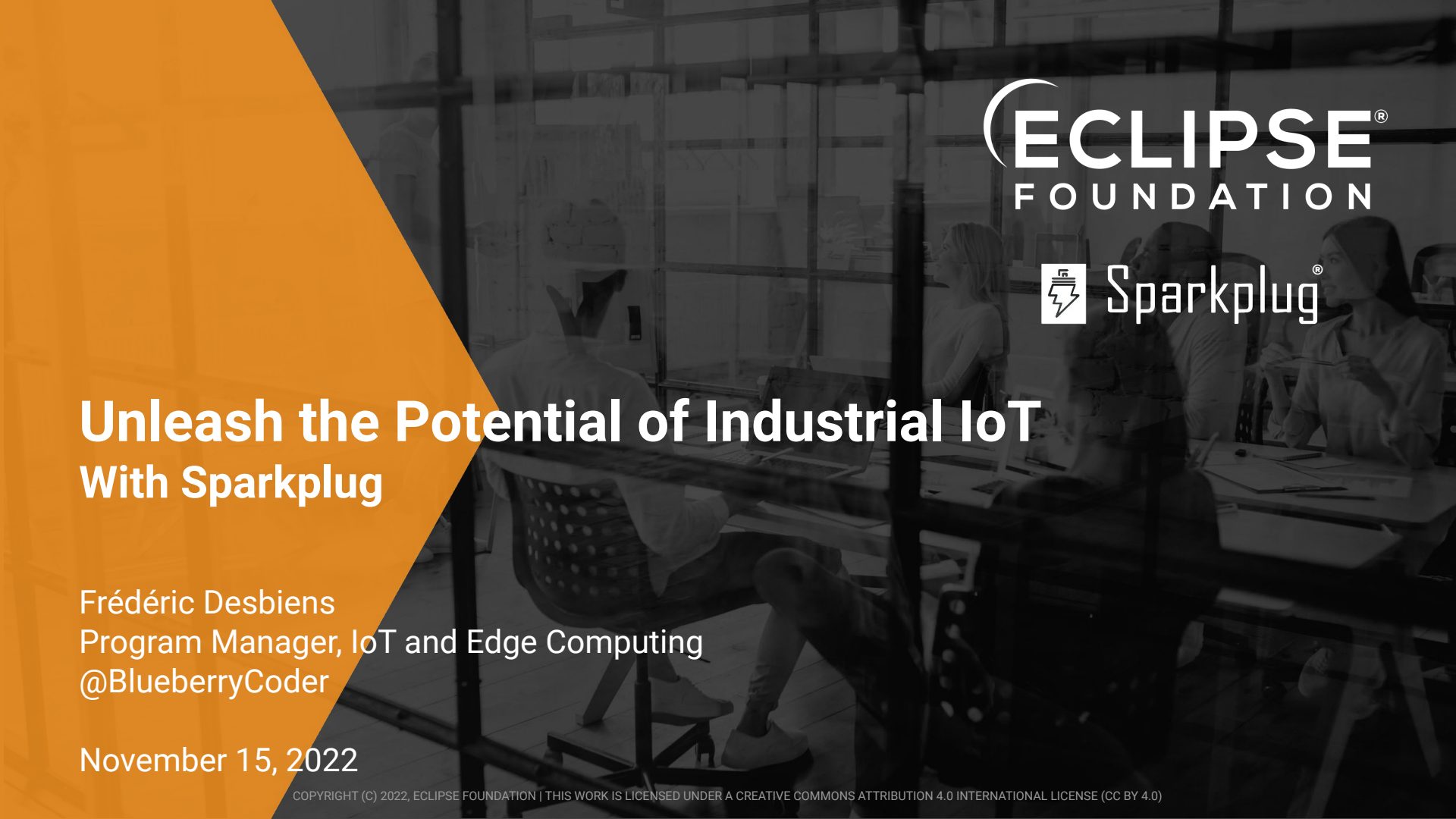

Unleash the Potential of Industrial IoT
With Sparkplug

Frédéric Desbiens
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November 15, 2022

About Me

Frédéric Desbiens
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B.Ed., B.Sc.A, MBA

Developer, Architect, Product Manager…

Oracle, Cisco, Pivotal…

Published author; Frequent Speaker

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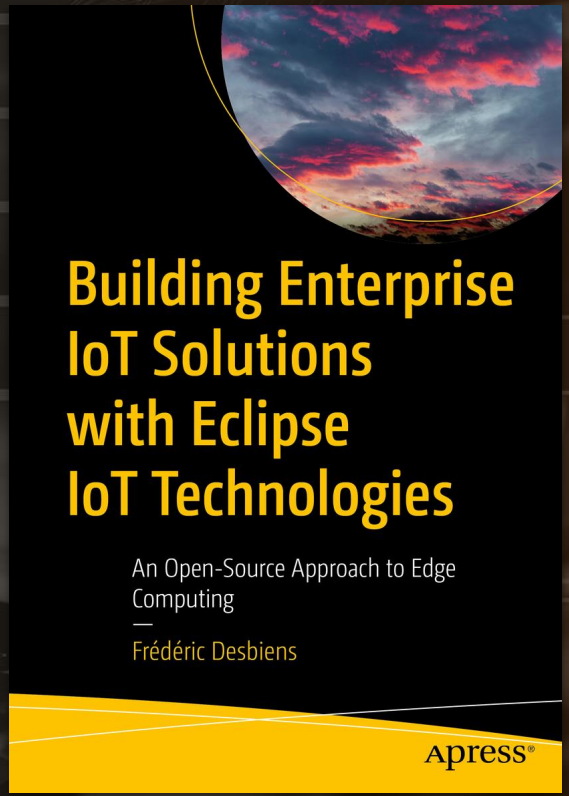
December 2022

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

ISBN: 978-1484288818



Agenda

- The Eclipse Foundation
- Interoperability in IIoT
- Sparkplug Overview
- Real-World Deployment

ECLIPSE FOUNDATION

The Community for Open Innovation and Collaboration

Community driven.
Code first.
Commercial-friendly.

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Strategic Focus Areas

Cloud Native Java

We provide a collaborative environment for the world's leading Java ecosystem players to advance open source enterprise Java technologies for the cloud.

IoT & Edge

We enable industry leaders to collaborate on an end-to-end IoT architecture that is secure, flexible, and fully based on open source and open standards.

Automotive

We provide leading automotive OEMs, their suppliers, and partners with a sustainable, transparent, and vendor-neutral platform to collaborate on open technologies and standards.

Tools

The Eclipse IDE is the critical development environment for more than 6 million active users. Our community is innovating on the next generation of cloud native developer tools.

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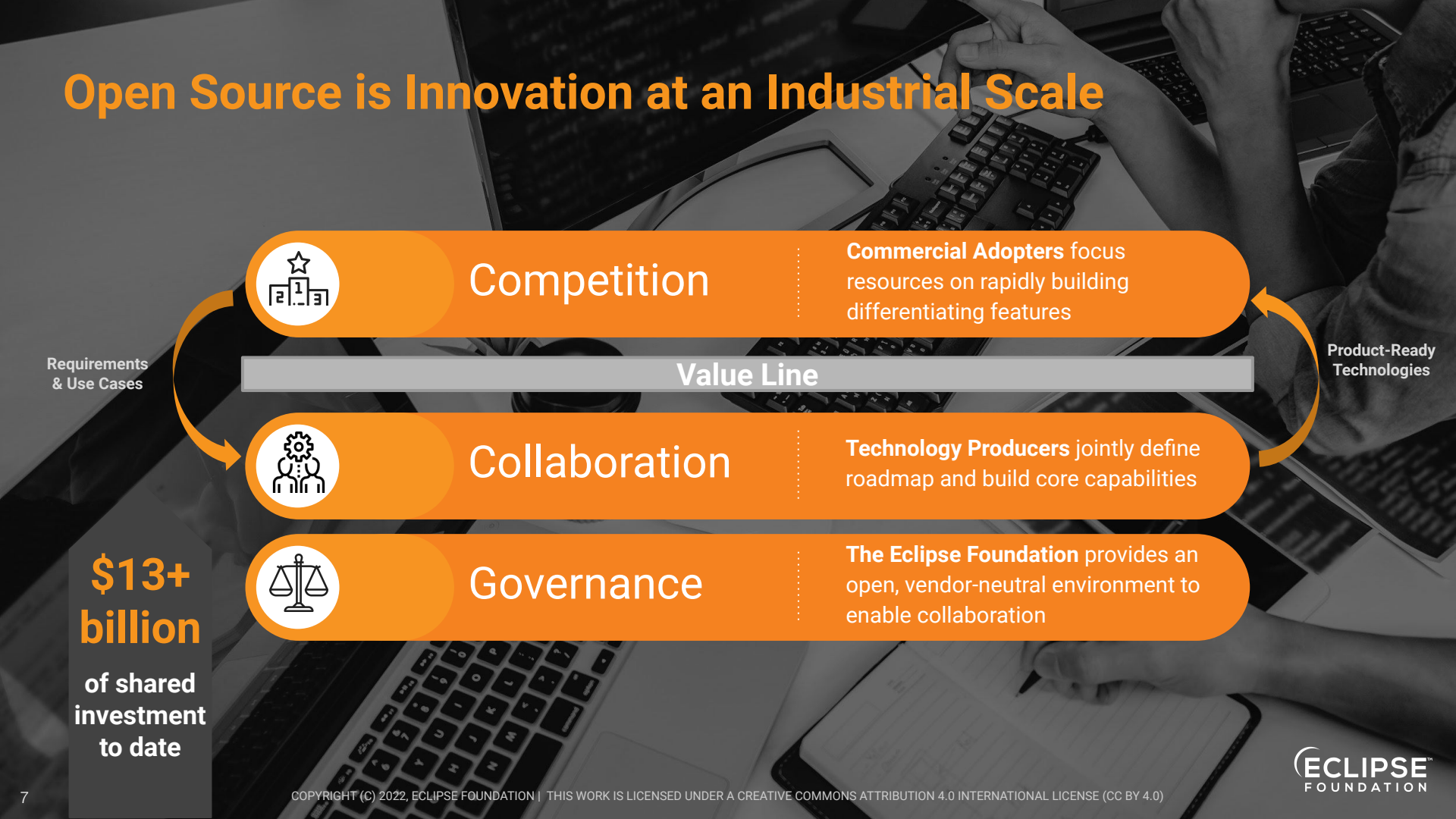
Open Source is Innovation at an Industrial Scale



$13+ billion

of shared investment to date

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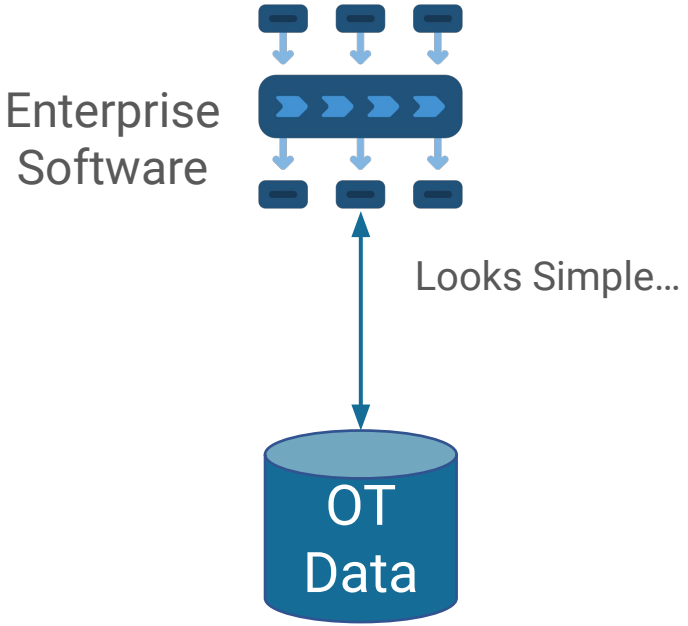
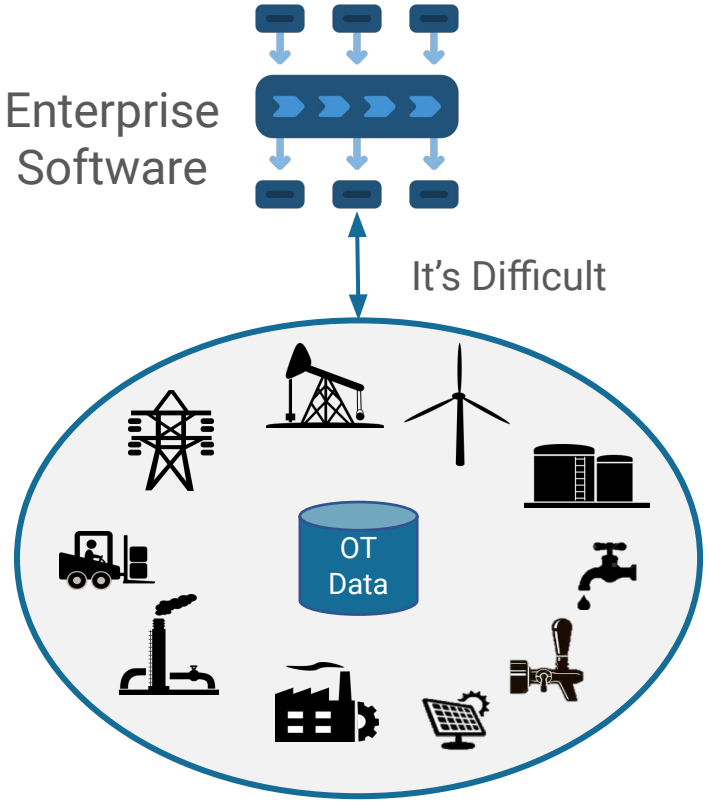
Dream… and Reality





Are We There Yet?

Traditional OT integration relies on polling/response

This wears your patience thin in the car…

…and wastes resources in the enterprise

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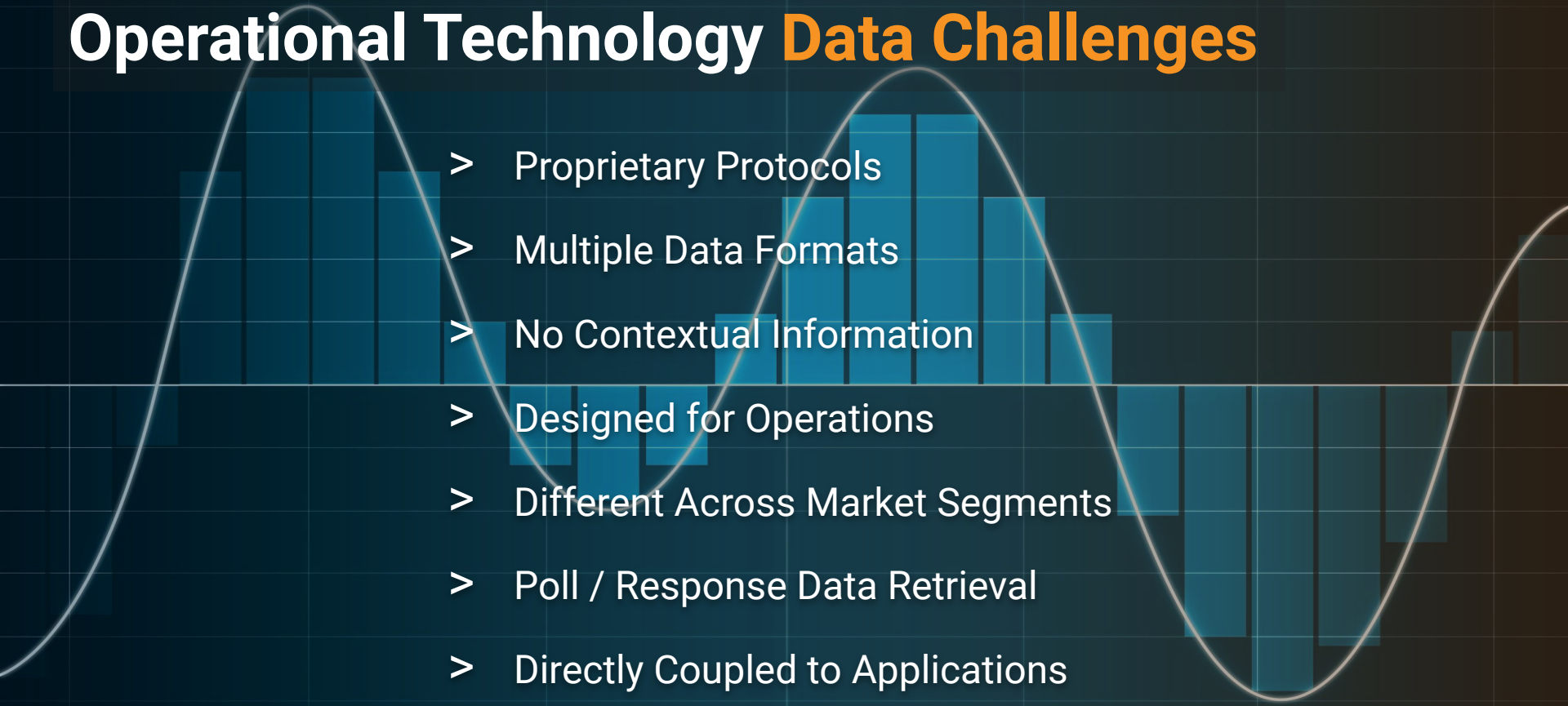
Operational Technology Data Challenges



- Proprietary Protocols
- Multiple Data Formats
- No Contextual Information
- Designed for Operations
- Different Across Market Segments
- Poll / Response Data Retrieval
- Directly Coupled to Applications
- Isolated Networks

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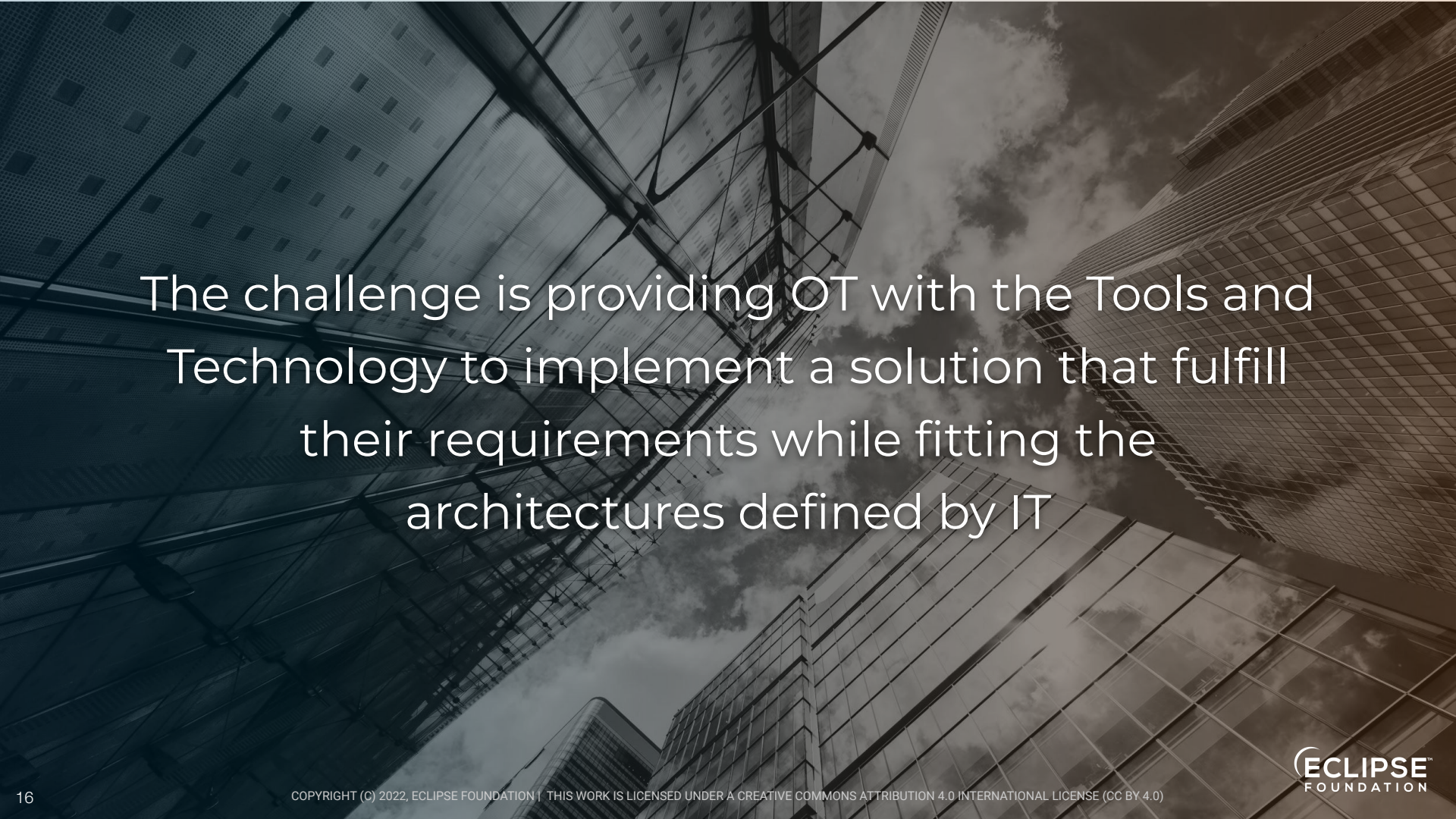
Information Technology Data Requirements

- Data Objects/Modeling
- Standard Data Formats
- Contextual Information
- Decoupled to Enterprise
- Publish / Subscribe Methodology
- Easy to Integrate
- Secure

IT vs OT

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



What MQTT Offers

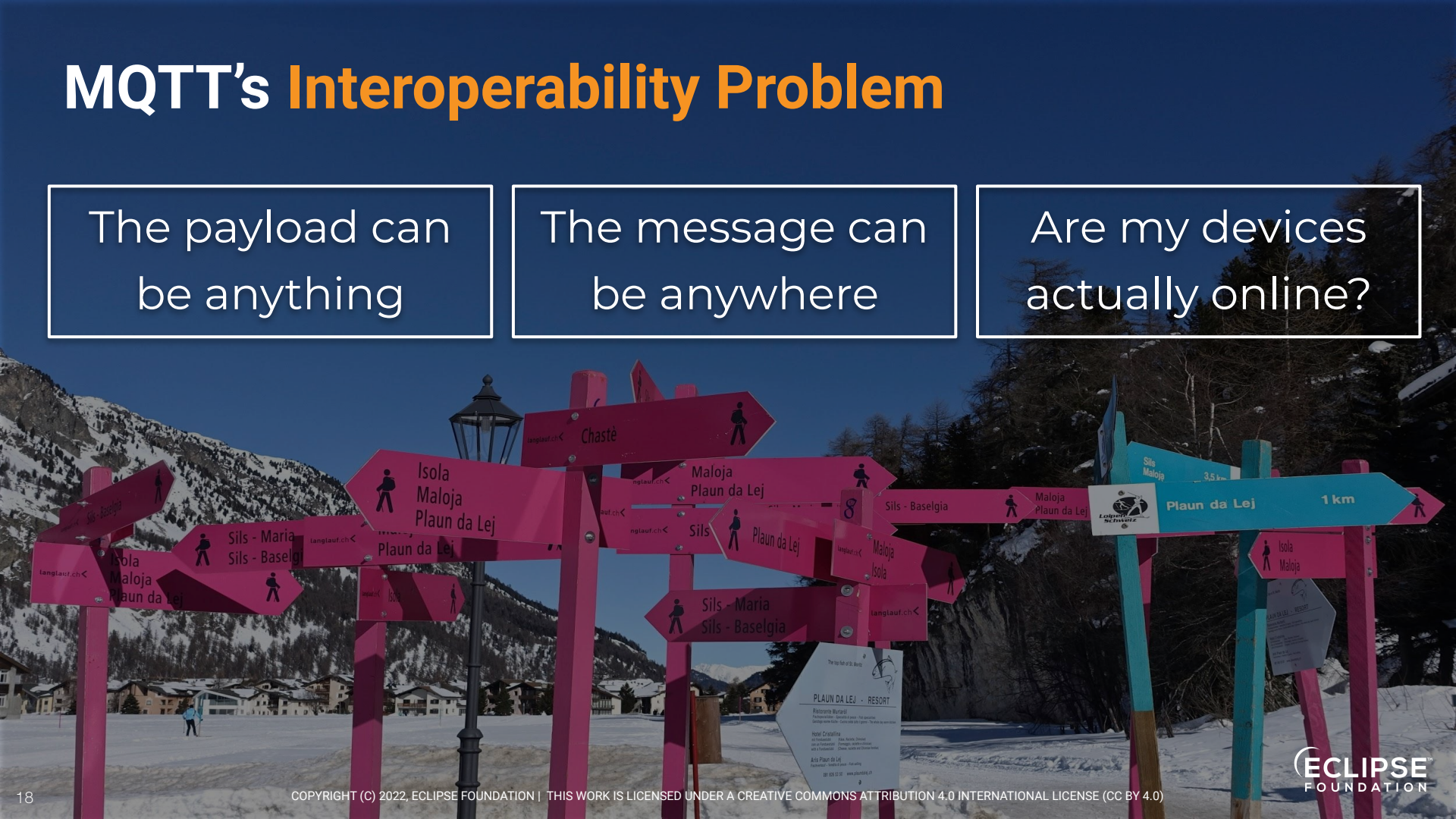
- Message Oriented Middleware
- Publish / subscribe infrastructure
- Invented for a real-time, mission critical SCADA solution
  - Simple – Easy to implement on constrained devices
  - Efficient – Use as little bandwidth and resources as possible
  - Stateful – Method in which to save on bandwidth
  - Secure* (leverages latest TCP/IP security technology)
  - Open – No vendor lock-in

MQTT's Interoperability Problem

The payload can be anything

The message can be anywhere

Are my devices actually online?



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Sparkplug Overview

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Sparkplug®

Interoperability for MQTT-based Industrial IoT solutions

Standard Payloads

Standard
Topic Structures

Session Management

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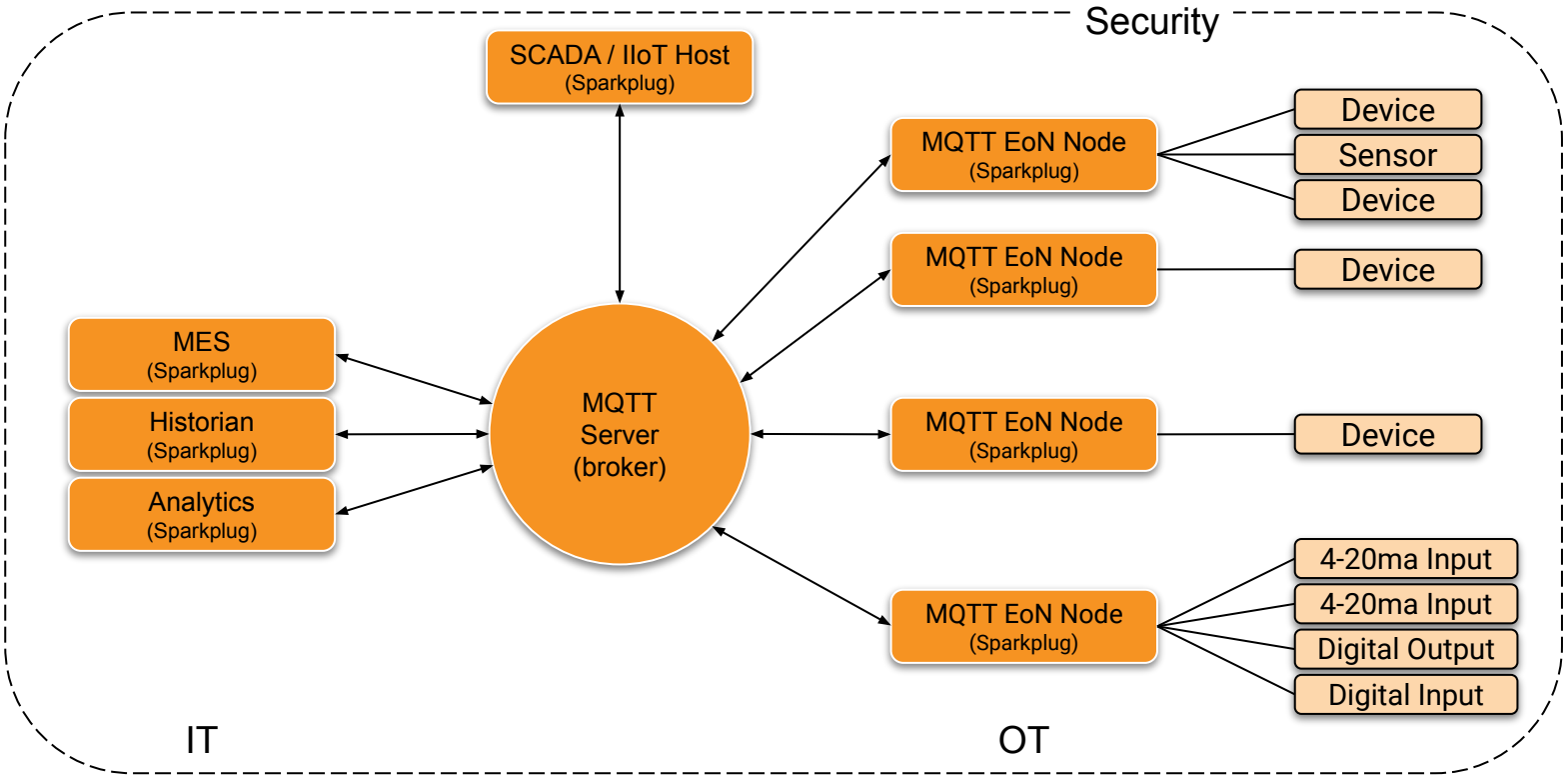
Sparkplug Architecture



The Road to The Industrial Internet of Things

The ”**Internet of People**” exploded due to two simple and open technologies:

Hypertext Transfer Protocol (HTTP)
An open protocol that defines “how” data can be transferred over the Internet.

Hypertext Markup Language (HTML)
An open specification that defines the structure of the data within HTTP messages.

For the “**Industrial Internet of Things**” to scale to its full potential the same type of open and simple technologies are needed:

MQTT
The dominant IoT messaging transport that is open and simple.

Sparkplug
An open specification that defines the structure and state of the data within MQTT messages.

Sparkplug Basic Principles

- **Publish/Subscribe approach**
  - Complete decoupling of devices and applications
- **Report by exception**
  - Reduces power and bandwidth requirements
- **Continuous session awareness**
  - Edge Nodes and Host applications advertise that they are now online or about to go offline
- **Birth and death certificates**
  - Relies on Last-will-and-testament feature of MQTT
- **Support for persistent and non-persistent connections**

Topic Structure

Name to group nodes logically

namespace/group_id/message_type/edge_node_id/[device_id]

spBv1.0

> "sp"

> [Payload encoding]

> [Encoding version]

> NBIRTH / NDEATH – Birth/death certificate for edge node. Birth: metric name, type, value for every metric. Death: all metrics marked as stale

> NDATA – Edge node data message. One or several metrics

> NCMD – Edge node command. Write metric on edge node.

> DBIRTH / DDEATH – Birth/death certificate for device.

> DDATA – Device data message. One or several metrics.

> DCMD – Device command. Write metric on device.

> STATE – Birth/death certificate of Host Application.

Payload Definition

- Payloads are always in binary
- Encoding: Google Protocol Buffers
- Encoding definition in .proto format
- JSON representation (right)
  - Metrics: Array of typed node or device metrics
  - Body: Arbitrary content (images, files)

```
{
  "timestamp": 1641948773752,
  "metrics": [],
  "seq": 1,
  "uuid": "base64png",
  "body": "an array of bytes"
}
```

Do you need

Metrics

- Defined as key/value/datatype
- Can add optional metadata and properties to them
- Sparkplug payloads can also contain DataSets and Templates.
  - DataSets: used to encode data matrices. You need to provide the number of columns, their names, and their types in addition to the data itself.
  - Templates: Allow you to define your custom data types

```
{
  "name": "exterior_temperature",
  "alias": 130870,
  "timestamp": 1641950175801,
  "datatype": "Int8",
  "is_historical": false,
  "is_transient": false,
  "is_null": false,
  "metadata": {},
  "properties": {},
  "value": 23
}
```

DBIRTH and DDATA example

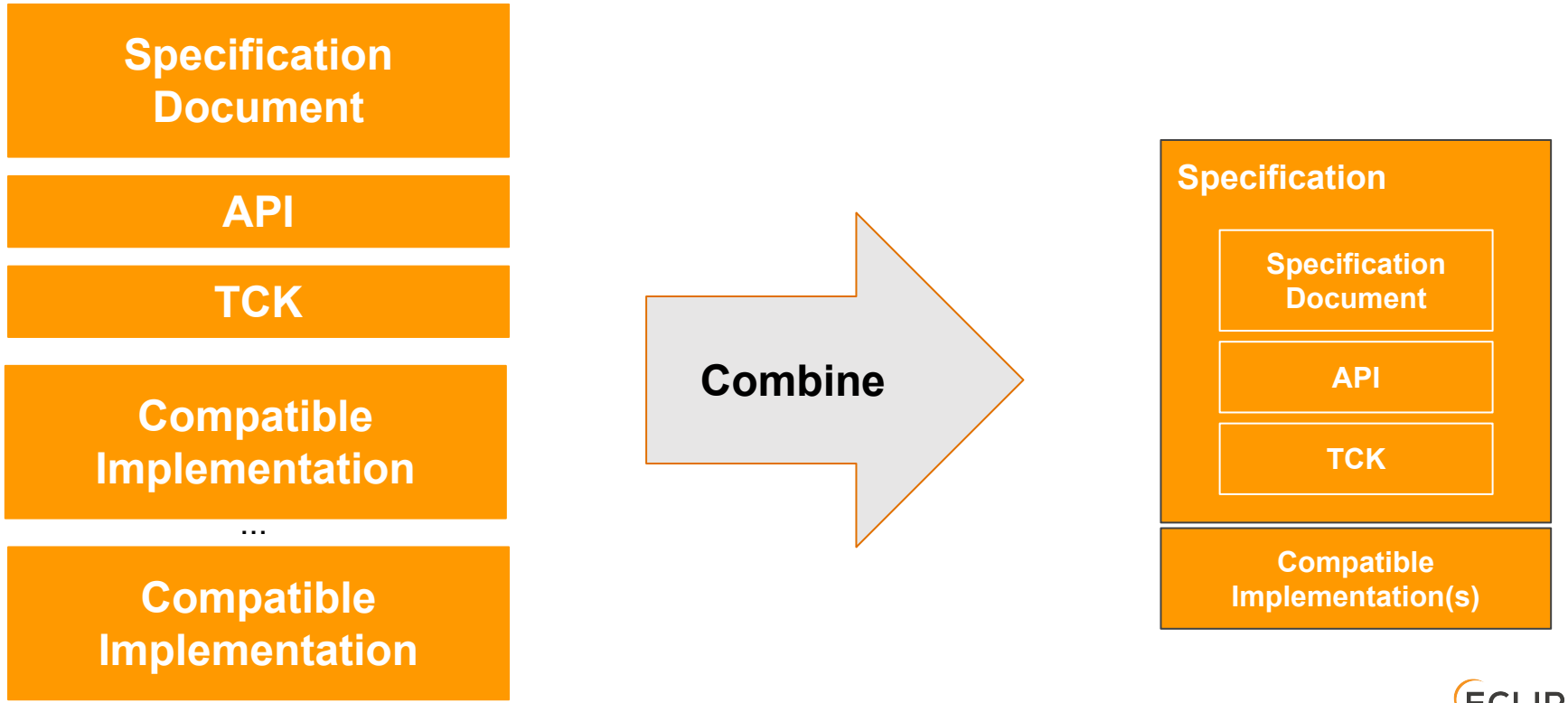

```
{
    "timestamp": 1641940113424,
    "metrics": [ {
        "name": "temp-value",
        "alias": 1,
        "timestamp": 1641940113424,
        "dataType": "Int8",
        "value": -24,
        "transient": false,
        "null": false,
        "historical": false
    }],
    "seq" : 1,
    "metricCount" : 1
}
```


DBIRTH


```
{
    "timestamp": 1641940114576,
    "metrics": [{
    "name": "",
    "alias": 1,
    "timestamp": 1641940024394,
    "dataType": "Int8",
    "value": -25
    }],
    "seq": 1
}
```


DDATA

What Is an Eclipse Specification?



Built in the Open

Specification document
Technology Compatibility Kit (TCK)

https://github.com/eclipse/sparkplug

Open Source
Compatible Implementation

https://github.com/eclipse/tahu

Implement Sparkplug

Anyone can implement Sparkplug free of charge, no membership required

Anyone can use the Sparkplug Technology Compatibility Kit (TCK) to validate conformance

“Sparkplug”, “Sparkplug Compatible” and the logos are trademarks of the Eclipse Foundation

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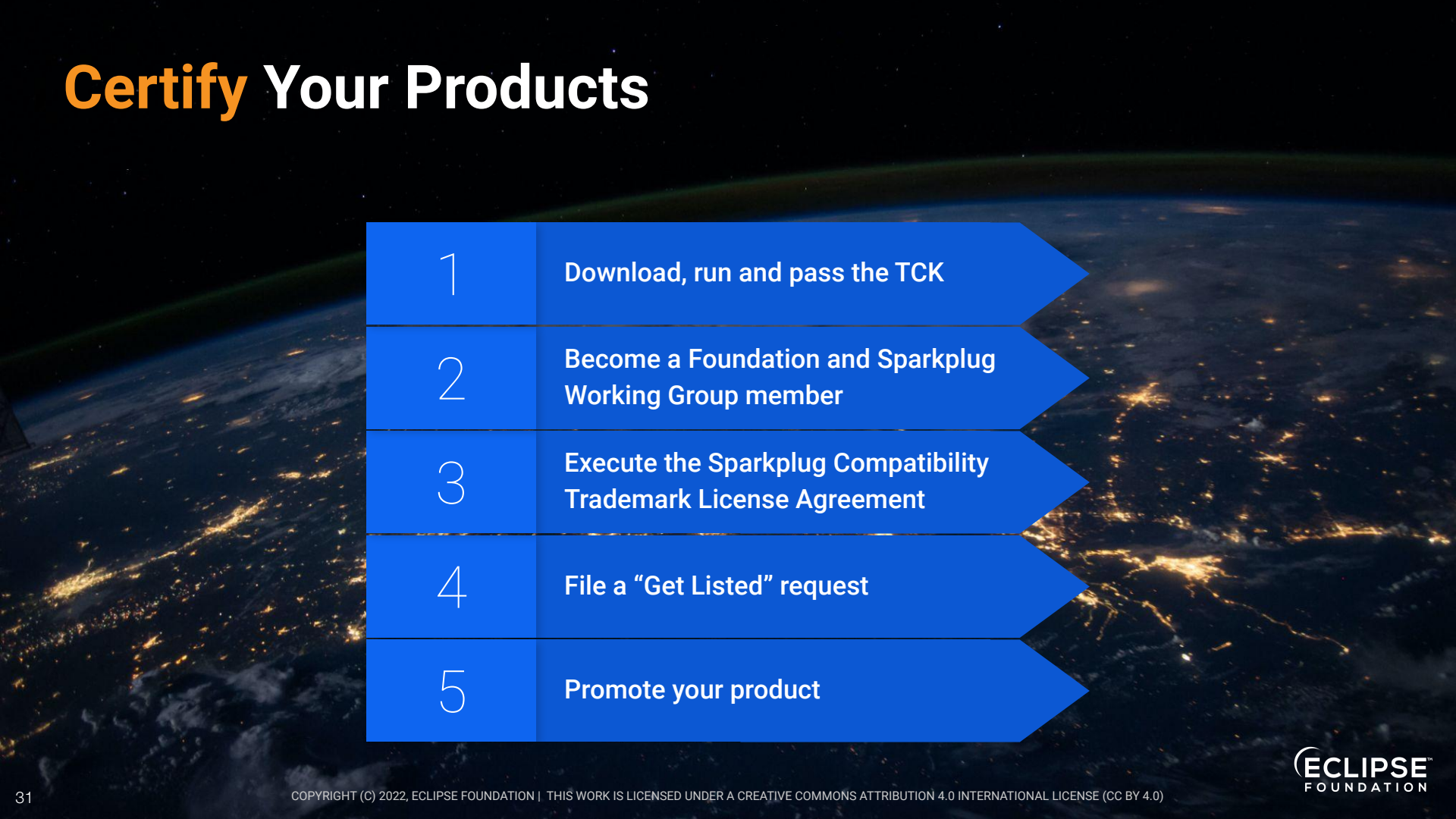
Certify Your Products



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Sparkplug Compatibility Program

Sparkplug® COMPATIBLE

Customer Confidence

Collaboration

Marketing Initiatives

Brand Development

Community Support

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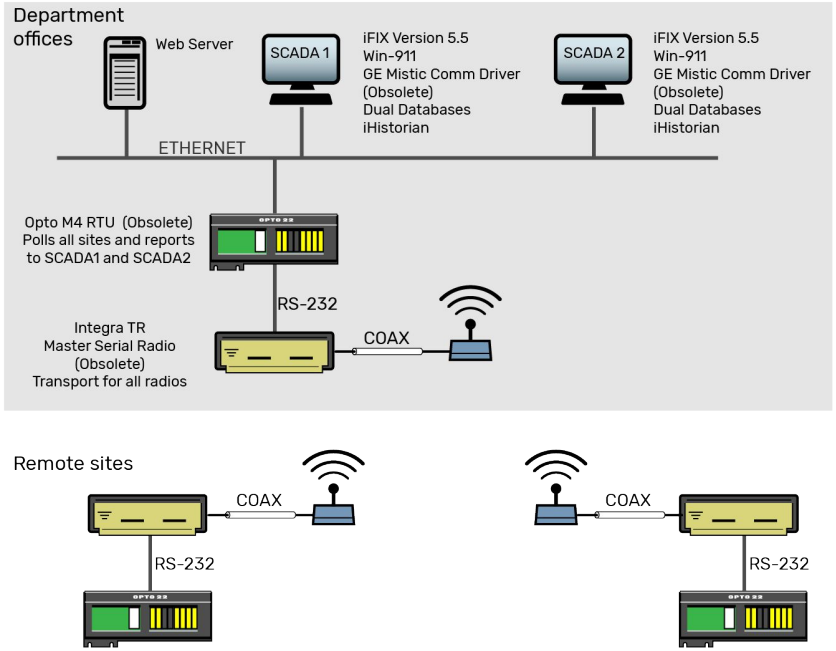
Client: Waterford Township DPW

- **Serves 72,000 residents**
  - 360 miles (579 km) of water main and appurtenances
  - 355 (571 km) miles of sanitary sewer
- **System Consists of:**
  - 63 sewer lift stations
  - 19 production wells
  - 11 iron filtration pants
  - 2 elevated and 1 ground storage tanks
  - 1 high service pumping station

Legacy System

Previous Configuration



> Legacy system issues

- Limited bandwidth
- Serial polling scheme
- Infrequent field activity

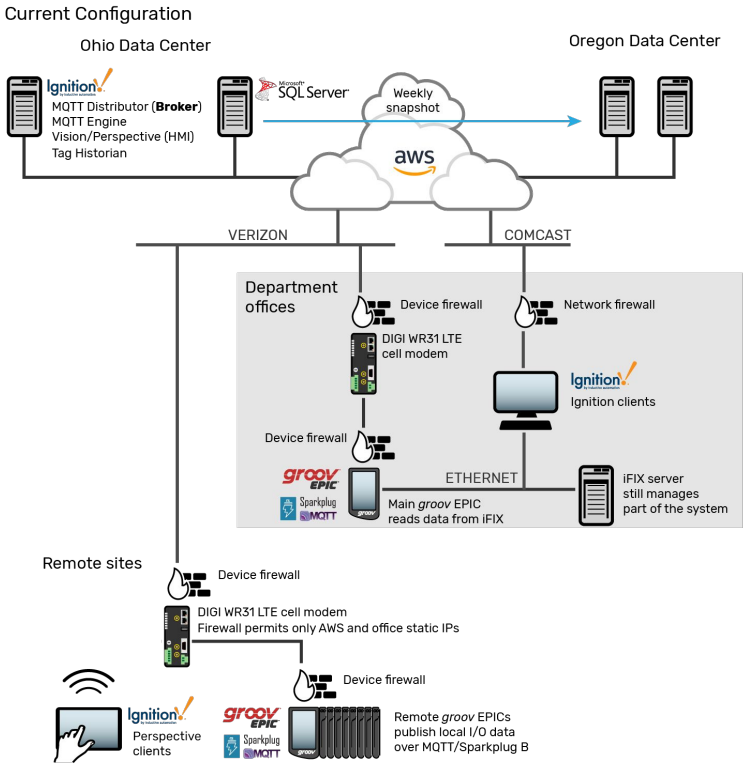
> Problems needing a solution

- Data from each site only updated every 3-4 minutes, resulting in data loss and missed notifications
- Scaling up the system to more sites increased latency

Why Sparkplug?

- **Single source-of-truth**
  - Tags at edge are defined, and available throughout entire system
- **No re-entry of tags in SCADA**
  - All edge tags automatically available to subscribing software applications
- **State management**
  - Status of all edge devices known
- **Device originating**
  - Outbound comms, no device ports opened
- **Bi-directional**
  - Devices able to receive messages from SCADA
- **Store & forward**
  - In event of comms failure, edge storage of process data stored, and forward upon comms restoration
- **Efficient payloads**
  - Binary encapsulated messages save bandwidth

Sparkplug Infrastructure



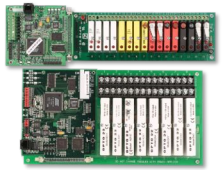
- Replaced old RTU/radio combo with groov EPIC/cellular modem
- Deployed over a private Verizon cellular network
- Hosted an Ignition MQTT broker on AWS cloud instance
- Encrypted all communications for MQTT/SpB messages with TLS
- Closed all incoming ports on EPIC except to trusted IPs

Results of Implementation

- Sub-second latency across entire system
- Decreased bandwidth consumption
- Never miss a system action or an alarm notification
- Timely operations, edge status, and diagnostics data
- More processing power at the edge
- Better fault-tolerance and disaster recovery

Implementation Partner

OPTO 22
Your Edge in Automation.™



PC-based I/O
(1980s)

Co-developer & Founding Member
(1996)

OPC FOUNDATION

Ethernet I/O
(1990s)

M2M
(2000s)

PACs
(2000s)

EPICs & RIOs
(today)

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sparkplug.eclipse.org

Implement Sparkplug

Join the Sparkplug Working Group

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Making IIoT Open and Interoperable, Together

canary
Chevron
Cirrus Link SOLUTIONS
inductive automation.
HIVEMQ
OPTO 22
FLOW SOFTWARE
intel
SIGNALFIRE WIRELESS TELEMETRY
The University Of Sheffield.

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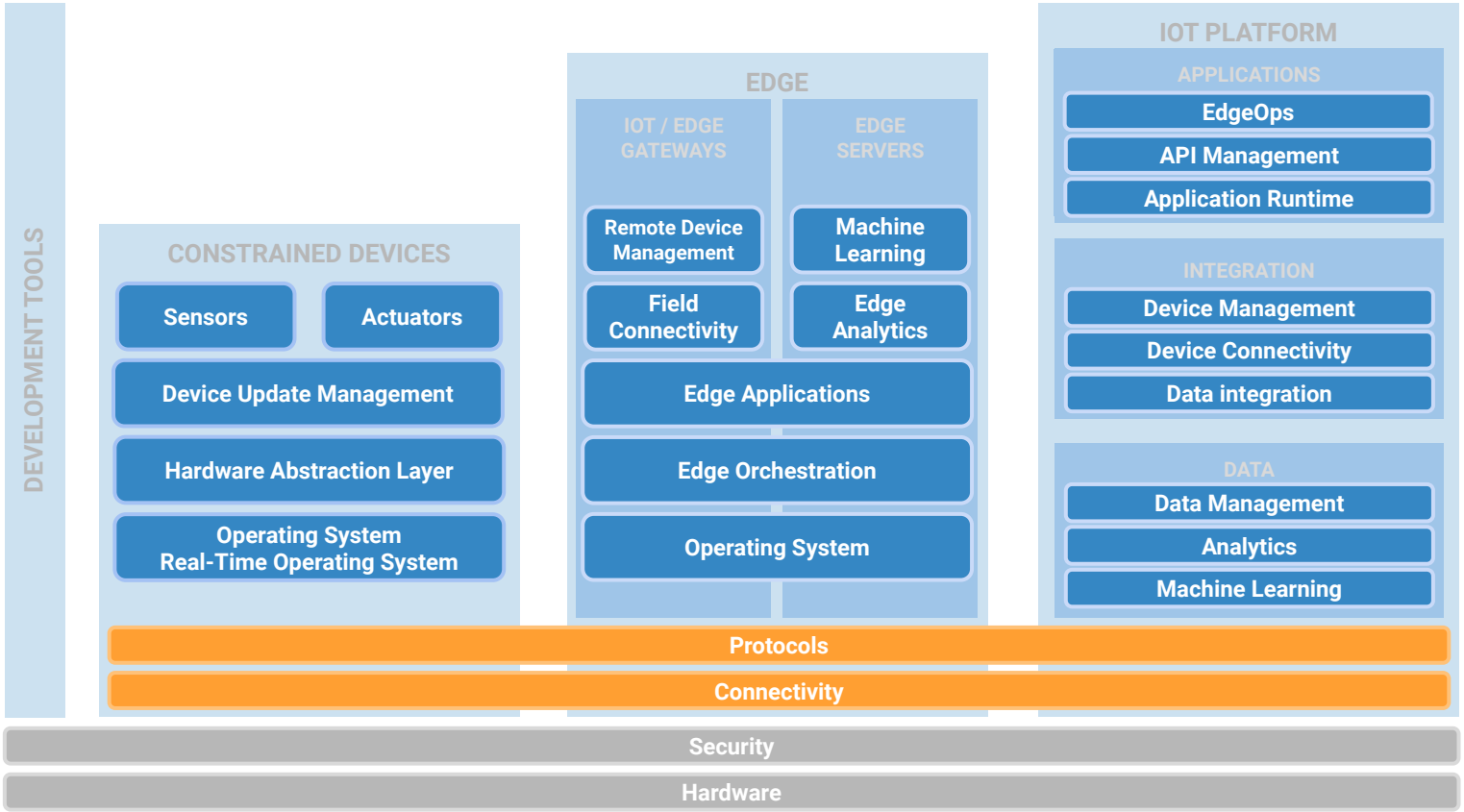
IoT Architecture



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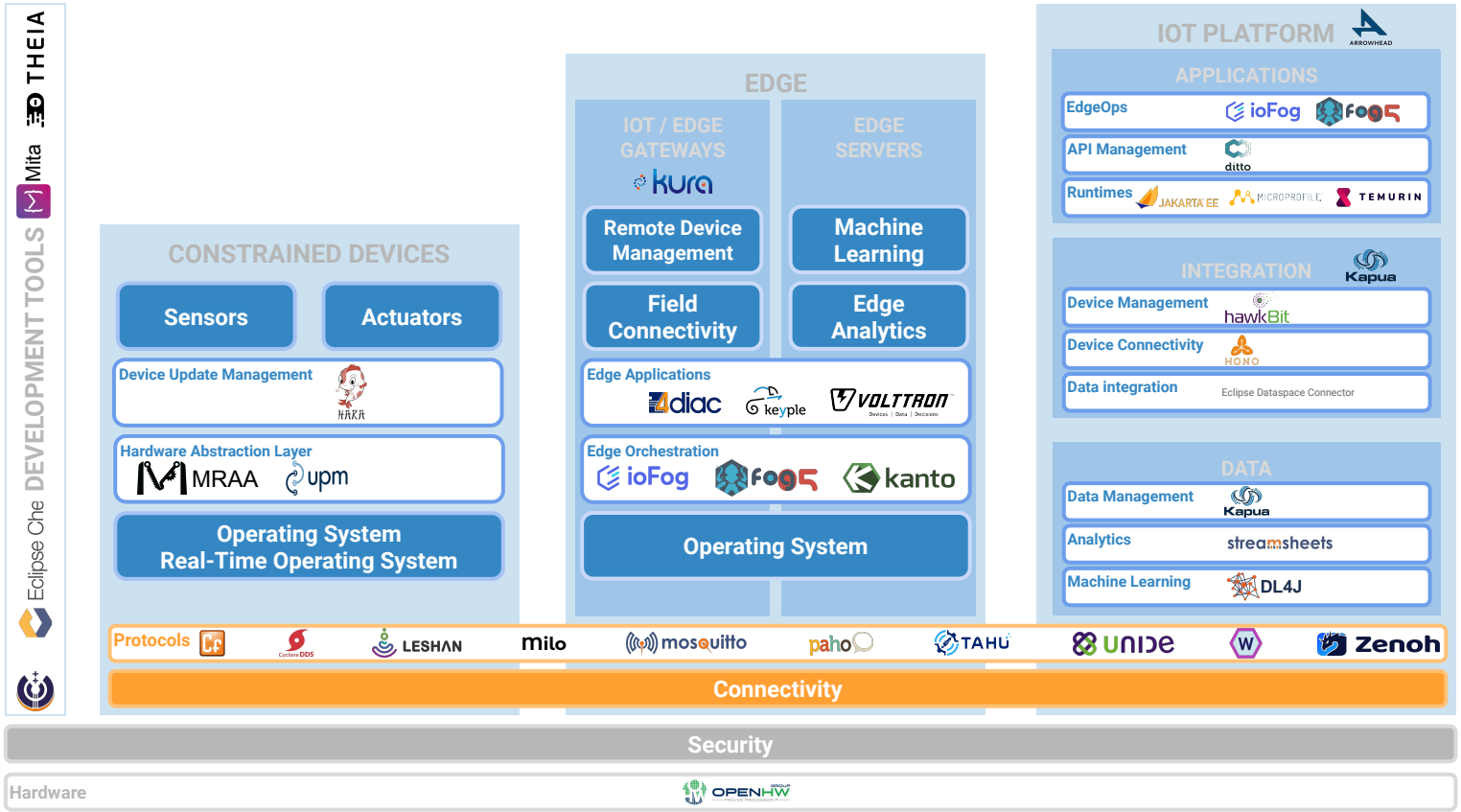
Where Eclipse Projects Fit



Thank You

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Email: iot@eclipse.org

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