Introduction to IoT solutions

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Agenda

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Introduction

What is IoT?

*Internet of Things (IoT) is the **combination of hardware and software** technologies that allows us to bridge the gap between the **physical** and the **digital** world.*

Nowadays everything can be connected to the internet, from a light bulb to an entire car, producing lots of data that can be analyzed and used to build meaningful software solutions.

When IoT technologies, techniques and principles are used within the industrial field it is usually called IIoT (Industrial Internet of Things).

Why there is so much hype around IoT?

Ideas behind IoT are not new. **Now we have the connectivity** (i.e. 4G/5G) **and the technology** to implement these ideas at scale with an affordable cost.

Currently, there is a **huge market** of $4.8 billion behind it and forecasts are anticipating a market size of $1,854.76 billion by 2028(1).

Forecasts on IoT **enterprise spending** shows a steady yearly growth of 26.7%(2) starting in 2022.

1) https://connect.comptia.org/blog/internet-of-things-stats-facts

2) https://iot-analytics.com/2021-global-iot-spending-grow-24-percent

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IoT project parts

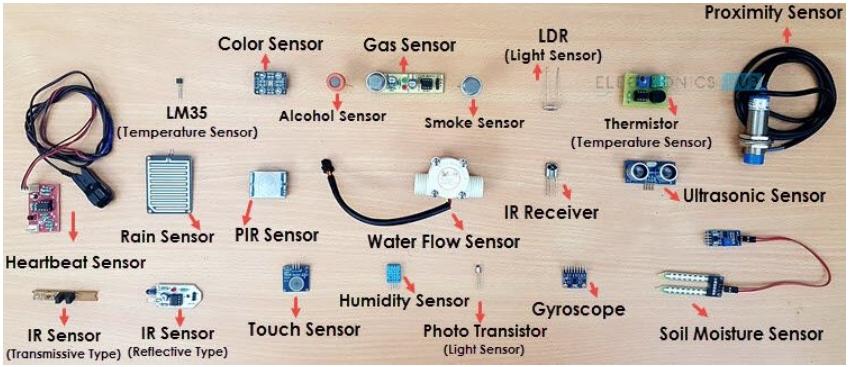
Hardware

Sensors

A sensor is a device that **produces an output signal** for the purpose of **sensing of a physical phenomenon**. It detects events or changes in its environment and **sends the information to other electronics**, frequently a computer processor.

Sensors can be used to measure temperature, gauge distance, detect smoke and a myriad of other uses.

Examples of sensors: humidity and temperature sensors, movement sensors, accelerometer sensors, water sensors...



Hardware

Actuators

An actuator is a device that, by **converting energy and signals, produces motion**.

When it receives a control signal, an actuator responds by converting the source's energy into mechanical motion.

Types of actuators:

- By motion: linear, rotary…
- By source of energy: electric, pneumatic, hydraulic…

Examples of actuators: solenoid valves to allow water or air flows (rotary&electric), door closers (linear&electric)…

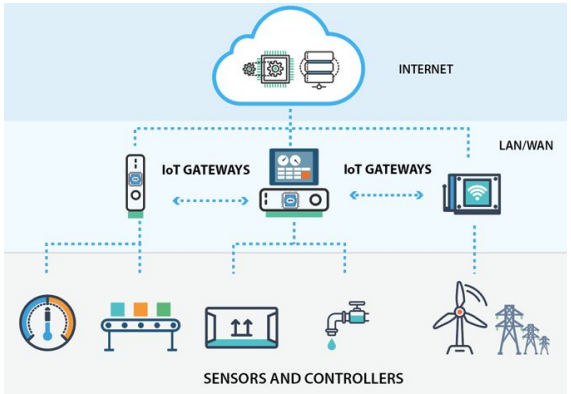
Hardware

IoT Gateways

An IoT gateway is a physical device or software program that serves as the **connection point** between the cloud and sensors, actuators and other intelligent devices, providing **bi-directional communication**.

Some sensors and actuators can directly communicate with the cloud/backend. Unfortunately, these are expensive compared with their not-so-smart counterparts.

IoT Gateways can provide **edge computing capabilities**.



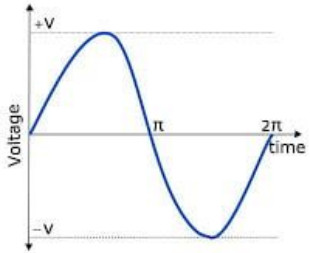
IoT Gateway examples: Siemens Simatic IoT Gateway product line, Raspberry Pi, Arduino...

Hardware

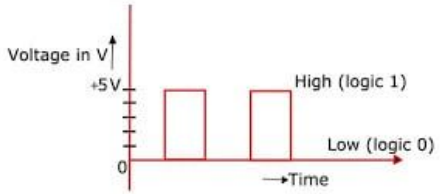
Electronics

Some knowledge on electronics will be mandatory for a full solutions design and **really helpful for developers**, even if they are just focused on the software side of things.

For instance, something basic like the difference between an **analog and digital signals** would affect the hardware being chosen for the data harvesting. As an example, Raspberry pi doesn't have analog input and that would affect the data harvesting setup.



Example of Analog Signal



Example of Digital Signal

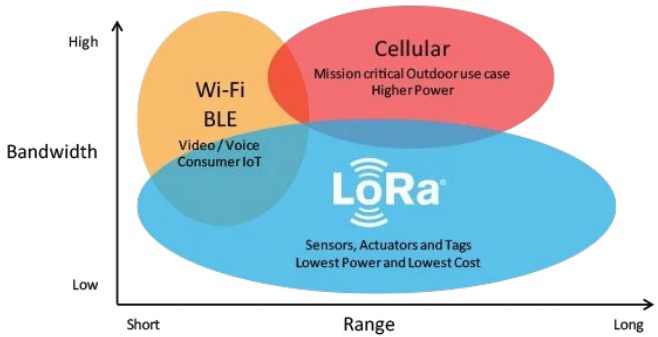
If you are planning on assembling your own components you may even deal with welding. Fun, fun!

Hardware

Besides WiFi, Bluetooth, and other wireless communication protocols, there is a really interesting alternative getting more and more traction within the IoT field: **LoRa**.

LoRa is **ideal for** applications that transmit **small chunks of data with low bit rates**.

Data can be **transmitted at a longer range compared to technologies like WiFi or Bluetooth**. These features make LoRa **well suited for sensors and actuators** that operate in low power mode.



LoRaWAN is a Media Access Control (MAC) layer **protocol built on top of LoRa modulation**. It is a software layer which **defines how devices use the LoRa hardware**, for example when they transmit, and the format of messages.

Software

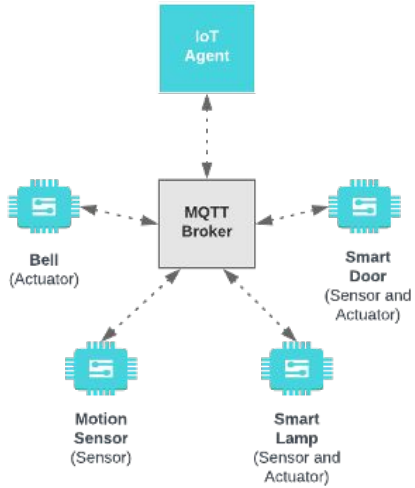
IoT Brokers

An IoT broker is a **processing engine** that acts as a **central hub** for the events/measurements sent as the data harvesting result. Many IoT brokers leverage mechanisms to provide **bi-directional communication** allowing interaction with field devices (i.e. actuators).

Communication between field devices and IoT Broker are usually based on standard communication protocols, being **MQTT the usual choice**.

IoT Brokers are offered by main **cloud providers**: Azure IoT Hub, AWS IoT Core or Google IoT Core.

There are **alternatives**, in both cloud and on-premise flavours: HiveMQ, Mosquitto, RabbitMQ (AMQP default, MQTT and others via plugin).



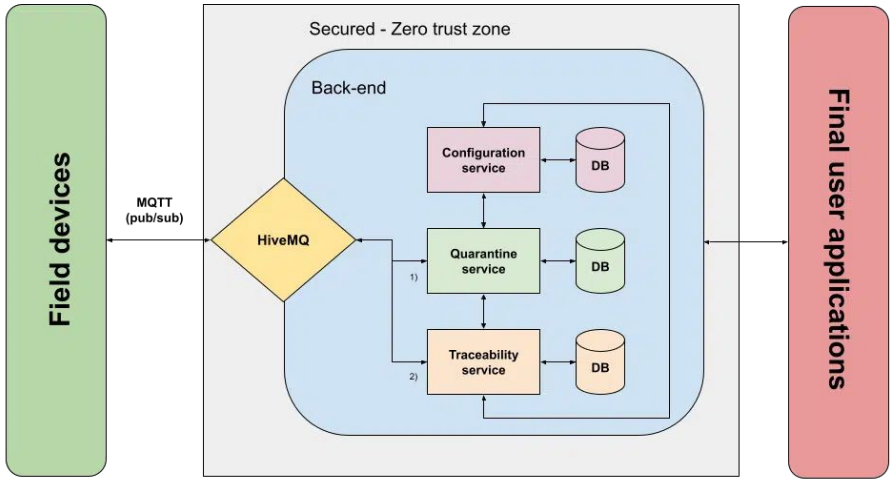
Software

Back end - Simple

Solutions where we don't want to differentiate between types of IoT events when processing them. Essentially, solutions where there is a **homogeneous IoT message processing without priorities.**

IoT Broker ingest the information generated by the field devices and redirects the information to the back end component interested on the message.

Back end architecture can be microservices, serverless, monolithic...

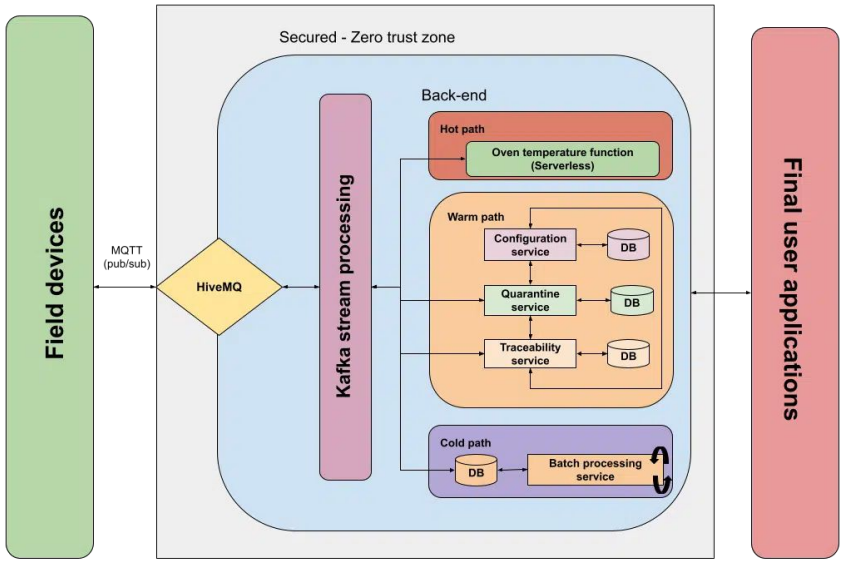


1) Subscribed to quarantine MQTT events that happen within the line.
2) Subscribed to manufacturing MQTT events that happens within the line.

Software

Back end - Advanced

Solutions handling **more complexity** in terms of the **variety** of events and the **priority** of these events.



We can follow an approach where we categorize the events in different **data paths**.

Hot data path is intended to represent the part of the system that should take care of the event data that is processed in near-real-time.

Warm data path is in charge of dealing with the events that should be processed as soon as possible but can accommodate longer delays.

Cold data path represents the lowest priority in terms of message processing.

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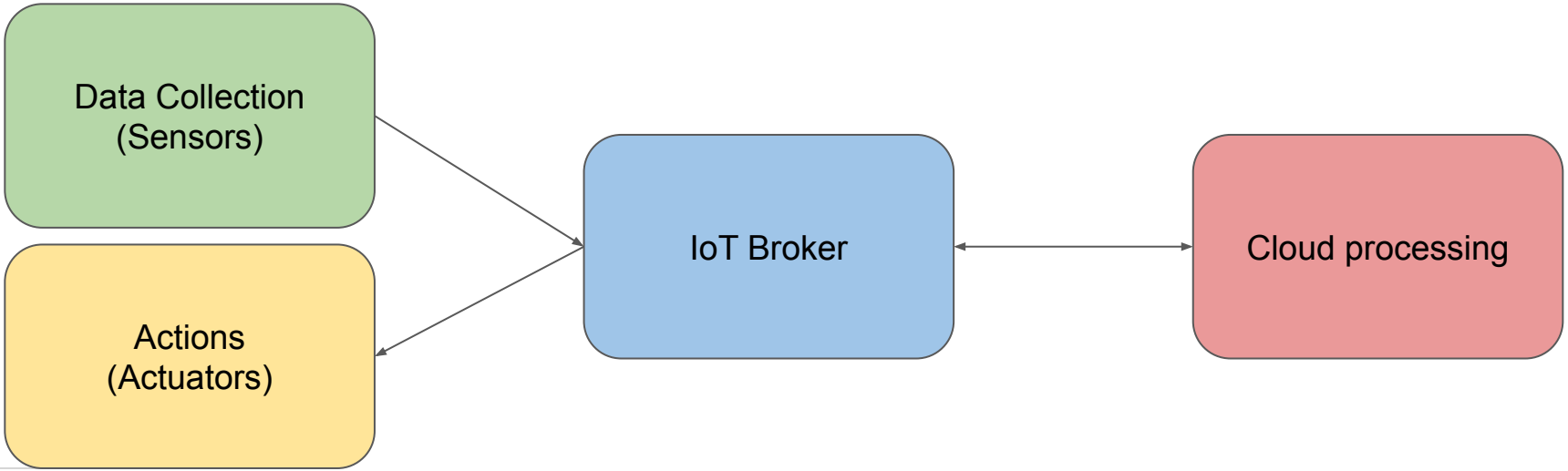
IoT project types

IoT project types

Pure cloud computing

Pure cloud computing solutions are those where the all **data computation**, business rules processing and data storage **only occurs on the cloud's back-end, after IoT Broker ingest** the data collected by the field devices.



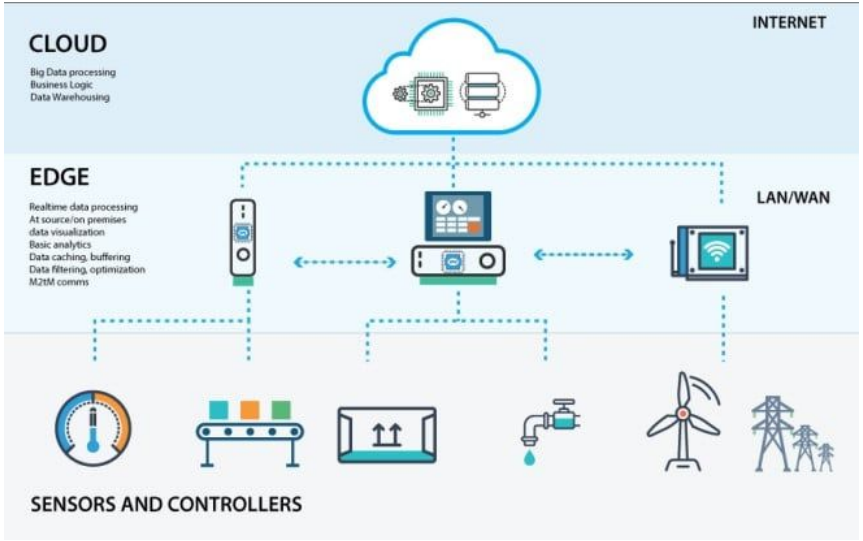
IoT project types

Edge + cloud computing

Edge computing, in the context of IoT solutions, is the **data processing and other computing actions close to where the data is generated** (i.e. sensors) and where the actions happens (i.e. actuators), which reduces latency, response time among other potential benefits.

Sometimes, the system being implemented **cannot afford even low latencies** for certain operations.

In other scenarios, there is some **data aggregation** that needs to be done before report some metrics (i.e. average measurement within an hour).



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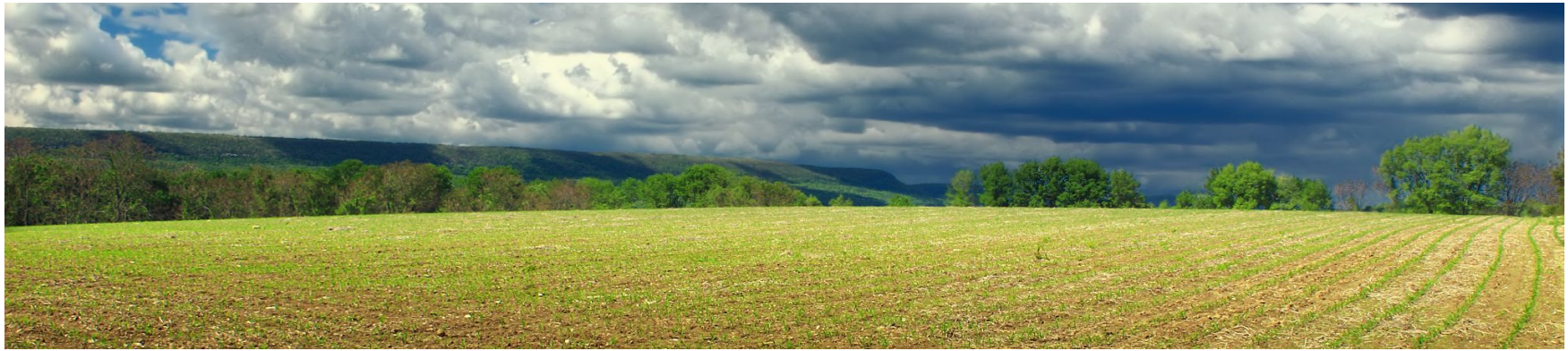
Sample project

Problem description

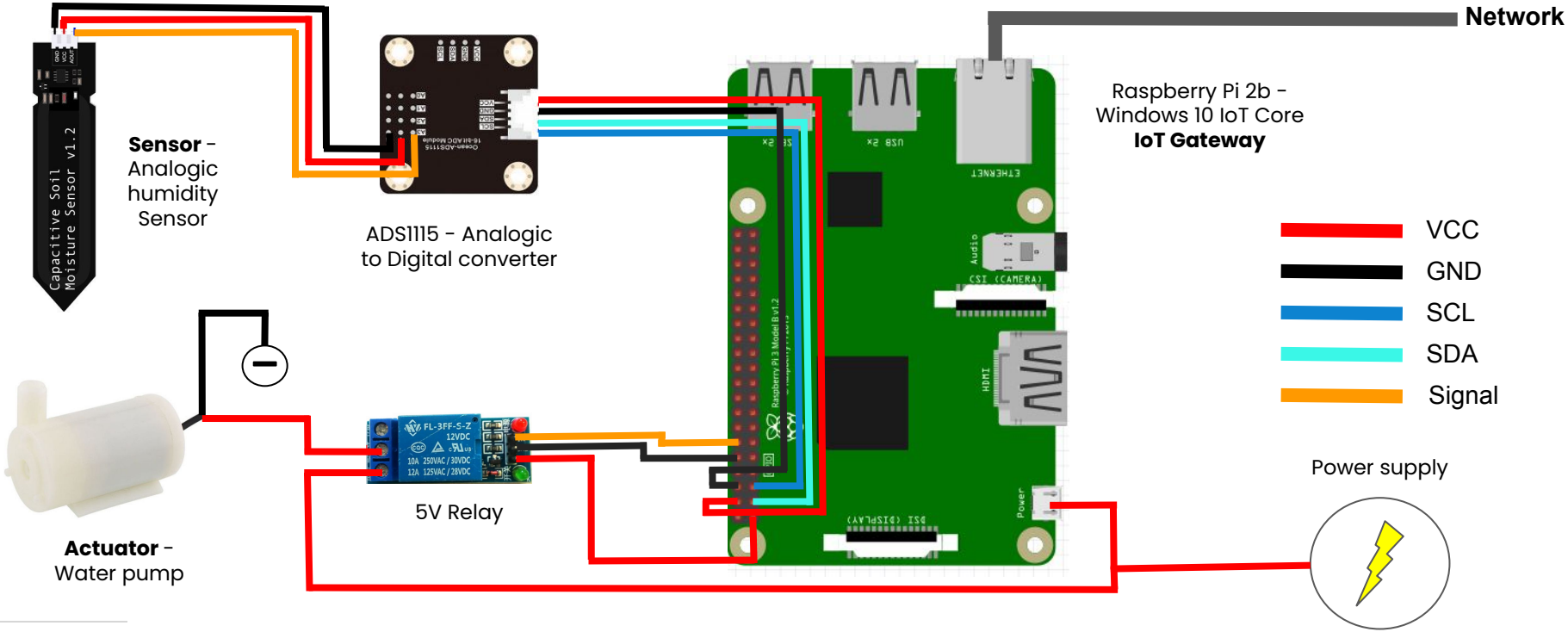
Cloudy Farm is a small farm focused on growing ecologic products that wants to use technology to **reduce the amount of water it uses for its farming operations.**

Doing so, they will not only reducing the cost of growing their vegetables but also being even more eco-friendly in a context of water shortage in many parts of the world.

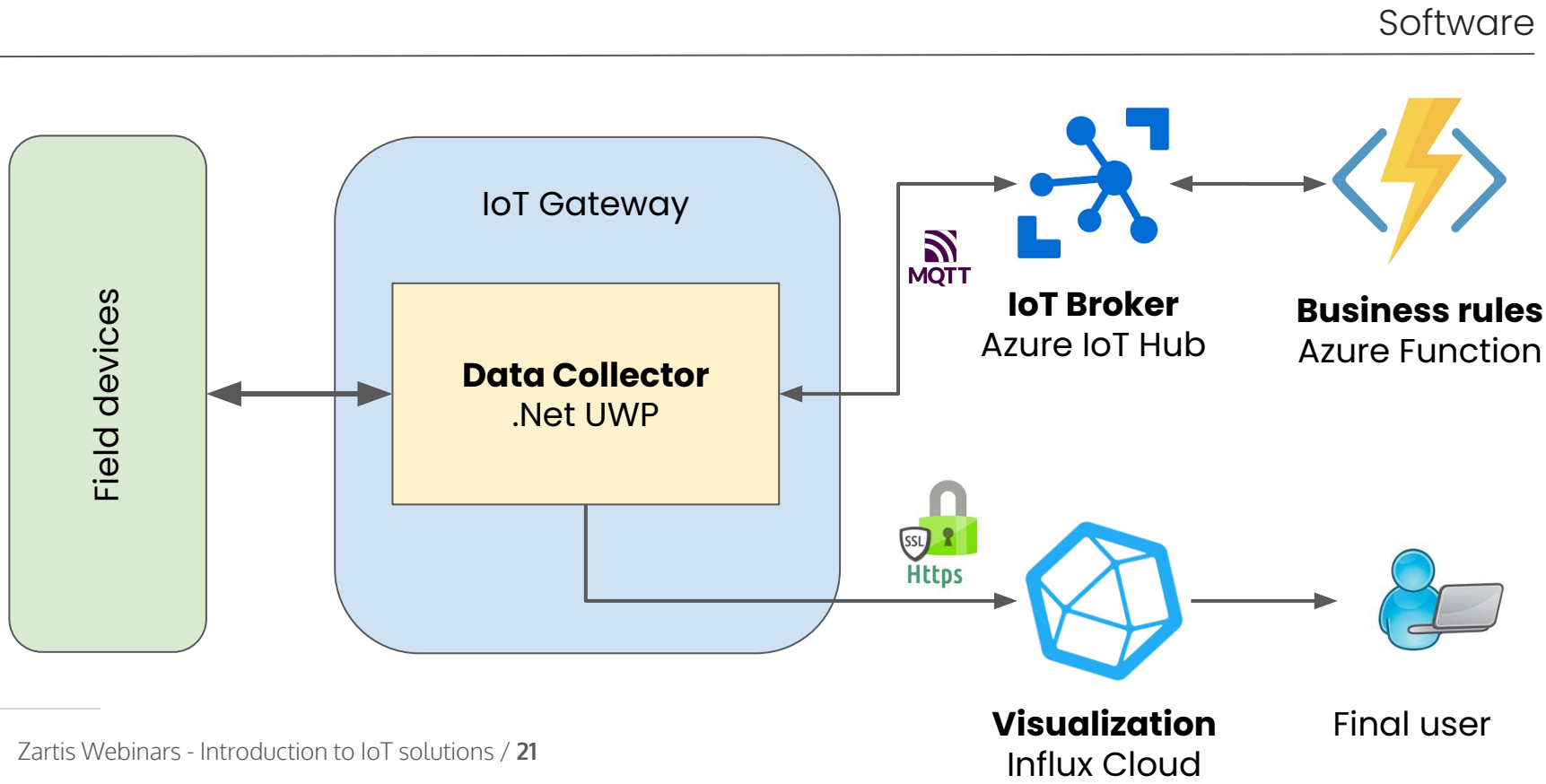


SetUp

Hardware



SetUp


Software
Field devices
IoT Gateway
Data Collector
.Net UWP
MQTT
IoT Broker
Azure IoT Hub
Business rules
Azure Function
SSL
Https
Visualization
Influx Cloud
Final user

Code can be found here: https://github.com/zartis-digital/iot-introduction

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Q&A

Q&A