

AC/DSim: Full System Energy Estimation with Modular Simulation



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1. Evaluating HW-Accelerated Systems -

- Many system and hardware design choices
- Manufacturing hardware is too costly and slow
- FPGAs are only an emulation for custom chips
 - Slower, higher energy consumption

How to evaluate system design choices?

- How much faster is the accelerated system?
- Is the accelerated system more energy efficient?

3. Challenge: Measuring Energy Use -

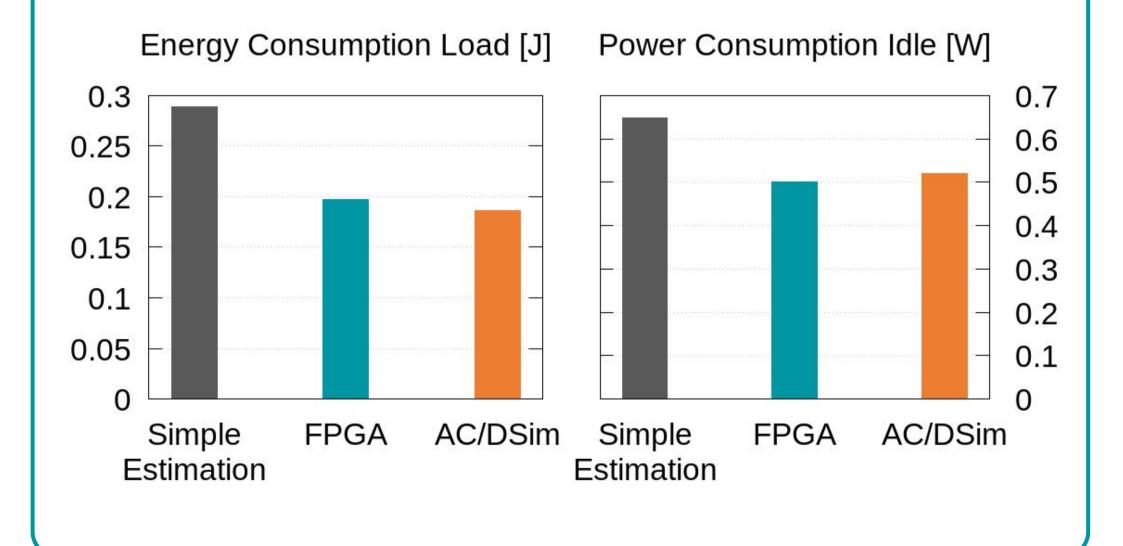
- Energy consumption is spread across components
- Depends heavily on dynamic runtime workload

How to measure system energy use w/ custom HW?

- Hardware tools offer RTL power estimation
- Must supply signal activities for accurate results
- Currently: model HW workload with RTL testbench
 - Correctly change circuit inputs at every clock cycle
- This is laborious and inaccurate
- Also need energy use for rest of the system

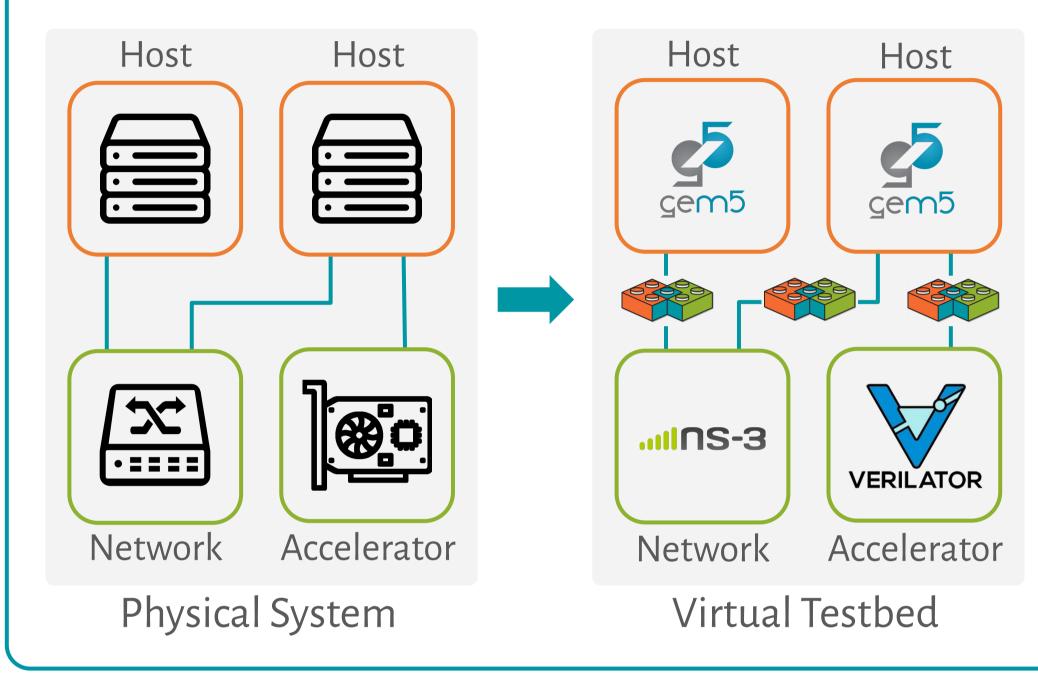
5. Preliminary Results

- Setup: SoC FPGA board, JPEG decoder accelerator
- FPGA allows us to validate against physical system
- Compare to simple estimation without workload



· 2. Evaluating Performance in Simulation ~

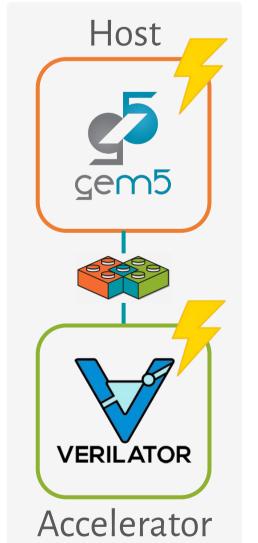
- We can simulate hardware before manufacturing
- Challenge: Need full-system performance
- **SimBricks** : Connect existing simulators into a full virtual testbed
- Run and measure complete system
 - Actual workload with unmodified SW (App, OS)
 - Captures complex interactions between components



4. AC/DSim: Modular Energy Estimation –

Combine existing component energy models with full system simulation for accurate workload inputs

- 1. Use SimBricks to simulate actual app workload
- 2. Collect necessary component workload metrics
- 3. Run separate per-component energy models
- 4. Combine (sum up) component energy use



Host: Architectural simulator running SW (OS, app, libraries), with online energy model

HW Accelerator: RTL simulator logging circuit signal traces, feed these into offline estimation tool

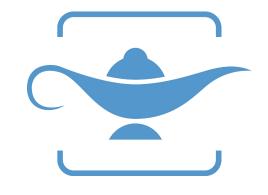
6. Next Steps

Improving accuracy, reducing trace size:

- Currently: average signal activities over whole execution -> large, inaccurate?
- Proposal: sample workload characteristics over smaller time intervals

Full network system estimation:

• Include models for currently missing components, e.g., NICs and network switches





https://simbricks.github.io