

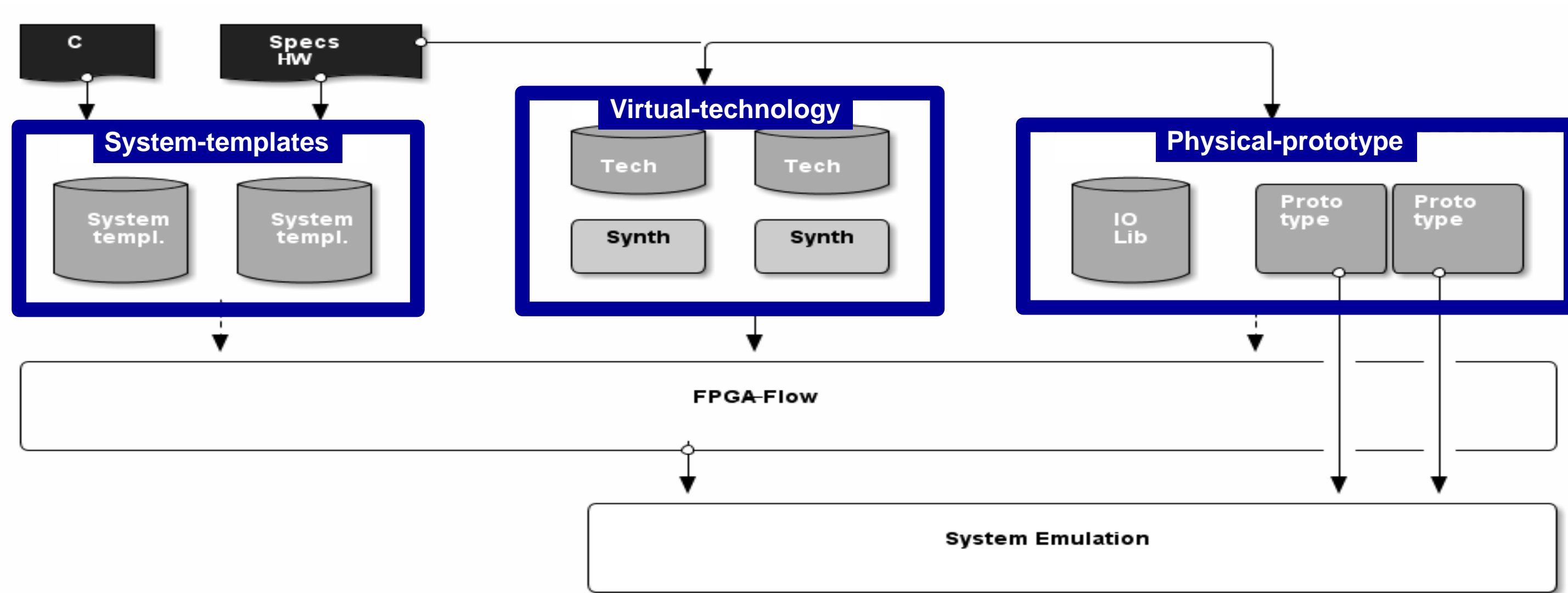
# A Framework for the Emulation and Prototyping of Nano-Photonic Optical Accelerators

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## Introduction:

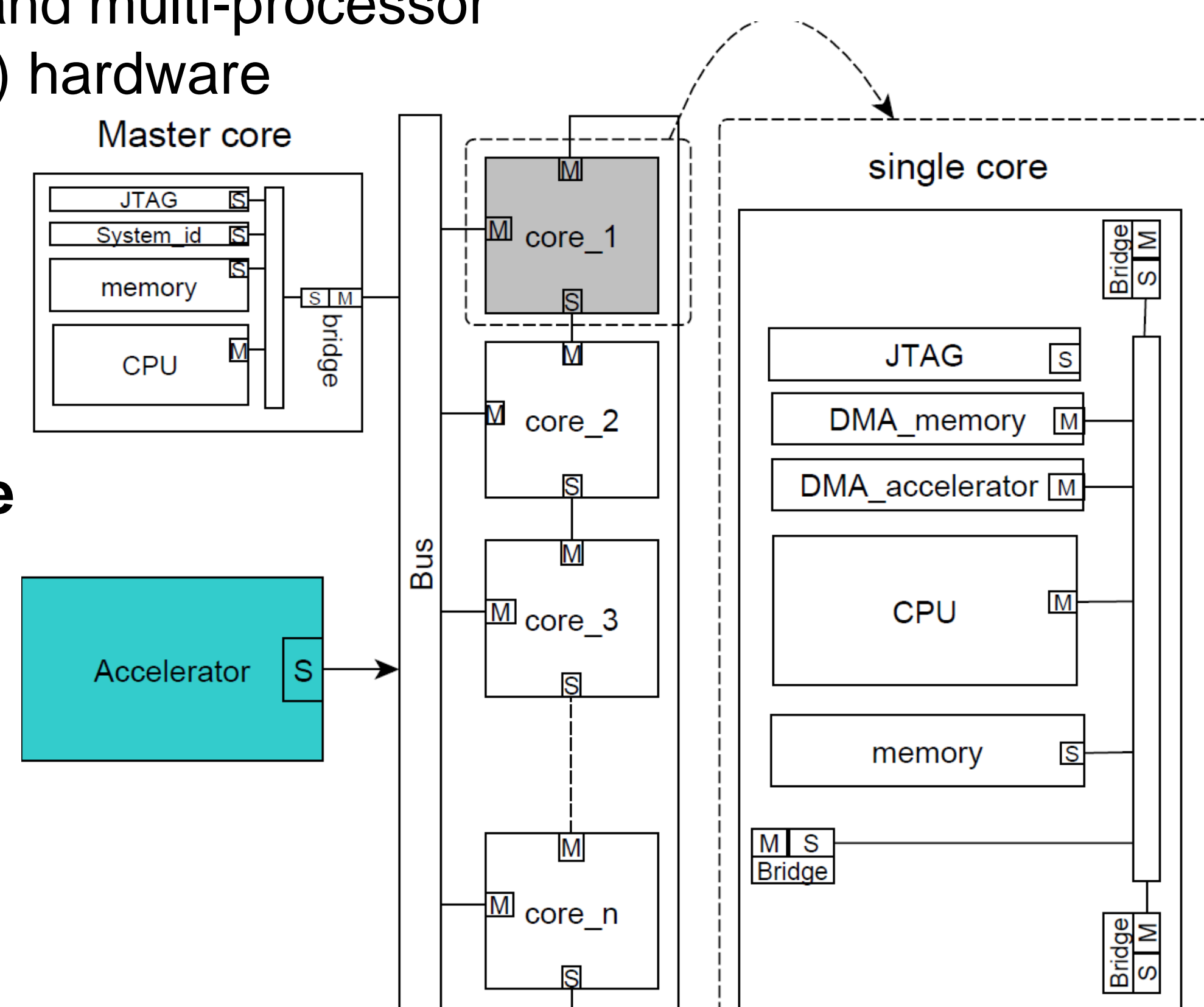
- This work presents a technology-agnostic rapid prototyping framework focusing on optical analog processing and digital optical gates.
- Motivation: System exploration for nano-photonic accelerators at an early stage.

## Early stage rapid prototyping framework



## System-templates

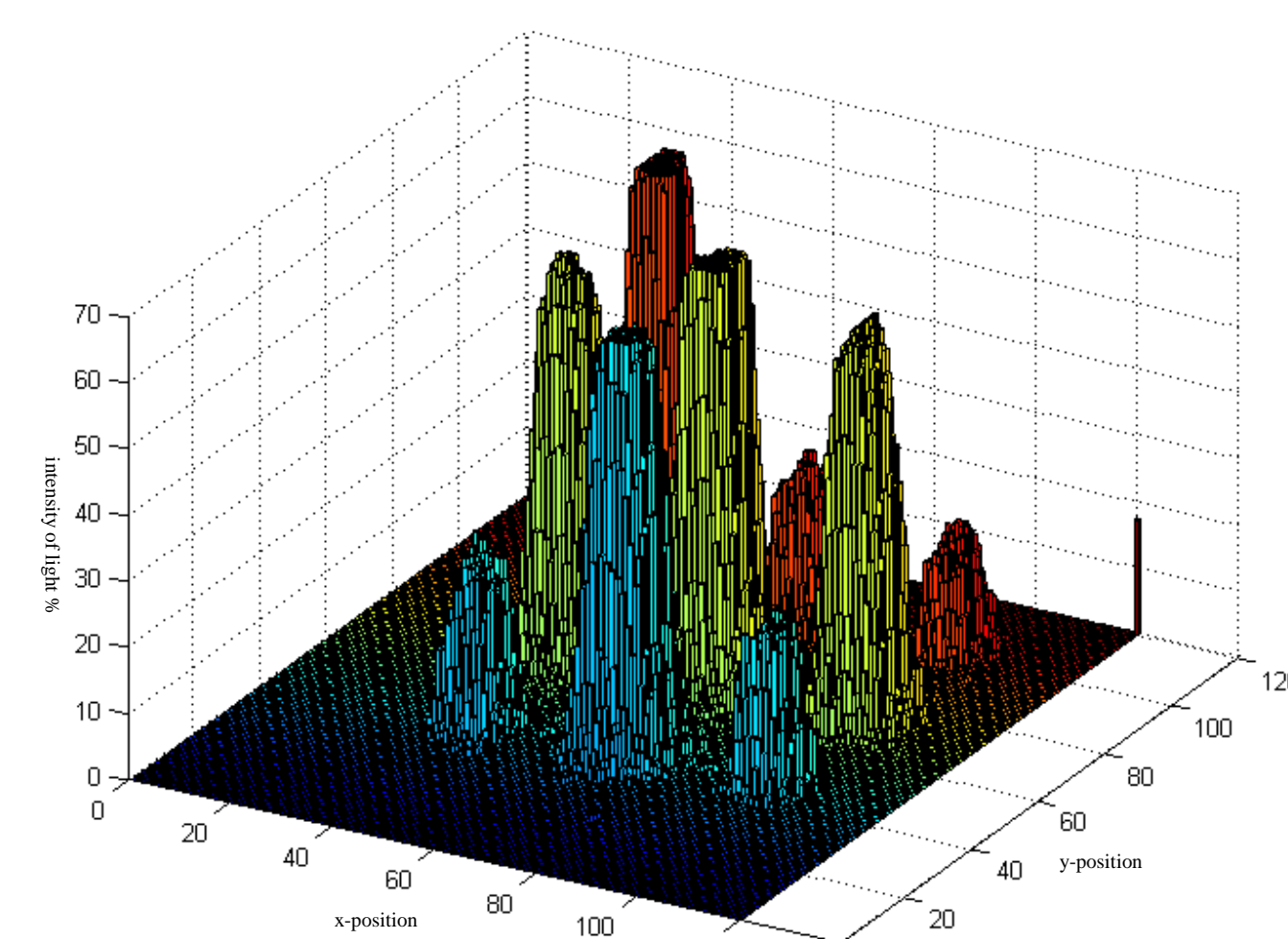
- Offers a set of single and multi-processor templates with (empty) hardware accelerators.
- The accelerators are constructed by the **virtual-technology** or **physical-prototype module**.
- FPGA-specific but independent of the optical Technology.



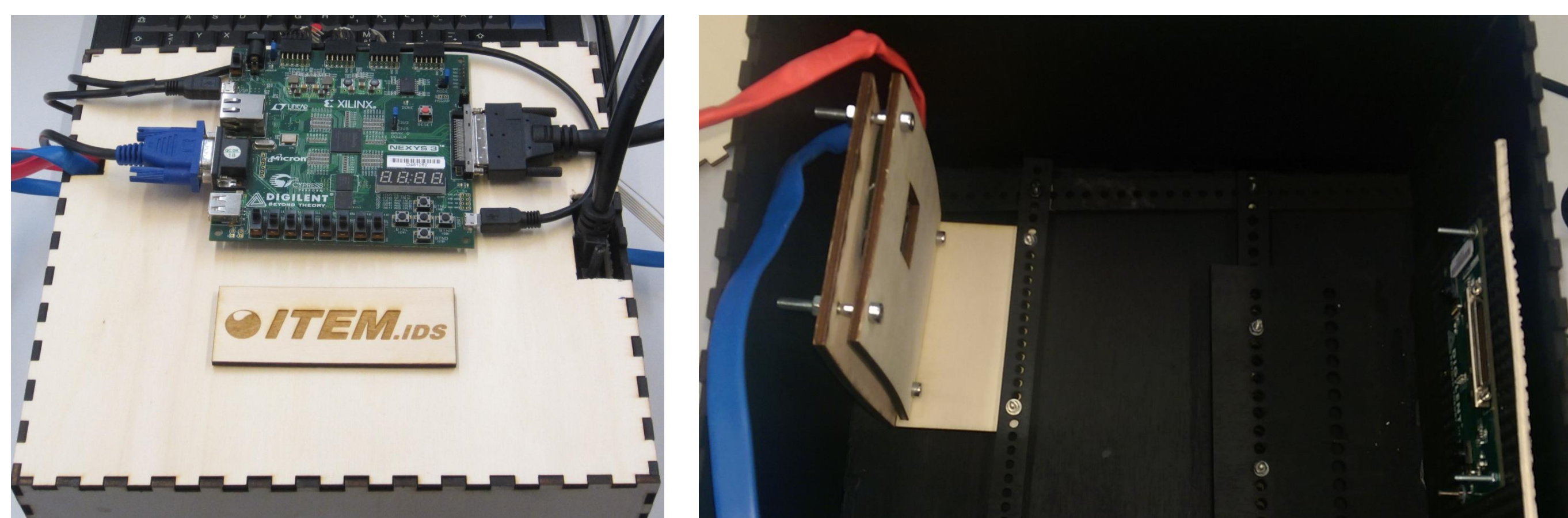
## Physical-prototype

### Example: Analog vector matrix multiplication

- Low-cost rapid prototype based on the principle of stanford multiplier.
- Optical nonidealities, like crosstalk and dispersion effects are easily observable.
- The user can program the application's algorithm in C and study the system performance.



Mixed light intensity of 3x3 matrix.

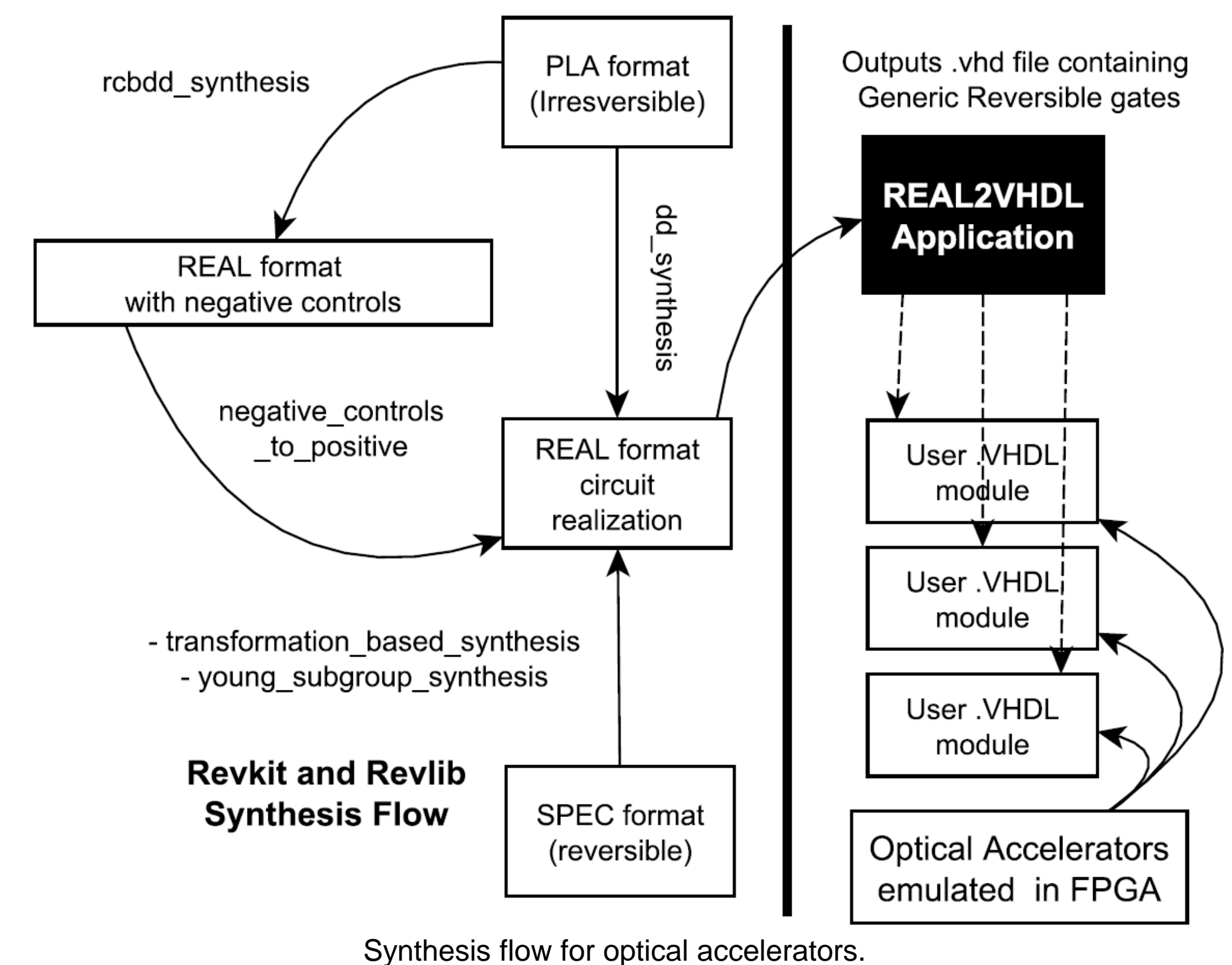


Physical low-cost prototype.

## Virtual-technology

- Offers the infrastructure required to emulate an optical technology.
- It includes a library of technologies and dedicated synthesis programs.

### Example: Reversible Circuits

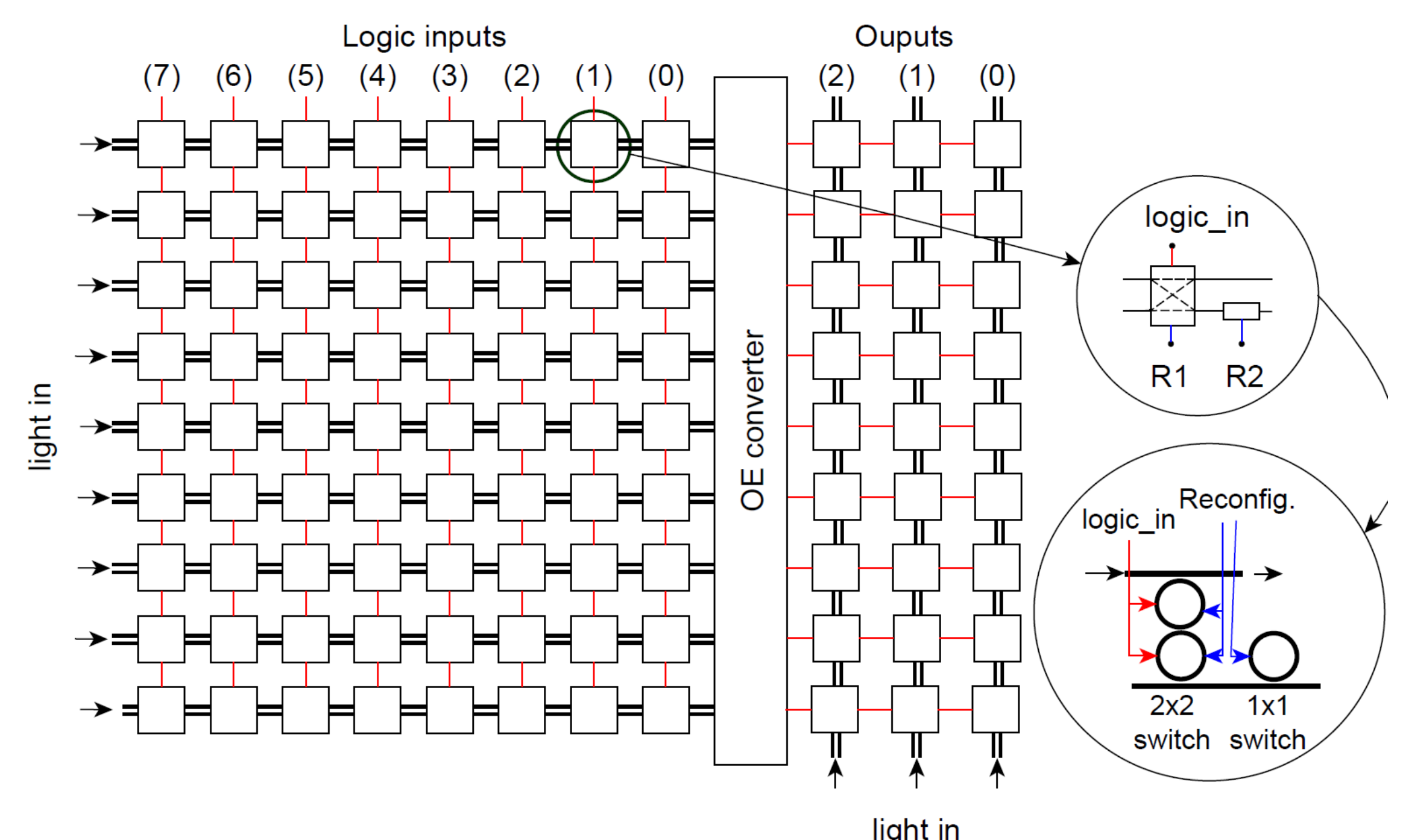


Synthesis flow for optical accelerators.

- Reversible gates can be realised as controlled optical gates.
- Reversible circuits do not lose information.
- They can be thermodynamically energy efficient.

### Example: Reconfigurable Directed Logic

- Same design flow like the reversible circuits.
- Controlled optical switch to direct the propagation of light
- The regularity facilitates test and improves yield, while the reconfiguration adds flexibility



Two-stage electro-optical reconfigurable Directed Logic architecture.

## Conclusion:

- This work proposes a rapid prototyping framework for nano-photonic accelerators.
- Rapid prototype allows at early development stage to investigate the impact of the optical accelerator behavior on the overall system performance.
- To illustrate its flexibility, we create a reversible accelerator, a system with reconfigurable directed logic, and a system with a physical prototype.