

Building iOS, Android and Web Apps that share a single Rust Core

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- 1 **What** is the problem with multi-platform app development today?
- 2 **Rust, WebAssembly, and Ports and Adapters**
- 3 **Crux** — experimental, open source tooling for building **headless** apps

Stu

- Software engineer
- Founder of Red Badger

@stuartharris



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1

What is the problem with multi-platform app development today?

2

Rust, WebAssembly, and Ports and Adapters

3

Crux — experimental, open source tooling for building **headless** apps

1

What is the problem with multi-platform app development today?



I Building a multi-platform app (don't @ me!)

	Platform Native	Kotlin MM	React Native	Capacitor Ionic	Flutter
Native UX	✓	✓	😐	✗	✗
Web?	✗	😐	😐	✓	✓
Development	😐	✓	😐	✓	✓
Testing	😐	😐	🤯	🤯	😐
Maintenance	😐	✓	😡	😡	✓
Effort	3x	2x	2x	1.5x	1.4x

1 Tooling and Architecture

Building quality apps across all platforms is too hard

- In order to reuse code we end up **compromising** on UX and/or DX
- UI-centric **architectures** make applications **hard to test** and maintain

1 UI-centric architecture

- UI layout is the **primary** organising principle
- Behaviour and interaction with the outside world are **secondary**

“It looks like this... and does that”

- 1 **What** is the problem with multi-platform app development today?
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2

Rust, WebAssembly, and Ports and Adapters



2

Better Tools and Better Architecture

- Rust is a **revolution**

everyone can now build reliable, high quality software in almost any space — perfect for multi-platform app development

- WebAssembly is a **revolution**

fast and portable — great for building apps in the languages we love

- Ports and Adapters is a **revolution**

behaviour-centric architecture — leads to better testability

2 What if we start with behaviour?

But how do we model behaviour?

- update a **model** in response to **events**
- emit **effects** — intent to perform side-effects

2 Behaviour

Update state when an Event is raised

```
fn update(event: Event, state: Model) -> Model {  
    // perform HTTP request  
}
```

2 Behaviour

A pure update function (cf. Elm, Redux, etc.)

```
fn update(event: Event, state: Model) -> (Model, Vec<Effect>)
```

A dirty function with side-effects

```
fn http(effect: Effect) { /* perform HTTP request */ }
```

2 UI

Imagine the UI as a projection of state (cf. early React)

```
fn view(state: Model) { /* update UI */ }
```

2 UI

A pure view function

```
fn view(state: Model) -> ViewModel
```

A dirty function — UI is a side-effect

```
fn render(view: ViewModel) { /* update UI */ }
```

2 Before

Behavior

```
fn update(event: Event, state: Model) -> (Model, Vec<Effect>)
```

```
fn http(effect: Effect) { /* perform HTTP request */ }
```

UI

```
fn view(state: Model) -> ViewModel
```

```
fn render(view: ViewModel) { /* update UI */ }
```

2 After

Core (pure)

```
fn update(event: Event, state: Model) -> (Model, Vec<Effect>)
```

```
fn view(state: Model) -> ViewModel
```

Shell (dirty)

```
fn http(effect: Effect) { /* perform HTTP request */ }
```

```
fn render(view: ViewModel) { /* update UI */ }
```

2 WebAssembly

WebAssembly helps us stay honest!



WA

A large, solid blue rectangular shape with a single black circular hole cut out from the top right corner. Inside this blue area, the letters 'WA' are written in a large, white, sans-serif font.

2 Behaviour-centric architecture

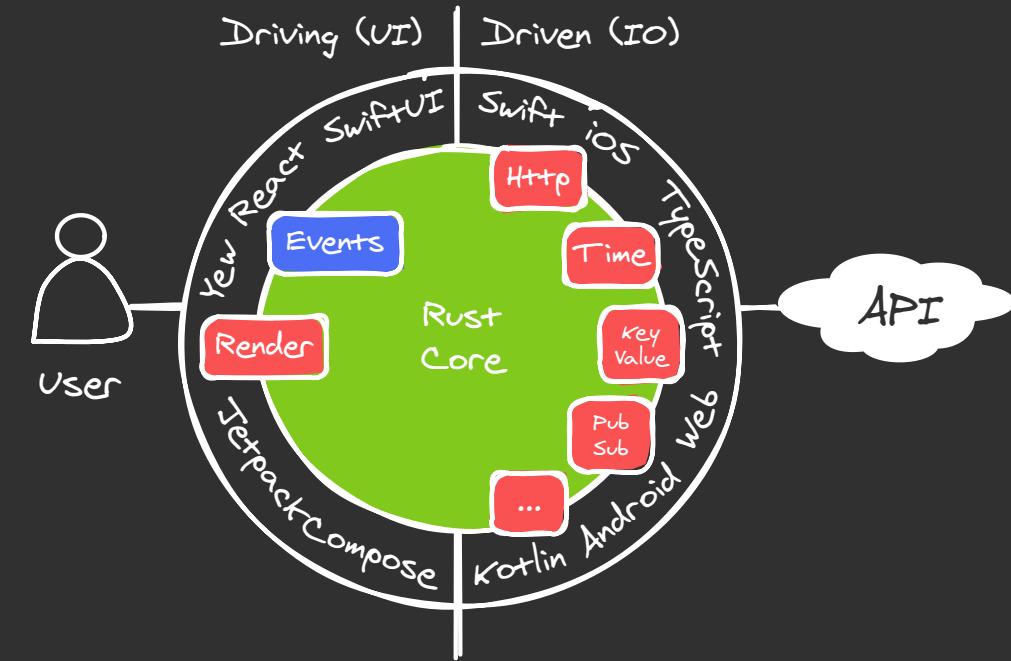
- Behaviour is the **primary** organising principle
- Interaction with the outside world is **secondary**
- UI is also a side-effect

| “It does this... and looks like that!”

2 Ports and adapters

Allow an application to equally be driven by users, programs, automated test or batch scripts, and to be developed and tested in isolation from its eventual run-time devices and databases.

Alistair Cockburn, 2005



Hexagonal Architecture

2 Ports and adapters

The application can be deployed in **headless** mode, so only the API is available, and other programs can make use of its functionality

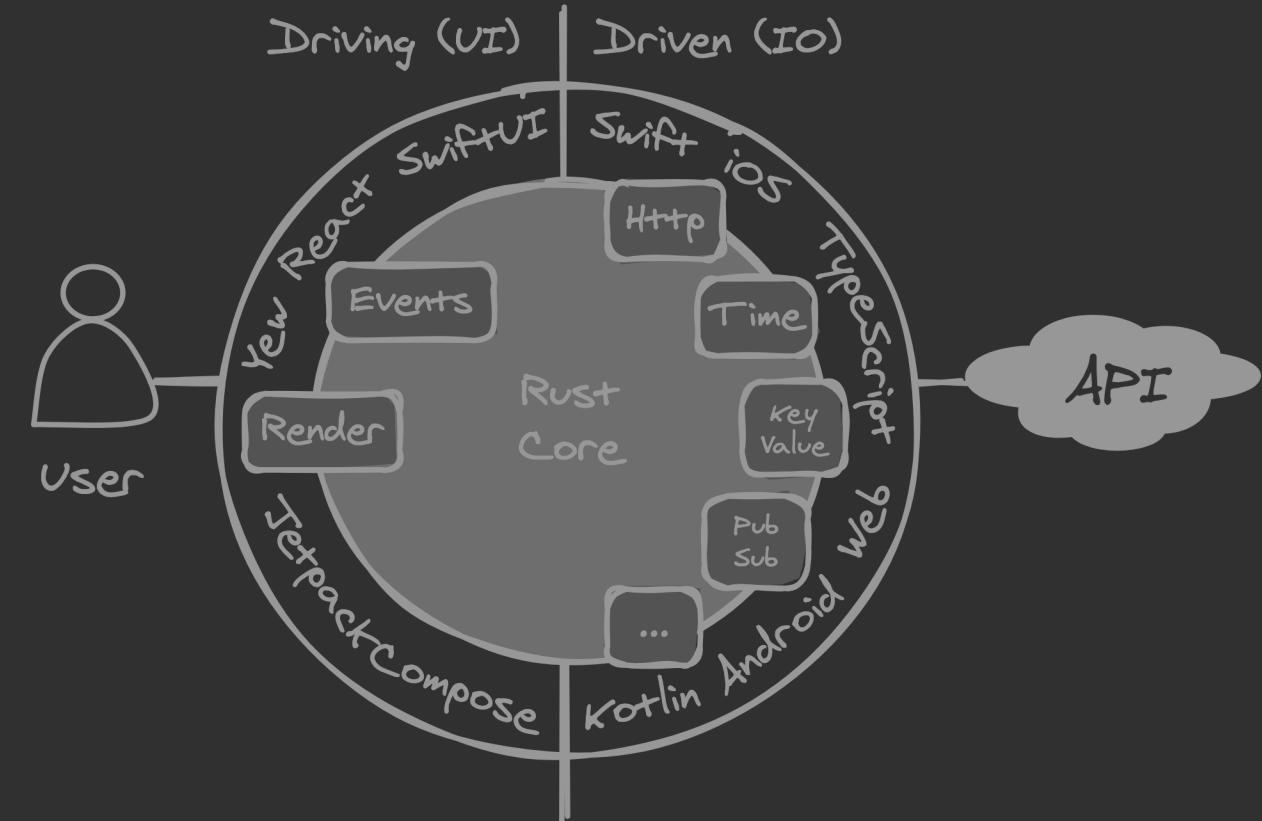
Alistair Cockburn, 2005

Hexagonal Architecture

1 What is the problem with multi-platform app development today?

2 Rust, WebAssembly, and Ports and Adapters

3 Crux — experimental, open source tooling for building headless apps

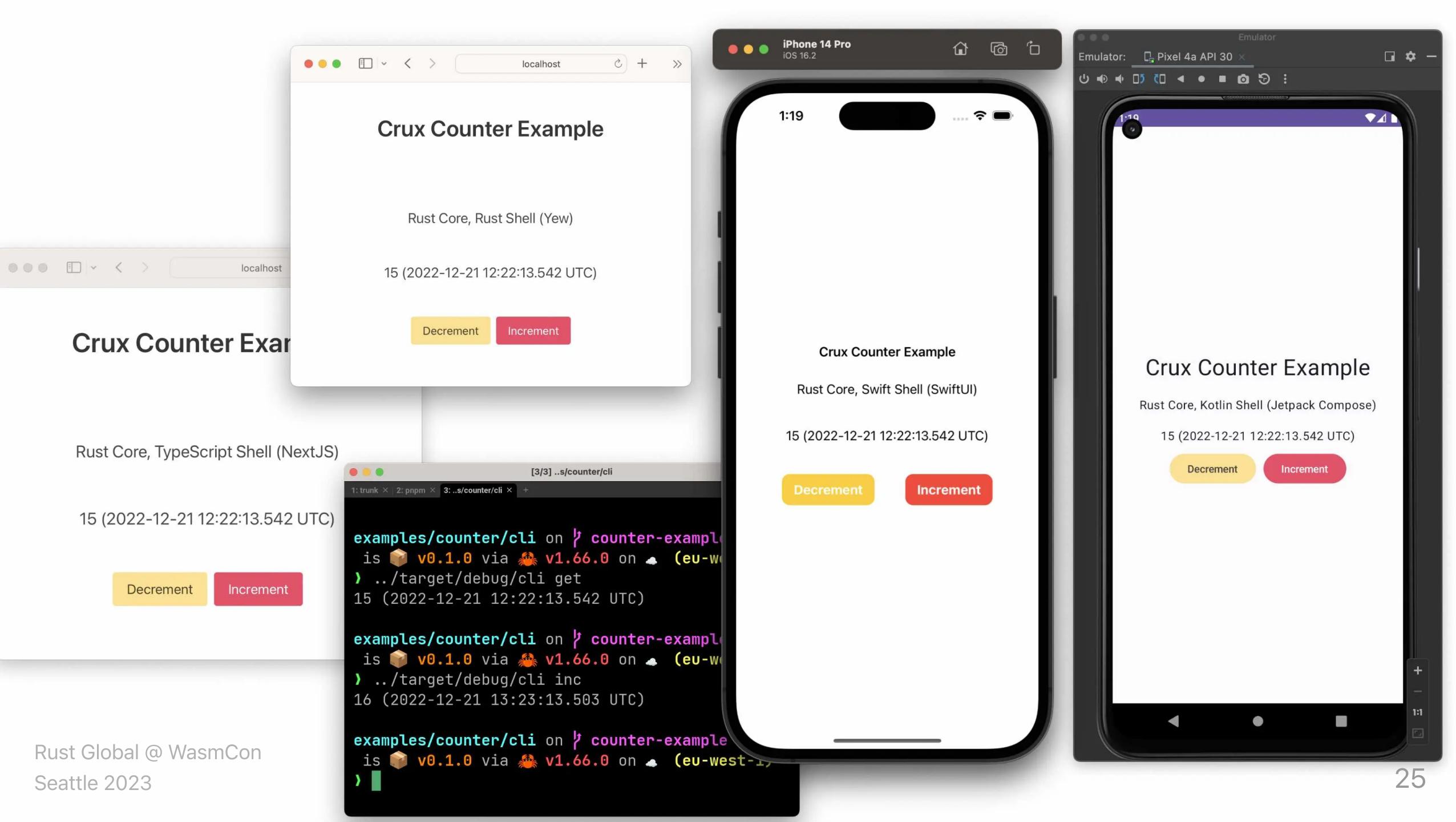




Crux

- Shared **behaviour**
- in **Rust** 🦀
- Platform **native** UX





3 Any platform

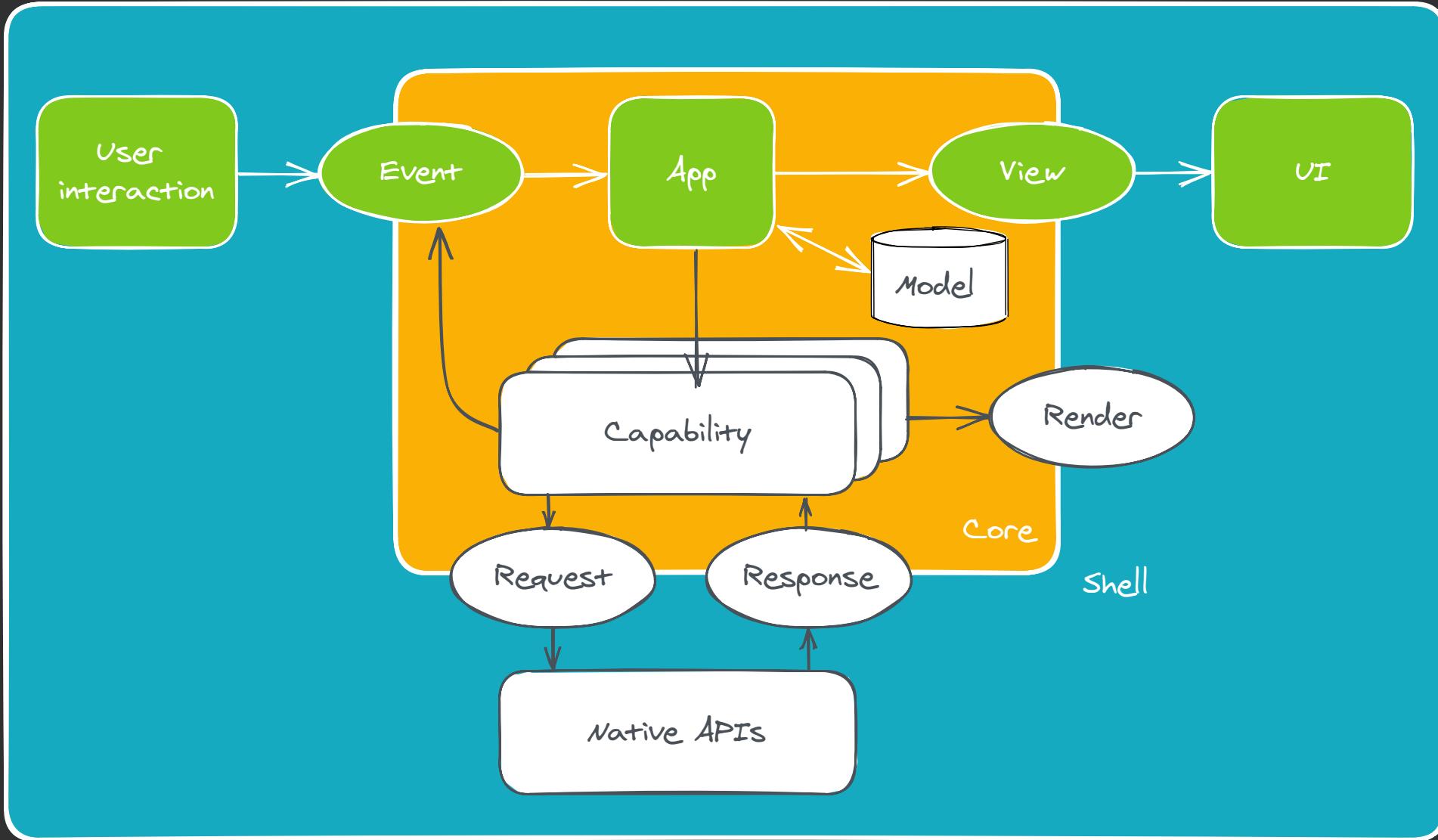
platform	language	UI	library	lib name	FFI
iOS	Swift	SwiftUI	static	libshared.a	uniffi-bindgen
Android	Kotlin	Compose	dynamic	libshared.so	uniffi-bindgen
Web	TypeScript	Remix	wasm	shared.wasm	wasm-bindgen
Web	Rust	Leptos	crate		
CLI	Rust	println!()	crate		

3 FFI

```
namespace shared {  
    bytes process_event([ByRef] bytes msg);  
    bytes handle_response([ByRef] bytes uuid, [ByRef] bytes res);  
    bytes view();  
};
```

Type generation with `serde-generate`

3



3 Capabilities

```
// fire and forget
caps.render
    .render();

// request/response
caps.http
    .post(API_URL)
    .header("Authorization", token)
    .body_json(json)
    .expect("could not serialize body")
    .expect_json()
    .send(Event::Created);

// streamed responses
caps.sse
    .get_json(API_URL, Event::Update);
```

3 Capabilities

- Built-in (Render)
- crux_* crates (Http , KeyValue , Platform , Time)
- Custom
 - ServerSentEvents in the Counter example
 - Delay example in the book
 - Timer and PubSub in the Notes example
- Community contributed

3

What does a Crux app look like?

```
#[derive(Default)]
pub struct App;

impl crux_core::App for App {
    type Event = Event;
    type Model = Model;
    type ViewModel = ViewModel;
    type Capabilities = Capabilities;

    fn update(&self, event: Self::Event, model: &mut Self::Model, caps: &Self::Capabilities) {
        match event {
            Event::Increment => model.count += 1,
            Event::Decrement => model.count -= 1,
            Event::Reset => model.count = 0,
        };

        caps.render.render();
    }

    fn view(&self, model: &Self::Model) -> Self::ViewModel {
        ViewModel {
            count: format!("Count is: {}", model.count),
        }
    }
}
```



③ What does testing look like?

3 What does a test look like?

```
#[cfg(test)]
mod test {
    use super::*;
    use crux_core::testing::AppTester;

#[test]
fn increments_count() {
    let app = AppTester::<App, _>::default();
    let mut model = Model::default();

    let update = app.update(Event::Increment, &mut model);

    // Check the app asked us to `Render`
    assert_effect!(update, Effect::Render(_));

    // Check view model is correct
    let actual_view = app.view(&model).count;
    let expected_view = "Count is: 1";
    assert_eq!(actual_view, expected_view);
}
```

3

17ms

```
crux/examples/notes on 🎨 remix [!] via 🐀 v1.71.0 on 🌐 (eu-west-1)
❯ cargo nextest run
    Finished test [unoptimized + debuginfo] target(s) in 0.06s
    Starting 25 tests across 3 binaries
        PASS [ 0.005s] shared app::editing_tests::removes_selection_on_backspace
        PASS [ 0.006s] shared app::editing_tests::inserts_text_at_cursor_and_renders
        PASS [ 0.006s] shared app::editing_tests::changes_selection
        PASS [ 0.006s] shared app::editing_tests::handles_emoji
        PASS [ 0.005s] shared app::editing_tests::renders_text_and_cursor
        PASS [ 0.006s] shared app::editing_tests::removes_character_after_cursor
        PASS [ 0.006s] shared app::editing_tests::removes_selection_on_delete
        PASS [ 0.006s] shared app::editing_tests::removes_character_before_cursor
        PASS [ 0.006s] shared app::editing_tests::moves_cursor
        PASS [ 0.007s] shared app::editing_tests::replaces_empty_range_and_renders
        PASS [ 0.005s] shared app::editing_tests::replaces_range_and_renders
        PASS [ 0.005s] shared app::note::test::splices_text
        PASS [ 0.005s] shared app::save_load_tests::creates_a_document_if_it_cant_open_one
        PASS [ 0.006s] shared app::editing_tests::replaces_selection_and_renders
        PASS [ 0.005s] shared app::note::test::inserts_text
        PASS [ 0.005s] shared app::save_load_tests::opens_a_document
        PASS [ 0.006s] shared app::save_load_tests::starts_a_timer_after_an_edit
        PASS [ 0.007s] shared app::save_load_tests::saves_document_when_typing_stops
        PASS [ 0.007s] shared app::sync_tests::concurrent_clean_edits
        PASS [ 0.007s] shared app::sync_tests::concurrent_conflicting_edits
        PASS [ 0.005s] shared app::sync_tests::one_way_sync
        PASS [ 0.005s] shared app::sync_tests::receiving_own_edits
        PASS [ 0.005s] shared app::sync_tests::two_way_sync
        PASS [ 0.005s] shared app::sync_tests::remote_insert_behind_cursor
        PASS [ 0.005s] shared app::sync_tests::remote_delete_moves_cursor
-----
Summary [ 0.017s] 25 tests run: 25 passed, 0 skipped
```



③ The crux of Crux

- headless, multi-platform, composable apps with shared **behaviour**
- better **testability**
- higher **quality** apps
- better **reliability**, safety, and security
- more **joy** from better tools

Thank you! 🎉

@stuartharris

Slides

[Crux Book](#), [Crux Github](#), [Crux Docs](#), [Crux Website](#)

[Rust Nation 2023 Talk](#)

