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*connecting the new enterprise*

# Planning an architecture for the Internet of Things

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# Leading connectivity platform for enterprise applications, mobile and IoT



3,500+ on-premise enterprise deployments

25,000+ cloud deployments

50% of the Global 500

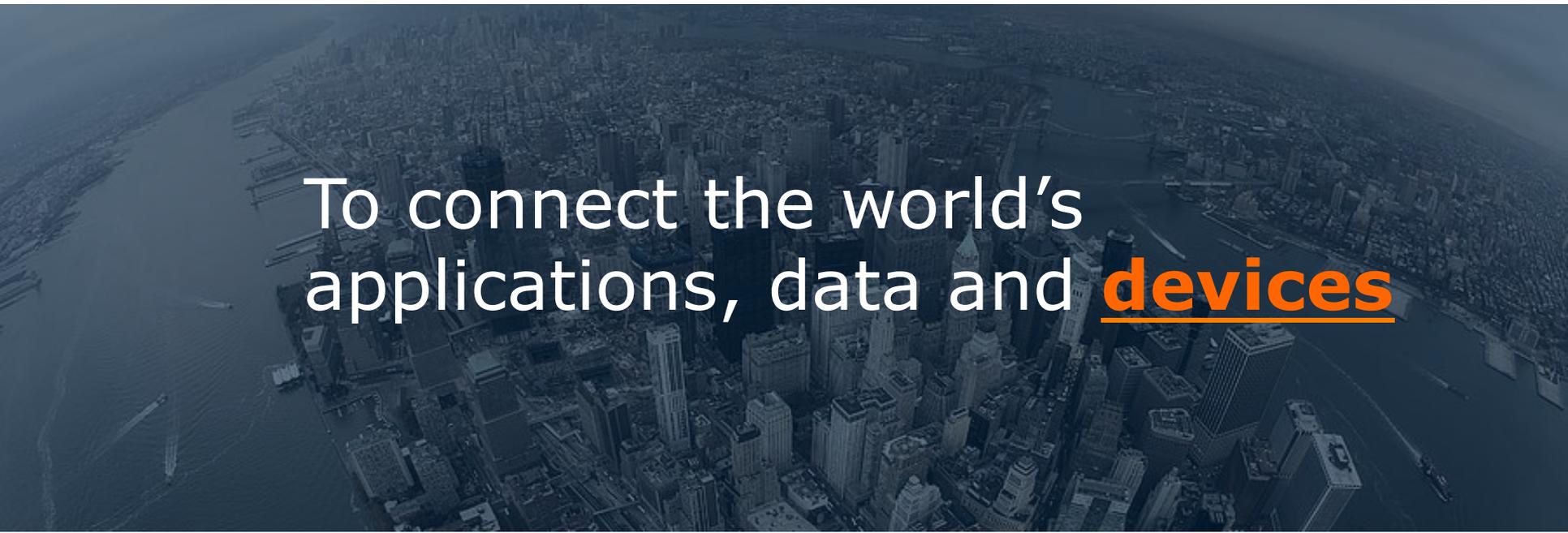
HQ in San Francisco with offices in New York, Atlanta, London, Rotterdam, Munich, Sydney, Singapore, Hong Kong, Buenos Aires, Rio De Janeiro



[www.mulesoft.com](http://www.mulesoft.com)

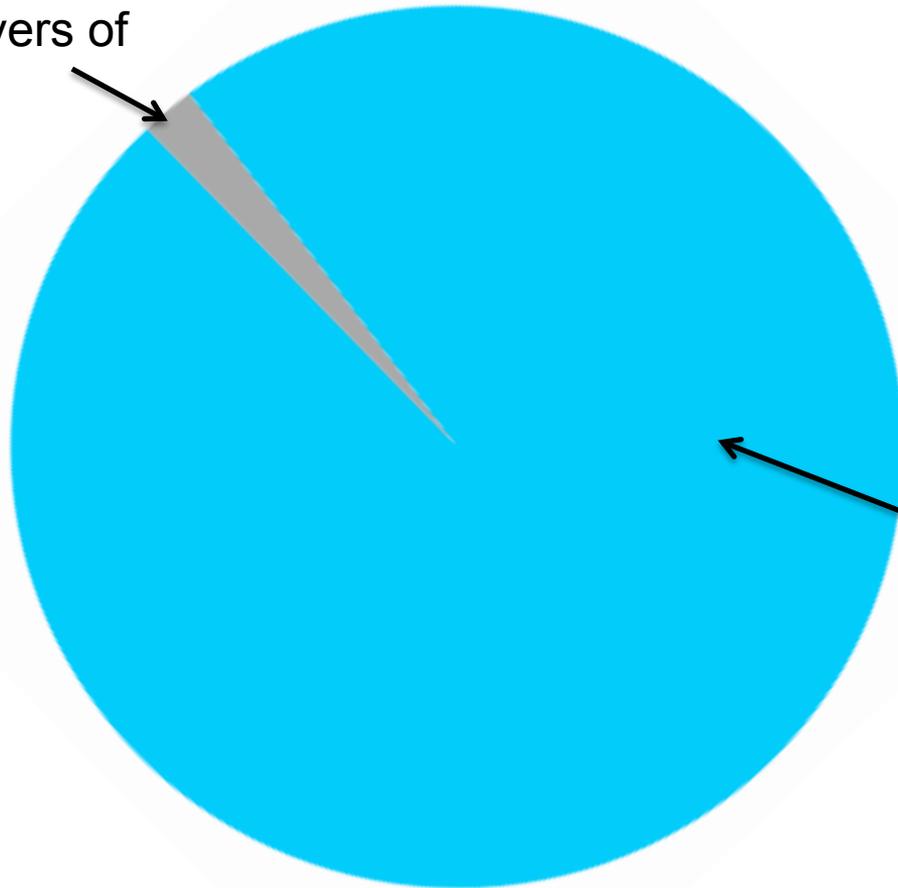


To connect the world's  
applications, data and devices

An aerial, high-angle view of a dense city skyline, likely New York City, with numerous skyscrapers and buildings. The image is overlaid with a semi-transparent dark blue filter. The text is centered over the city.

To connect the world's  
applications, data and **devices**

Business  
drivers of  
IoT



# Architectural Patterns in an IoT Stack

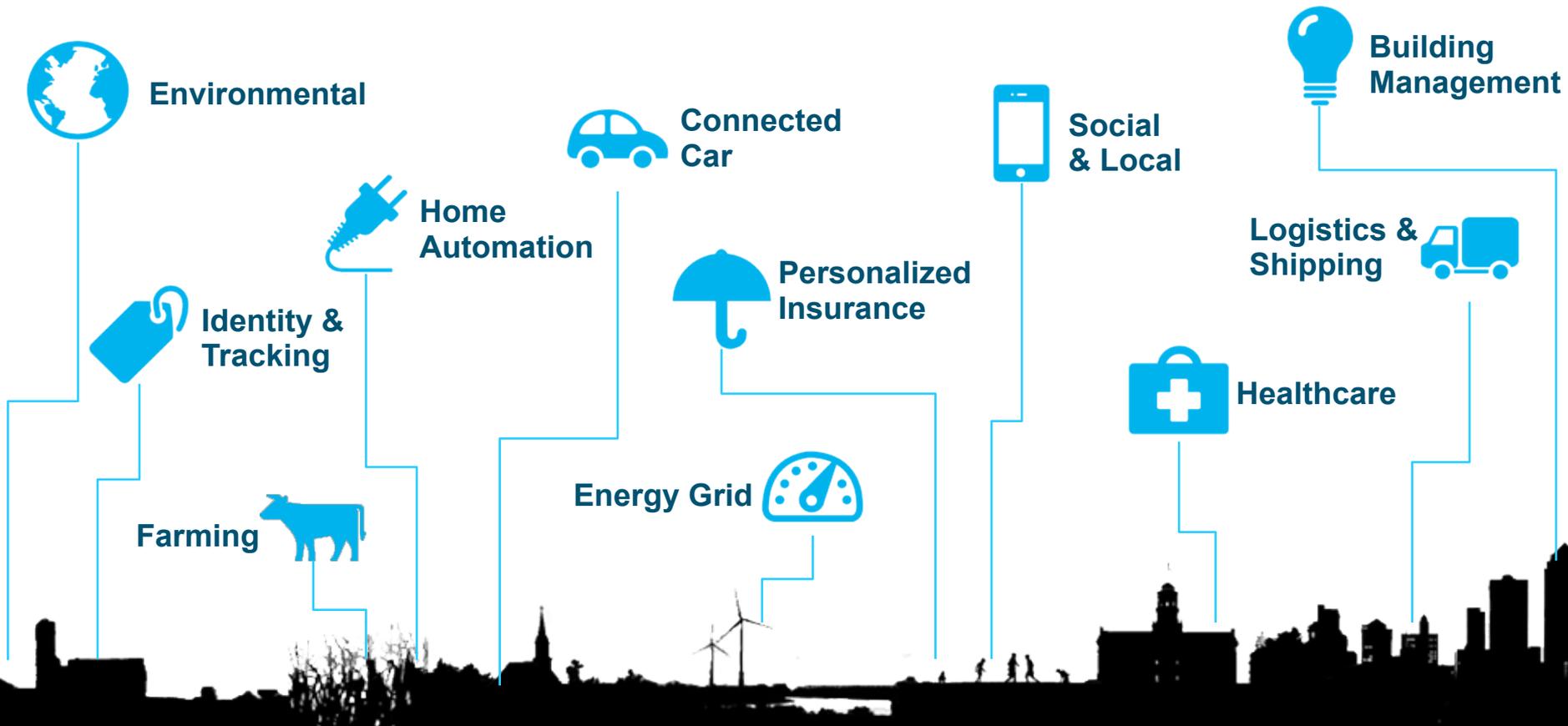
# Why plan for an IoT stack?

Everything needs to connect



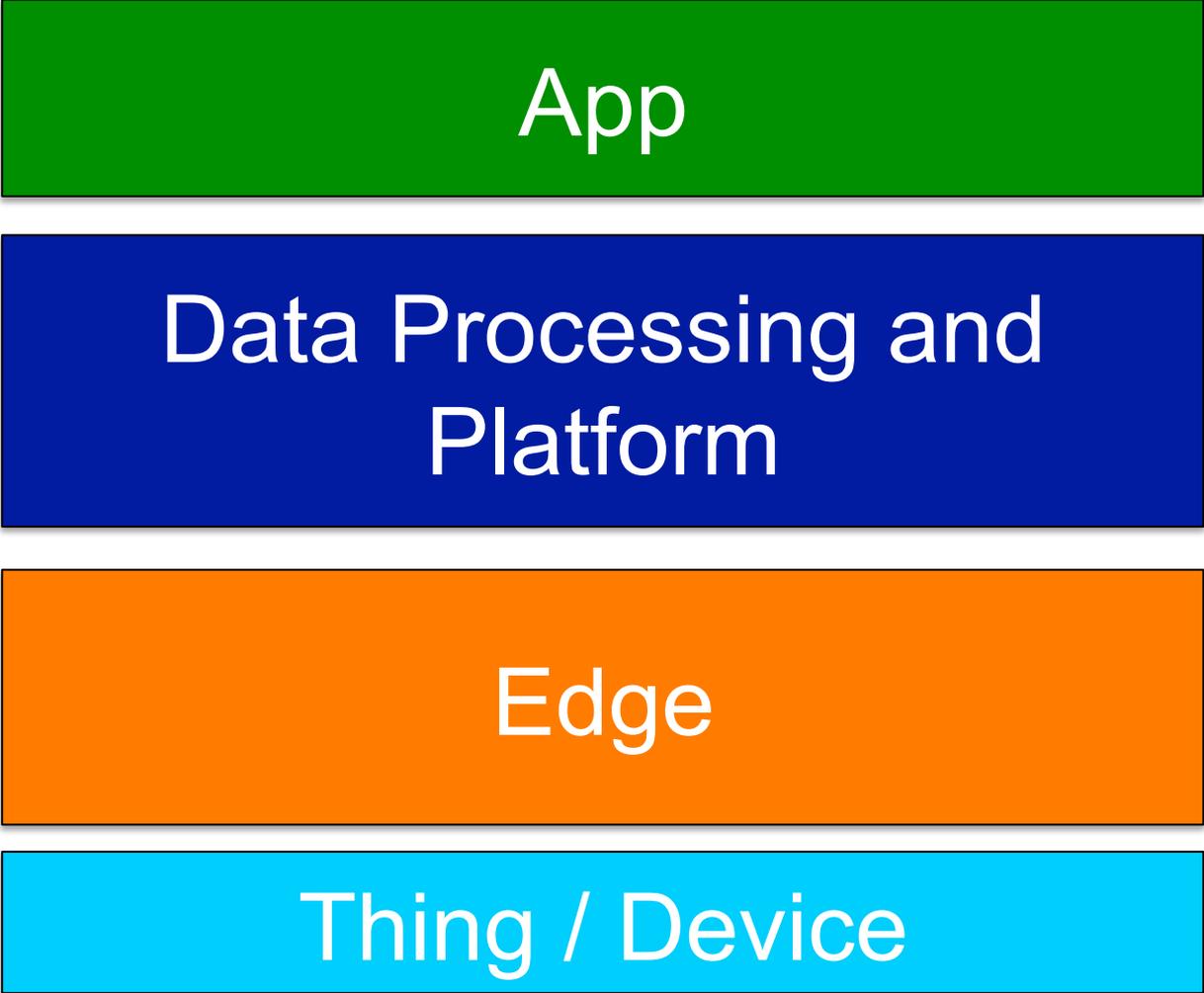
**50,000,000,000+**  
**connected devices**

# Connecting the physical world to the Web



# Architectural patterns in an IoT stack

At a high level this is the general IoT stack



App

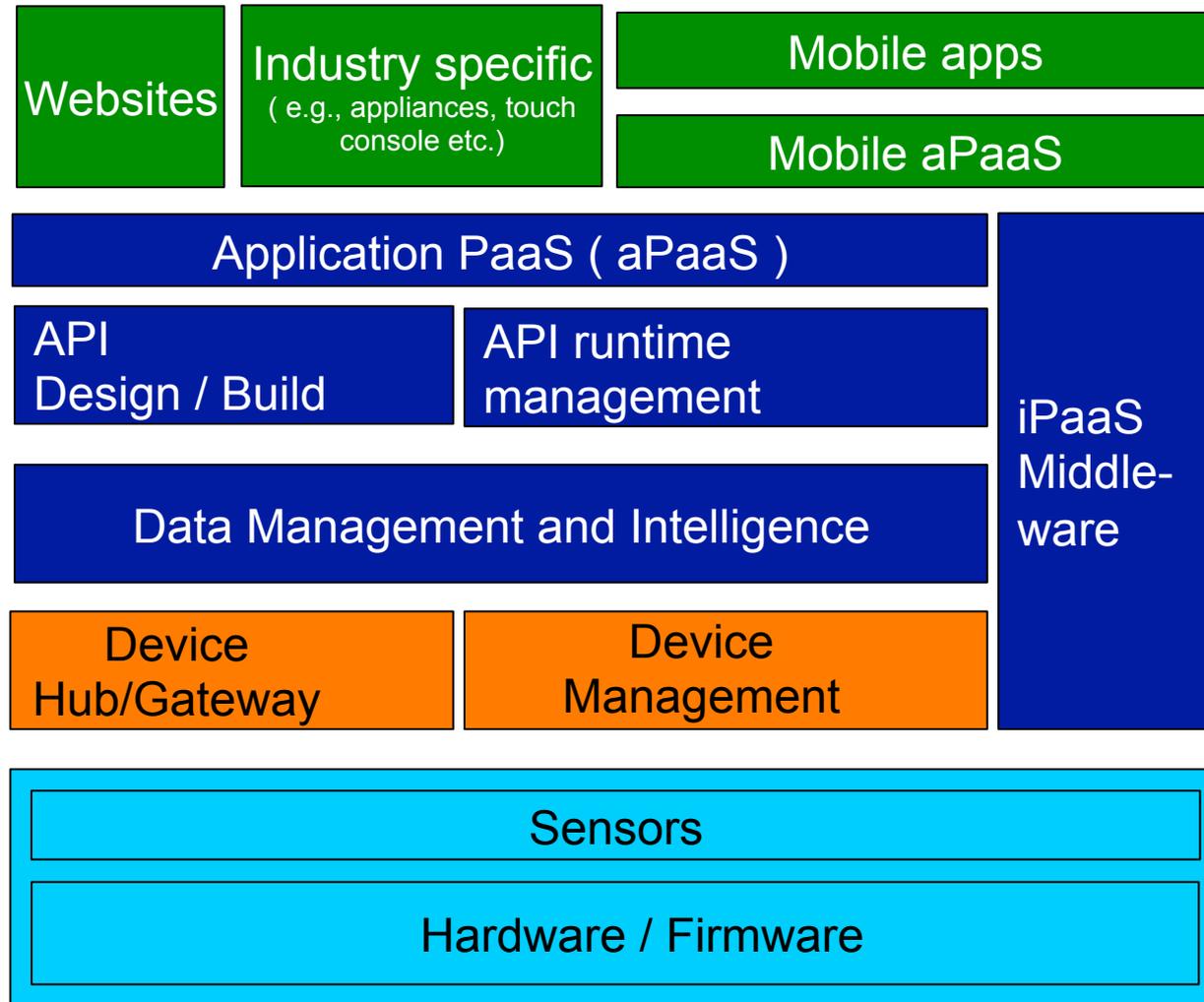
Data Processing and  
Platform

Edge

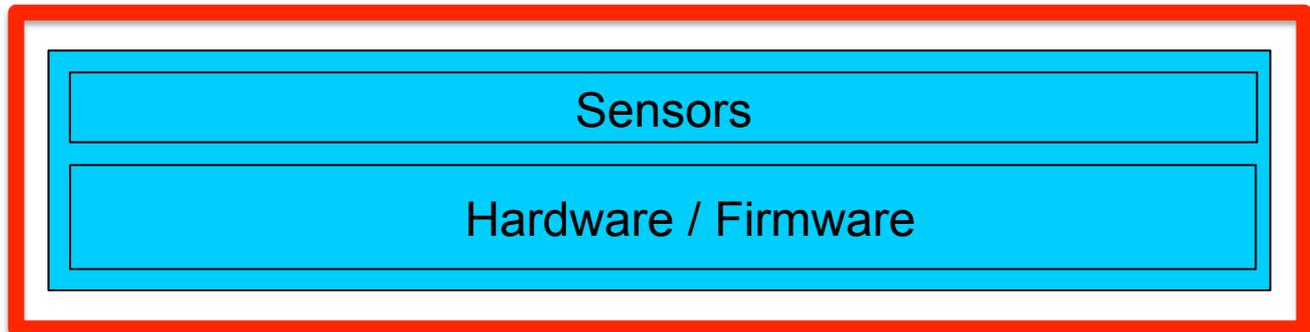
Thing / Device

# Breaking down the IoT stack

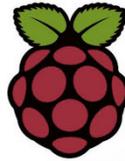
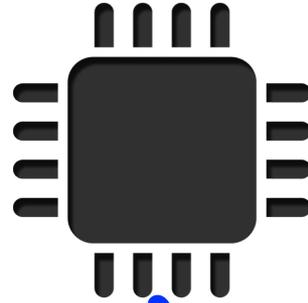
# The IoT Stack



# IoT Stack: Devices / Things



Devices: Many chipsets / platforms to choose from.  
( Becoming more and more vertically integrated with software stacks).



electric imp



# Big focus on prototyping: Lots of tools to cater to the makers and tinkerers

**Integrated SDKs to speed development, testing and optimization.**

MARVELL®



intel Galileo



electric imp



QUALCOMM®



# Dragonboard based on Snapdragon processor ( many more like this from many vendors )



RS 232 socket Ethernet HDMI 5M camera 1M camera

Snapdragon S3 APQ8060

Radio Card  
•WLAN  
•Bluetooth

Touch screen Display

Sensor Board  
•Pressure  
•Temperature  
•Proximity  
•Ambient Light  
•3-axis  
-Accelerometer  
-Gyro  
-Compass

Keyboard

JTAG x2 pin socket  
Micro SD slots  
Mini USB Port  
3.5 mm Audio Jack



# Sensors: Smart or Simple



## Smart Sensors

Onboarding

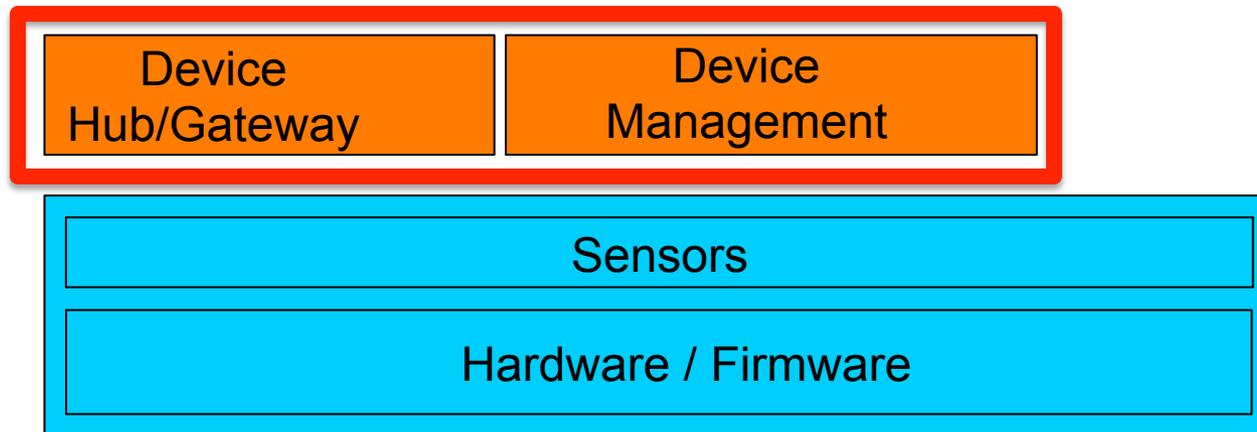
Receive Notifications

Receive Config

Send Data / Events

Simple Sensors

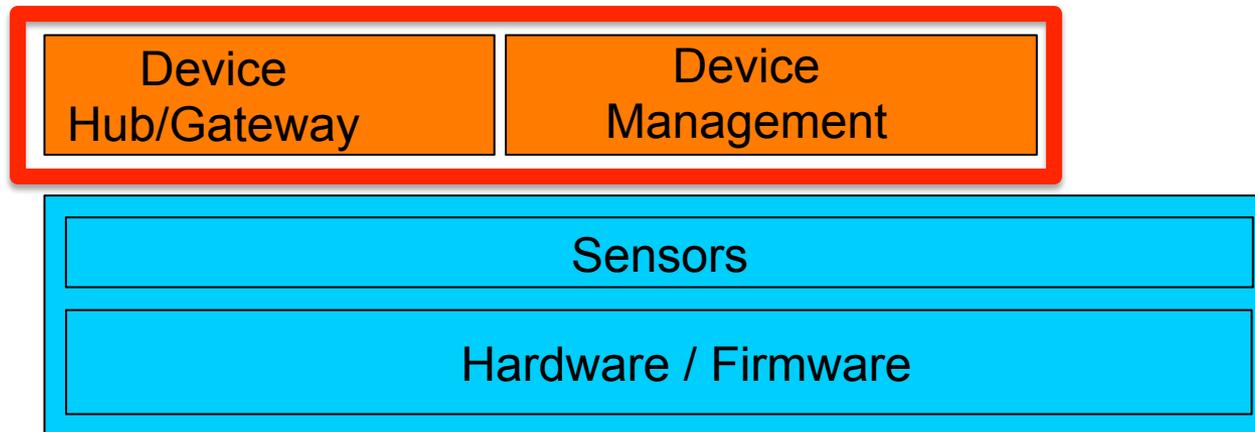
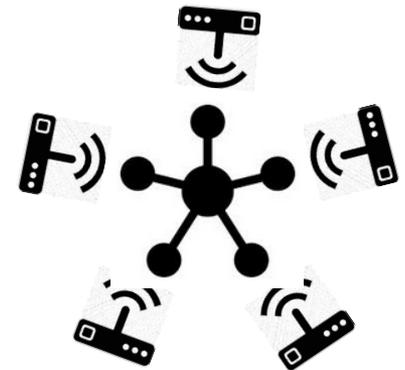
# IoT Stack: Device Edge



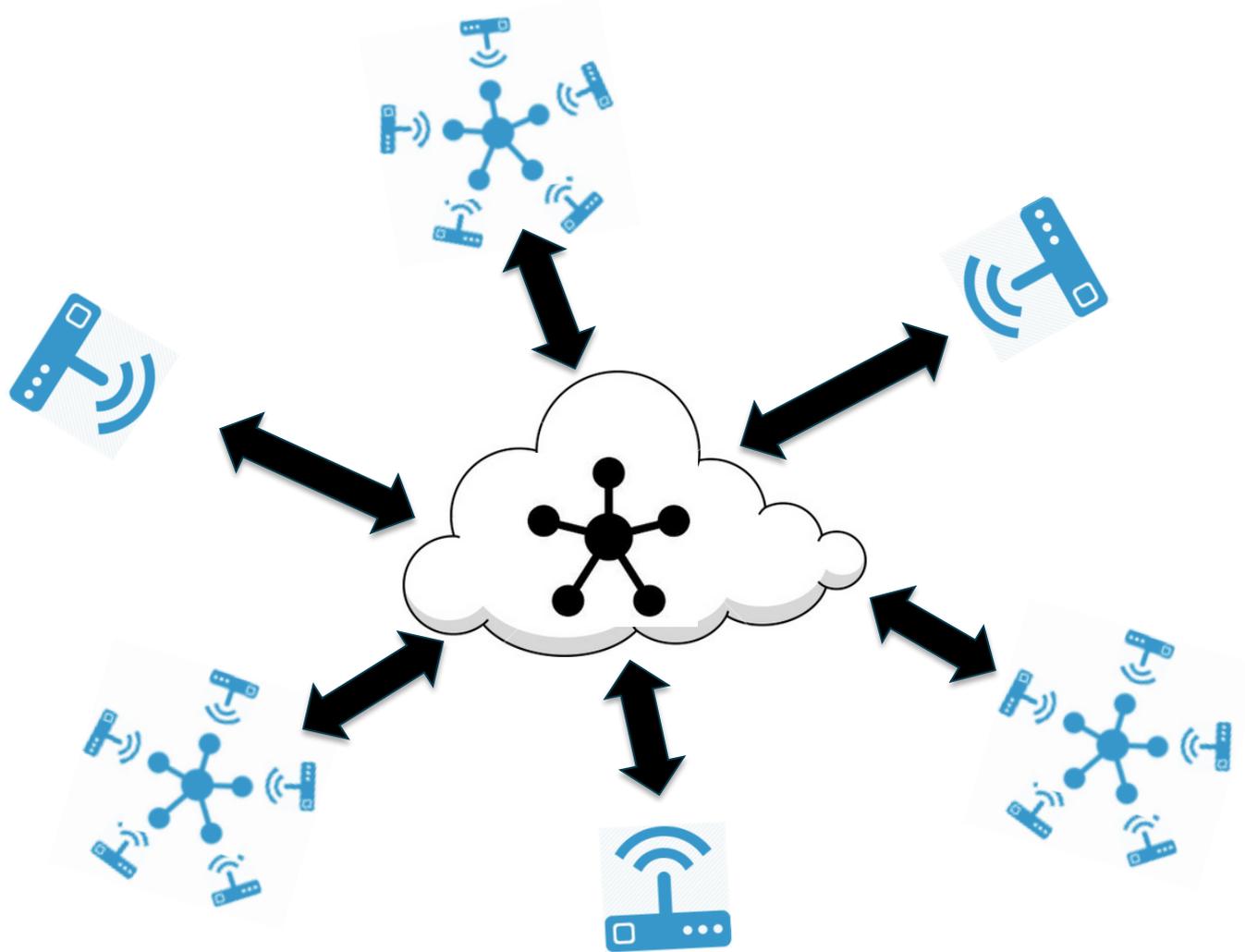
# IoT Stack: Device Edge

Key charter is to establish and maintain a secure, robust, fault-tolerant connection between the cloud and the edge devices in order to:

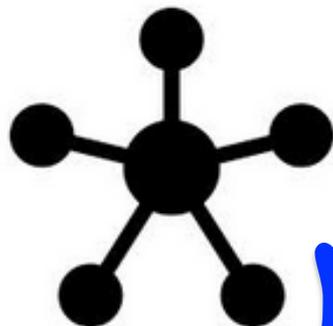
- Collect and aggregate device data
- Manage the device



Typically a combination of a localized gateway, and a cloud based gateway, at the edge



# Reference capabilities for a gateway



Enable scalable, real-time, dependable, high-performance and interoperable data and device management related exchanges between publishers and subscribers

Connectivity

Software mgmt

Registry

Routing

Control Events

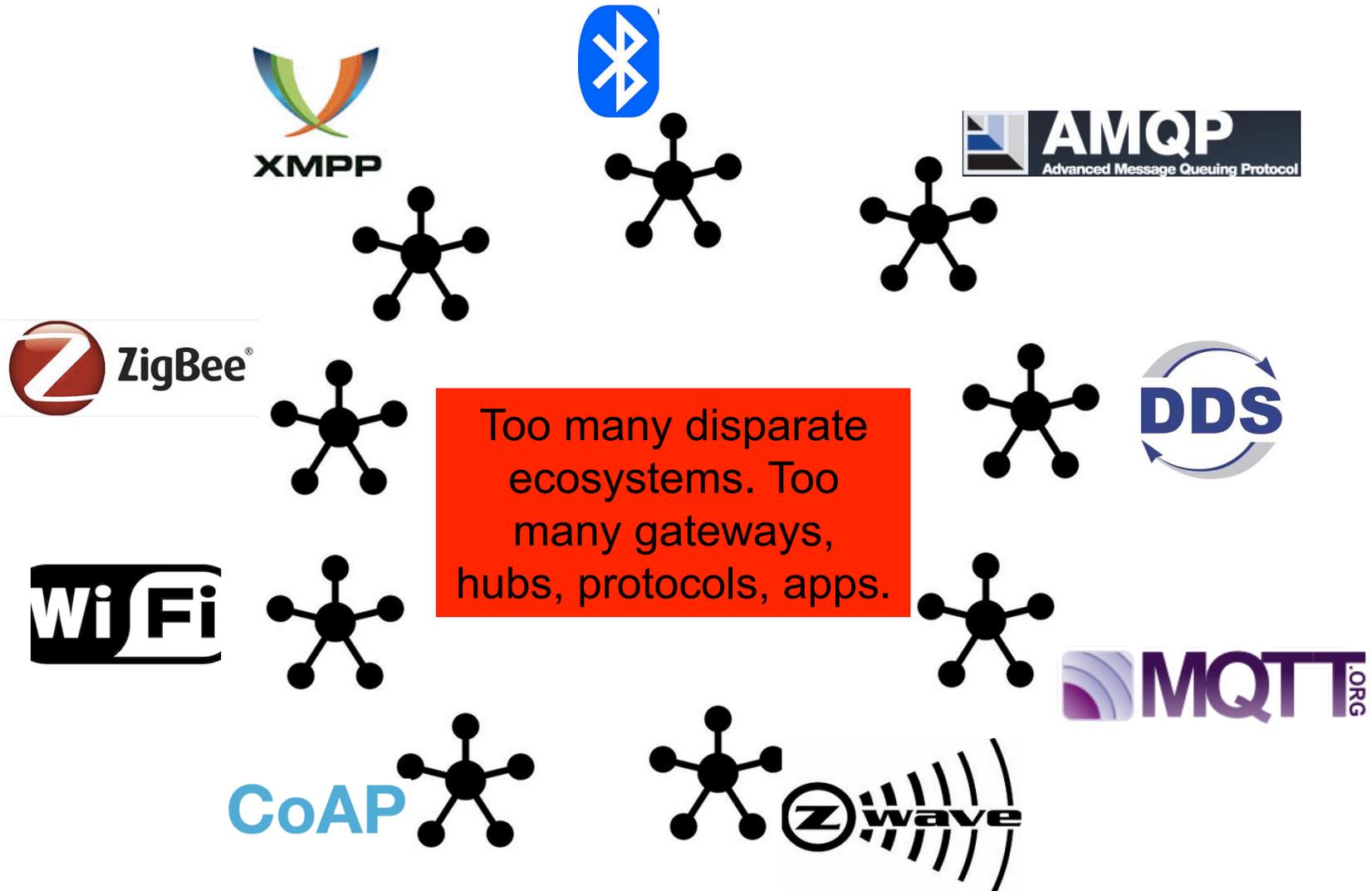
Actuator

Aggregation

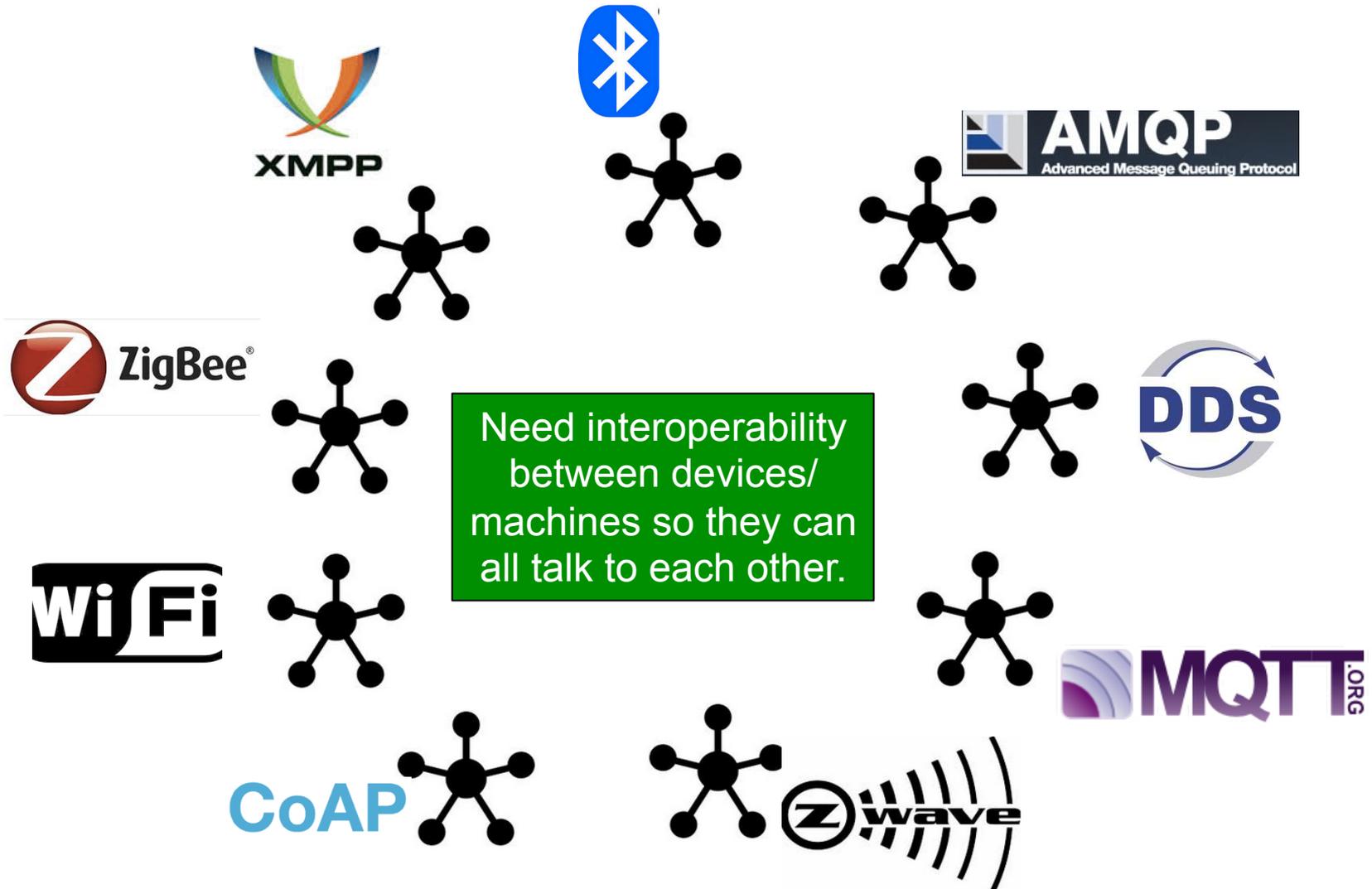
Transformation

Provisioning

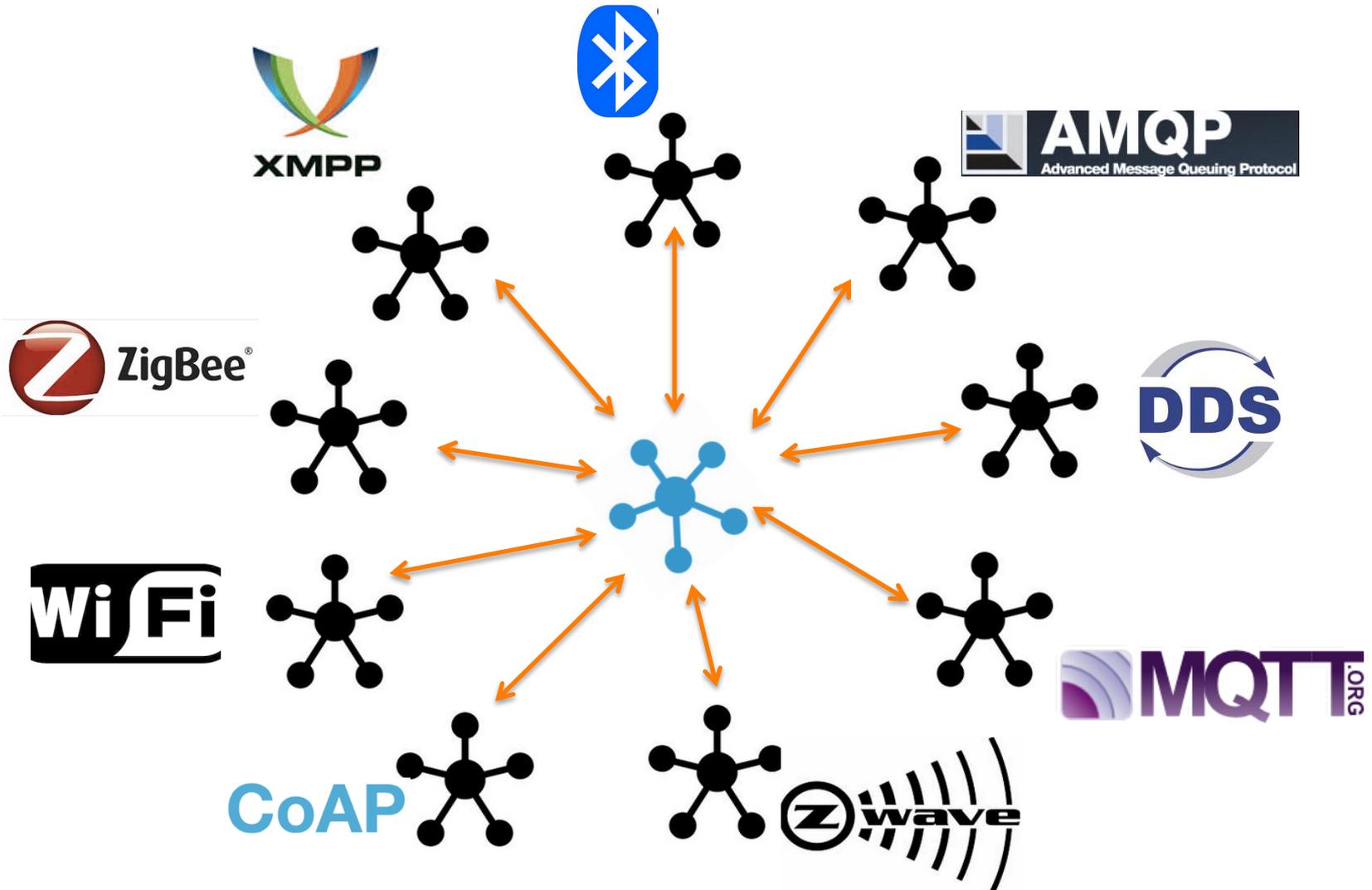
# Device, and Device gateway sprawl is going to be a challenge



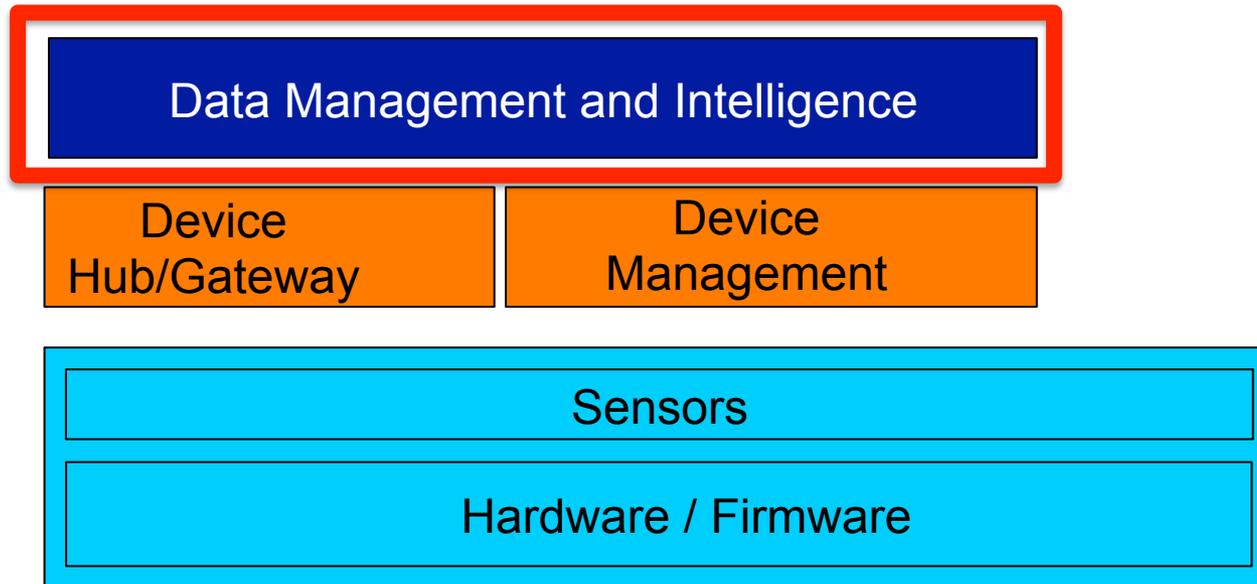
# Solution to the sprawl: A hub of all hubs



# Solution to the sprawl: A hub of all hubs



# IoT Stack: Data management and intelligence



# Capabilities required for Data Management and Intelligence



- Data collection, storage, and analysis of sensor data
- Run rules on data streams
- Trigger alerts
- Advanced analytics/machine learning
- Expose HTTP (REST) APIs

Data, HTTP,  
connectivity

Data enrichment

Pattern Discovery/  
Model re-training

Real time event  
processing

Routing and  
Orchestration

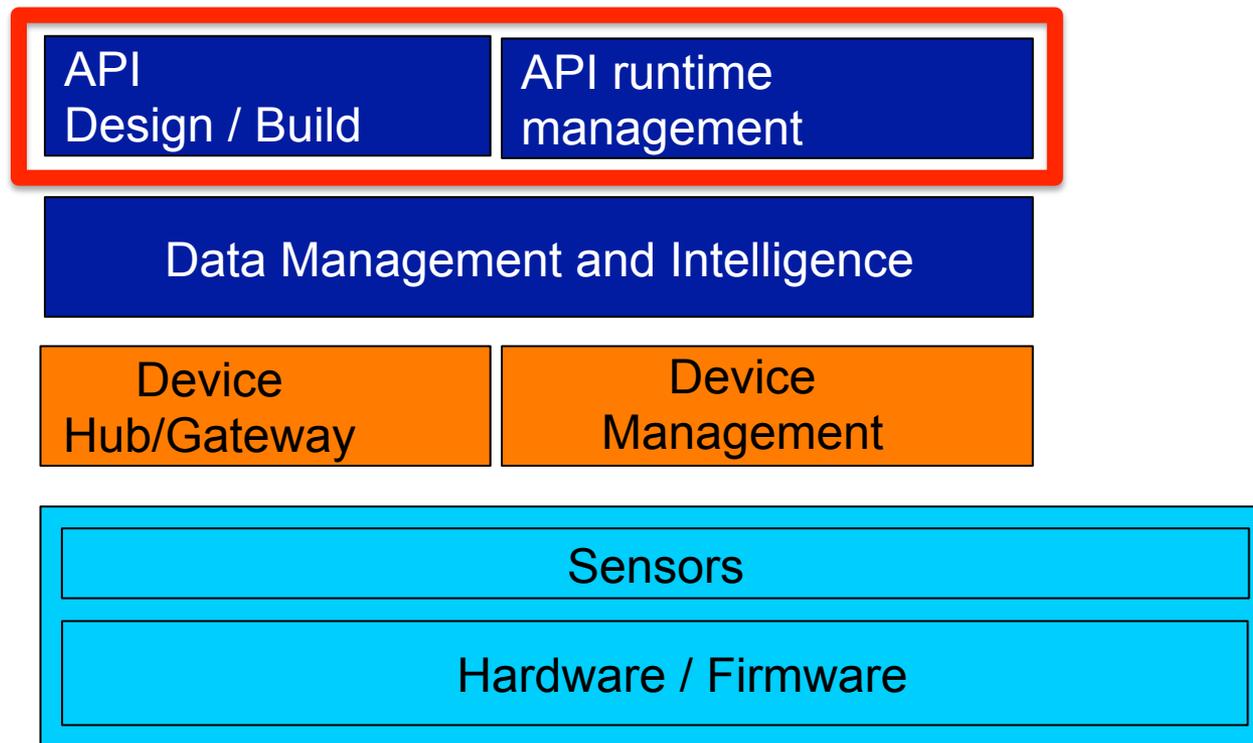
Driving Forces  
Identification

Batch processing

BigData solution  
connectivity

Predictive Analysis

# IoT Stack: API lifecycle tooling and platform



API lifecycle tooling can be split between design time and runtime

Rapidly design, deploy and publish APIs

API  
Design / Build



API runtime  
management



# API lifecycle: Design time capabilities

## Rapidly design, deploy and publish APIs

API  
Design / Build



API runtime  
management



API design  
lifecycle

API spec  
creation

Reusable API  
patterns

API mocking/  
modelling

Deployment  
automation

# Outside In API development: What if we could whiteboard an API? Springboard for optimizing “APX”

API  
Design / Build



# APX Design Lifecycle

API  
Design / Build



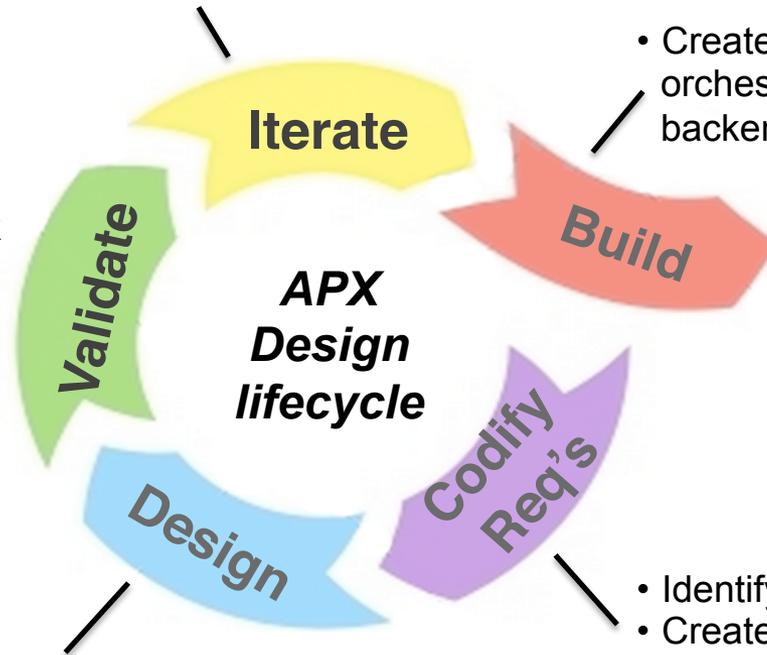
- Mock up the API
- Publish interactive console
- Create Notebook use cases
- Receive developer feedback

- Modify API design as appropriate based on developer feedback.
- Continue to validate

- Create and implement orchestration logic for backend connectivity

- Model API resource models
- API operations/methods
- Request/response payload/codes

- Identify process and biz reqs
- Create logical data model
- Translate into logical service/API groupings



# API lifecycle: Runtime capabilities

## Rapidly design, deploy and publish APIs

API  
Design / Build



API runtime  
management



Rate limiting /  
Throttling

Multi-tenant org /  
RBAC support

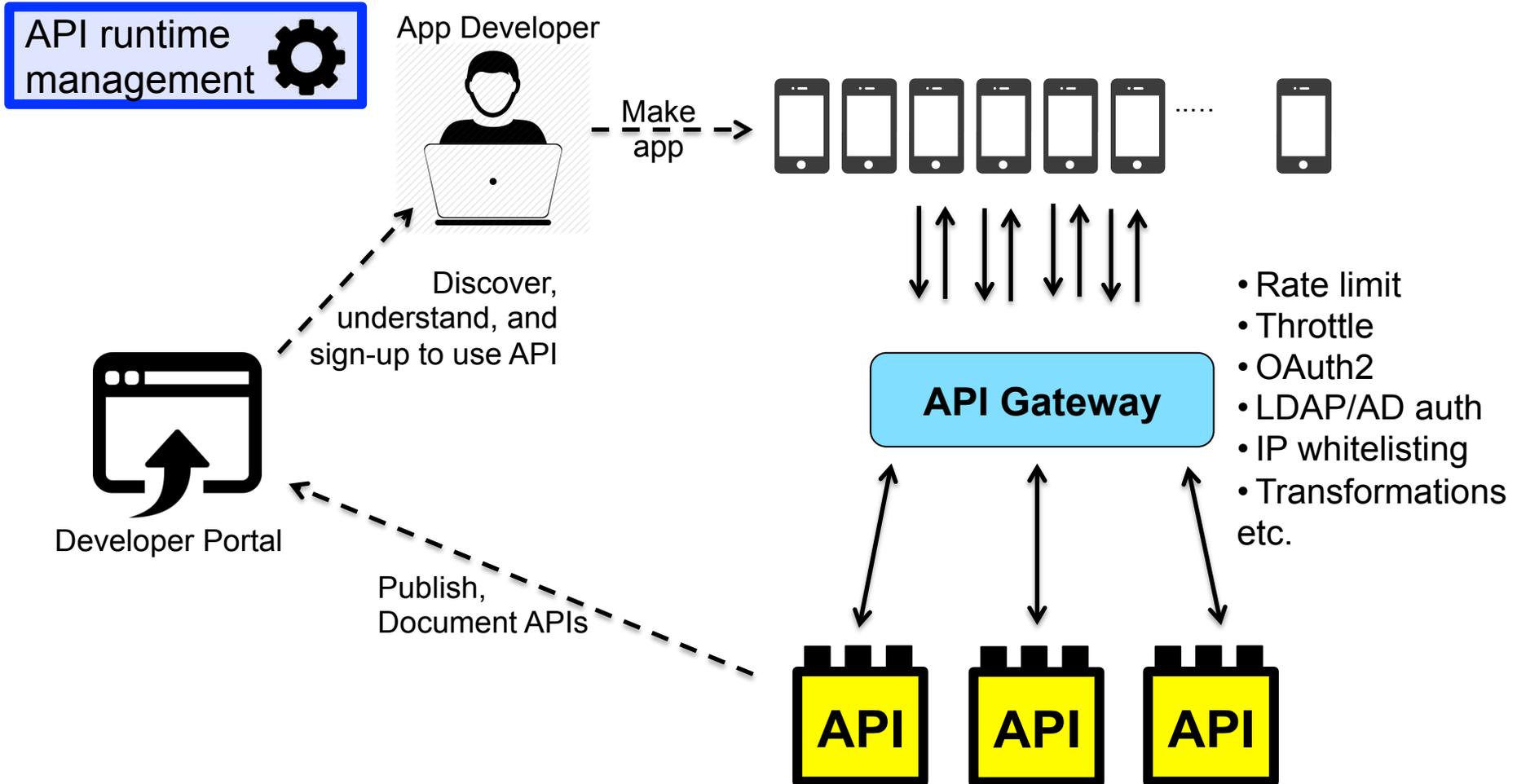
API SLA  
management

Deployment  
automation

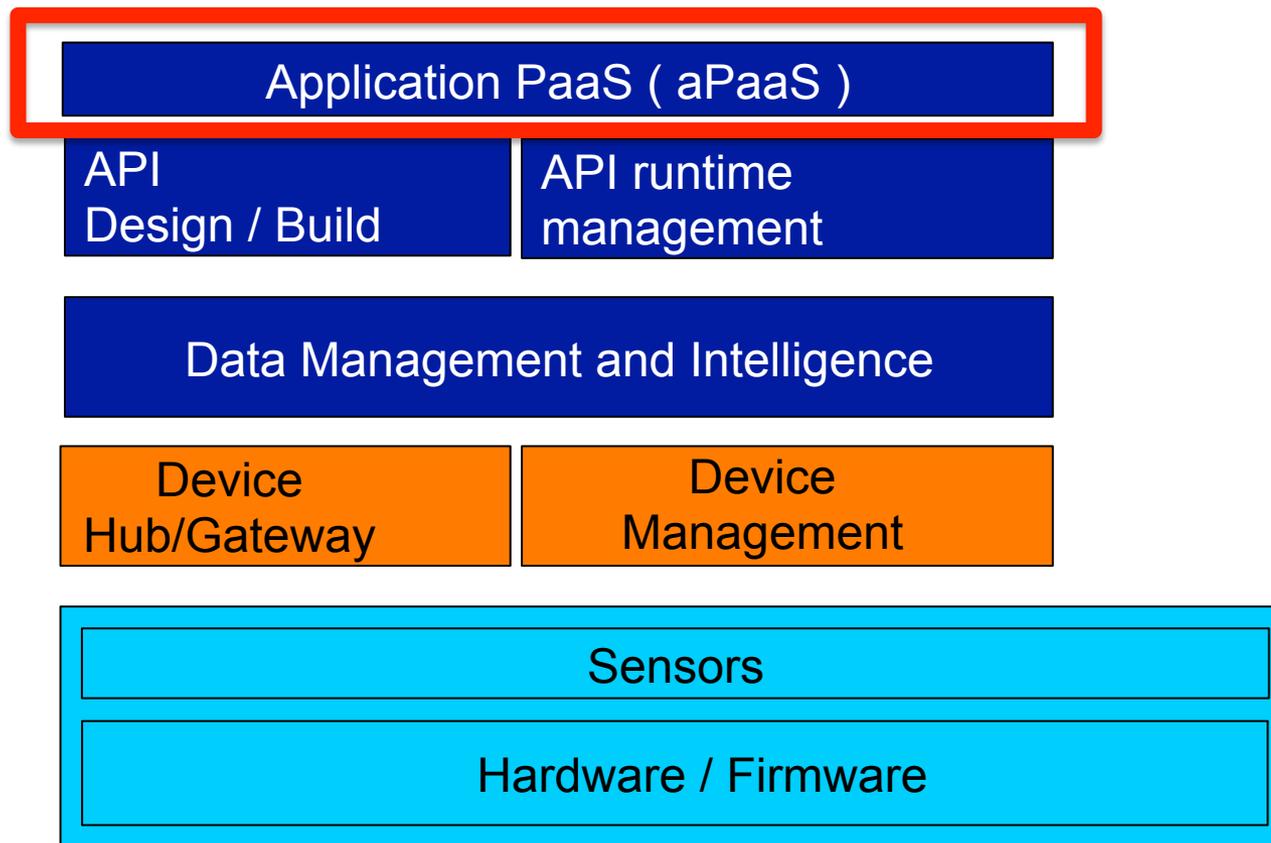
Custom policy  
engine

API and data  
security

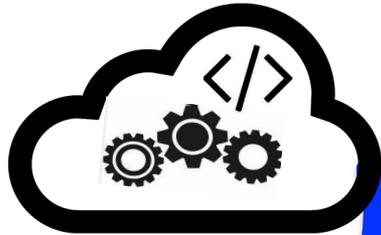
# API runtime management



# IoT Stack: Application PaaS ( aPaaS )



## Application PaaS ( aPaaS )



- Hosted in the cloud
- Provides platform to build applications.

OS/DB, Storage, Server,  
Network

Design and  
Development tooling

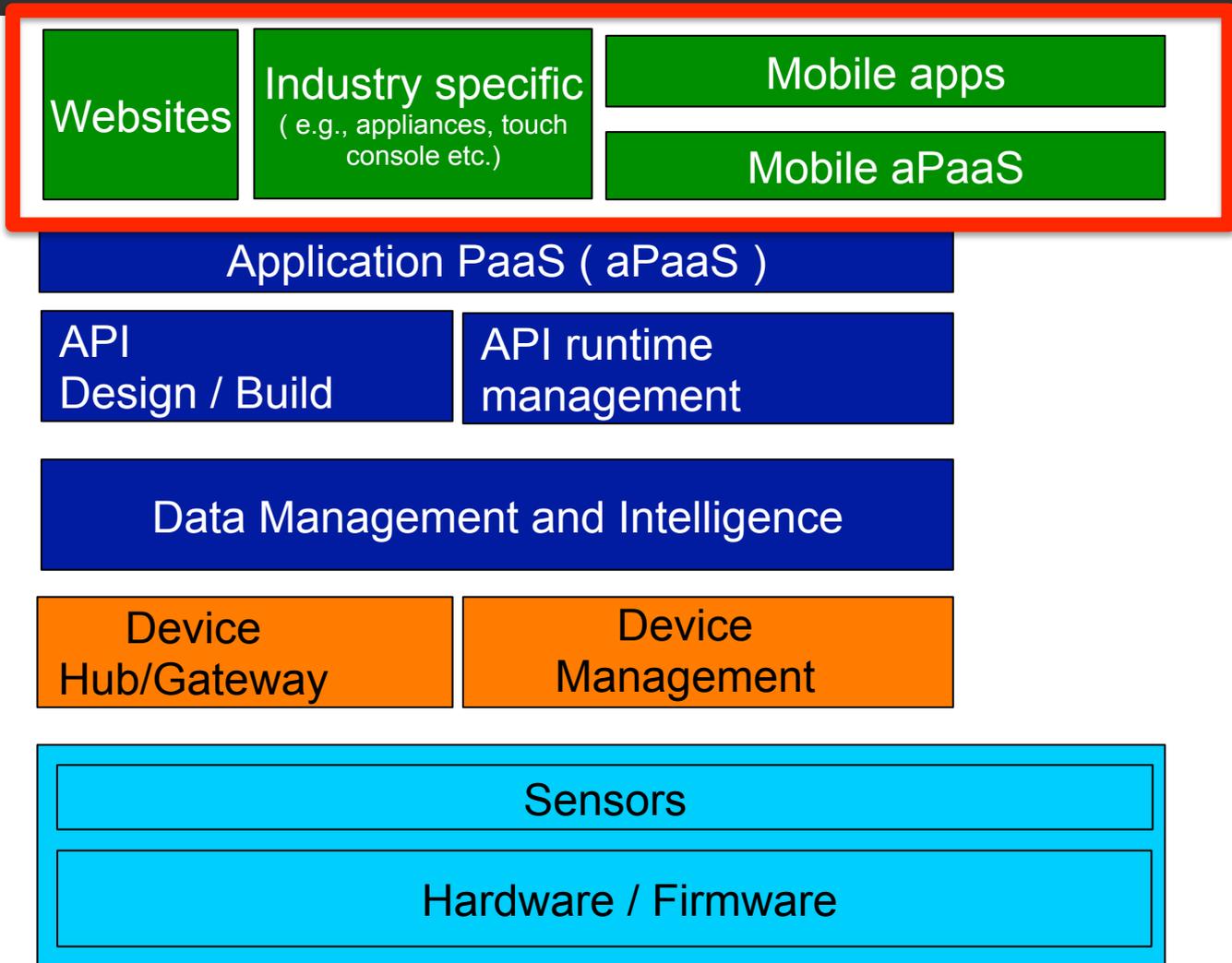
Management and  
analytics tooling

Routing, transform,  
orchestration services

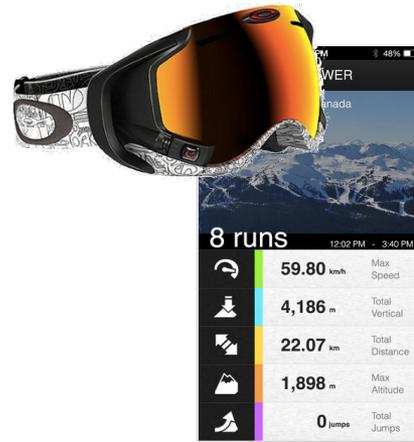
Web, Database,  
Application Server

Administrative portal

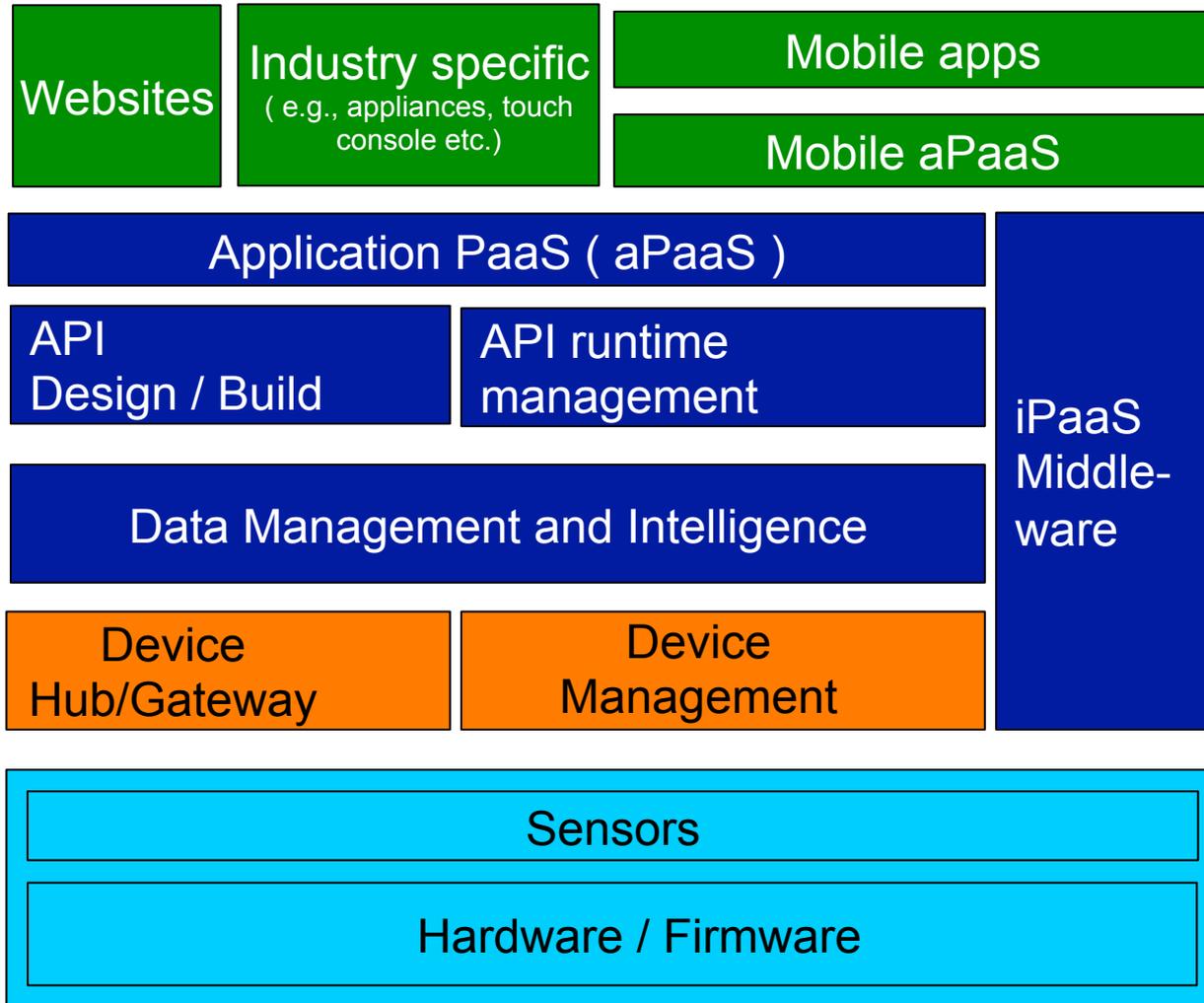
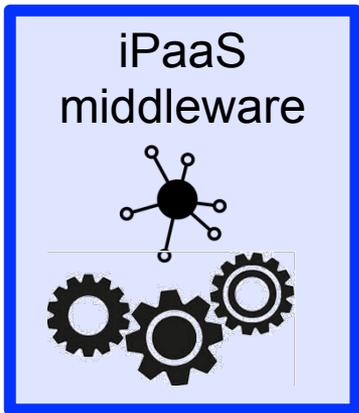
# IoT Stack: End applications



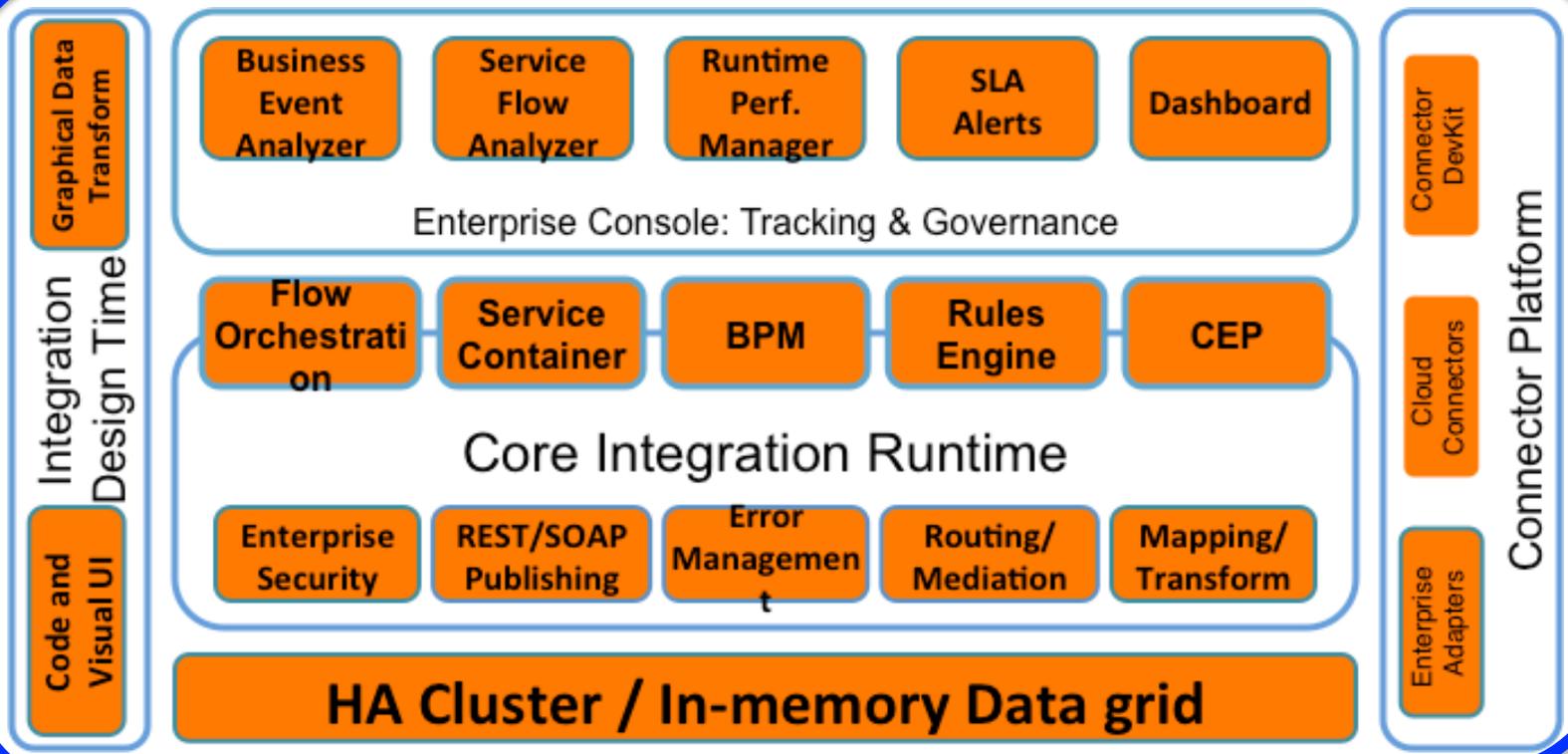
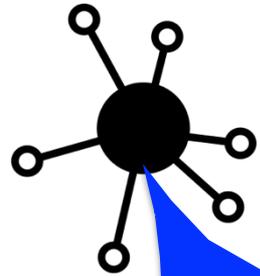
# IoT/loE is a driver of mobile / tablet interfaces



# IoT Stack: iPaaS integration – middleware: Don't forget to integrate!



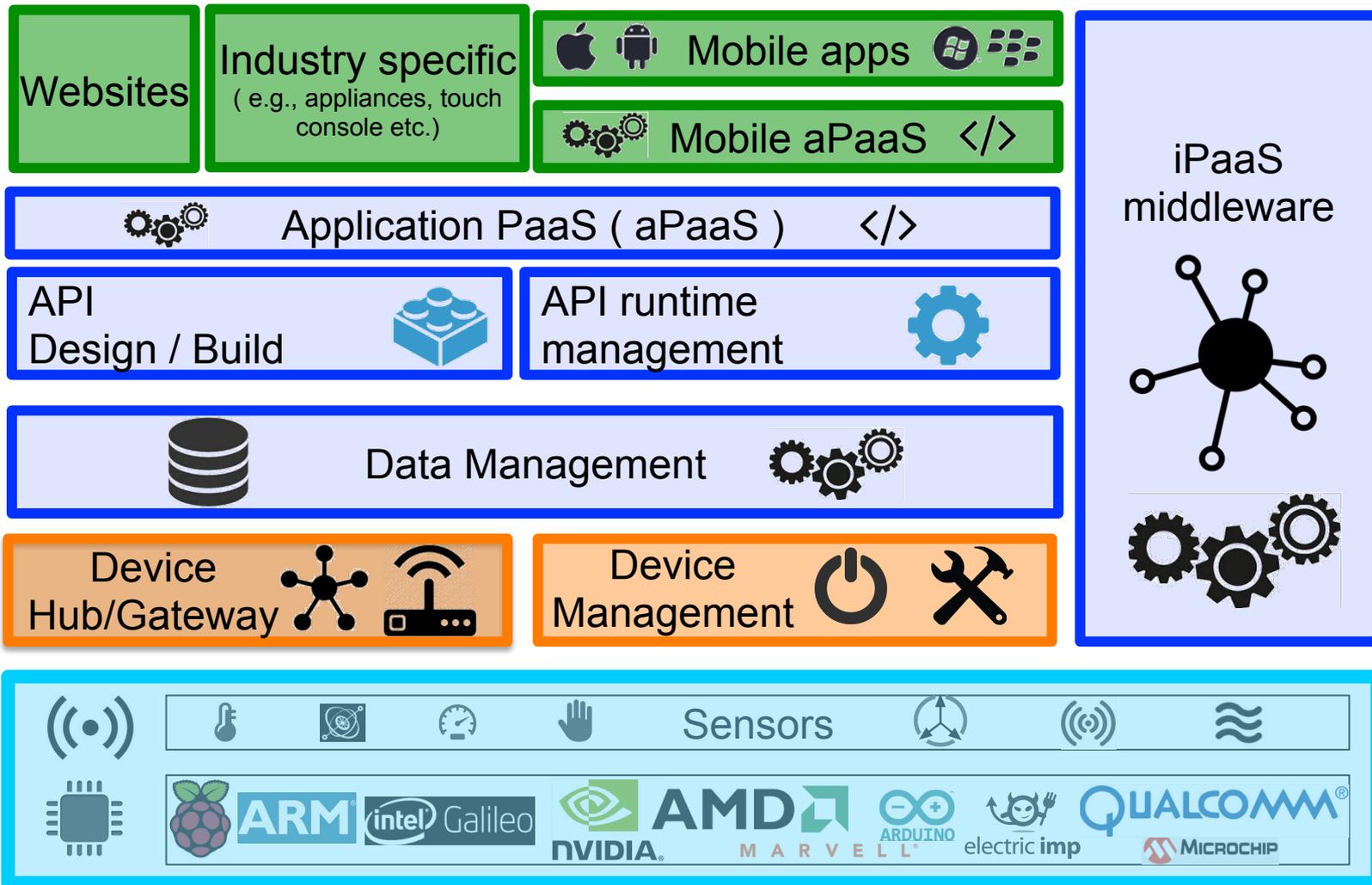
# iPaaS Capabilities: Don't forget to integrate!



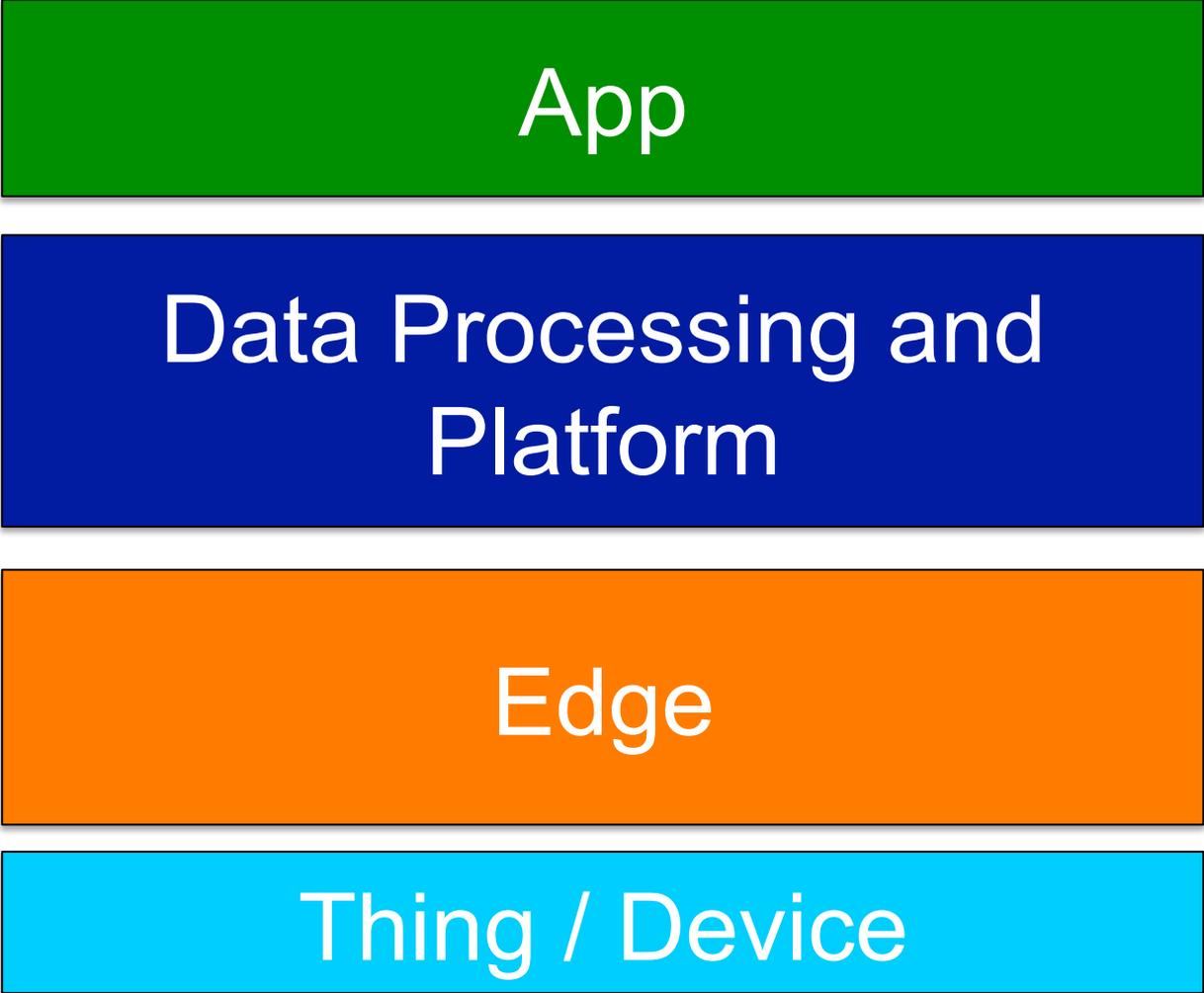
# Summary



# IoT Stack



One final thought: the stack as it exists today is also converging...



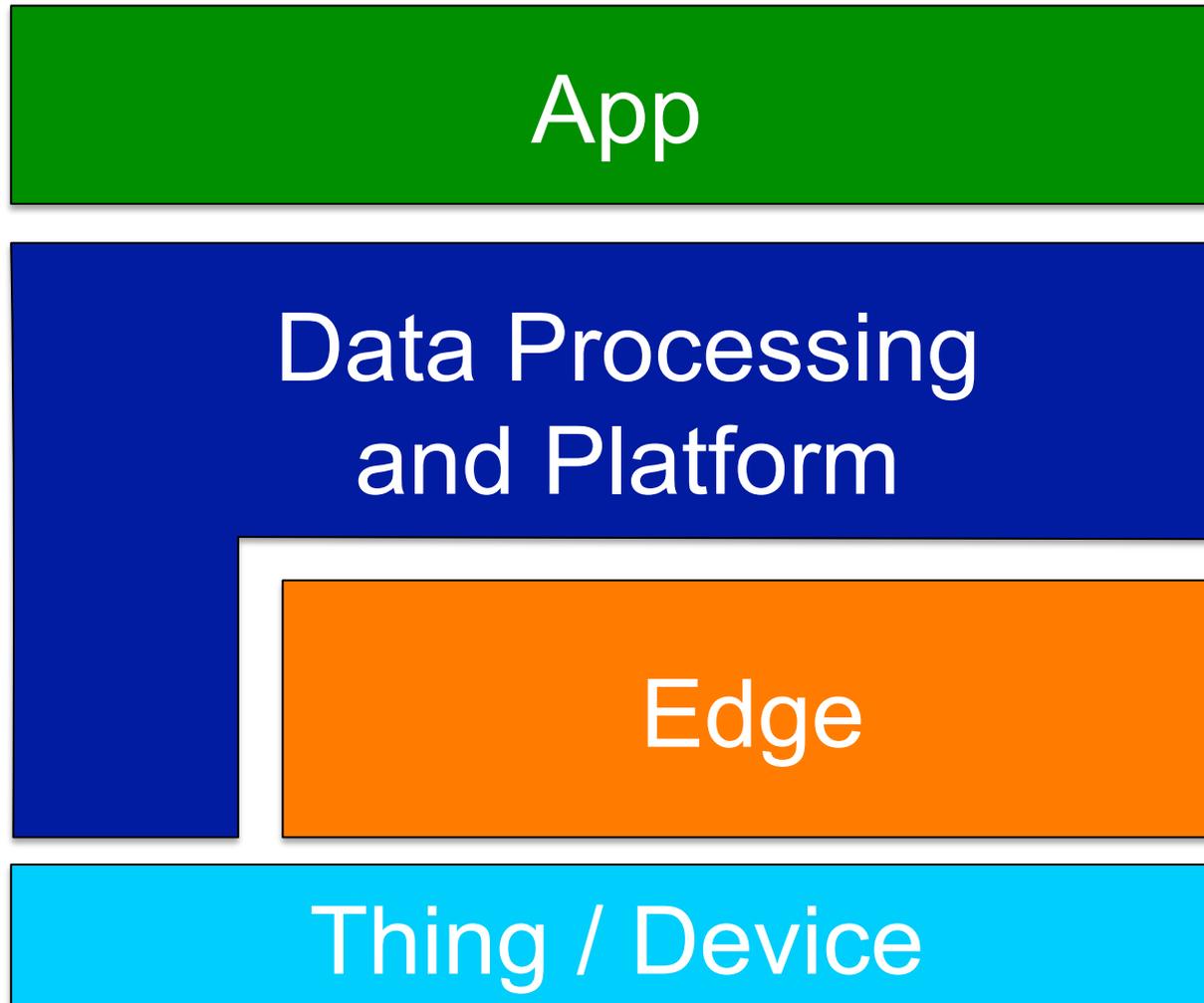
App

Data Processing and  
Platform

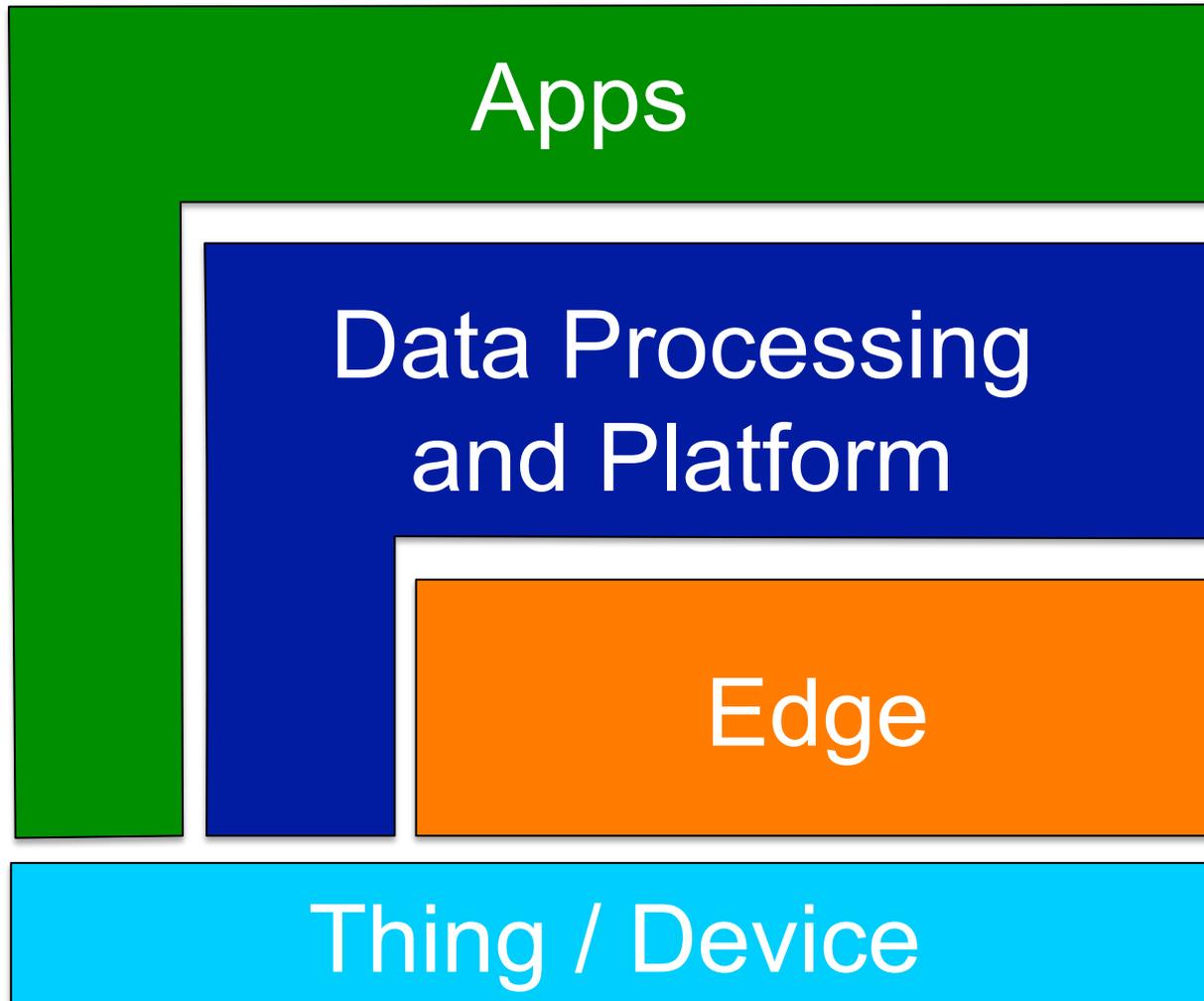
Edge

Thing / Device

# Scenarios where the middleware and edge have converged ( i.e., MuleSoft Anypoint Edge )



And there are also scenarios where the app layer is directly connected to the Thing/Device layer ( i.e., embedded Android, Java, Javascript etc. )



Thank you!

Questions?

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