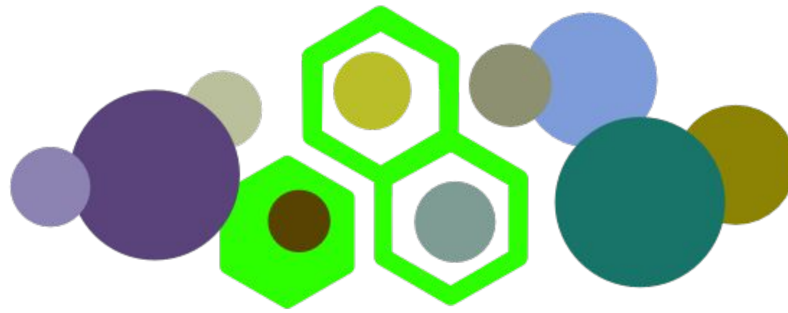


WASM + Dela

smart contract execution env.

Master Semester Project

Responsible : Prof. Bryan Ford
Supervisor : Noémien Kocher
Student : Maxime Sierro

Introduction

The project

Implementation of a new WebAssembly smart contract execution environment for the DEDIS Ledger Architecture

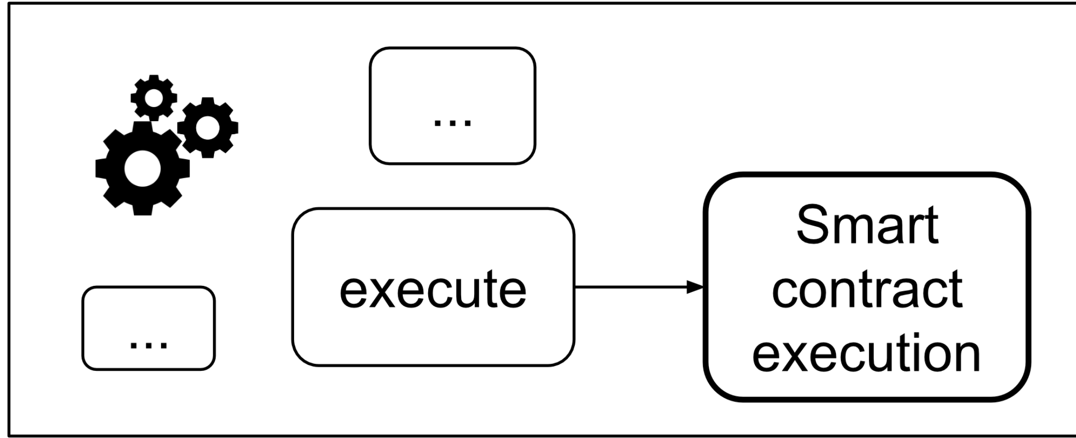
Motivation

2 big disadvantages with the current native execution module :

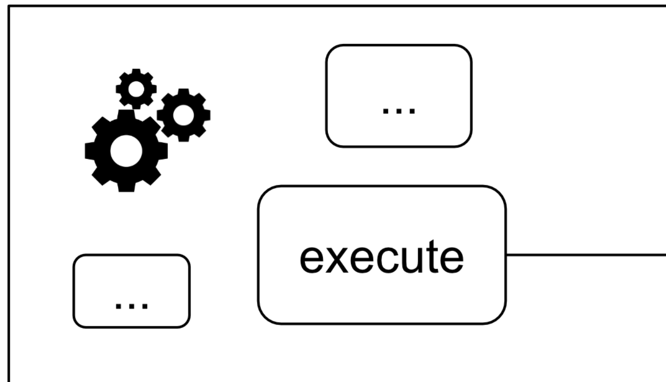
1. Necessary recompiles of the entirety of the node’s environment

2. Support for Go smart contracts only

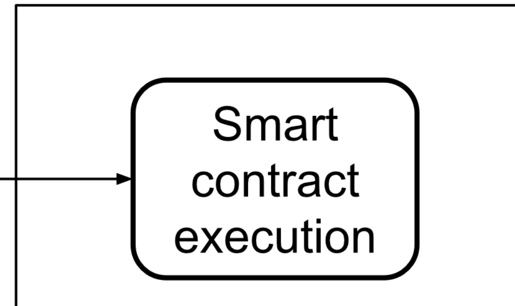
Node environment (in Dela)



Node environment (in Dela)



Smart contract execution environment



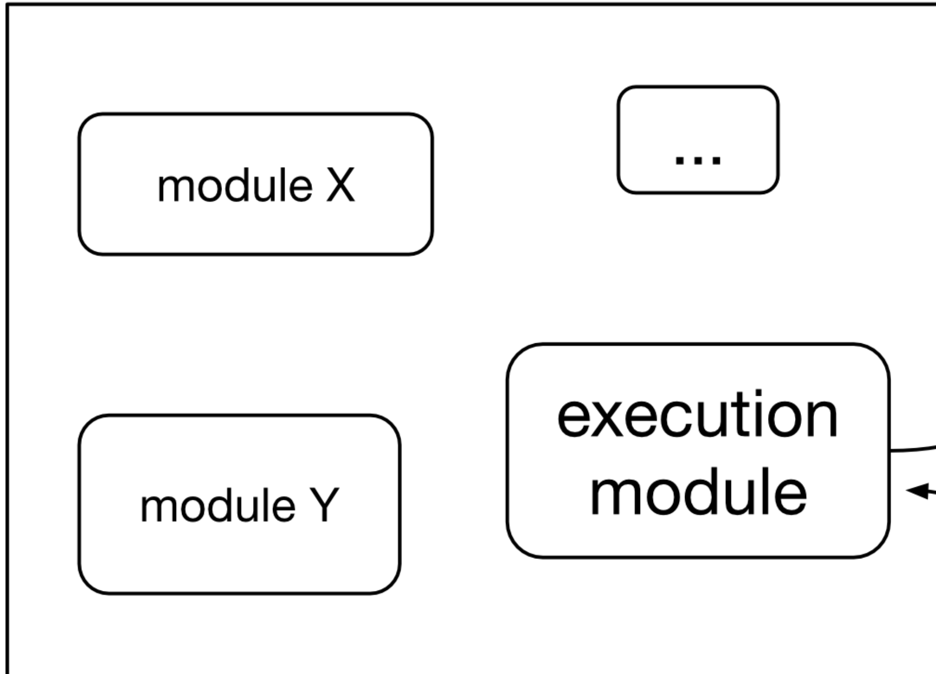
WebAssembly (WASM)

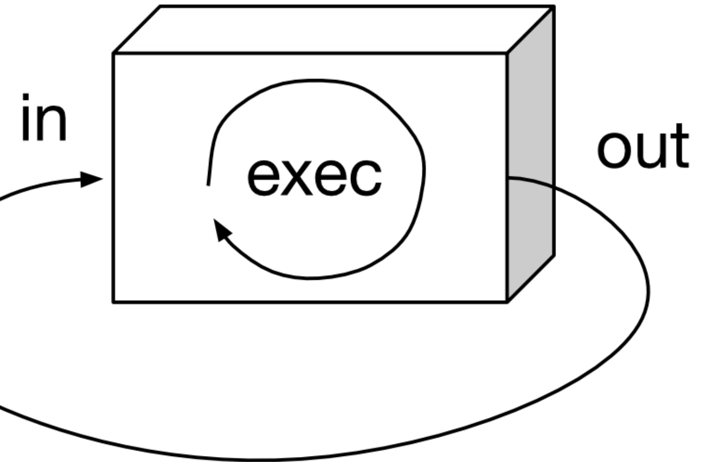
- Binary format obtained from higher level “source languages”
- Introduced in 2017 for web browser use
- Sandboxed execution
- eWASM : Ethereum’s proposed execution layer redesign

Goals

- Fully functional alternative to the native module
- Simultaneous support of multiple source languages
- Determinism analysis
- Ideally : automated smart contract loading

Design


Dela ledger node
module X
...
execution module
module Y


WASM execution env. (the ‘box’)
in
exec
out

3 possible solutions

1. Web browser application
2. Web server
3. Unix daemon

Main factors

- Amount of relevant resources
- Ease of communication
- WASI transition

WASI

- WebAssembly System Interface, extension of WASM to the OS level
- Newer : 2019
- Less languages are WASI-compatible

Final choice : Node.js application

Best of both worlds :

- Easy communication with the framework
- JavaScript's "standard WASM" API

C/C++ support arguments

- State of the art binary translation
- 2 languages with one stone
- Prevalence

Go support arguments

- Accurate comparisons with native executions

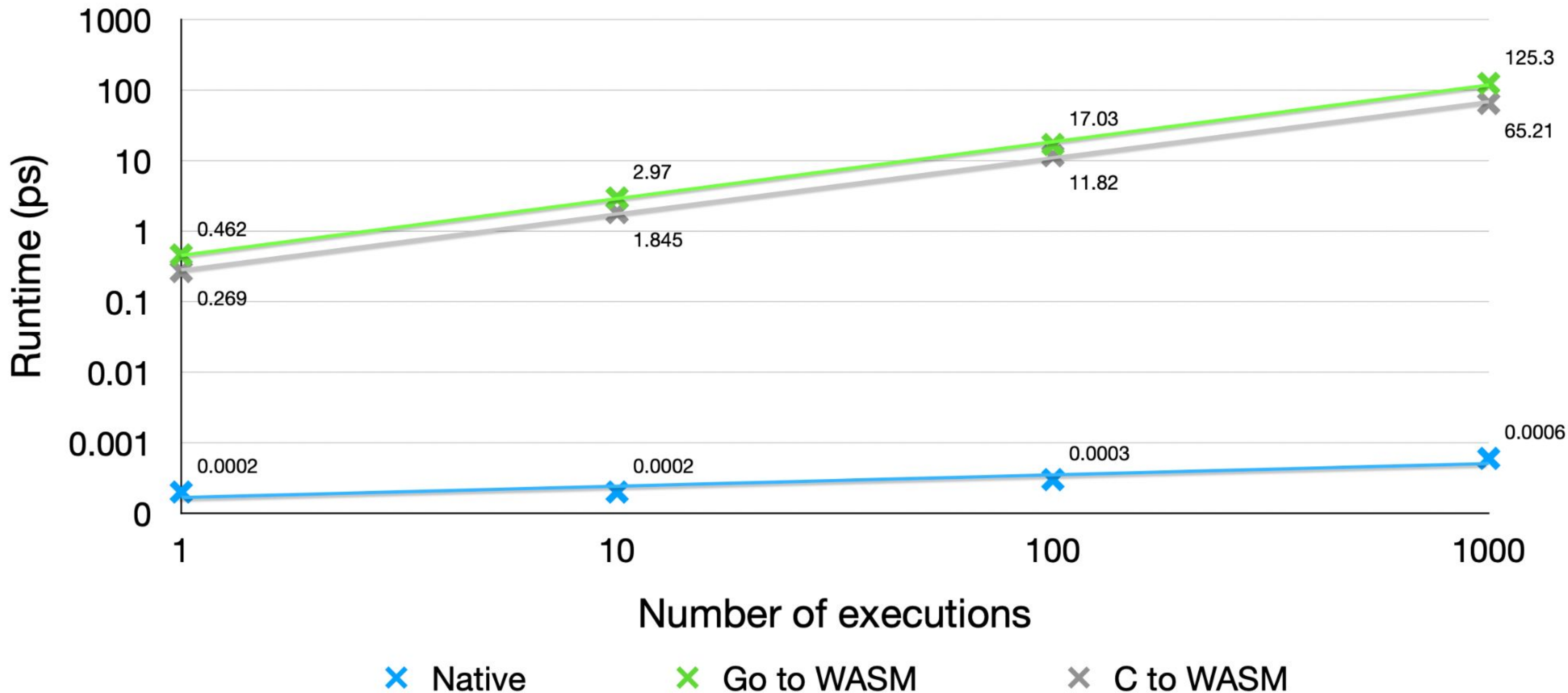
- Frequently used by the lab

Differences

- C/C++ treat WASM as a **library**, Go treats it as an **application**.

- Very different implementation issues

Results



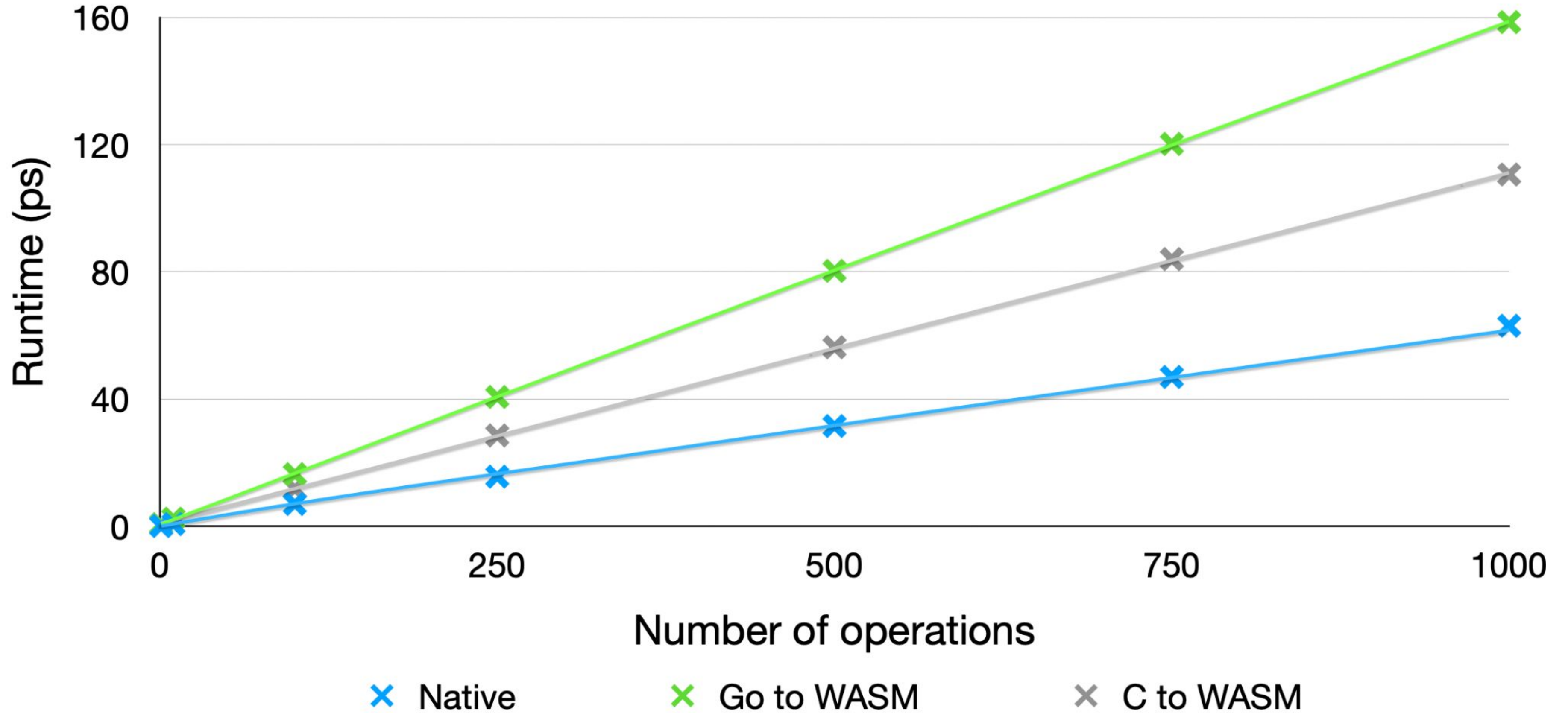
CPU : 2.5 GHz

Incrementation of a randomized counter

Ed25519 crypto operations

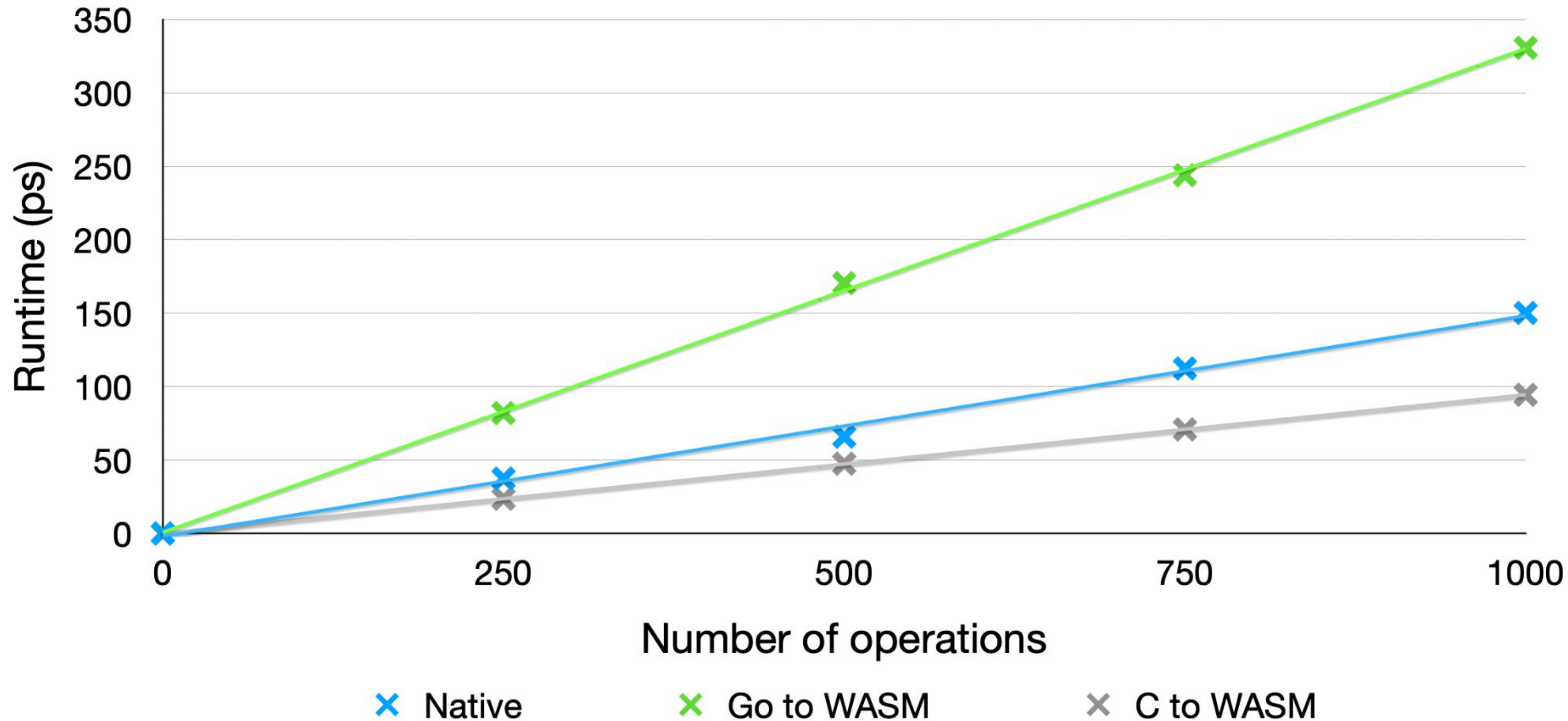
Single executions of smart contracts containing sequential operations

- Go : DEDIS’s Kyber library
- C : Libsodium library



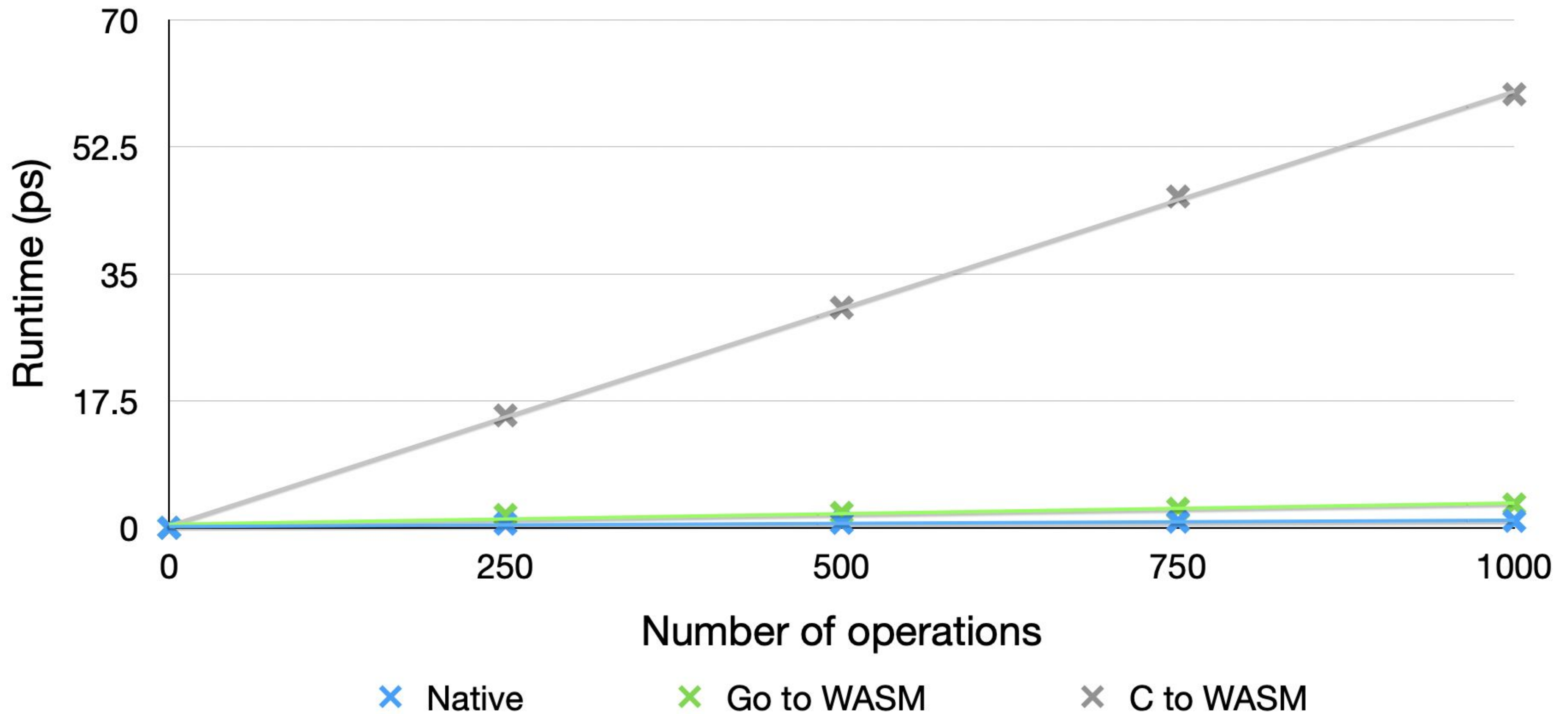
CPU : 2.5 GHz

Randomized scalar multiplications of the (x, 4/5) base point



CPU : 2.5 GHz

Randomized scalar multiplications of points



CPU : 2.5 GHz

Randomized additions of two points

Trustworthy takeaways

- Very low overhead
- Similar order of magnitude for all executions
- Go to WASM up to 3 times slower than native

Determinism

Sources of nondeterminism

1. Nondeterministic imports

2. NaN result from a floating point operator

3. Resource exhaustion

WASM is “almost deterministic”

OK for experiments, **not** for a realistic use case

What should be done if anyone can submit a smart contract ?

eWASM’s solution : Sentinel

- Smart contract validator released in “Alpha0” state
- No documentation, written in Rust
- Last commit 2.5 years ago 🧐

Sentinel strategy

1. Nondeterministic imports => **Reject if there is an illegal import**
2. NaN result => **Reject if there is a floating point operator**
3. Resource exhaustion => **Fix a limit on the stack size**

Sentinel strategy

Theoretically applicable : Sentinel validates contracts **after** the WASM compilations

Reverse engineer without the metering injector ?

Does it really guarantee strict determinism ?

Automated smart contract loading

Current smart contract loading

1. Compile the smart contract to WASM

2. Add the binary in the environment’s correct folder

3. Add ~10 lines of JavaScript code

4. Recompile & relaunch

WASM compilation automation

Unfeasible for C/C++ : unpredictable fixes required in practice

Probably not worth the trouble anyway

Automatic handling of new smart contracts

First idea : automatically handle new binaries

Problem : the API does not expect a large nor variable number of them

Solution : switch from “1 binary per smart contract” to “1 binary **per source language**”

Conclusion

Suitable for experiments : multiple languages, on par with native module, satisfying performance...

But **can it become more ?**

Future work

Immediately useful, should be quick :

- Rust support

Crucial but would take a lot of time :

- Strict determinism (if possible) & automated smart contract loading

Maybe slightly better in many years :

- Support WASI and use the relevant Node.js API

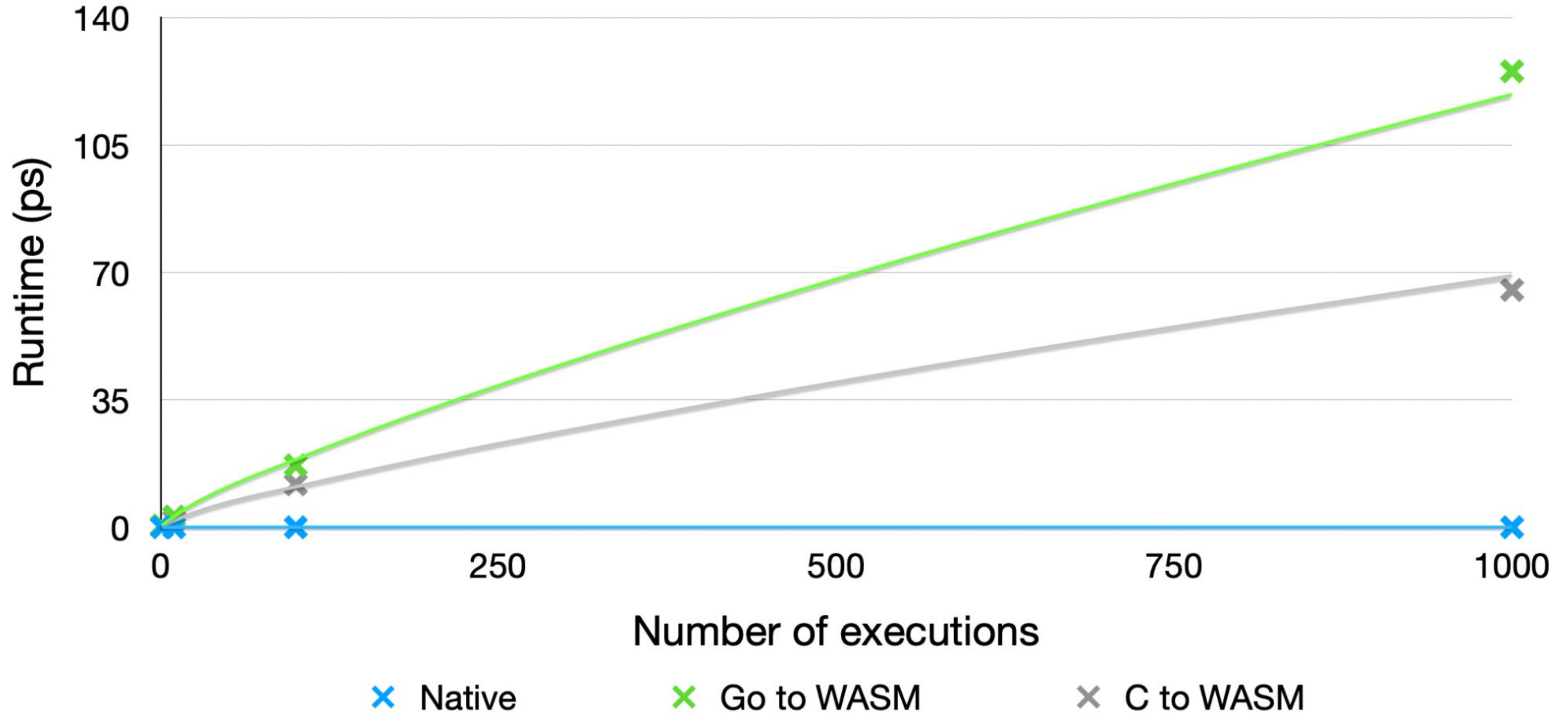
Questions

Backup Slides

Strong candidate : Rust

- Top tier WASM support

- Similar to C/C++ : Emscripten



CPU : 2.5 GHz

Incrementation of a randomized counter

Automatic handling of new smart contracts

Switch from “1 binary per smart contract” to “1 binary **per source language**”

Achieved differently depending on the language

Simplified and scalable JavaScript code

Drawback : users must update and compile larger files