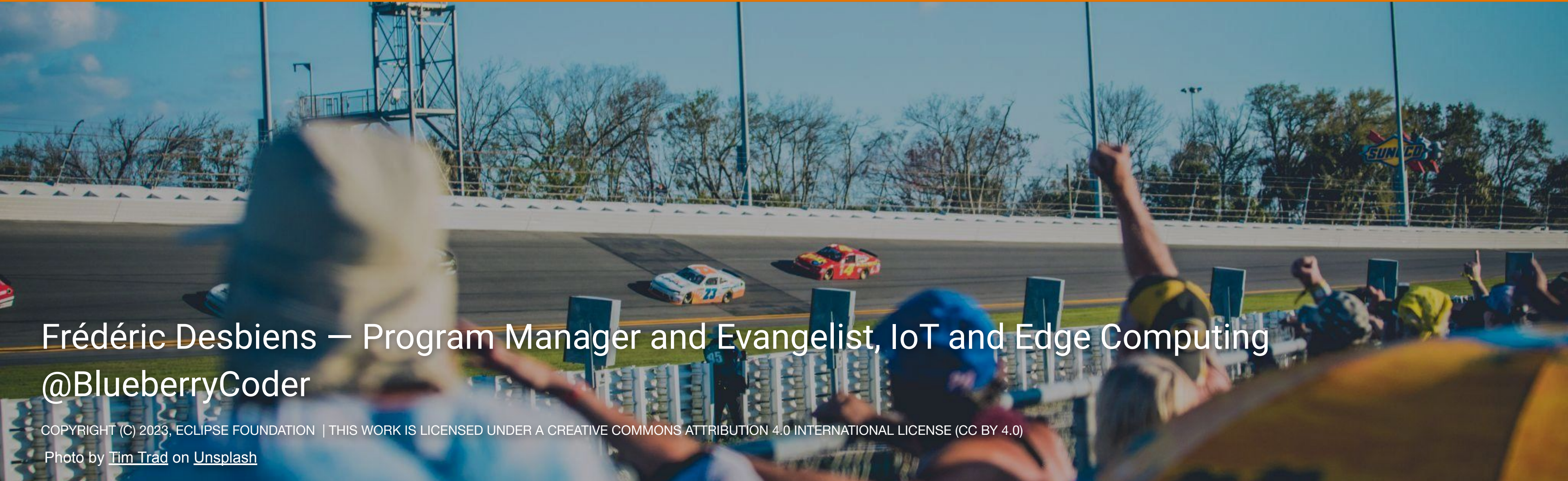
Pasadena Nights

The Legend of Rust vs Zephyr

March 11, 2023



Frédéric Desbiens — Program Manager and Evangelist, IoT and Edge Computing
@BlueberryCoder

Photo by Tim Trad on Unsplash

About Me

Frédéric Desbiens
Program Manager and Evangelist — IoT and Edge Computing

B.Ed., B.Sc.A, MBA

Developer, Architect, Product Manager…

Oracle, Cisco, Pivotal…

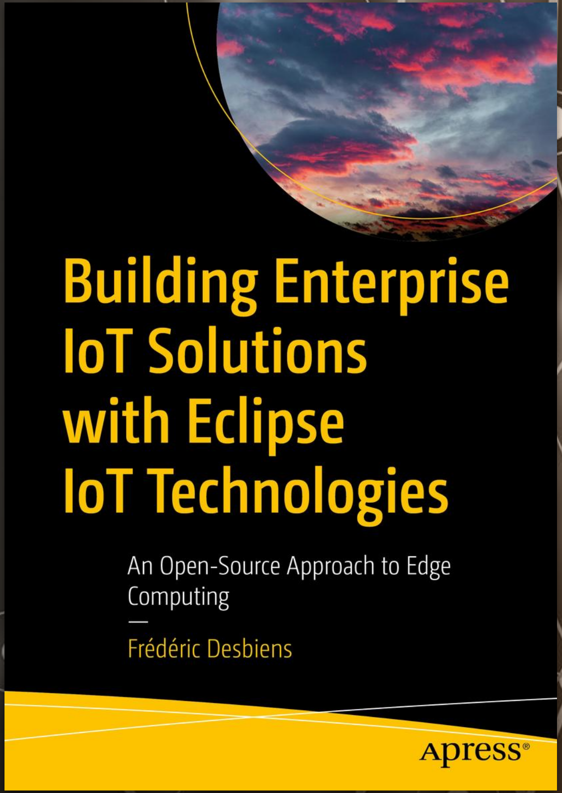
Published author; Frequent Speaker

@BlueberryCoder
https://ca.linkedin.com/in/fredericdesbiens

December 2022

A comprehensive overview of the open-source IoT and Edge Computing platforms available at the Eclipse Foundation

ISBN: 978-1484288818


Building Enterprise IoT Solutions with Eclipse IoT Technologies
An Open-Source Approach to Edge Computing
—
Frédéric Desbiens
Apress®

Come See Us!

Booth 215

Agenda

01 Do We Need RTOSes?

02 Zephyr

03 Rust

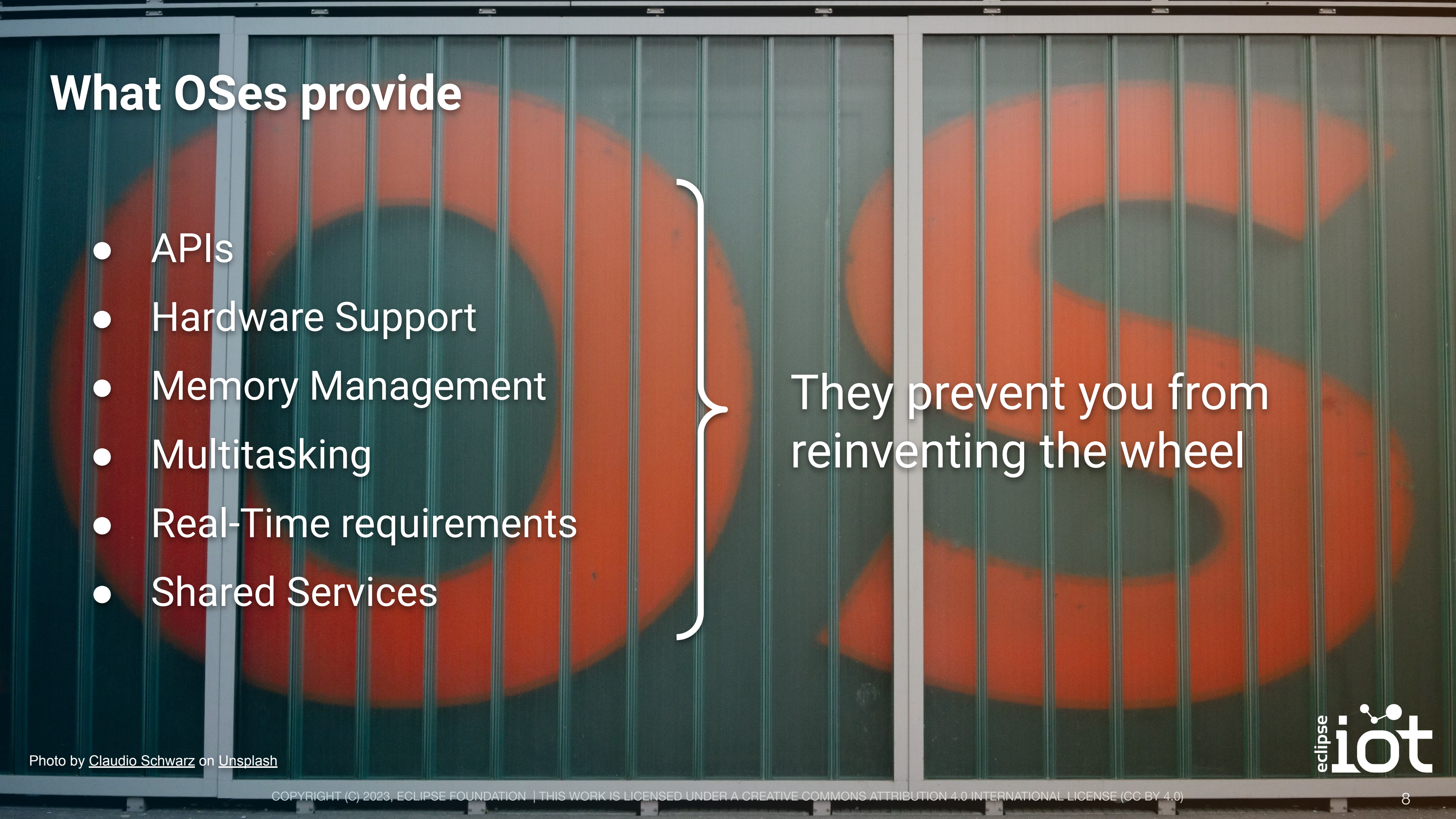
04 SHOWDOWN!!!

Do We Need RTOSes?

Do We Need RTOSes?

Photo: By Lamune (Talk) — Copied from English Wikipedia Tandycoco2.jpg], Copyrighted free use, https://commons.wikimedia.org/w/index.php?curid=460962

What OSes provide

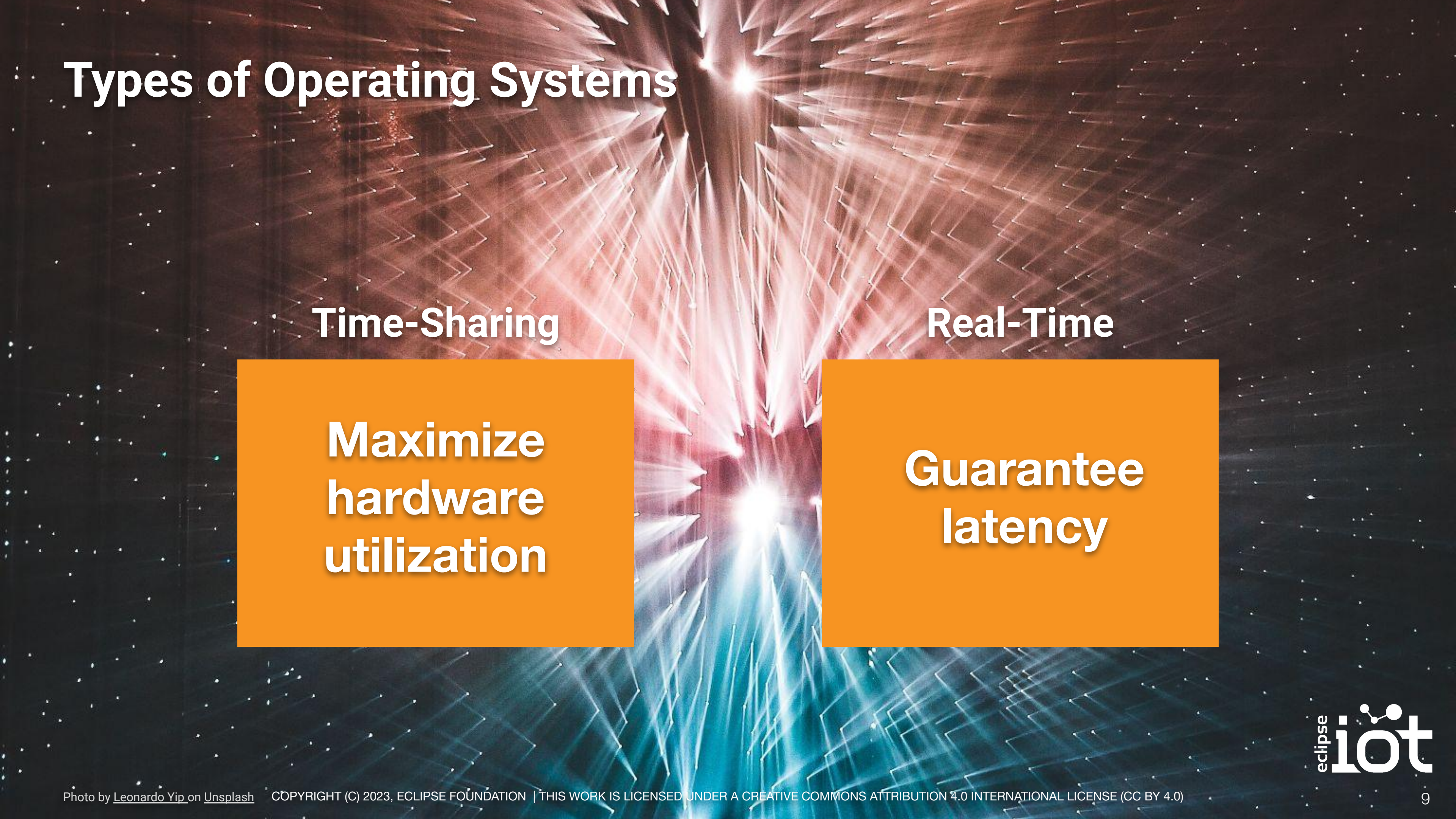


- APIs
- Hardware Support
- Memory Management
- Multitasking
- Real-Time requirements
- Shared Services

They prevent you from reinventing the wheel

Photo by Claudio Schwarz on Unsplash

Types of Operating Systems



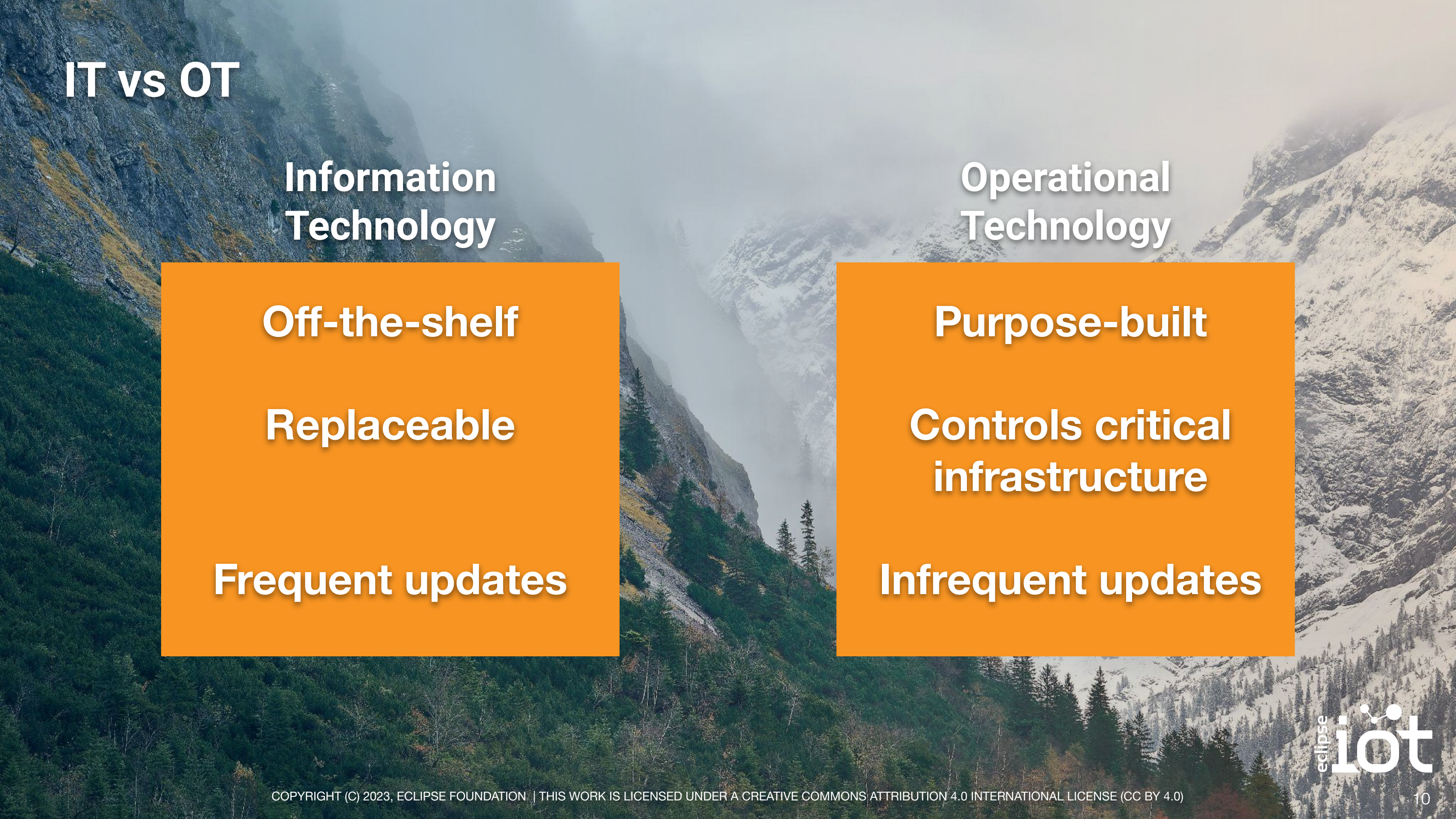
Time-Sharing

Maximize hardware utilization

Real-Time

Guarantee latency

Photo by Leonardo Yip on Unsplash



IT vs OT

Information Technology	Operational Technology
Off-the-shelf	Purpose-built
Replaceable	Controls critical infrastructure
Frequent updates	Infrequent updates

How to Decide?

What kind of hardware platform do you have?

What are the requirements for the software?

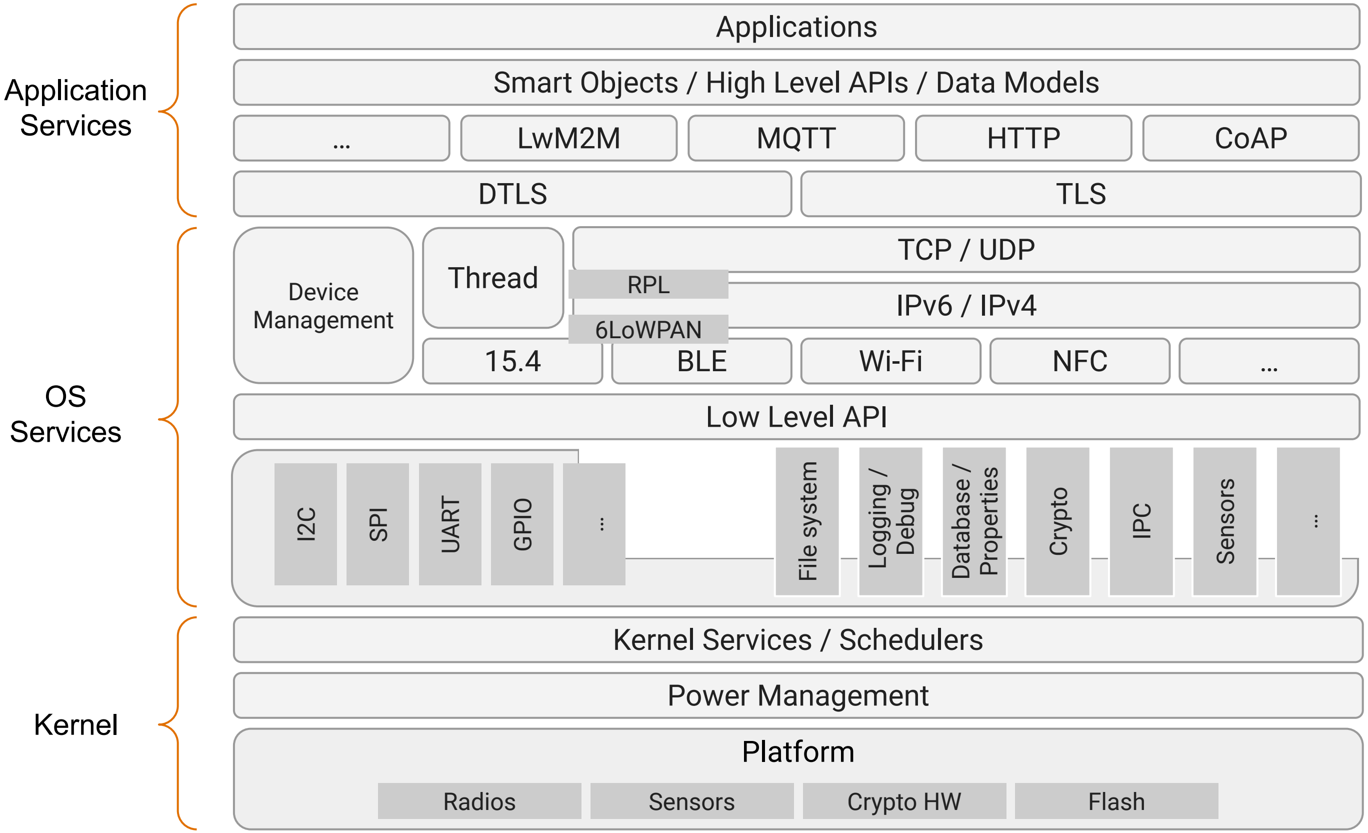
What peripherals and busses do you need to leverage?

Zephyr

Zephyr: Main Features

- Written in C
- Kernel services
- Multiple scheduling algorithms
- Configurable and modular
- Memory protection
- Native networking stack
- Bluetooth Low Energy 5.0 support
- Non-volatile storage

Zephyr Architecture



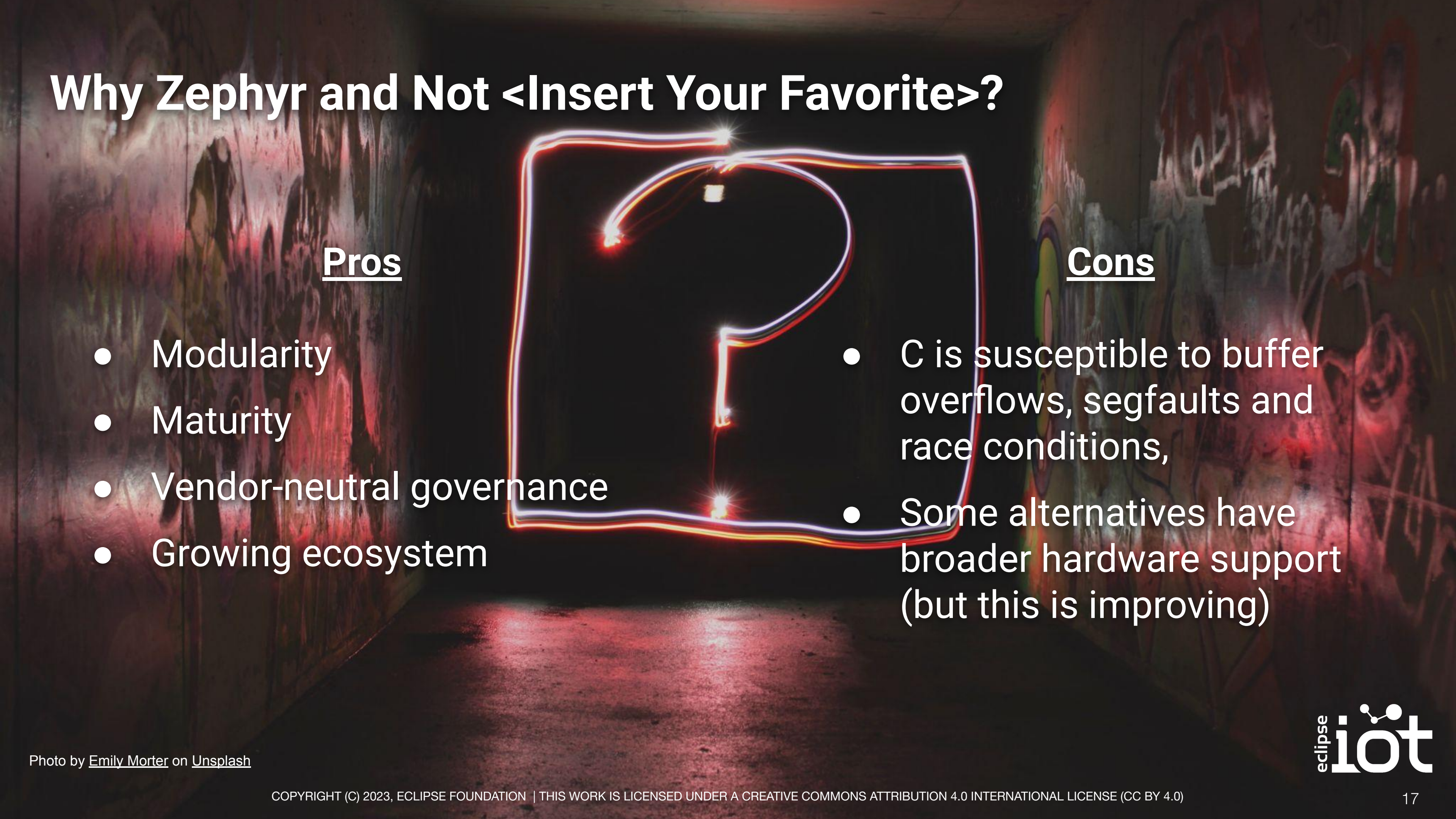
Kernel Services

- Multi-threading
  - Cooperative, priority-based, non-preemptive, and preemptive threads
- Interrupt
  - Compile-time registration of interrupt handlers
- Memory Allocation
  - Dynamic allocation and freeing of fixed and variable-size memory blocks
- Inter-thread Synchronization
  - Binary semaphores, counting semaphores, and mutex semaphores
- Inter-thread Data Passing Services
  - basic message queues, enhanced message queues, and byte streams
- Power Management
  - Tickless idle and an advanced idling infrastructure

Scheduling Algorithms

- Cooperative and Preemptive Scheduling
- Earliest Deadline First (EDF)
- Meta IRQ scheduling (“interrupt bottom half” or “tasklet” behavior)
- Timeslicing (between preemptible threads of equal priority)
- Available queuing strategies:
  - Simple linked-list ready queue
  - Red/black tree ready queue
  - Traditional multi-queue ready queue

Why Zephyr and Not <Insert Your Favorite>?



Pros

- Modularity
- Maturity
- Vendor-neutral governance
- Growing ecosystem

Cons

- C is susceptible to buffer overflows, segfaults and race conditions,
- Some alternatives have broader hardware support (but this is improving)

Photo by Emily Morter on Unsplash

Rust

Rust and Constrained (Embedded) Devices

- Rust is attractive for constrained devices
  - Memory and thread safety
- Supports bare metal development
  - Bootloaders
  - Operating Systems
  - Applications
- Thriving embedded ecosystem; no mature RTOS
- Libraries (crates) → Cargo package manager

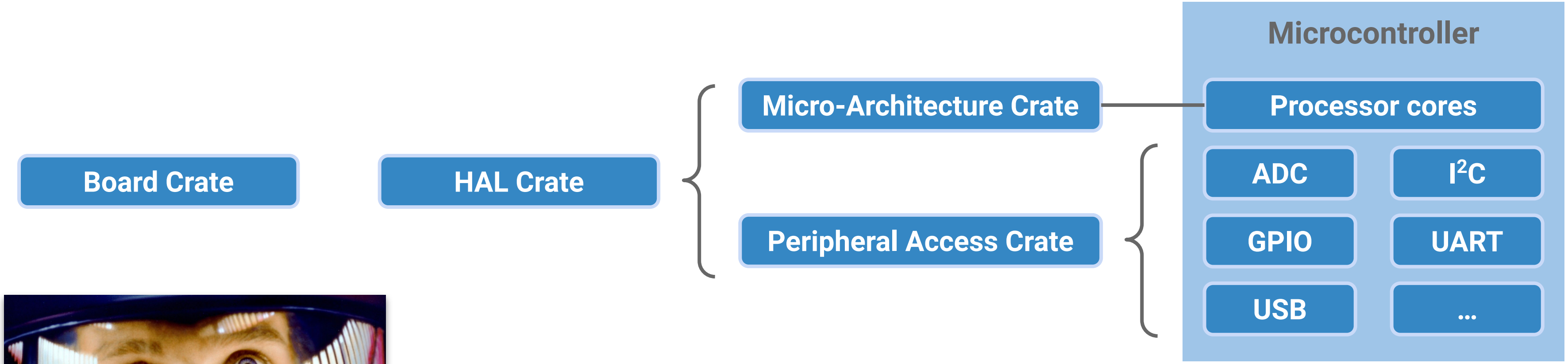
Language Characteristics

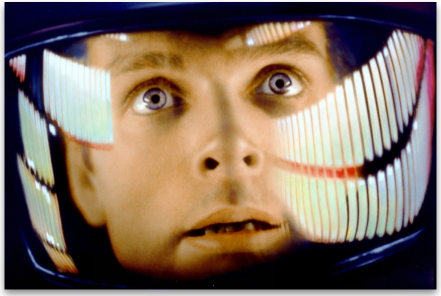
- Variables immutable by default
- Statically typed
- Memory safety without a garbage collector
  - Each value has an owner
  - Only one owner at a time
  - Variable is dropped when owner out of scope
- Inspired by functional and object-oriented programming languages but is neither

Two possible runtimes

- **Libstd (std crate)**
  - Sets up stack overflow protection
  - Spawns the main thread before the main function is invoked
  - Platform-specific (OS integration)
- **Libcore (core crate or no_std)**
  - Platform-agnostic subset of libstd
  - No heap (dynamic allocation) or collections unless additional crates added

My god, it's full of ~~stars~~ crates





Why Rust

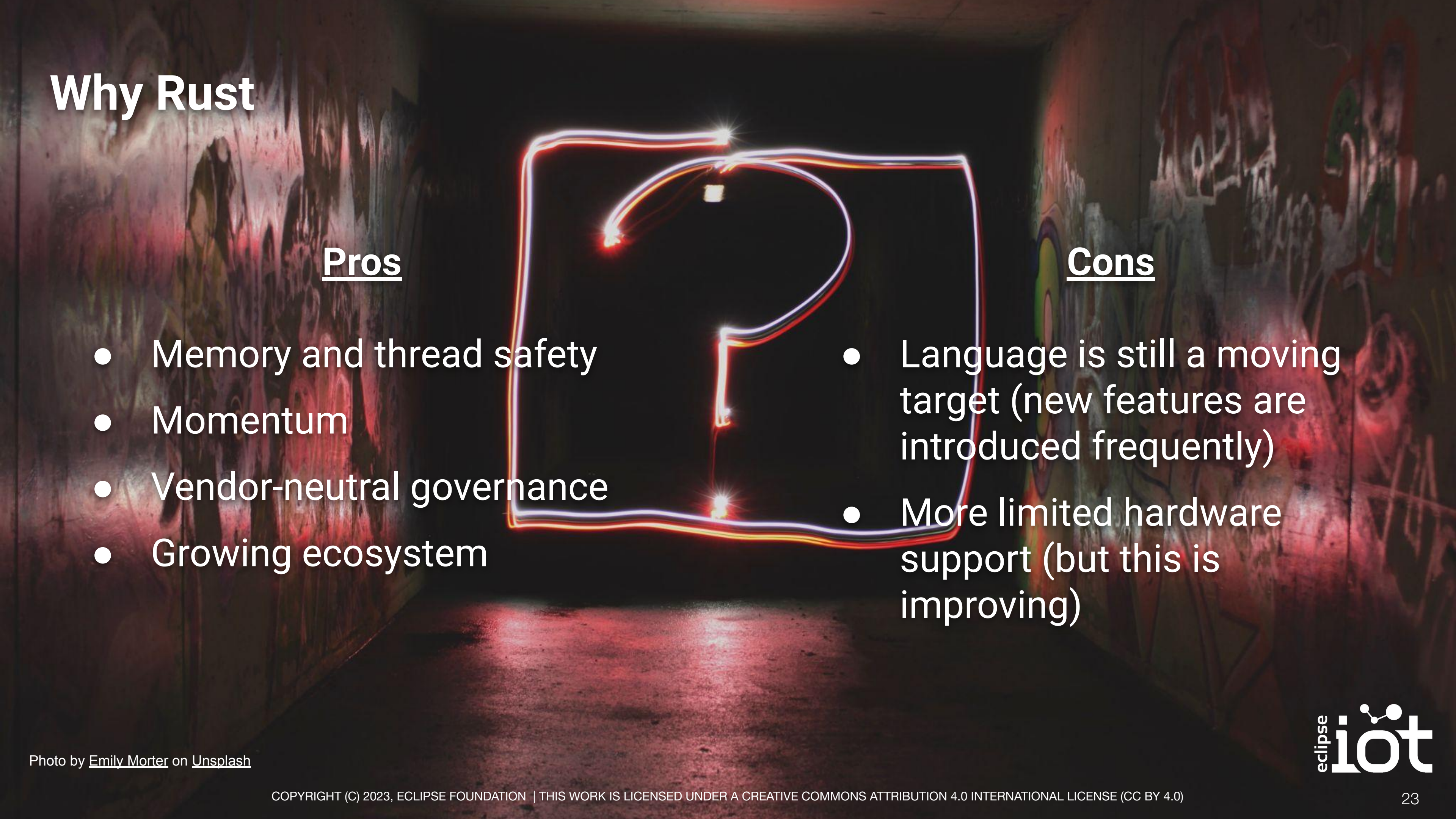


Photo by Emily Morter on Unsplash

Pros

- Memory and thread safety
- Momentum
- Vendor-neutral governance
- Growing ecosystem

Cons

- Language is still a moving target (new features are introduced frequently)
- More limited hardware support (but this is improving)

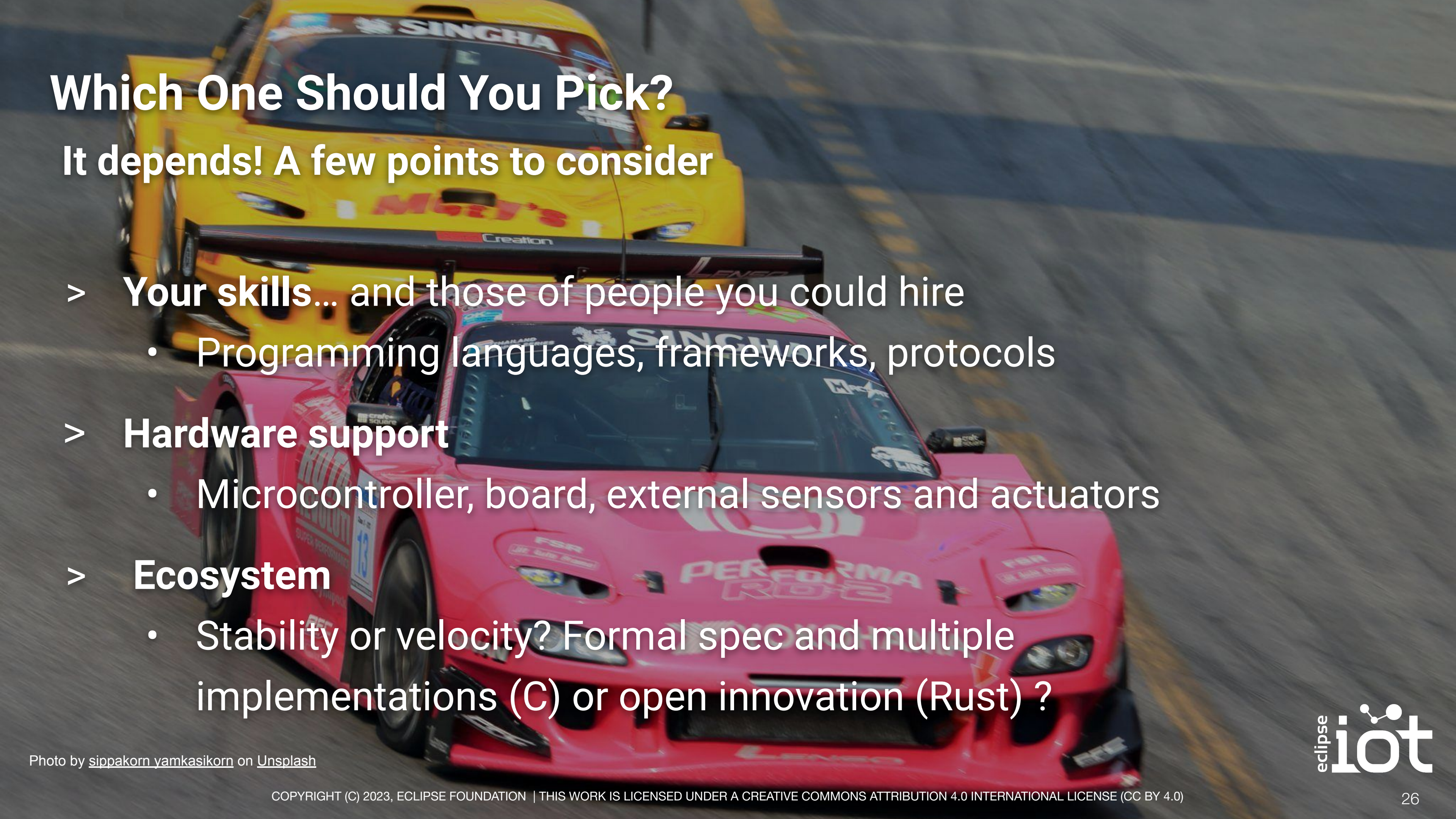
SHOWDOWN!!!!!

Which One Should You Pick?

Photo by sippakorn yamkasikorn on Unsplash

Which One Should You Pick?

It depends! A few points to consider



> **Your skills**… and those of people you could hire
> - Programming languages, frameworks, protocols

> **Hardware support**
> - Microcontroller, board, external sensors and actuators

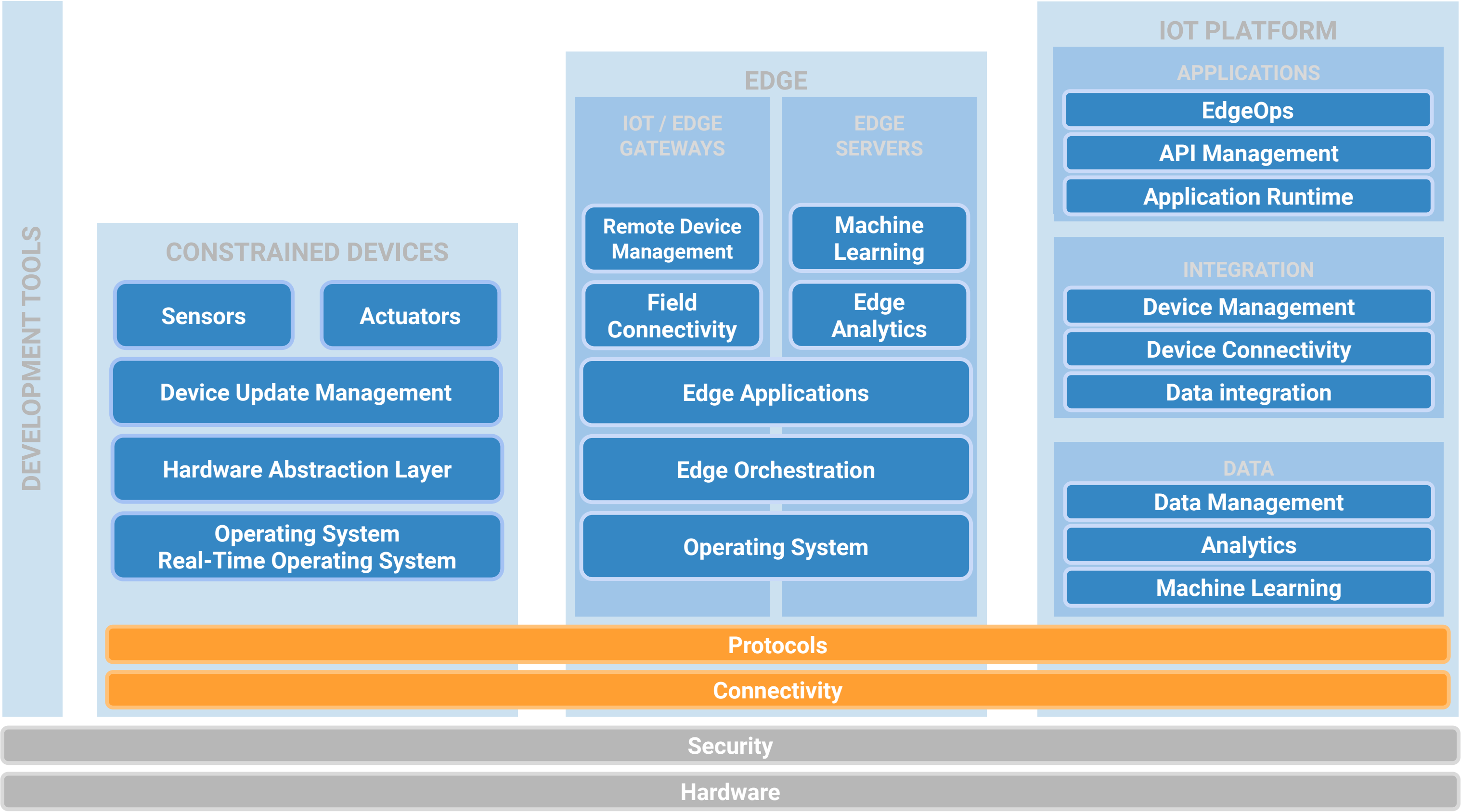
> **Ecosystem**
> - Stability or velocity? Formal spec and multiple implementations (C) or open innovation (Rust) ?

Photo by sippakorn yamkasikorn on Unsplash

The True Winner: One Punch Man

About Eclipse IoT

IoT Architecture


DEVELOPMENT TOOLS

CONSTRAINED DEVICES

Sensors

Actuators

Device Update Management

Hardware Abstraction Layer

Operating System
Real-Time Operating System

EDGE

IOT / EDGE GATEWAYS

Remote Device Management

Field Connectivity

EDGE SERVERS

Machine Learning

Edge Analytics

Edge Applications

Edge Orchestration

Operating System

IOT PLATFORM

APPLICATIONS

EdgeOps

API Management

Application Runtime

INTEGRATION

Device Management

Device Connectivity

Data integration

DATA

Data Management

Analytics

Machine Learning

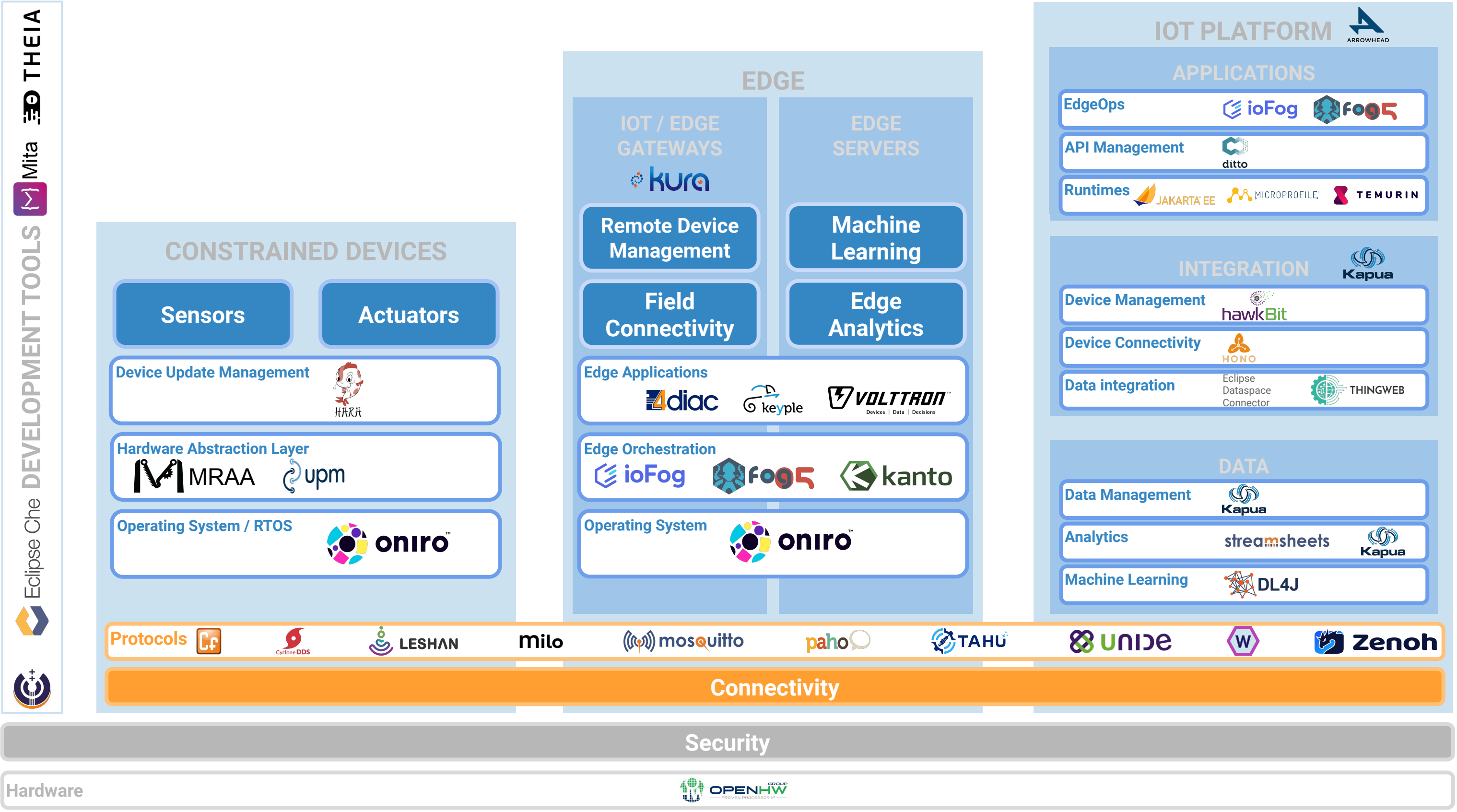
Protocols

Connectivity

Security

Hardware

Where Eclipse Projects Fit



Eclipse Che DEVELOPMENT TOOLS Mita THEIA

CONSTRAINED DEVICES

Sensors

Actuators

Device Update Management HARA

Hardware Abstraction Layer MRAA upm

Operating System / RTOS oniro

EDGE

IOT / EDGE GATEWAYS kura

Remote Device Management

Field Connectivity

EDGE SERVERS

Machine Learning

Edge Analytics

Edge Applications 4diac keyple VOLTTRON Devices | Data | Decisions

Edge Orchestration ioFog Fog05 kanto

Operating System oniro

IOT PLATFORM ARROWHEAD

APPLICATIONS

EdgeOps ioFog Fog05

API Management ditto

Runtimes JAKARTA EE MICROPROFILE TEMURIN

INTEGRATION Kapua

Device Management hawkBit

Device Connectivity HONO

Data integration Eclipse Dataspace Connector THINGWEB

DATA

Data Management Kapua

Analytics streamsheets Kapua

Machine Learning DL4J

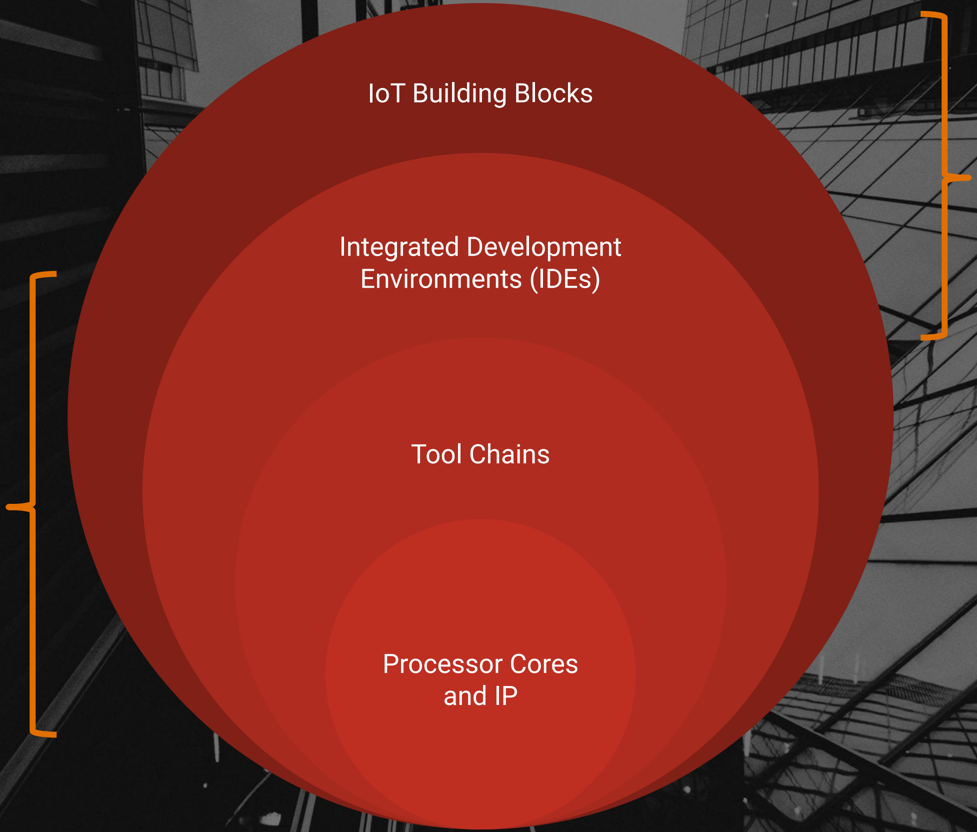
Protocols Cf Cyclone DDS LESHAN milo mosquitto paho TAHU UNIDE W Zenoh

Connectivity

Security

Hardware OPENHW GROUP

Towards a Comprehensive Open Source IoT RISC-V stack



IoT Building Blocks

Integrated Development Environments (IDEs)

Tool Chains

Processor Cores and IP

OPENHW GROUP

ECLIPSE FOUNDATION

eclipse iot

Thank you!

Questions?

Frédéric Desbiens
@BlueberryCoder

iot.eclipse.org
edgenative.eclipse.org
sparkplug.eclipse.org