Overview

This is the architecture documentation of the software project done for MSE TSM_SoftwEng 2023.

If you are reading this as a PDF, note that there is a much prettier, interactive version embedded in the application itself.

Architecture Decision Records

We document our design decisions as architecture decision records. We follow the simple format proposed by Michael Nygard.

Rust everywhere

Status

Accepted.

Context

The requirements for this project include:

- collecting data on a microcontroller
- storing and serving the data with a web service
- displaying the data in an SPA

These are vastly different domains, for which different programming languages are well suited. For an SPA, JavaScript is completely dominant. For the embedded part, C has the necessary performance and ecosystem. In the web service space, competition is lively. Java, Python and Go and more are common choices.

The only language that's a rock-solid option for every one of these domains is Rust. It has the performance and control of C with memory-safety on top and a fast-paced embedded ecosystem. Its expressive type system makes it a breeze to build reliable and correct web services. Finally, its best-in-class support for compiling to webassembly and GUI-libraries utilizing state-of-the-art rendering patterns make it well-suited for developing an SPA.

Decision

The entire software system will be written in Rust.

Consequences

Developing both the SPA and the microcontroller will be more challenging, as Rust doesn't have as mature of an ecosystem as JavaScript and C respectively.

It will be significantly easier to share code between the three software components. Developing cross-cutting features will require less context-switching. Testing and CI/CD will be significantly easier to setup, as there is only one toolchain to worry about.

HTTP routing with axum

Status

Accepted.

Context

The Rust standard library does not include an HTTP router. A common task like that is best solved by using a library. There are several suitable ones available for Rust. Actix and axum are the most popular at the time of writing. For our simple requirements, neither is better or worse. There is existing experience with axum in the development team.

Decision

HTTP routing in the web service will be handled using axum.

Consequences

HTTP routing will not have to be done by hand.

JSON with serde

Status

Accepted.

Context

Web services communicate using well-specified formats, typically JSON. The best way to do de-/serialization of JSON or another format in Rust is to use serde. Since our tech stack is pure Rust, there is no need for OpenAPI or similar contract enforcement mechanisms. Shared definitions of the data types sent across process boudaries ensure compatibility. JSON, being a text-based format, is not the most efficient, but easily inspectable. For more efficient communication, binary formats are better suited.

Decision

The web service communicates via JSON, powered by serde.

Consequences

De-/serialization of inter-process messages will not have to be done by hand. A potential future migration to a more performant format than JSON is trivial.

SPA with Leptos

Status

Accepted.

Context

Modern single-page-applications are written using component-based UI libraries. This is because updating the DOM globally in am imperative manner quickly becomes unmanageable. In the JavaScript ecosystem, React is the most popular, but there are other ones using different reactivity systems. Rust also has several such UI libraries, despite the ecosystem being much younger. The Rust-equivalent for React is Yew, but another notable library is Leptos. It has comparable popularity to Yew and uses a rendering system most similar to JavaScript's Solid. For our requirement of implementing the flux/redux/store pattern, both are equally suitable. Both provide an API for making a reactive singleton object accesible to the entire component tree. There is existing experience with Leptos in the development team.

Decision

The SPA will be developed using the Leptos UI library.

Consequences

Developing the SPA will be a smooth experience.

Notifications with WebSocket

Status

Accepted.

Context

The traditional combination of REST API with SPA has no good mechanism for server-to-client communication. The standard way to solve this problem is to use websockets. They are lightweight and flexible, but they do add some amount of complexity to an application. Websockets should therefore only be used if they provide concrete value. For most applications, data mutations are immediately triggered by the user themself. In that case, the REST API responses are usually sufficient to keep user's data up-to-date with the server. In our case however, data mutations are mainly triggered by an IoT device without user interaction. Therefore, we require server-to-client communication to ensure the user's data is up-to-date.

Decision

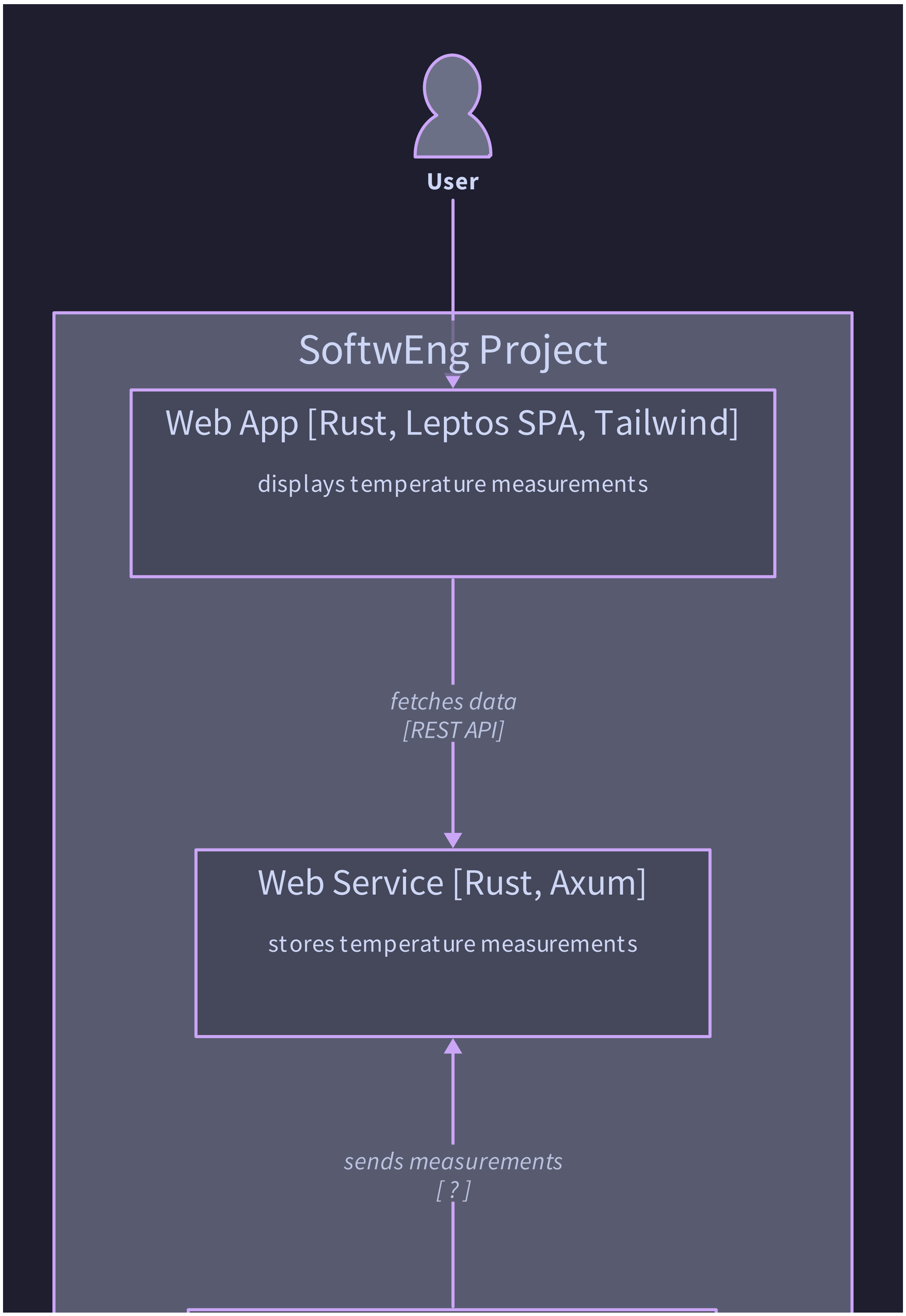
Websockets will be used for server-to-client communication.

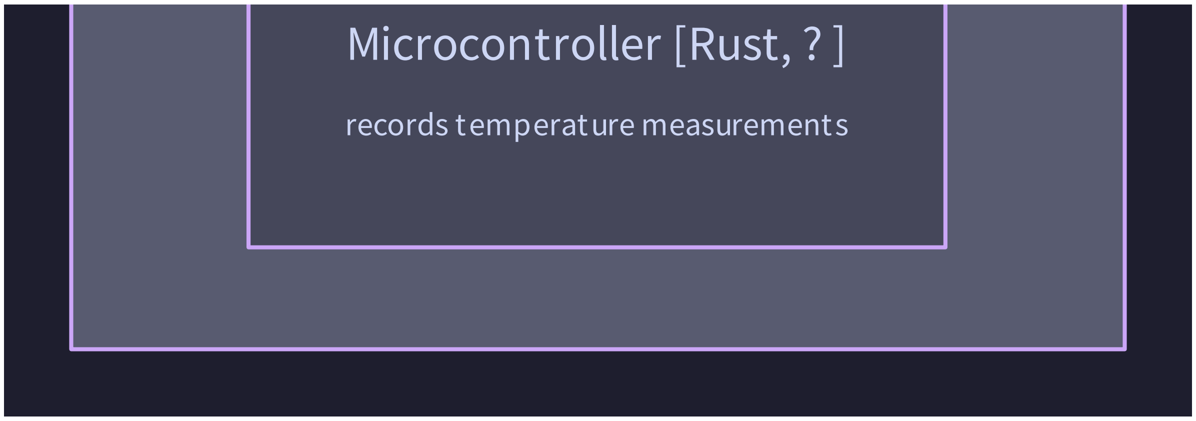
Consequences

The user experience will be more responsive. Ensuring correct bidirectional communication between server and client across two protocols will be more challending.

Architecture Diagrams

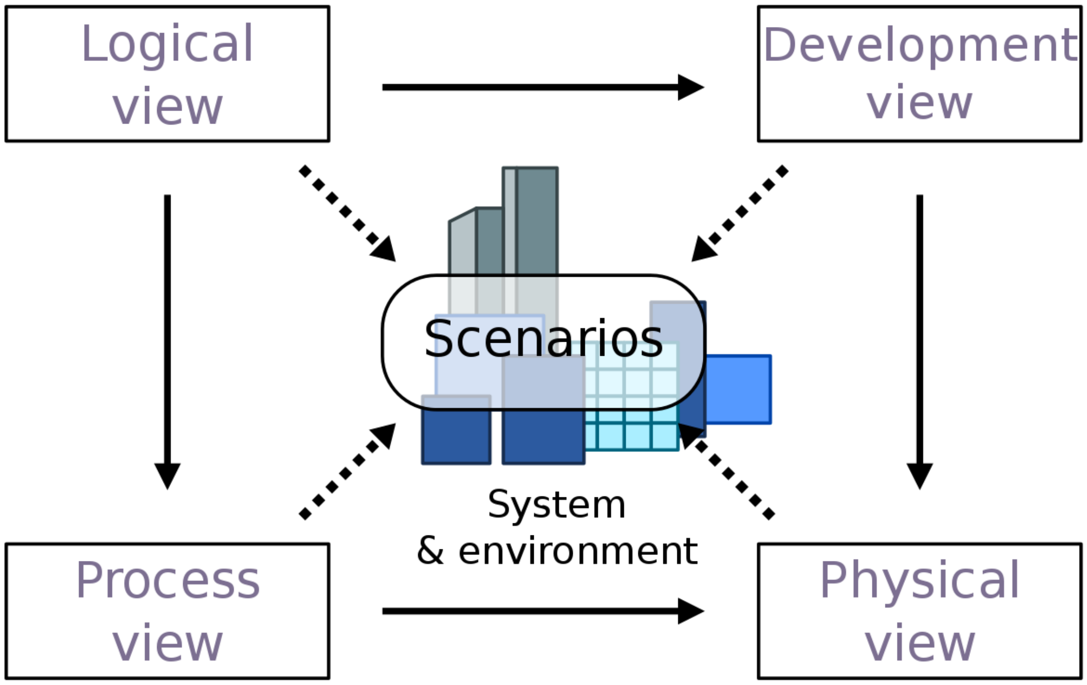
C4 Container Diagram


User
SoftwEng Project
Web App [Rust, Leptos SPA, Tailwind]
displays temperature measurements
fetches data
[REST API]
Web Service [Rust, Axum]
stores temperature measurements
sends measurements
[?]



4+1 model

TODO


Logical view
Development view
Scenarios
System & environment
Process view
Physical view