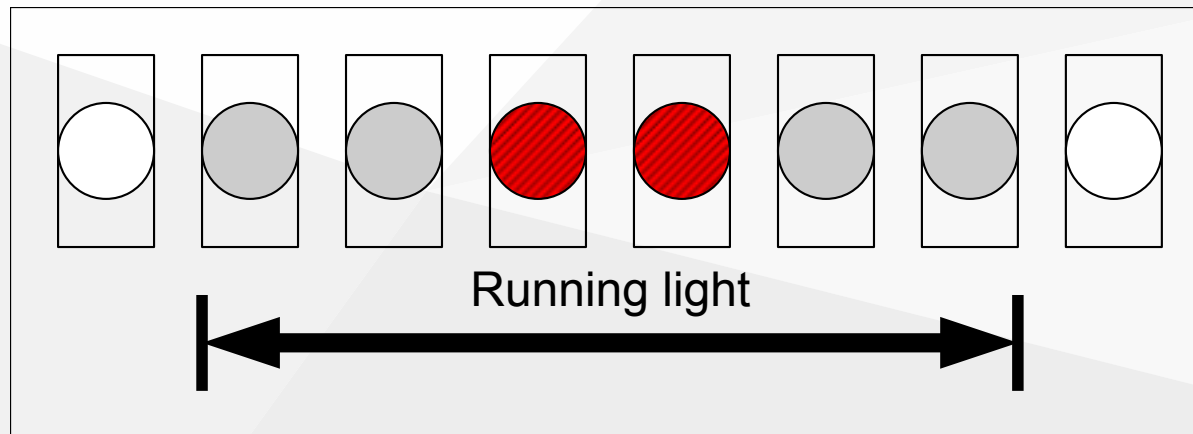


RISC-V Lab

Ex1: Introduction Verilog Background



Content

1. Organisation
2. Project overview
3. Exercise 1: HDL Entry & Simulation
4. Group registration

Organisation

- 4 students per team
- **project**: **self defined** HW (FPGA) / SW (RISC-V)
e.g.: real time video & audio, many-core X, networking...

Formals

- module = lecture + project
- 6 ECTS (\Leftrightarrow *27.5h / 12 lecture weeks = 14h/week)
- project ET / CS
- see module description for exam details

(To) Do's

1. 6 assignments **completed in time** (=one week, deadline 2 weeks)
walk you through the design flow & build base of your project
2. your project's **self specified** functionality demonstrated **on FPGA**
3. **take part** in mid- and final presentations (incl. video clip)
4. project specification & documentation
("on the go", effort minimized)

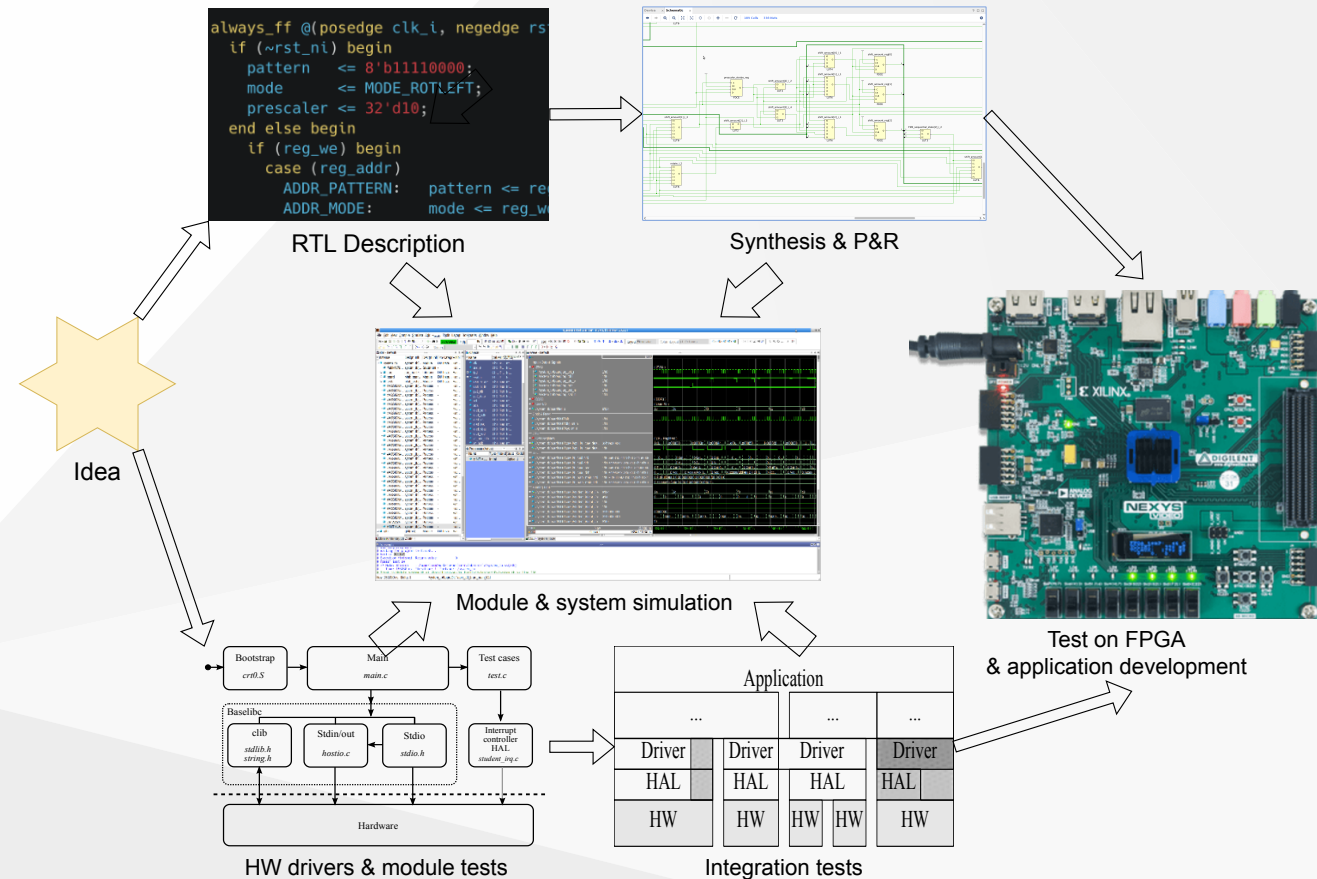
Support

- `/home/rvlab/docs/index.html` !!!
- IT (workstations, EDA tools, licenses ..)
 - Adela Westedt: adela.westedt@tu-berlin.de, 24248, EN435a
 - Rene Hartman: rene.hartmann@tu-berlin.de, 25351, EN435a
- Marco Liem: marco.liem@campus.tu-berlin.de (-> ZOOM)
- Tobias Kaiser: kaiser@tu-berlin.de, 25561, EN411

Rvlab Overview

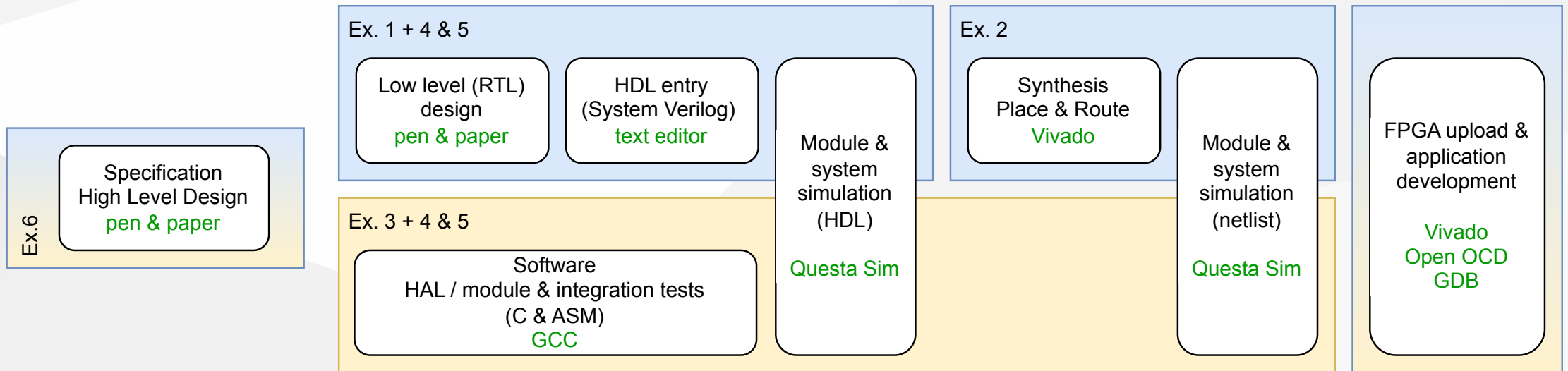
Flow (simple)

Simulation is king !
(not PCB tinkering)

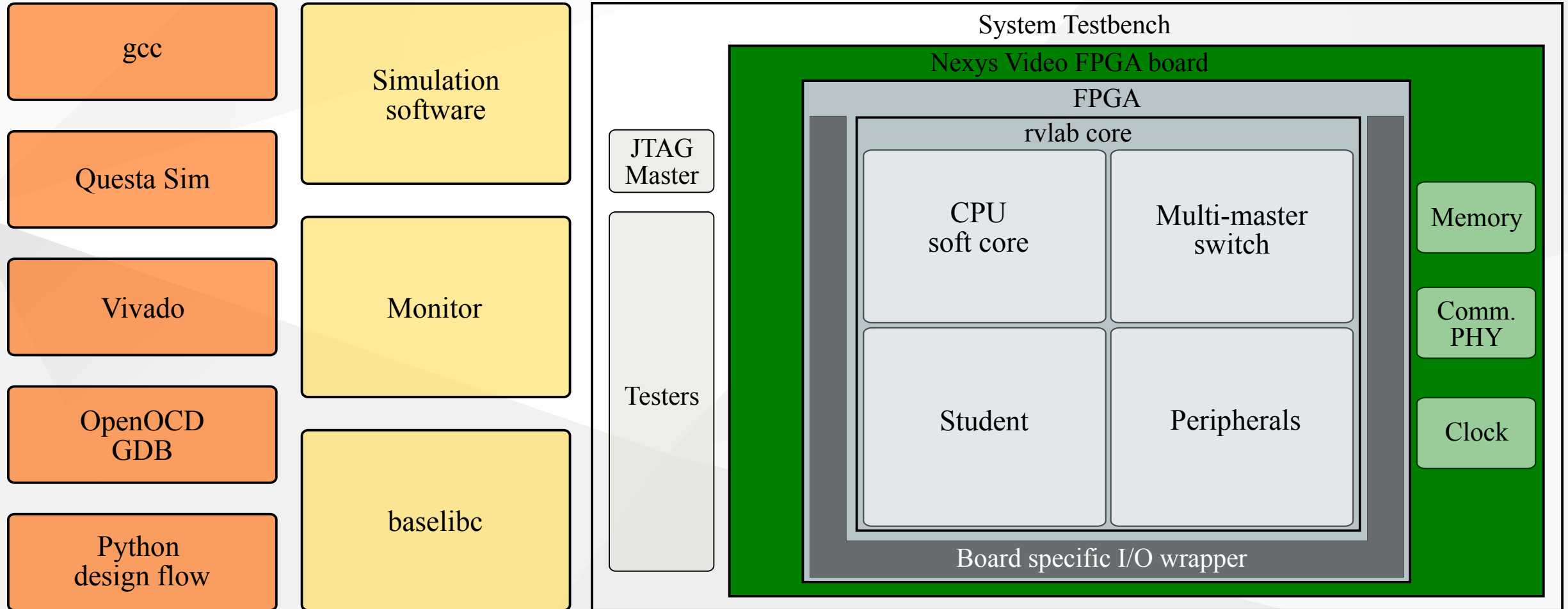


Rvlab Flow

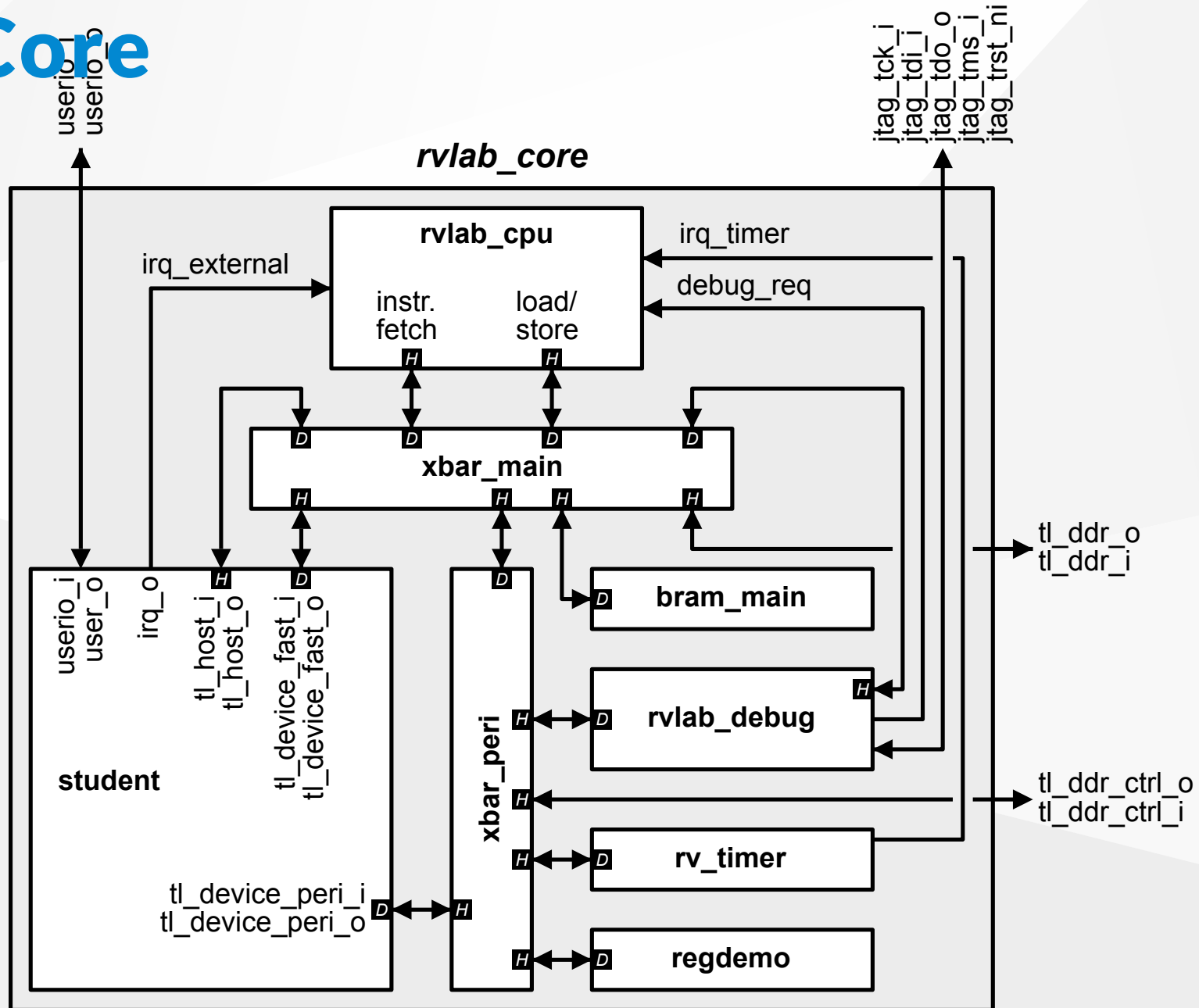
Your
Idea



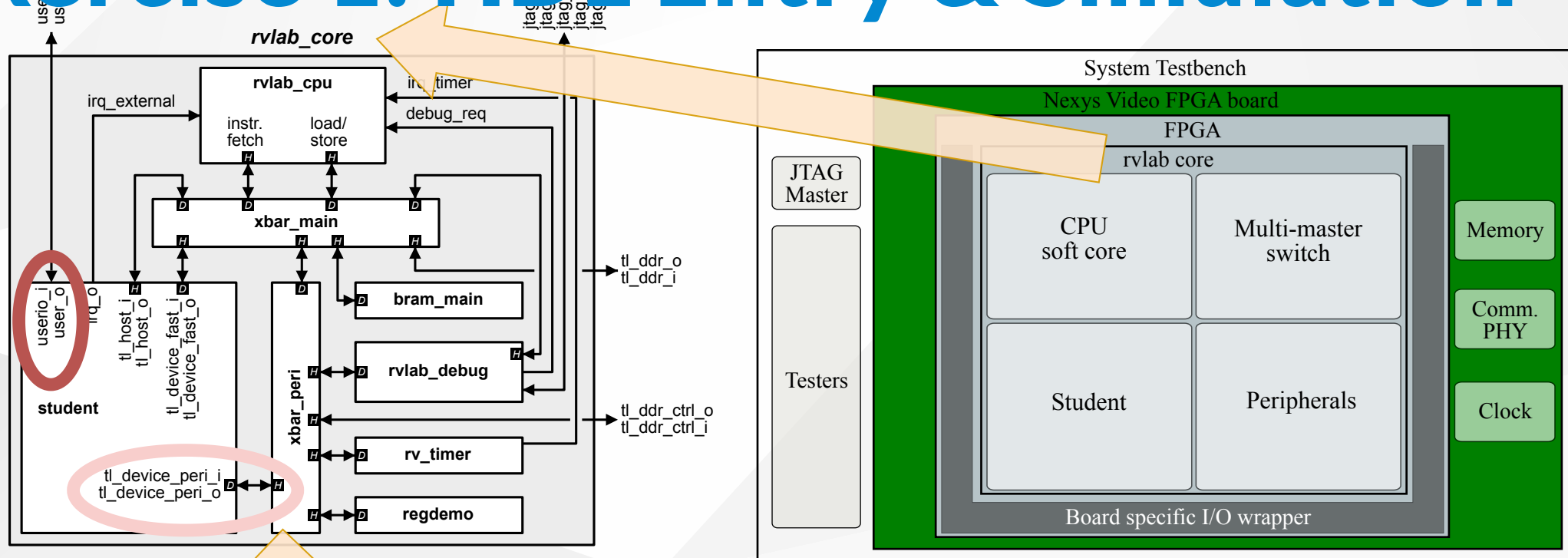
Rvlab System



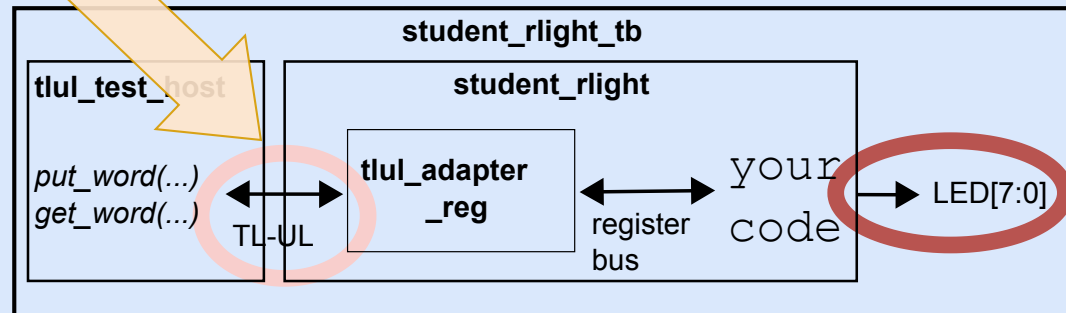
Rvlab Core



Exercise 1: HDL Entry & Simulation

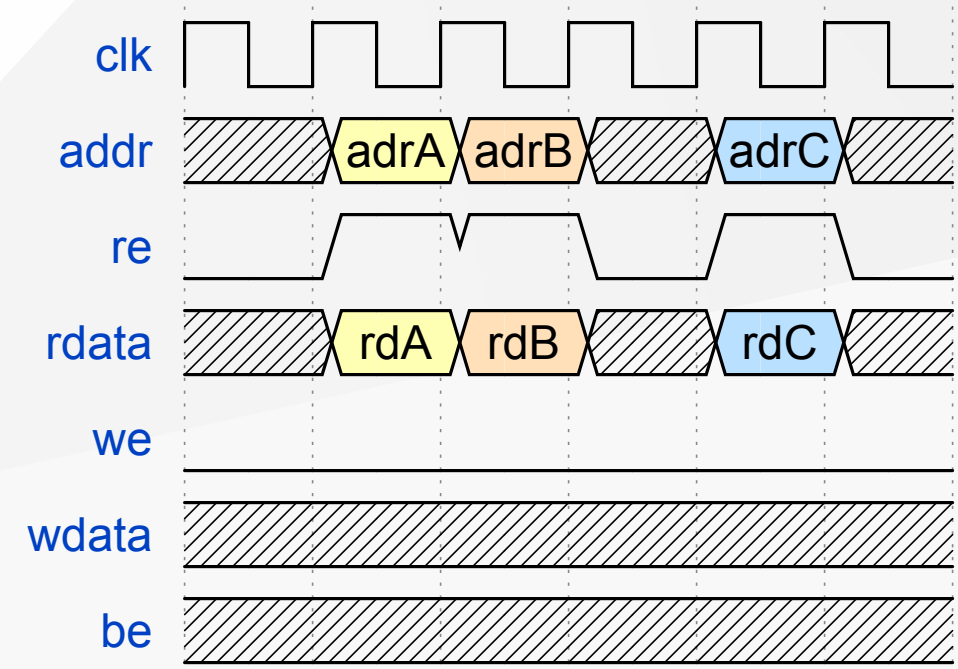


Exercise 1



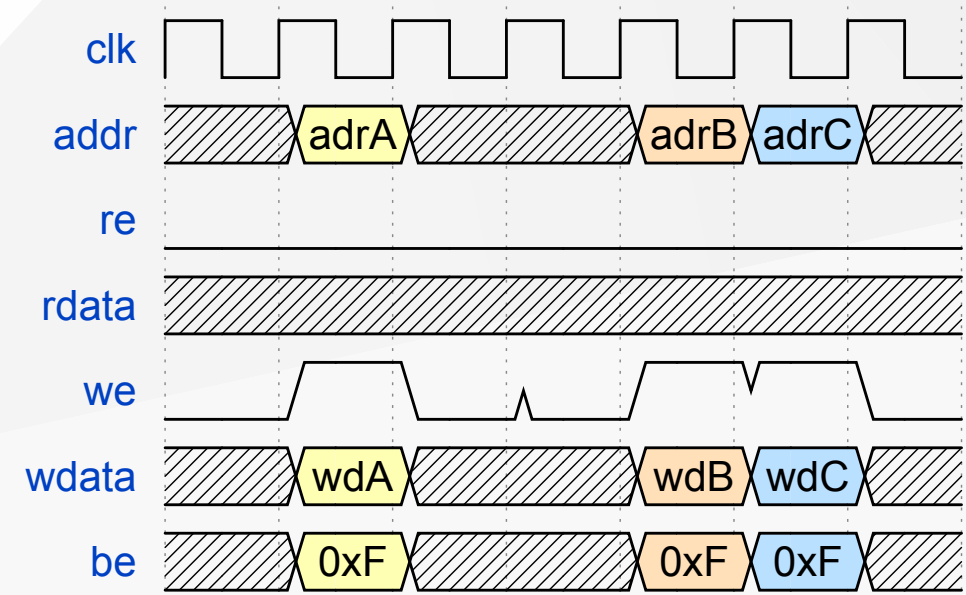
Register bus read

```
localparam logic [3:0] ADDR_REGA = 4'h0;  
localparam logic [3:0] ADDR_REGB = 4'h4;  
  
logic [31:0] regA;  
logic [ 7:0] regB;  
  
always_comb begin  
    rdata = '0; // !!!  
    if (re) begin  
        case (addr)  
            ADDR_REGA: rdata[31:0] = regA;  
            ADDR_REGB: rdata[ 7:0] = regB;  
            default:   rdata      = '0;  
        endcase  
    end  
end
```



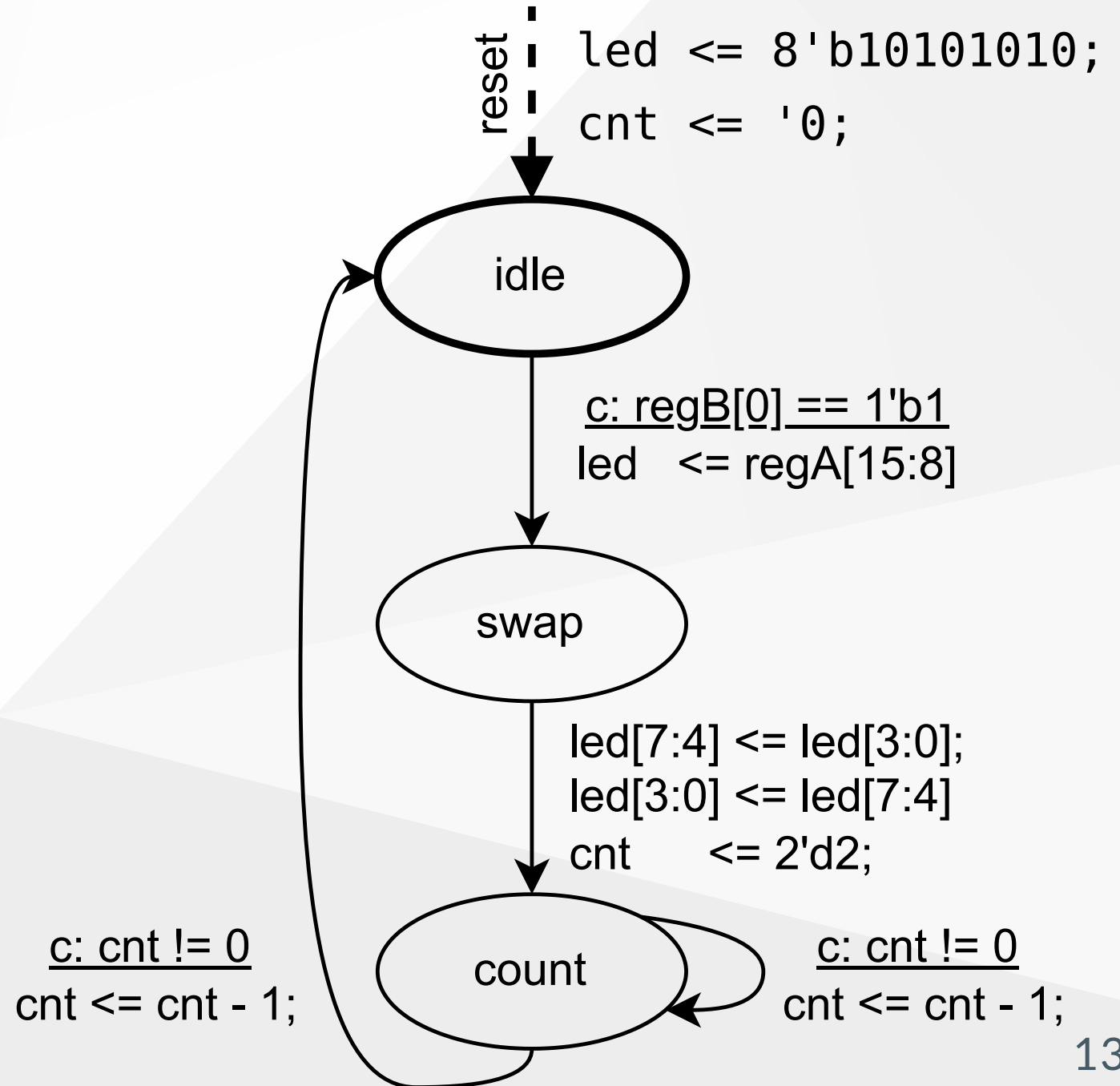
Register bus write

```
always_ff @(posedge clk_i, negedge rst_ni) begin
  if (~rst_ni) begin
    regA    <= 32'h0000AFFE; // reset value
    regB    <= '0;           // reset value
  end else begin
    if (we) begin
      case (addr)
        ADDR_REGA: regA <= wdata[31:0];
        ADDR_REGB: regB <= wdata[ 7:0];
        default: ;
      endcase
    end // if(we)
  end // if (~rst_ni) else
end
```



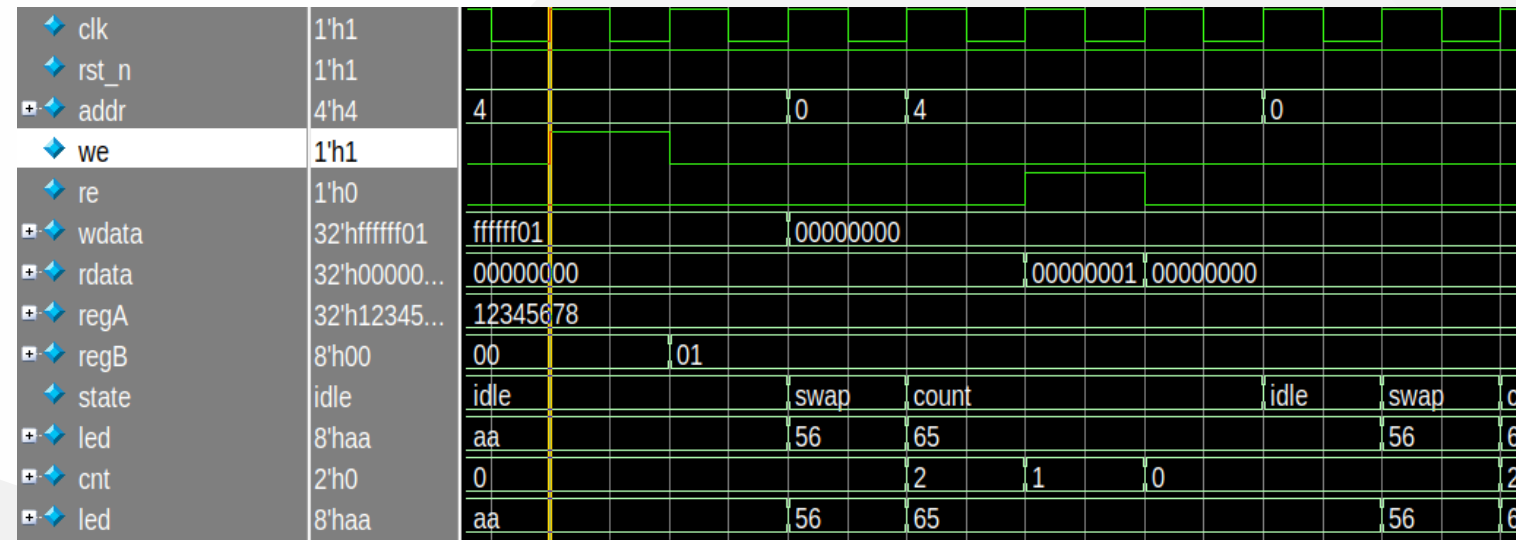
Demo FSM

```
enum logic[1:0] {idle, swap, count} state;
logic [7:0] led;  logic [1:0] cnt;
always_ff @(posedge clk_i, negedge rst_ni) begin
  if (~rst_ni) begin
    state  <= idle;
    led    <= 8'b10101010;
    cnt    <= '0;
  end else begin
    case (state)
      idle: begin
        if (regB[0] == 1'b1) begin
          led  <= regA[15:8];
          state <= swap;
        end
      end
      swap: begin
        led[7:4] <= led[3:0];
        led[3:0] <= led[7:4];
        cnt      <= 2'd2;
        state    <= count;
      end
      count: begin
        if (cnt != 0) begin
          cnt <= cnt - 1;
        end
        else begin
          state <= idle;
        end
      end
      default: begin state <= idle; end
    endcase;
  end // if (~rst_ni) else
end
```



Demo FSM

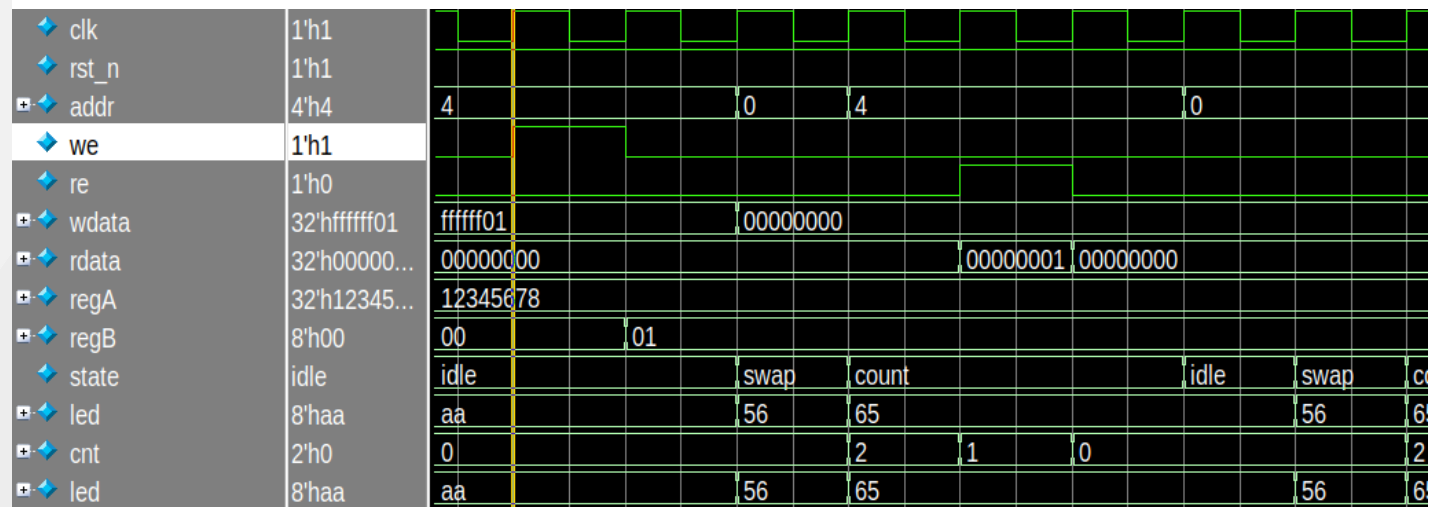
```
enum logic[1:0] {idle, swap, count} state;
logic [7:0] led;  logic [1:0] cnt;
always_ff @(posedge clk_i, negedge rst_ni) begin
    if (~rst_ni) begin
        state    <= idle;
        led      <= 8'b10101010;
        cnt      <= '0;
    end else begin
        case (state)
            idle: begin
                if (regB[0] == 1'b1) begin
                    led  <= regA[15:8];
                    state <= swap;
                end
            end
            swap: begin
                led[7:4] <= led[3:0];
                led[3:0] <= led[7:4];
                cnt      <= 2'd2;
                state    <= count;
            end
            count: begin
                if (cnt != 0) begin
                    cnt <= cnt - 1;
                end
                else begin
                    state <= idle;
                end
            end
            default: begin state <= idle; end
        endcase;
    end // if (~rst_ni) else
end
```



Demo FSM

```
enum logic[1:0] {idle, swap, count} state;
logic [7:0] led;
logic [1:0] cnt;
always_ff @(posedge clk_i, negedge rst_ni)
begin
    if (~rst_ni) begin
        state <= idle;
        led <= 8'b10101010;
        cnt <= '0;
    end else begin
        case (state)
            idle: begin
                if (regB[0] == 1'b1) begin
                    led <= regA[15:8];
                    state <= swap;
                end
            end
            swap: begin
                led[7:4] <= led[3:0];
                led[3:0] <= led[7:4];
                cnt <= 2'd2;
                state <= count;
            end
            count: begin
                if (cnt != 0)
                    cnt <= cnt - 1;
                else begin
                    state <= idle;
                end
            end
            default: begin
                state <= idle;
            end
        endcase
    end // if (~rst_ni) else
end
```

```
count: begin
    if (cnt != 0)
        cnt <= cnt - 1;
    end
else begin
    state <= idle;
end
end
default: begin
    state <= idle;
end
endcase;
end // if (~rst_ni) else
end
```



RTL Simulation with Questa Sim

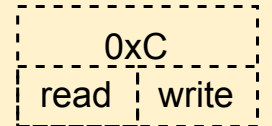
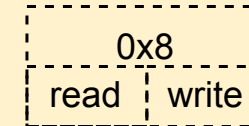
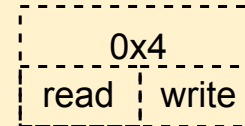
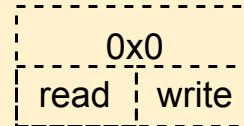
- Inputs
 - RTL design in *synthesisable* HDL
 - test bench in HDL
 - tcl scripts: wave view formatting (.do), ...
- Outputs
 - value trace of all signals
 - messages from display\$()

```
flow student_rlight_tb.sim_rtl_questa
```

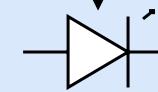
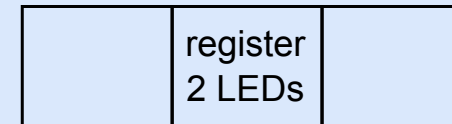
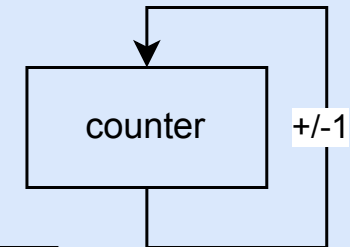
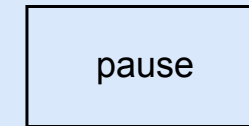
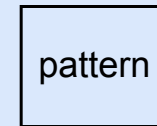
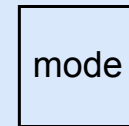

Hints for Ex.1

- address space ("registers") != physical registers
- handle conflicting writes (HW vs. SW)!
Suggestions !

Programmer's view: "registers" (=addresses)



Physical realisation (example)



Group registration & 1st login

1. **Self organize** groups of 4 students each
2. Each group comes forward & registers
3. Each group receives one account for the msc network
user: rvlab[01-20] / password:
4. Walk to EN4141 / Door code:
or
 - i) connect to TUBIT VPN
 - ii) log in using wiki.x2go.org
 - iii) X2GO server: msclab.msc.tu-berlin.de, desktop: XFCE
5. Change password immediately: `passwd`
Detailed instructions for X2GO on ISIS page.

Getting rvlab

1. Log into the msc network using your rvlab?? account.
2. Clone the git using your TUBIT account:

```
git clone https://git.tu-berlin.de/msc/rvlab
```

3. Start with the 1st exercise sheet:

```
firefox /home/rvlab/docs/index.html
```

*(**No** support: If you want to run rvlab on your own machine see `rvlab/README.rst`.)*

Appendix

Kill a dead session on the server

1. ssh on the server
2. `x2go listsessions` to list your running sessions and get their ID
It will return a string, e.g. 494|slehmann-62-1536514901_stDXFCE_dp24|62|mscx2go|...
The second field is the session ID e.g. "slehmann-62-1536514901_stDXFCE_dp24"
3. `x2go terminate-session slehmann-62-1536514901_stDXFCE_dp24`