PRISM: Accelerating Ray Tracing on RISC-V GPU

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Motivation

Limitations

- Existing open-source ray tracing simulators abstract away important hardware behaviors.
- Traversal is modeled with an unrealistic unbounded stack.
- Programmable shader callbacks are simplified.

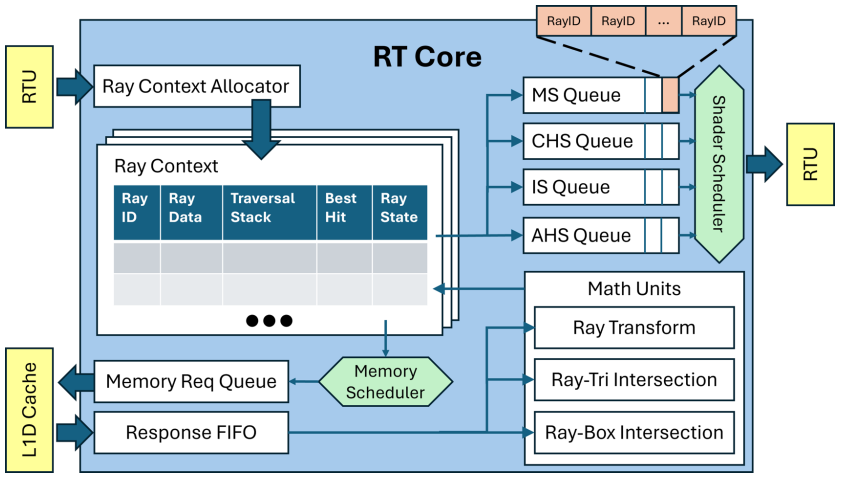
Research Challenges

- Inaccurate architectural performance evaluation.
- Lack of open-source RTL-oriented research platforms.

PRISM

- Stateful RT Core
- Custom RISC-V ISA

PRISM Design



Ray Tracing ISA

TRACE	WAIT	FETCH
ATTR	COMMIT	

Five custom RISC-V instructions provide the interface between SIMT cores and the RT Core.

Results

Research Capabilities

- Cycle-accurate traversal latency analysis
- Shader callback stall characterization
- RT Core sensitivity analysis

Key Outcome

- Up to 55× reduction in memory fetch stalls (vs. Vulkan-Sim)
- Enables cycle-accurate, RTL-oriented evaluation of programmable ray tracing architectures.

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