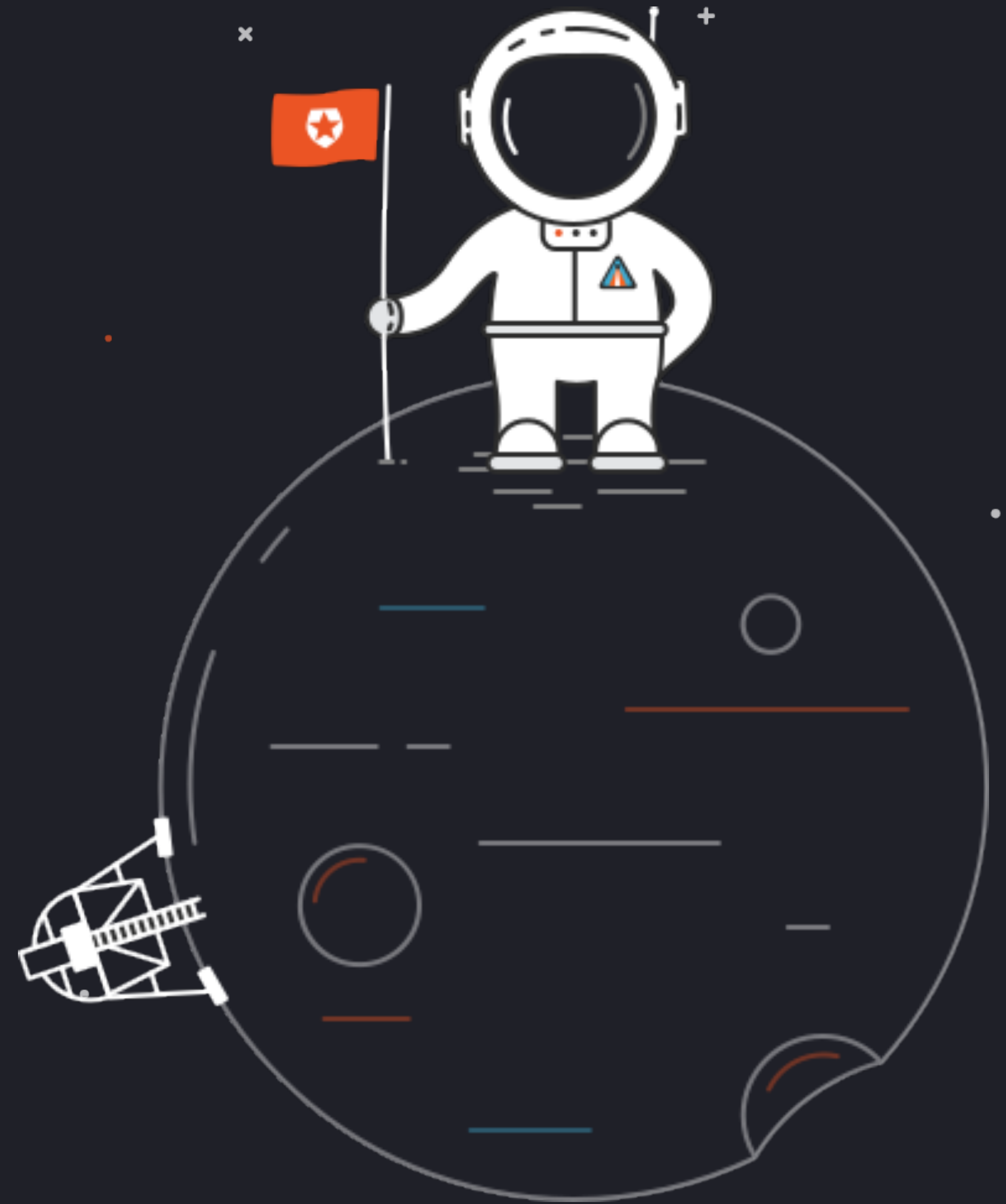# Beyond the Things

Implications in an IoT Project

THE DEVELOPER'S CONFERENCE

"The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction"
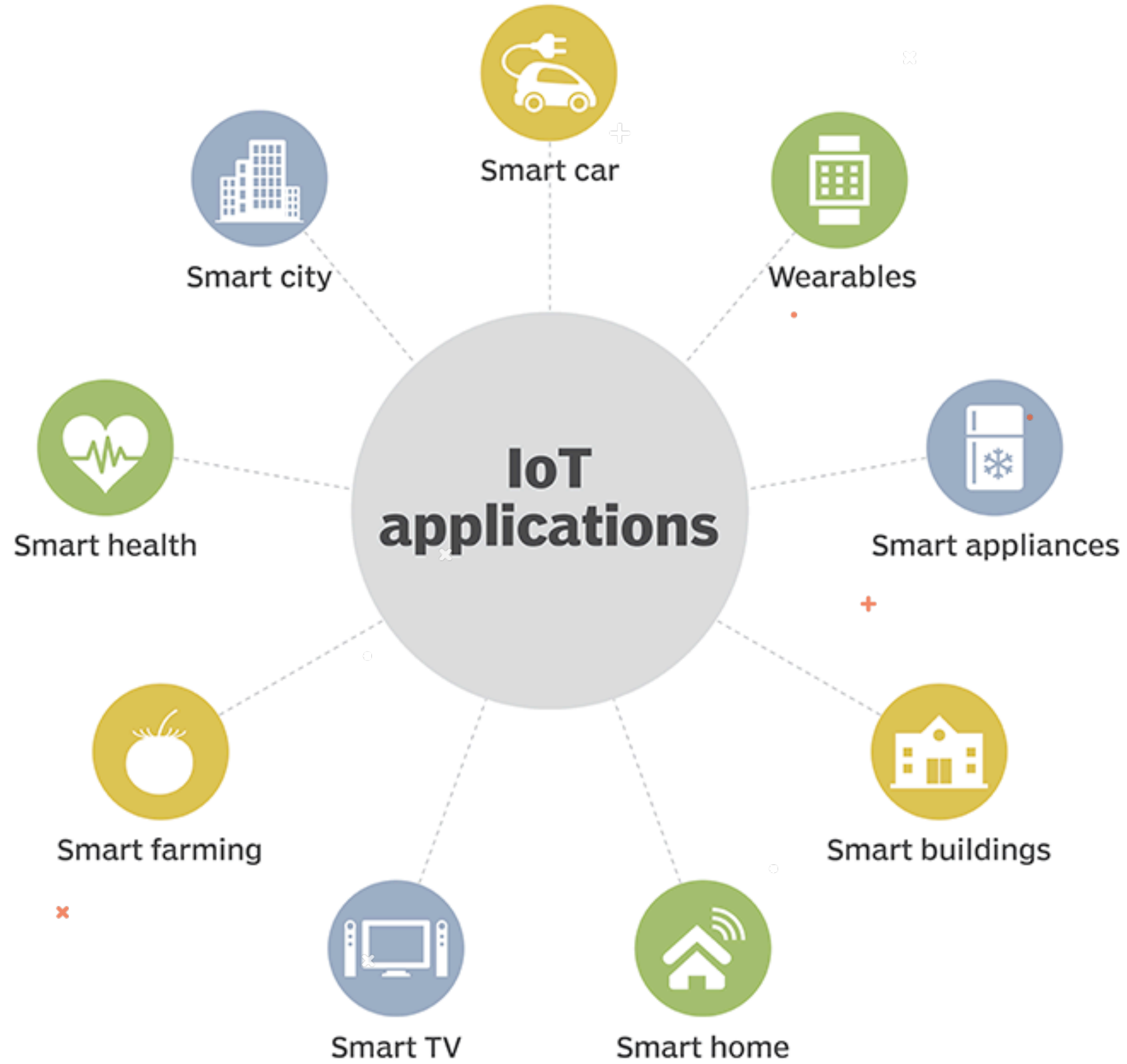
– formal definition

@itrjwyss

AMBASSADOR

Coke Machine
Carnegie Mellon University

@itrjwyss

Oracle
Groundbreaker
Ambassador

Smart car

Wearables

Smart city

IoT applications

Smart appliances

Smart health

Smart buildings

Smart farming

Smart TV

Smart home

@itrjwyss

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WASSER °C
40 60 80 100

0 1 2 3 4 5   0 ¼ ½ ¾ 4/4
OEL DRUCK   KRAFTSTOFF
FERN LICHT
OEL °CELS.
120 100 60 40

150 140 130 120 110 100 90 80 70

0.8
U9588

50 45 40 35 30 25 20

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Example of an IoT system

Collect data → **Collate and transfer data** → **Analyze data, take action**

Collect data	Collate and transfer data	Analyze data, take action
IoT device (e.g., sensor)	IoT hub or IoT gateway	User interface (e.g., smartphone, human-machine)
IoT device (e.g., antenna)		Analytics of business application (e.g., customer relationship management, ERP)
IoT device (e.g., microcontroller)		Back-end systems

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@itrjwyss

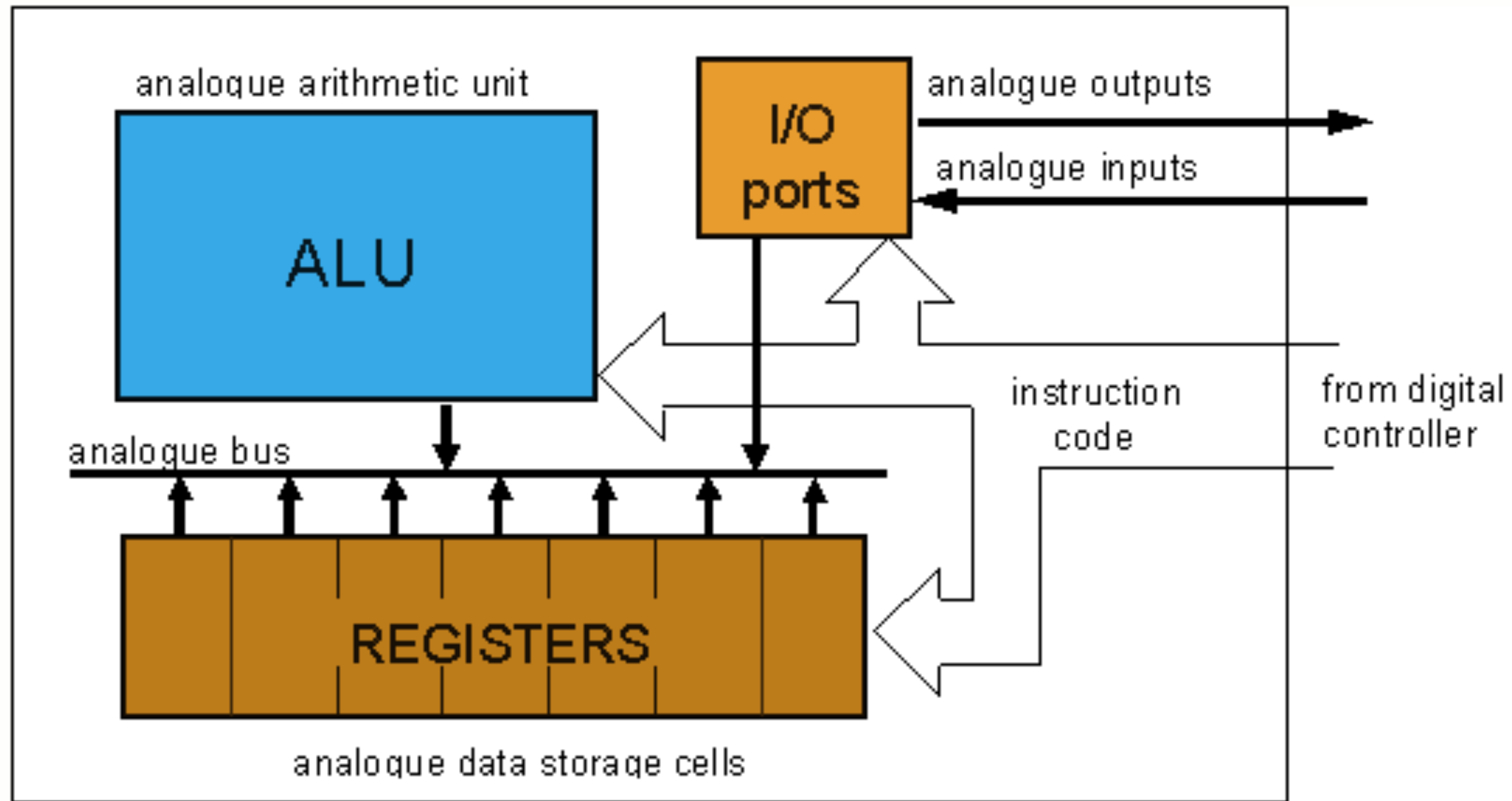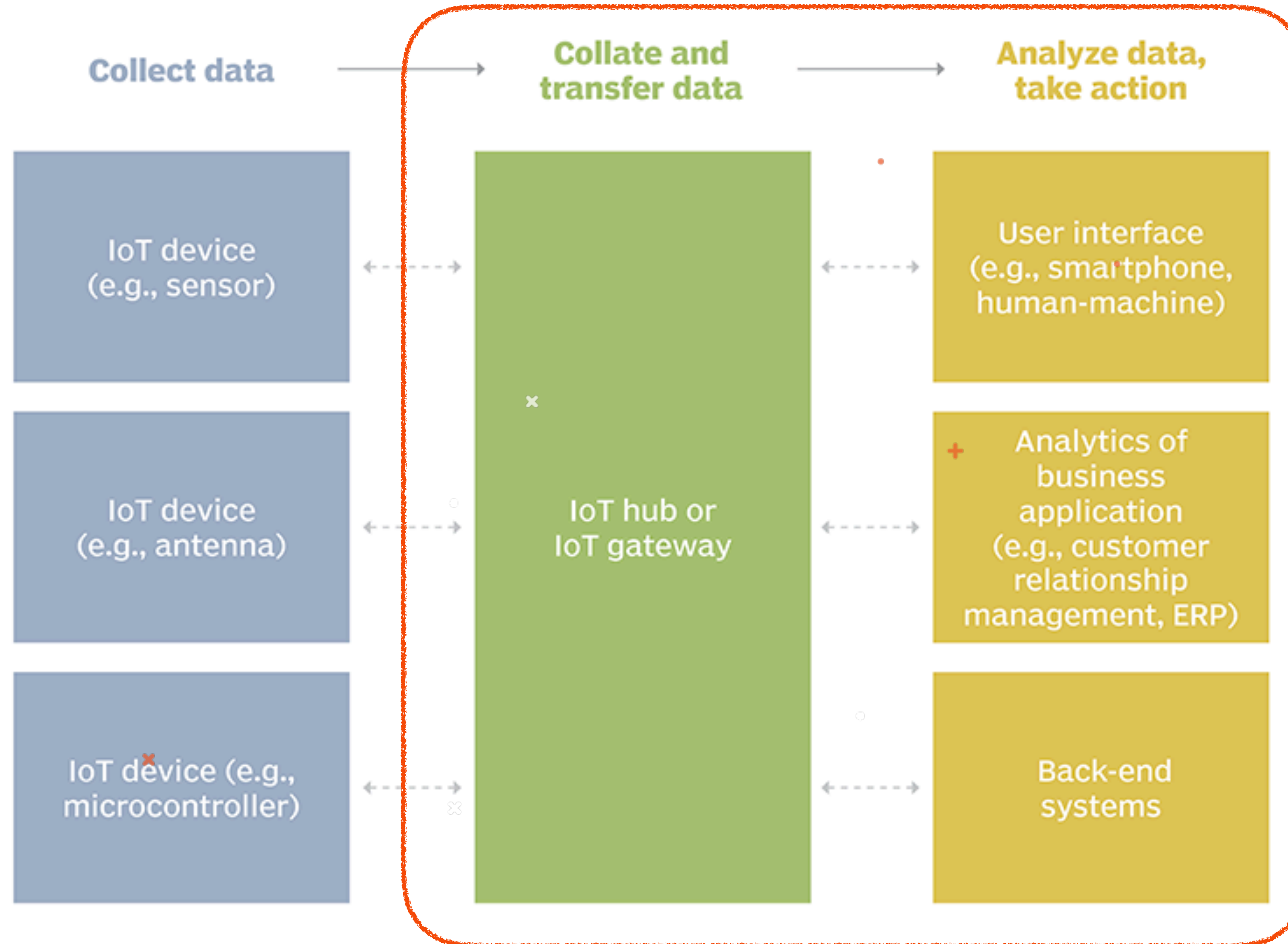Oracle Groundbreaker Ambassador

VS.

@itrjwyss
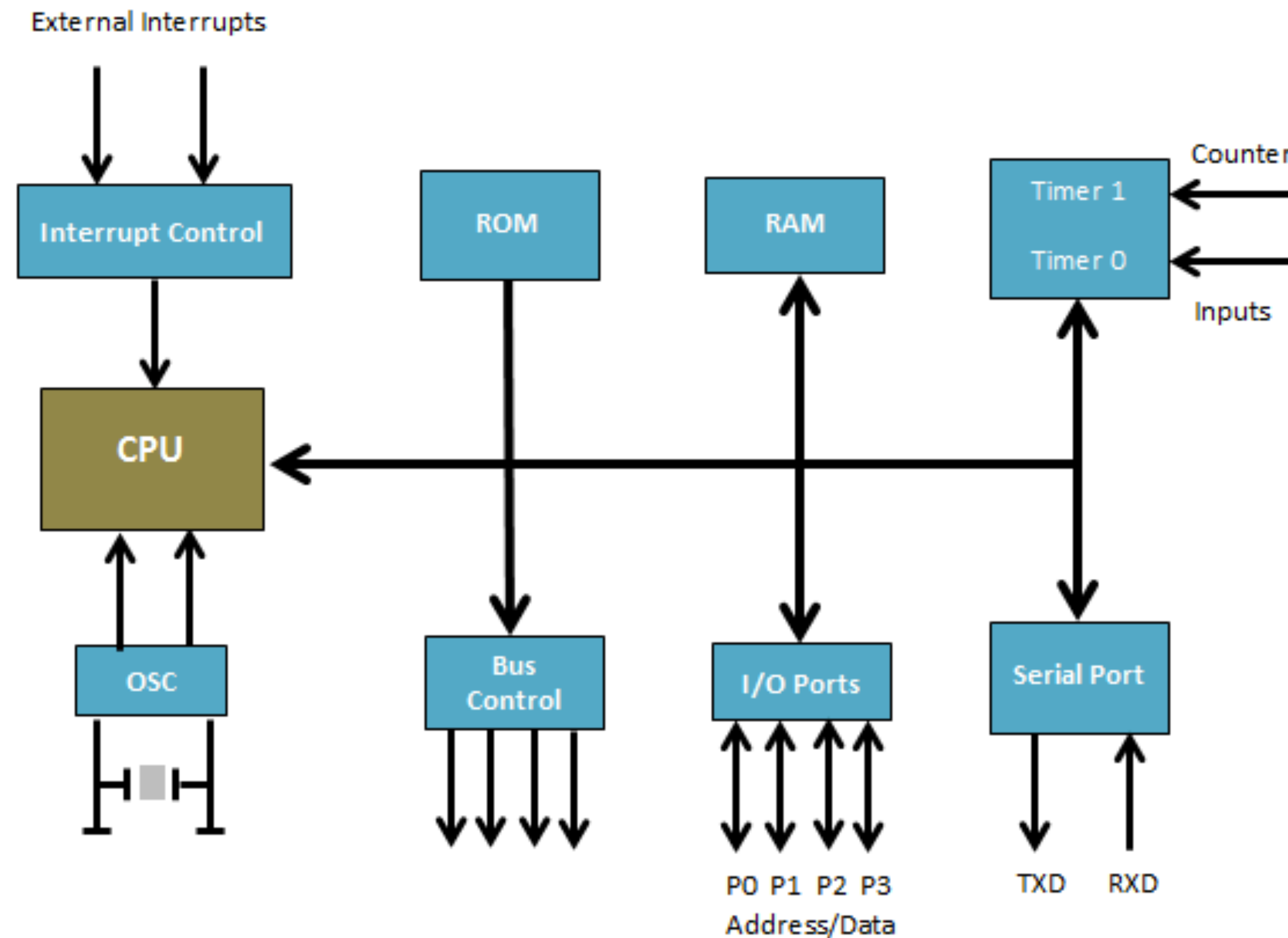
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Microcontroller
Small computer on a single IC

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Microprocessor

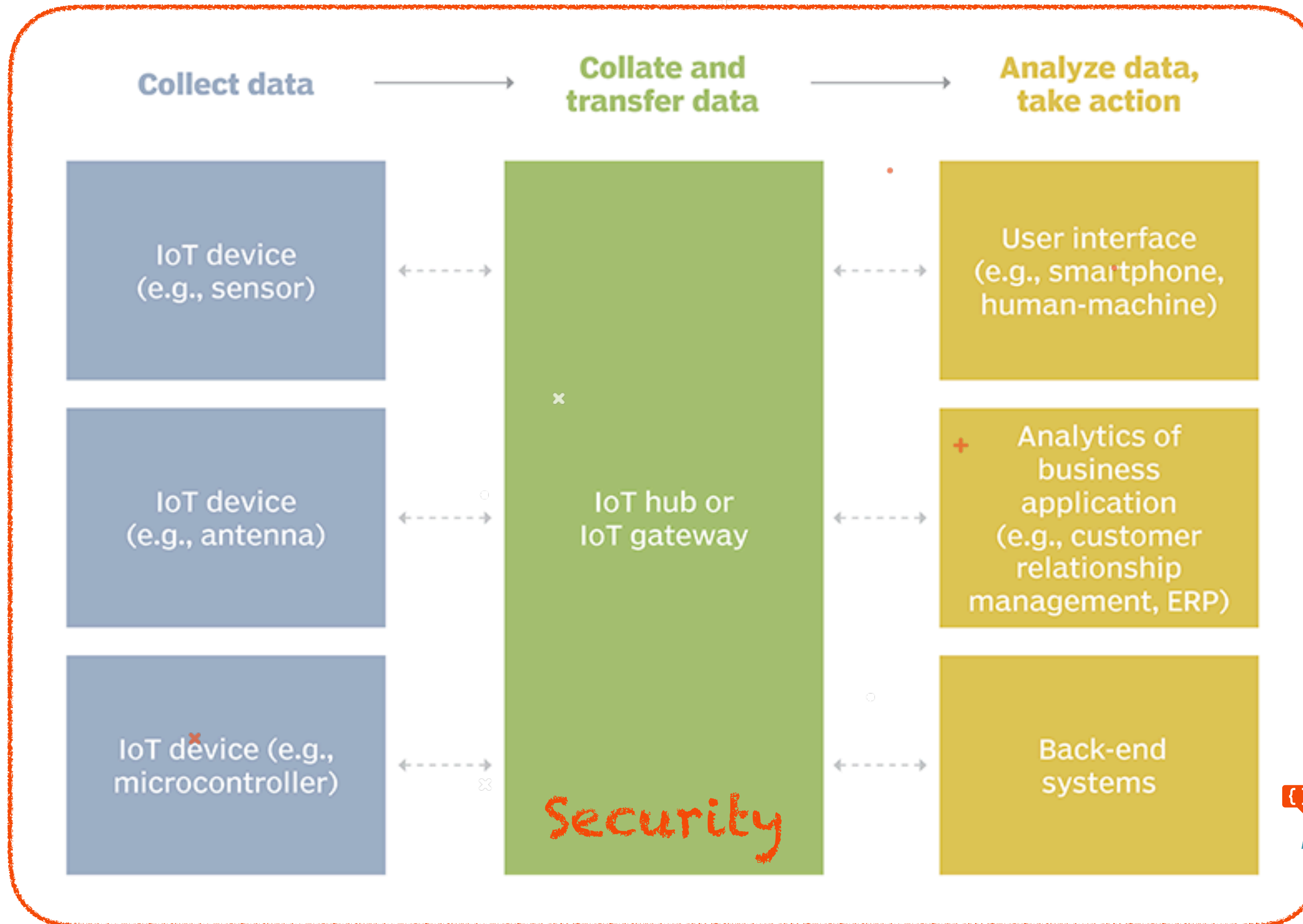Has only a CPU inside one or few IC.

Example of an IoT system

Collect data → Collate and transfer data → Analyze data, take action

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IoT device (e.g., microcontroller)	Security	Back-end systems

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Beyond the Things

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Community Leader
Devs+502 & JDuchess Chapter Guatemala

Ex-JUG Member
Guatemala Java Users Group (GuateJUG)

Chief Technology Officer (CTO) at Produactivity
Full Stack Developer

Auth0 Ambassador &
Oracle Groundbreaker Ambassador

Mercedes Wyss
@itrjwyss

The cost of connectivity
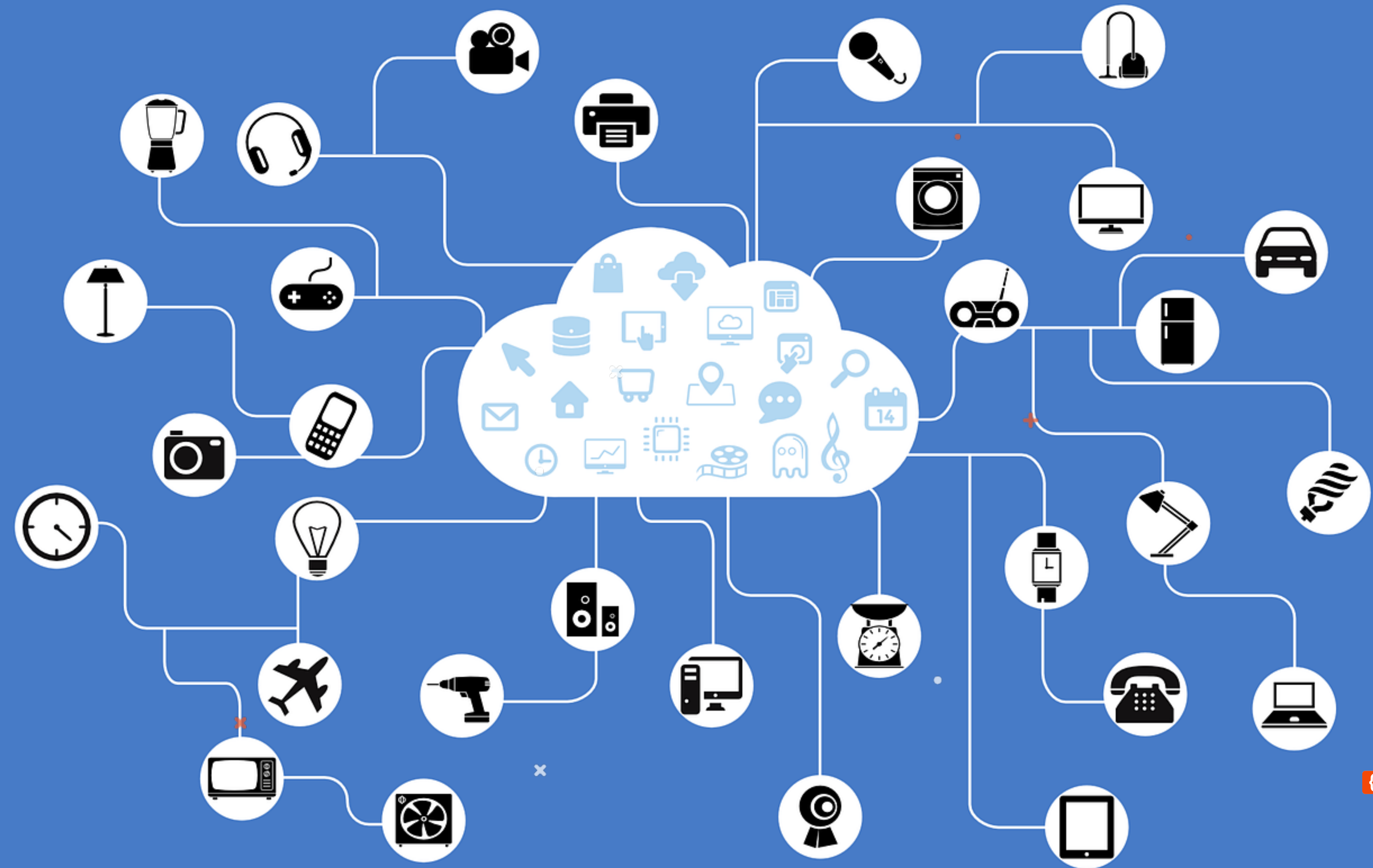
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WiFi

- Fast data transfer

- Handle high quantities of data

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Bluetooth

- short-range communication technology

- Reduced power consumption

- Transfer small chunks of data

- Is not really designed for file transfer

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6LoWPAN

- Network protocol that defines encapsulation and header compression mechanisms

- For home or building automation

- Can be used across multiple communications platforms, including Ethernet, Wi-Fi, 802.15.4 and sub-1 GHz ISM.

Z-Wave

- low-power Radio Frequency

- Designed for home automation

- Data rates up to 100kbits/s

- Operates in the sub-1GGz band

- Is impervious to interference from Wi-Fi, Bluetooth or ZigBee.

- enabling control of up to 232 devices.

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Thread

- Home automation environment

- Based on 6LoWPAN

- Designed as a complement to WiFi

Zigbee

- Based on the IEEE802.15.4 protocol.

- Requires relatively infrequent data exchanges at low data-rates.

- Restricted area and within a 100m range.

- Significant advantages (low-power operation, high security, robustness, high scalability)

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Cellular

- Operation over longer distances.

- High quantities of data.

- High expense and power consumption.

- Consumes around 5,000 microwats.

Near Field Communication

- Enables simple and safe two-way interactions.

- Perform contactless payment transactions, access digital content and connect electronic devices.

- Distances less than 4cm.

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Sigfox

- Wide-range technology, uses ISM bands.

- Uses Ultra Narrow Band (UNB)

- low data-transfer speeds (10-1,000 bits/s)

- Consumes only 50 microwatts

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Neul

- Operates in the sub-1GHz band.

- Leverages TV White Space specturm for access the UHF spectrum.

- Is called **Weightless**

- Data rates (few bits/s up to 100 kbps)

- low consumption (2xAA batteries for 10 to 15 years)

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LoRaWAN

- Designed to provide low-power WANs

- Support low-cost mobile

- Secure bi-directional communications

- Support large networks with millions of devices

- Data rates from 0.3 kbps to 50 kbps

LoRa™

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Example of an IoT system

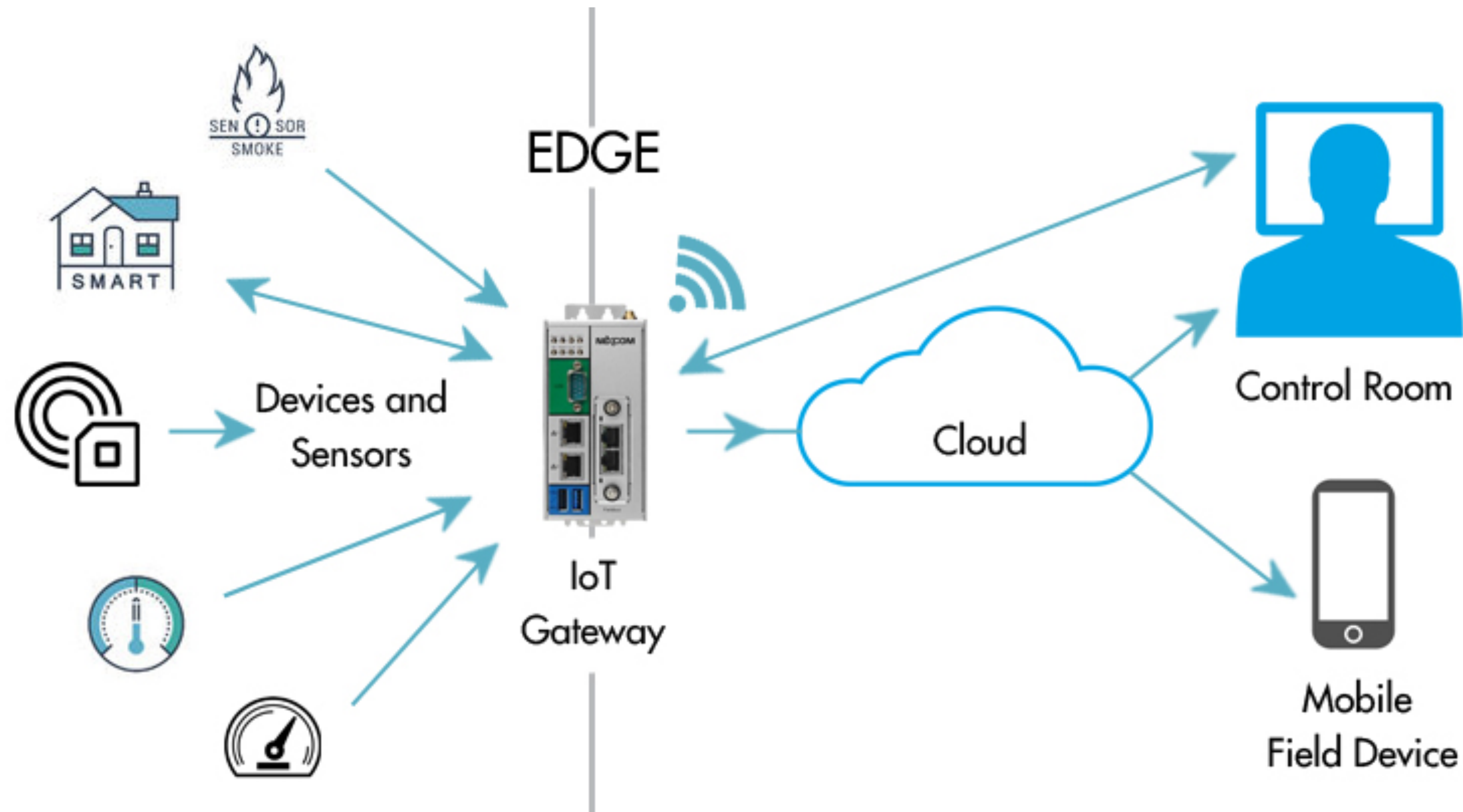**Collect data** → **Collate and transfer data** → **Analyze data, take action**

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IoT Hub

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IoT Gateway

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Transport Information Protocol

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Principles and Assumptions

- Simplicity, simplicity, simplicity!

- Publish/subscribe messaging.

- Zero administration (or as close as possible).

- Minimize the on-the-wire footprint.

- Data agnostic.

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Principles and Assumptions

- Expect and cater for frequent network disruption

- Continuous session awareness

- Expect that client applications may have very limited processing resources available.

- Provide traditional messaging qualities of service where the environment allows. Provide "quality of service"

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XML

```xml
<empinfo>
    <employees>
        <employee>
            <name>James Kirk</name>
            <age>40></age>
        </employee>
        <employee>
            <name>Jean-Luc Picard</name>
            <age>45</age>
        </employee>
        <employee>
            <name>Wesley Crusher</name>
            <age>27</age>
        </employee>
    </employees>
</empinfo>
```

JSON

```json
{  "empinfo" :
    {
        "employees" :  [
        {
            "name" : "James Kirk",
            "age" : 40,
        },
        {
            "name" : "Jean-Luc Picard",
            "age" : 45,
        },
        {
            "name" : "Wesley Crusher",
            "age" : 27,
        }
        ]
    }
}
```

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× Headers Preview Response Cookies Timing

Request URL: http://localhost/drupal-7/user
Request Method: GET
Status Code: 🟢 200 OK
▶ Request Headers (10)
▼ Response Headers   view source
  Cache-Control: no-cache, must-revalidate, post-check=0, pre-check=0
  Connection: Keep-Alive
  Content-Language: en
  Content-Type: text/html; charset=utf-8
  Date: Thu, 17 Oct 2013 10:43:04 GMT
  ETag: "1382006584"
  Expires: Thu, 17 Oct 2013 10:53:04 +0000
  Keep-Alive: timeout=5, max=100
  Last-Modified: Thu, 17 Oct 2013 10:43:04 +0000
  Server: Apache/2.2.23 (Unix) mod_ssl/2.2.23 OpenSSL/0.9.8y DAV/2 PHP/5.4.10
  Transfer-Encoding: chunked
  X-Frame-Options: SAMEORIGIN
  X-Generator: Drupal 7 (http://drupal.org)
  X-Powered-By: PHP/5.4.10

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What About Security?

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MQTT client

MQTT broker

3. MQTT connect
(access token)

6. Connect success

4. Validate token

5. Validation
success

2. Return access token

Authorization server

1. Send credentials for authentication
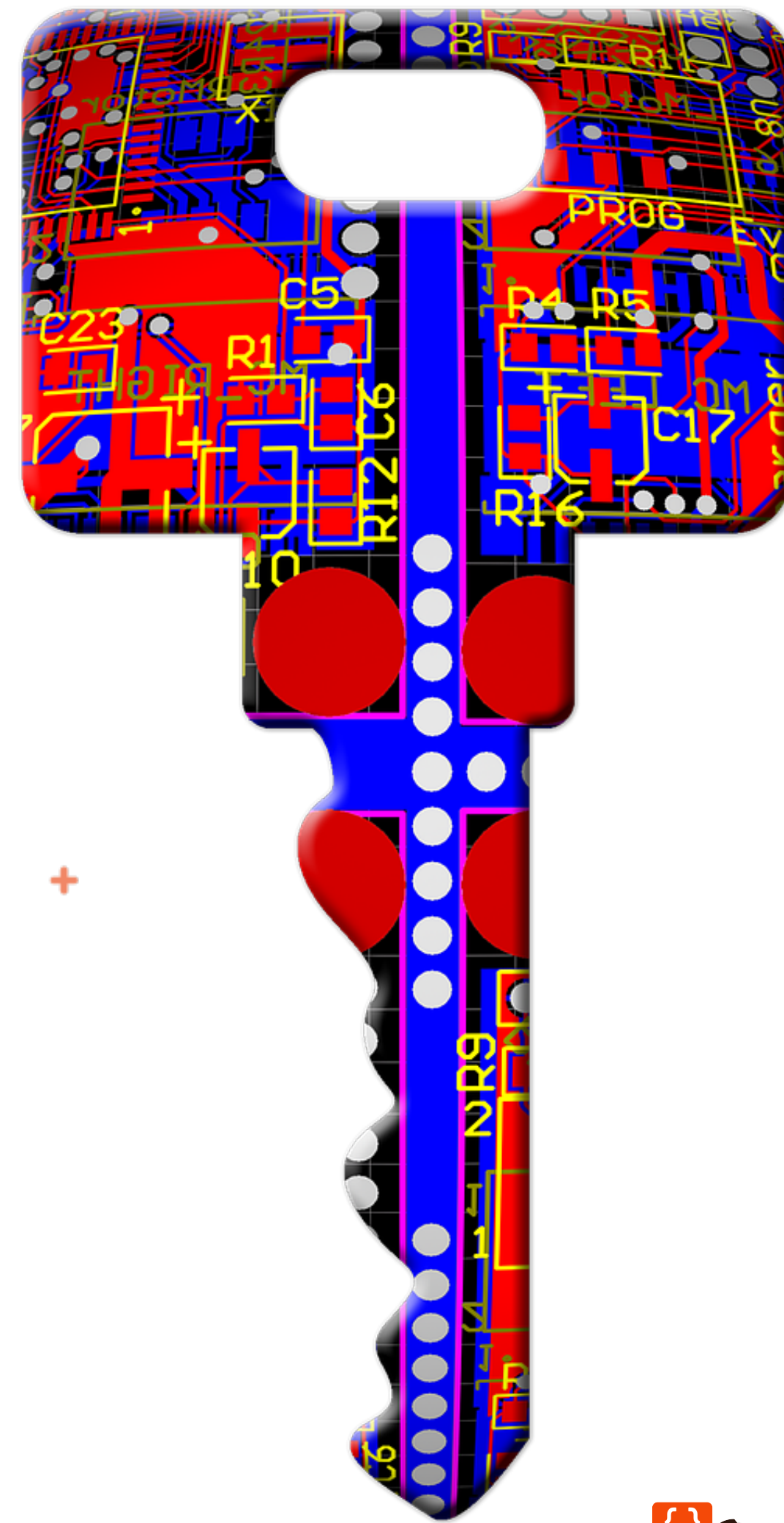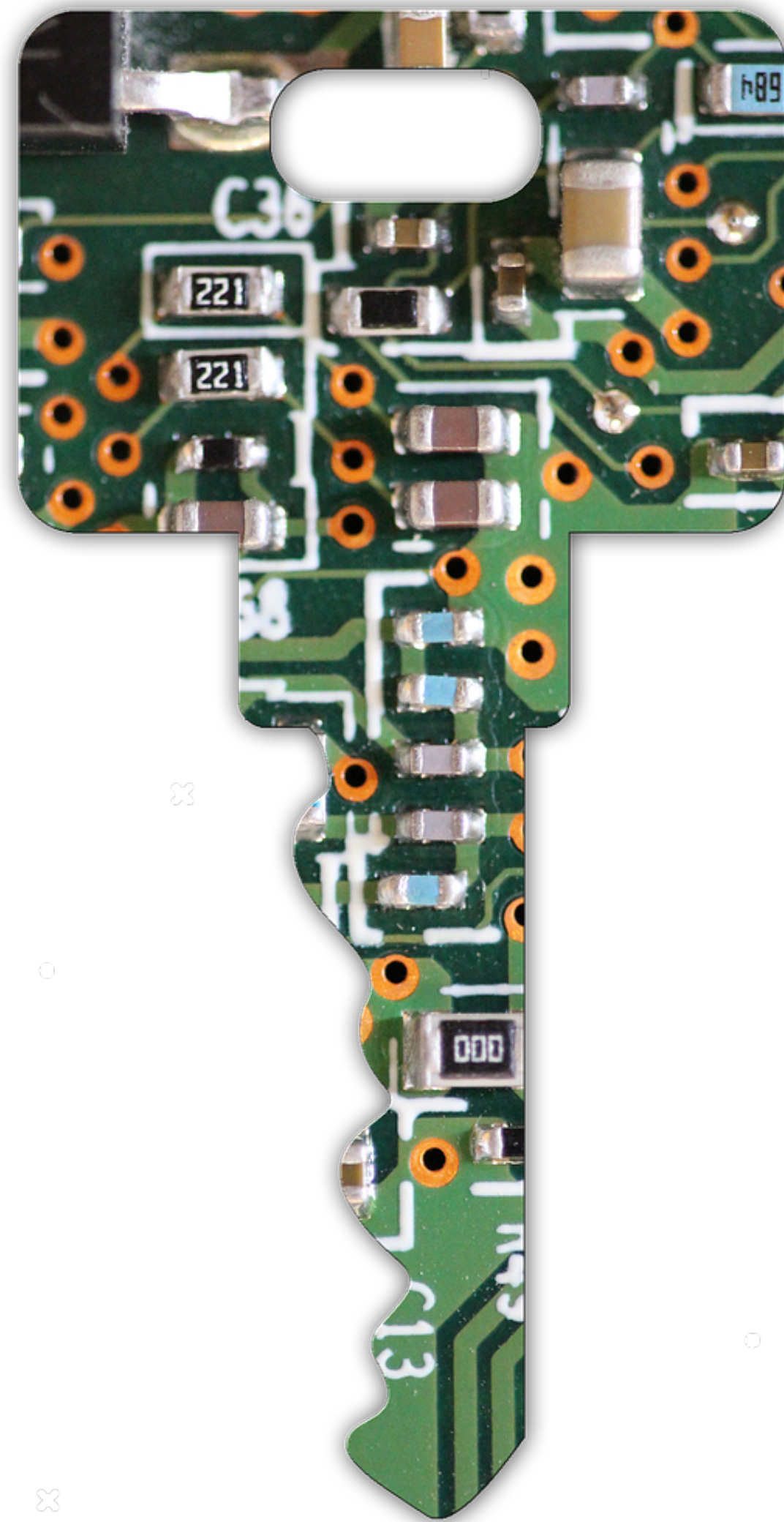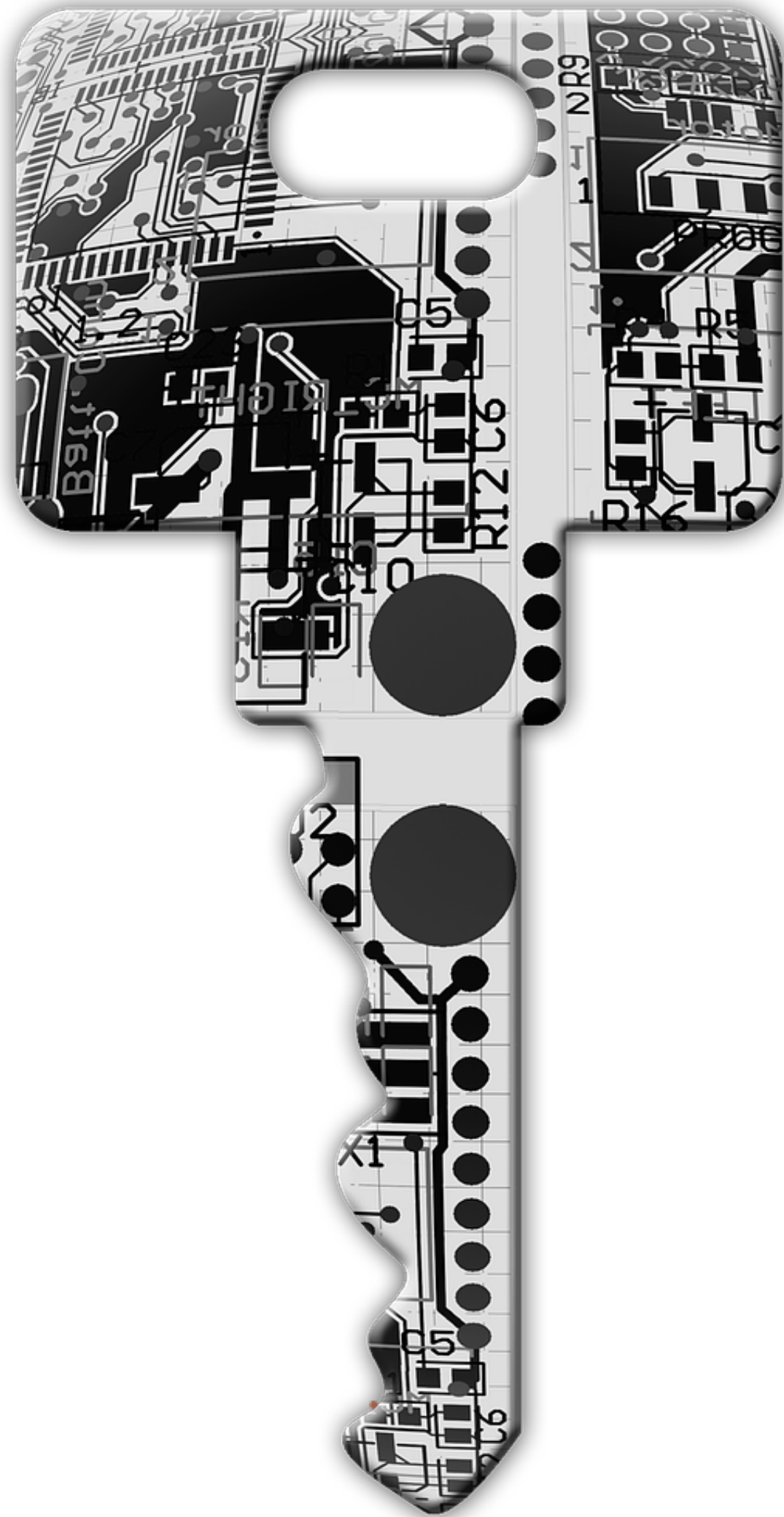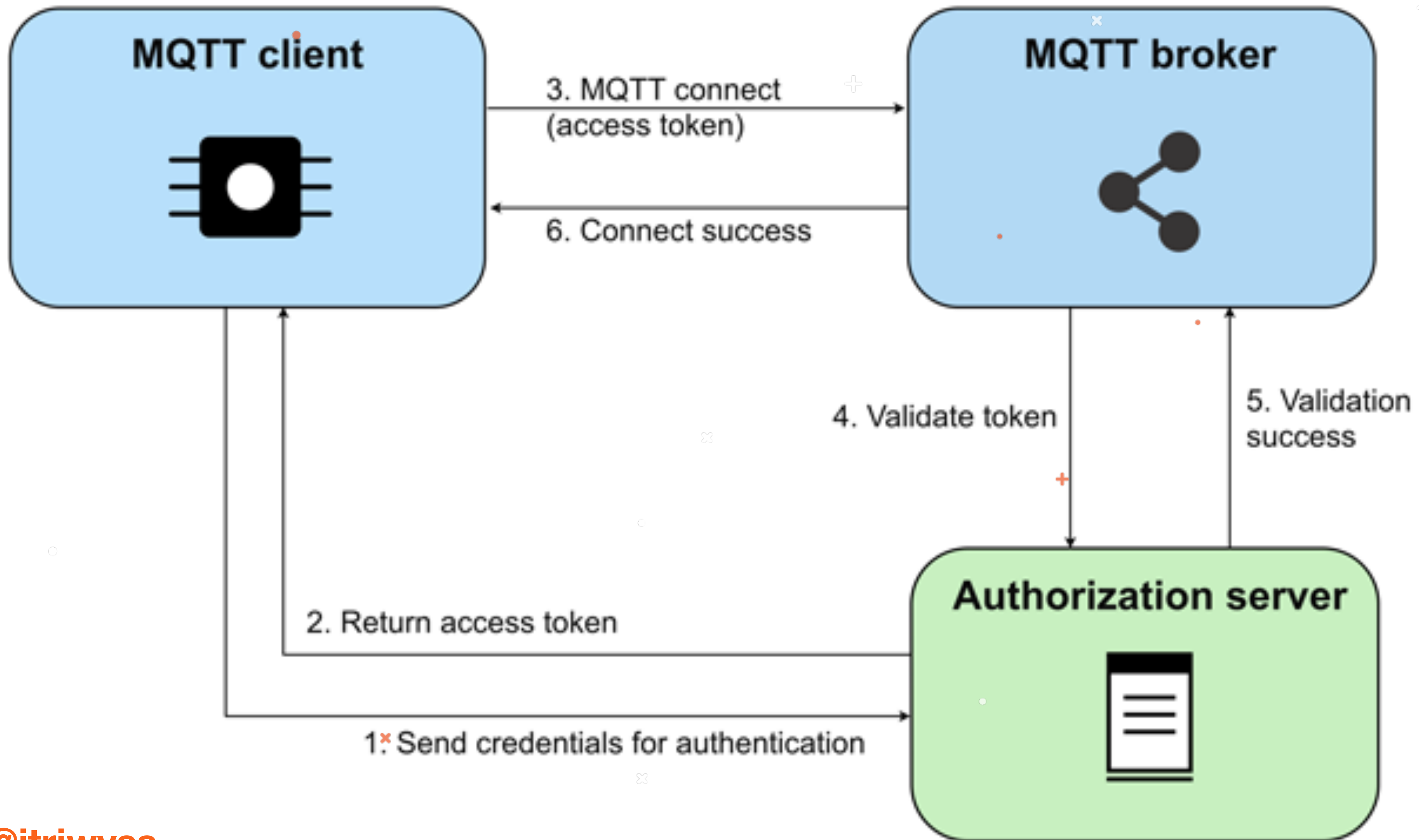
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Serverless as Backend

There is no cloud

it's just someone else's computer

Spoiler alert: Santa Claus and the Easter Bunny also do not exist

Storj Labs courtesy

"**Serverless architectures** refer to applications that significantly **depend** on third-party services (knows as Backend as a Services - **BaaS**) or on custom code that's **run** in **ephemeral containers** (Function as a Service - **FaaS**)"

MartinFowler.com

Backend as a Service

- Applications that significantly or fully depend on 3er party applications / services ("in the cloud") to manage server-side logic and state.

- Cloud accessible databases (Parse, Firebase)

- Authentication Services (Oracle Identity Cloud Service, Auth0, Amazon Cognito)

Functions as a Service

- Run in stateless compute containers that are event-triggered

- Ephemeral

- Fully managed by a 3rd party

- AWS Lambda, Google Cloud Functions, Firebase Functions, Azure Functions, FNProject

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MONOLITHIC ARCHITECTURE

MICROSERVICES ARCHITECTURE

User Interface

Business Logic

Data Access Layer

DB

User Interface

Microservice

Microservice

Microservice

Microservice

Microservice

DB

DB

DB

DB

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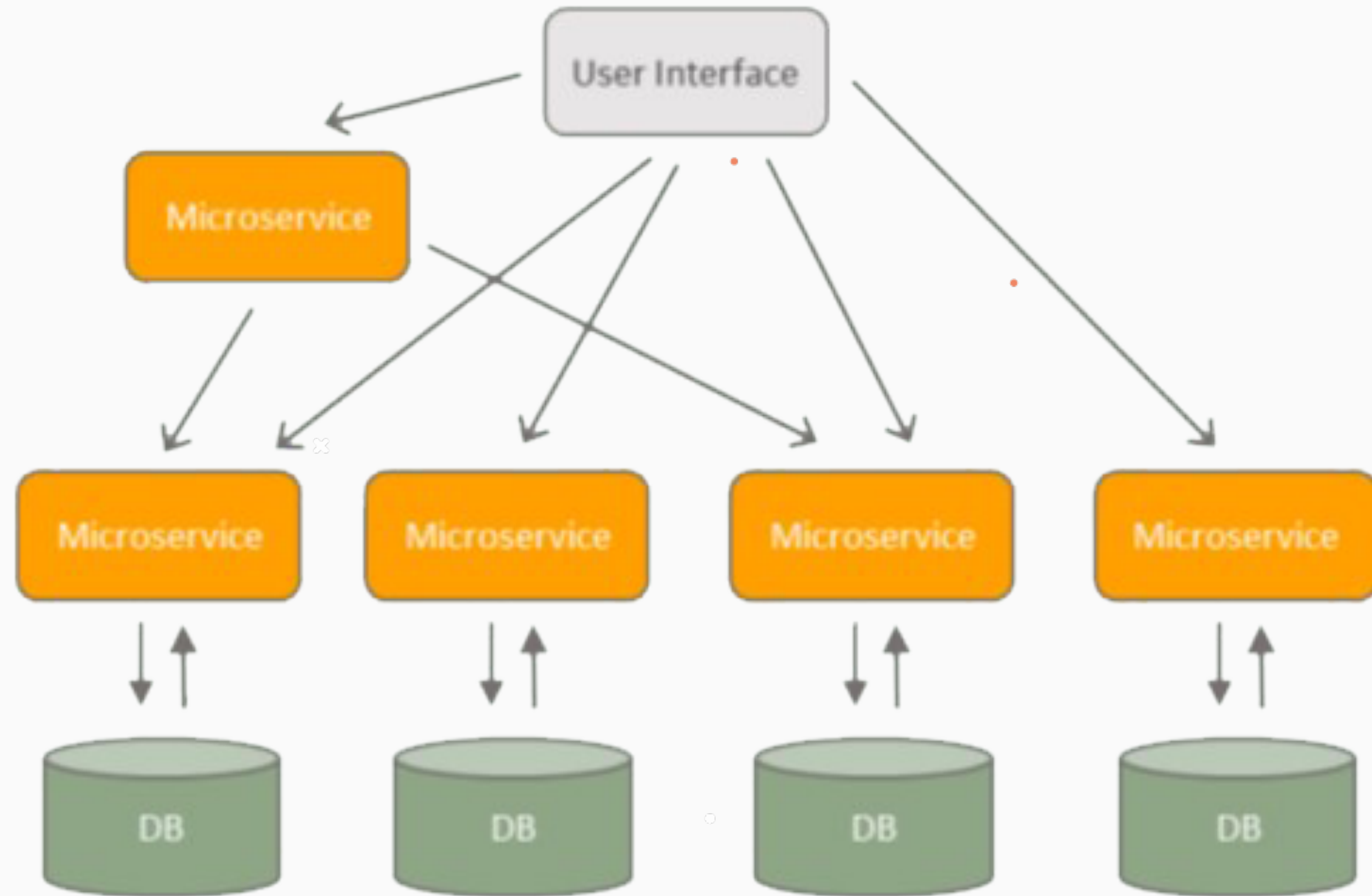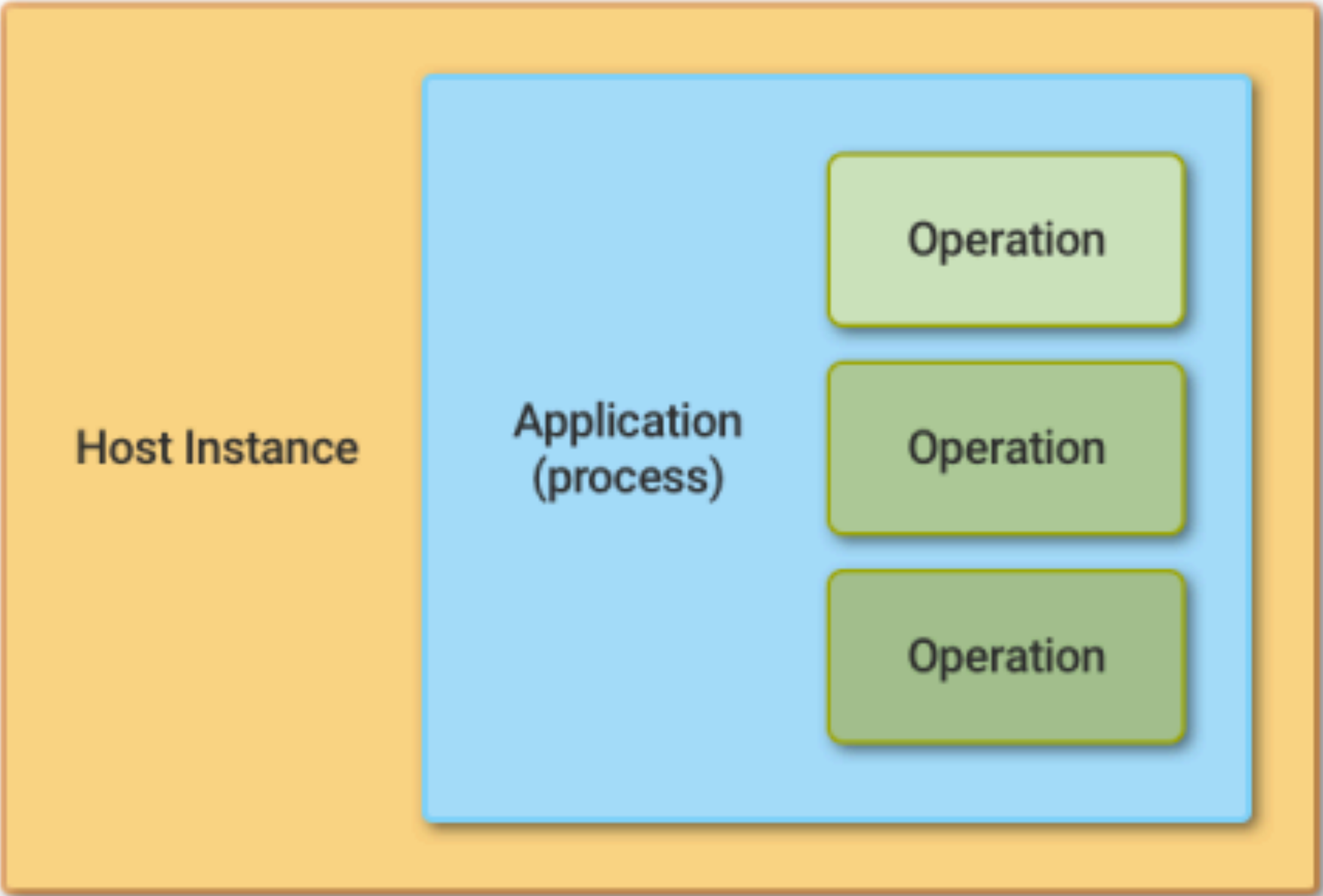
Serverless

- Functions as the unit of scale

- Run in ephemeral containers

- We can focus just on developing

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Complexity

code
wiring

Reduce **cost**

Handle **load**
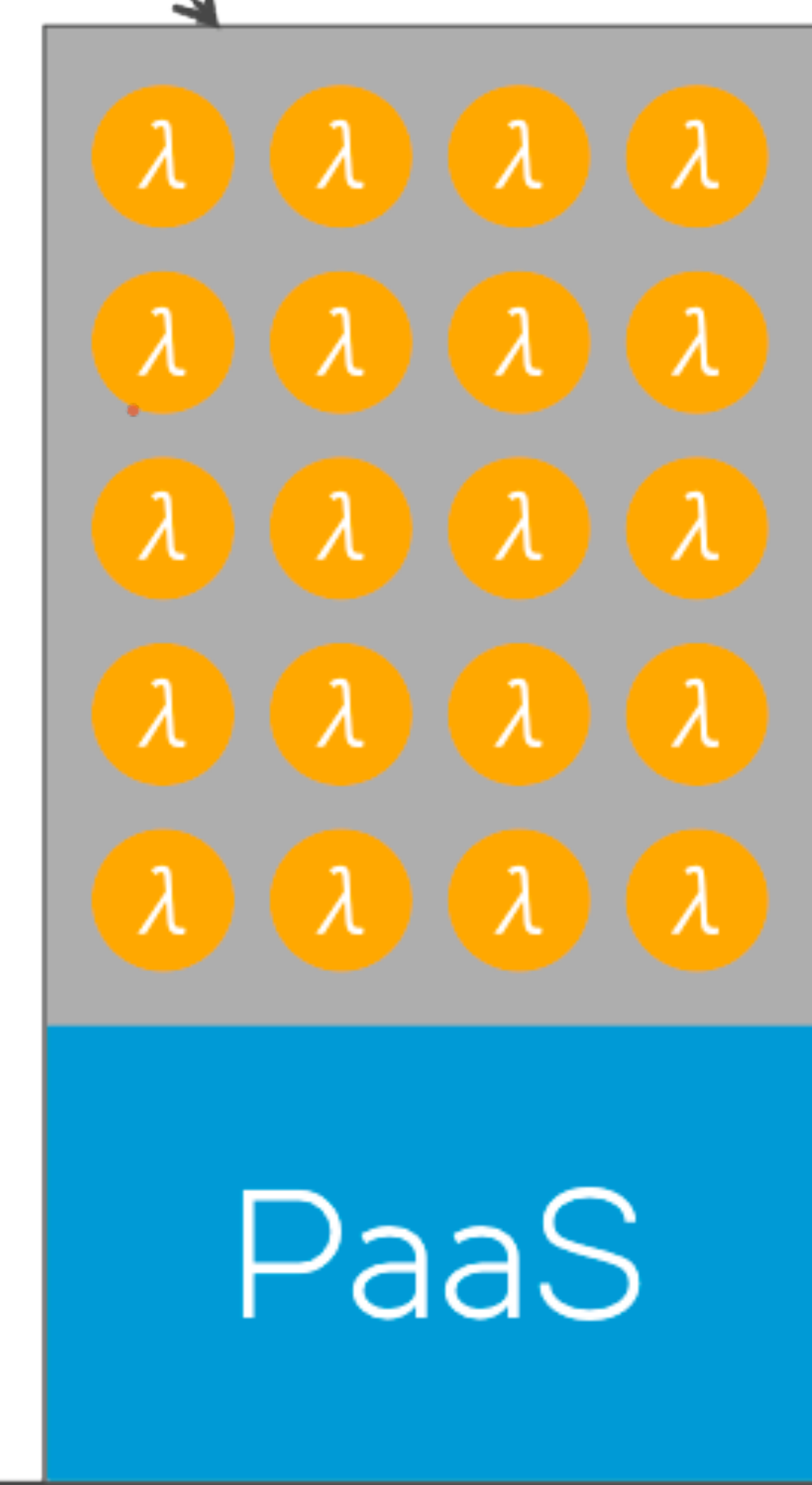
Monolith

Microservices

Serverless

PaaS

AMBASSADOR
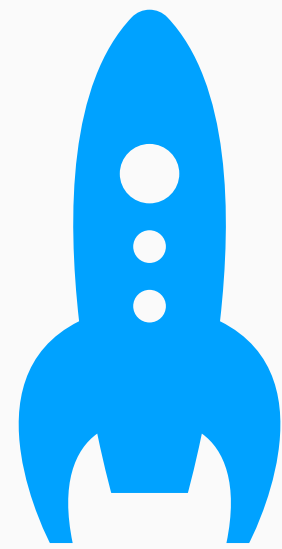
Serverless

No server management
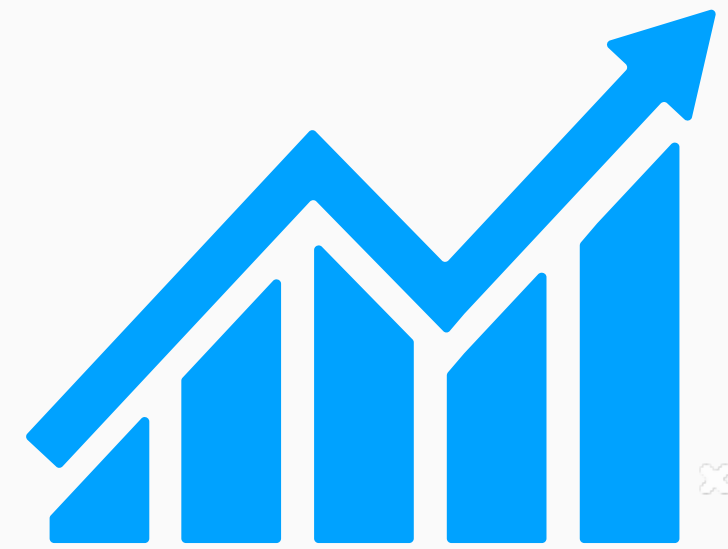
High availability

Flexible Scaling

Pay as you go

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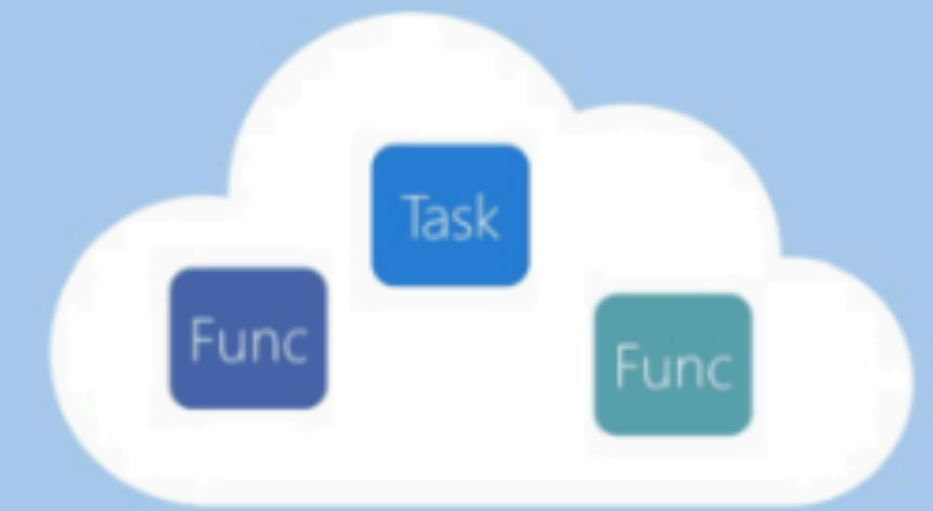
Function as a Service

- Serverlees computing vs Serverless Architecture

- Deploy an individual "function", action, or piece of business logic.

- Event-driven processing part of the serverless architecture.

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FaaS Facts

- Are stateless (Provide pure functional transformations of their input.)

- FaaS functions are typically limited in how long each invocation is allowed to run.

- Programming languages to use.
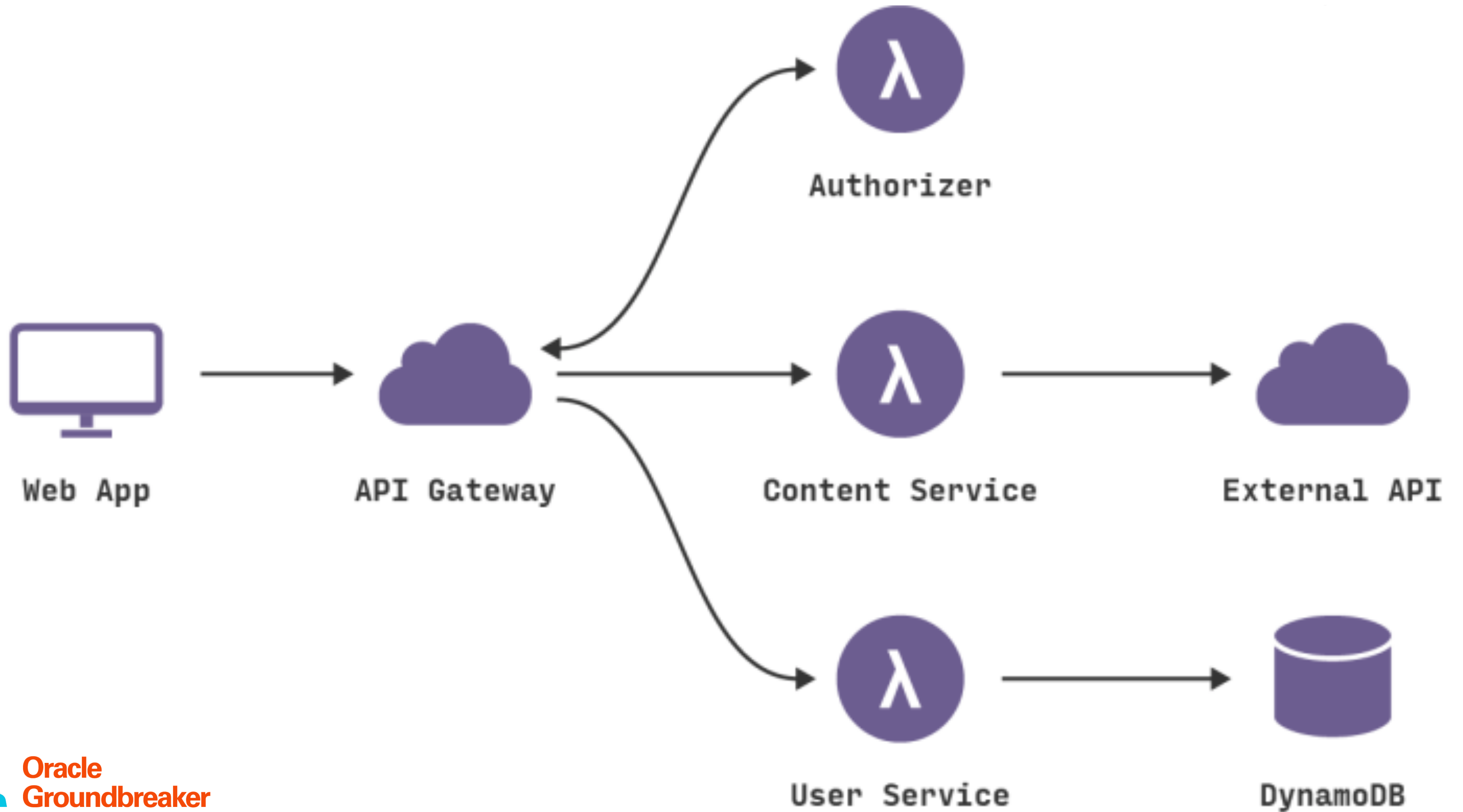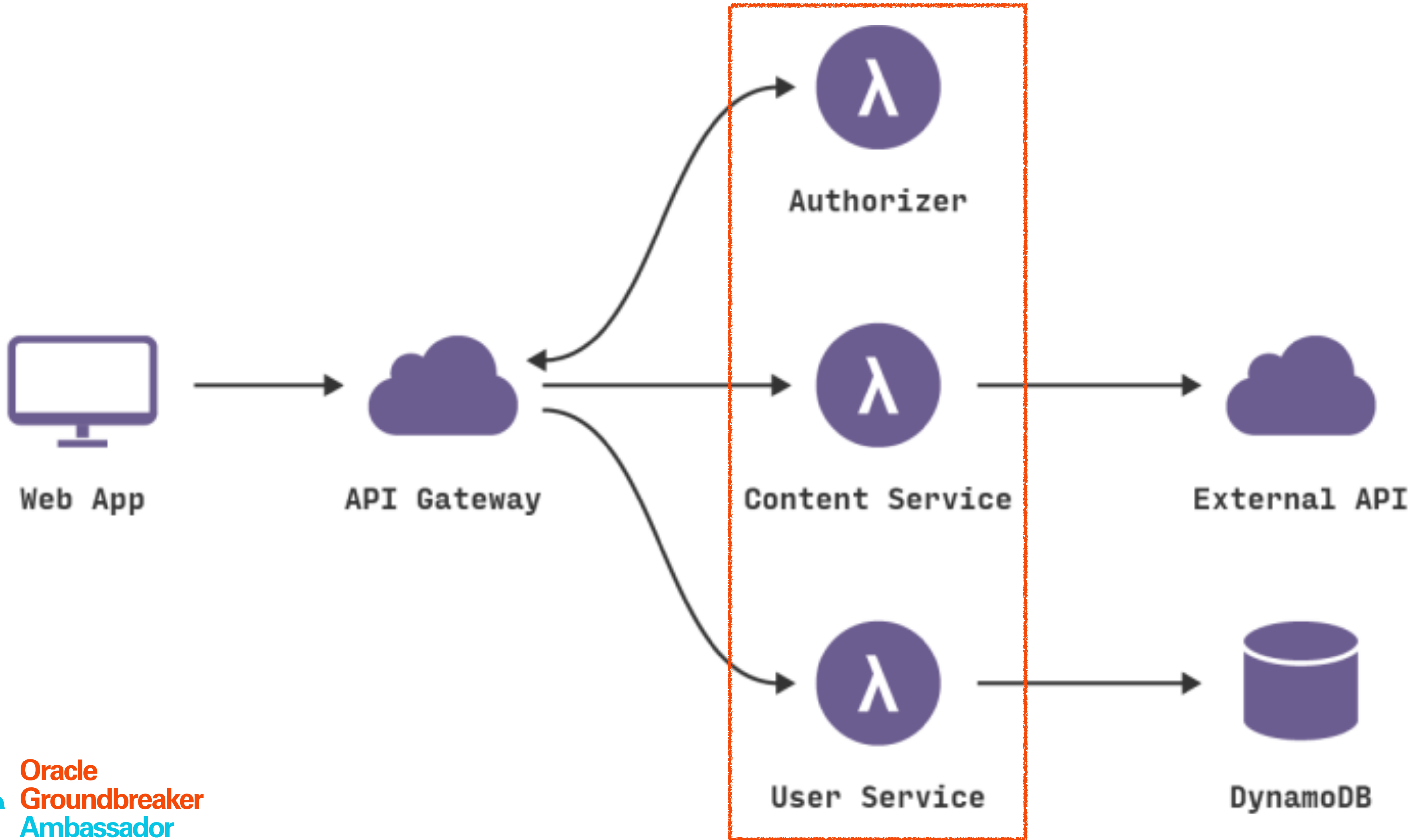
- "Availability" and "Scalability"

FaaS in the Cloud

- Serverlees is a cloud solution.

- Deploy an individual "function", action, or piece of business logicRun code without provisioning or managing servers.

- Zero administration. Just upload the code, and we will run and "Scale".

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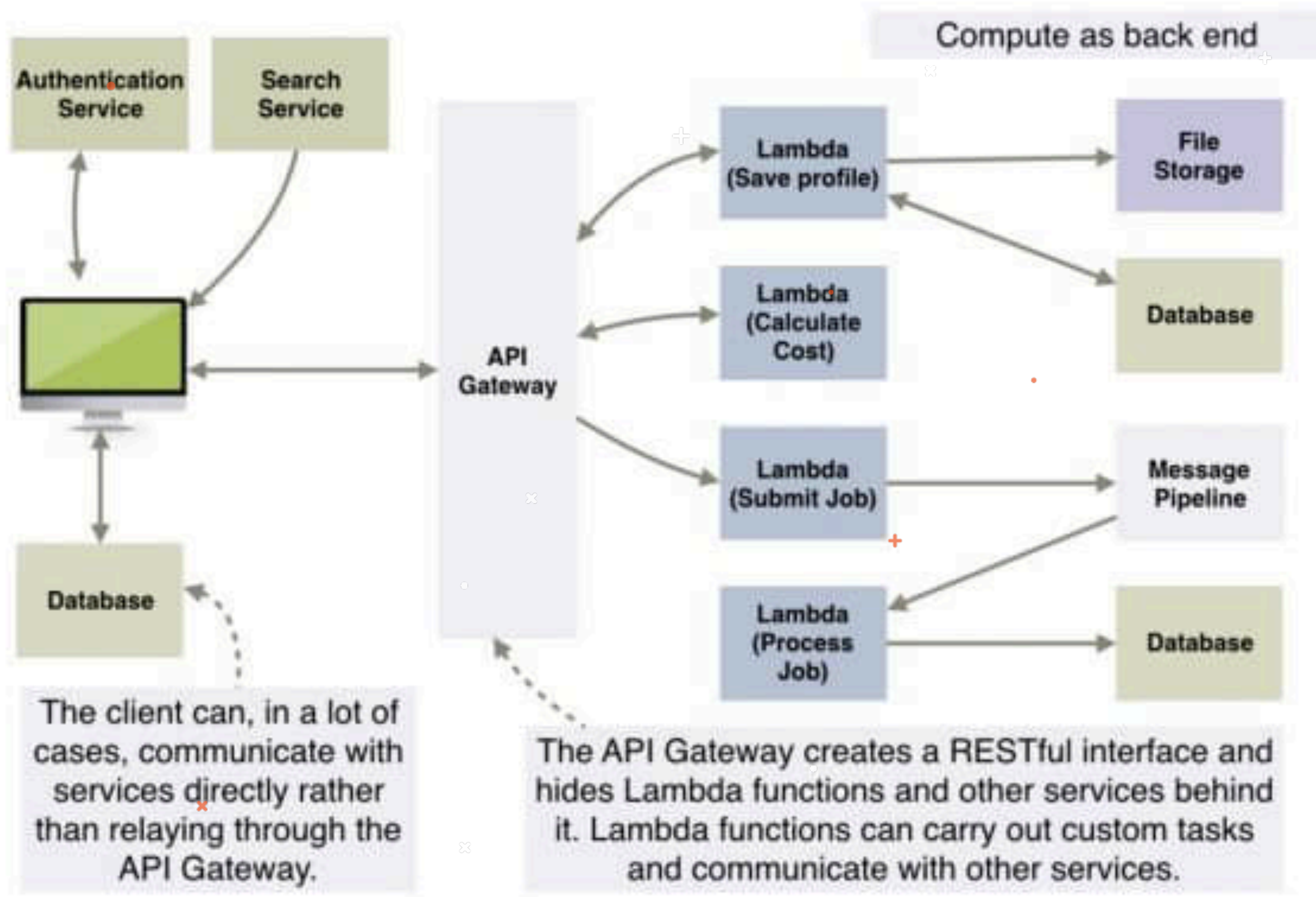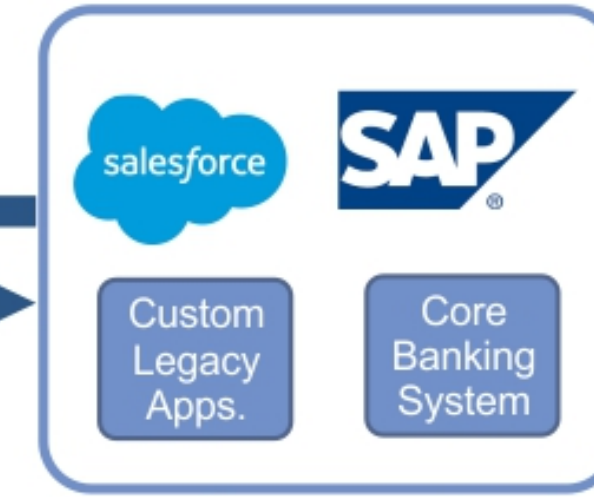# Serverless is a
Software Architecture

Authorizer

Web App → API Gateway → Content Service → External API

User Service → DynamoDB

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Web App → API Gateway → Authorizer / Content Service / User Service → External API / DynamoDB

Compute as back end

Authentication Service

Search Service

Lambda (Save profile)

File Storage

Lambda (Calculate Cost)

Database

API Gateway

Lambda (Submit Job)

Message Pipeline

Lambda (Process Job)

Database

Database

The client can, in a lot of cases, communicate with services directly rather than relaying through the API Gateway.

The API Gateway creates a RESTful interface and hides Lambda functions and other services behind it. Lambda functions can carry out custom tasks and communicate with other services.
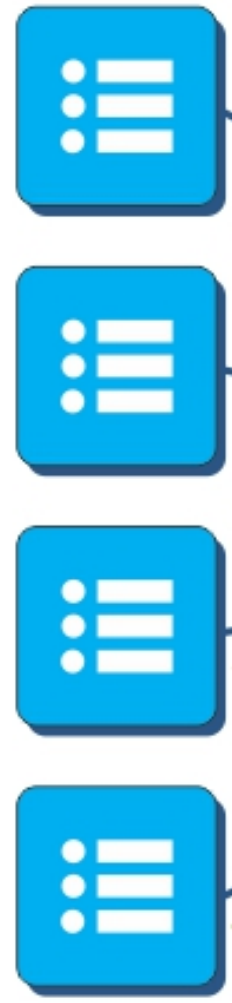
Figure 2: The front end can communicate with services directly and invoke Lambda functions through the API Gateway (Sbarski, Serverless Architectures on AWS, 2016).
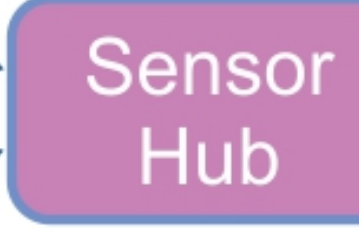
APPs

API Management

Fiorano ESB
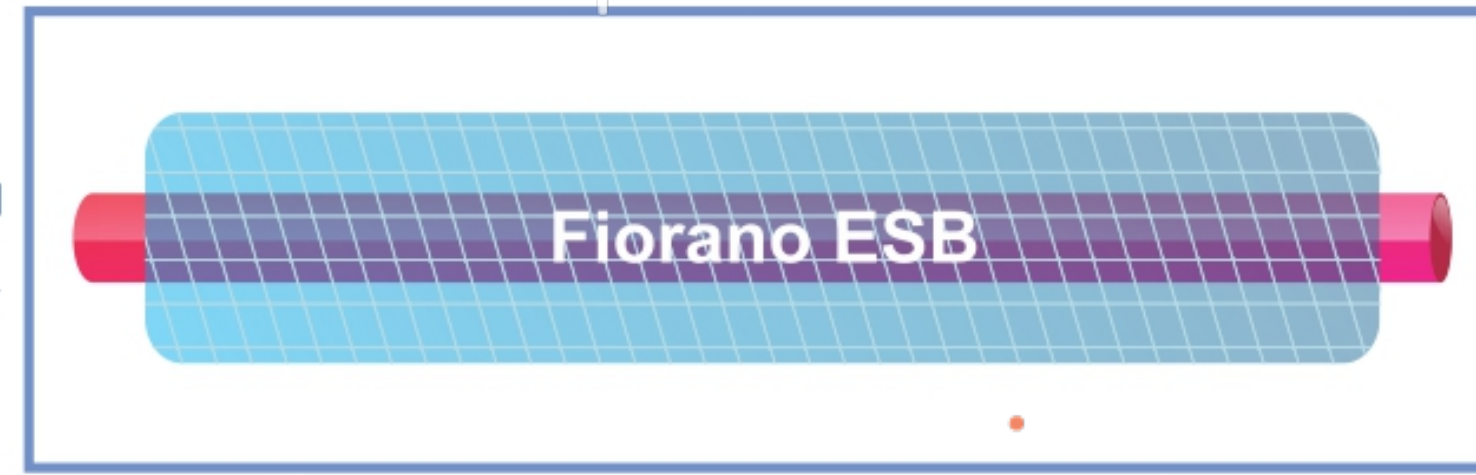
Enterprise Applications

salesforce SAP
Custom Legacy Apps. Core Banking System

Devices Sensors

MQTT Publisher
JMS
MQTT Publisher
MQTT

Sensor Hub

MQTT

MQTT SN

Fiorano MQTT

MQTT

JMS
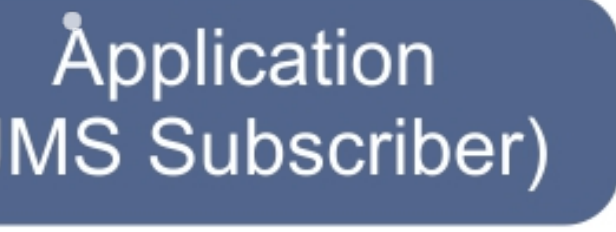
Big data
hadoop

Application (MQTT Subscriber)

Application (JMS Subscriber)
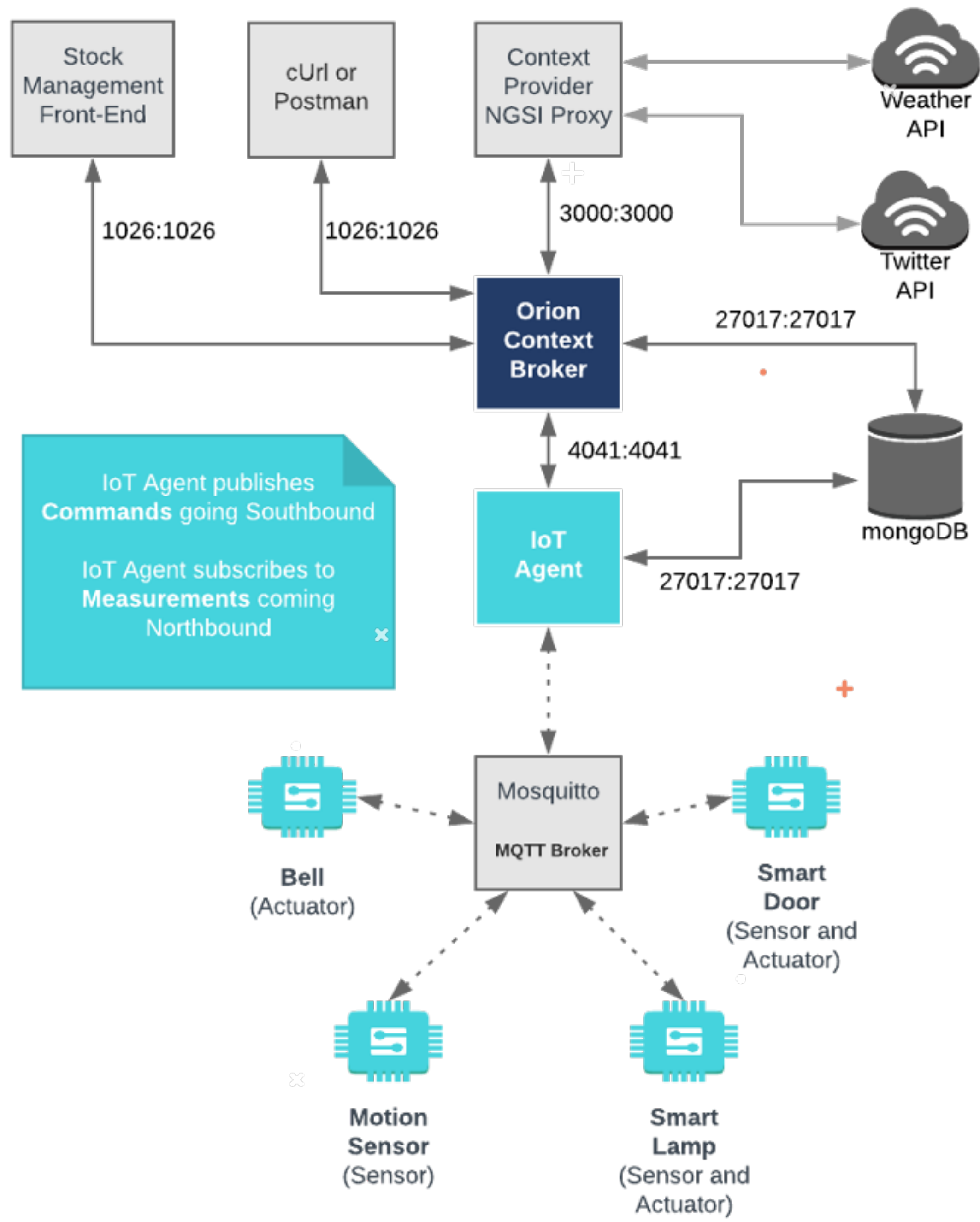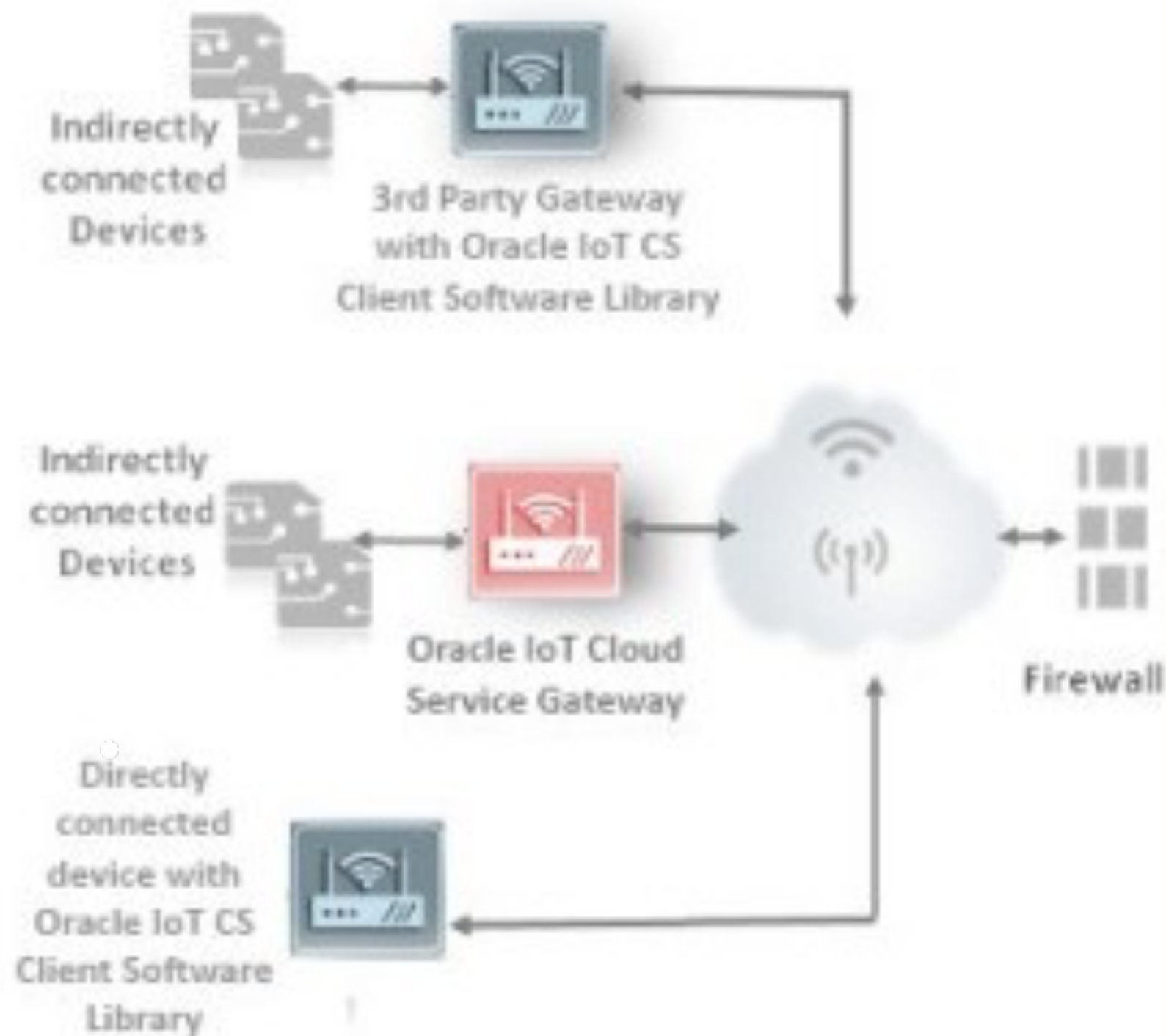
QoS
MQTT - JMS conversion

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Cloud Solutions
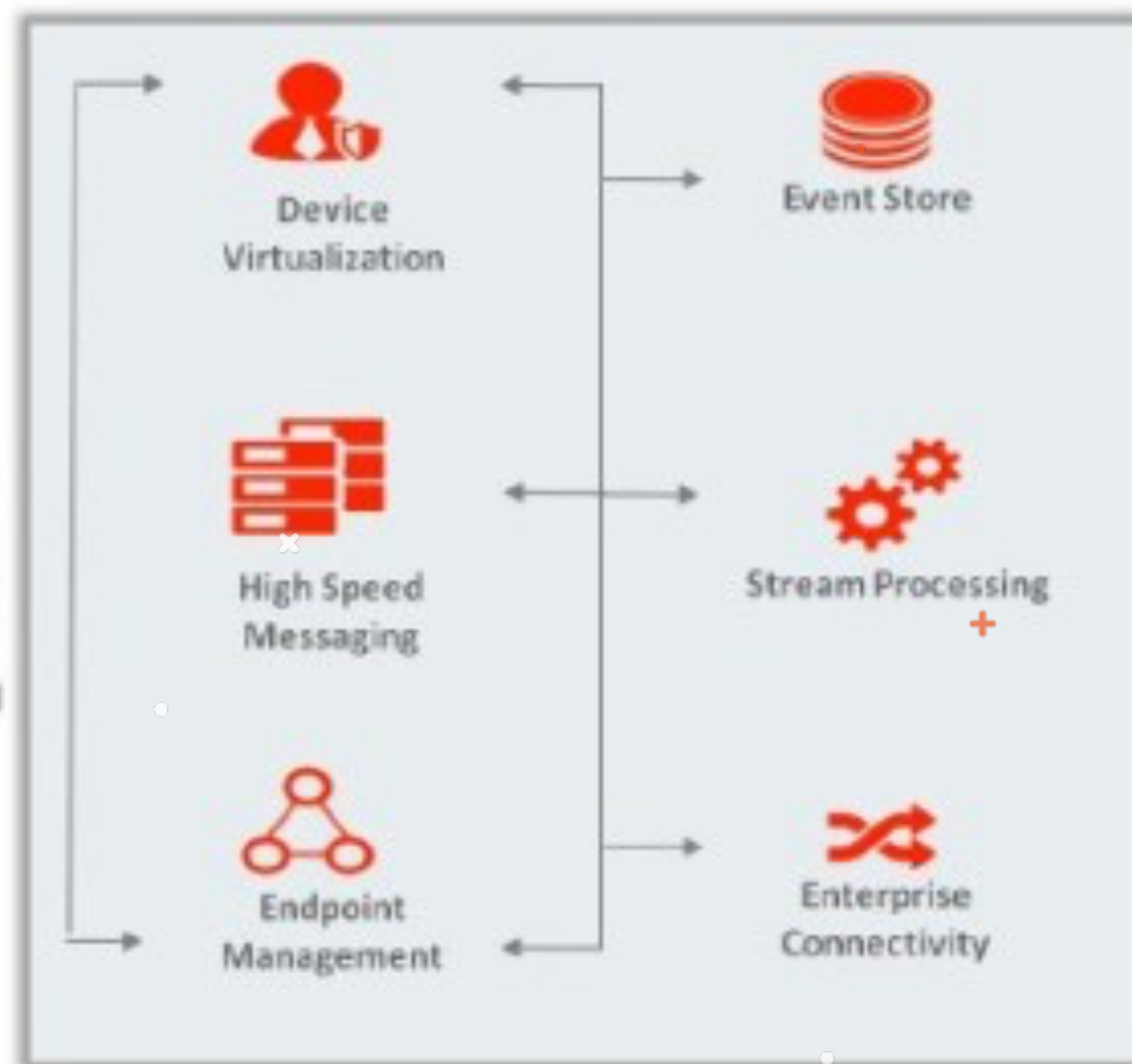
Oracle
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Oracle IoT Cloud Service Client Software · Oracle IoT Cloud Service · Oracle Services · Enterprise Apps (Cloud or On Premise)
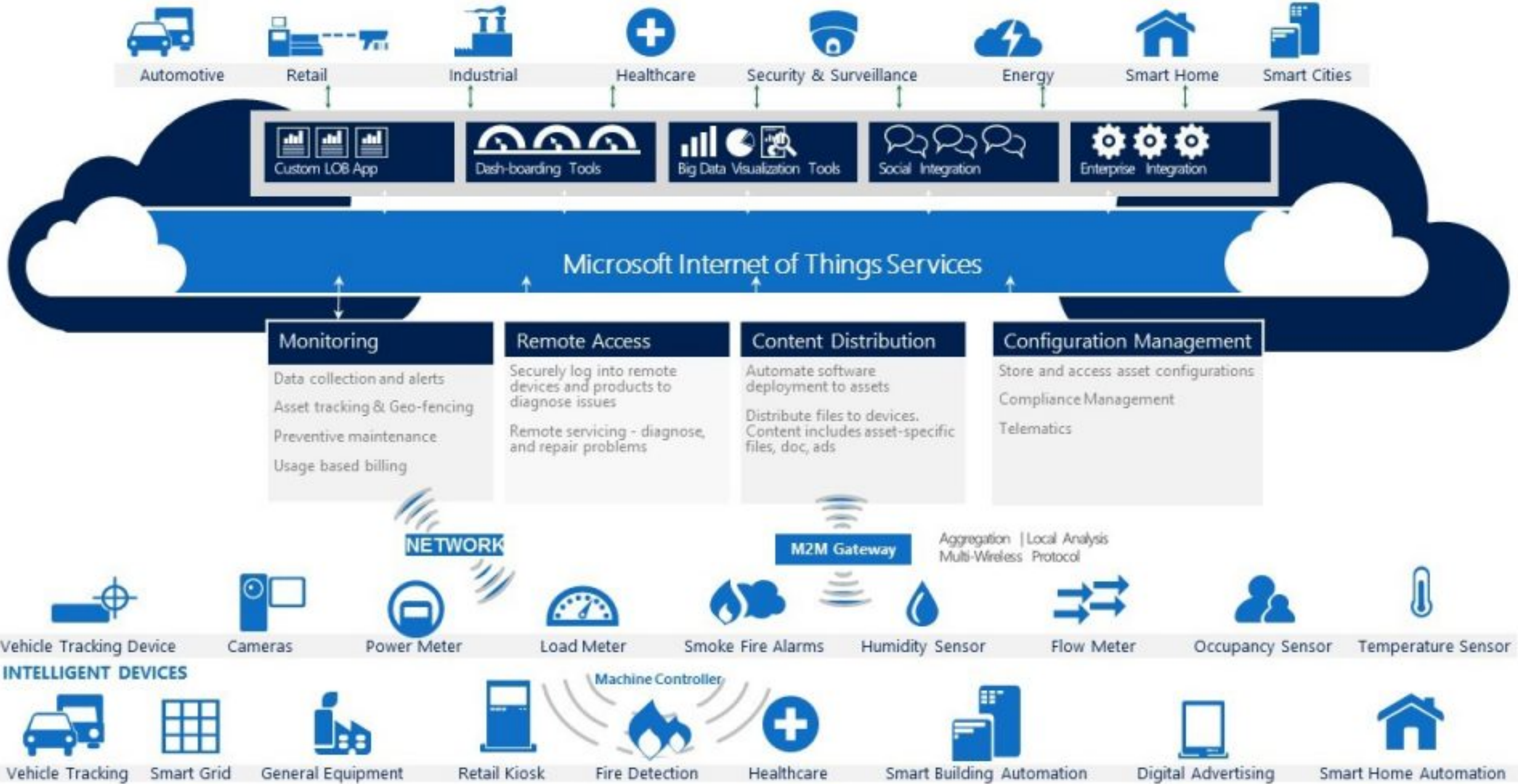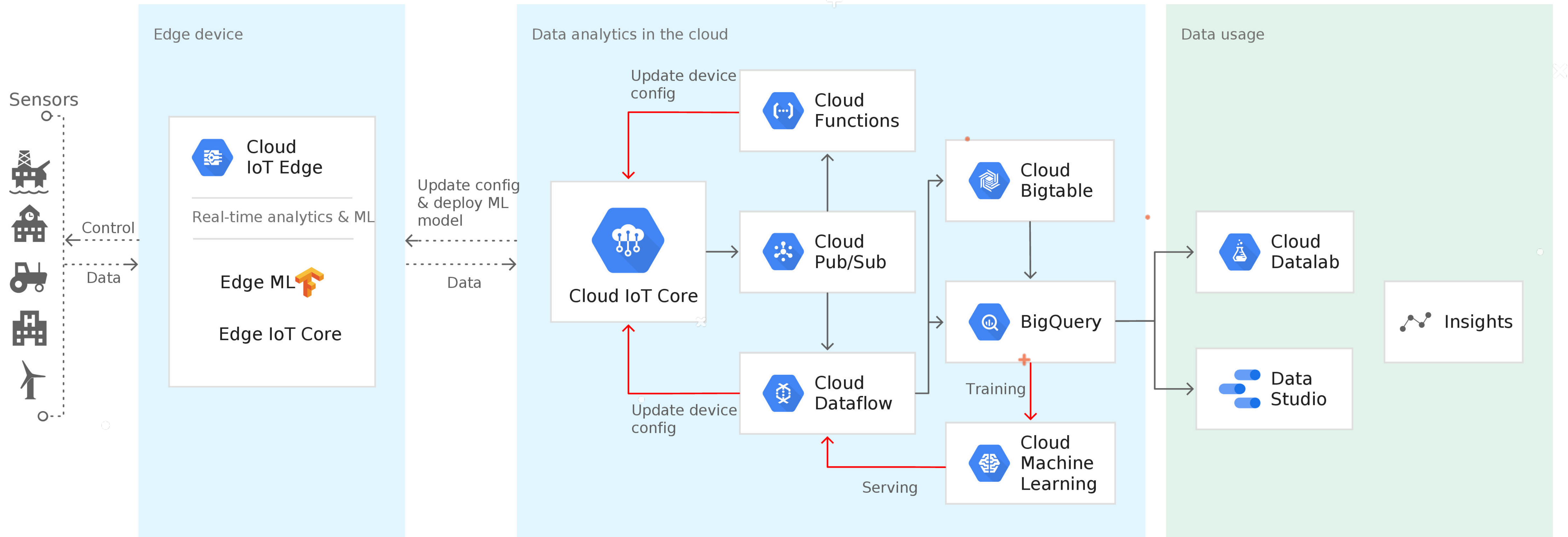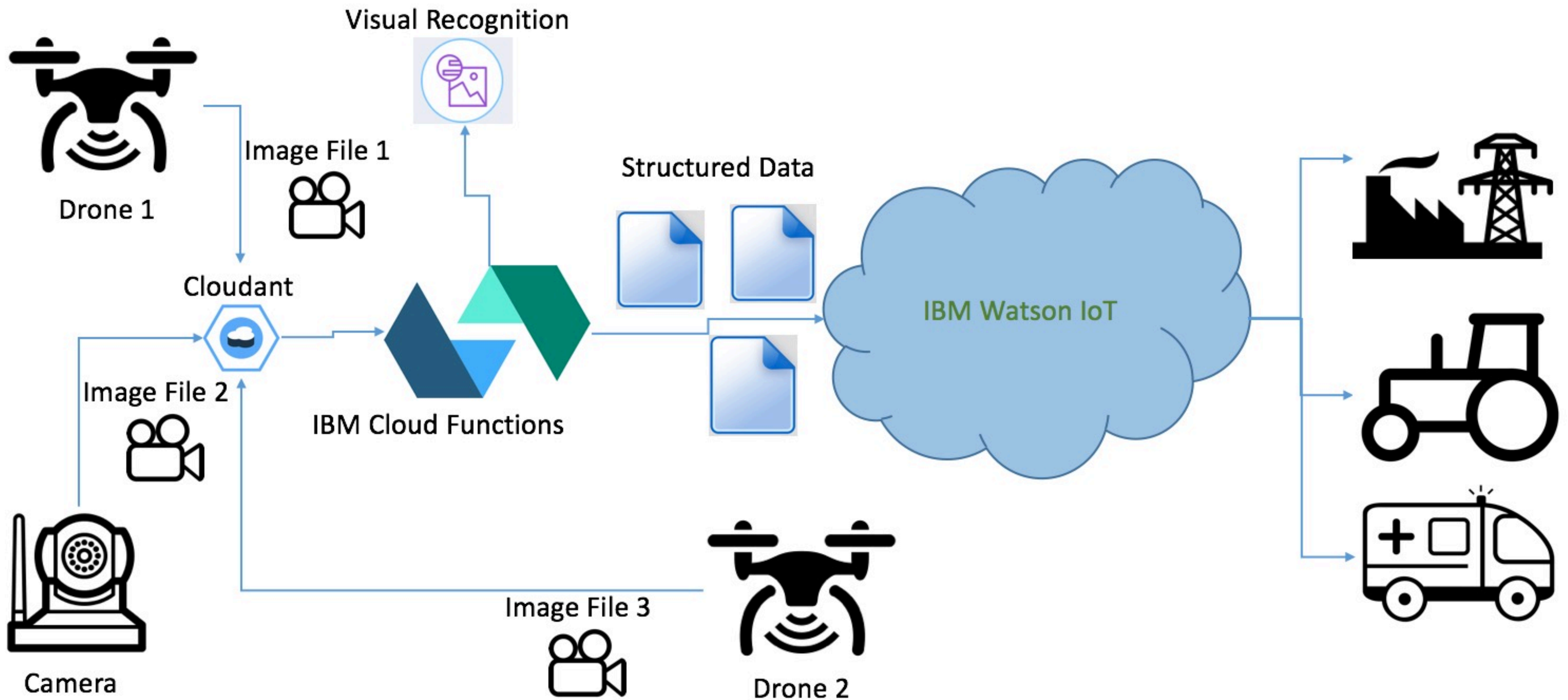
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Microsoft IoT Solution Architecture

Visual Recognition

Drone 1

Image File 1

Cloudant

Image File 2

Camera

IBM Cloud Functions

Structured Data

Image File 3

Drone 2

IBM Watson IoT

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AWS

Amazon S3 bucket
Store raw and processed data

Amazon QuickSight
Visualize IoT data

Batched incoming data files - JSON

Batched processed data files - CSV

AWS IoT
Ingest device data

IoT rule
Send data to Amazon Kinesis Firehose

Amazon Kinesis Firehose
Source stream to batch incoming data

Amazon Kinesis Analytics
Process data using SQL

Amazon Kinesis Firehose
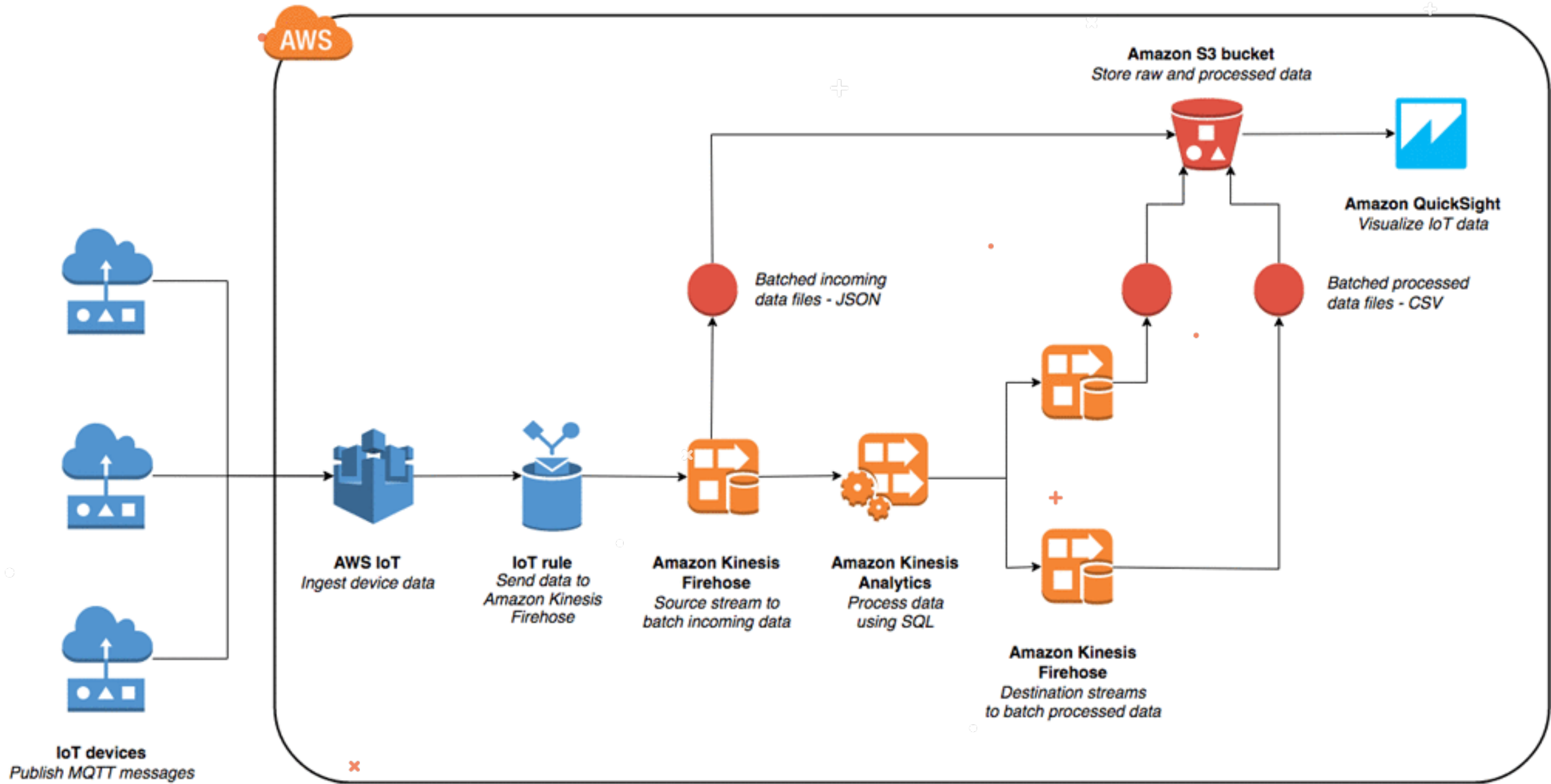*Destination streams to batch processed data*

IoT devices
Publish MQTT messages

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Cisco Internet of Things Portfolio

| Manufacturing | Mining | Energy-Utility | Oil and Gas | Transportation | City | Defense | SP/M2M |

Connected Factory • Connected Train • City Safety and Security • Energy Distribution Automation • Connected Well
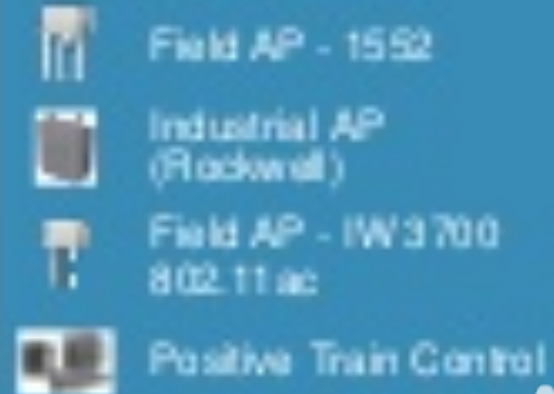
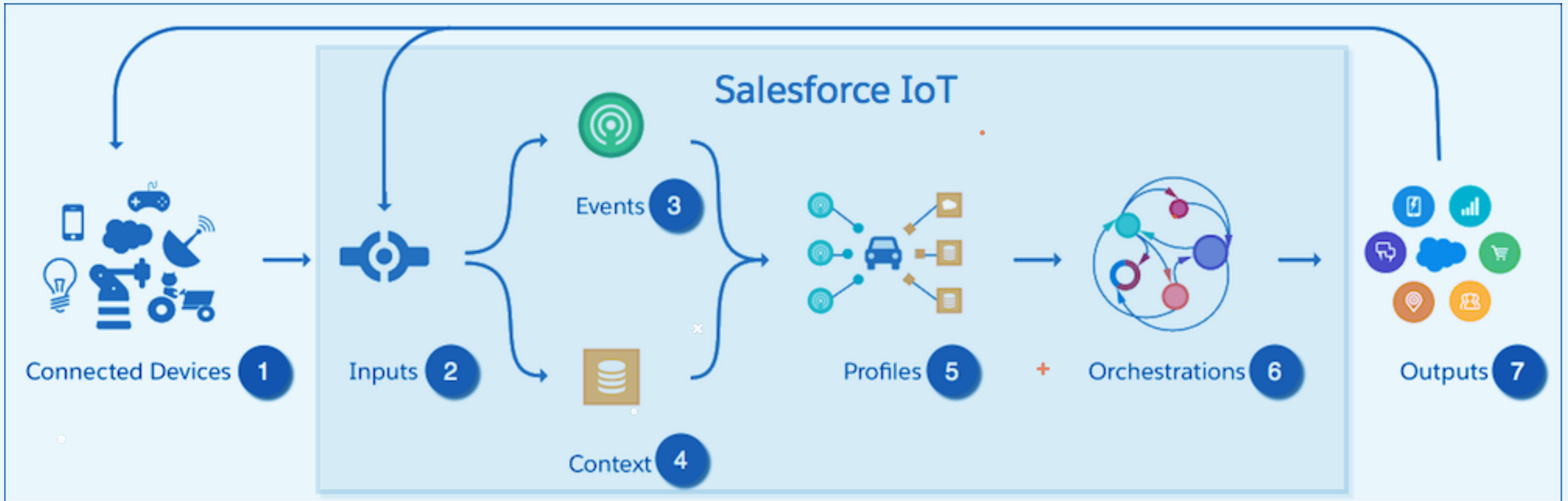| Industrial Switching	Industrial Routing	Industrial Wireless	Field Network	Embedded Networks	Connected Safety & Security	Digital Media
IE 2000 IE 3000 CGS2000	CGR 2000	Field AP - 1552	CGR 1000	5900 ESR, ESS 2020 Switches	Video Surveillance Manager and IP Cameras	DMM Digital Media Manager
IP67 IE 4000	ASR 903	Industrial AP (Rockwell)	819H IR910	5921 ESR Software Router	Physical Access Manager	Digital Media Processors
IE 5000		Field AP - IW3700 802.11ac	IR 509			
		Positive Train Control	829H			
			809H			

IoT Security

Application Enablement [Fog Computing/IOx]

Management

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Salesforce IoT

Connected Devices 1 — Inputs 2 — Events 3 / Context 4 — Profiles 5 + Orchestrations 6 — Outputs 7

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APPLICATION

Operator's dashboard

Real-time alerts

Data storage / analytics

Field service application

Customer web-portal

MIDDLEWARE

KAA

HARDWARE

Sensors

PLCs

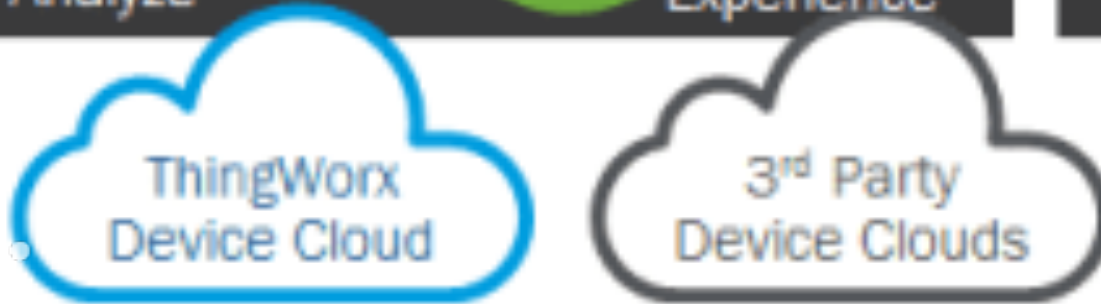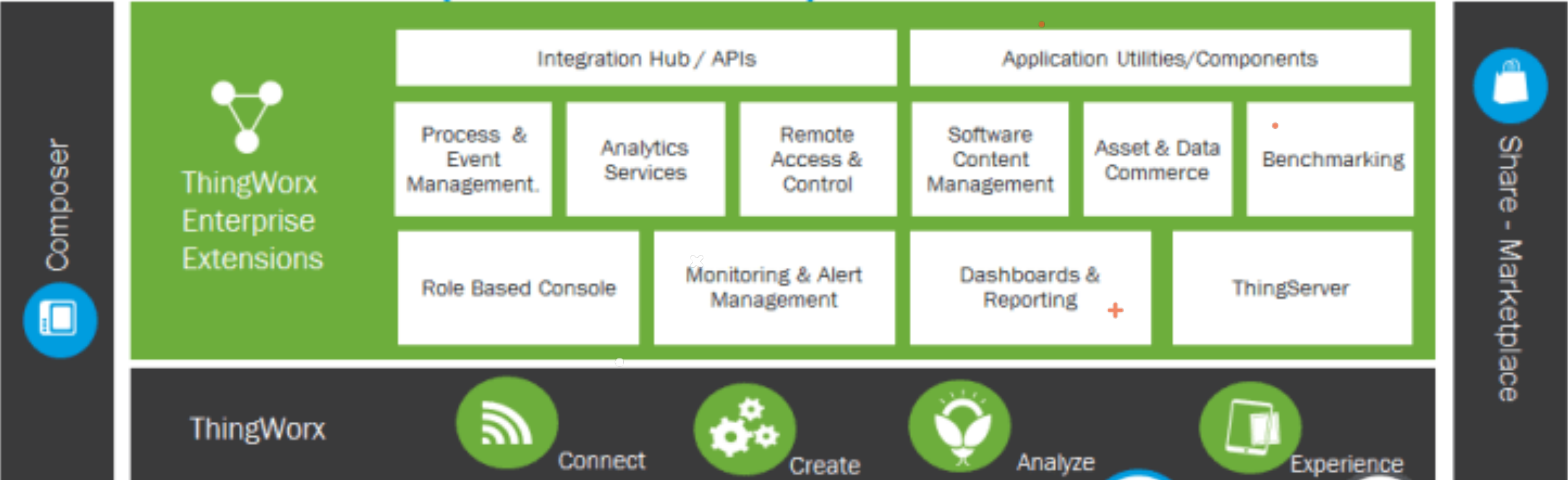Loaders

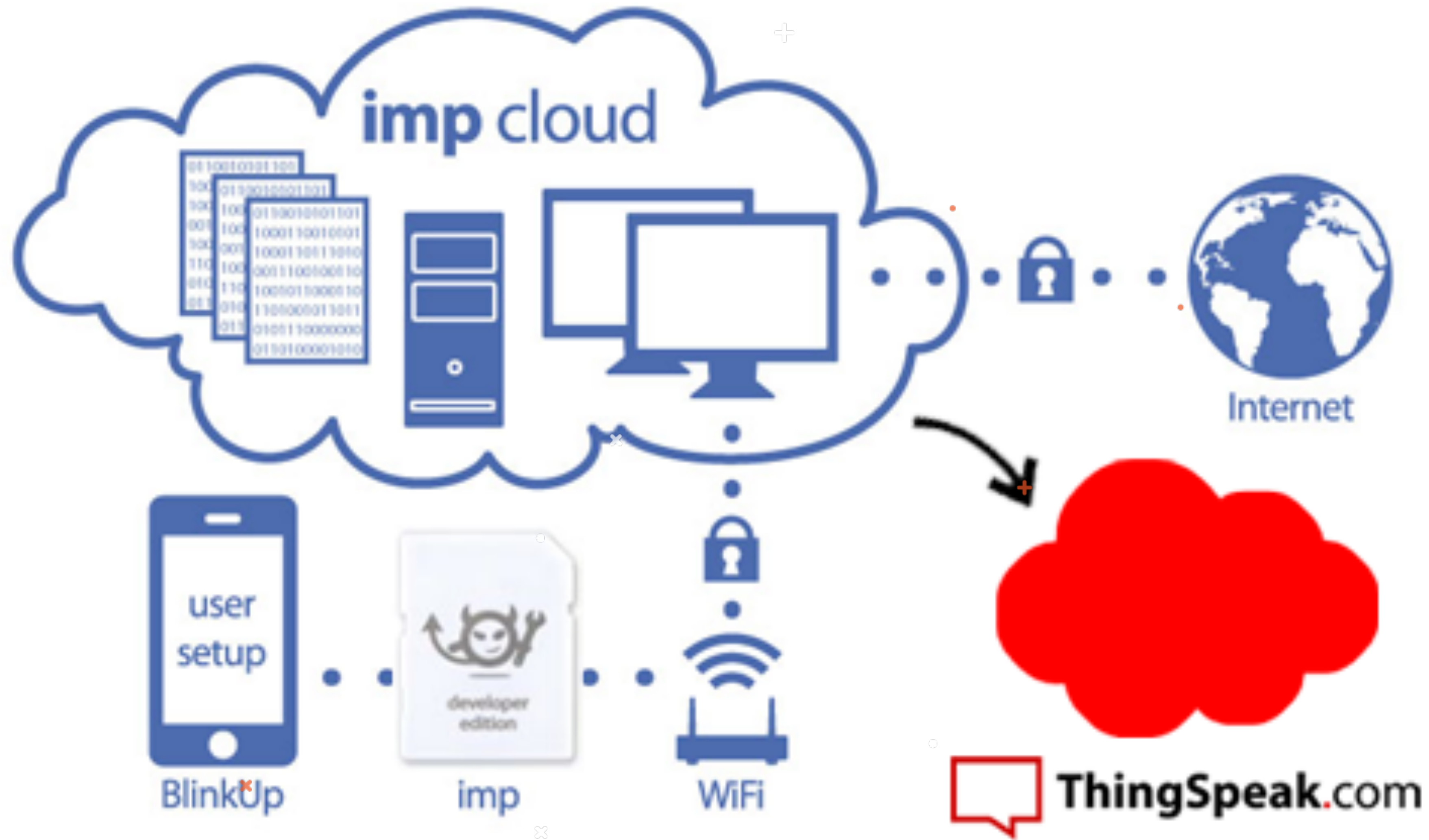Gateway

Industrial machinery

Handheld devices

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Applications & Solutions Powered by ThingWorx

Composer

ThingWorx Enterprise Extensions

Integration Hub / APIs

Application Utilities/Components

Process & Event Management.	Analytics Services	Remote Access & Control	Software Content Management	Asset & Data Commerce	Benchmarking
Role Based Console	Monitoring & Alert Management		Dashboards & Reporting	ThingServer	

Share - Marketplace

ThingWorx

Connect   Create   Analyze   Experience

ThingWorx Device Cloud

3rd Party Device Clouds

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IoT Application Pattern

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https://github.com/itrjwyss/BeyondTheThings/

https://www.facebook.com/itrjwyss

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