Towards Just-In-Time Compiling of Operating Systems

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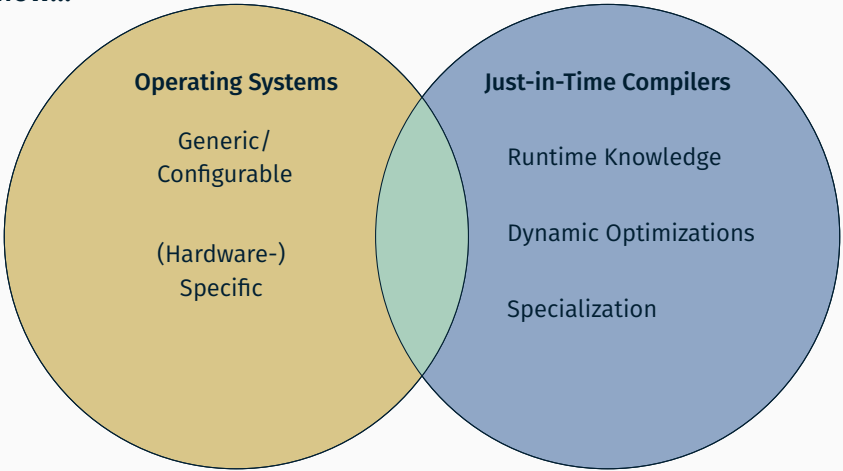
Friedrich-Alexander-Universität
Faculty of Engineering

Chair in Distributed Systems
and Operating Systems

JIT + OS = ?

We all know...



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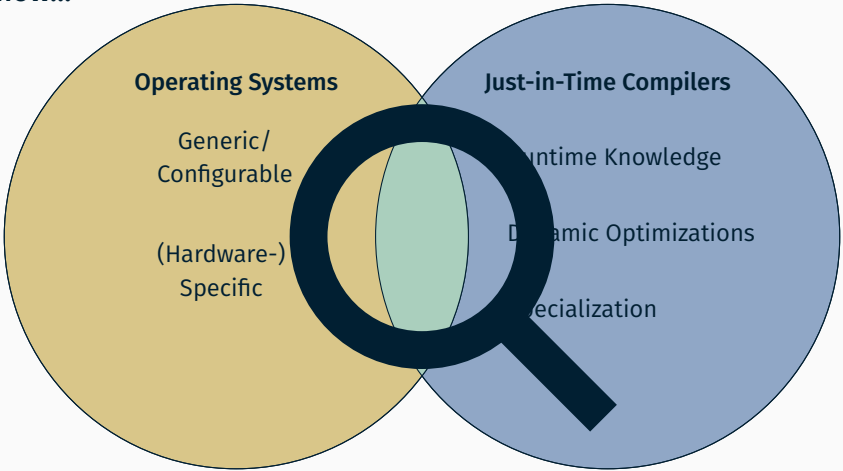

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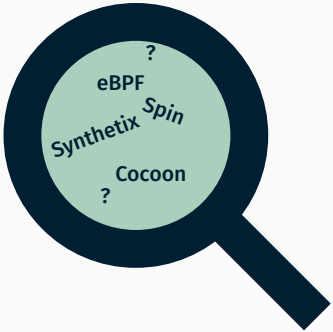
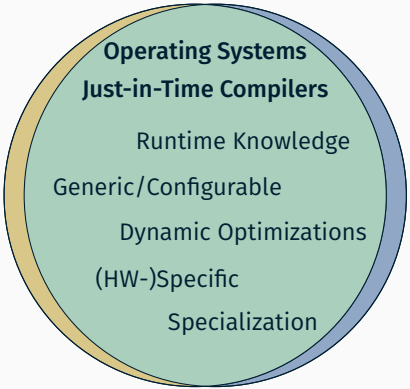


Dynamic specialization so far:

- **SPIN**: Change OS functionality via dynamic linking from applications
- **Synthesis**/**Synthetix**: Use code-synthesis techniques to specialize system functions
- **Cocoon**: Apply target-dependent optimizations at boot time

JIT + OS = ?

Our goals: Specialize **whole OS** at runtime based on **whole system state**:



- Utilize full potential of underlying system
- Re-compile for configuration transitions
  - → e.g. Adaptive Locking Mechanism
  - → e.g. Adaptive Scheduling Strategies

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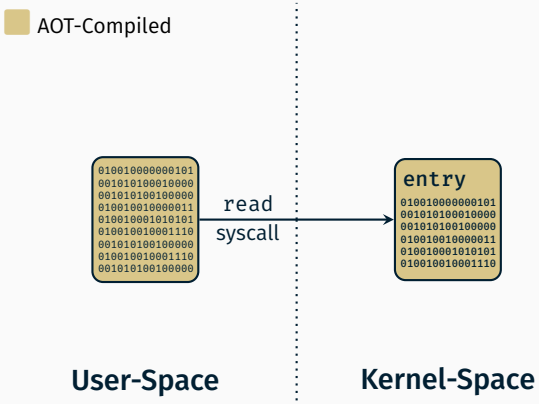

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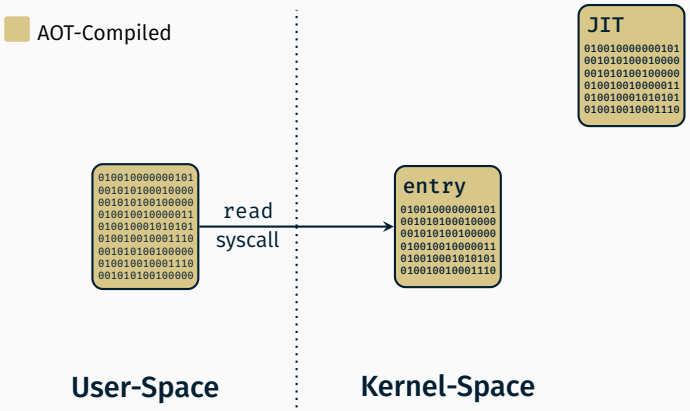

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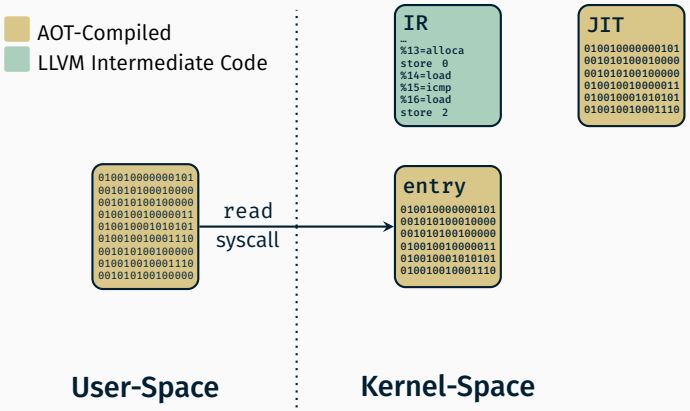

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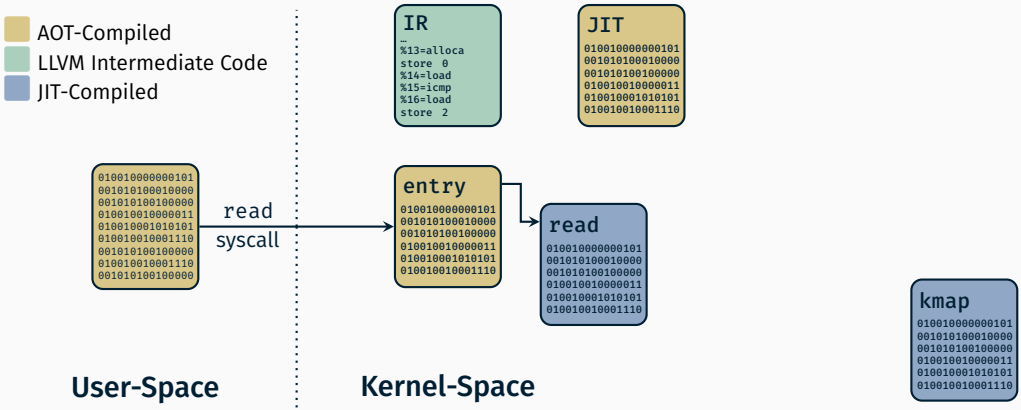

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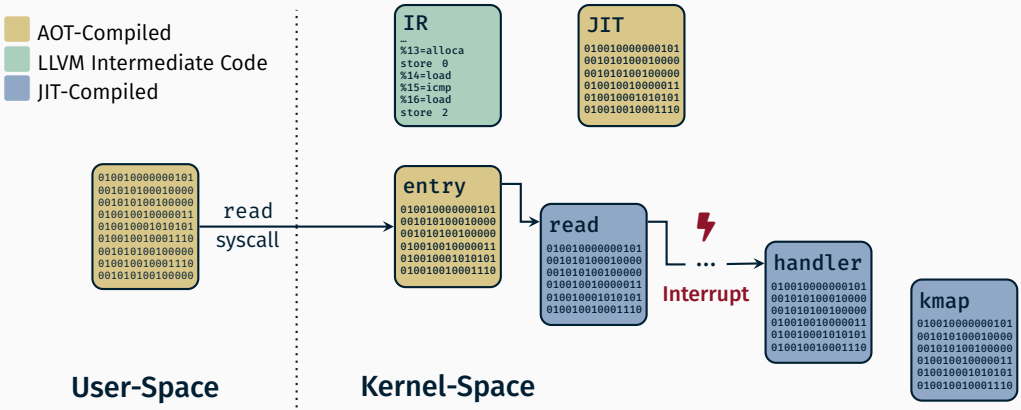

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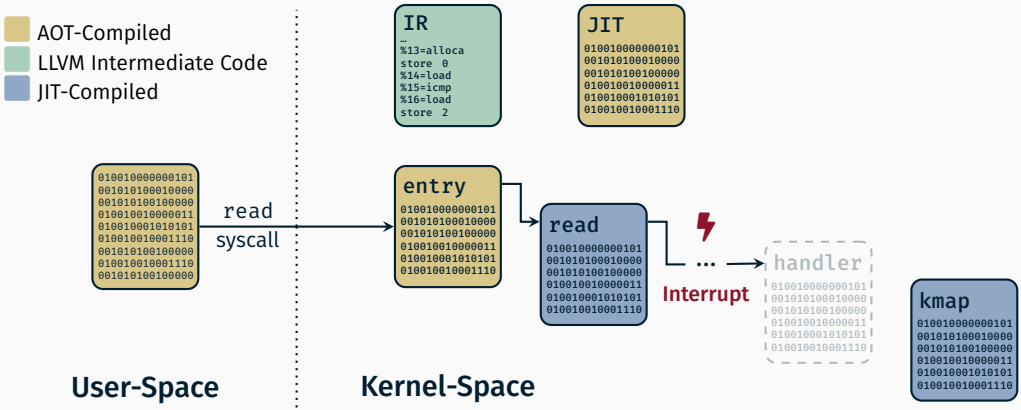

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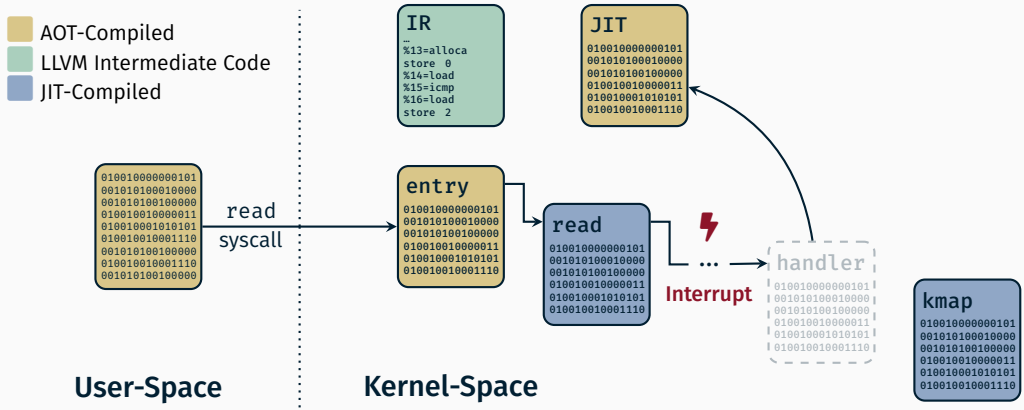

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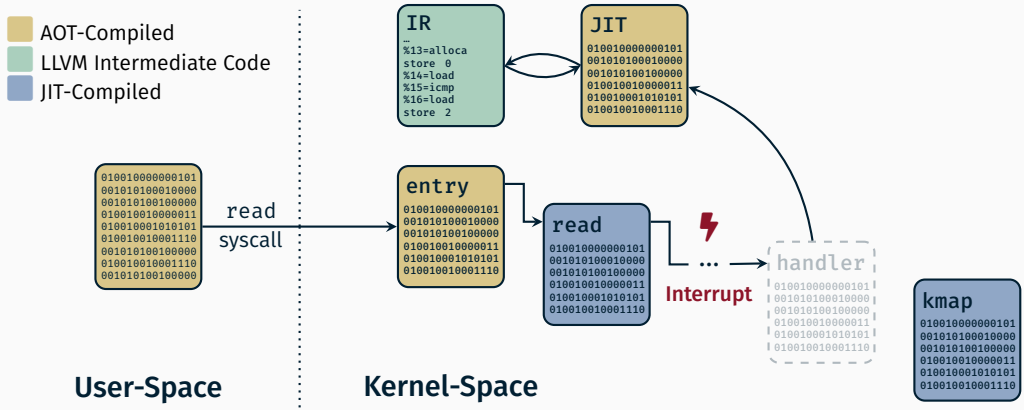

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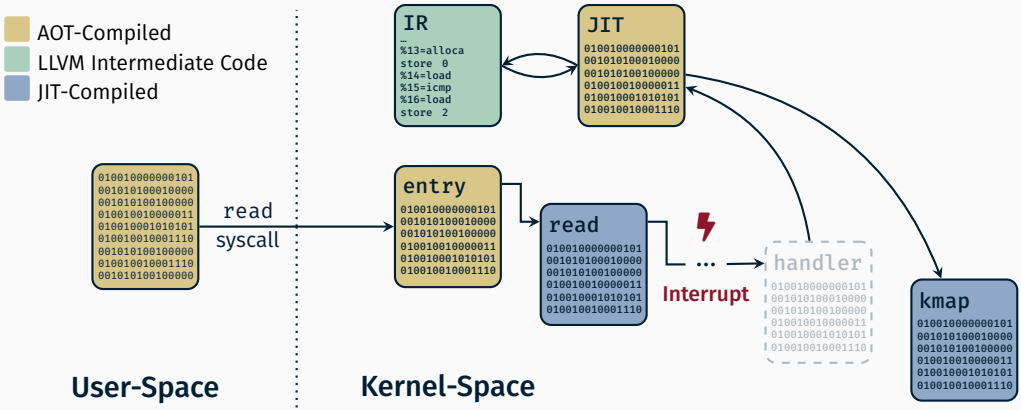

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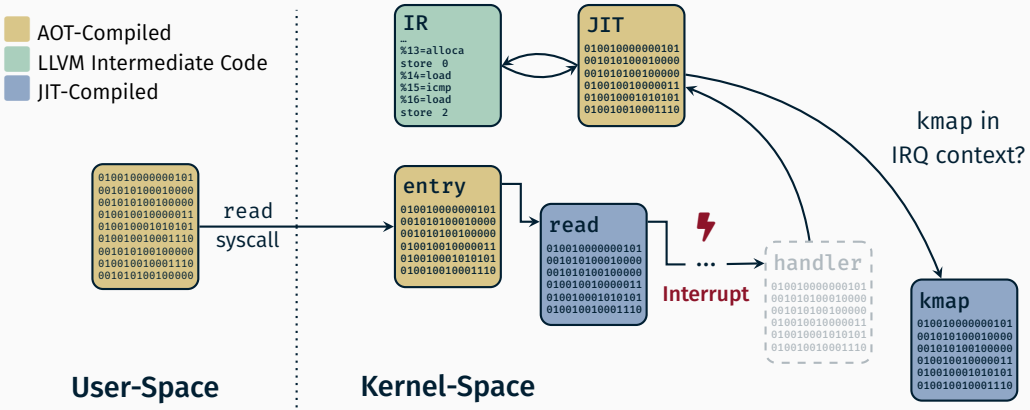

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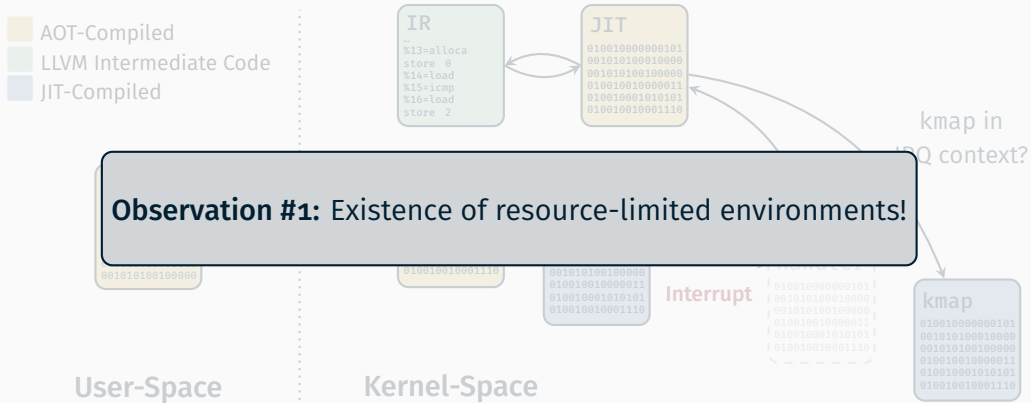

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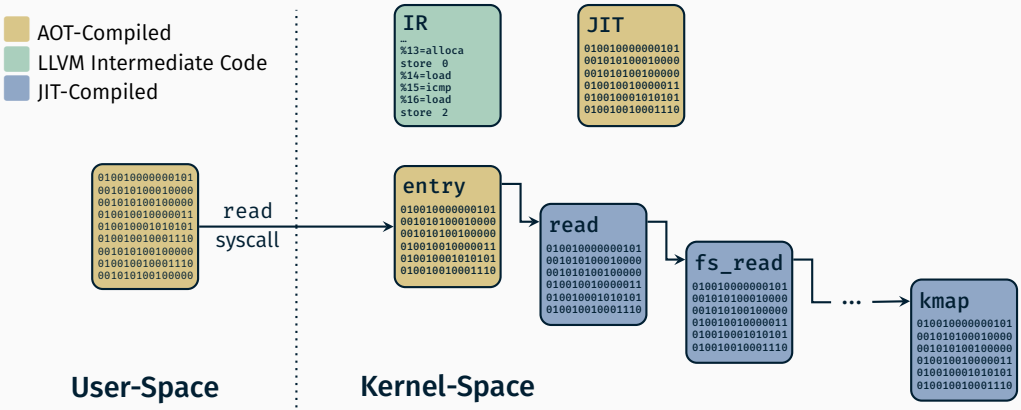

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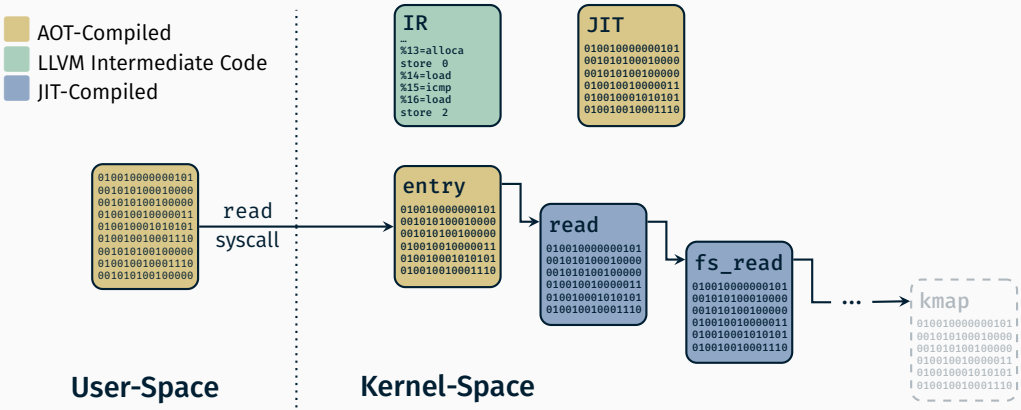

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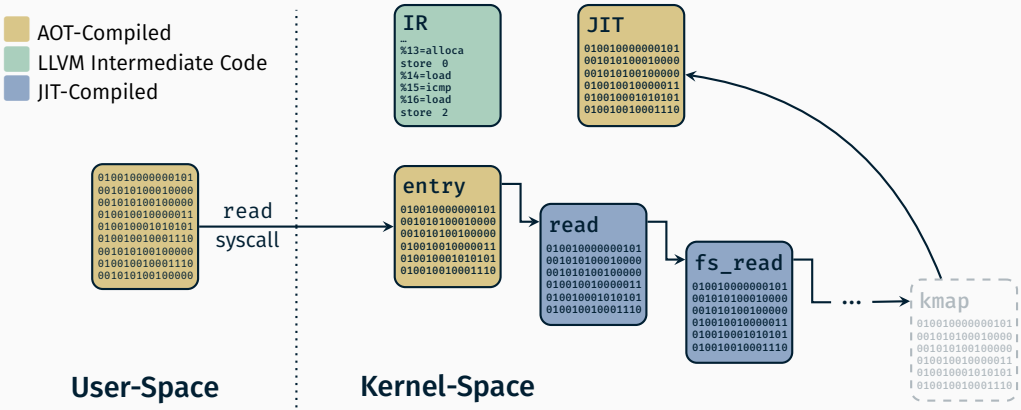

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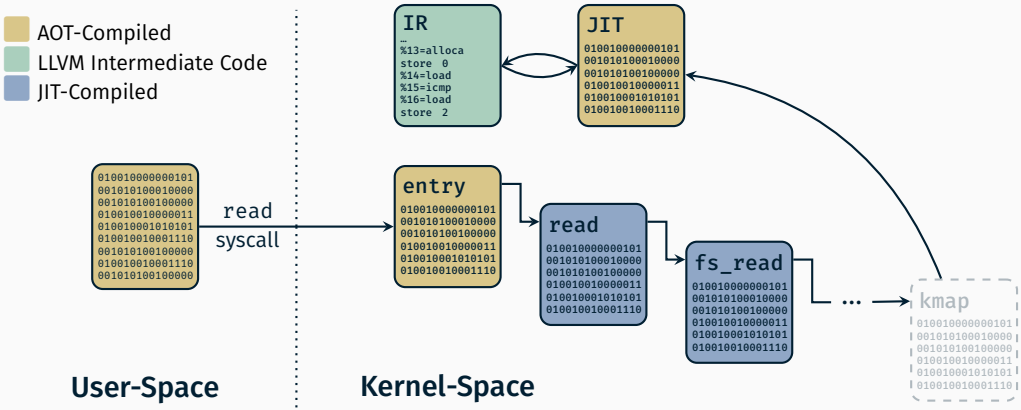

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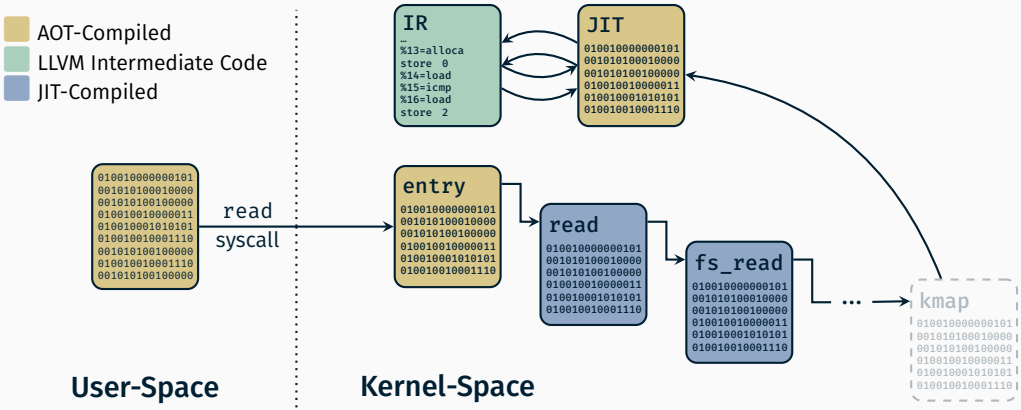

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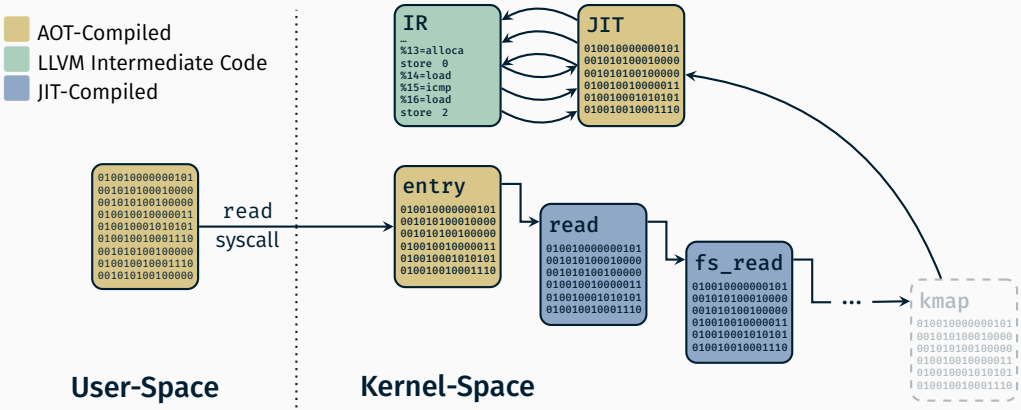

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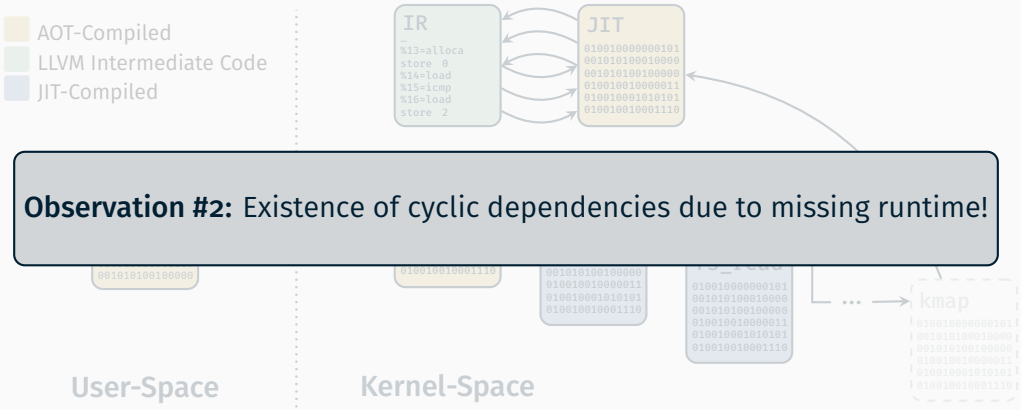

Observation #2: Existence of cyclic dependencies due to missing runtime!

DOSY: First steps towards on-demand compilation of operating systems.

- **Design** for future symbiosis of OSs + Just-in-Time compiler[1] + Interpreter.
- **Implementation** of interpreter for resource-limited environments.
- **Static Analysis** to enforce required interpreter properties.

[1] currently Work-in-Progress

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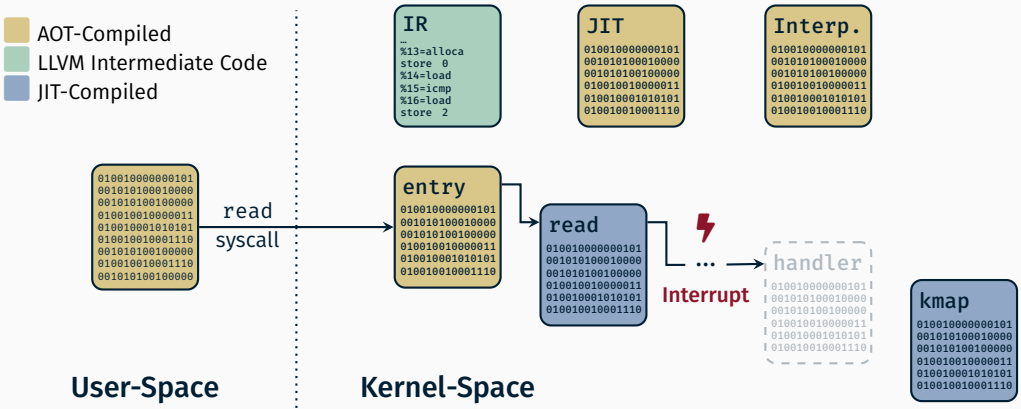

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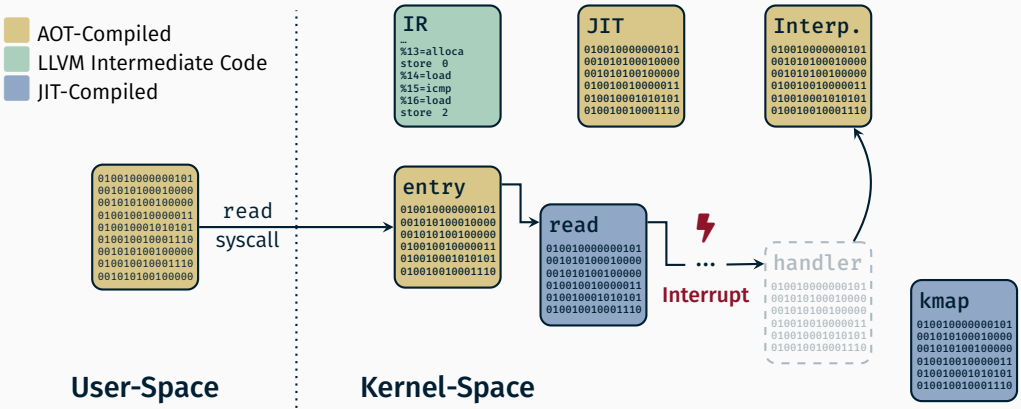

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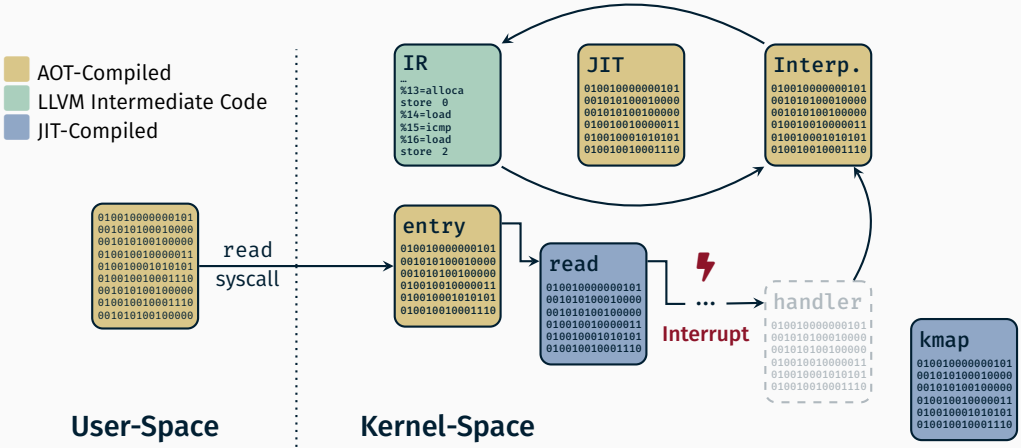

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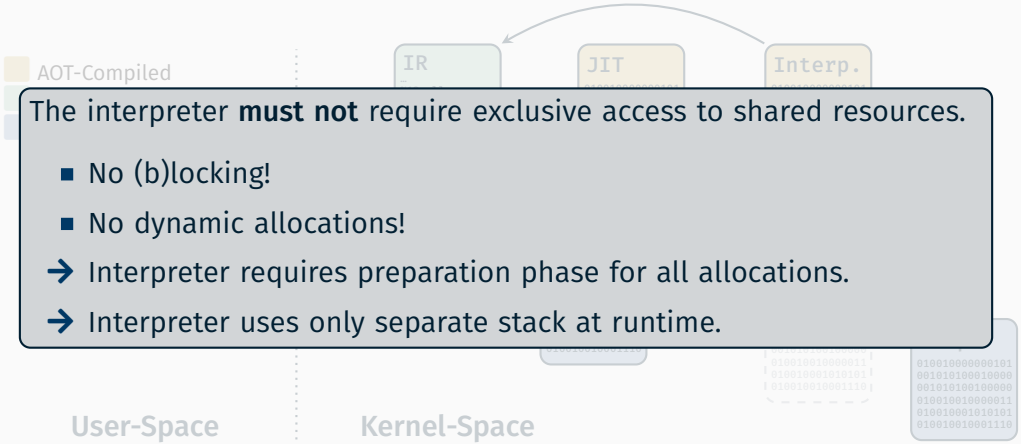

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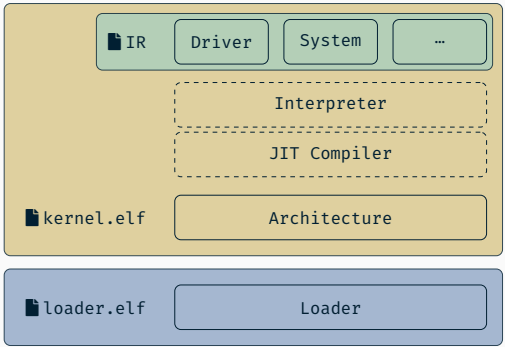

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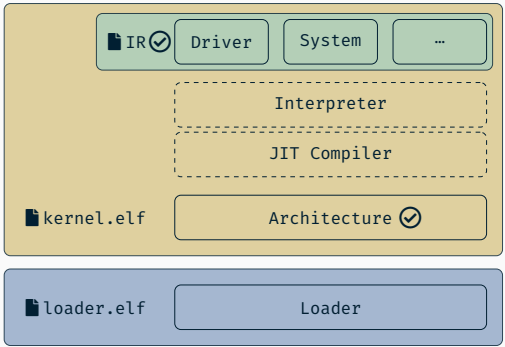

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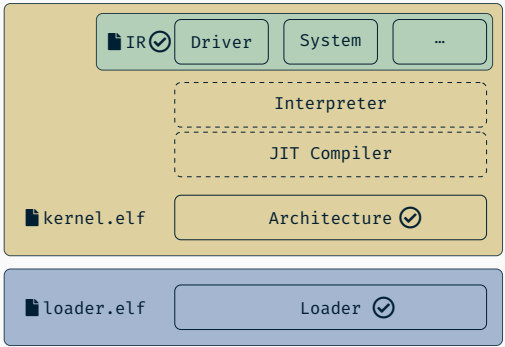

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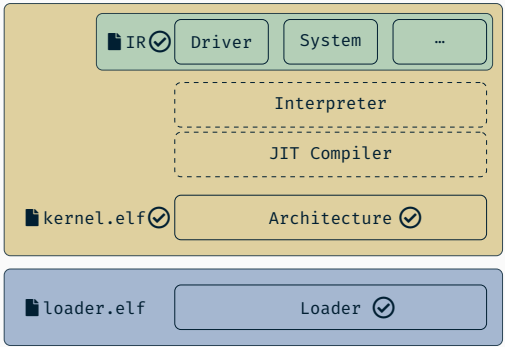

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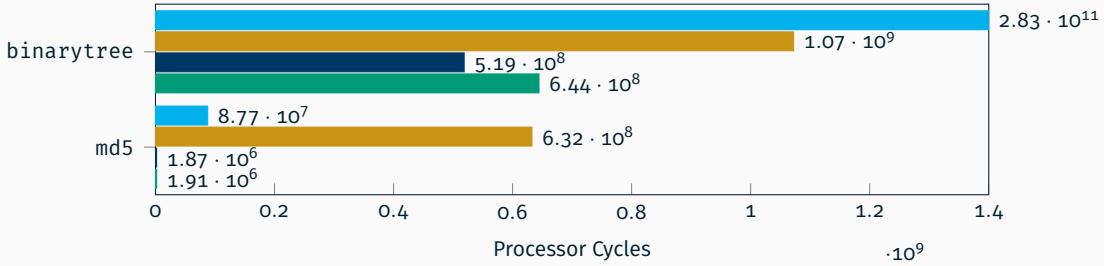

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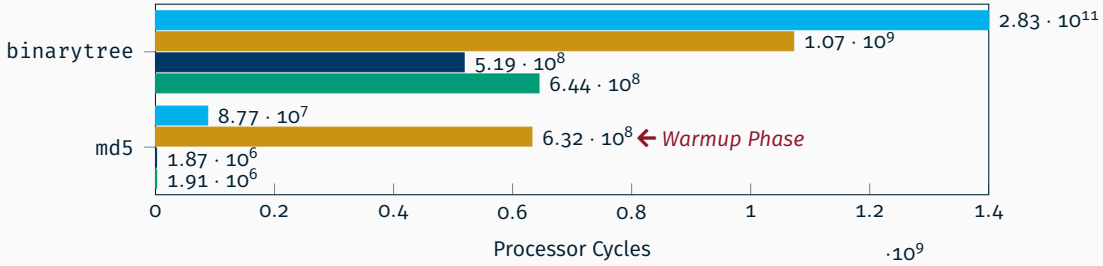

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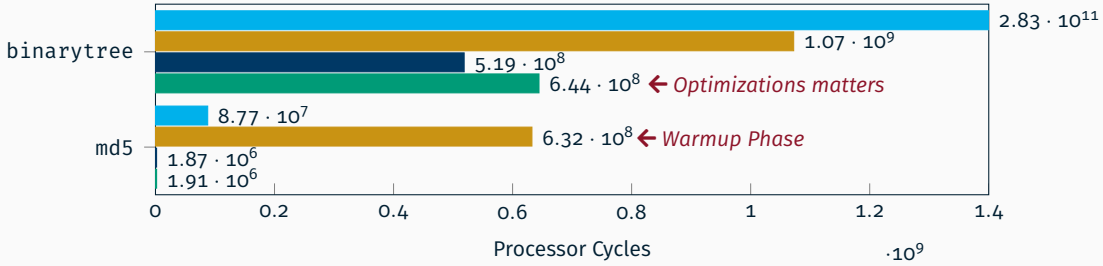

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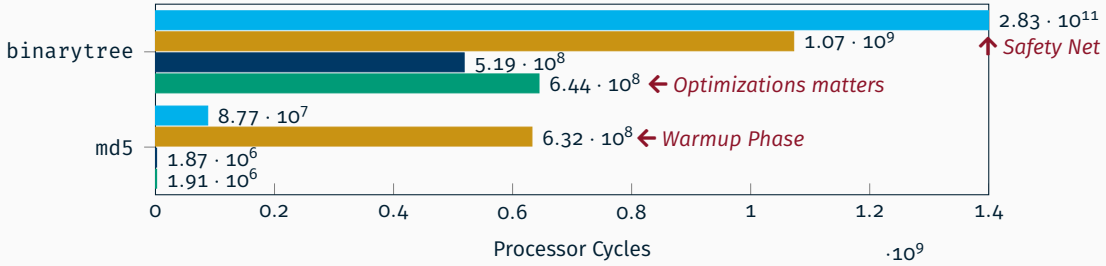

DOSY: Dynamic Operating System

Future symbiosis of...

- Operating Systems: JITTY OS 🕓, built to be *JITed*
- Just-In-Time Compiler
- Interpreter: DOSY Interpreter, used as *safety net*

...based on whole system state

Preprint version of the accepted PLOS '23 paper

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Static Analysis

Problem: Hidden allocations within interpreter.
Solution: Static analysis based on minimal annotations.

Basic algorithm:

1. Assign initial annotations
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3. Generate call graph for each function
4. Extended call graph based on collected trait information
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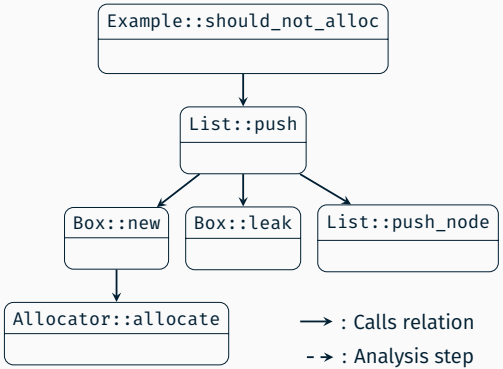

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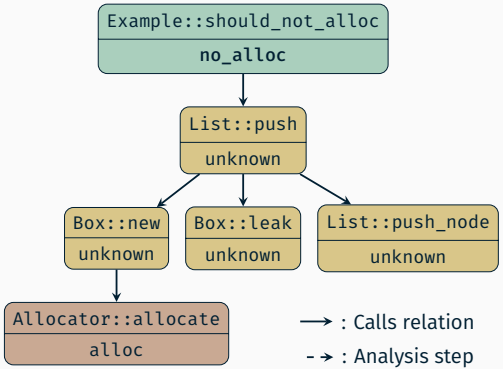

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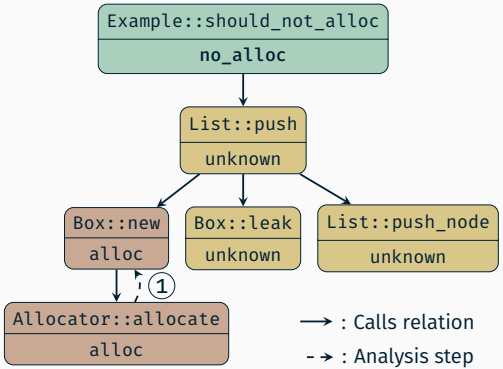

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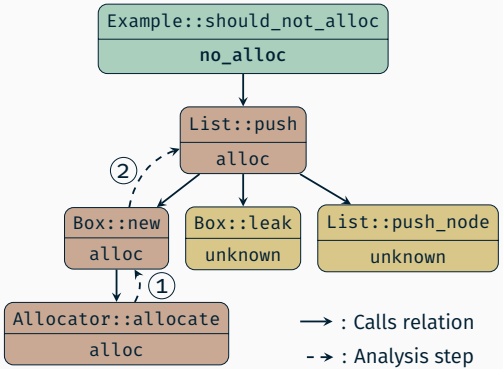

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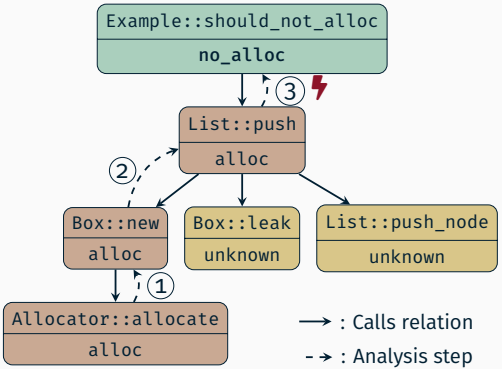
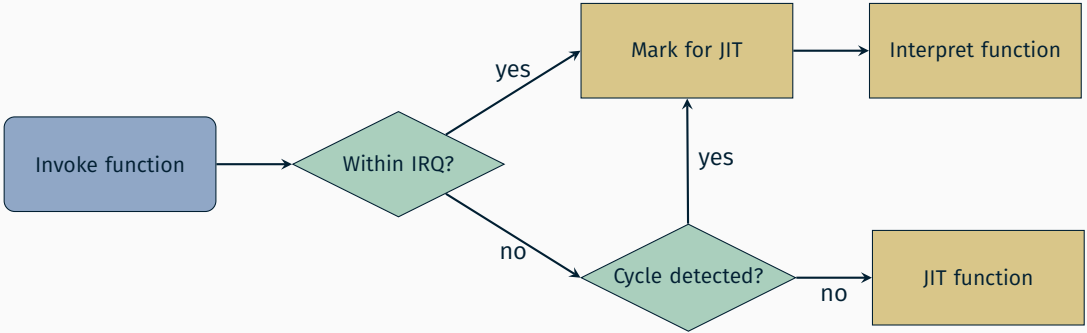


Invocation Mechanism



- Each function described by **Global Function Table** (GFT)
- Implementation similar to PLT/GOT

Global Function Table