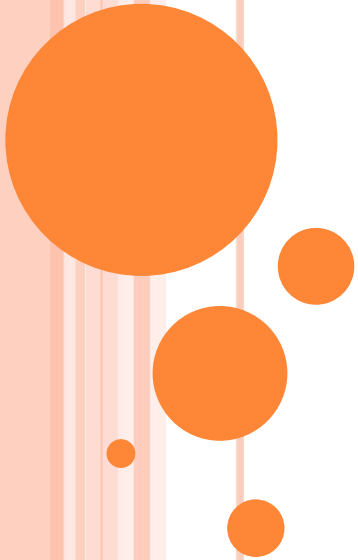
Architecture



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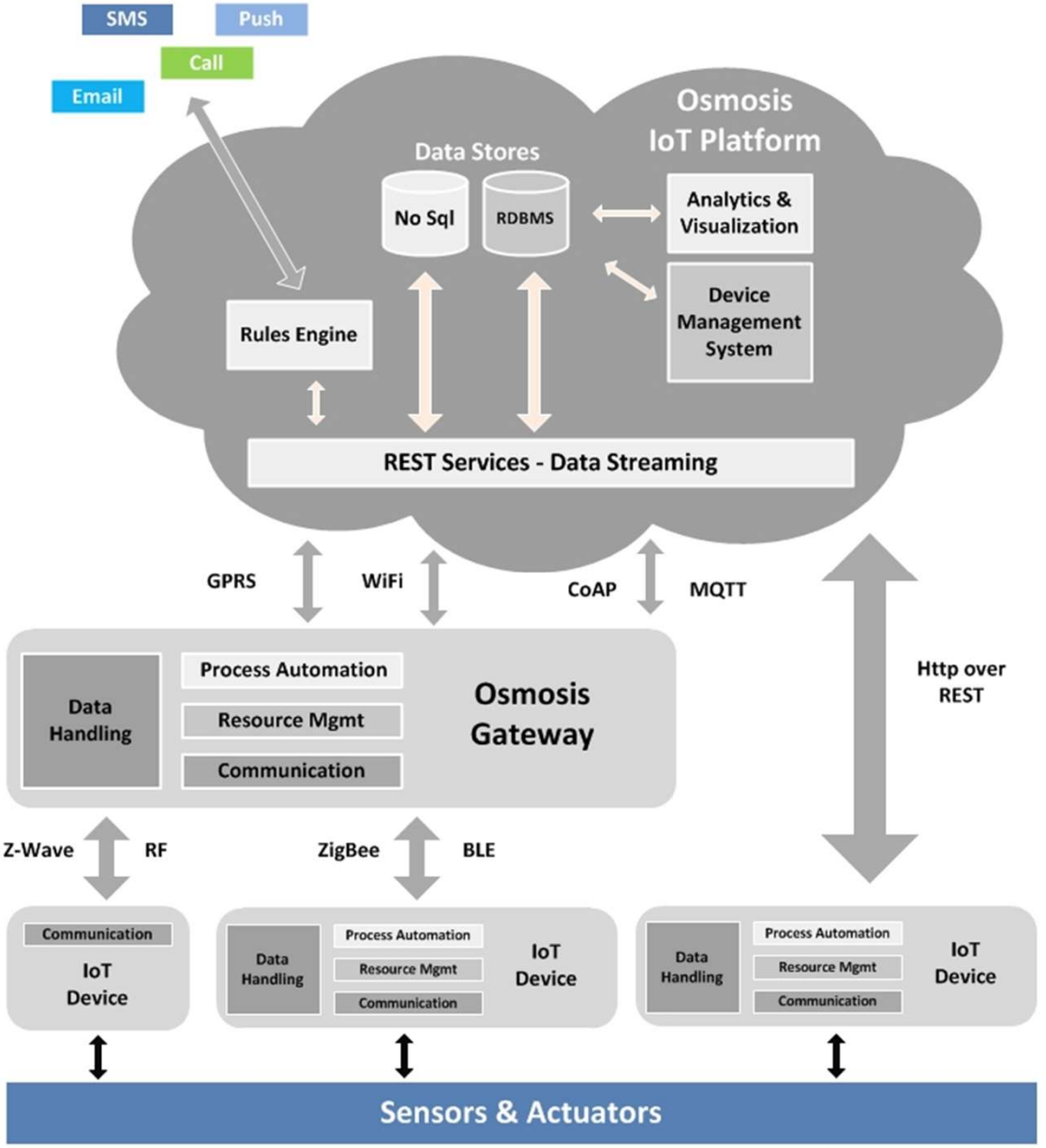

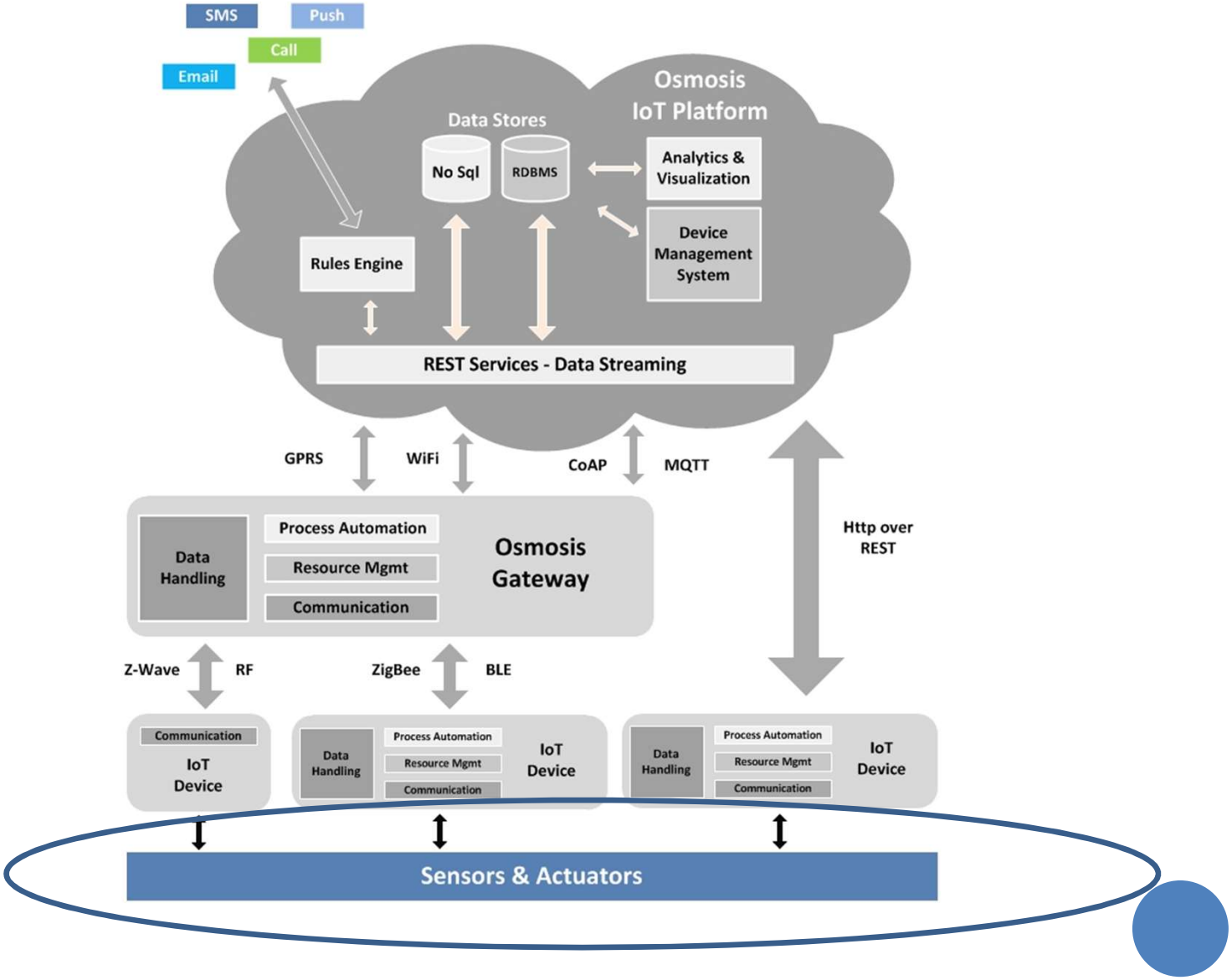
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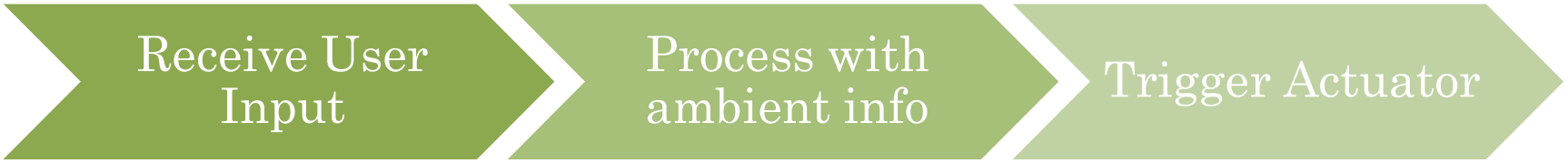
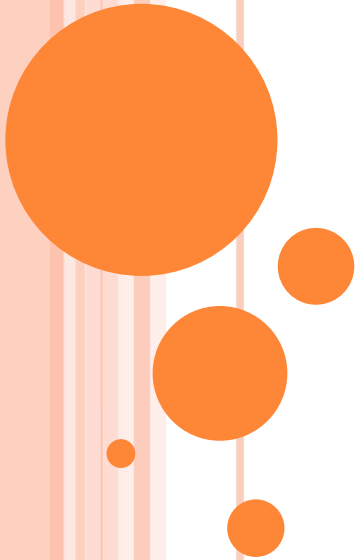
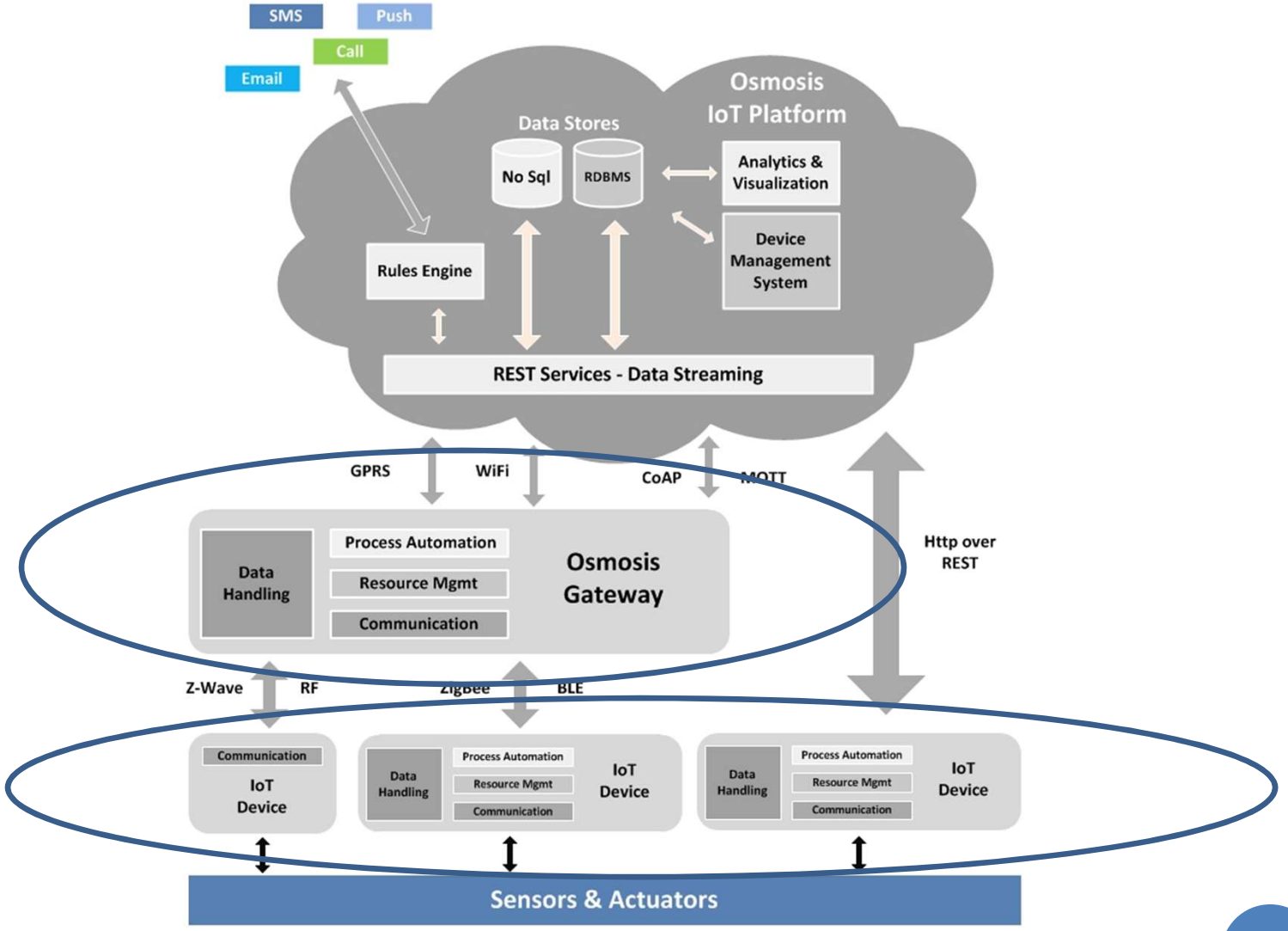
Communication Flow



Hardware

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Hardware

Types

- Microcontrollers
- Microprocessors
- SoCs

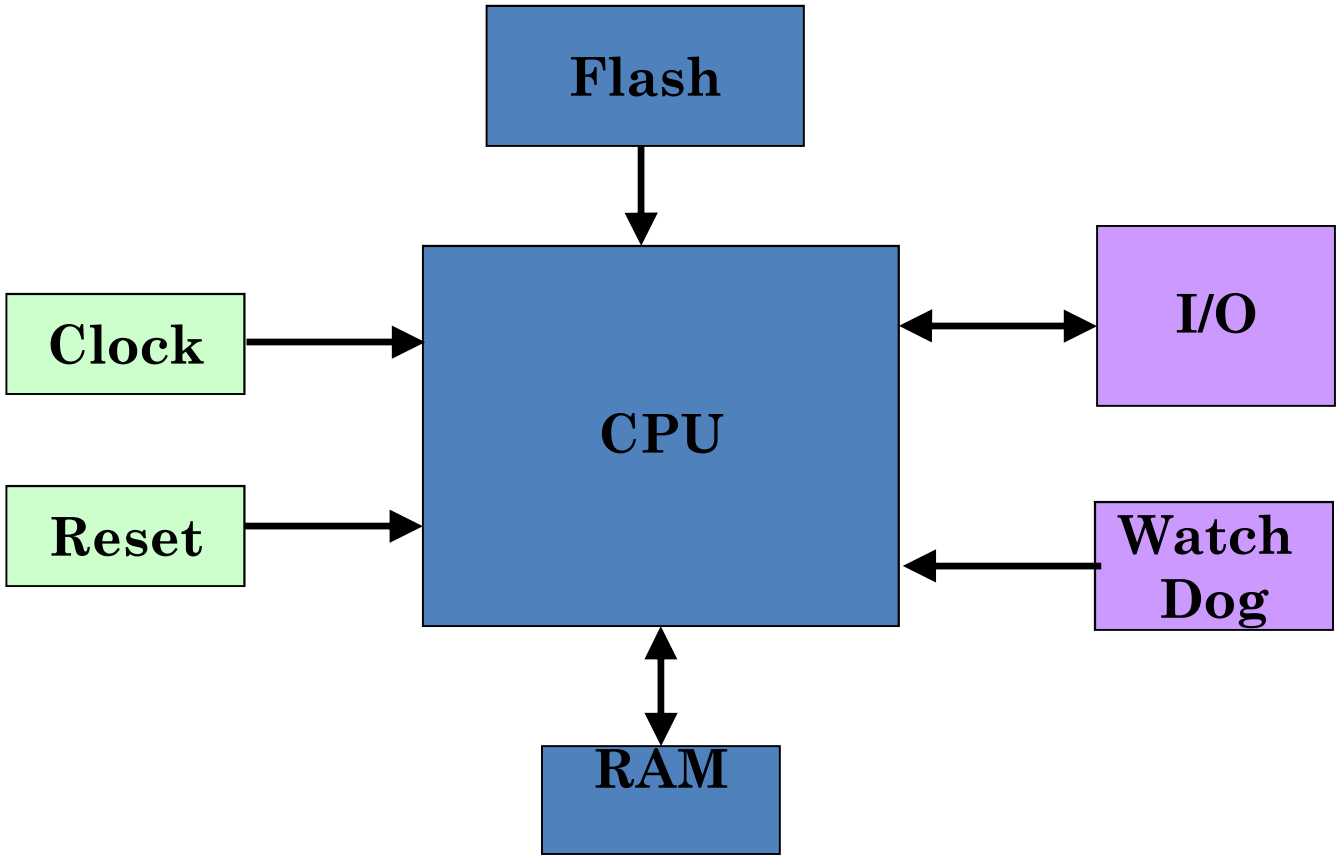
Chip Vendors

- ARM
- Atmel
- TI
- Intel

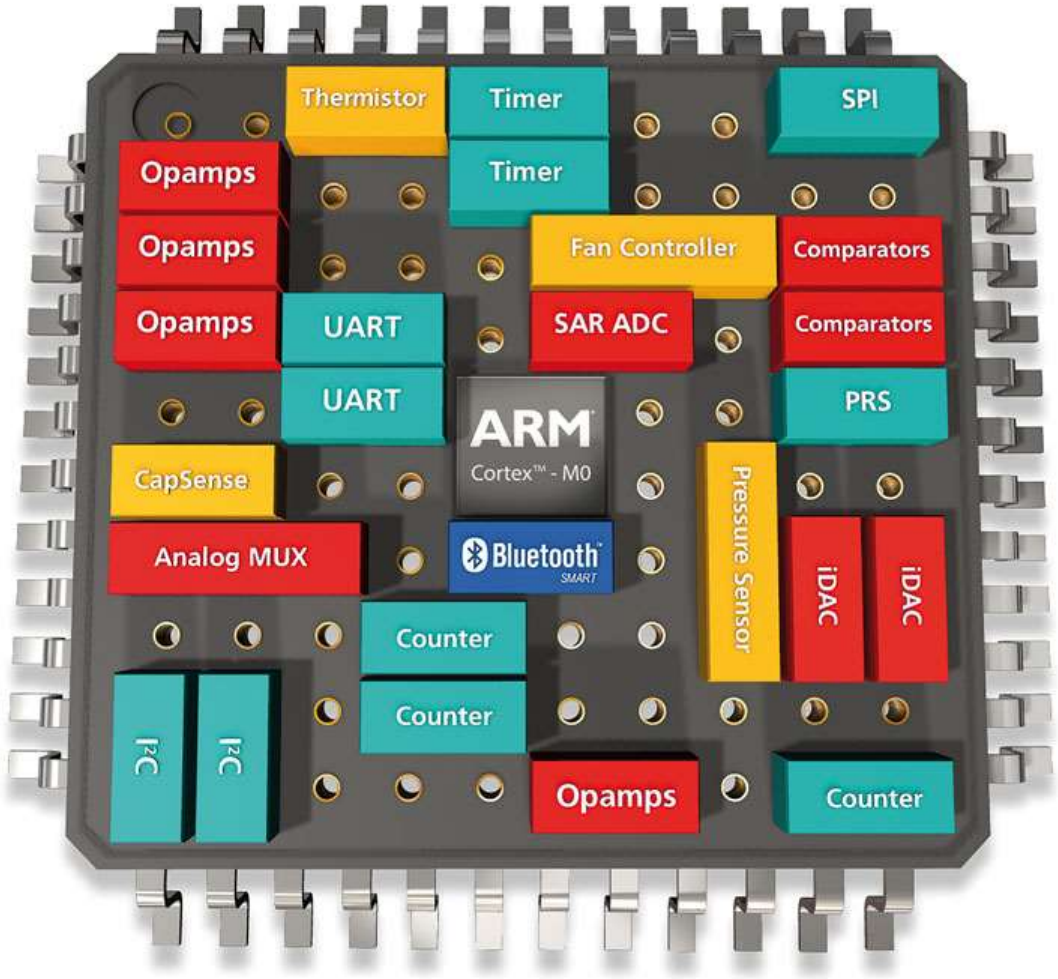
Dev Boards

- Arduino
- ARM
- RaspberryPi
- BeagleBone
- Atmel
- Intel Galileo / Gen 2 / Edison

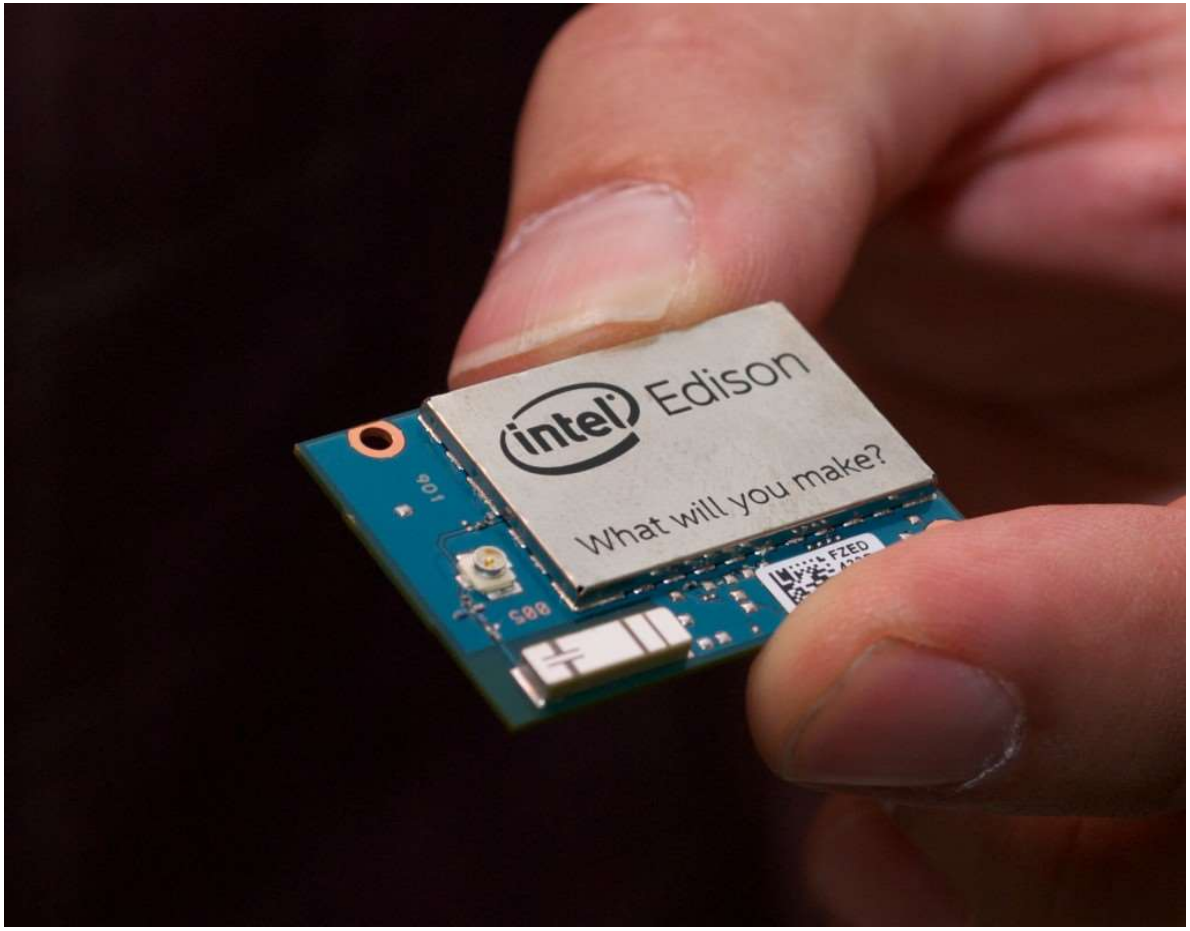
Microcontroller



System on Chip



Intel Edison

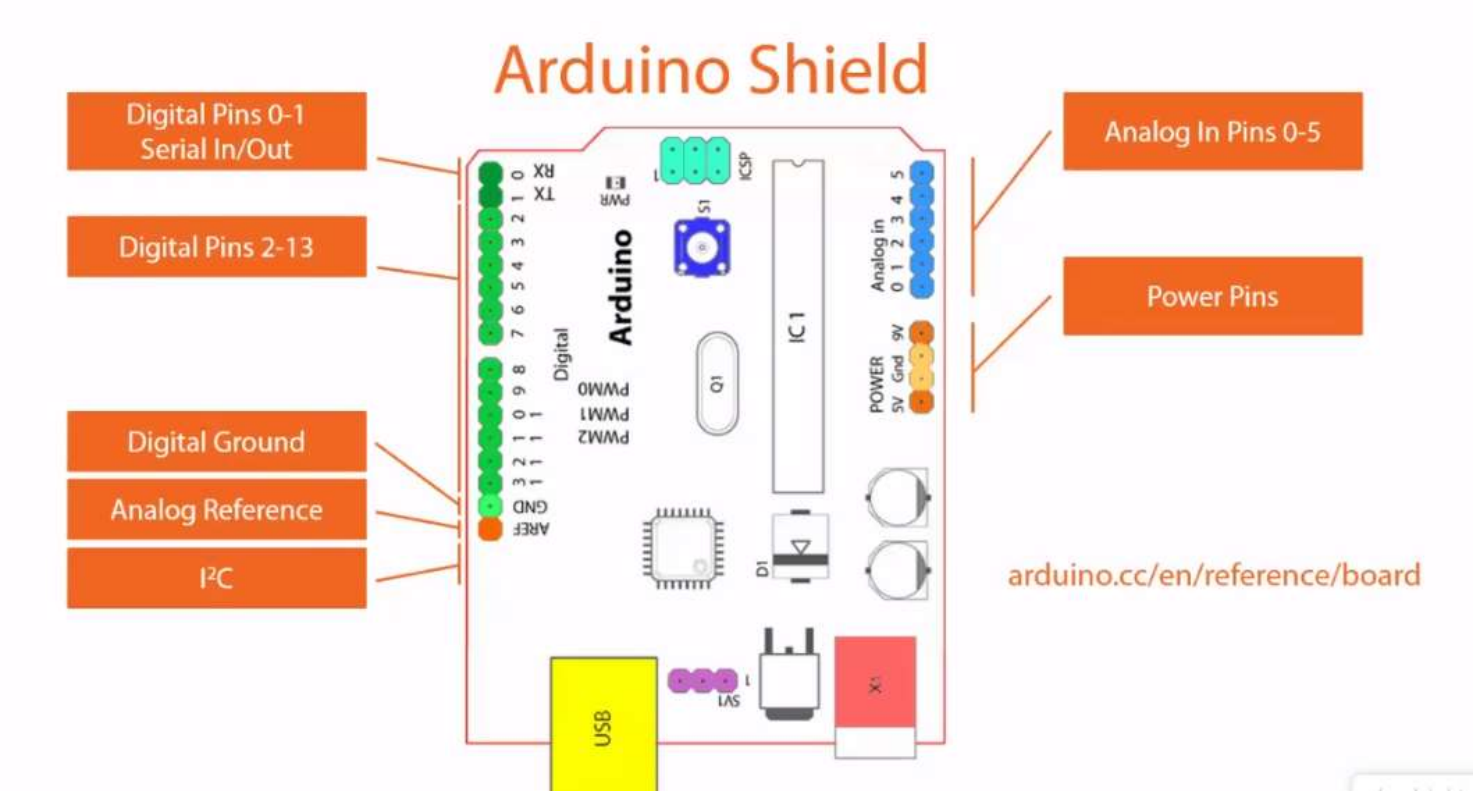


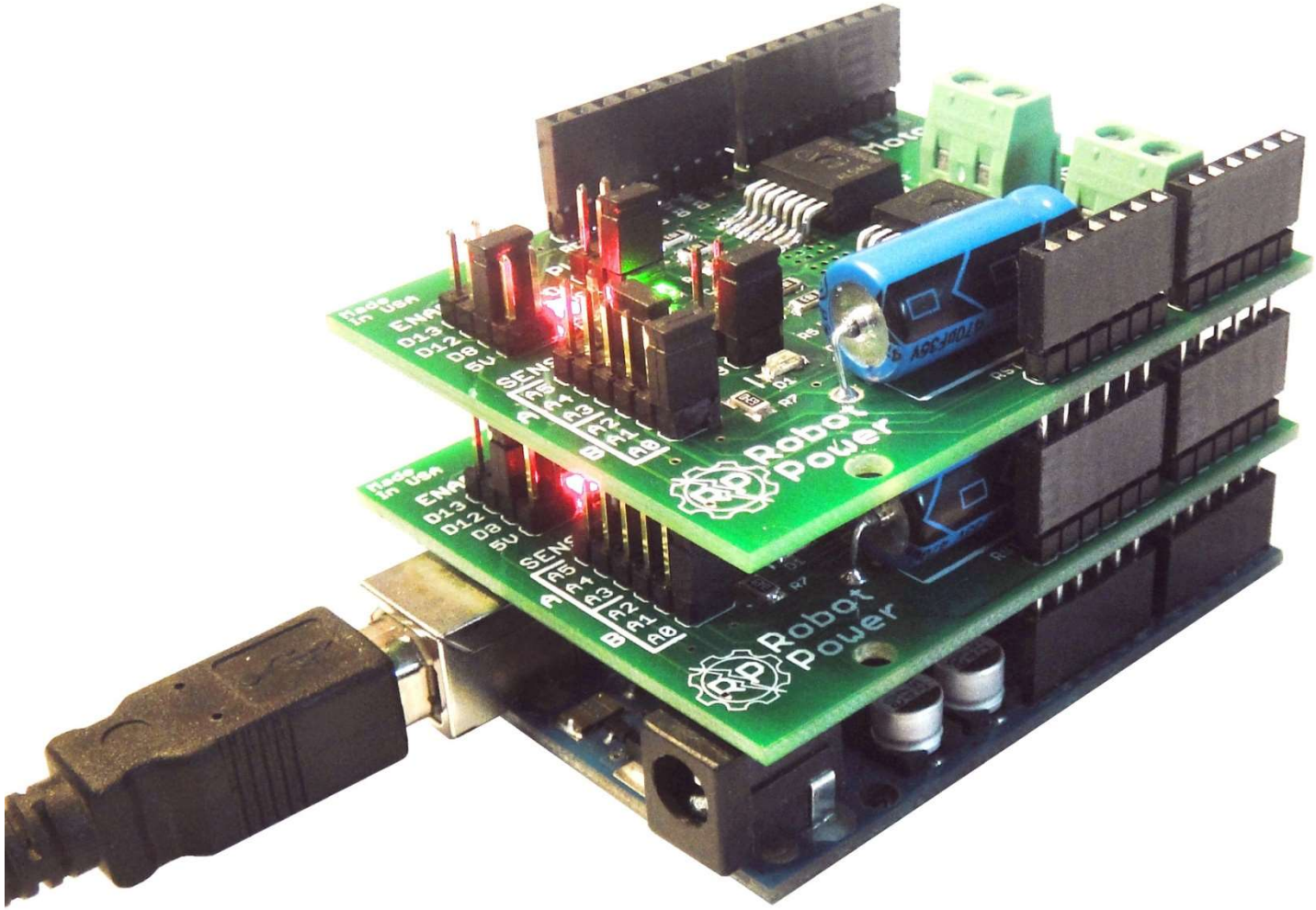
TI – CC 2540

SOC

Red Bear

Arduino


Arduino Shield
Digital Pins 0-1
Serial In/Out
Digital Pins 2-13
Digital Ground
Analog Reference
I²C
Analog In Pins 0-5
Power Pins
arduino.cc/en/reference/board
Arduino
Digital
Analog in
POWER
IC 1
Q1
D1
USB
ICSP
PWR
PWM0
PWM1
PWM2
GND
AREF
5V
Gnd
9V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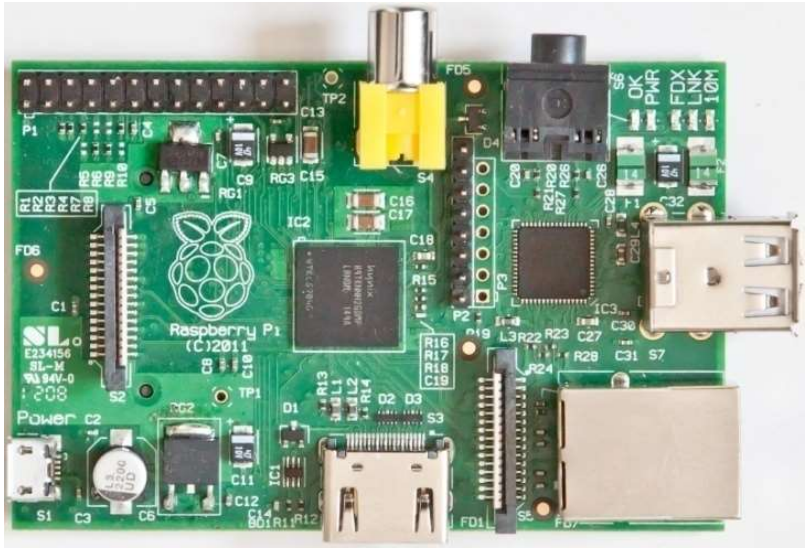
Robot
Power



Raspberry Pi

STM32 Cortex M3

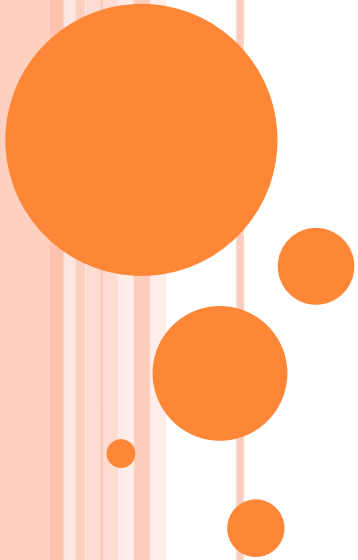
ARM7 LPC2148 Board

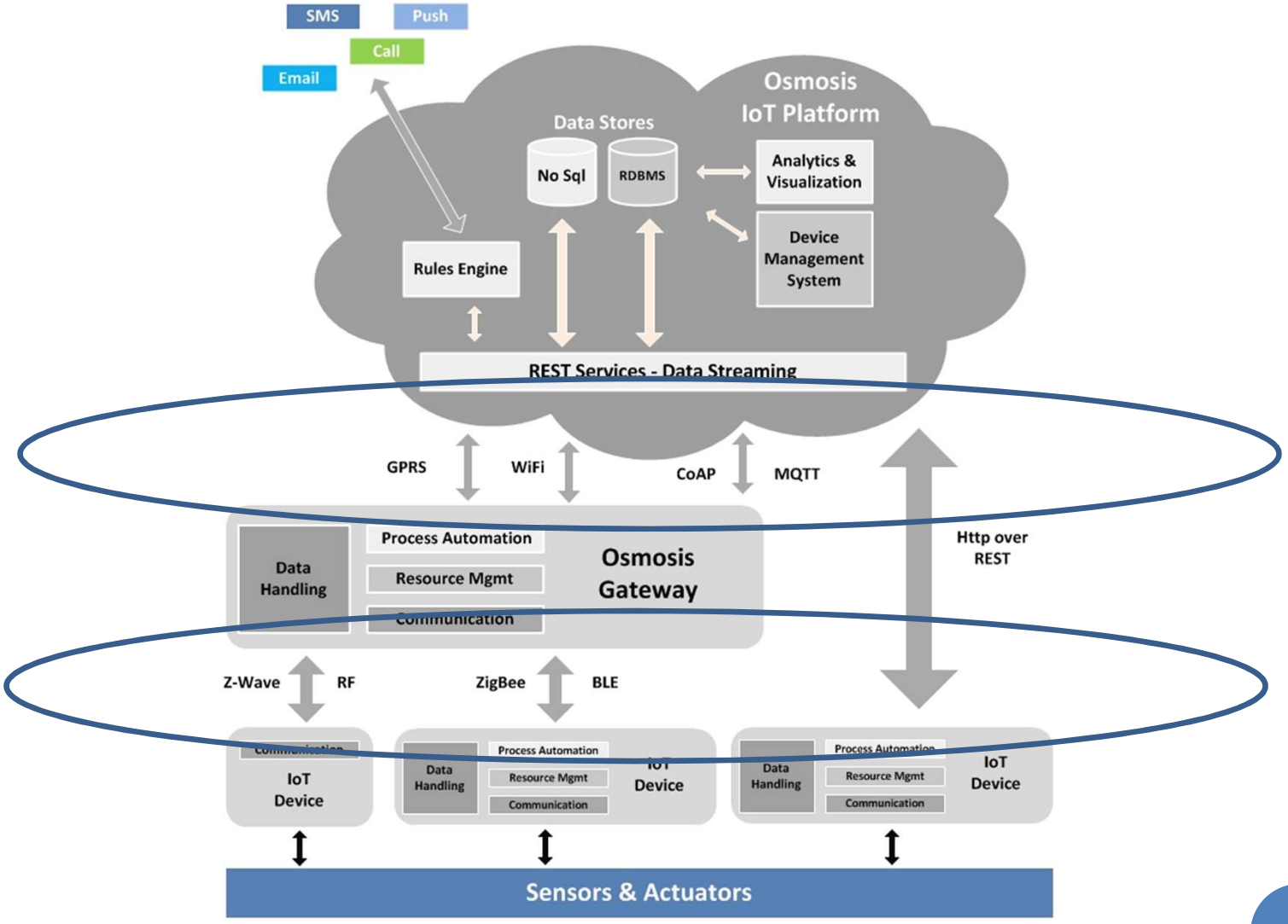
8051 ADVANCED TRAINER BOARD

Node Vs Gateway

Parameter	Node	Gateway
Cost	$10	$80
Power	Battery	Continuous
Communication	Short Range Wireless	Cloud
Computing Power	Low	Medium
Size	1”	6”
Unique IP	Not necessary	Most likely

Communication

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RF

Components

- **Transmitters**
- **Receivers**
- Transceivers
- System on Chip [SoC]

Typical Bands

- **433 Mhz**
- 868 MHz – recommended for India
- 2.4 GHz

Examples / Protocols

- ZigBee
- Z-Wave
- Blue Tooth
- BLE
- Wi-Fi
- Proprietary

Cloud Communication

Components

- Gateway
- Server

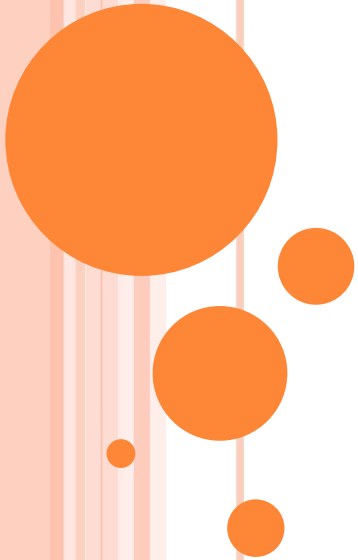
Channels

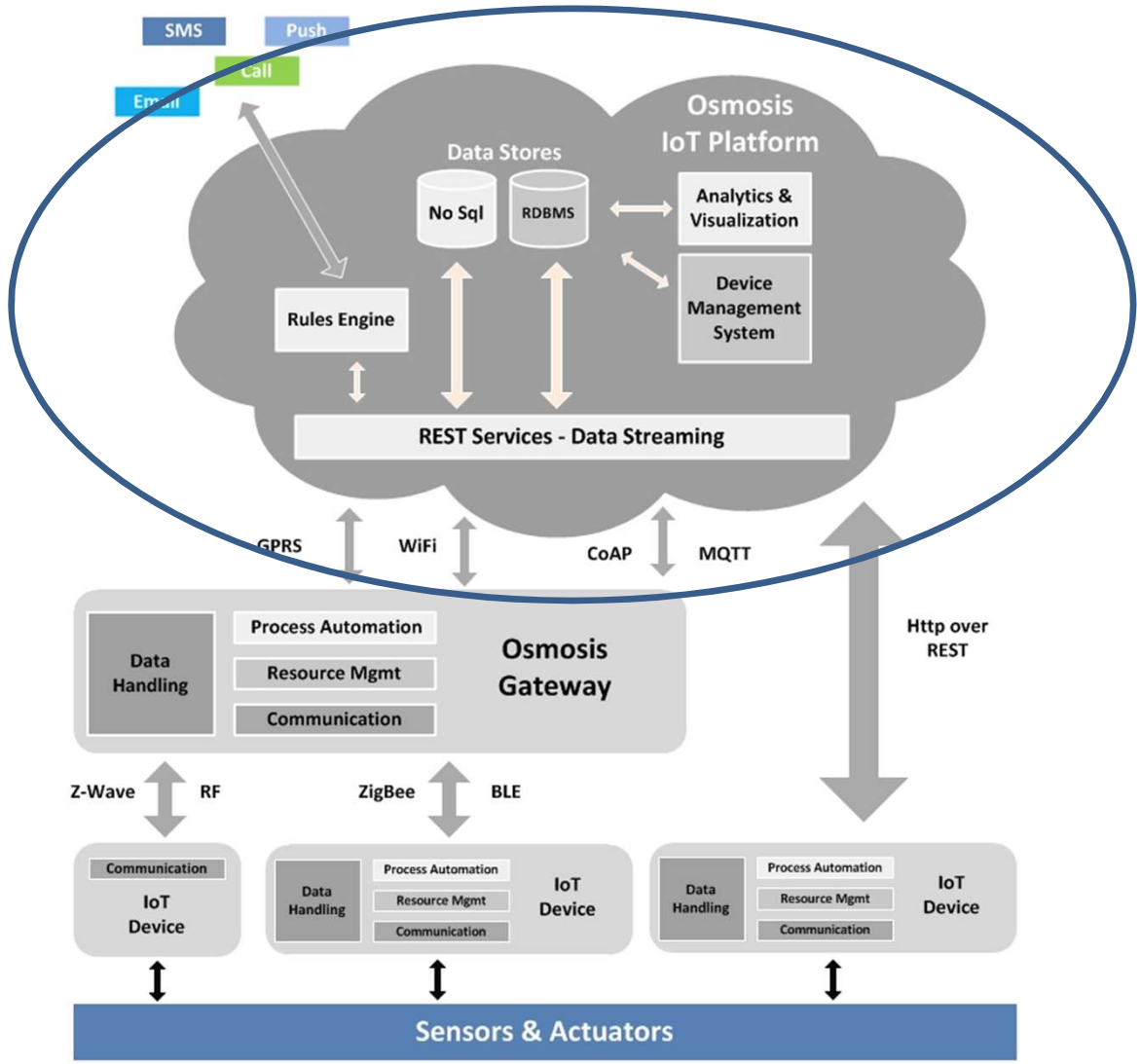
- WiFi
- Ethernet
- **GSM / GPRS**
- 3G
- LTE
- PLC

Protocol Examples

- **Http** / Https
- TCP / IP
- UDP
- MQTT
- CoAP
- XMPP

Cloud

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CLOUD

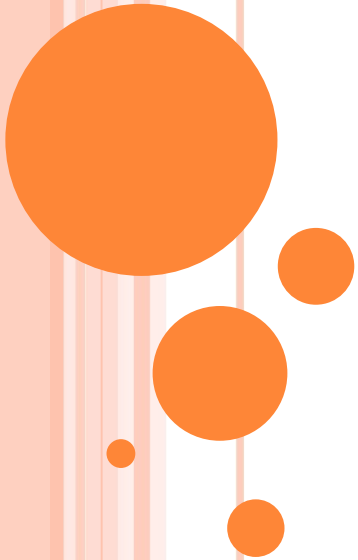
Components

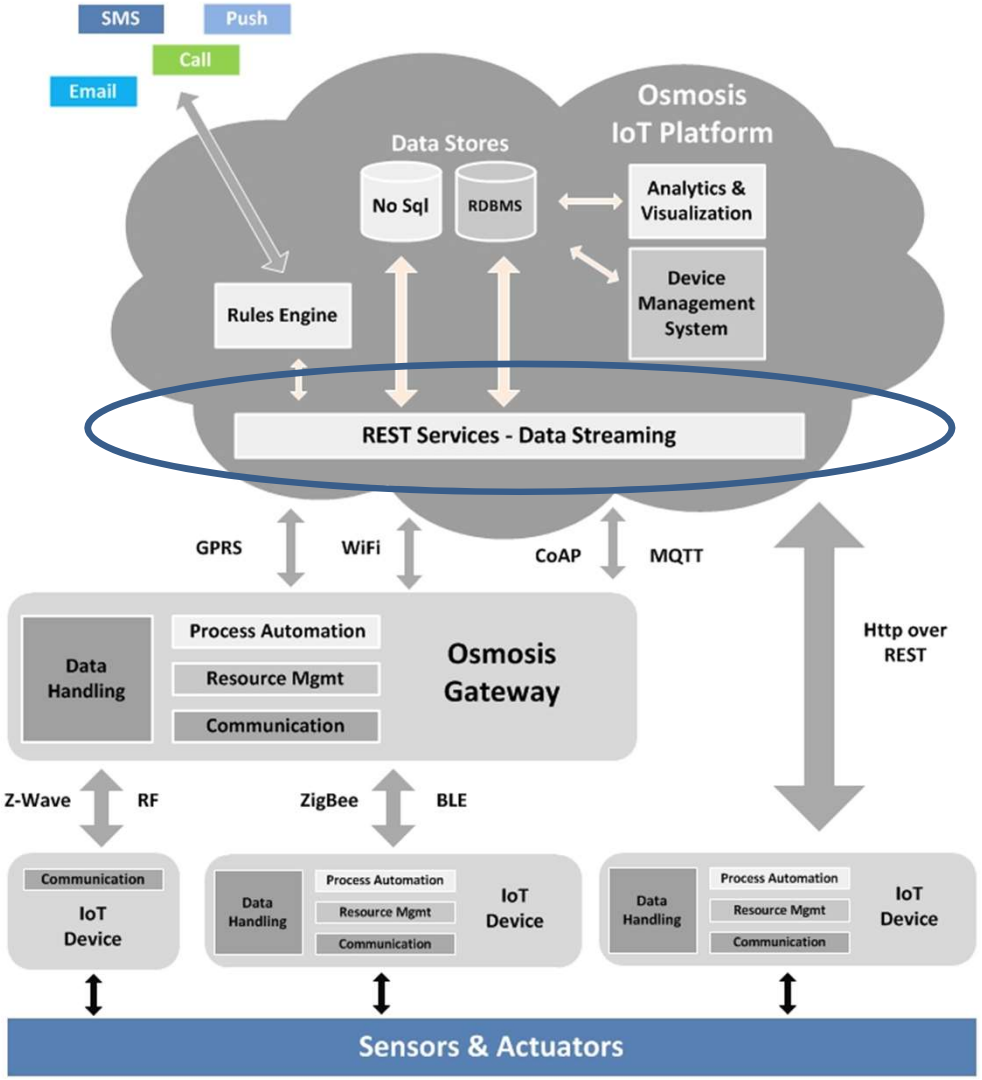
- Streaming
- Data Stores
- Rules processing & Notification
- Device Management Systems
- Analytics and Reporting Engines

Examples

- **AWS**
- IBM
- CISCO
- Microsoft

Data Streaming

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Data Streaming

Components

- Streaming Server
- Actuation
- Over the Air Updates

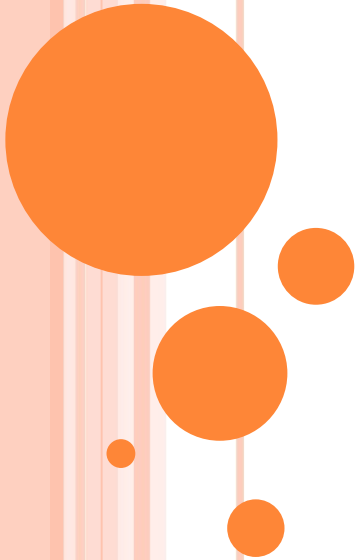
Examples

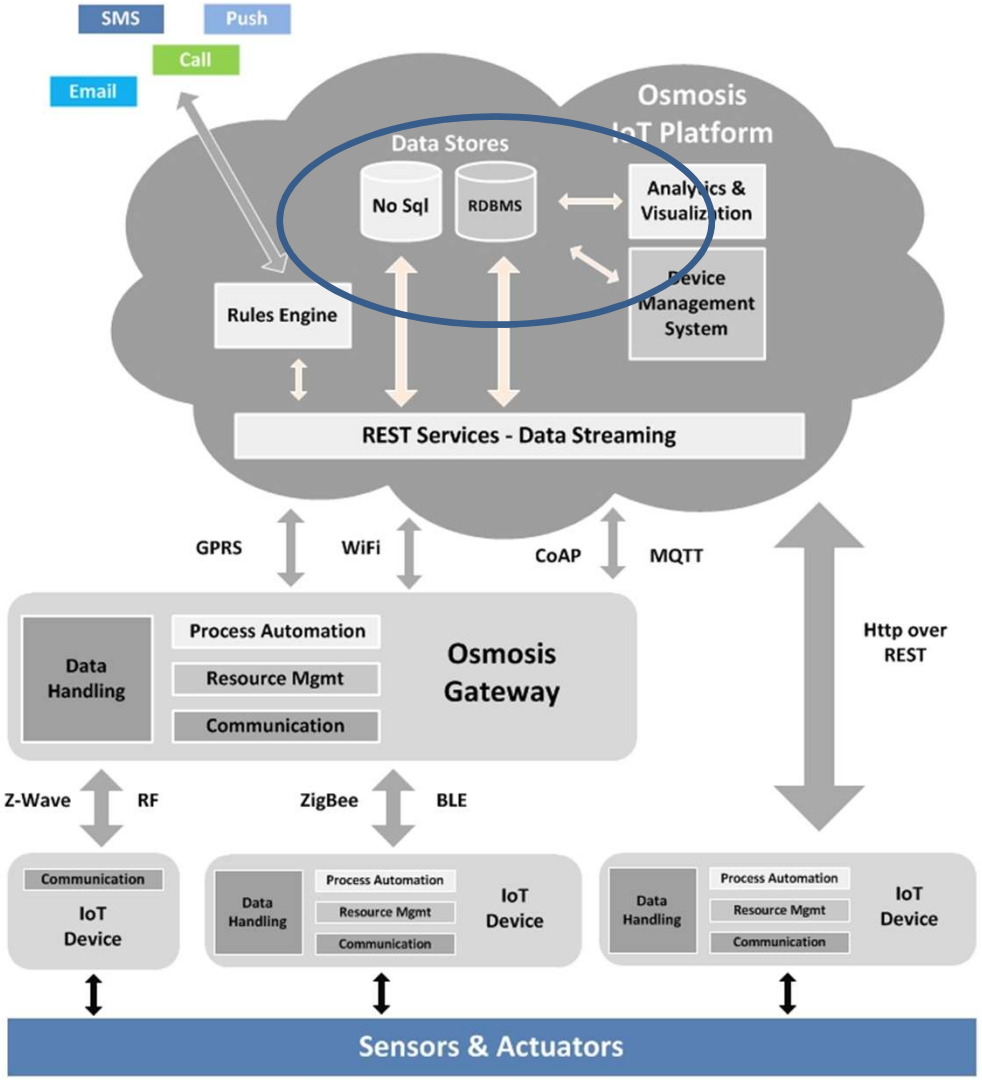
- Tomcat
- JBoss
- Websphere
- Mosquitto
- Node.js - TCP/IP

Approach

- REST over Http / Https
- Jersey reference implementation
- Entire Functionality over REST services
- REST over CoAP under development

Data Stores

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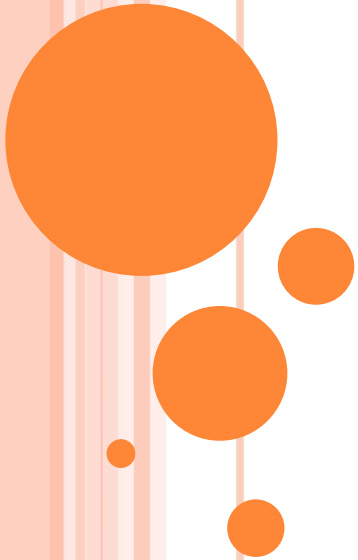
Data Stores

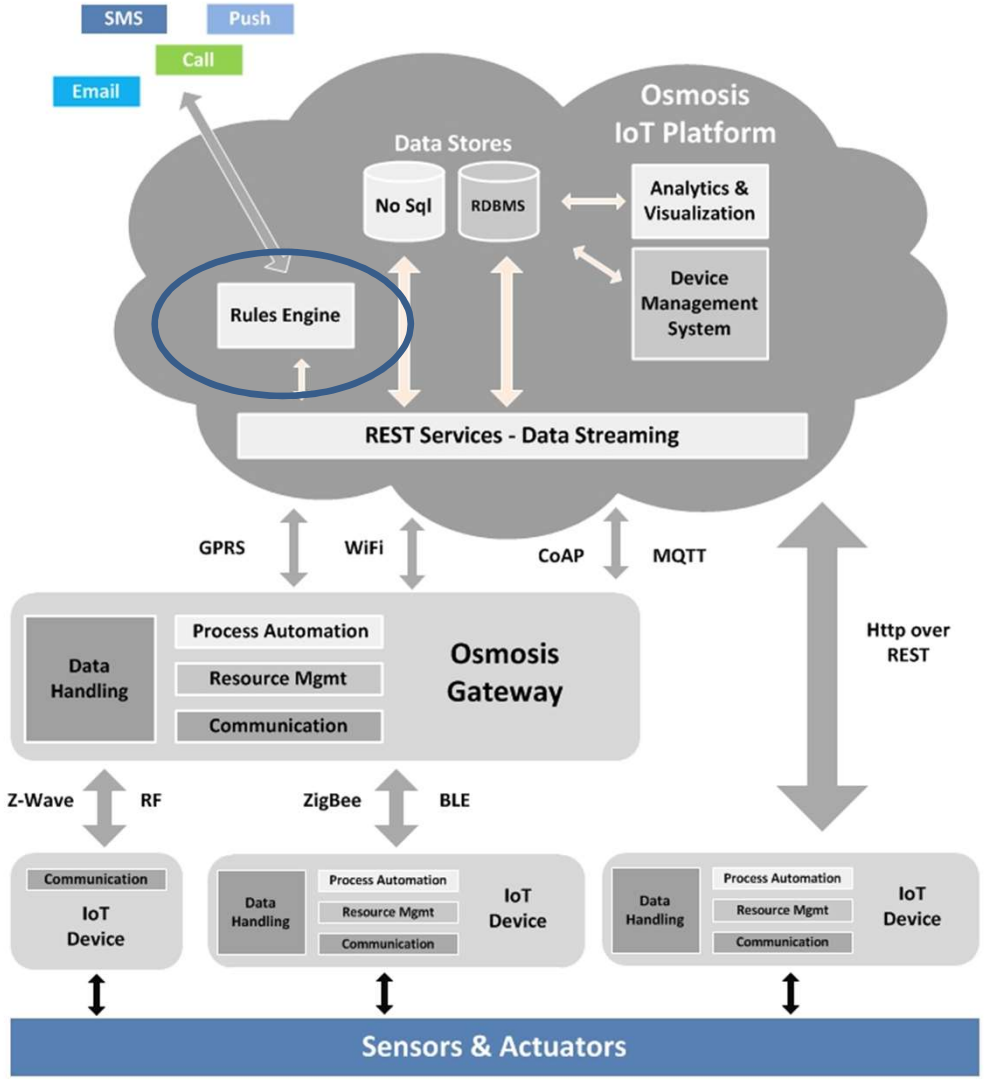
- Sql
  - Oracle
  - **MySql**
- NoSql
  - Key Value – Redis, Amazon SimpleDB
  - Column – Cassandra, HBase
  - Document – CouchDB, **MongoDB**
  - Graph – Neo4J, InfoGraph

Approach

- Hybrid
- Hibernate
- Modularization

Event Processing

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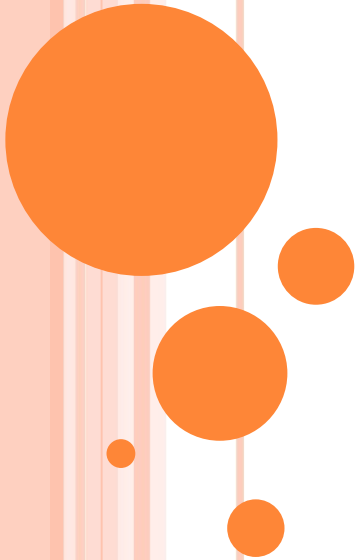
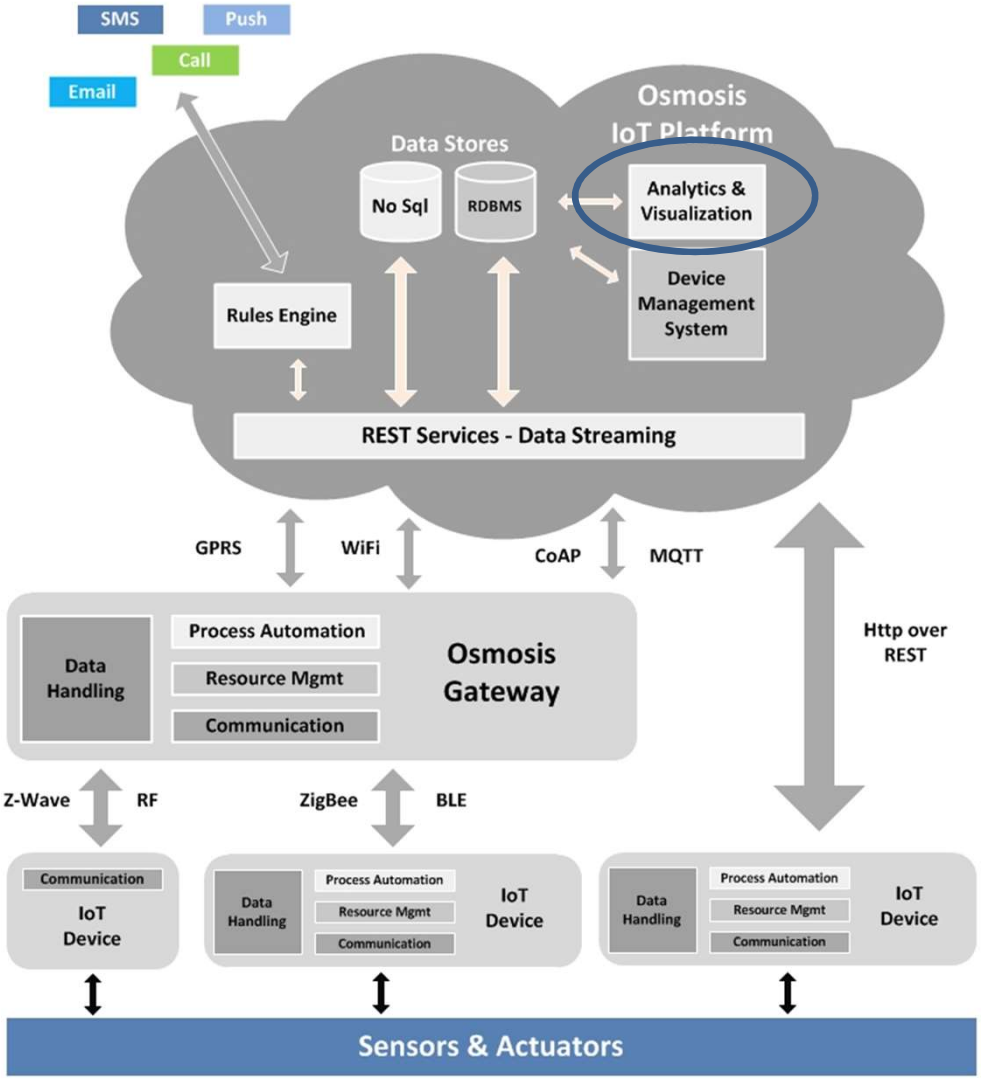
Analytics

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ANALYTICS

Components

- Real time
- Offline
- Visualization

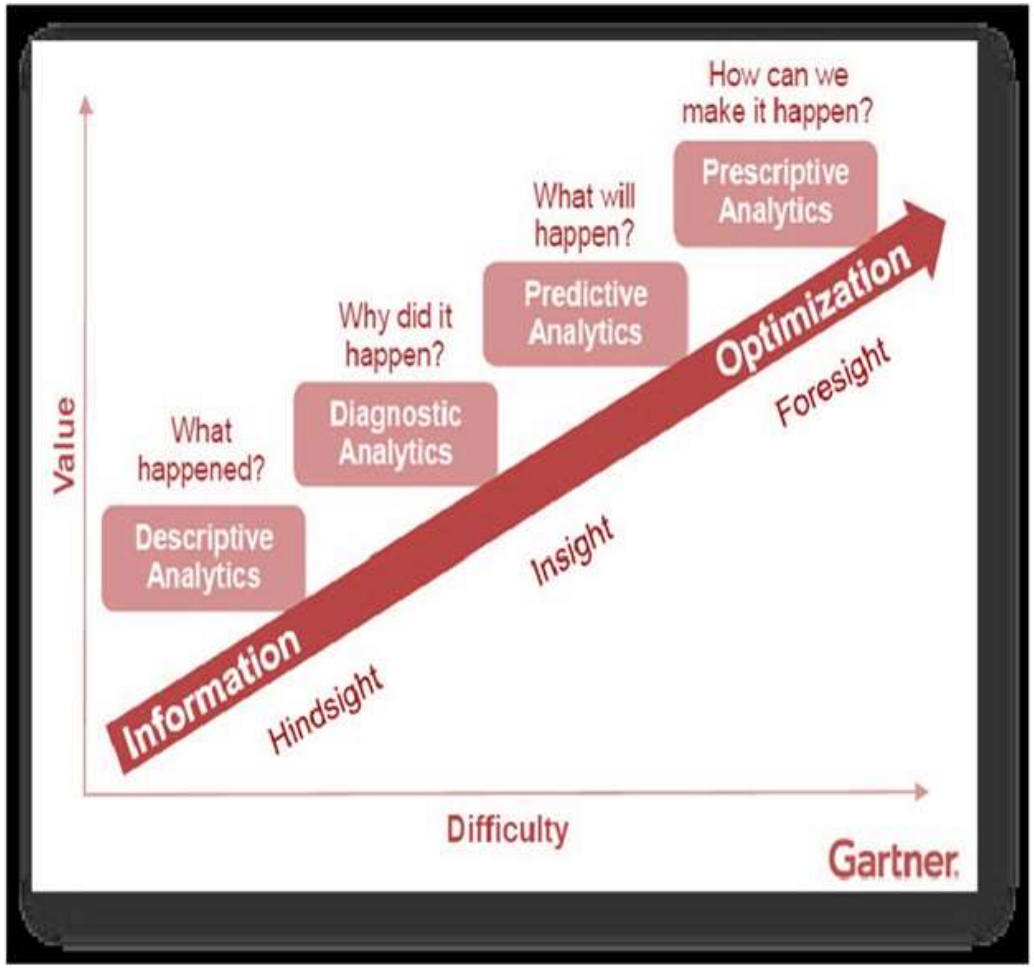
Examples

- Hadoop Ecosystem
- Spark
- MongoDB
- D3
- Tableau

Approach

- MongoDB – Map Reduce
- NVD3 - Visualization
- Real time Dashboards
- Domain Ontologies

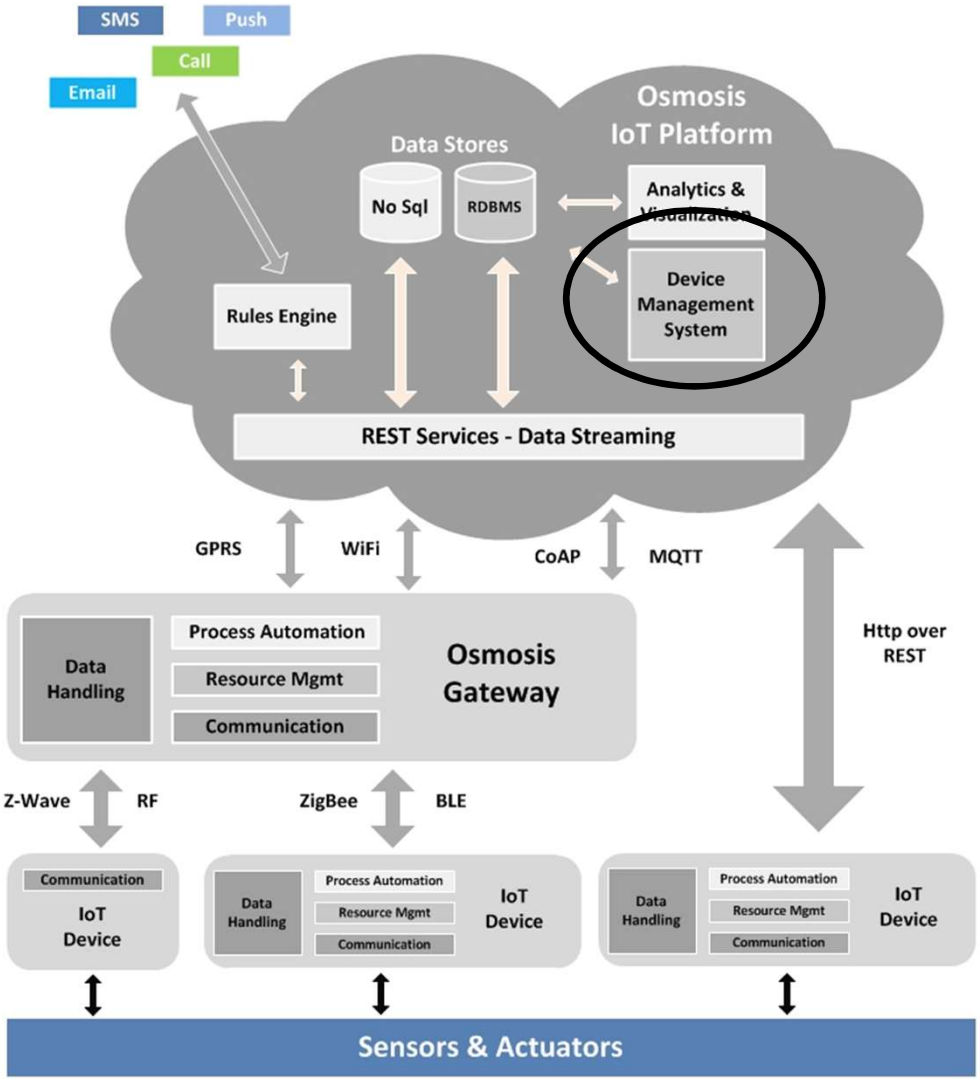
Analytics Maturity



What is Visual Analytics

- Science of analytical reasoning facilitated by visual interactive interfaces
- Integrates new computational and theory-based tools with innovative interactive techniques and visual representations to enable human-information discourse
- Design is based on human cognitive and perceptual principles

Device Management System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UI Technologies

Components

- Business Logic
- Data Store
- Visualization
- Integration and Services

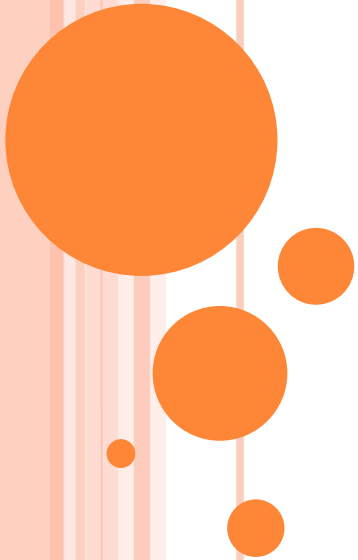
Examples

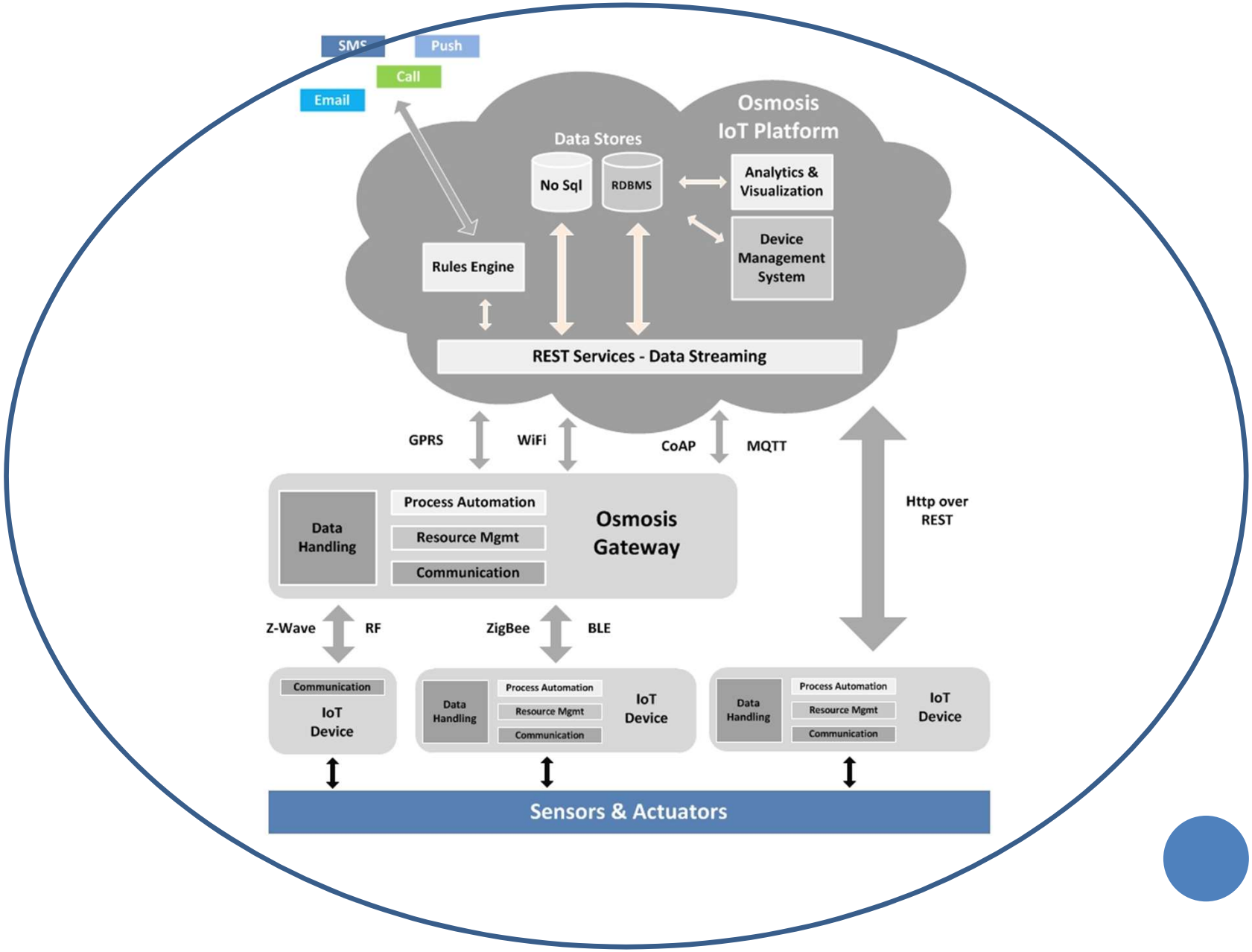
- Angular JS
- Google Toolkit
- Spring MVC / Grails
- Ruby on Rails

Approach

- Spring MVC
- Bootstrap and jQuery
- Hibernate
- MySQL

Security

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SECURITY

Components

- Wireless Communication
- Communication with Server
- Security of Data in Cloud

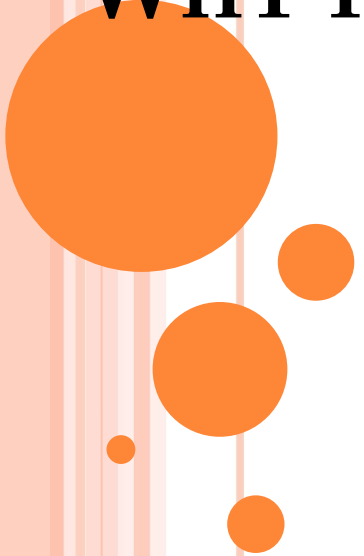
Examples

- DTLS
- Https
- BLE

Approach

- HTTPS
- Psuedo Random Numbers
- Proprietary Encoding / Decoding
- Fused Code on Chip
- AWS Security infrastructure

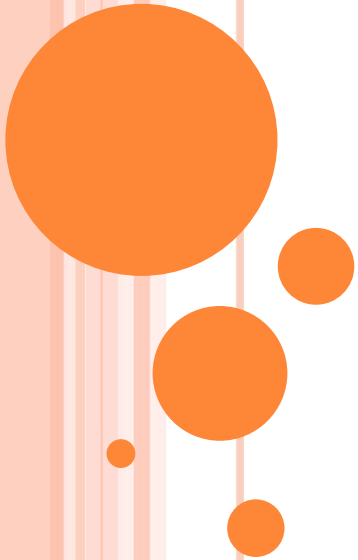
Why is IOT security difficult?



Because…

1. Wireless communication
2. Physical insecurity
3. Constrained devices
4. Potentially sensitive data
5. Lack of standards
6. Heterogeneity: weakest link problem
7. A systems, not software problem
8. Classic web / internet threats
9. Identity management & dynamism
10. Inconvenience and cost

Threats to IoT systems



The physical devices

- Can be stolen
- Can be modified
- Can be replaced
- Can be cloned

The software

- Can be modified (firmware / OS / middleware)
- Can be decompiled to extract credentials
- Can be exhausted (denial of service)

The Network

- Eavesdropping
- Man-in-the-middle attacks
- Rerouting traffic
- Theft of bandwidth