RUST ON CHERIOT

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CHERI Blossoms, March 2026

WHAT?

CHERI

We all know and love it

RUST

A solution to the same problems?

“Choose one”

WHAT?

We all know and love it

A solution to the same problems?

Choose both!

CHERI gives you spatial safety!

```
char stack[] = "short buffer";
stack[sizeof(stack)] = '\0';
```

```
static char stack[] = "short buffer";
stack[sizeof(stack)] = '\0';
```

```
char *heap = new char[16];
heap[sizeof(heap)] = '\0';
```

These all deterministically trap on CHERI.

CHERIoT also gives you temporal safety!

```
…
free(heap);
heap[0] = 'H';
```

This deterministically traps on CHERIoT.

CHERIoT and its RTOS also let you handle these traps.

- A general-purpose systems language
- Builds on previous research on programming languages
- …But isn’t a research programming language!
- Automatic memory management without GC
- Expressive type system (System F, type classes, regions, linear/affine)
- You’ve heard of it at least once

Rust gives you spatial safety!

```
let mut stack = [0, 1, 2, 3];
stack[4] = 0;
```

```
static mut stack: [u8; 4] = [0, 1, 2, 3];
stack[4] = 0;
```

```
let mut heap = vec![0, 1, 2, 3];
heap[4] = 0;
```

```
$ cargo build
error: this operation will panic at runtime
index out of bounds: the length is 4 but the index is 4
```

Rust also gives you temporal safety!

```
drop(heap);
heap[0] = 10;
```

```
$ cargo build
error[E0382]: borrow of moved value: `heap`
```

WHY?

WHY?

Greater than the sum of its parts

	RUST	CHERI
Your code	Rich compile-time guarantees for safe fragments Expressive type system	Non-bypassable runtime guarantees Easy compartment restart for availability Guarantees extend to any language
Dependencies	Rich interfaces for non-malicious libraries Mature package management tools like cargo	Strong isolation of untrusted code Auditable rights for third-party components

Greater than the sum of its parts

RUST & CHERI

Non-bypassable runtime guarantees

Rich compile-time guarantees for safe fragments

Easy compartment restart for availability

Expressive type system

Guarantees extend to any language

Rich interfaces for non-malicious libraries

Strong isolation of untrusted code

Mature package management tools like cargo

Auditable rights for third-party components

Demo 1: off-by-one

```
let v = [0, 0];
let indices = [1, 2];
let mut count = 0;
for i in indices {
 unsafe {
     count = count + *v.get_unchecked(i);
   }
}
```

On other platforms:

Calling this method with an out-of-bounds index is undefined behaviour even if the resulting reference is not used.

source

Demo 2: Rust-to-C FFI

```c
extern "C" int verify(char *s) {
  int len = strlen(s);
  …
  return valid_len;
}
```

```rust
unsafe {
 let payload: String = get();
 let valid_len = verify(payload.as_ptr());
 let valid = str::from_raw_parts(payload.as_ptr(), valid_len);
}
```

On other platforms this is, again, undefined behaviour

Greater than the sum of its parts

RUST & CHERI

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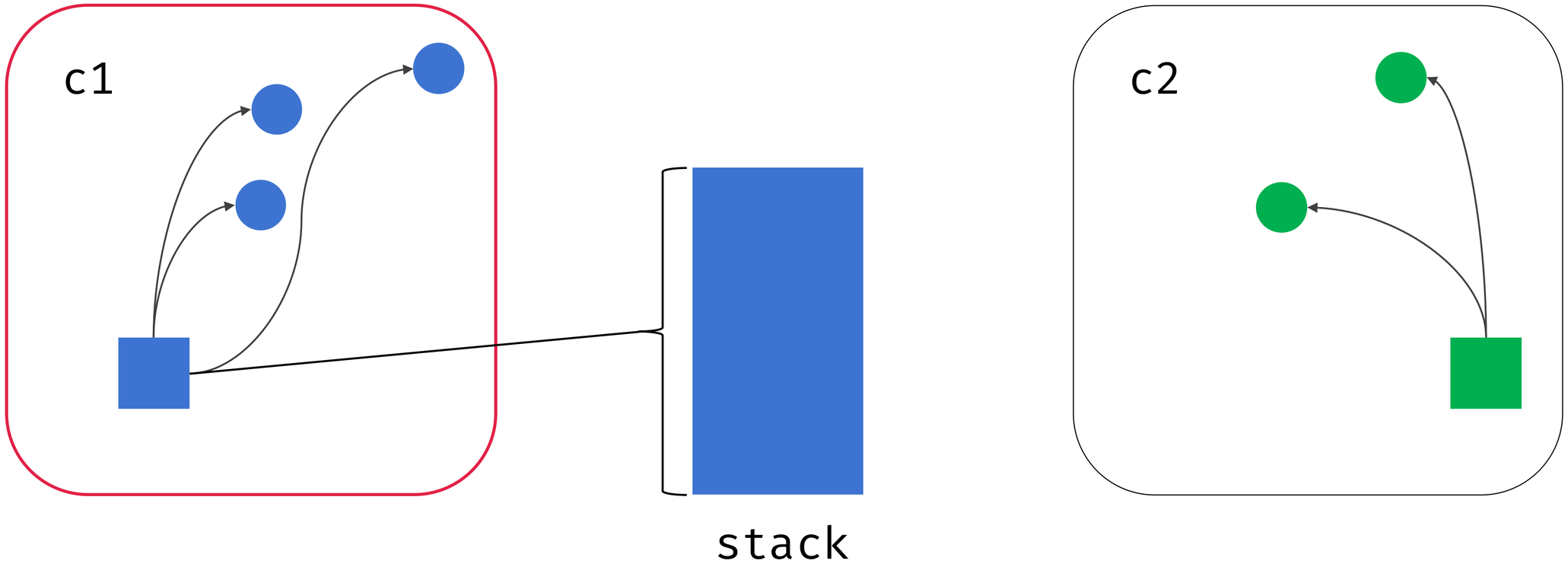
Strong isolation of untrusted code

Mature package management tools like cargo

Auditable rights for third-party components

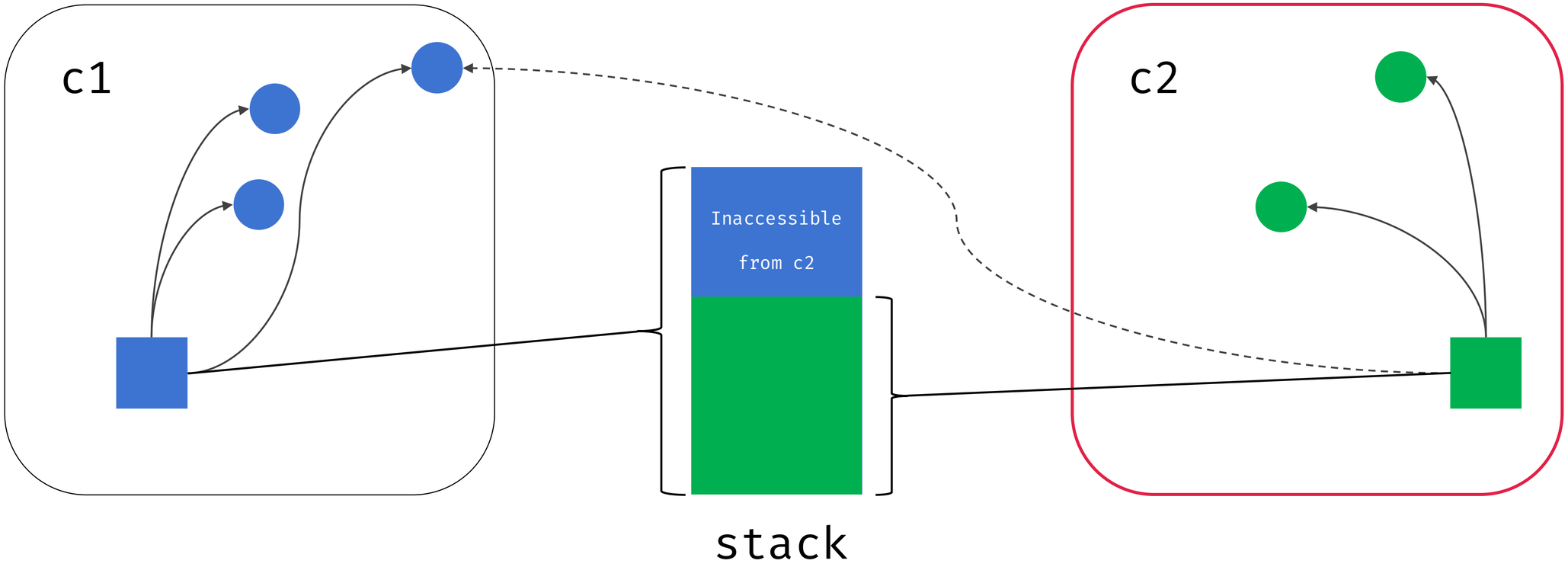
Strong isolation of untrusted code

(compartmentalisation)



Strong isolation of untrusted code

(compartmentalisation)



Demo 3: supply chain attack

```
let password = get_password();
let user = get_user();

kvlog::record("auth.request", &user);

if allow(&user, &password) {
   . . .
}
```

c1

```
fn record(key: &str, value: &str) {
 println!("[kvlog] {key}-> {value}");
 if key == "auth.request" {
  unsafe {
   let addr = frameaddr();
   let ptr = addr.sub(..);
   let password: &String = transmute(ptr);
   send_username_password(&value, &password)
  }
 }
}
```

c2

On other platforms there's nothing stopping `record` from accessing the caller's stack

How?

In 2025 DSbD funded SCI Semiconductor funding
to make Rust work on CHERIoT.

1. Adapt previous work on Morello to latest Rust releases
2. Add the CHERIoT target and CHERI intrinsics
3. Make `core` and `alloc` compile to it
4. Test `core` and `alloc` (might require building std too)
5. Add CHERIoT-specific frontend attributes (CC, MMIO, SharedObjects, ..)
6. Integration tests with the rest of the CHERIoT platform (the RTOS, networking stack, compartments)
7. Enforcing Rust properties at FFI/compartment boundaries

Required changes to the compiler

```
pub enum Primitive {
        Int(Integer, bool),
        Float(Float),
        Pointer(AddressSpace),
}
```

```
impl Primitive {
        pub fn size<C: HasDataLayout>(self, cx: &C) -> Size
}
```

Required changes to the compiler

```
pub enum Primitive {
        Int(Integer, bool),
        Float(Float),
        Pointer(AddressSpace),
}
```

```
impl Primitive {
        // How many bits to store this value?
        pub fn in_memory_size<C: HasDataLayout>(self, cx: &C) -> Size
        // How many bits _of data_ can be stored here?
        pub fn capacity<C: HasDataLayout>(self, cx: &C) -> Size
}
```

How?

...evolving the crab...

```
fn insert_alignment_check<'tcx>(..) -> {
    // Transmute the pointer to a usize (equivalent to `ptr.addr()`).
-   let rvalue = Rvalue::Cast(CastKind::Transmute, Operand::Copy(ptr), tcx.types.usize);
+   let rvalue = Rvalue::Cast(CastKind::PointerExposeProvenance, Operand::Copy(ptr), tcx.types.usize);
}
```

`Transmute` is lowered to `poison` if the types have different sizes.

How?

…evolving the crab…

```
$ ./x test tests/codegen-llvm –target=riscv32cheriot-unknown-cheriotrtos
test result: ok. 602 passed; 16 failed; 402 ignored
```

60% of codegen-llvm tests pass, 39% can’t run on CHERIoT, 1% fail

```
$ cargo test library/coretests –target=riscv32cheriot-unknown-cheriotrtos
test result: ok. 1709 passed; ? failed; 1257 ignored
```

57% of coretests pass, 43% need investigation

Making it work is only part of the story. We also need to have a plan for the future.

The cherry on top would be that of being able to upstream a new CHERI target and be able to maintain it in the future.

This is not an easy task: it requires a lot of expertise, designs and social skills!

WHERE?

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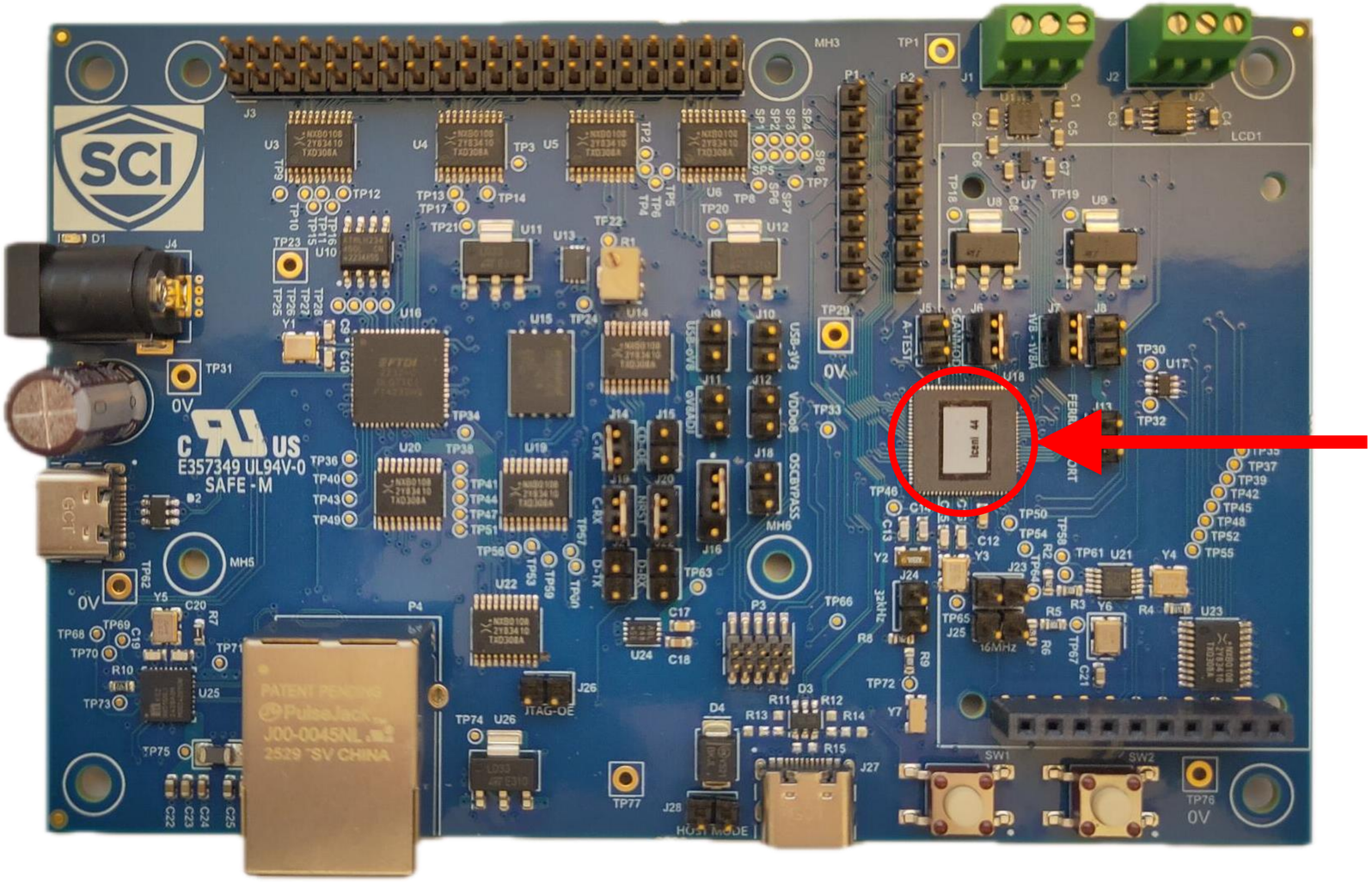
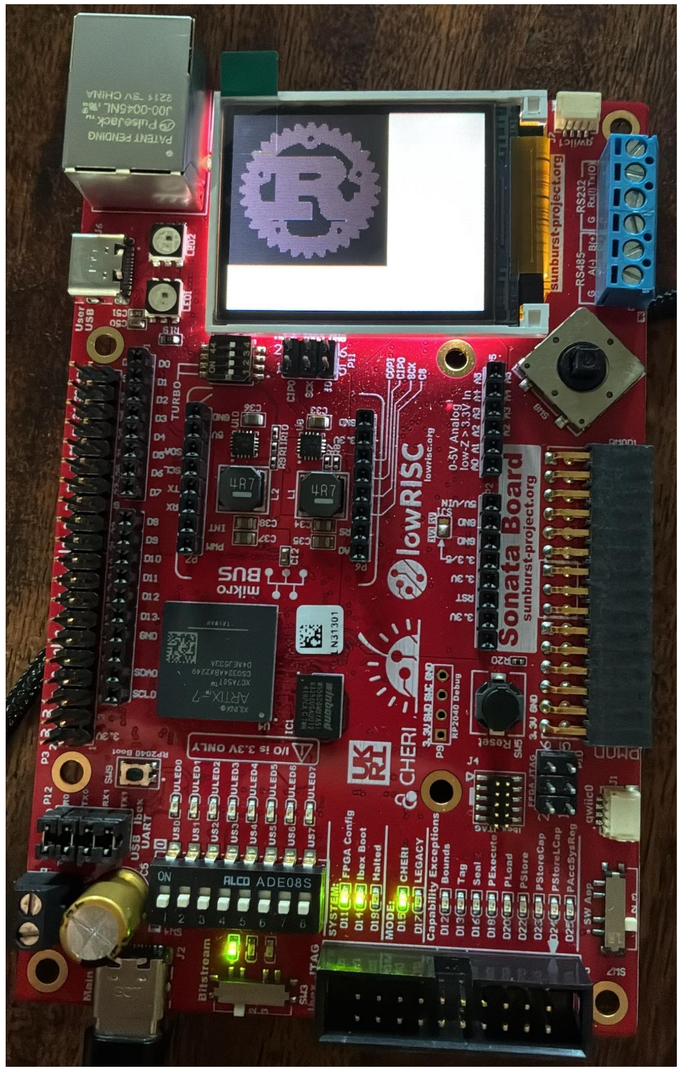

SCI
E357349 UL94V-0
SAFE-M
PATENT PENDING
Pulse Jack
J00-0045NL
2529 SV CHINA
LCD1
16MHz
JTAG-OE
HOST MODE

WHERE?



Devcontainer with simulators, clang and rustc

[lowRISC Sonata](#) running embedded-graphics

WHERE?

All the work is open source, and lives in the CHERIoT-Platform/cheri-rust repository on GitHub.

THANK YOU!