

Jack of all trades, master of none.

Education

- B.Sc. Physics & Maths.
- M.Sc. Comp. Sci.
- Ph.D Electrical Eng.

Prev. employment

- NVIDIA: Graphics & Image Pro.
- CISRO: Precursor to R
- IBM: IP Version 5, broke it 🐱

Projects & Ongoing collaborations

- Road traffic control (TENS, Greenerflow)
- Sensor fusion (ROADVIEW)
- **Edge networking (ANIARA, this presentation)**
- Text summarisation (LCM, Linz, Austria)
- System of Systems (Ericsson, Finland)
- Intention Recognition for safety (Canon, France)



Cloud-Edge platforms made easy

“The middleware you always needed”

Ian Marsh (Ind. systems)

ian.marsh@ri.se

September

2023

Free



Cloud-Edge systems
are not easy to
build.

Journalists, consultants,
researchers 🤪, cloud
providers, others will tell
you Industry 4.0 is easy (and
coming).

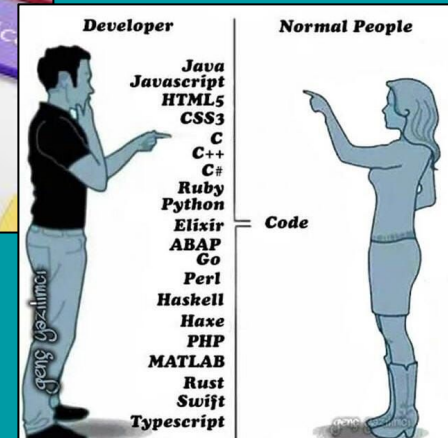
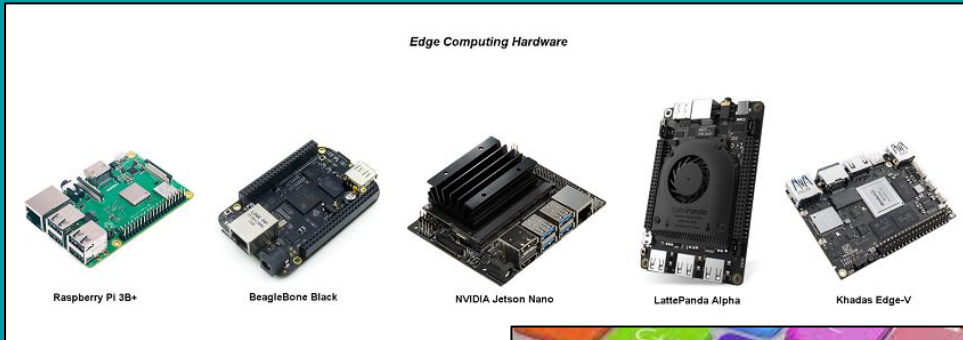
What's the problem?

(It's not you, it's me)

Big mess, sorry heterogeneity...



<https://www.dublinlive.ie/news/dublin-news/heartbreak-dublin-institution-close-doors-26800431> (Apr 2023) 106 years



Give me all the (other) bad stuff up front, please.

“Gärna”

The operator, chained networked ownership, latency,
4-5-(6)G, Wifi, 1-10GBe, TSN, CPS systems, ownership, code security, on-off-prem, power loss,

polling, control, compiling code, legal issues, maintenance ...

Another eye test

RI.
SE



Hang on.. you
haven't mentioned
the problem yet...

The Blurb.

If, one can sort out the edge hardware, decide on a coding language, (find) the code, hire programmers, we still have a problem.

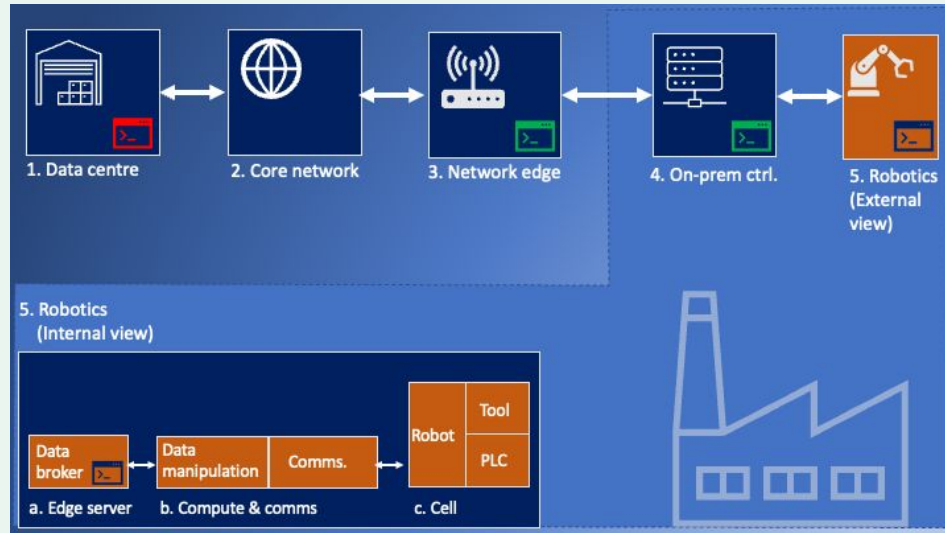
Where should the code run? Who takes ownership, updates, fixes and the whole shebang*, or DevOps cycles.

Not a trivial problem.

*Everything

A Cyber-Physical System.

(in Germany)



Cloud-Edge platforms made *easier*

“The middleware RISE will show you”

Dodgy Researcher

give.me.cash@ri.se

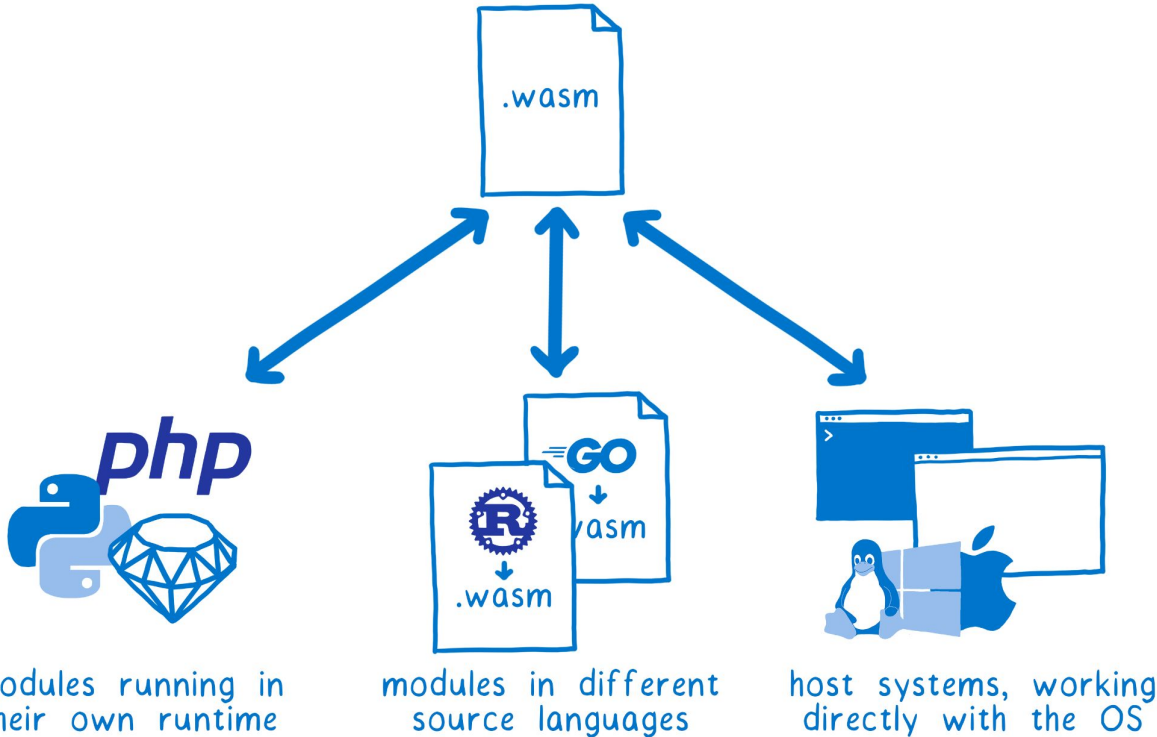
September

2023

Not free

Link

WebAssembly Interface Types Interoperate with ALL THE THINGS!



"Write Once, Run everywhere"

Javascript
"machine code"

Compiler support
(AoT, JiT)

Open W3C standard

Safe,
Sandboxed

Multi lang,
multi hw

“If WASM + WASI existed in 2008, we wouldn't have needed to create Docker. That's how important it is. WebAssembly on the server is the future of computing”

Solomon Hykes, co-founder of Docker, [link](#)



Insights, please

Cyber Physical Requirements

Sector	Latency	Source	Source / Notes
Industrial applications	5-500ms	Industrial consortium [4]	Industry 4.0 book.
Industrial Robotics ¹	50ms	HAL Robotics Ltd. Arc <i>Welding</i>	Interposition time along a robot's toolpath where new joint positions are calculated.
Industrial Robotics ²	100ms	HAL Robotics Ltd. Electrical <i>signal polling</i> .	Frequency polled for an action i.e. to grab a part, move when a laser beam is broken etc.
6G	<1ms	Ericsson report [3]	"6G-connecting a cyber-physical world."
5G-Edge	1-10ms	ANIARA EU proposal [5]	Use case dependent: robotics, automotive.
5G	<10ms	3GPP Rel. 16/17	Quoted as 1ms, practically, 10's ms, see MONROE [6].
4G	<50ms	3GPP Rel. 8	OFDM, all IP, compression.

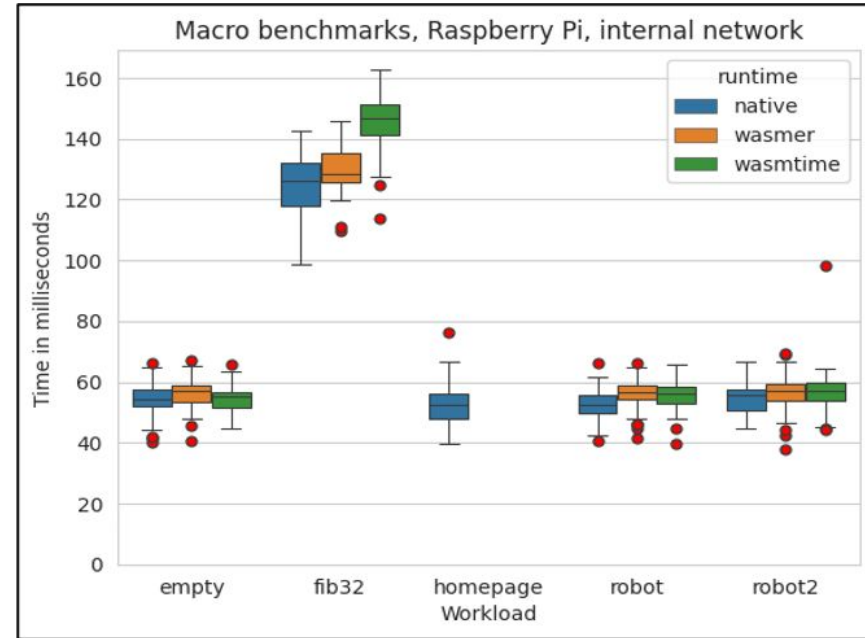
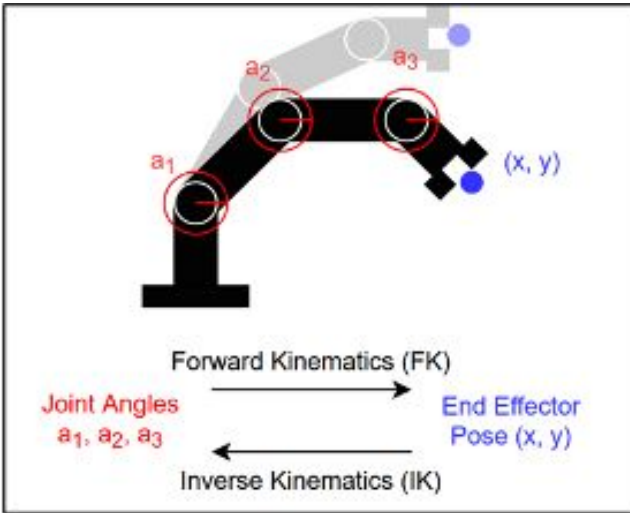


So, did you get
anywhere?

Yes: WebAssembly compared to native code!

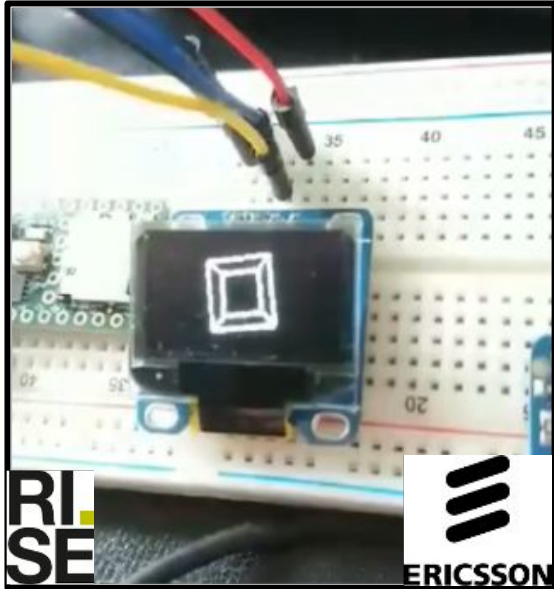
Macro-benchmark: how does WASM compare to native binaries that are compiled for a particular platform in an end-to-end setting.

We implemented 2 software robots to generate workloads (robot and robot2). Run on a Raspberry Pi4.



Demos

WASM-based lightweight runtime



With Pontus Sköldström.

WASM-controlled Arduino robot runtime



With Remo Scolati

PDFs

The responsiveness and deployment of WebAssembly runtimes in Cyber-Physical Systems

Ian Marsh
ian.marsh@ri.se
RISE AB, Sweden

Remo Scolati
scolati@kth.se
KTH, Sweden

The placement and responsiveness of WebAssembly runtimes in Cyber-Physical systems

Ian Marsh
ian.marsh@ri.se
RISE AB, Sweden

Andrew Williams
andrew.williams@ericsson.se
Ericsson AB, Sweden

Sebastian Andraos
s.andraos@hal-robotics.com
HAL Robotics Ltd., UK

Wolfgang John
wolfgang.john@ericsson.se
Ericsson AB, Sweden

Pontus Sköldström
pontus.skoldstrom@qamcom.se
QamCom AB, Sweden

Evolving 5G: ANIARA, an Edge-Cloud perspective

Ian Marsh
RISE AB, Sweden

Wolfgang John
Ericsson AB, Sweden

Ali Balador
Ericsson AB, Sweden

Federico Tonini
Chalmers University, Sweden

Jalil Taghia
Ericsson AB, Sweden

Andreas Johnsson
Ericsson AB, Sweden

Paolo Monti
Chalmers University, Sweden

Jonas Gustafsson
RISE AB, Sweden

Pontus Sköldström
Qamcom AB, Sweden

Johan Sjöberg
Ericsson AB, Sweden

Jim Dowling
Hopworks AB, Sweden



KTH ROYAL INSTITUTE
OF TECHNOLOGY

Degree Project in Computer Science and Engineering
Second cycle, 30 credits

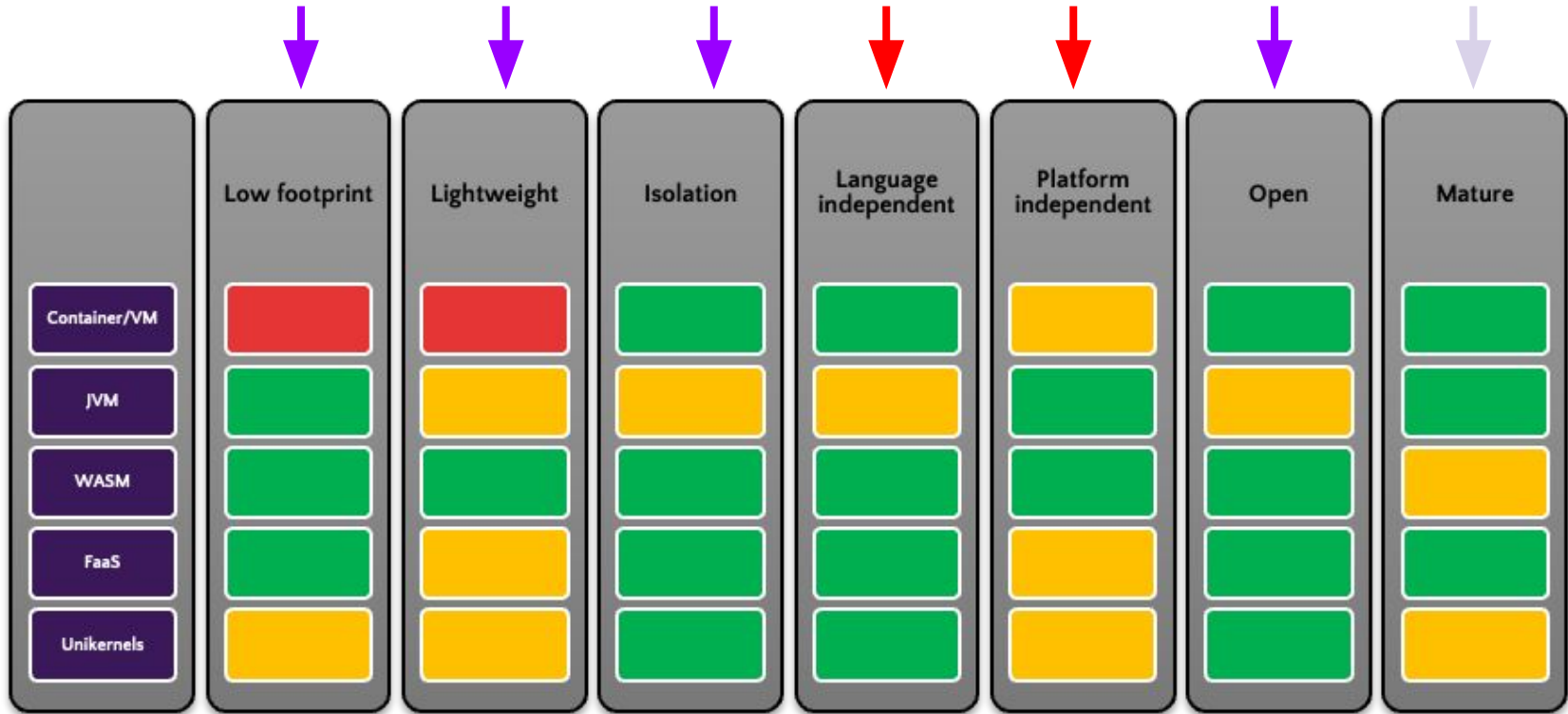
Measuring the responsiveness of WebAssembly in edge network applications

REMO SCOLATI

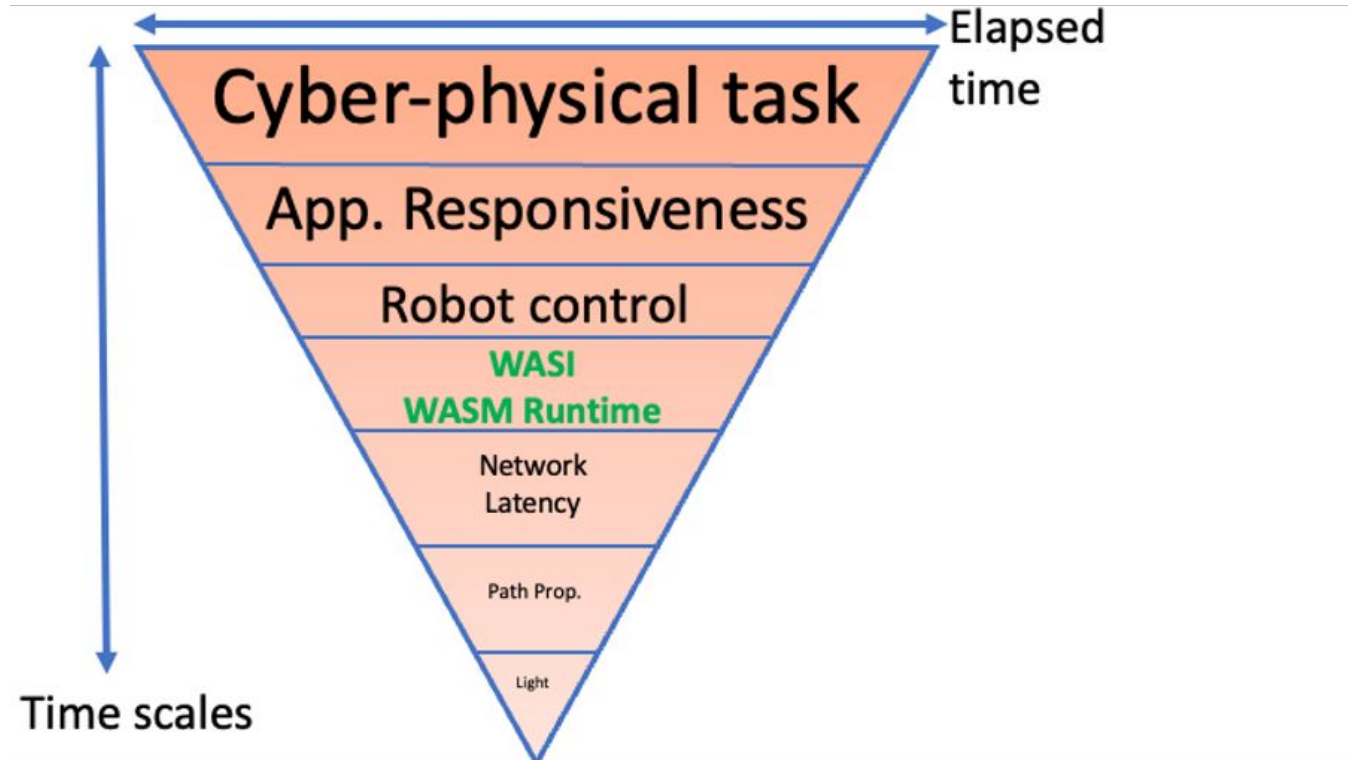
Stockholm, Sweden, 2023

RISE

Comparison: environment(s) + execution



Insight: Responsivness



Is WebAssembly all greatness and light?

- Confusing choice of runtimes (at least 30)
- WASM runs in a sandbox, operating system and network calls have to go through an API (called WASI)
- Windows 'system' slightly different (Blazor)
- Ahead of time (AoT) and Just In Time (JiT) compilation options have tradeoffs



Q & A.

Presentation link

ian.marsh@ri.se

