RISC-V architecture

CSCI 425 - Operating Systems Design

Logan Humbert

Colorado Mesa University

May 6, 2024

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Introduction

What is RISC-V

- Open-source instruction set architecture (ISA)
- Focused on simplicity and efficiency, unlike complex x86 and ARM

RISC ?

- RISC: Reduced Instruction Set Computer
- Opposed to CISC (Complex Instruction Set Computer)

History

Early 2010s

- RISC-V project born at UC Berkeley
- Built on decades of RISC research (RISC-I and II in 1981)

2011

First RISC-V chip created

2014

Publication of a paper on the benefits of open instruction

2015

Creation of the RISC-V foundation

Design

Simplicity

Characteristics

- **Small Instruction Set**: Limited, well-defined set of instructions
- **Fixed Instruction Length:** Makes decoding faster and hardware simpler
- **Load/Store Architecture:** Dedicated instructions for memory operations improve efficiency

Design

Modularity

Characteristics

- **Base ISA:** Core set of essential instructions
- **Standard Extensions:** Floating-point, compressed instructions, ...
- **Custom Extensions:** Design custom extensions for specialized tasks

Benefits

- Devices only use the instructions they need, reducing chip power and complexity
- Enables innovation and tailoring ISAs for specific application areas
- Promotes a collaborative ecosystem around RISC-V development

Design

Trade-offs and Challenges 1/2

Software Ecosystem

- Limited software ecosystem compared to x86 and ARM
- Porting some software needed: development overhead

Industry Adoption

- Growing adoption, but less ubiquitous than x86 and ARM
- Finding experienced RISC-V developers might be harder

Design

Trade-offs and Challenges 2/2

Instruction Complexity

- Complex tasks may need longer instruction sequences (no specialized instructions)
- Potential performance impact in some cases

Fragmentation

- Openness could lead to some fragmentation (Various implementations)
- Extra care needed for software compatibility

Applications

Embedded systems

- Microcontrollers for IoT devices, wearables, industrial control
- Meets power consumption requirements of space-constrained and battery-operated designs

Mobile devices

- Handle the performance needed to power smartphones
- Can act as a co-processor for specialized tasks

Automotive, High-Performance computing

- Handle complex computational tasks with customized ISAs
- RISC-V extensions: greater energy efficiency

Aerospace and Government

Meets High reliability, security requirements + resilience to radiation

Conclusion

Recap

- Open-source architecture accelerates innovation and collaboration
- Simplicity and modularity lead to efficiency and tailored solutions
- Wide range of applications, with potential to disrupt traditional markets
- Has some trade-offs compared to CISC architecture

The End

Thank you for your attention!
Do you have any question?