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MEETUP: Rust meets C++

Dennis J. Alberts en Sander Geerts

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Speakers

Dennis

- 7+ years experience as SE
- Did projects for different customers:
  - Alstom, Kverneland, Shell, JOZ, Somnox, Marine
- Used different languages
  - C, C++, C#, Fortran, Java, Python, Bash..
  - Only using Rust for hobby projects

Sander

- 12+ years of experience as SE
- Lead software engineer @ JOZ
- Embedded Linux
- Used different languages
  - **C/C++**, Bash, C#, *Lua, Python*, *Java*
  - New to Rust

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Introduction

- About Rust
- Why consider Rust?
- Transition strategies
  - Neutral Intermediary
  - Incremental replacement
- Conclusion
- Questions

Introduction

- Integrating Rust into a C++ codebase.
- Growing interest in Rust:
  - There has been a push to stop using languages that do not account for memory safety [1][2][3]. Start using Rust?
  - Rust is being used in the development of the Linux Kernel [4] since version 6.1. (11 December 2022)
- Cyber secur

Linus Torvalds: Rust will go into Linux 6.1

At the Kernel Maintainers Summit, the question wasn't, "Would Rust make it into Linux?" Instead, it was, "What to do about its compilers?"

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About Rust

- Rust was created as a personal project by Graydon Hoare in 2006 @Mozilla Research
- Promising replacement for C and C++, particularly for systems-level programming, infrastructure projects, and embedded software development.
- Version 1.0 was released in 2015
- Major upgrades were made in 2018 and 2021.

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Why consider Rust?

Rust is a system programming language that offers several key features making it a popular choice for developers:

- Guaranteed Memory Safety
- Threads without Data Races
- Zero Cost Abstraction
- Error Messages
- Pattern Matching
- Efficient C Bindings

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Transition Strategies

- As we all know there is only one thing constant in Software Engineering and that is that everything **CHANGES**.
- As organizations mature so do their requirements which puts increased pressure on Software Engineering to deliver a secure stable product.
- Improved tooling, of which Rust can be a part, is the solution.
- But let's be honest! Nobody is going to replace their entire codebase in one go!

Transition Strategies

- New Projects Only
- Neutral Intermediary
- Incremental Replacement of Existing Code

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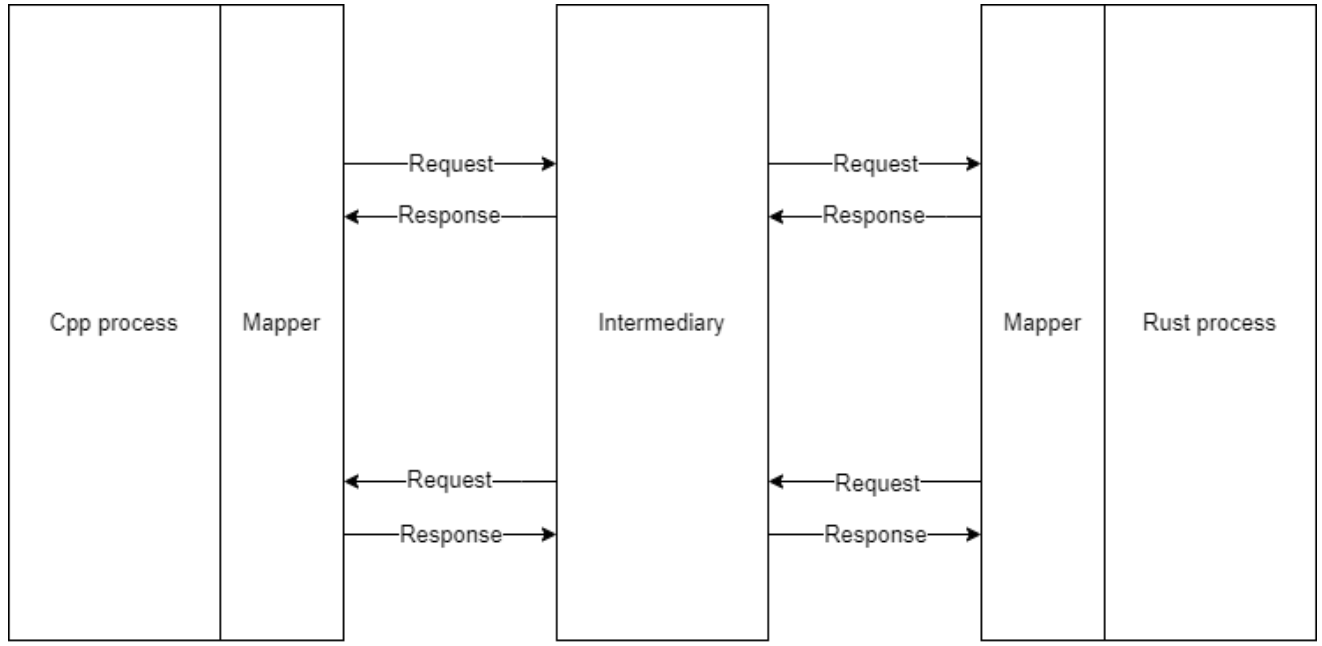
Neutral Intermediary

- A layer is used between to processes.
  - IPC (inter process communication)
  - Third-party framework.

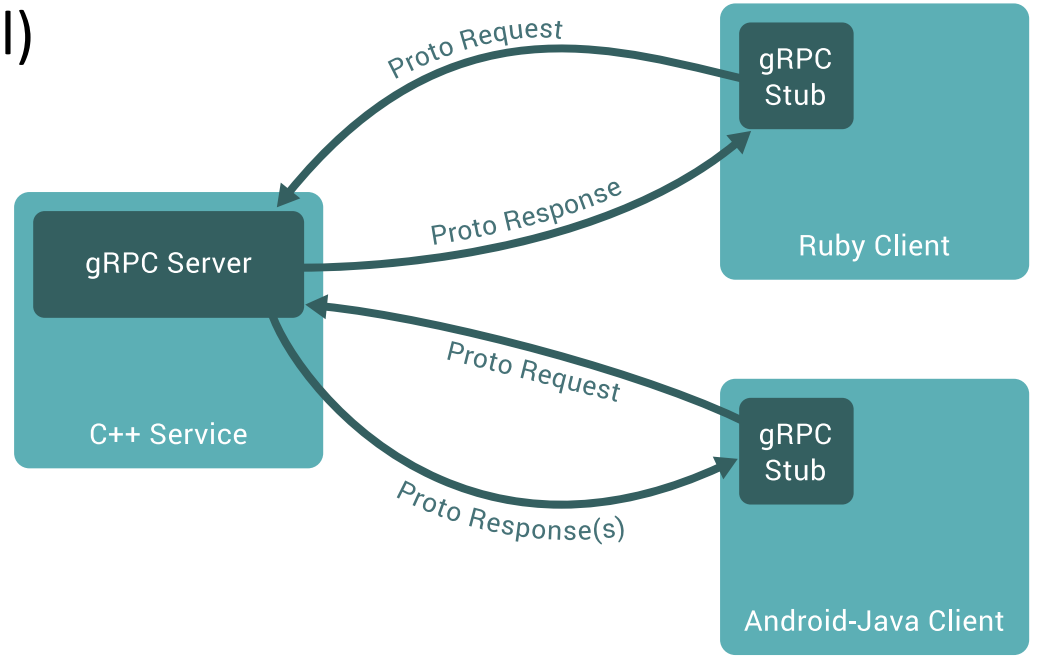
Neutral Intermediary

- Create a new Rust process that lives next to the C++ process.
- Establish a connection through a neutral intermediary.
- Map properties to message.
- Communicate with other process
- Receive response.
- Map response back to domain.



Neutral Intermediary

- gRPC (google Remote Procedure Call)
  - Security
  - Error handling
- Define proto files
  - Messages
  - Service
- Protoc compiles to C++/Rust code
  - Tonic crate for Rust
- Use classes to do remote calls



Demo: Neutral Intermediary – gRPC protobuf

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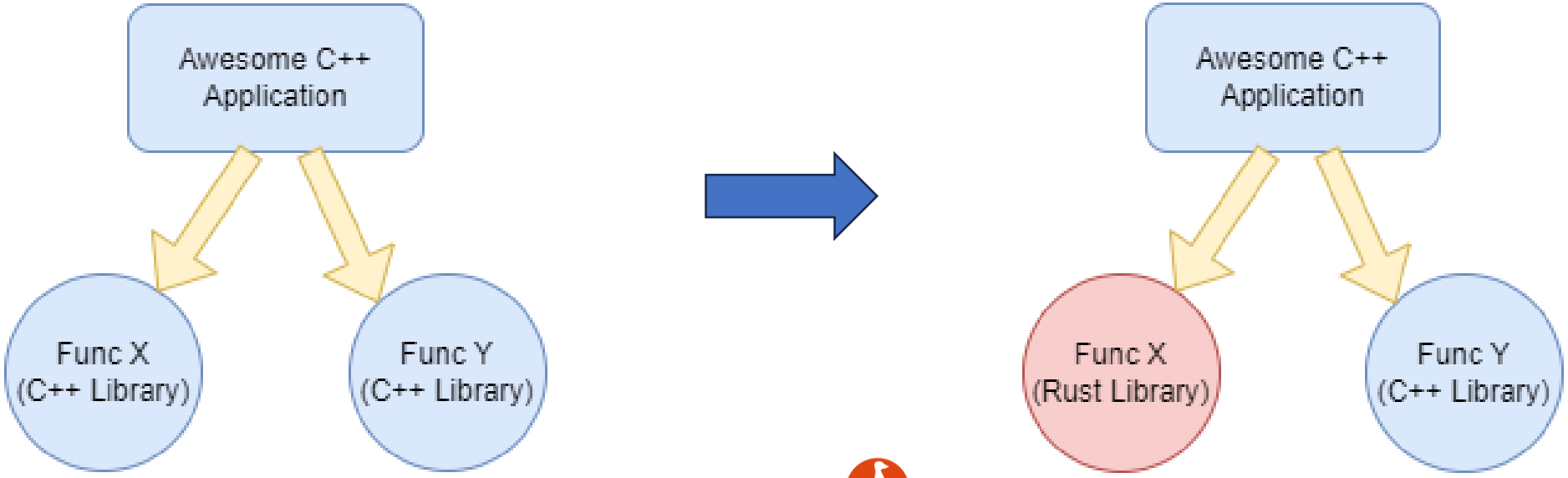
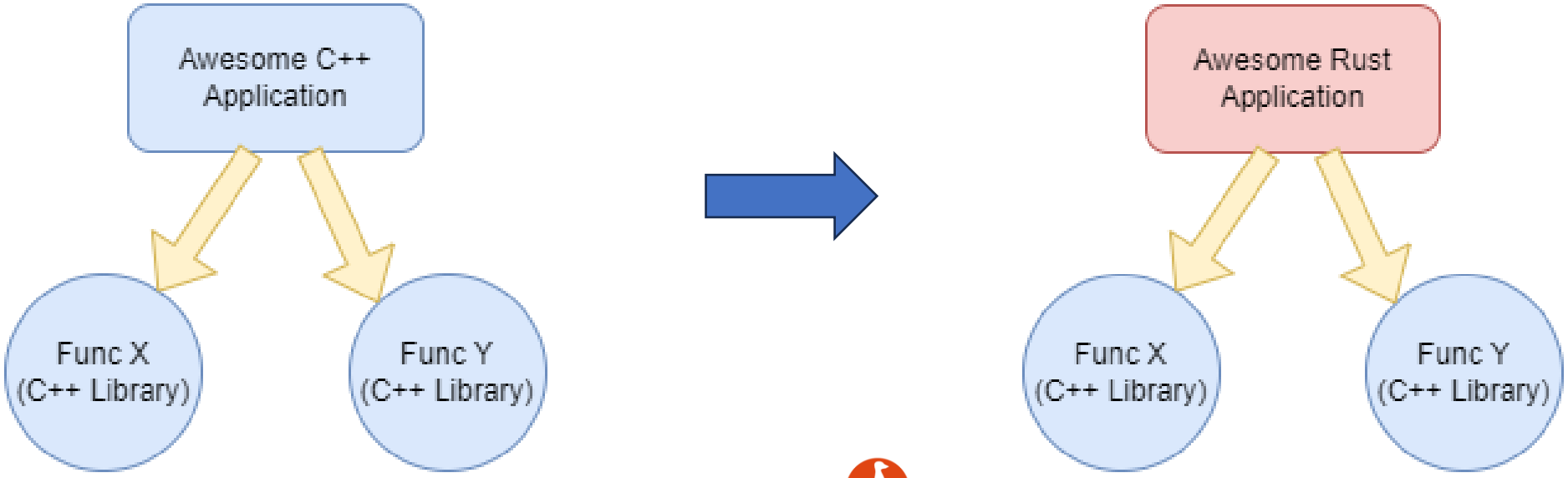
Incremental Replacement

- Bottom to Top
  - C/C++ as controlling layer using Rust components



Incremental Replacement

- Top to Bottom
  - Rust as controlling layer using C/C++ components



Incremental Replacement – FFI

- Foreign Function Interface, also known as FFI
- Cumbersome to create/maintain by hand
- Generators to the rescue

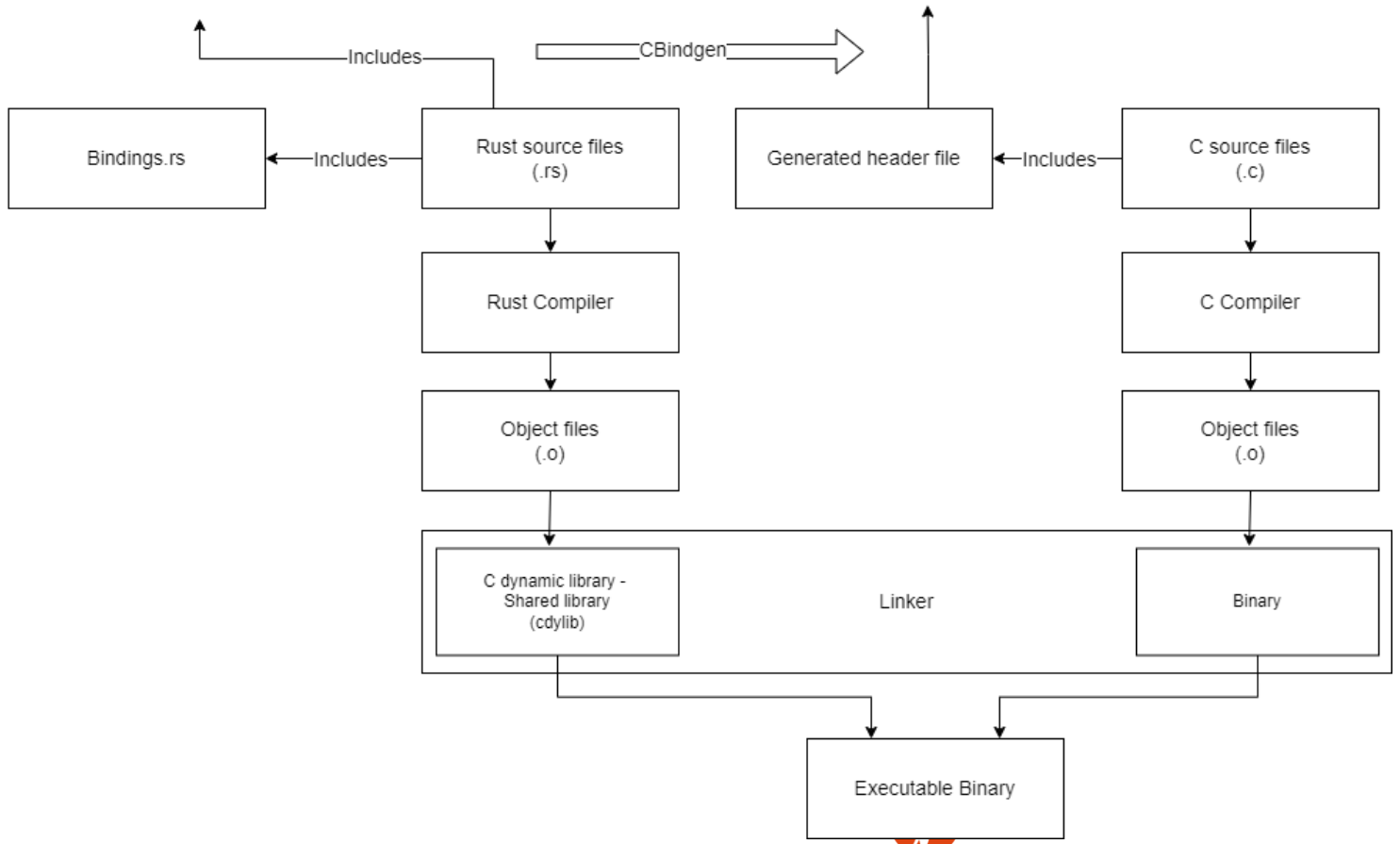
C++ -> Rust with CBindgen

- C++ controller layer
- Rust functionality
- CBindgen automatically generates C header that can be used by C++ to call Rust functions.

C++ -> Rust with CBindgen

```rust
#[no_mangle]
pub extern "C" fn add(left: i32, right: i32) -> i32 {
    left + right
}
```

```c
int32_t add(int32_t left, int32_t right);
```



Demo: C++ -> Rust with CBindgen

Rust -> C++ with Bindgen

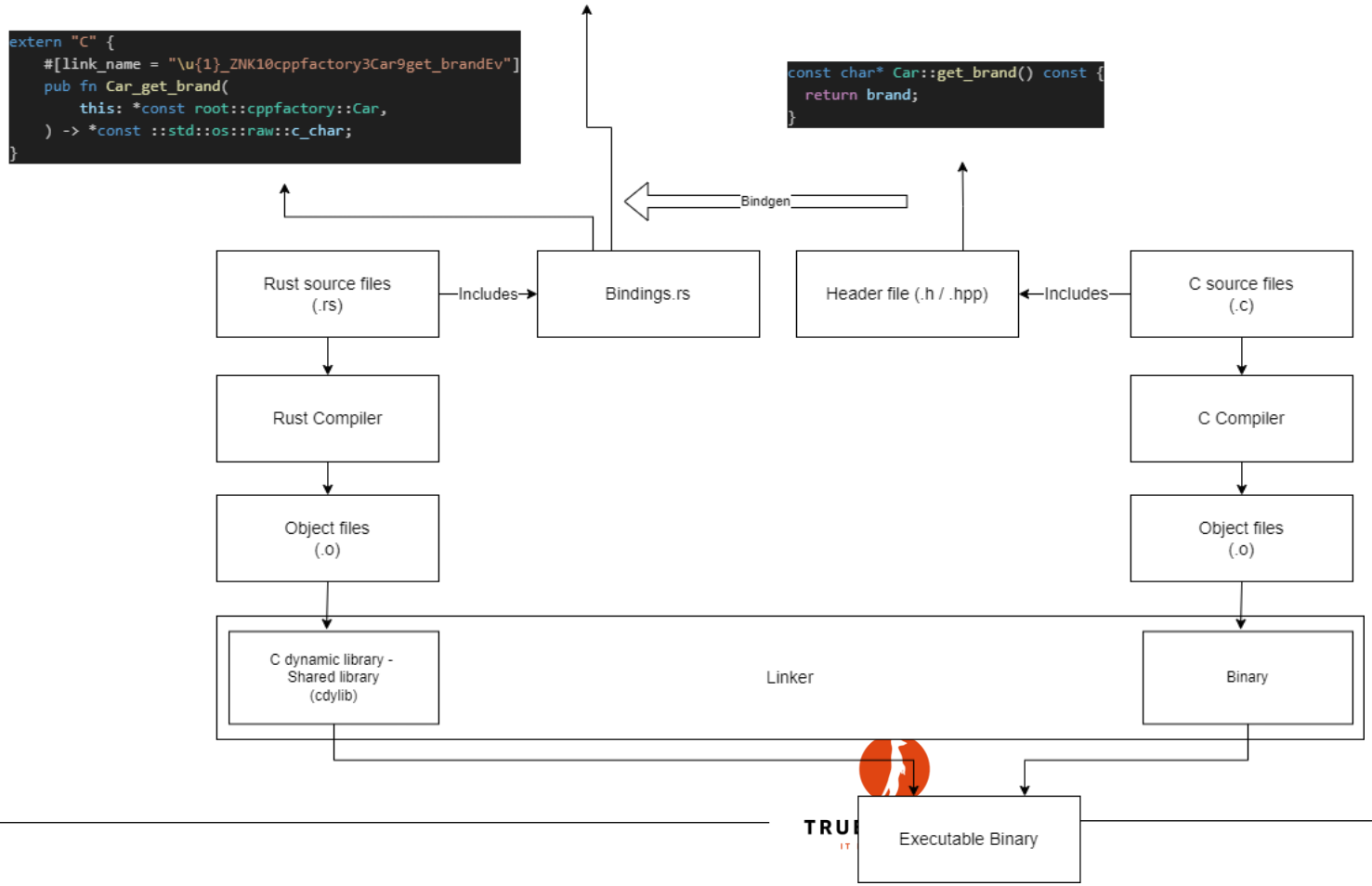
- Rust controller layer
- C++ library
- Bindgen automatically generates Rust file that can Rust can use

Rust -> C++ with Bindgen

```rust
impl Car {
    #[inline]
    pub unsafe fn get_brand(&self) -> *const ::std::os::raw::c_char {
        Car_get_brand(self)
    }
}
```

```rust
extern "C" {
    #[link_name = "\u{1}_ZNK10cppfactory3Car9get_brandEv"]
    pub fn Car_get_brand(
        this: *const root::cppfactory::Car,
    ) -> *const ::std::os::raw::c_char;
}
```

```cpp
const char* Car::get_brand() const {
  return brand;
}
```



Demo: Rust -> C++ with Bindgen

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Conclusion

- Integrating Rust into C/C++ is a powerful approach to gradually harness the advantages of Rust
- Tooling is continually improving

Try it out yourself!

https://gitlab.com/djalberts/cpp-and-rust

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Questions?

- `[no_std]` means that the standard lib is not included. Therefore, a reduced set of functionality is available when using Rust. Mostly applied in bare metal programming.
  - Note: No stack overflow protection
- For bare metal embedded development, crates, such as, mynewt and embassy can be used. Both are RTOS variants.

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[3] “White House warns against using memory-unsafe languages,” The New Stack, Available: https://thenewstack.io/white-house-warns-against-using-memory-unsafe-languages/ [Accessed: Mar. 26, 2024].

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[5] “MSRC-security-research/2019_01 - bluehatil - trends, challenge ... - github.” [Online]. Available: https://github.com/Microsoft/MSRC-Security-Research/blob/master/presentations/2019_02_BlueHatIL/2019_01%20-%20BlueHatIL%20-%20Trends%2C%20challenge%2C%20and%20shifts%20in%20software%20vulnerability%20mitigation.pdf. [Accessed: 13-Mar-2023].

[6] “Chrome: 70% of all security bugs are memory safety issues,” *ZDNET*. [Online]. Available: https://www.zdnet.com/article/chrome-70-of-all-security-bugs-are-memory-safety-issues/. [Accessed: 13-Mar-2023].