StkTokens: Enforcing Well-Bracketed Control Flow and Stack Encapsulation Using Linear Capabilities

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POPL, January 19, 2019

Overview

StkTokens-paper in the big picture

Defining well-bracketed control flow and local state encapsulation

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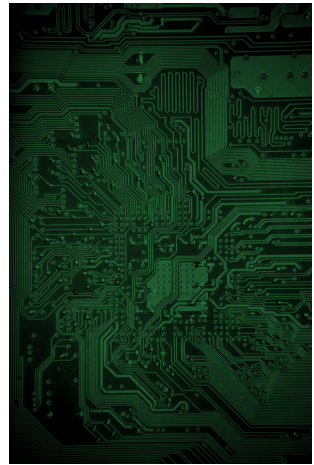
StkTokens-paper in the big picture

Defining well-bracketed control flow and local state encapsulation

Abstractions all the way down



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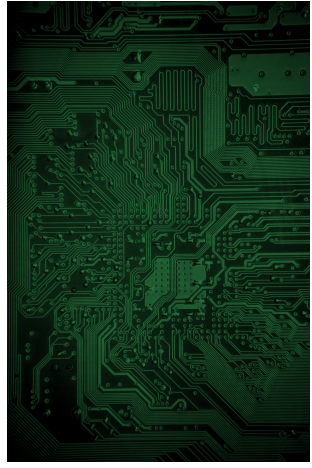

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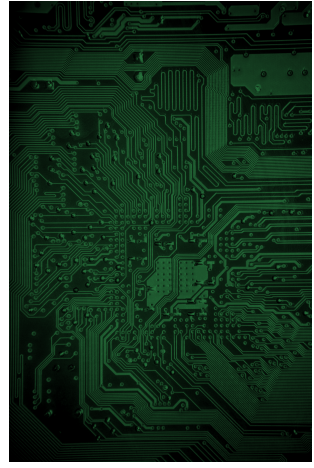

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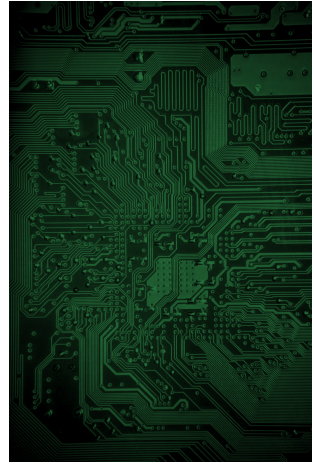

Abstractions all the way down

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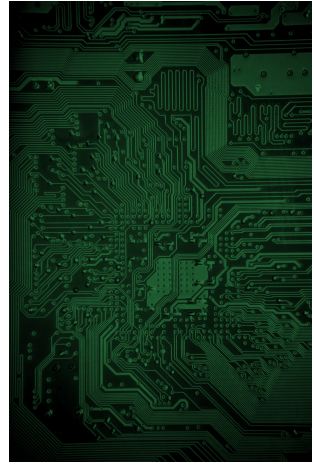

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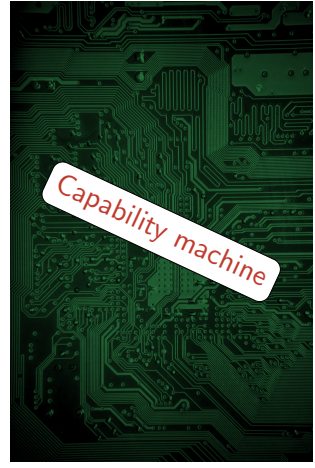

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ir → ir'

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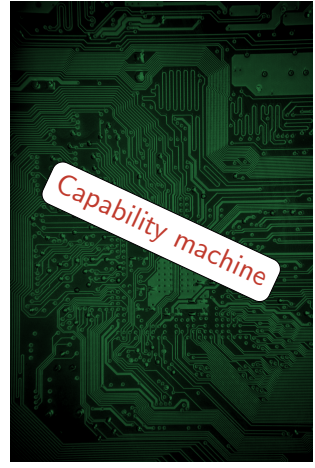

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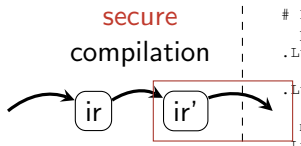


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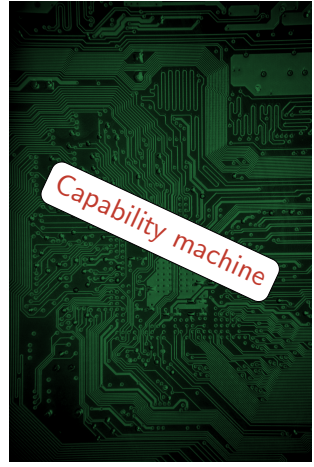

Paper Contents Overview

Formalization of CHERI-like capability machine with linear capabilities

StkTokens a calling convention that provably guarantees local-state encapsulation (LSE) and well-bracketed control-flow (WBCF)

Fully-abstract overlay semantics a novel way to prove LSE and WBCF claims

Overview

StkTokens-paper in the big picture

Defining well-bracketed control flow and local state encapsulation

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```
void a()
{
    int y = 40+2;
    return;
}

void b()
{
    int x = 5;
    a();
    x = 2;
    a();
    return;
}
```

Defining well-bracketed control flow and local state encapsulation

```
void a()
{
    int y = 40+2;
    return;
}
```

Function `a` cannot access variable `x`

```
void b()
{
    int x = 5;
    a();
    x = 2;
    a();
    return;
}
```

Local-state encapsulation

Defining well-bracketed control flow and local state encapsulation

```
void a()
{
    int y = 40+2;
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```

Well-bracketed control flow

Desired properties of the WBCF and LSE definition

1. *Intuitive*
2. *Useful for reasoning*
3. *Reusable in secure compiler chains*
4. *Arguably "complete"*

Fully-Abstract Overlay Semantics

Given

- Target semantics
- Calling convention

Define

- New semantics for the same syntax
- Properties by inspection

In this case:
Given

- Capability machine with linear capabilities
- StkTokens

Define

- Same machine, but with built-in call stack
  - Series of instructions corresponding to call and return are interpreted as call and return, respectively, using the call stack

Evaluating the definition

1. *Intuitive*
2. *Useful for reasoning*
3. *Reusable in secure compiler chains*
4. *Arguably "complete"*

Evaluating the definition

1. *Intuitive*
   Yes, call stack corresponds exactly to our intuition.
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   Yes, fully-abstract compilations compose vertically, so oLCM can be used as a target for other compilation phases.
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Thank you!