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# All the Binaries Together

— **Andrew Wagner**, Amal Ahmed —



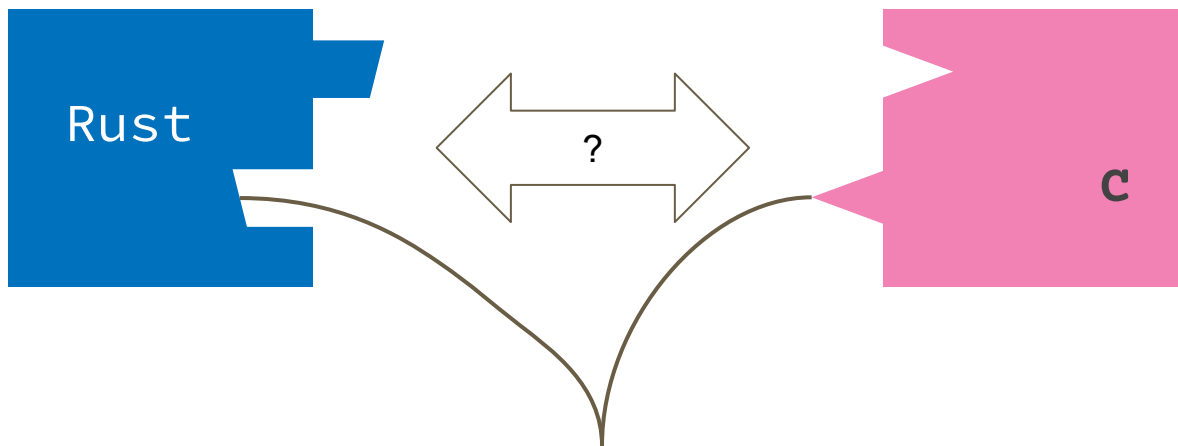
SILC (Secure Interoperability, Languages, and Compilers)

# Interoperability

How can we safely compose diverse programs?

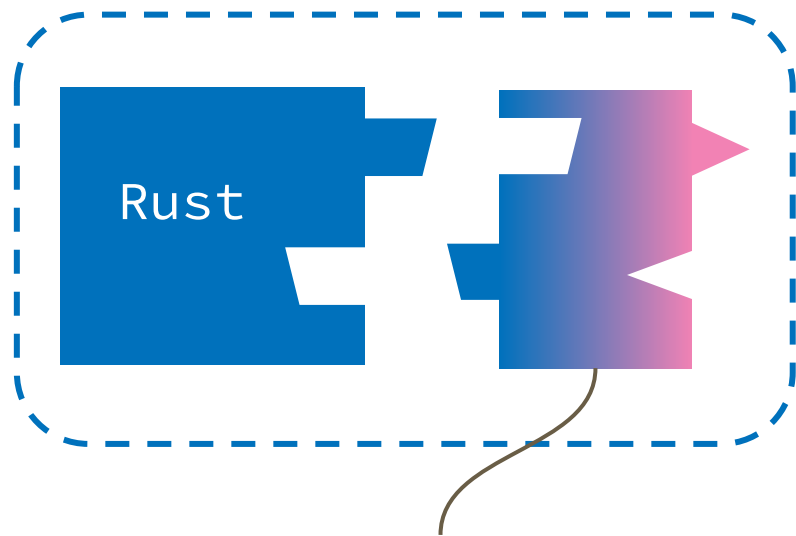
- ★ Most software is multilingual
- ★ Even monolingual software can have diverse components
  - *E.g., built from different compilers*
  - *Backward/forward compatibility*
  - *“DLL Hell”*

# All the Languages Together



Application Programming Interface (**API**)

# All the Languages Together ...

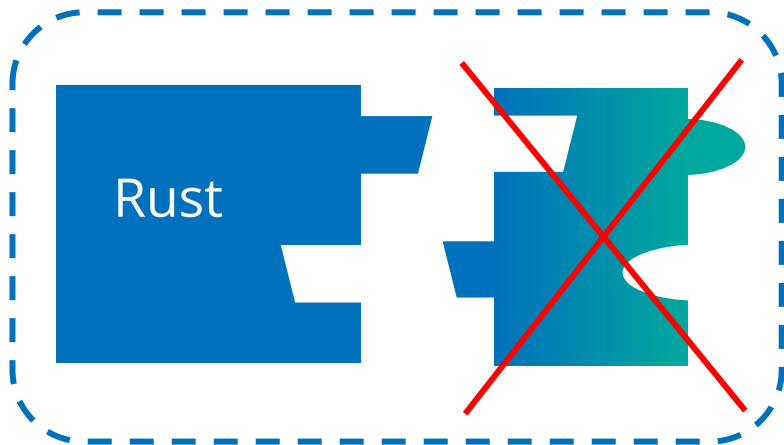


Foreign Function Interface (**FFI**)

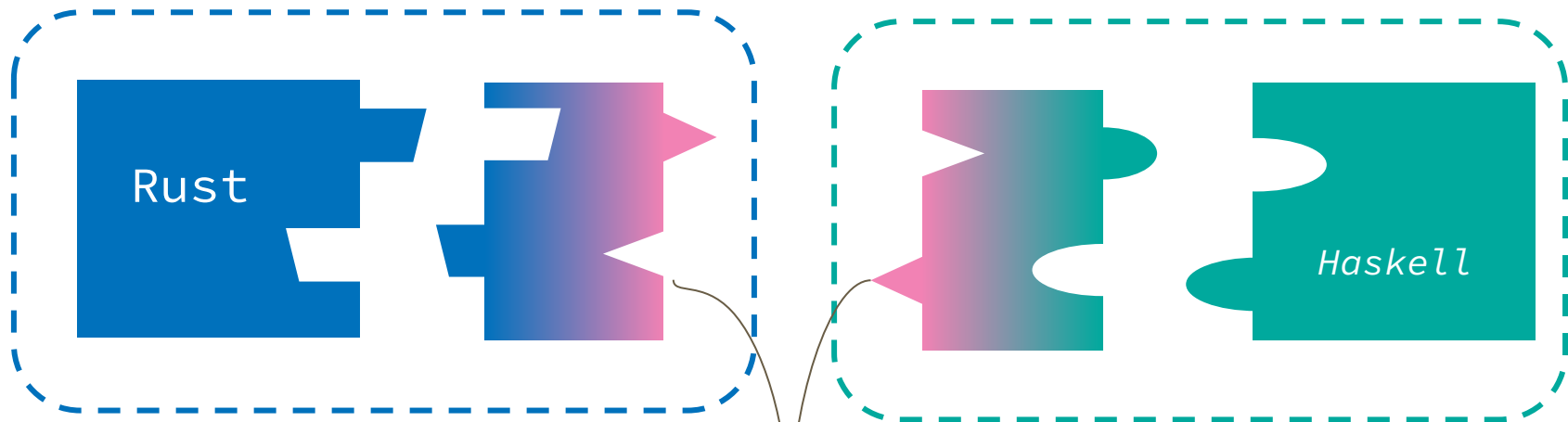


*Linking Types*  
Patterson, Wagner, Ahmed  
TyDe23

# All the ~~Safe~~ Languages Together



# All the Languages Together Again



More **C** Code 🤖

## But Why C?

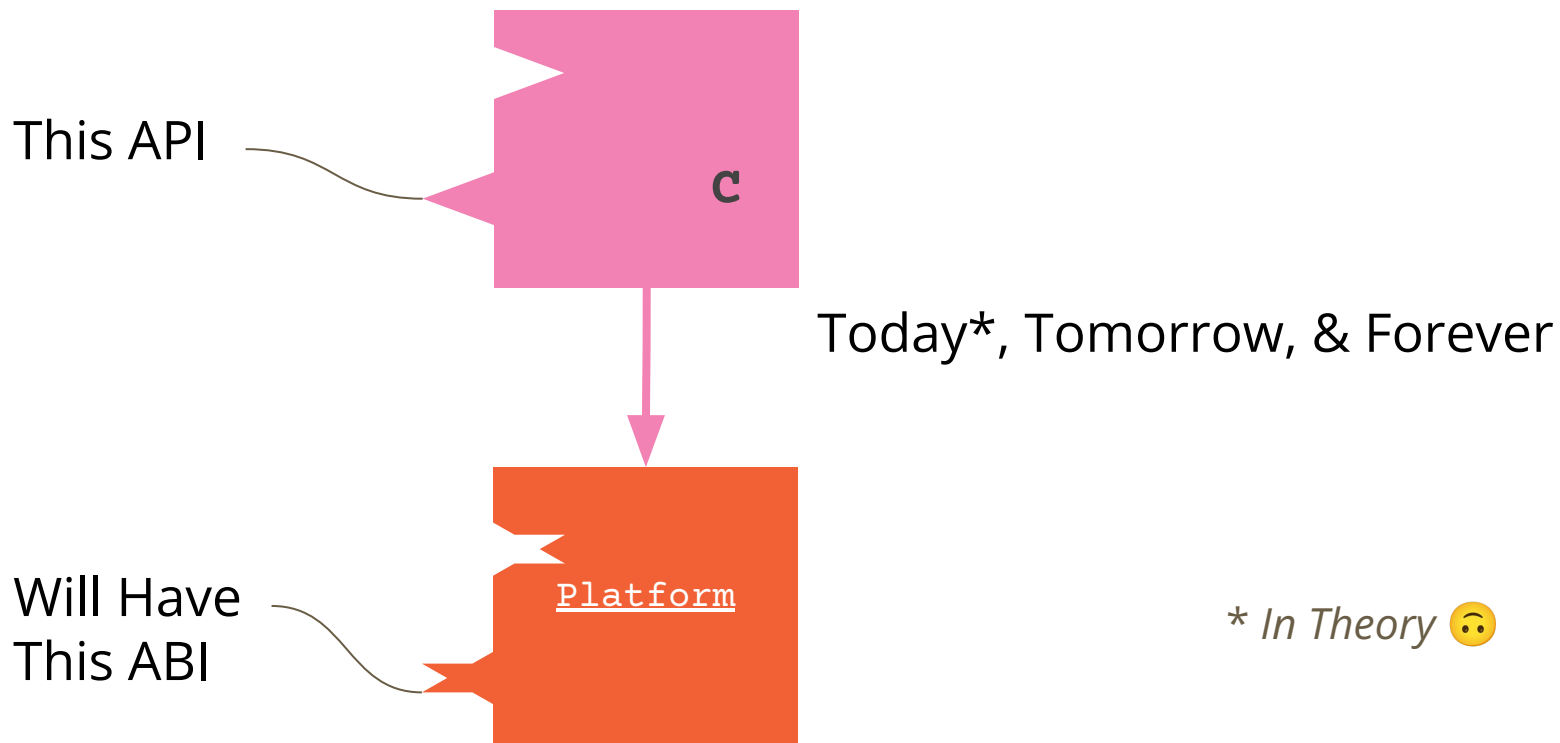
**Shallow Answer:** Because every language speaks **C**

## But *Why* Does Every Language Speak C?

**Deeper Answer:** Because **C** has a stable application binary interface (**ABI**)

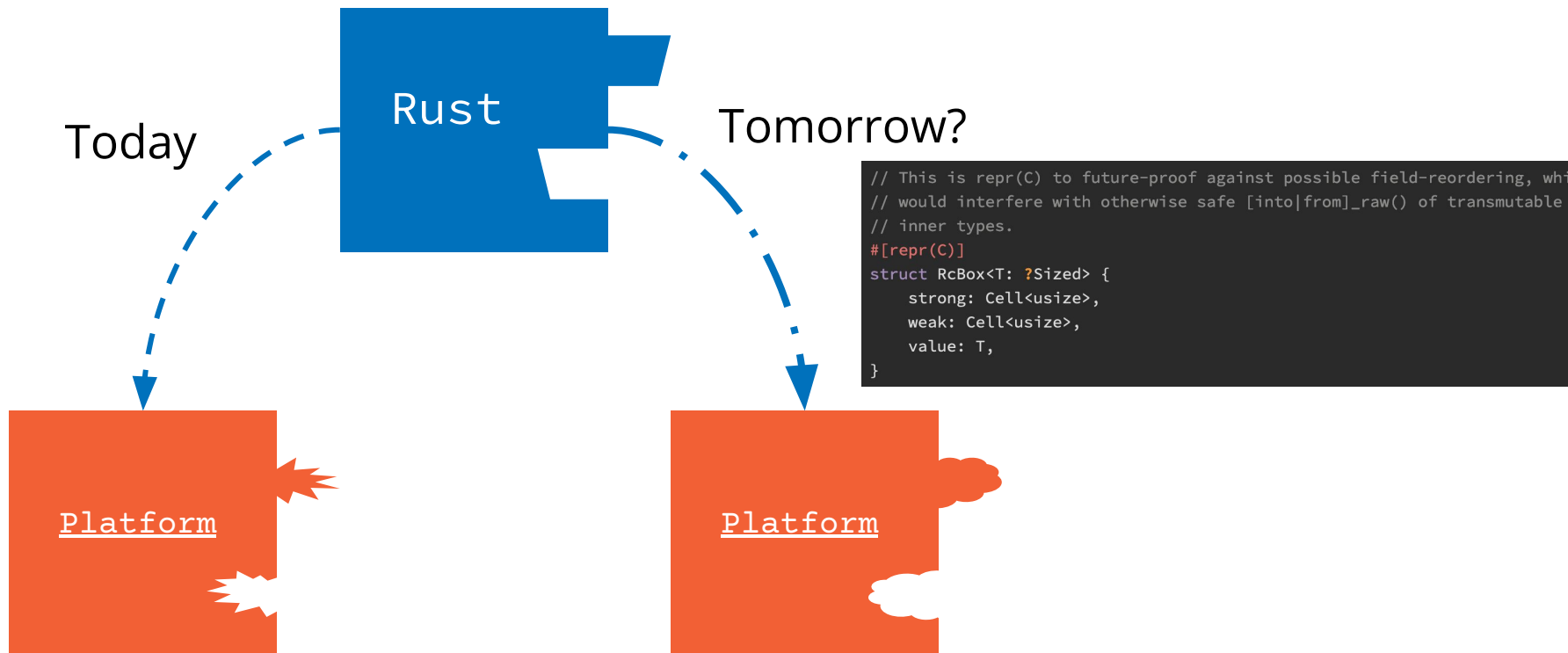
- ★ Data layout
  - ★ Calling conventions
  - ★ Name mangling
  - ★ And more? 🙌
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# ABI Stability





# ABI Instability



# ABI Stability?

## Pros

- + Precise control over interface to other languages
- + Proper support for shared libraries

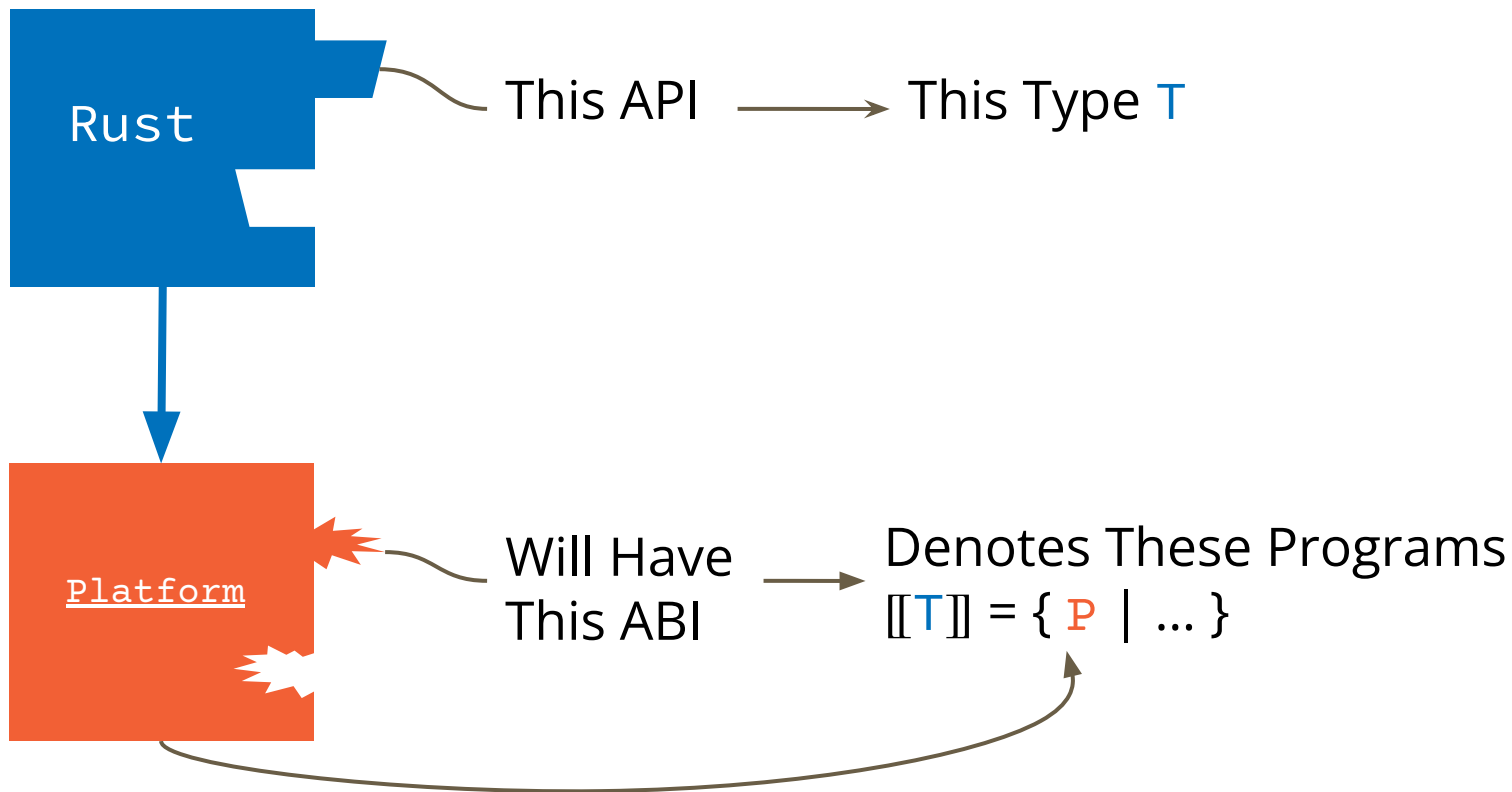
## Cons

- Can stunt language growth
- Limits compiler optimizations
- Tension between flexibility and performance
- Pressure on library developers

# The Times They Are a-Changin'

- ★ **Swift:** *ABI Stability Manifesto*
- ★ **Rust:** RFC#3470 – *crABI*
- ★ **WASM:** *Component Model Proposal (FKA, Interface Types)*
- ★ Abundance of libraries, plugins, and tools for low-level interoperability

# Formalizing an ABI



# A Semantic ABI

## Realizability Model:

Set of **platform terms** indexed by **source types**

$$\mathcal{V}[\mathbf{u32}] \stackrel{\text{def}}{=} \{ n \mid n < 2^{32} \}$$

$$\mathcal{V}[\mathbf{Box}\langle T \rangle] \stackrel{\text{def}}{=} \{ l \mid l \in \mathcal{M}[\mathbf{T}] \}$$

...

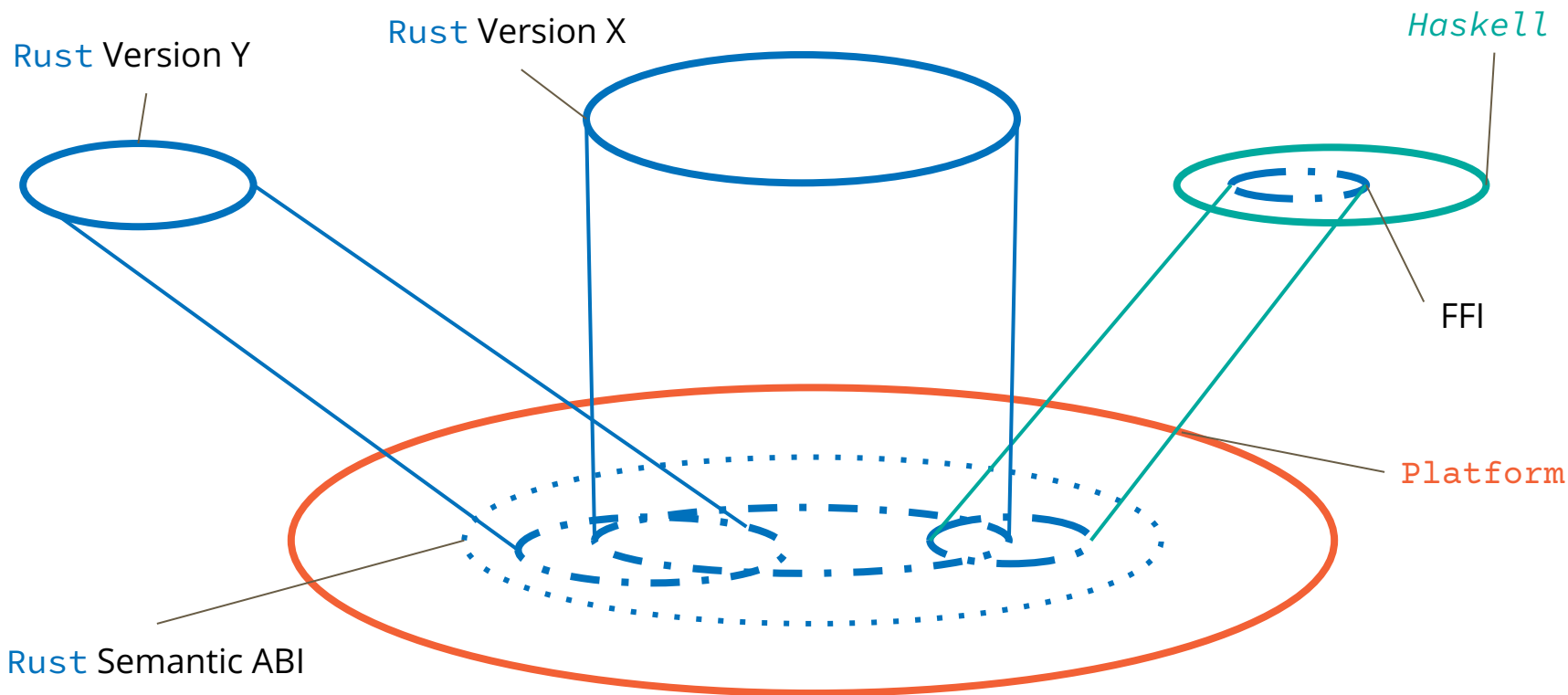
$$\mathcal{M}[\mathbf{u32}] \stackrel{\text{def}}{=} \{ l \mid \exists n < 2^{32}. l \mapsto n \}$$

$$\mathcal{M}[\mathbf{(T}_1, T_2)] \stackrel{\text{def}}{=} \{ l \mid l \in \mathcal{M}[\mathbf{T}_1] * (l + \text{size}(T_1)) \in \mathcal{M}[\mathbf{T}_2] \}$$

...

$$\mathcal{C}[\mathbf{T}] \stackrel{\text{def}}{=} \{ P \mid \text{wp}(P)\{ v. v \in \mathcal{V}[\mathbf{T}] \} \}$$

# All the Binaries Together!



**You Can't Spell  
*Interoperability*  
Without *ABI!***

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