RV-IOV: Tethering RISC-V Processors via Scalable I/O Virtualization

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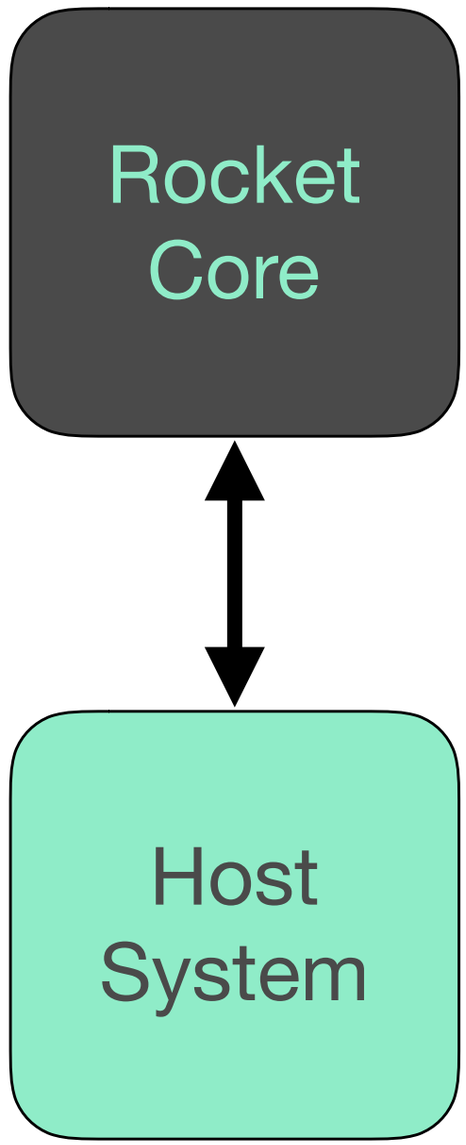
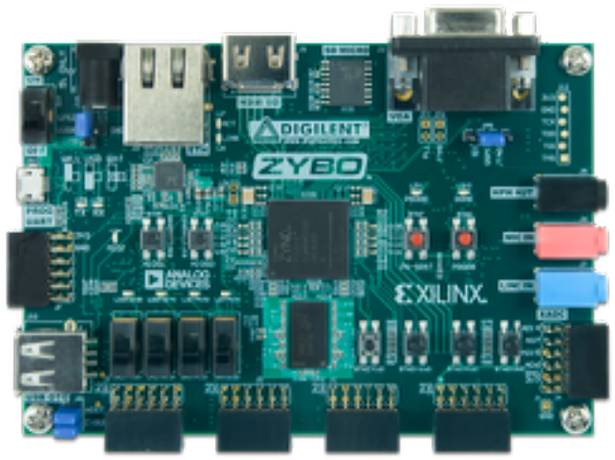
Berkeley's Tethered Rocket core

The host system provide support for:

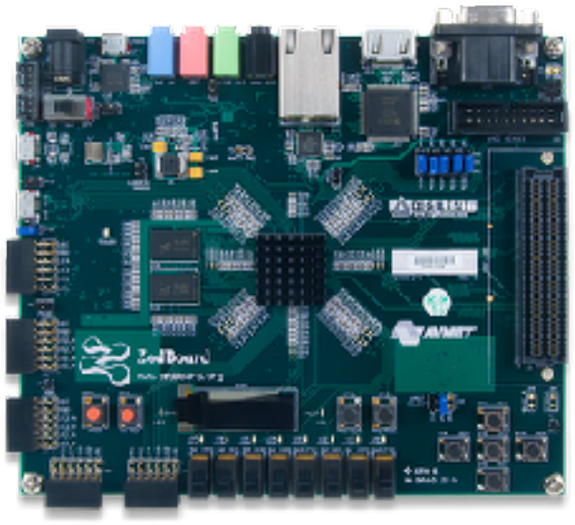
- Memory subsystem
- Load binaries
- Start/terminate programs
- System call offloading (w/ PK)
- Emulate peripheral devices (w/ OS)



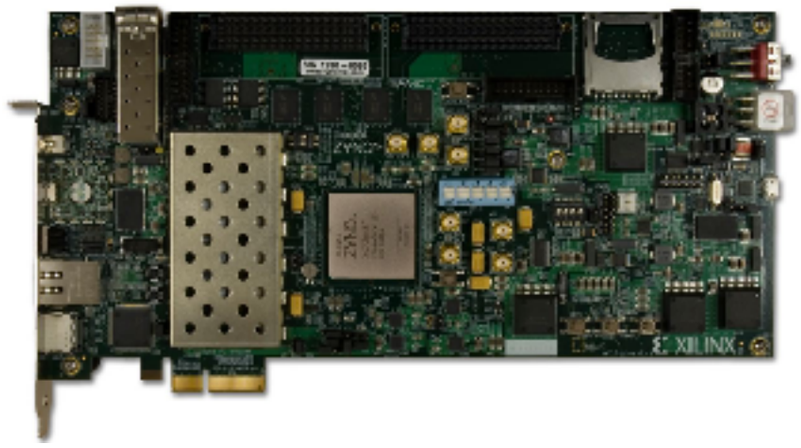
Berkeley's Rocket Emulation Platforms



Zybo



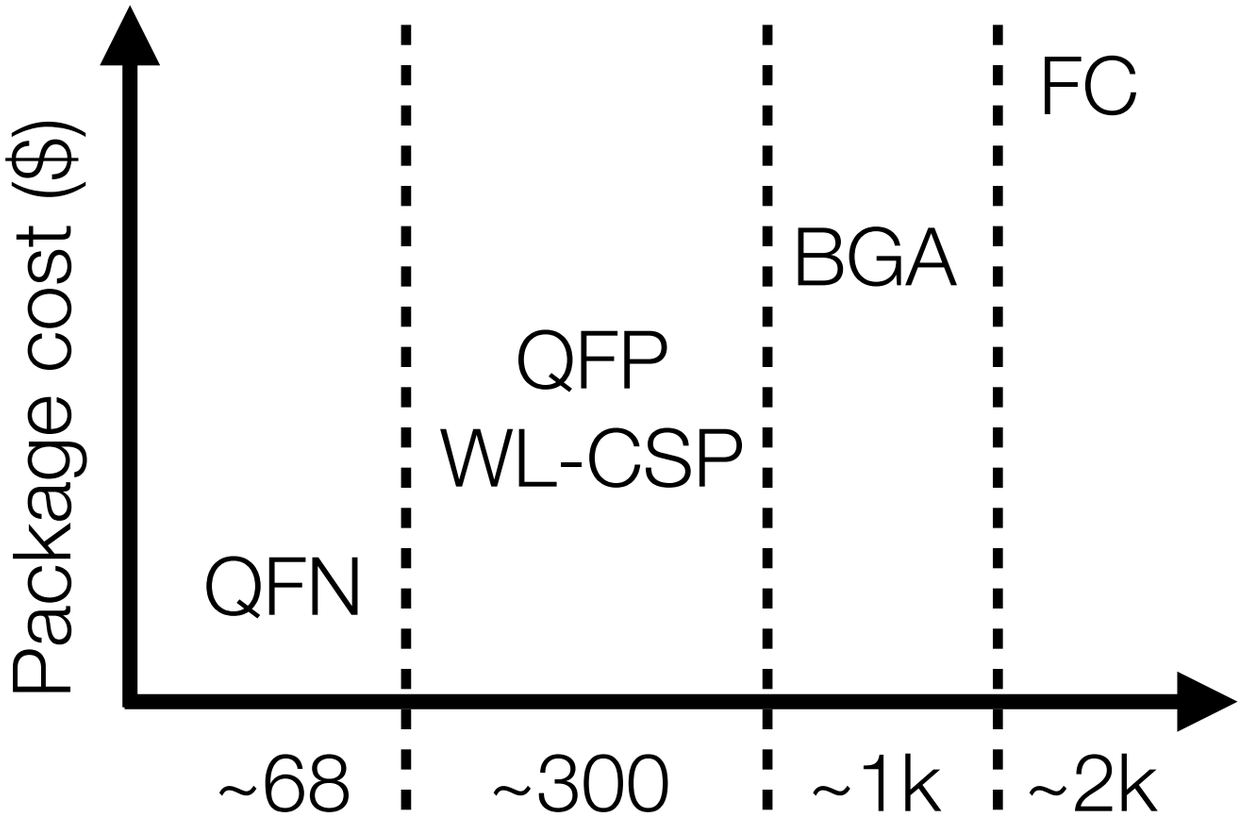
Zedboard

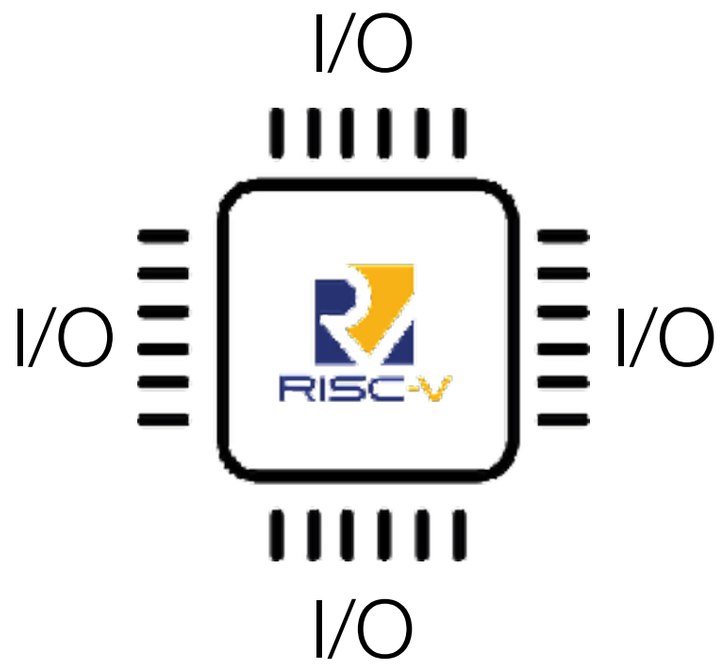


ZC706

https://github.com/ucb-bar/fpga-zynq

Challenge #1: ASIC prototyping

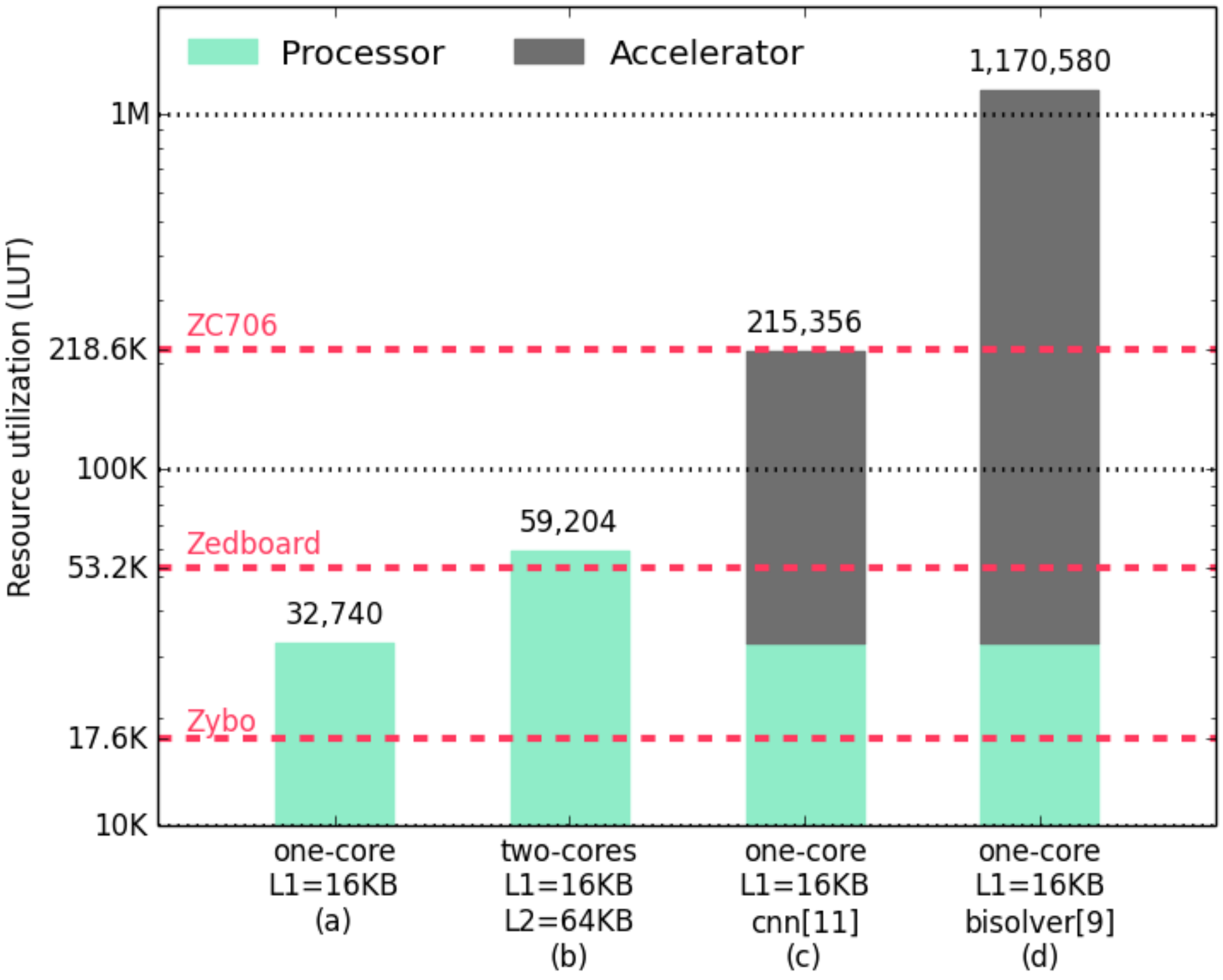




I/O	Host	Mem	Total
#	36	298	334

Total Package I/O ~~ 3 x Data-I/O
(power supply reasons)

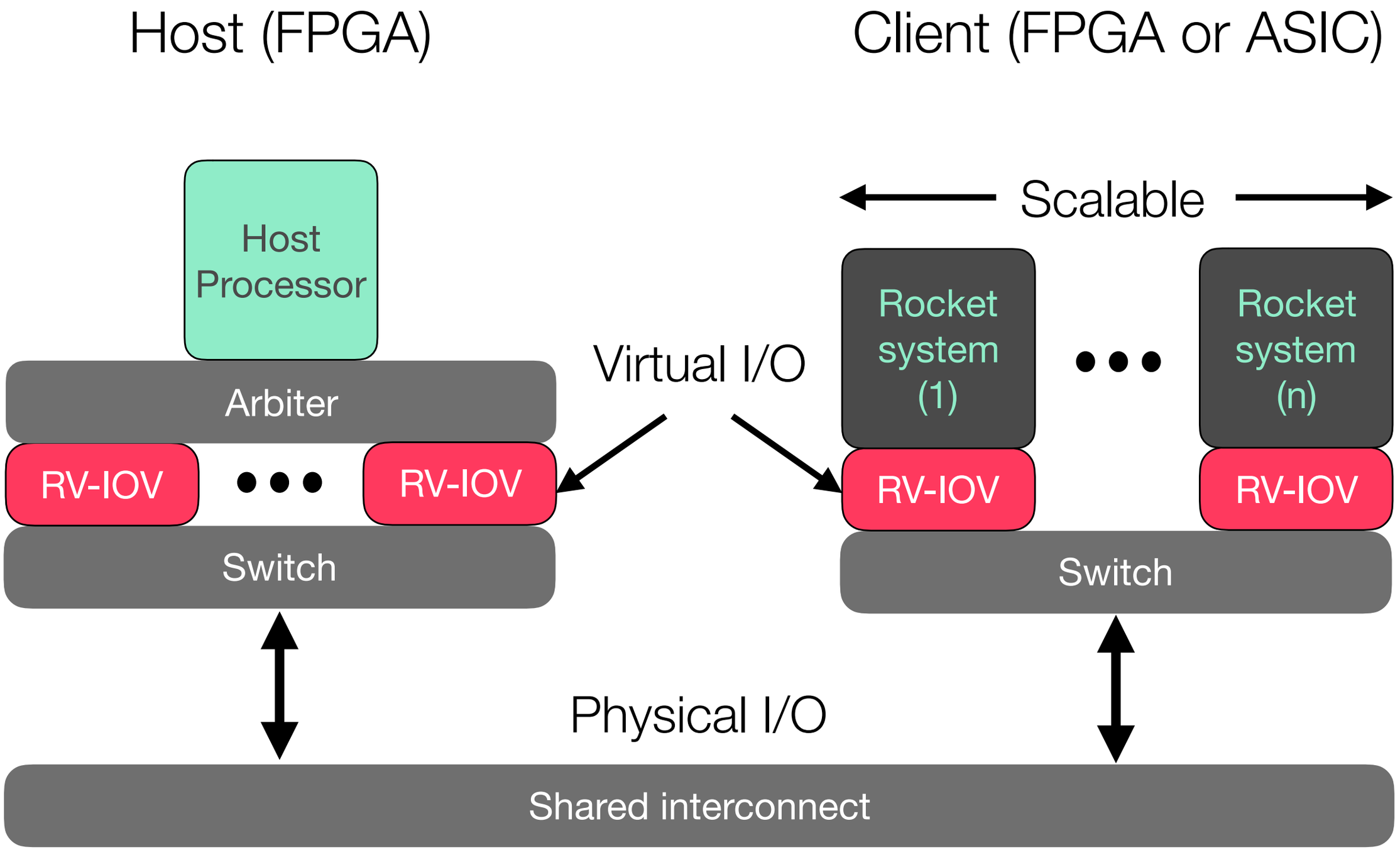
Challenge #2: FPGA (LUT) resources



Solution: RV-IOV

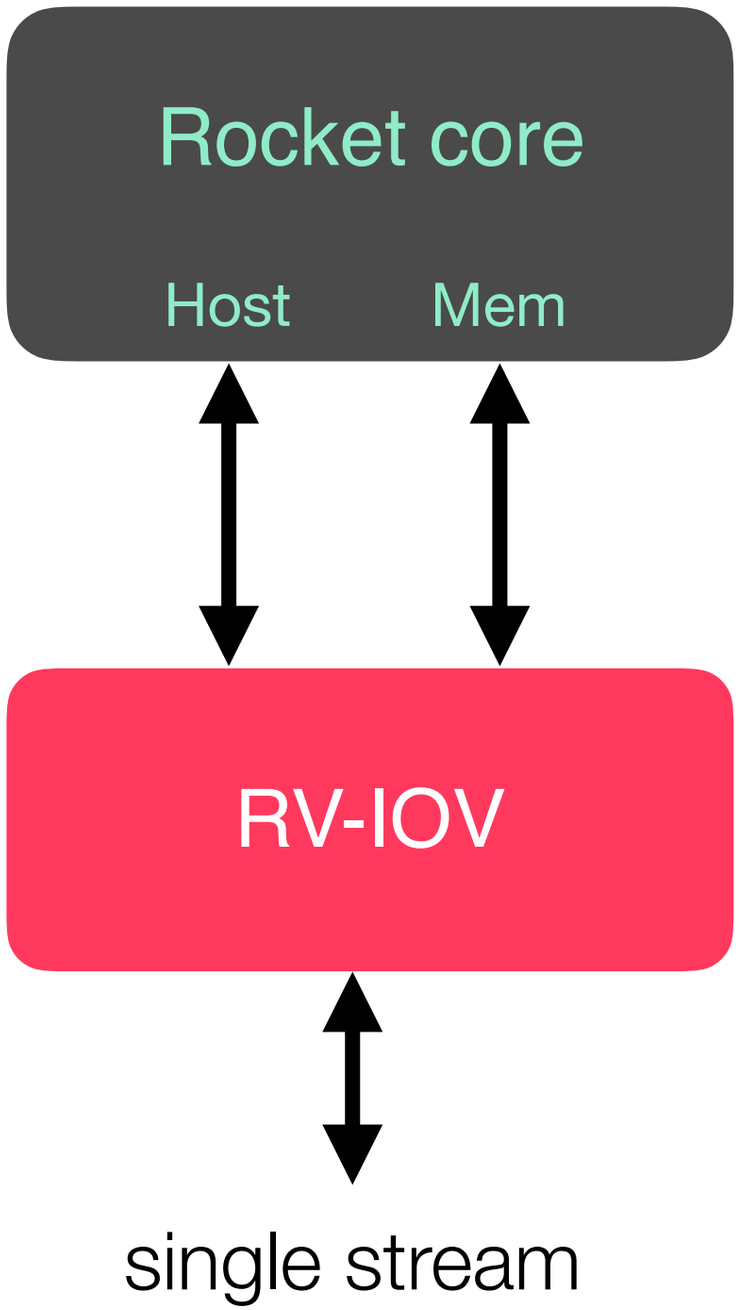
- RV-IOV decouples the Rocket core from the host processor
- RV-IOV allows multiple Rocket cores to be implemented on external ASIC prototypes or FPGA emulation boards
- RV-IOV extends Rocket supported FPGA boards

RV-IOV system level



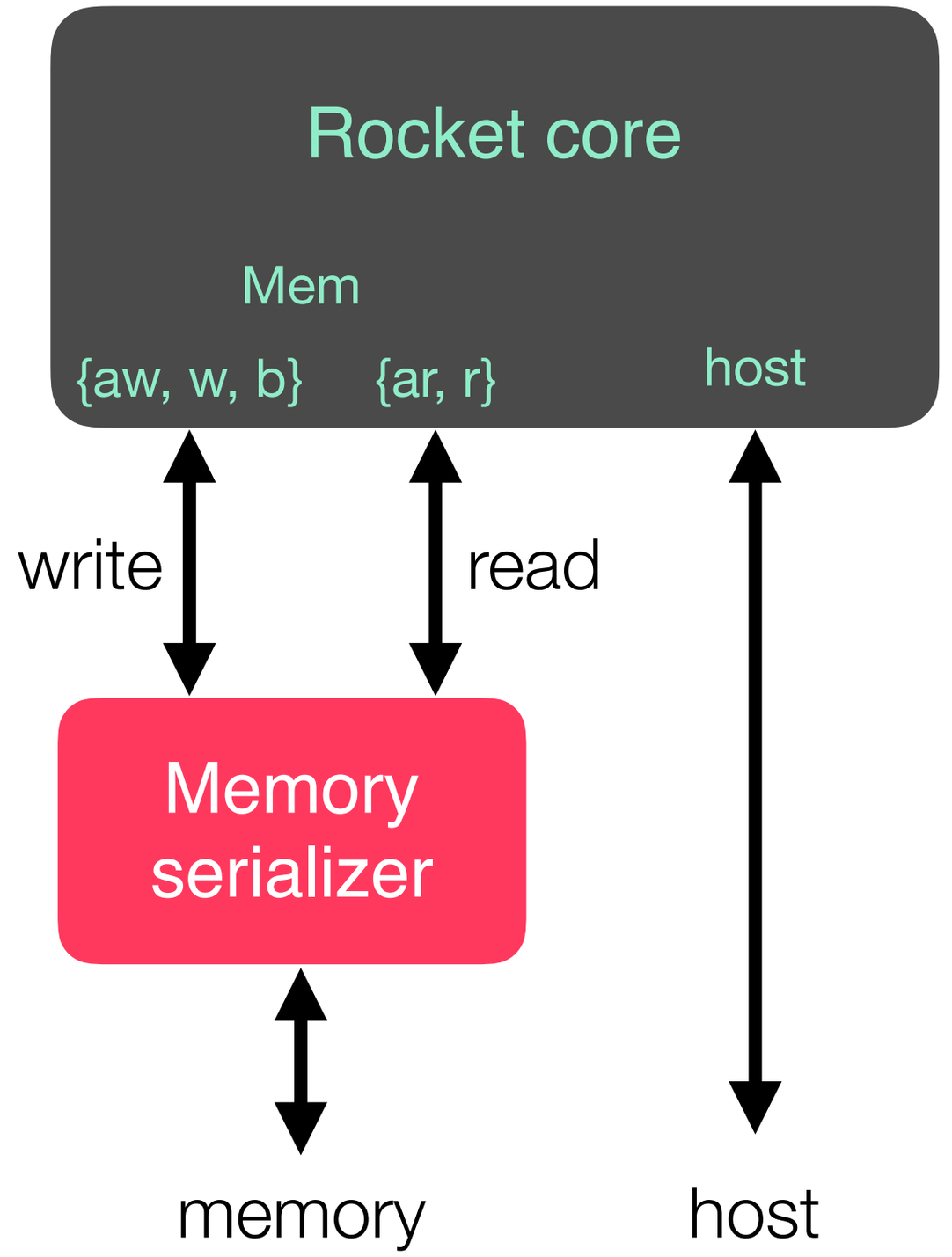
RV-IOV - internal operations

1. Memory serialization
2. Stream interleaving



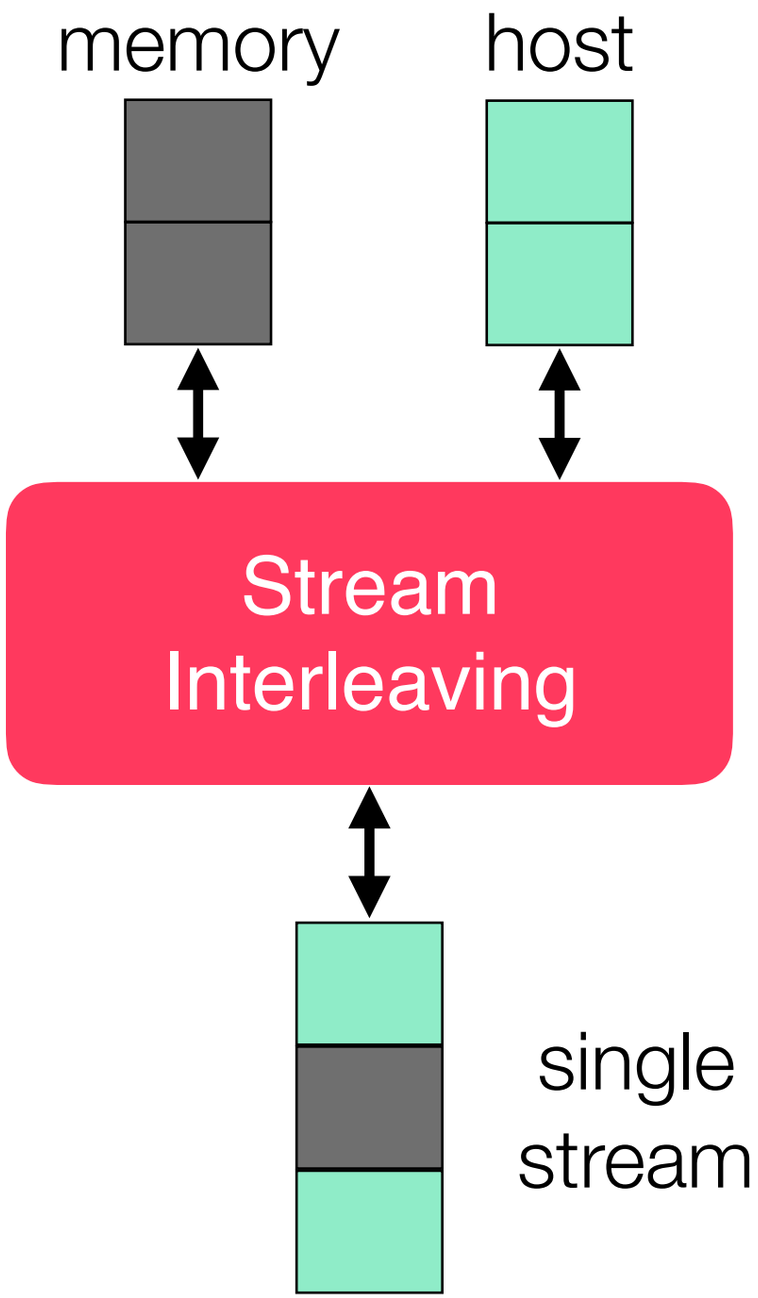
RV-IOV - memory serialization

- AXI4 memory protocol is serialized
- Merge write/read memory channels into a single bidirectional channel

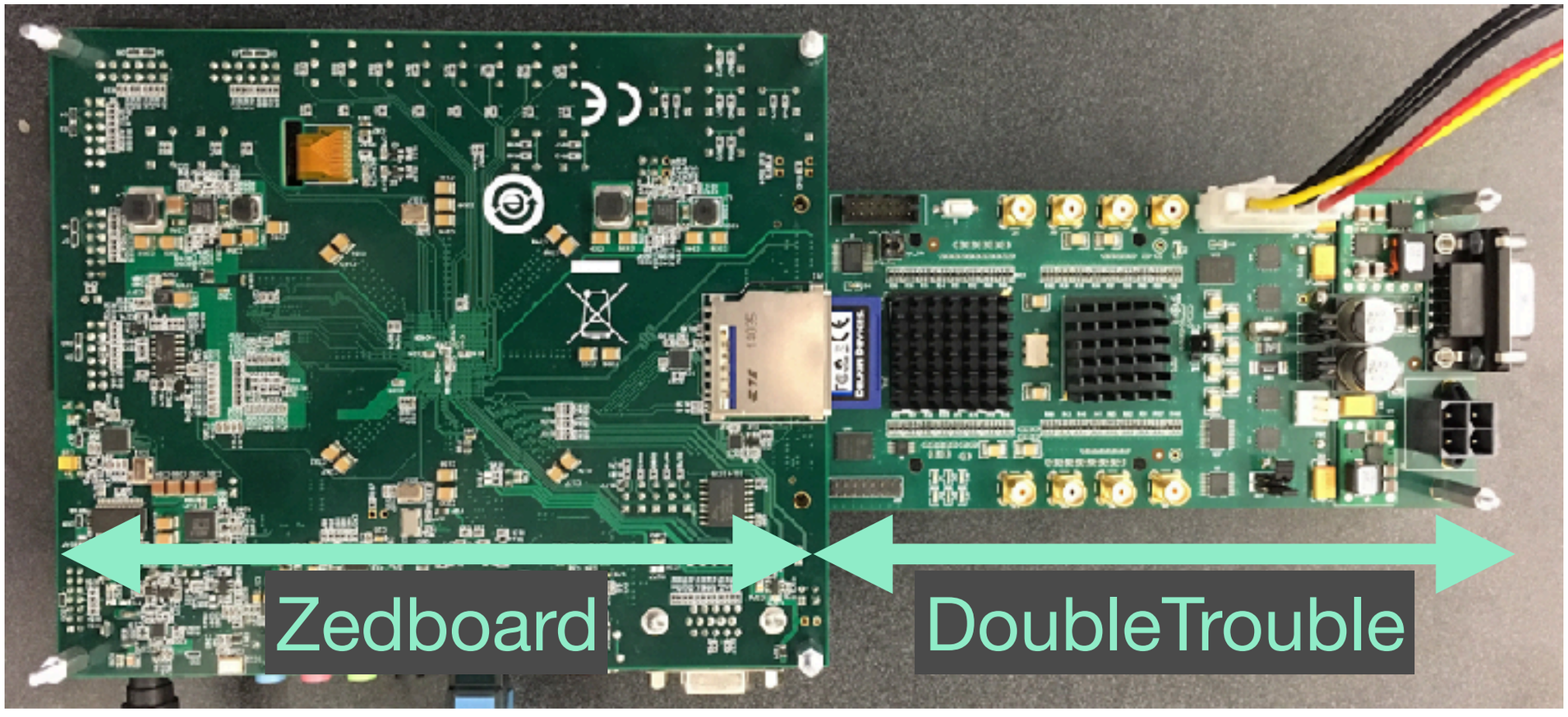


RV-IOV - stream interleaving

- Interleave memory and host packets
- Round robin fashion
- Flow control: credit protocol
  - Maximize throughput
  - Avoid deadlocks



RV-IOV FPGA evaluation



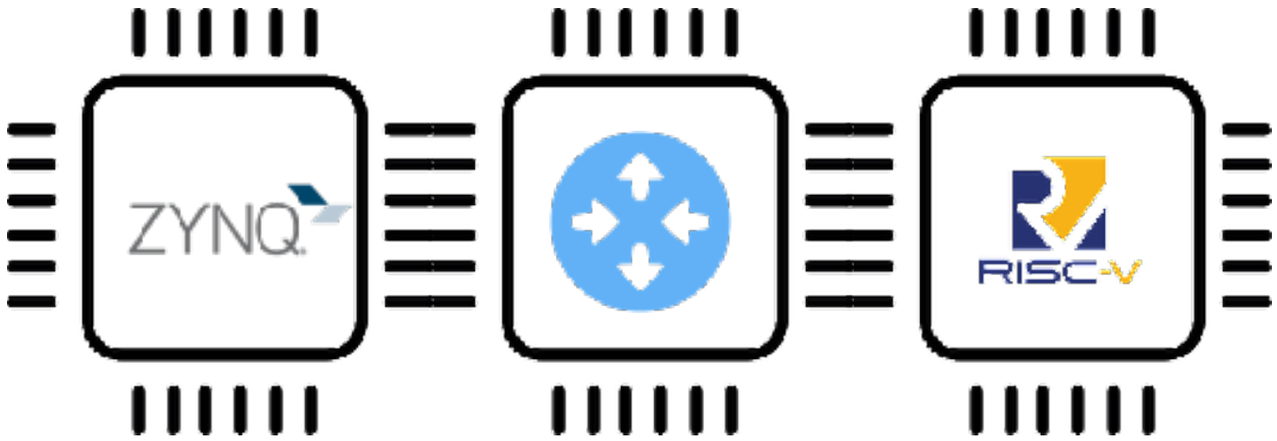
DoubleTrouble is an Open Source Emulation Platform

https://bjump.org

RV-IOV FPGA evaluation

One hop system

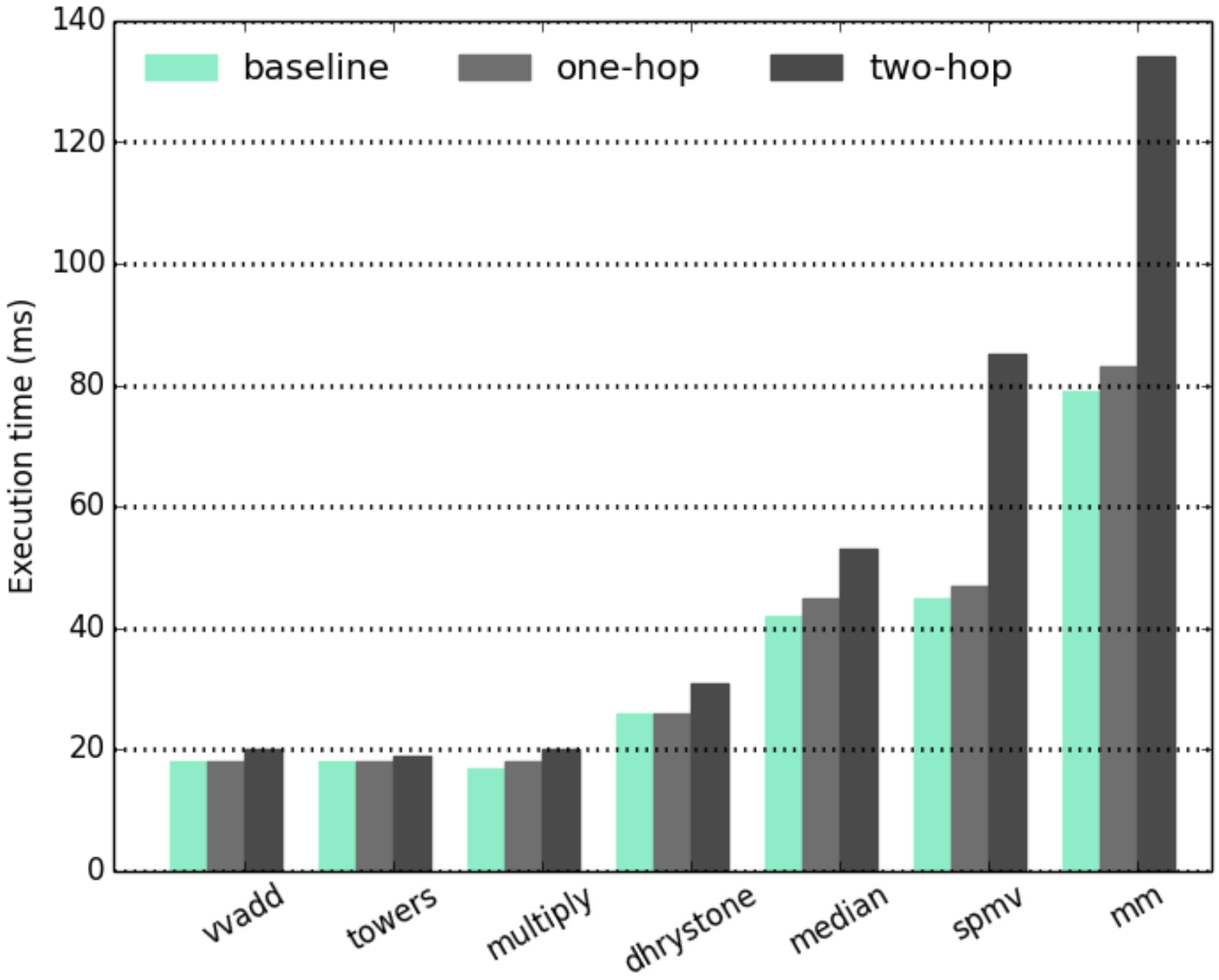
Two hop system



Rocket core configuration

- 5 stage, in-order, scalar processor
- Double precision, floating point
- I-cache: 16 KB 4-way assoc.
- D-cache: 16 KB 4-way assoc.
- RV64G ISA

Results


baseline
one-hop
two-hop
Execution time (ms)
0
20
40
60
80
100
120
140
vvadd
towers
multiply
dhrystone
median
spmv
mm

Conclusion

- RV-IOV increases implementation flexibility for both ASIC and FPGA Rocket designs

- RV-IOV allows larger Rocket core configurations, i.e. multi-core and powerful accelerators

- RV-IOV will be available @ https://bjump.org/rv_iov

Questions?