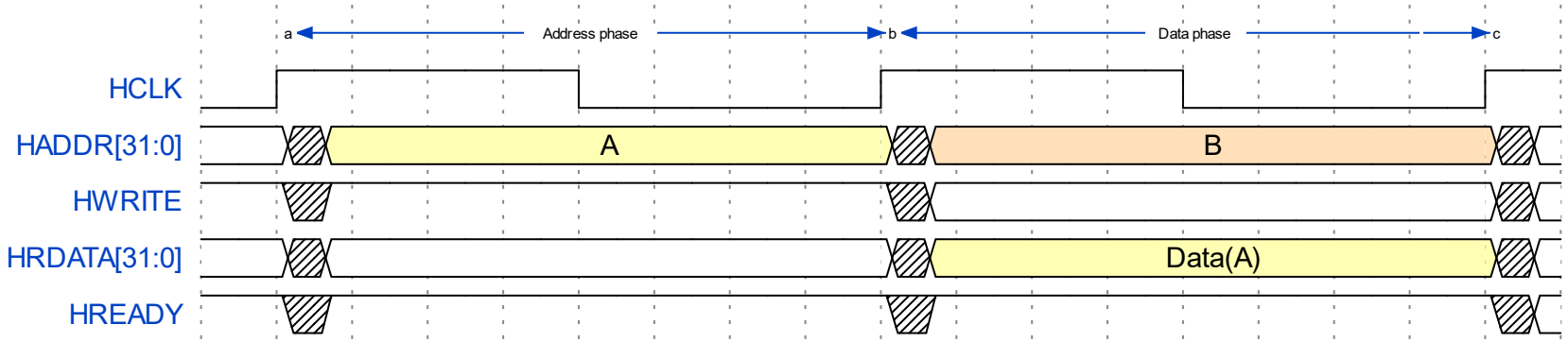



### Write



# AHB-Lite

## AHB bus pipeline



# Advanced Microprocessor Bus Architecture (AMBA)

- General presentation
- AHB and APB
- AHB-Lite
- **EDA tools**

# GRLib AMBA bus

- AHB/APB AMBA bus
  - With AHB arbiter (AHBctrl) and AHB/APB bridge
- (AHBBridge)
- IP core library
- Gaisler add-ons
  - Plug and play

# GRLib AMBA bus

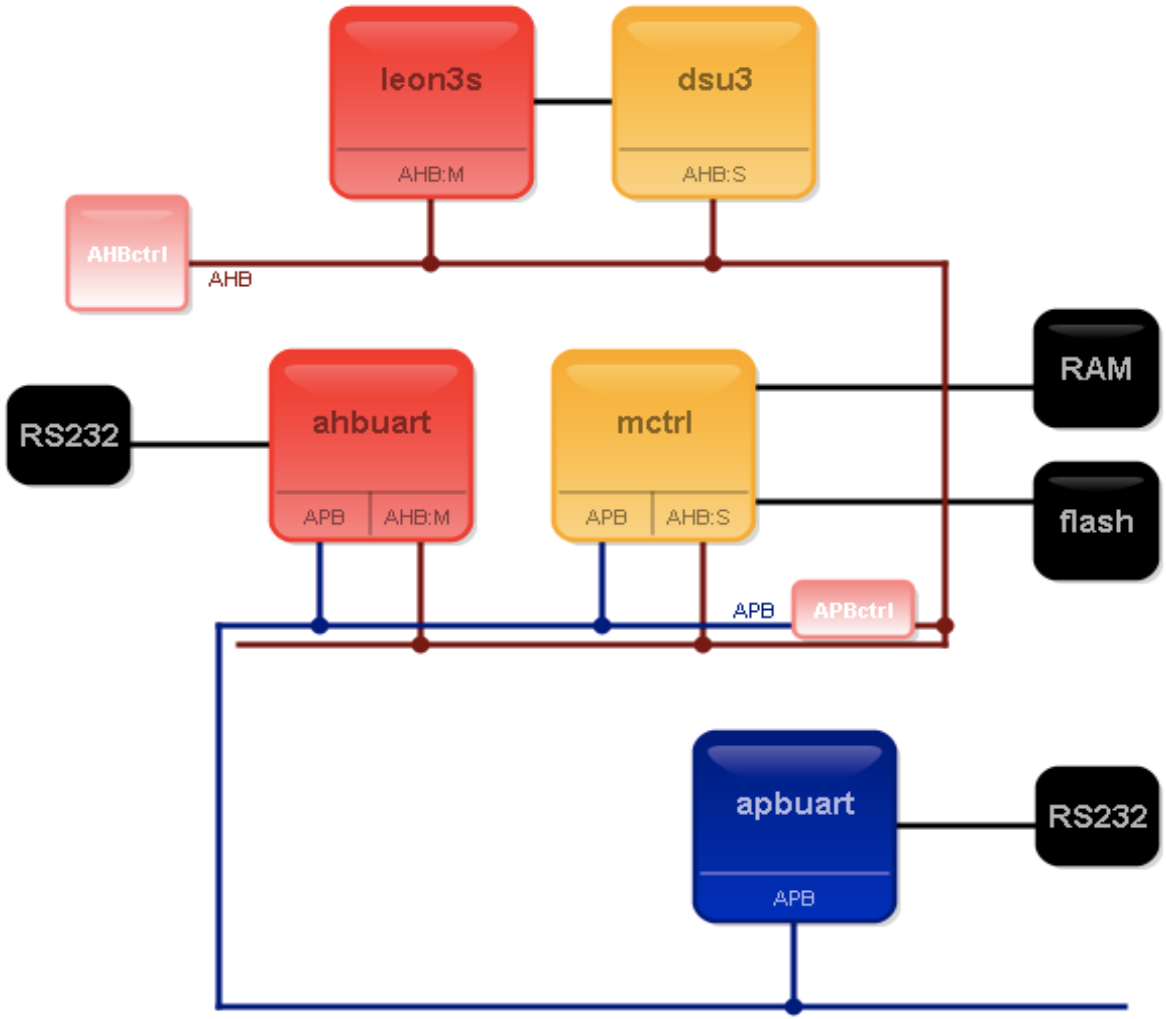
## AMBA Draw

- GUI for GRLib
- Developed at HES-SO
  - http://ambadraw.hevs.ch/
- Allows to draw a GRLib-based design
  - Simple representation for documentation purpose

# GRLib AMBA bus

## AMBA Draw

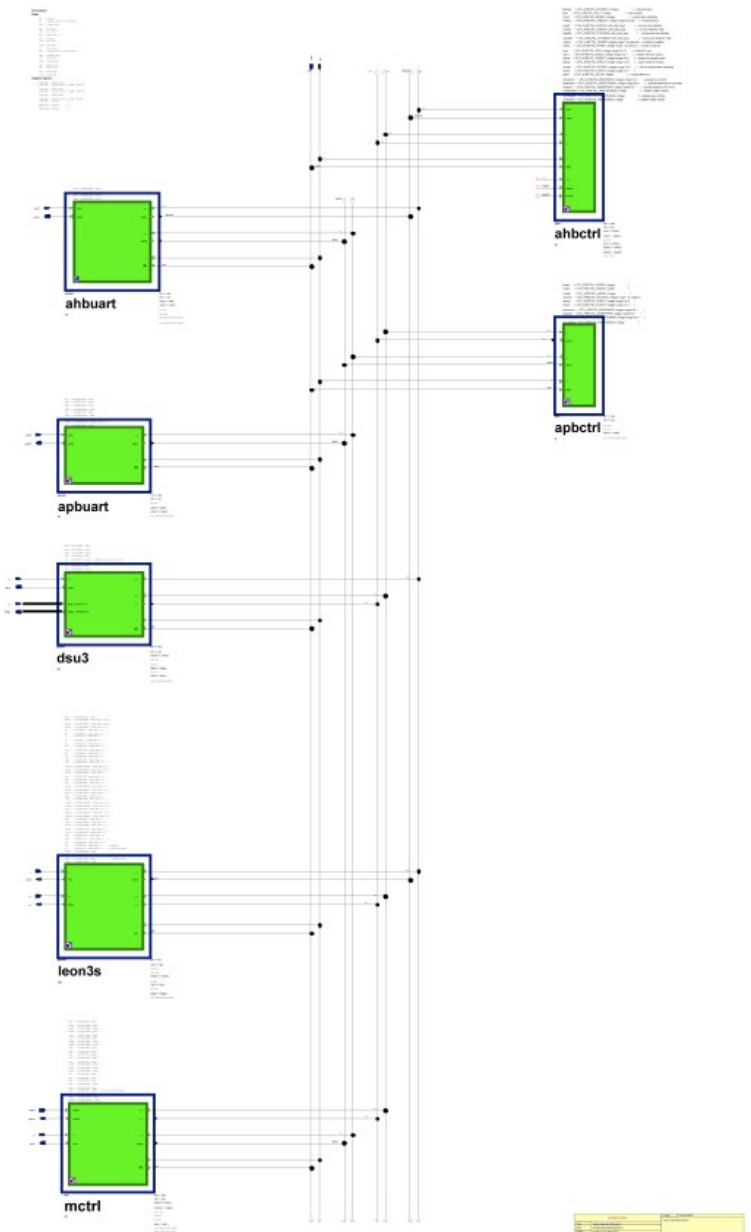
- Placing blocks
- Some blocks or lines only for description
- Editing blocks:
  - Lookup GRLib IP
  - Core user's manual
  - Bus connection(s)
  - Memory mapping



# GRLib AMBA bus

## HDL Designer

- HDL circuit generated by AMBAdraw
  - Trimmed-down version of a reference design with all GRLib IP cores
  - Blocks with generic parameters
  - and a library with constants
- With signals and ports defined as records



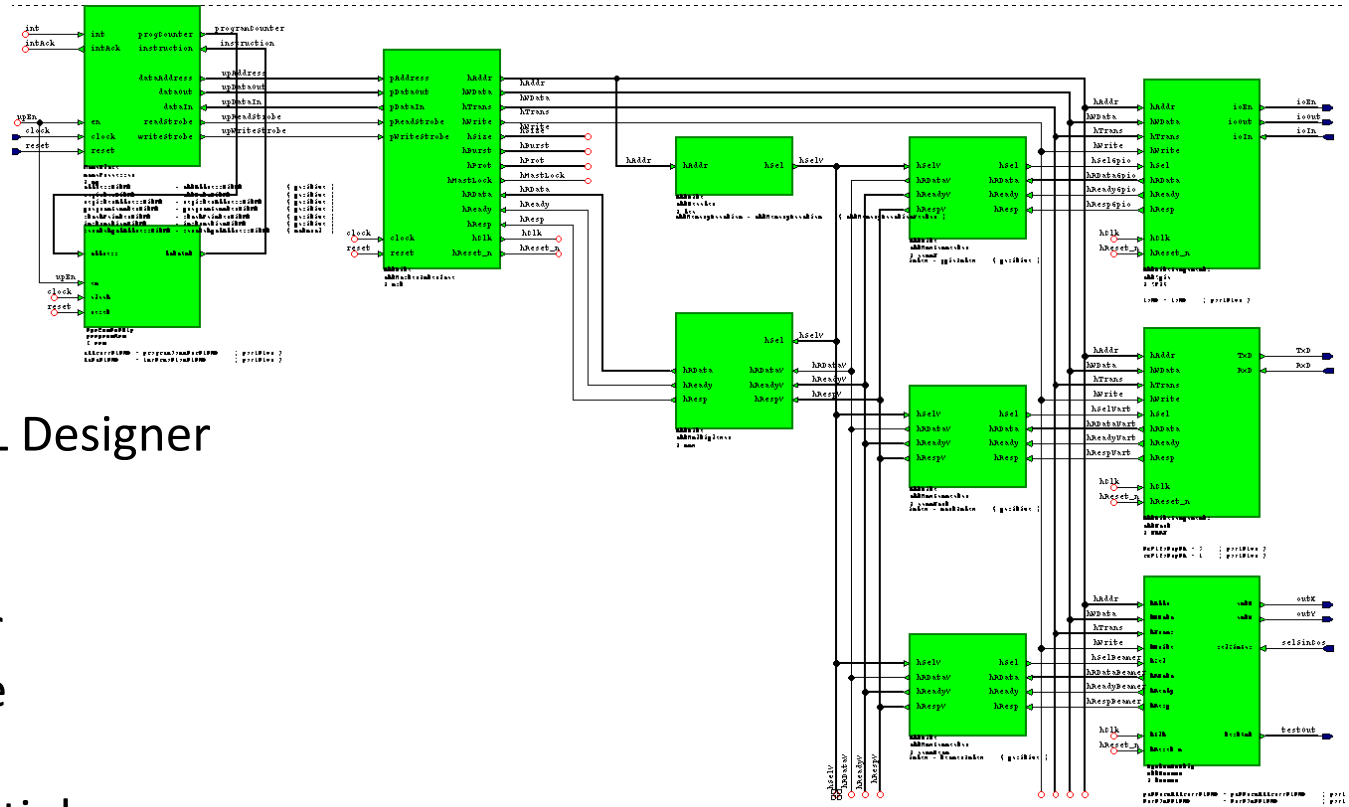
# GRLib AMBA bus

## Lab AHB-Lite system

- Processor (nanoBlaze => Risc-V)
- Initializes the peripherals' registers
- Interprets commands from serial port for reading and writing in the address space
- Could be replaced by a state machine

# GRLib AMBA bus

## Lab AHB-Lite system



- Directly drawn in HDL Designer

- Components:
  - microprocessor
  - AHB-Lite bridge
  - decoder
  - distributed multiplexer
  - Peripherals:
    - GPIO
    - UART
    - beamer

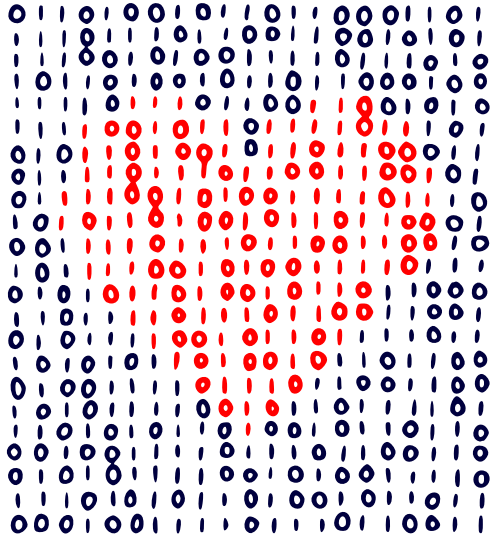
# GRLib AMBA bus

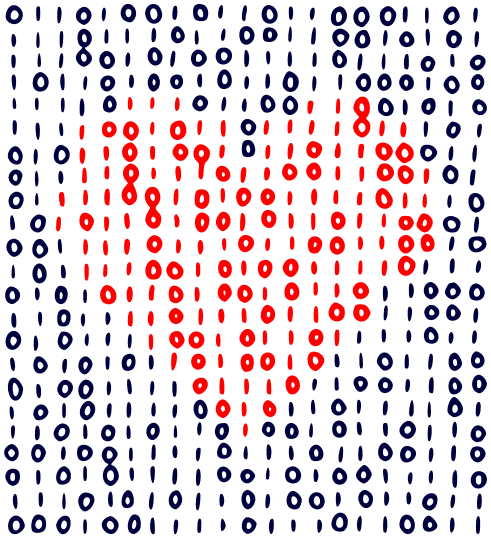
## AHB-Lite system components

- ahbMasterInterface
  - from the processor to the AHB-Lite bus
- ahbDecoder
  - address decoder, bases on constants to be declared
- ahbMultiplexor, ahbMuxConnector
  - distributed multiplexer (expandable)

# VHDL

- We now know everything about:
  - AMBA Bus
  - AHB and APB
  - AHB-Lite
  - EDA tools






:
Σ
π
≈
&