



Rusty Linux: Advances in Rust for Linux Kernel Development

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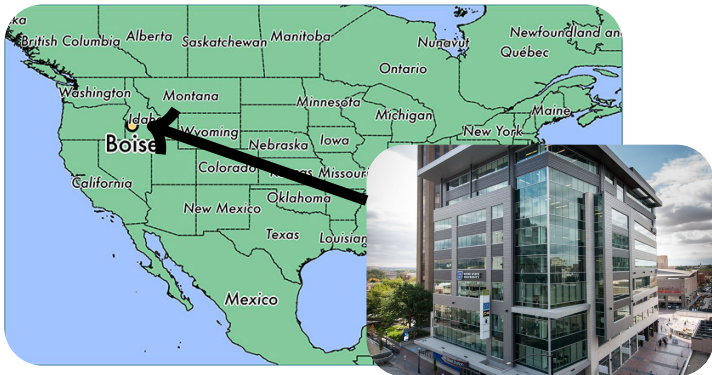
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Boise State University

The Computer Science Department is located in Beautiful downtown Boise Idaho, United States!



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We aim to find the current advances in using Rust in Kernel development to reduce the number of memory safety vulnerabilities in one of the most critical pieces of software that underpins all modern applications (SLR).

► Paper Link

Figure: A rusty computer¹



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¹AI Prompt: A rusty computer with a penguin next to it



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- Low-level **control** like C and C++



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- Low-level **control** like C and C++
- Strong **safety** guarantees



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- Low-level **control** like C and C++
- Strong **safety** guarantees
- **Modern**, functional paradigms



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- Low-level **control** like C and C++
- Strong **safety** guarantees
- **Modern**, functional paradigms
- Industrial development and backing



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- Low-level **control** like C and C++
- Strong **safety** guarantees
- **Modern**, functional paradigms
- Industrial development and backing
- No garbage collector needed! All checks are performed at compile time



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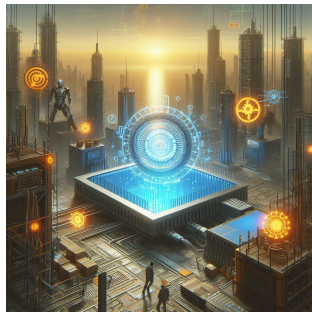
RQ4: Lessons

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RQ1: What are the existing approaches for implementing operating system kernels in Rust?²



²Fun side note: What happens if we put our research questions into an AI image generator?



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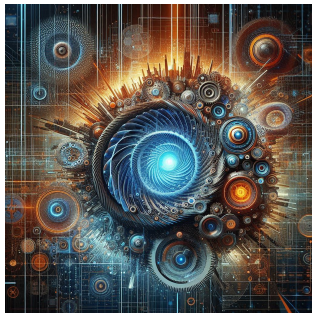
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RQ2: What are the performance implications of using Rust for operating system kernel development?





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RQ3: What are the major challenges and limitations when developing operating system kernels in Rust?





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RQ4: What are the lessons learned when developing operating systems kernels in Rust?





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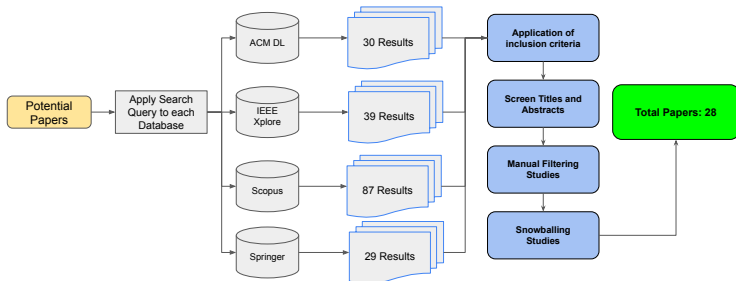
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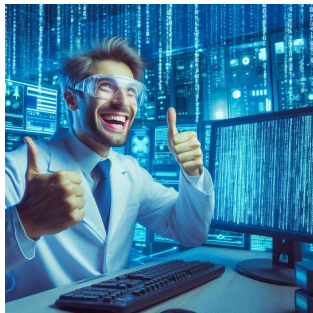
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Our findings!

Figure: Super happy researcher!¹



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¹AI Prompt: scientist getting research results and is super happy in a cyberpunk universe with lots of computers showing matrix code on them



Table: Approaches and Methodologies for Rust in the Kernel

Approach	Papers	Operating System in Rust
Monolithic	4	Linux Kernel v6.1+
Micro-kernel	5	Atmosphere, Redox, Redleaf
Embedded	2	Tock, Hubris, Drone, Bern, HarSaRK
Unikernel	4	RustyHermit, Theseus



Table: Performance Implications of Rust in the Kernel

No.	Implication	Studies that Reported the challenge
1	Performance	3
2	Throughput	1
3	Latency	1

- Performance issues - Caused by the safe \rightarrow unsafe transition layer
- Throughput issues - Caused by immature and or missing bindings within the FFI layer
- Latency issues - Caused by the interrupt layer written in Rust



RQ3: Challenges and Limitations

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- Binary Size
 - Rust can produce larger binaries
 - The same issue that C++ templates have!



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- Binary Size
 - Rust can produce larger binaries
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- Missing Features
 - Rust still evolving and adding features
 - Makes it difficult to integrate into the classroom due to the rapid evolution



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- Soundness - How to deal with raw memory without sacrificing safety?
- Panics - What happens when things go wrong?
- C Interop - Specific to mixed language kernels



RQ4: Lessons Learned

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- Impossible to use 100% rust - Same with C, some low level asm is needed to setup initial stack pointer, etc.



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- Impossible to use 100% rust - Same with C, some low level asm is needed to setup initial stack pointer, etc.
- Rust is not as expressive as other formal verification techniques



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Questions?

- Impossible to use 100% rust - Same with C, some low level asm is needed to setup initial stack pointer, etc.
- Rust is not as expressive as other formal verification techniques
- Ownership root - An OS provides memory to rust so if the OS is itself written in rust who is the root owner?
 - Open research question if this can even be done in software
 - Researchers looking at hardware support (CHERI)



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- We are still in the early stages of figuring out who to do kernel dev in Rust



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- We are still in the early stages of figuring out who to do kernel dev in Rust
- High potential for enhanced security and stability



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- We are still in the early stages of figuring out who to do kernel dev in Rust
- High potential for enhanced security and stability
- Need to address integration issues (FFI)



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Questions?

- We are still in the early stages of figuring out who to do kernel dev in Rust
- High potential for enhanced security and stability
- Need to address integration issues (FFI)
- Need to expand the body of empirical evidence on Rust's impact! (Or more generally low level memory safe languages)



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Figure: Happy People¹



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¹AI Prompt: People attending a conference who all want to ask a question and are really excited!