Why memory safety is not enough

Lessons from rewriting systems software in Rust

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About me

Ruben Nijveld

- Working at tweede golf since 2011
- Learned about Rust around 2013
- First commercial usage in 2017 (mapserver bindings)

Trifecta Tech Foundation

- Januari 2022: NLNet Foundation grant for implementing a PTP prototype
- April 2022: Contracted by Prossimo (ISRG) to implement NTP in Rust
- December 2022: Contracted by Prossimo (ISRG) to implement Sudo in Rust
- August 2023: Sovereign Tech Fund (now Sovereign Tech Agency) grant for Pendulum (NTP + PTP)
- April 2024: Trifecta Tech Foundation started

nlnet FOUNDATION PROSSIMO Sovereign Tech Agency

Current Trifecta projects

- **Time synchronization**: Pendulum (ntpd-rs and statime)
- **Privilege boundary**: sudo-rs
- **Data compression**: zlib-rs and bzip2-rs
- **Smart grid protocols**: openleadr-rs
- *Education - teach-rs*
- *Making Rust faster than C*

Trifecta Tech Foundation

Open infrastructure software in the public interest

What is systems software?

"System software is software designed to provide a platform for other software"

- Generally relatively low-level software
- Relatively low overhead and high performance
- Protocols, algorithms and formats

Why these projects?

It has to be interesting

We’re in it for the long haul, and we want to keep our work interesting

Why not?

Just find the projects with the most buffer overflow issues, right?

Why not?

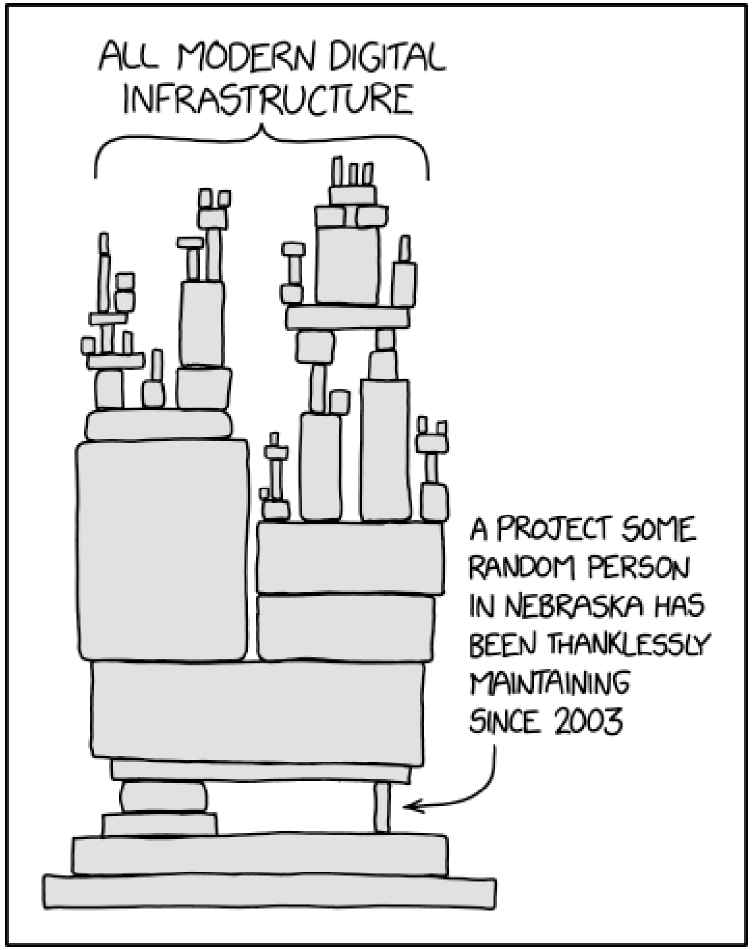
Pick your battles, not every project needs a rewrite

- Just rewriting in Rust is not enough
- Be careful for the negatives
  - Communities can be split
  - Users don't see any changes
- Focus on the positives, those that don't join your effort aren't the enemy
- Never fear a hobby project though

Why these projects?

Finding vulnerable projects, protocols or ideas

- Few people working on it, lots of people relying on it
- A history of security issues
- Unstructured codebase
- Not just related to the Rust ecosystem


ALL MODERN DIGITAL INFRASTRUCTURE
A PROJECT SOME RANDOM PERSON IN NEBRASKA HAS BEEN THANKLESSLY MAINTAINING SINCE 2003

And now...

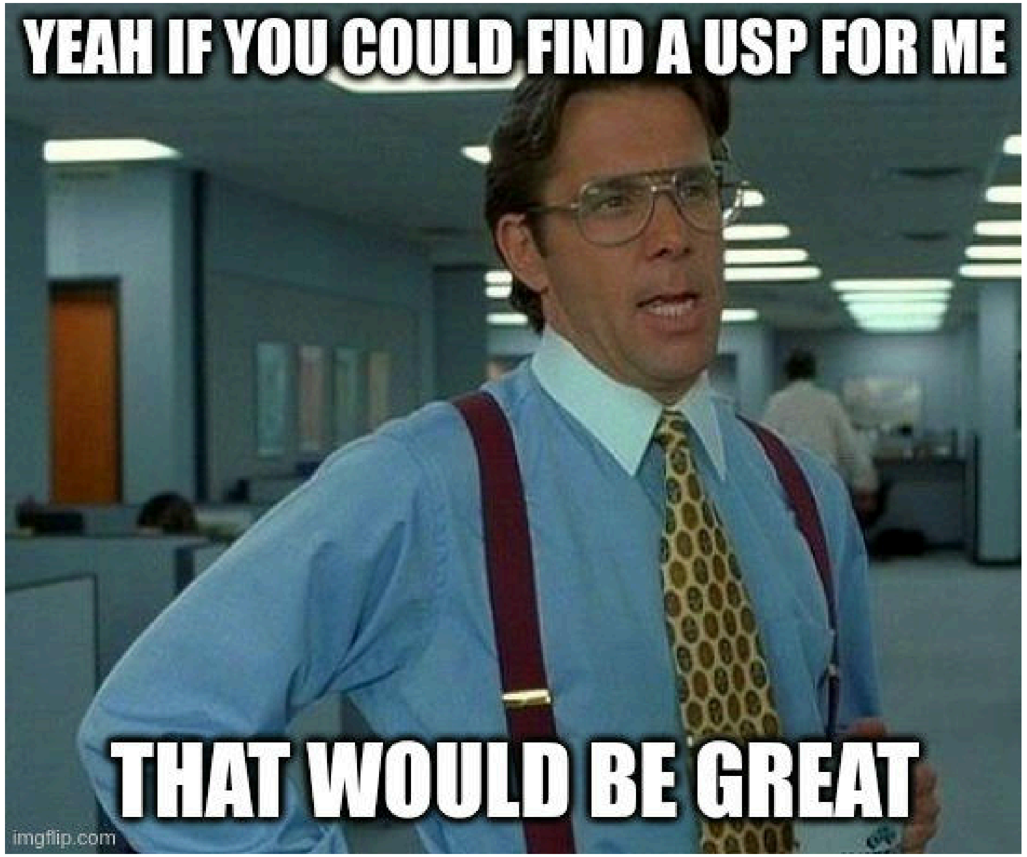
So we found something that could use a little Rust

- Are you aware of a significant portion of the problem space?
- If not: just start trying stuff! Make it your hobby! Enjoy!
  - Encourage people new to the problem space, even if you don't like Rust
- Make sure to look at competing implementations (beware of licenses though)

Your unique selling point

Think about what would sell your new implementation

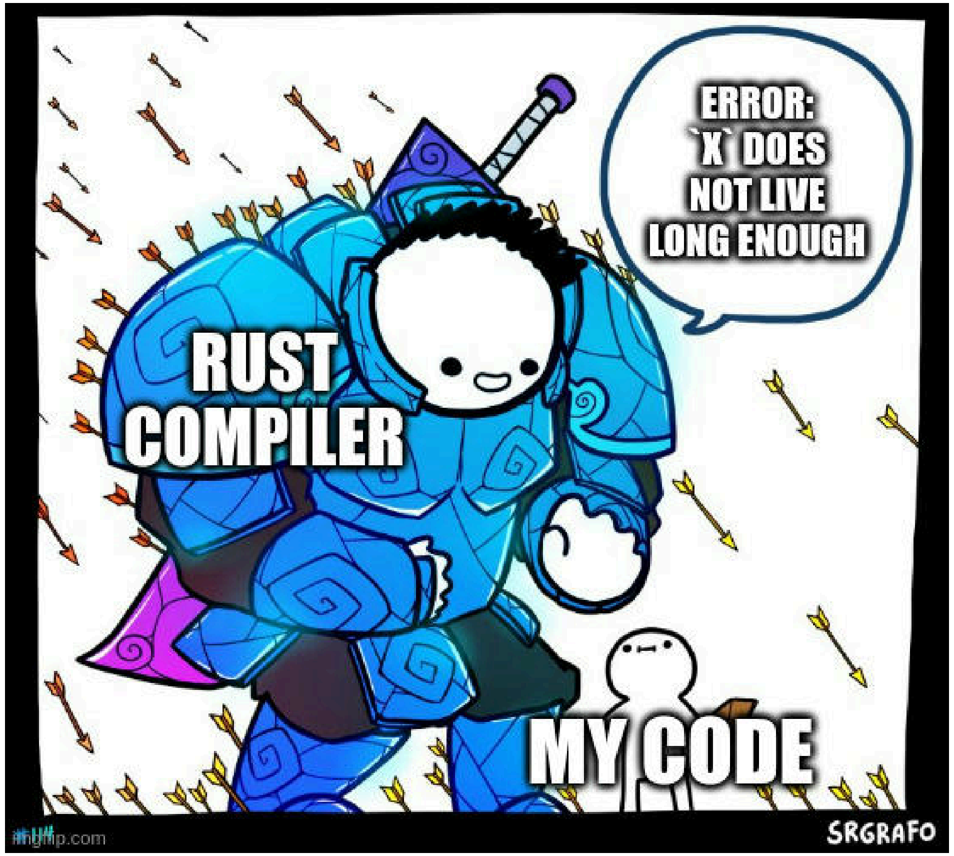
- Something other than: Rust brings memory and type safety
- We Rust programmers care about type safety a lot
- This is not what your users care about though



Focus on security

Maybe your implementation focuses on being more secure?

- Think beyond just the memory and type safety
- In *sudo-rs*: Which features are really needed? Lower attack surface?
- In *ntpd-rs*: Focus on Network Time Security and have stricter defaults



Focus on performance

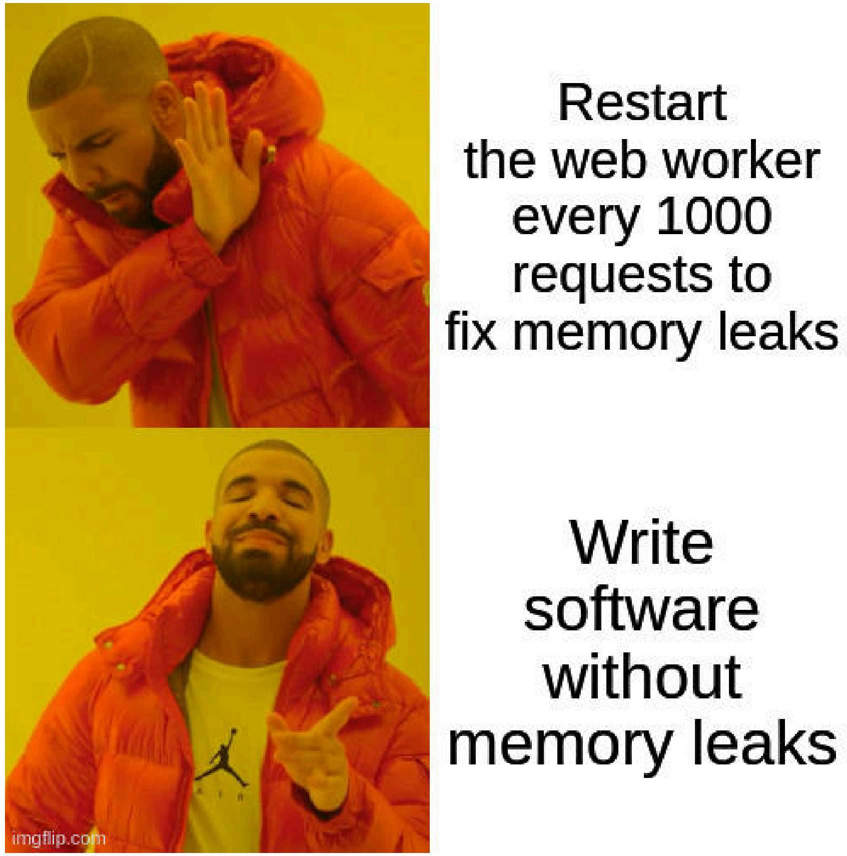
Maybe your implementation focuses on being more performant?

- Maybe a little unsafe can perform better?
- Balance security, usability and performance
- Make sure you benchmark what you are claiming
- In *zlib-rs*: Use SIMD instructions, focus on relative performance

Focus on stability

Maybe your implementation focuses on being stable in some way?

- Think about memory leaks
- Stable API: make sure your API does not need to change for a long time
- In *ntpd-rs*: Worked toward 1.0, stability guarantees
- In *zlib-rs*: Existing C zlib interface as primary way to interact


Restart the web worker every 1000 requests to fix memory leaks
Write software without memory leaks
imgflip.com

Find your own focus

Your focus is your strength, and also helps others

- Be the change you want to see
- Help other implementations, document what works and what doesn't

Make it the best project ⭐ ⭐ ⭐ ⭐ ⭐

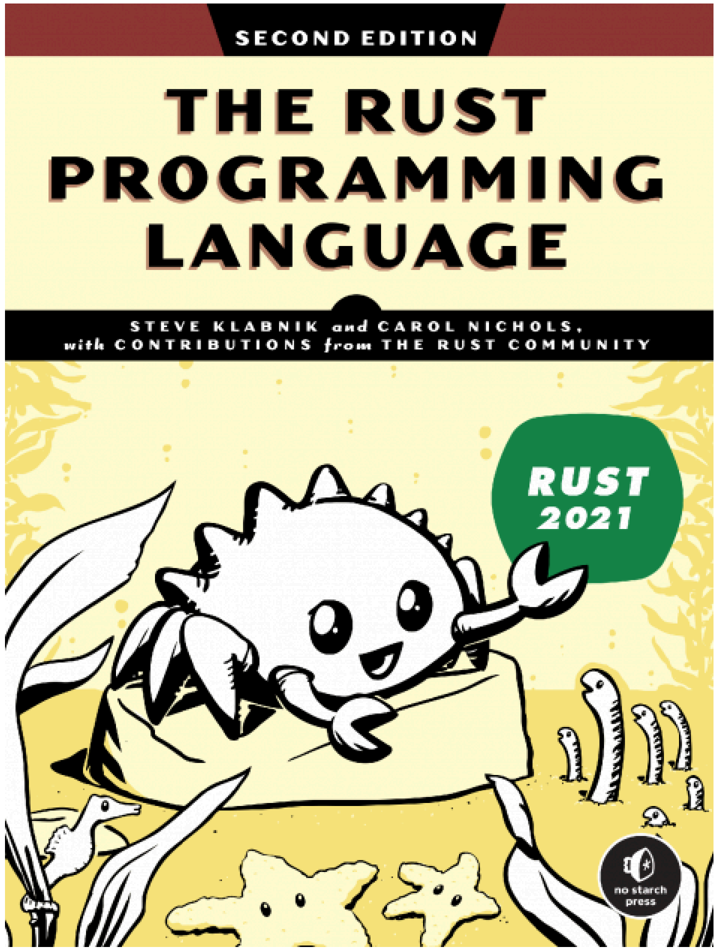
- From here on out, iteration is needed
  - On your code
  - On your unique selling point
- Take some time, no rush
- Some points of attention:
  - Documentation
  - Dependencies
  - Distribution

Documentation

- As a Rust user we clearly make the best ever API documentation
- You obviously have `#![forbid(missing_docs)]` and `#![forbid(clippy::undocumented_unsafe_blocks)]`
- So every public interface is expertly document, including tested examples

Documentation

- Your users know way less than you do
- Just API docs with rustdoc is not enough
- Examples and tutorials
- High level guide
- Reference guide


SECOND EDITION
THE RUST PROGRAMMING LANGUAGE
STEVE KLABNIK and CAROL NICHOLS, with CONTRIBUTIONS from THE RUST COMMUNITY
RUST 2021
no starch press

Dependencies

- Dependencies solve problems so you don't have to
- The Rust ecosystem offers a lot of libraries these days
- New projects: use them! All of them!

Dependencies

Dependencies are a risk as well

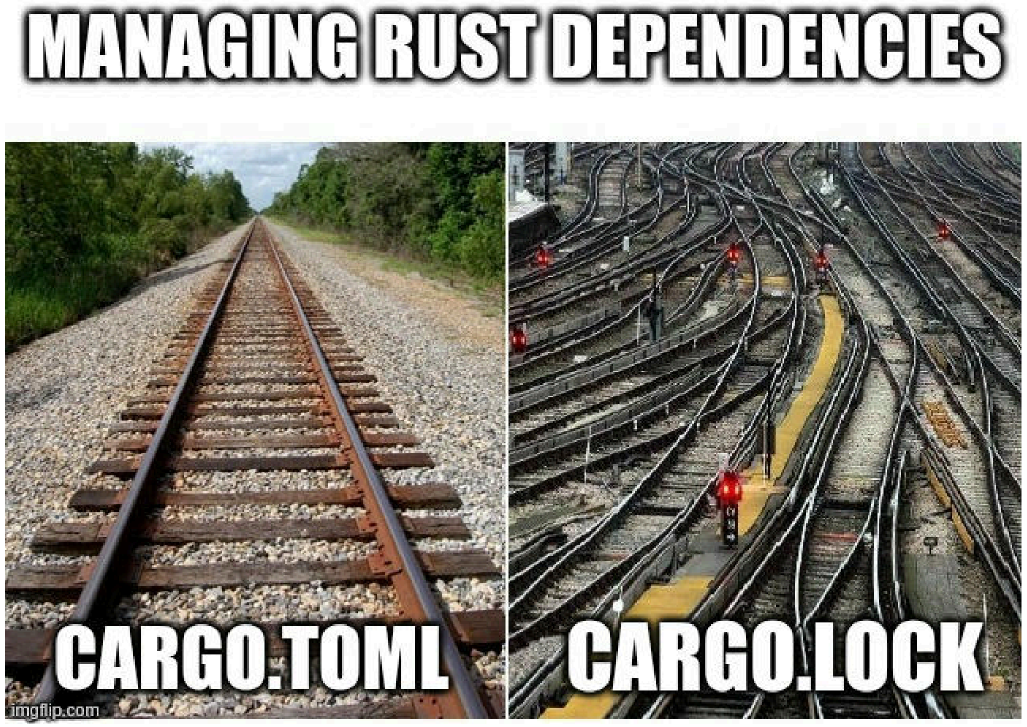
- A burden risk
  - Don’t take on more dependencies than you need
- A trust risk
  - Only take on well known dependencies with trusted maintainers
- A dependency’s goals might not always align with yours
- Make sure you take these into consideration

Dependencies

- Trust is nice, verify is better
- You can use tooling like `cargo vet` to share review load for dependencies
- Dependencies can also be part of your distribution story

Dependencies and Debian packaging

- Targeting Linux? Debian-based distributions will be large part of your userbase
- Debian packages each of your dependencies as individual source packages
- Only one version of a package will be available in a Debian distribution



Distribution

- Just publish on crates.io right?
- Your users aren’t Rust users, and don’t need or want a Rust compiler
  - `cargo install` is not a distribution mechanism
- If your intent is to replace an existing piece of software:
  - Using your software should be just as easy as the one you are replacing
- (Linux) distributions and other downstream maintainers are your friends!
  - Rust packaging tools often prefer to use crates.io as a source
- The biggest impact can be made by supporting the widest ecosystem

Whoops, my crate name is not available

- No need to get it right the first time, you can always rename
- People are horrible at naming things
- Just ask, quite often people will respond
- It helps if you have something to show

You need to build up trust

- In the end a lot of what we’re doing is about people
  - Users
  - Contributors
  - Dependency maintainers
  - Downstream maintainers
- Show that you are a reliable partner
- Have a way to handle security issues

So what have we done?

- We picked the project that needed RIIR treatment
- We found something to focus on that uniquely identifies our project
- We iterated and created the best software package ever
- We made the best documentation ever
- We limit, trust and verify our dependencies
- We distribute our software to the widest audience
- We’ve communicated so well that everyone trusts us

So what have we done?

Just download my software already!

Thank you!

Any questions?

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Trifecta	https://trifectatech.org/
ntpd-rs	https://github.com/pendulum-project/ntpd-rs/
sudo-rs	https://github.com/trifectatechfoundation/sudo-rs/
zlib-rs	https://github.com/trifectatechfoundation/zlib-rs/