

ECA Assignment 1

Objective

The assignment involves the performance evaluation and optimization of a convolution application across various RISC-V architecture configurations and implementations.

Dates

Project Q&A: September 10

Presentation: September 24

Report: September 26

Task Details

Convolution Task:

- Perform a 2x2 convolution on a 13x13 matrix.
- Overflow handling is not required.

Hardware configurations

Configuration	ISA	Number of LUTs ("area")
base	RV32I	2308
medium	RV32IMC	4868
performance	RV32IMC	6958

Evaluation Rubric (10 Points Total)

1. Hardware Testing and Description (2.5 Points)

- Test and describe the three provided hardware configurations.
- Perform a performance evaluation using the performance counters.
- Find the bottlenecks in performance for each configuration.
- Note: Be mindful of the -march parameter

2. Software Optimization and Description (2.5 Points)

- Implement and describe software optimizations for each configuration.
- Note: Make use of both compiler flags (e.g., loop unrolling, constant substitution, instruction scheduling) AND handmade optimizations. While you can use global optimization options (-O1, -O2, etc), you can't use them without understanding what exactly they did to the code or what optimizations they implemented.

3. Performance Evaluation (2.5 Points)

- Find the best performance for (in terms of cycles) for each configuration, and decide on a winner.
- Note: Lower cycle counts are better.

4. Energy-Delay Product (EDP) Evaluation (2.5 Points)

- Calculate EDP using the provided formula.
- Identify the combination of software and hardware that yields the best (lowest) EDP result.

Energy-Delay Product (EDP)

$$EDP = E \times t = P \times t^2$$

Very rough approximation for this course expects that all elements have the same average switching activity. This is factually incorrect, but will give us an easy way to calculate the EDP:

$$P \approx |\text{LUTs}|$$

$$t \approx |\text{cycles}| \div \text{frequency}$$

Additional Notes

- Your test methodology, chosen optimizations, and achieved cycle values will be evaluated during the presentation (rubrics 1, 2 and 3).
- You will have the opportunity to improve your EDP evaluation (rubric 4) for the final report based on feedback received after the presentation.

Requirement for the presentation

- 5-minute presentation (strict), addressing the key points of your optimization, hardware evaluation and the achieved cycles and EDP results.
- Submit (in canvas) the slides in PDF format before the presentation (at least 30 minutes before).

Requirement for the report

- Text should be written in English
- Max of 2 pages, IEEE double column format (suggest getting the official Latex template)
- No cover page and no table of contents.
- Name of all the group members in the author list and group number in the title
- Delivery in PDF format