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Open Source GPUs: How can RISC-V play a role?

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Outline

Introduction

- My HW activities
- Why Open-Source GPU?

Statue Quo

- What's out there?
- MIAOW
- FGPU
- Nyuzi

Take-home

- Challenges
- Opportunities (4 RISC)
- Summary

My Computing Hardware Activities

Multi-Processor System-on-Chip

- 4-32 nodes
- Network-on-Chip
- RISC V cores
- GPU cores
- Approx. Cores
- Other accelerators

Open Source GPGPU

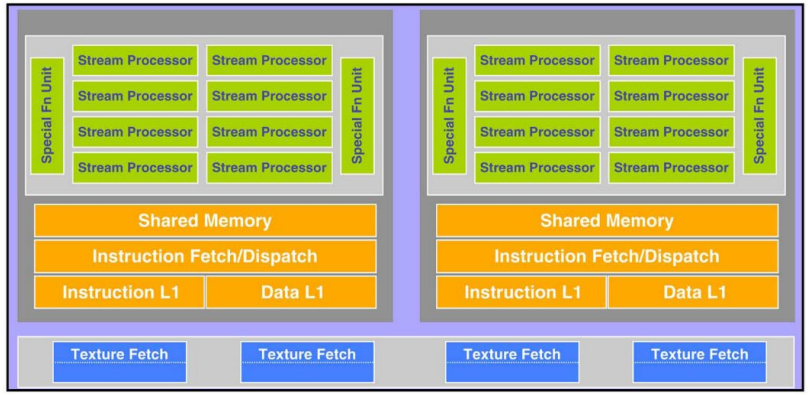
- Nyuzi (Vector Processor)
- Other custom CUs

FPGA Validation

Others

- Partial Reconfiguration
  - For Education
  - For (IoT) Applications
- Image Processing
- Others

NVIDIA GPUs



2010, Fermi

2013, Keppler

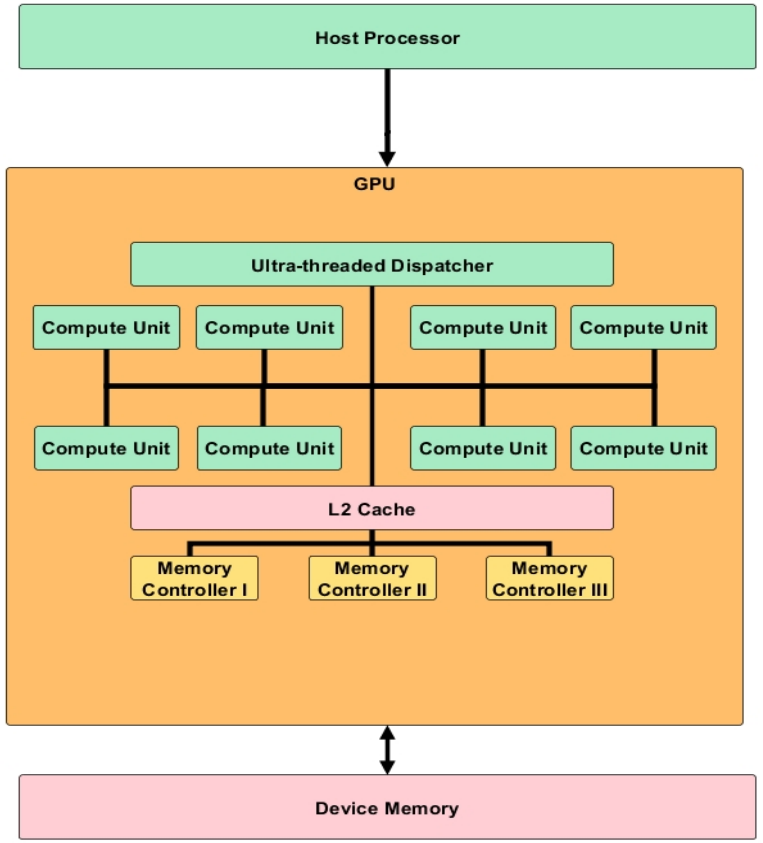
2016, Pascal

Some of the Open Source GPUs

Francis Bruno's Kickstarter	Diego Gonzales' MSc Thesis	OpenShader	Theia
FlexGrip	MIAOW	FGPU	Nyuzi

MIAWO (Many-core Integrated Accelerator of deepwater/Wisconsin)

- Part of AMD Southern Island (Multicore Design)
- OpenCL (Partial Support)
- No Graphical Interface Support
- 133k Slices + 100k Registers, 50MHz on Virtex7, 3.9 fps, 1.1 W
- Team of 11 (for a short period, currently seems on halt)

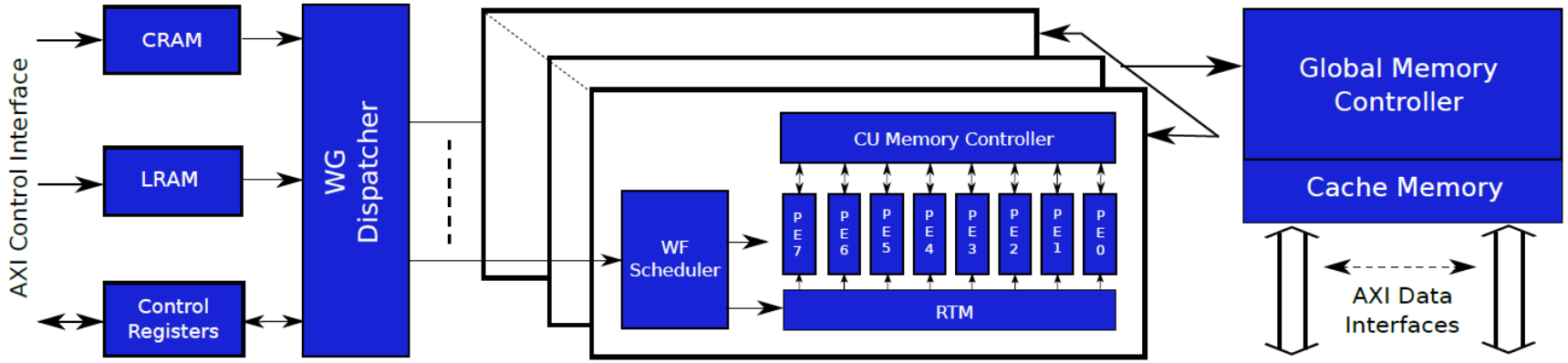


R. Balasubramanian, et al., "Enabling GPGPU Low-Level Hardware Explorations with MIAOW: AnOpen-Source RTL Implementation of a GPGPU", ACM Trans. Architec. Code Optim. 12, 2, Article 21 (June 2015), 25 pages

FGPU

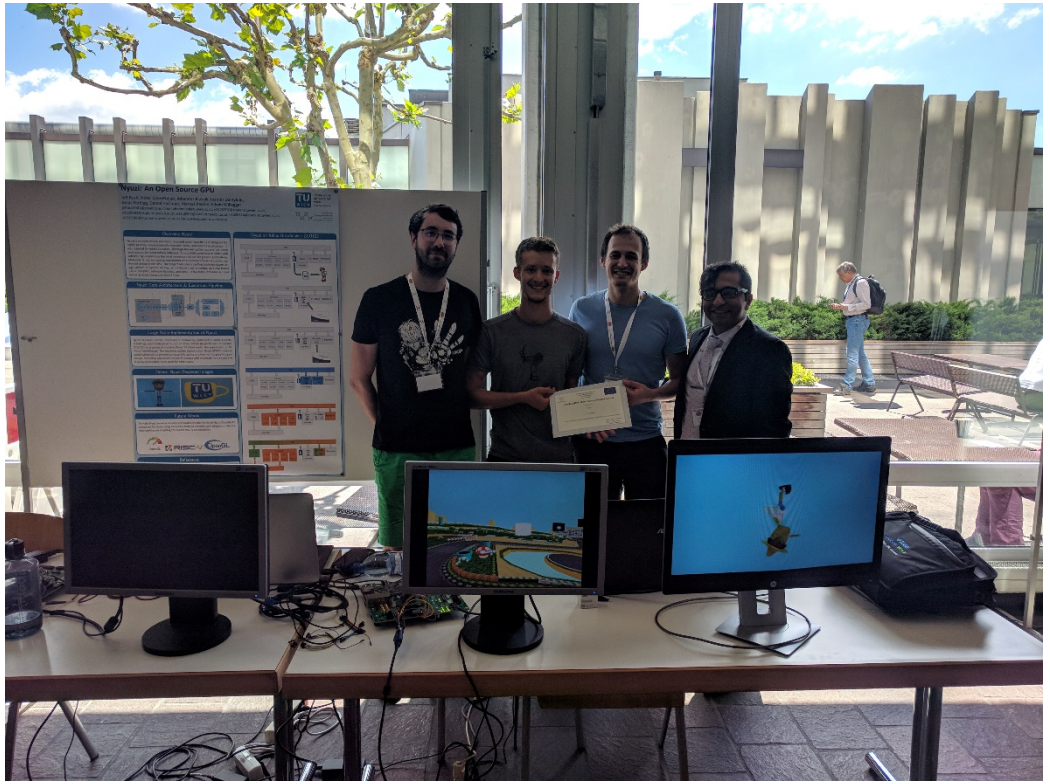
- SIMT, Custom ISA, Custom Architecture
- OpenCL (Partial Support)
- No Graphical Interface Support
- 125k Slices, 200-250 MHz on Zynq, 1.7-4.4 W
- Team of 4

M. Al Kadi et al., "General-Purpose Computing with Soft GPUs on FPGAs", *ACM Trans. Reconfigurable Technol. Syst.* 11, 1, Article 5 (January 2018), 22 pages



Nyuzi GPGPU

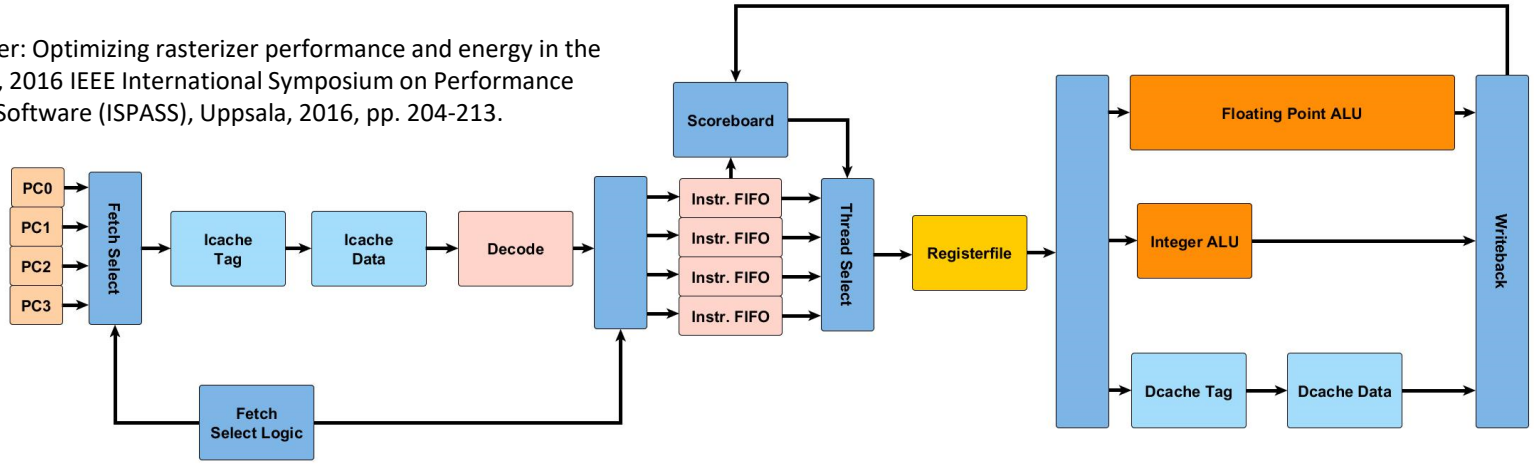
- Collaboration with Jeff Bush
- 32-bit Vector Processor (Intel's Larrabee), SIMD
- Custom ISA
- 1st Prize @ Eurolab4HPC open-source HW competition



Nyuzi

- C++ Compiler, OpenCL support (in progress)
- The only open-source GPU with support for graphics
- 51k Slices, 180MHz on Zynq, >24 fps (640px480p)
- Team of 1(+0.5) main contributor(s), 8-12 partial contributors

J. Bush et al., “NyuziRaster: Optimizing rasterizer performance and energy in the Nyuzi open source GPU”, 2016 IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS), Uppsala, 2016, pp. 204-213.



Challenges

HARDWARE

Knowledge

- We know much less than we think we know

Implementation

- No Silicon Validation
- Very few FPGA Validation
- No Formal Verification

Practical Challenges

- Interfaces
- Resources
- Stability

SOFT(WARE)

Tool-chain

- Often incomplete
- Partial Support
- Too customized

Graphic Support

- Only Nyuzi
- Again Partial & Customized

Small Teams

- Short periods
- Isolated works

How can RISC contribute?

HARDWARE

Knowledge

- High performance RISC cores
- Many-core implementations

Implementation

- Silicon & FPGA Validation
- Formal Verification
- Tool-chain Support -> GPGPU

Including (GP)GPUs

- Floating point & vector operations already supported
- Extended instruction support is possible
- Explicit inclusion is needed!

SOFT(WARE)

Tool-chain

- Off-loads designers significantly
- Complete support is possible

Graphic Support

- Micro codes are enough
- Standard ISA helps

Large Community

- Enough resources for reliable tool-chain dev.
- Complementary works

Summary

WHERE WE ARE?

- Giant GPU companies have little incentive for innovation
- Open GPUs teach us a lot and allow exploration of innovative solutions
- We can already provide enough performance for IoT Devices, …

WHAT TO DO?

- Build Communities (around RISC-V?) and work together
- Create a tool-chain comparable to what commercial GPUs support
- Explore new solutions (approximation, variable precision, ..)

I'd like to thank my

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- ...