A Reference Architecture for IoT

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Director, Architecture

WSO2
lean • enterprise • middleware

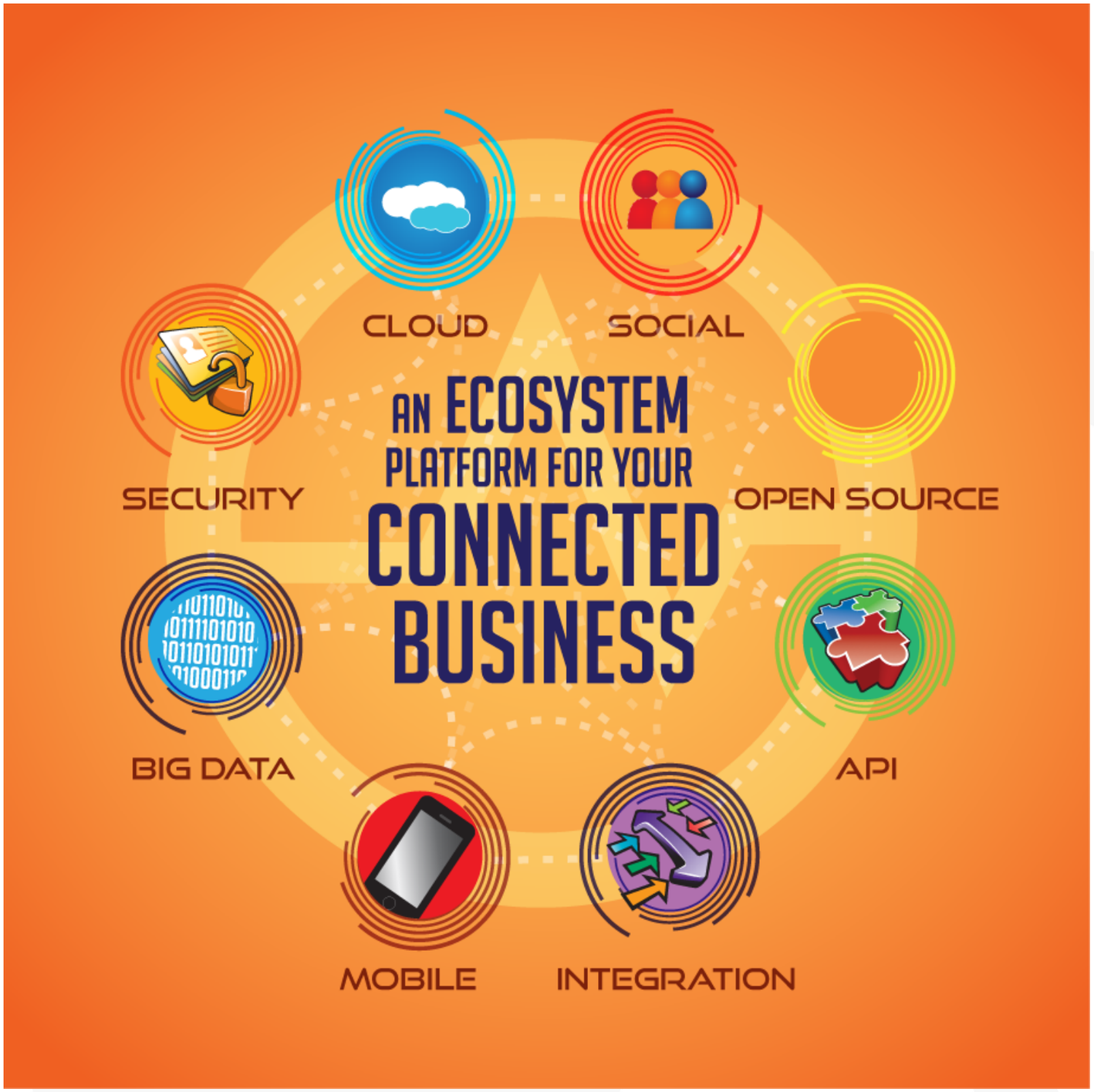
About the Presenter

- PMC member Apache Axis, Committer Apache Synapse, Web Services & Apache Stratos
- Member, Apache Software Foundation
- Co-author, Axis2 Web Services
- Director of Architecture, WSO2 Inc.
- Hobbyist (Arduino/RPi/Electronics/4x4)
- Blog: http://blog.afkham.org

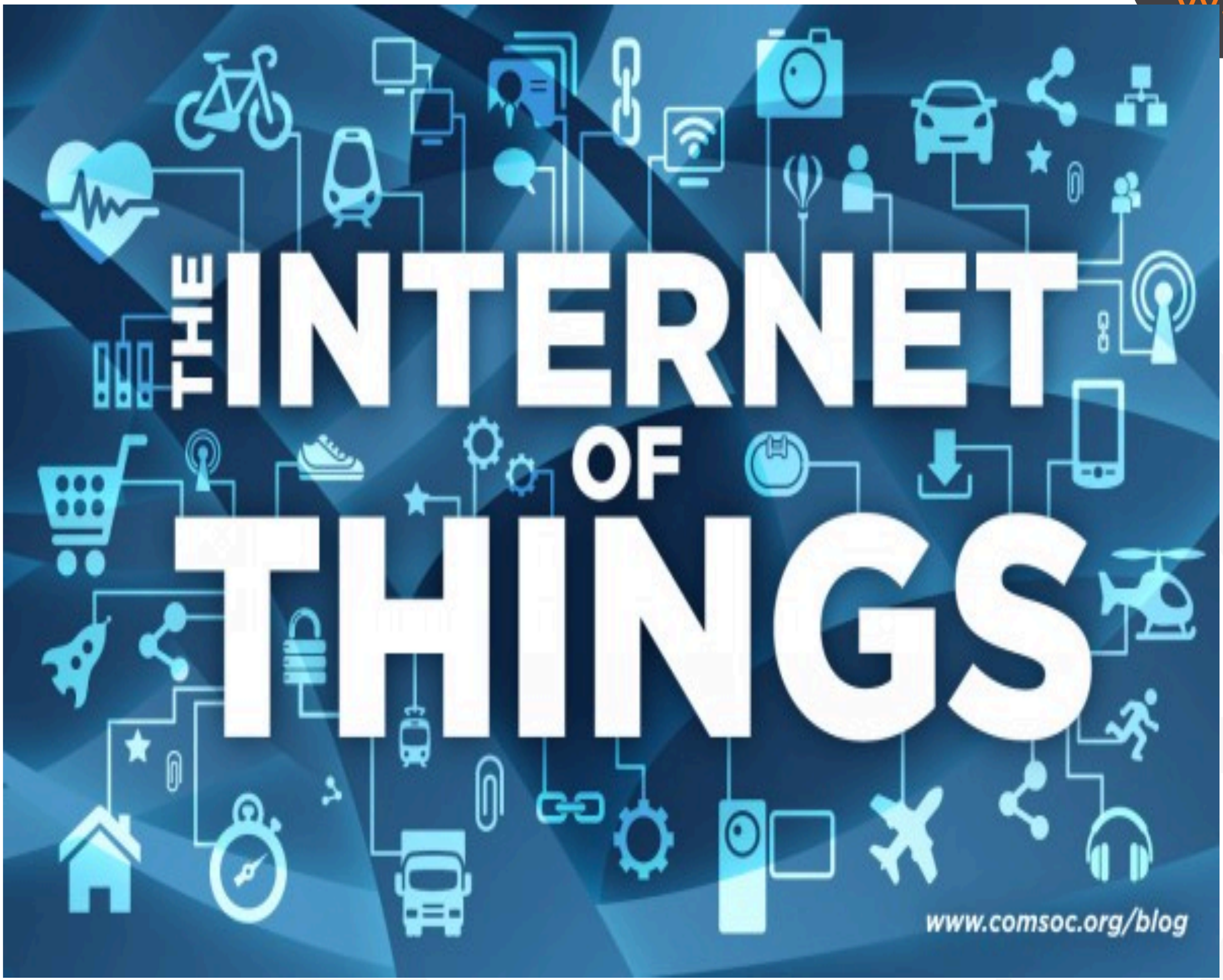
About WSO2

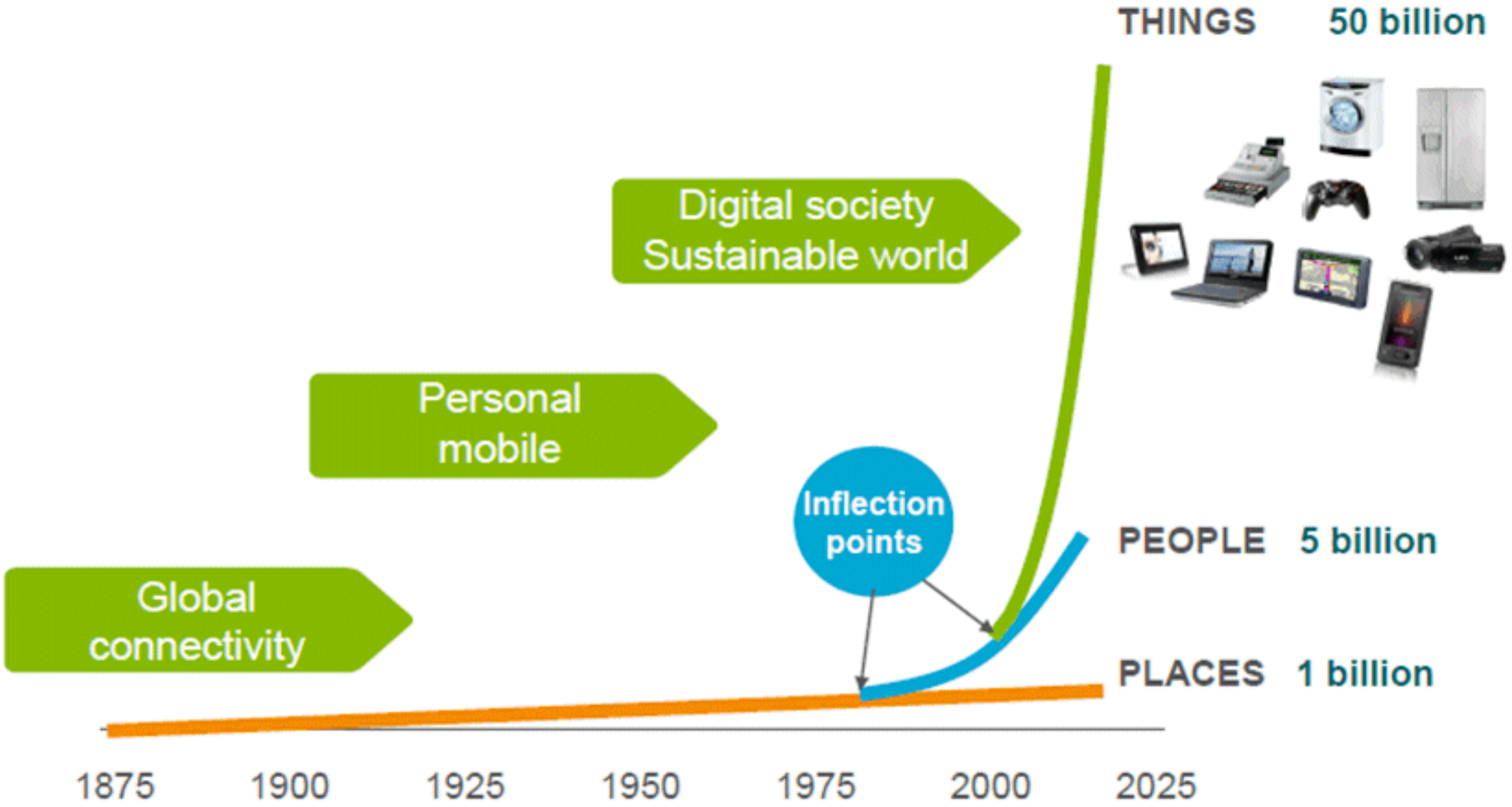
- Global enterprise, founded in 2005 by acknowledged leaders in XML, web services technologies, standards and open source
- Provides only open source platform-as-a-service for private, public and hybrid cloud deployments
- All WSO2 products are 100% open source and released under the Apache License Version 2.0.
- Is an Active Member of OASIS, Cloud Security Alliance, OSGi Alliance, AMQP Working Group, OpenID Foundation and W3C.

- Driven by Innovation
  - Launched first open source API Management solution in 2012
  - Launched App Factory in 2Q 2013
  - Launched Enterprise Store and first open source Mobile solution in 4Q 2013



What WSO2 delivers

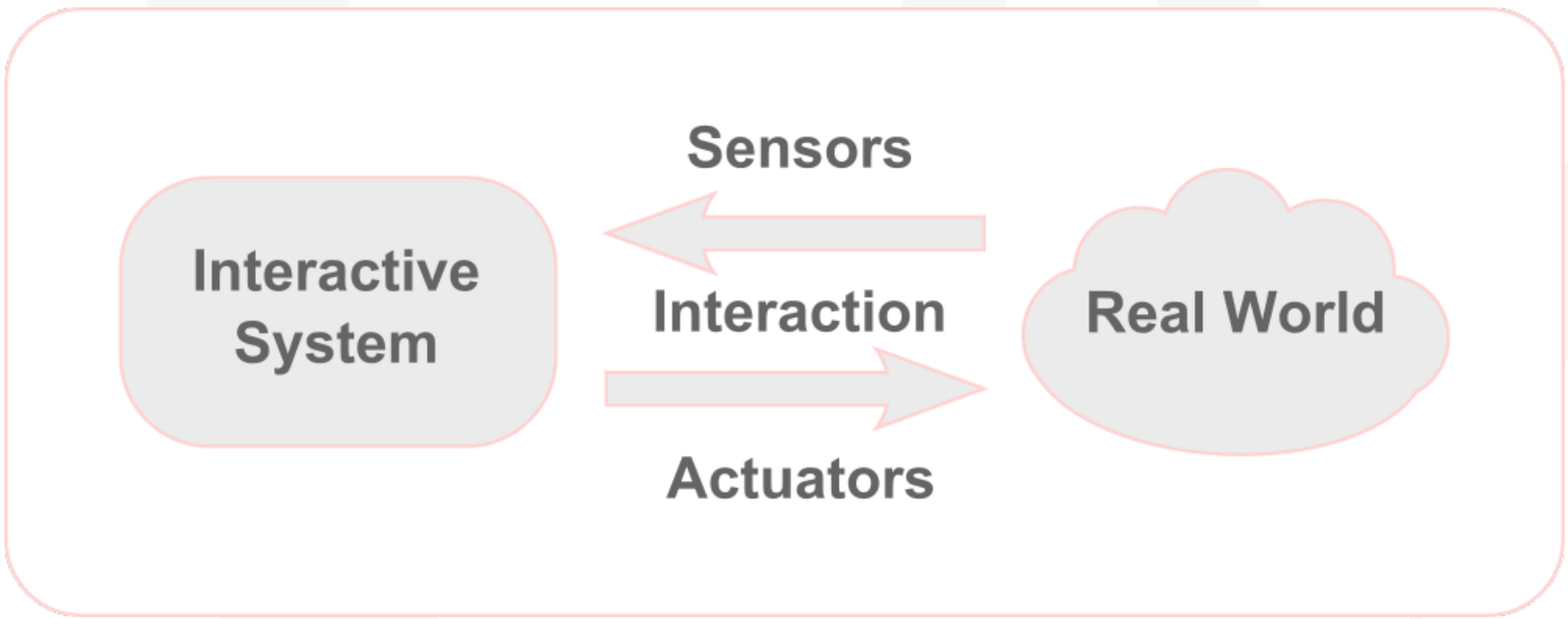




Source: Ericsson AB, "Infrastructure Innovation - Can the Challenge be met?," Sept 2010

Physical Computing

building interactive physical systems by the use of software and hardware that can sense and respond to the analog world



Internet of Things?

- A term coined in 1999 by Kevin Ashton
- Refers to uniquely identifiable objects & their virtual representations in an Internet-like structure

Internet of Things?

- Wireless Sensor Networks
- Internet-connected wearables
- Low power embedded systems
- RFID enabled tracking
- Use of mobile phones to interact with the real world
- Devices that connect via Bluetooth enabled mobile phones to the Internet
- Smart Homes
- Connected Cars
- etc.

History of IoT

- The term was coined in 1999 by Kevin Ashton from MIT
- Concept has been discussed since 1991
- “What if the Internet was allowed to go beyond connecting desktops and laptops and could somehow be tied to the devices around us?”

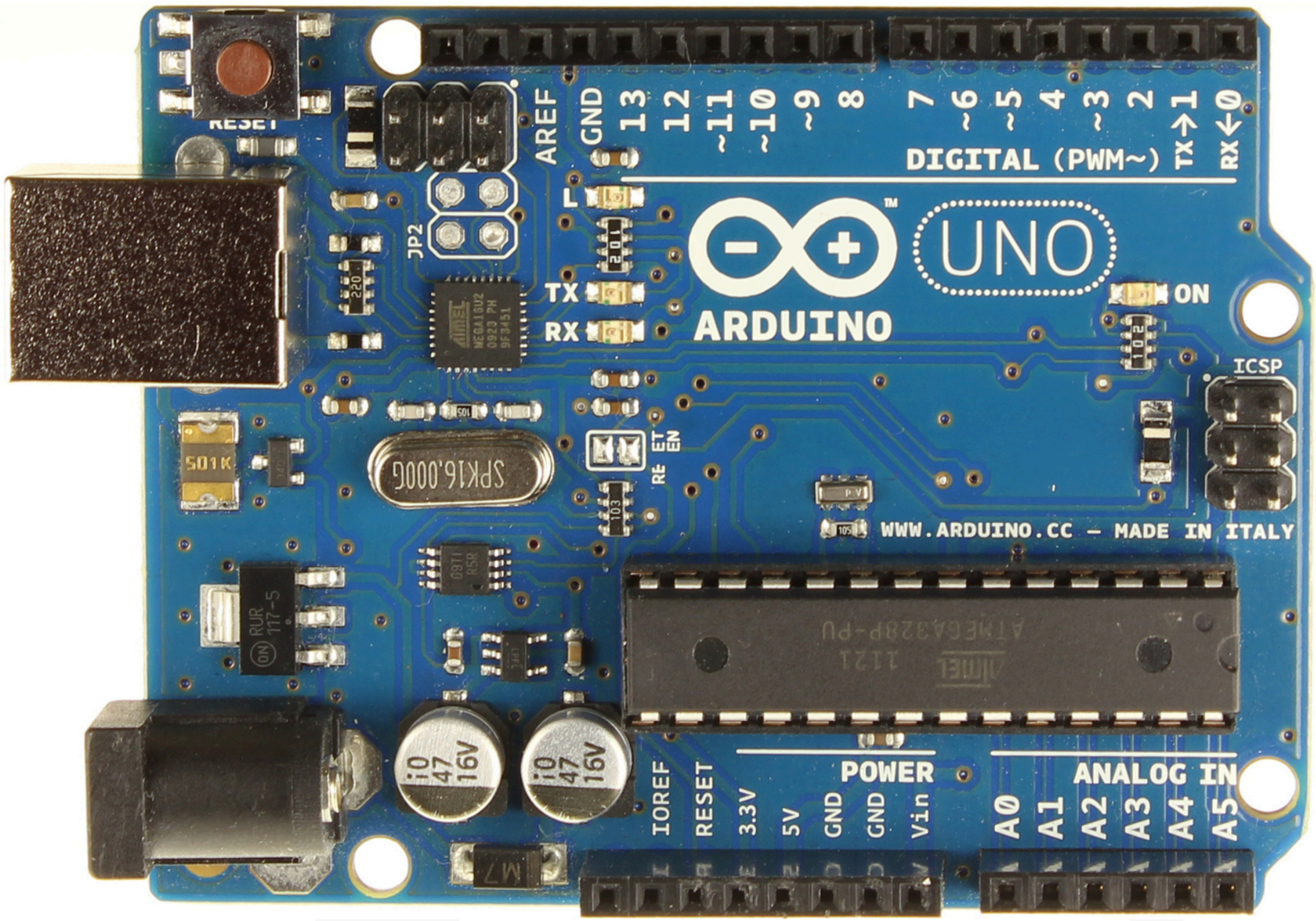
Core Concerns

- Security
- Power consumption/Battery life
- Software updates
- Recovering from network failures & other failures
- Connectivity and communications
- Device Management
- Data collection, analysis, and actuation
- Scalability

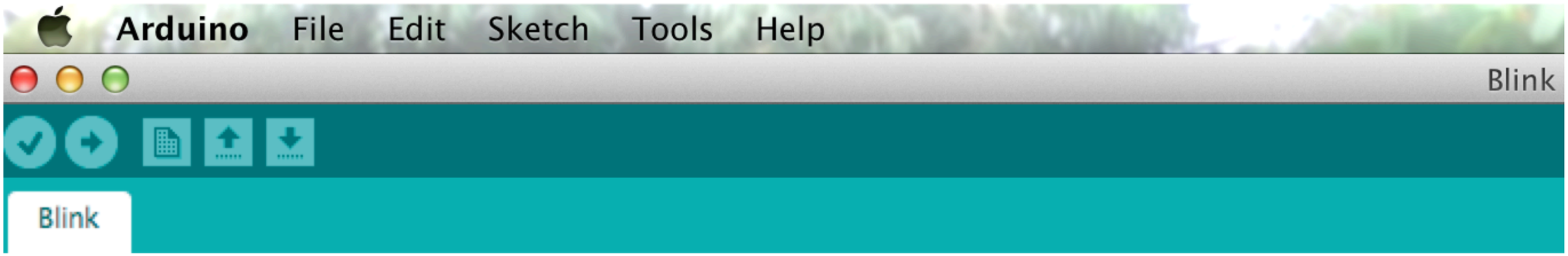
Device Types

- 8-bit SOC controllers
  - Arduino
  - No Operating System
- Systems based on Atheros or ARM processors
  - Arduino Yun
- 32/64 bit computing platforms
  - Raspberry Pi/BeagleBone

Arduino

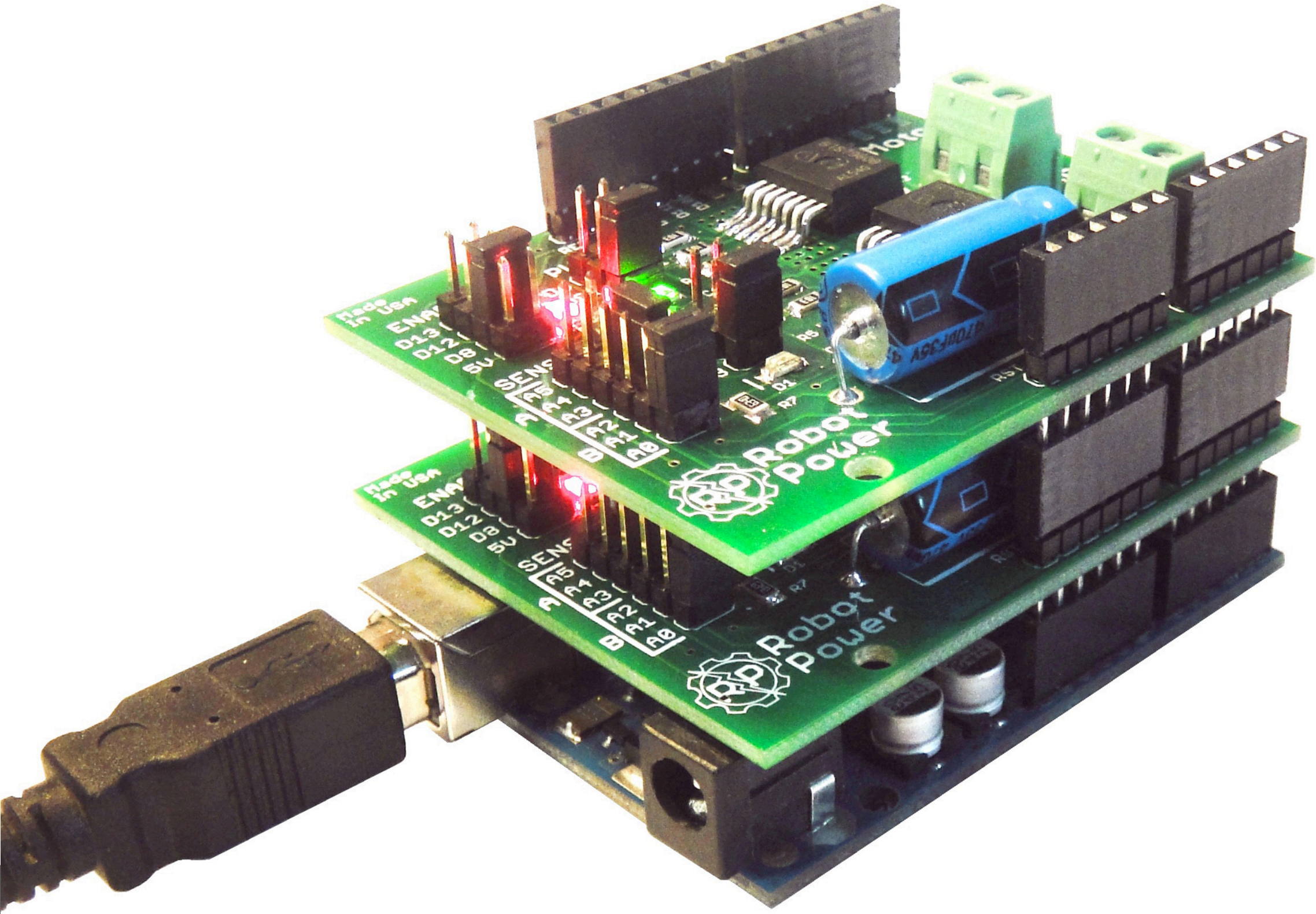


Arduino IDE

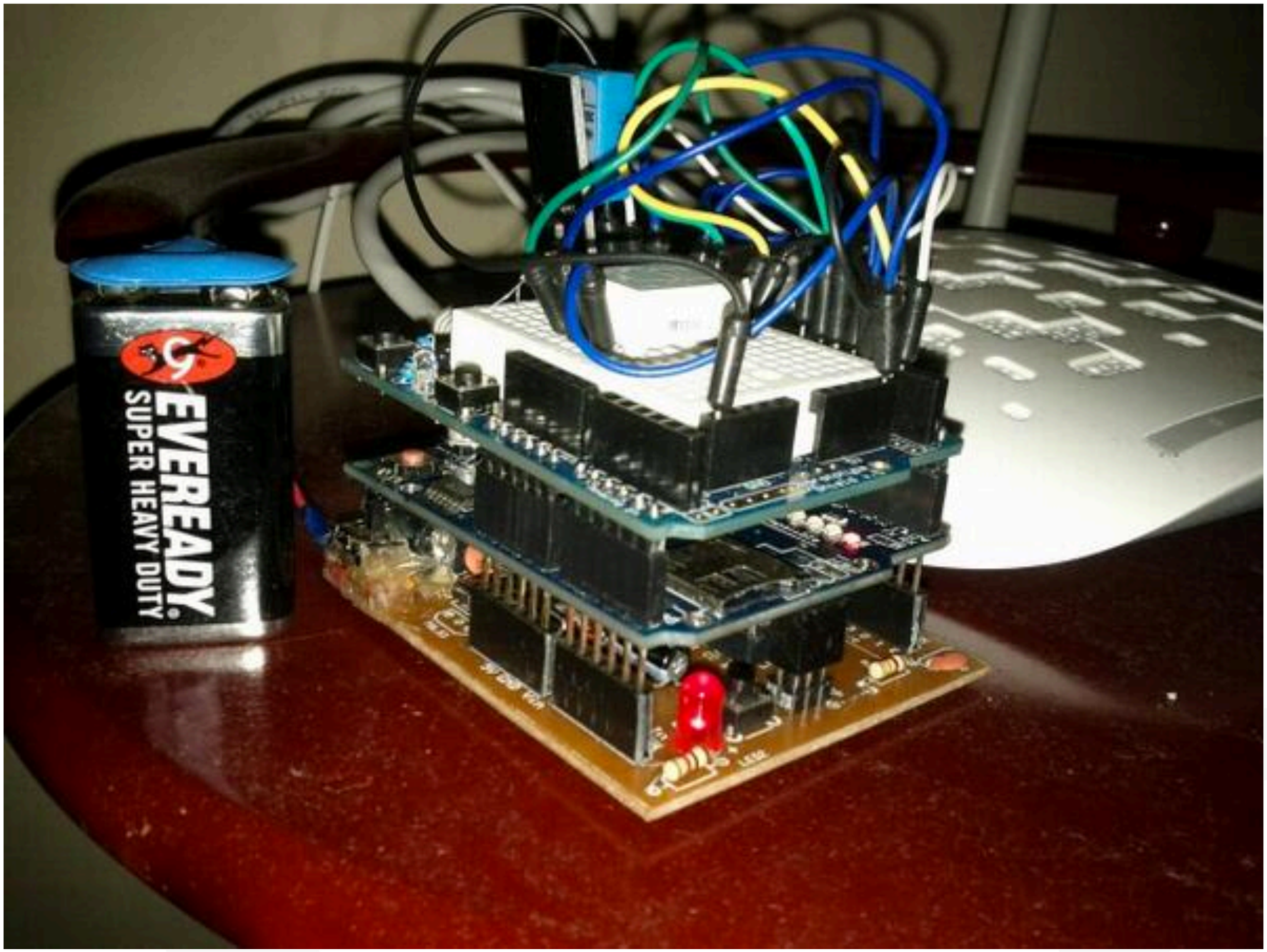



```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedly.

  This example code is in the public domain.
 */

// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;

// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  digitalWrite(led, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);               // wait for a second
  digitalWrite(led, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);               // wait for a second
}
```

Arduino Shields



Mini weather station



https://xively.com/develop/b4ep-s-aKQZpPKjks4k-

Personal | WSO2Con-Manager | XML Schema Tutorial | WebServices | StratosManager | NoSQL

Product Secret a49bda99bf6b97e184483a5b748013b333a997db

Serial Number 7JWXWMMQPNRR

Activation Code 4bb52847300c5c3c407caac0e5c07e7201f953a8

Learn about the Develop stage

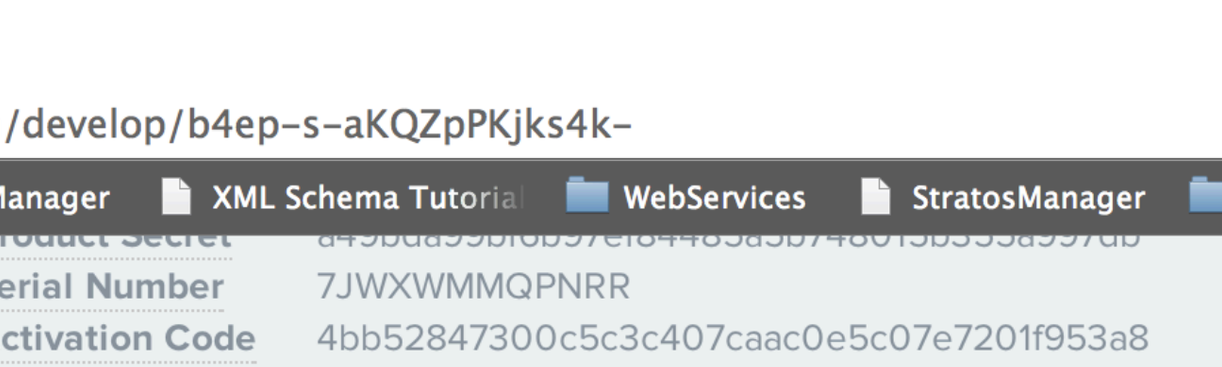
Channels

Last updated 3 months ago

Graphs

temperature 28 C

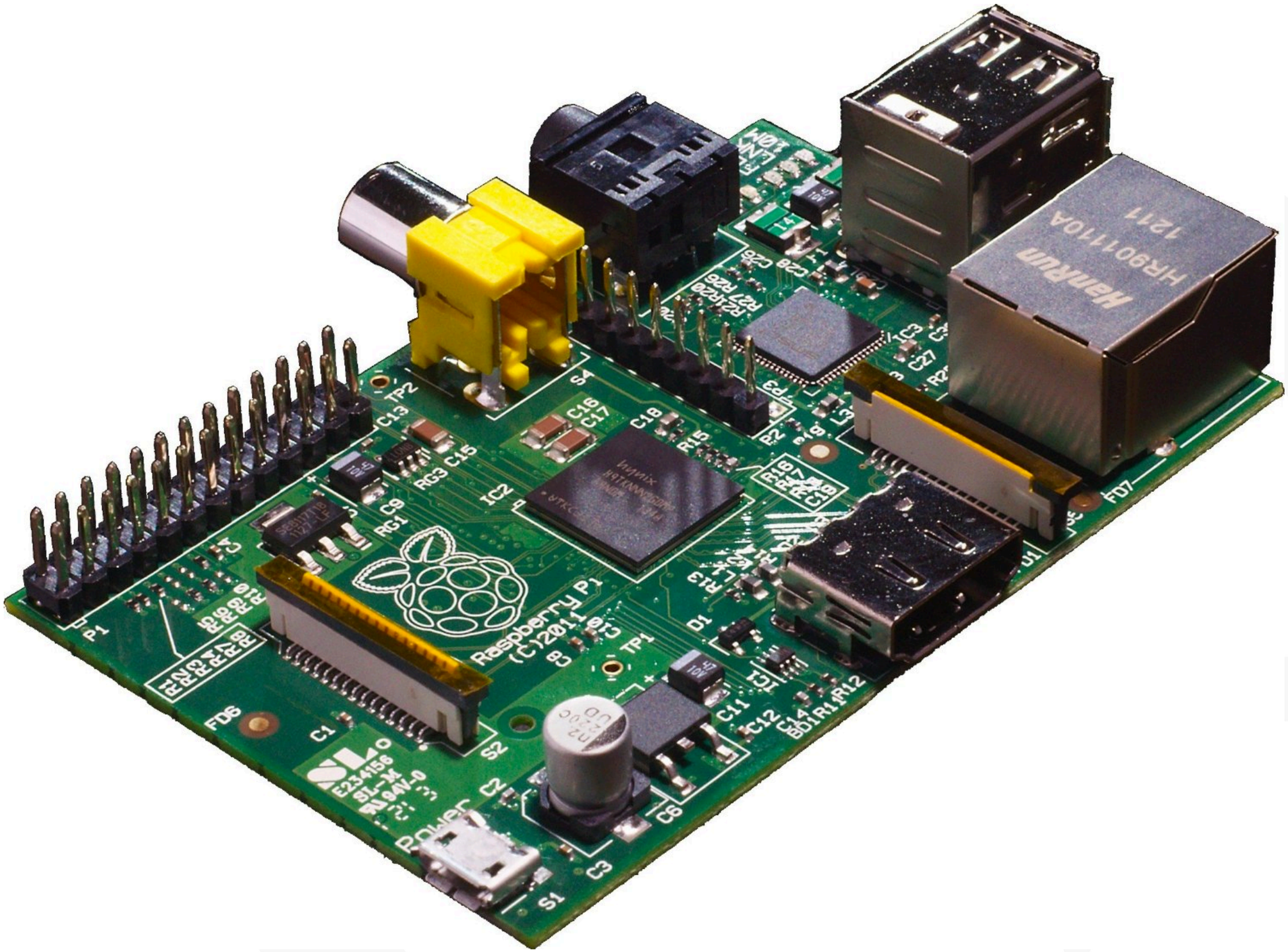
Last updated 3 months ago



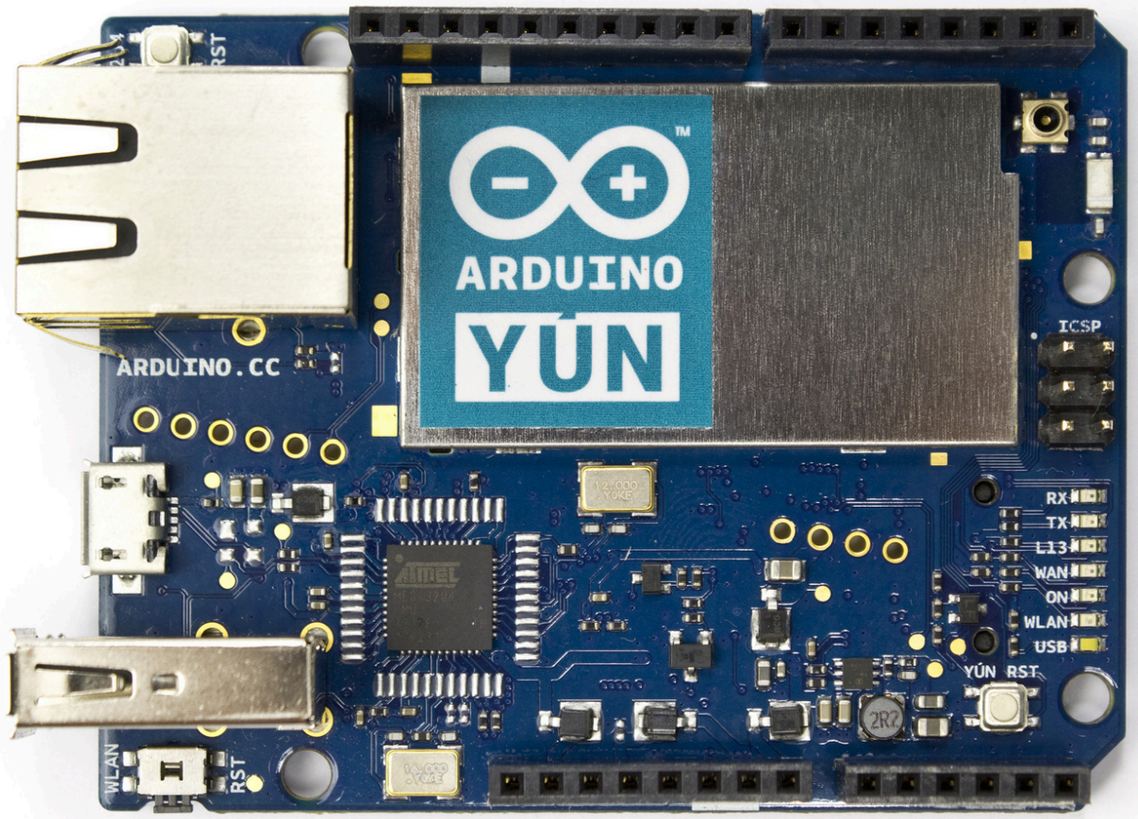
Edit Delete

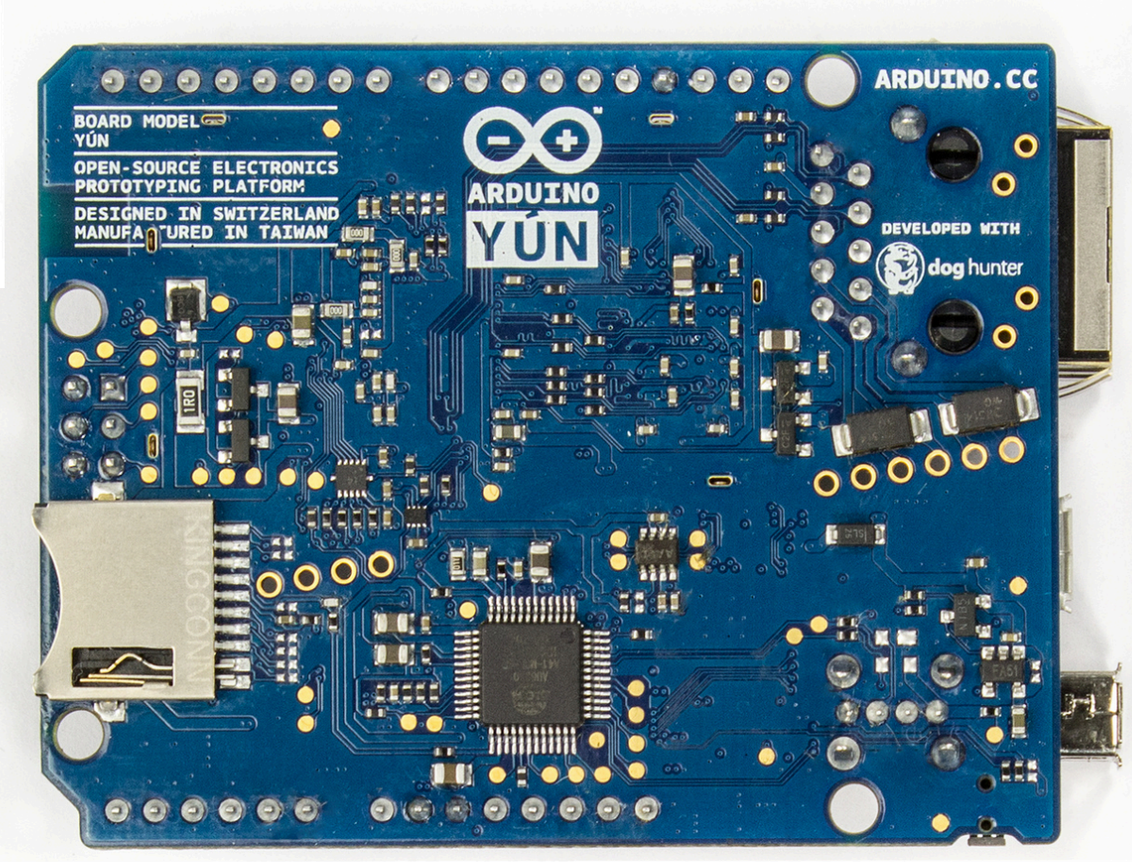
+ Add Channel

Raspberry Pi

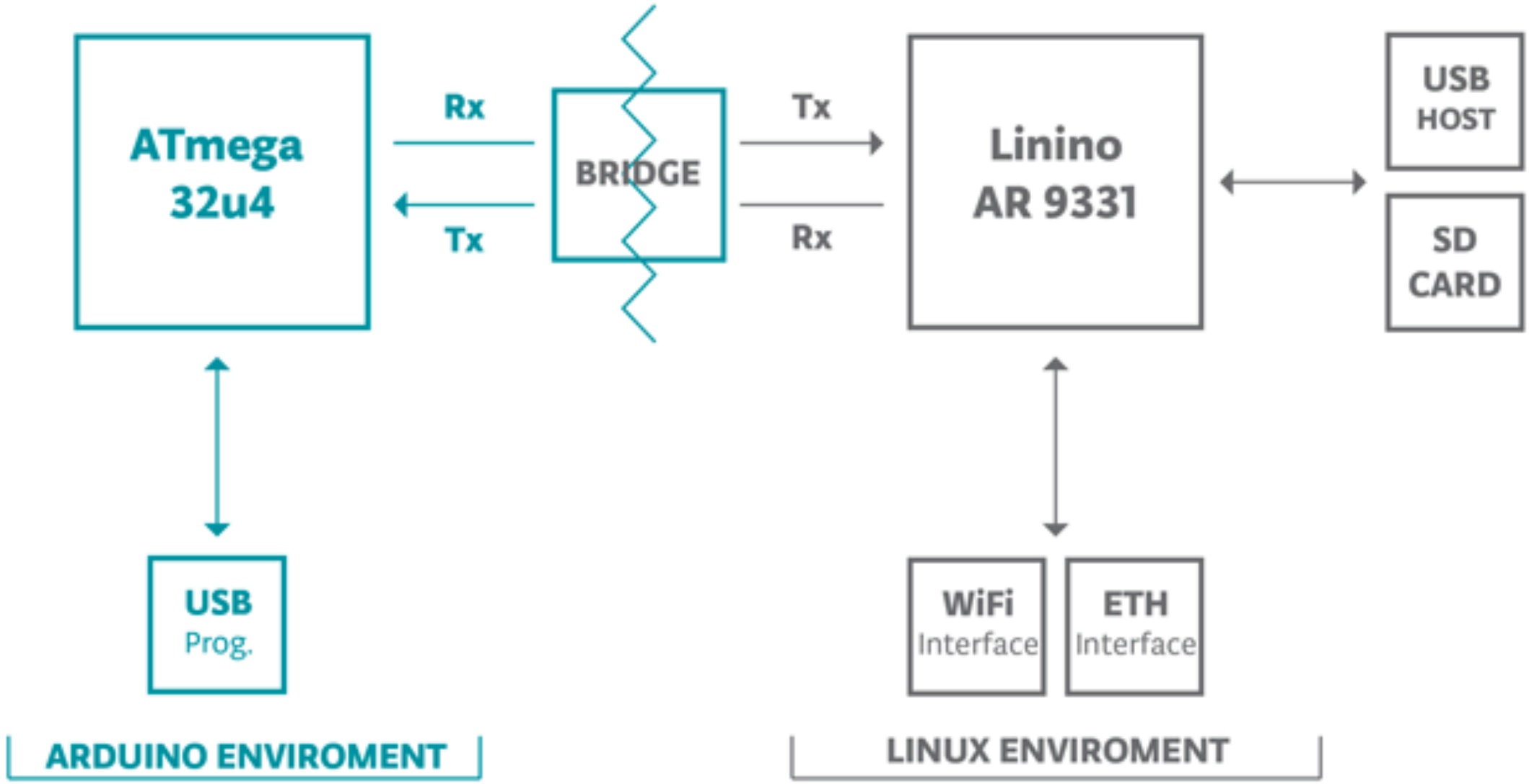


Arduino Yún


ARDUINO
YÚN
ARDUINO.CC
ICSP
RX
TX
L13
WAN
ON
WLAN
USB
YÚN RST
WLAN
RST

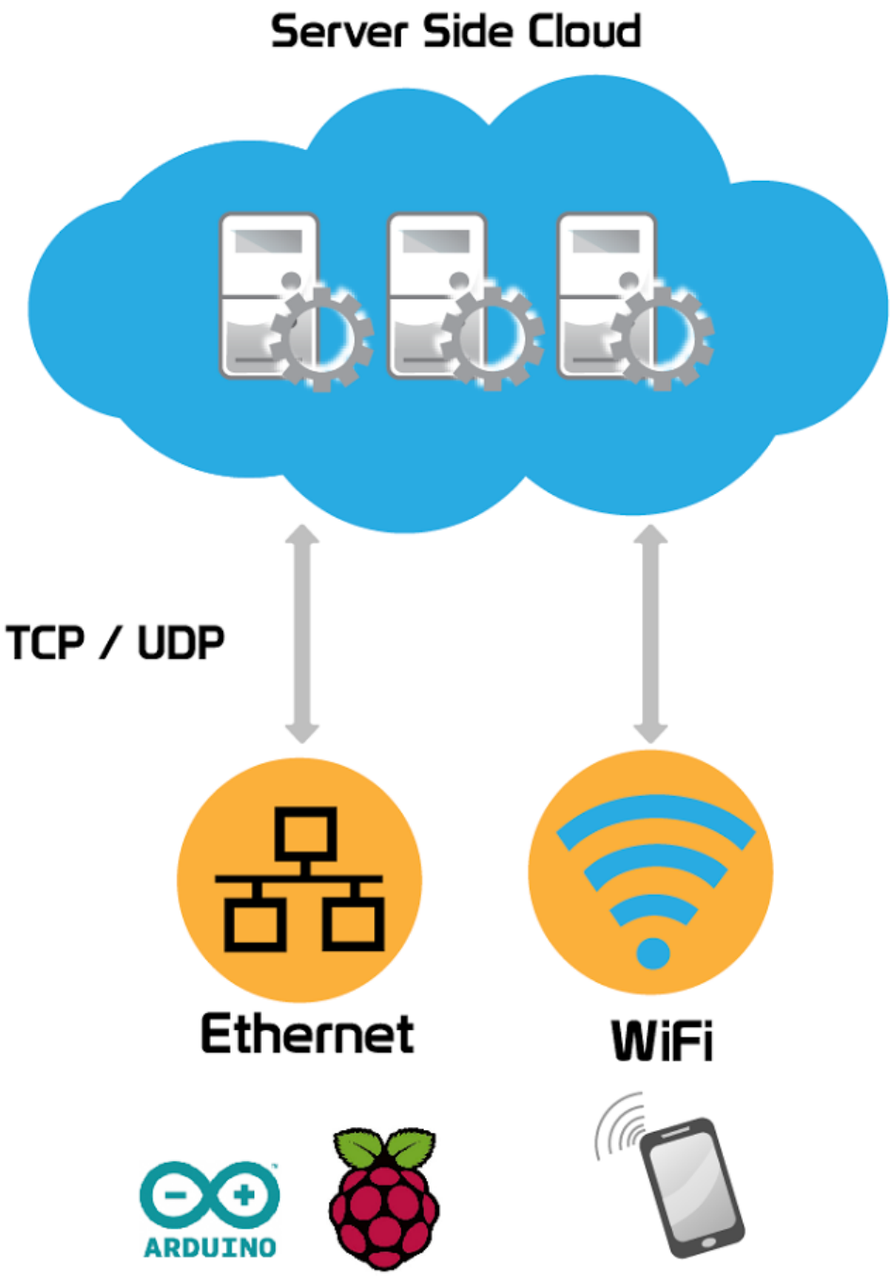

BOARD MODEL
YÚN
OPEN-SOURCE ELECTRONICS
PROTOTYPING PLATFORM
DESIGNED IN SWITZERLAND
MANUFACTURED IN TAIWAN
ARDUINO
YÚN
ARDUINO.CC
DEVELOPED WITH
dog hunter

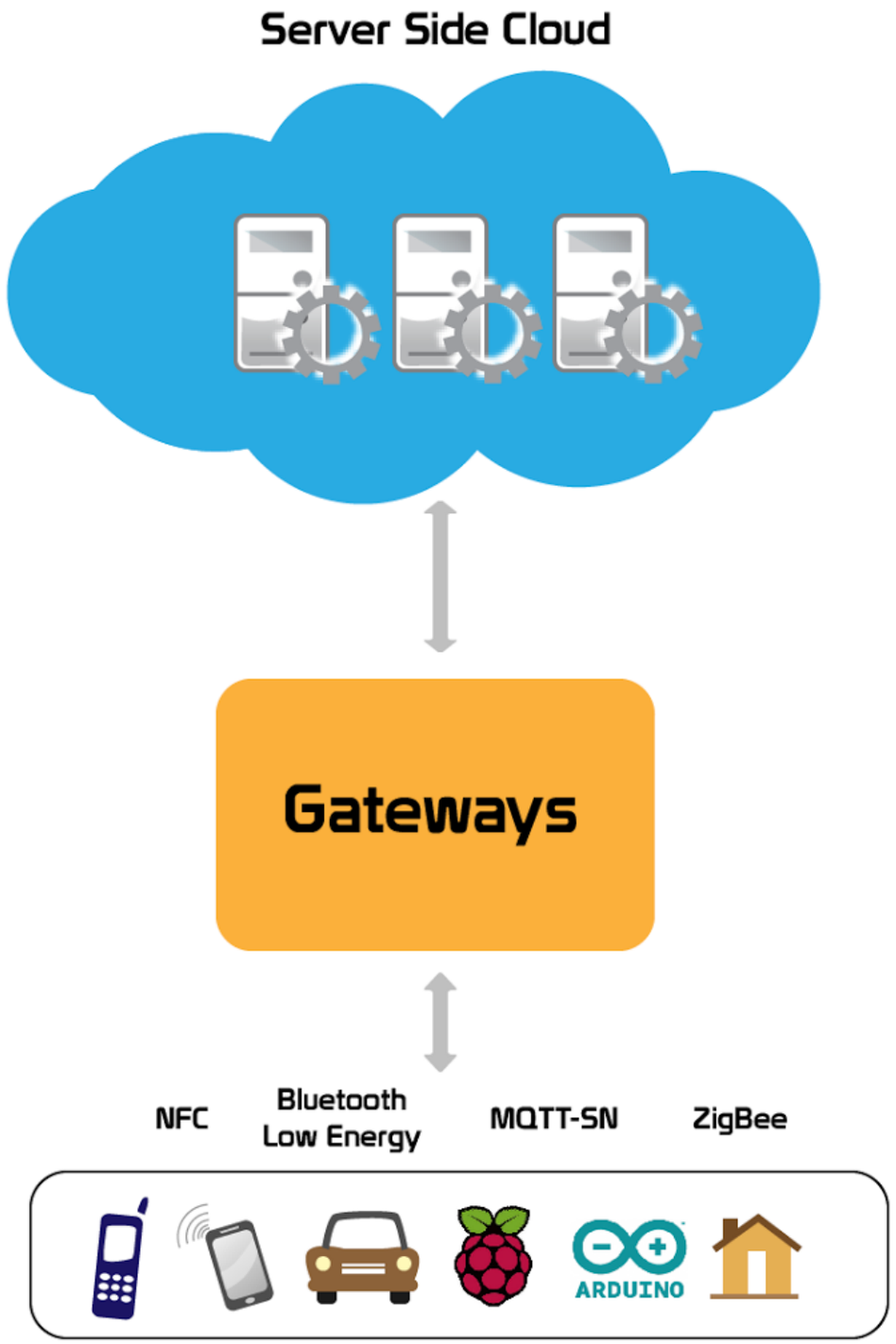
Arduino Yún



Communication

- Direct Ethernet/Wi-Fi/3G – Long range
- Bluetooth Low Energy (BLE)) – low range
- RFID/Near Field Communication (NFC) – low range
- Zigbee or other mesh radio networks – medium range


Server Side Cloud
TCP / UDP
Ethernet
WiFi
ARDUINO


Server Side Cloud
Gateways
NFC
Bluetooth
Low Energy
MQTT-SN
ZigBee
ARDUINO

Communication Protocols

- HTTP
- MQTT (MQ Telemetry Transport)
- CoAP (Constrained Application Protocol)

MQTT

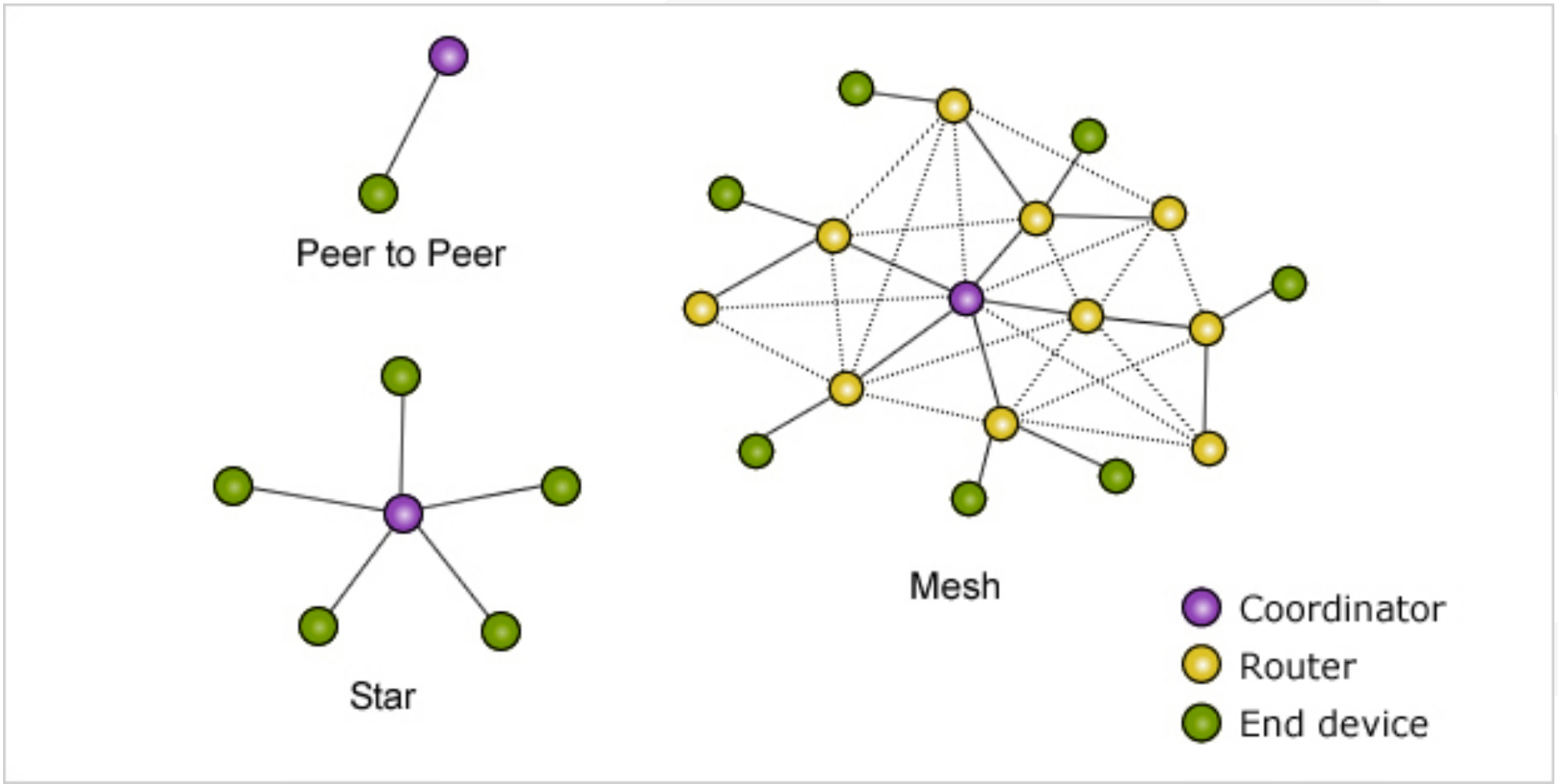
- M2M/IoT connectivity protocol
- Extremely lightweight pub/sub messaging transport
- Useful for connections with remote locations where a small code footprint is required and/or network bandwidth is at a premium
- Low latency, assured messaging over fragile networks and efficient distribution to one or many receivers.
- Focuses on
  - minimising the amount of bytes flowing over the wire
  - low power usage
- Better at a high volume of low size messages
- Provides a two-way communication channel

MQTT vs HTTP

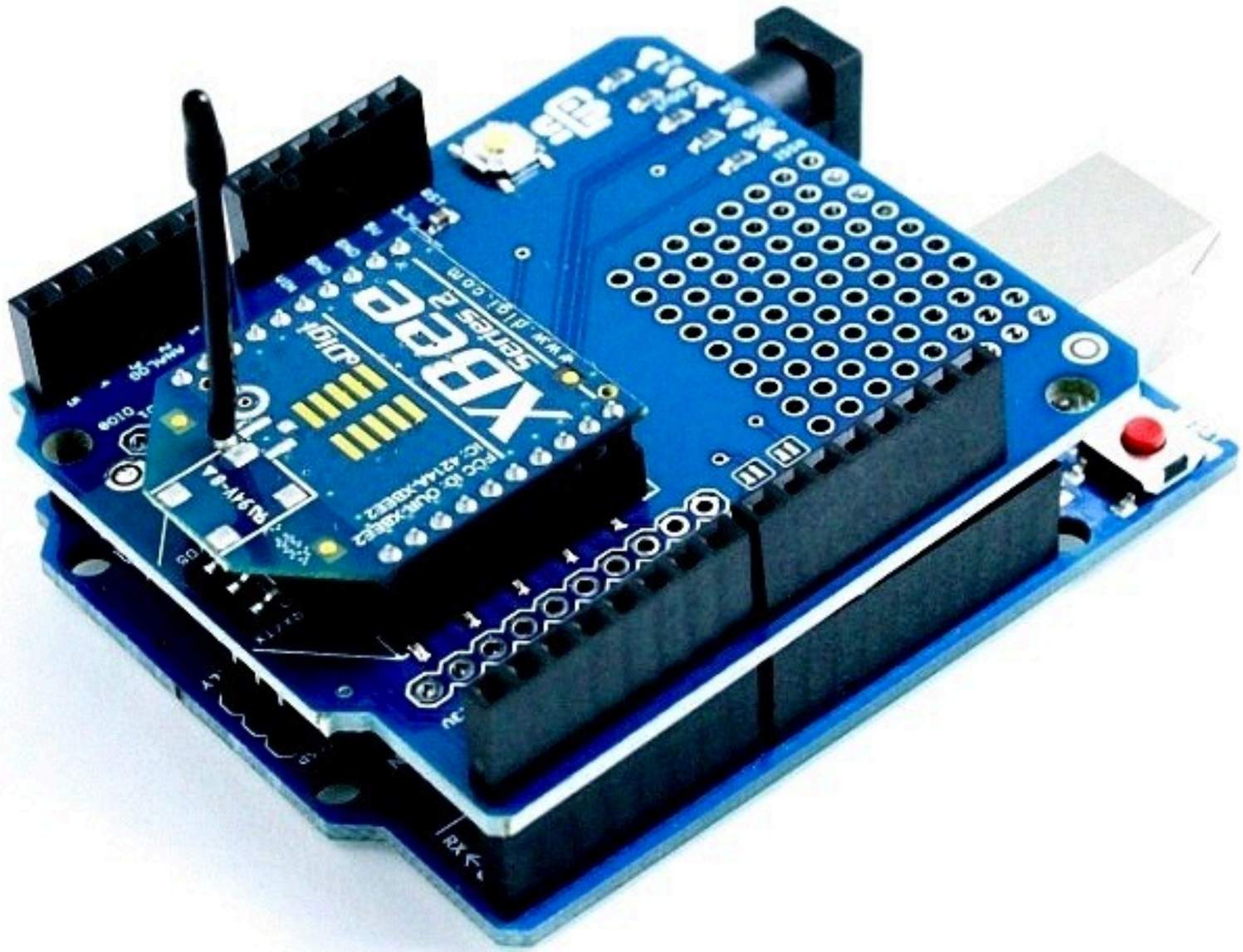
		3G		Wifi	
		HTTPS	**MQTT**	**HTTPS**	**MQTT**
receive	msgs / hour	1,708	160,278	3,628	263,314
	% battery / msg	0.01709	0.00010	0.00095	0.00002
	msgs (note losses)	240 / 1024	1024 / 1024	524 / 1024	1024 / 1024
send	msgs / hour	1,926	21,685	5,229	23,184
	% battery / msg	0.00975	0.00082	0.00104	0.00016

Source https://www.ibm.com/developerworks/community/blogs/c565c720-fe84-4f63-873f-607d87787327/entry/tc_overview?lang=en

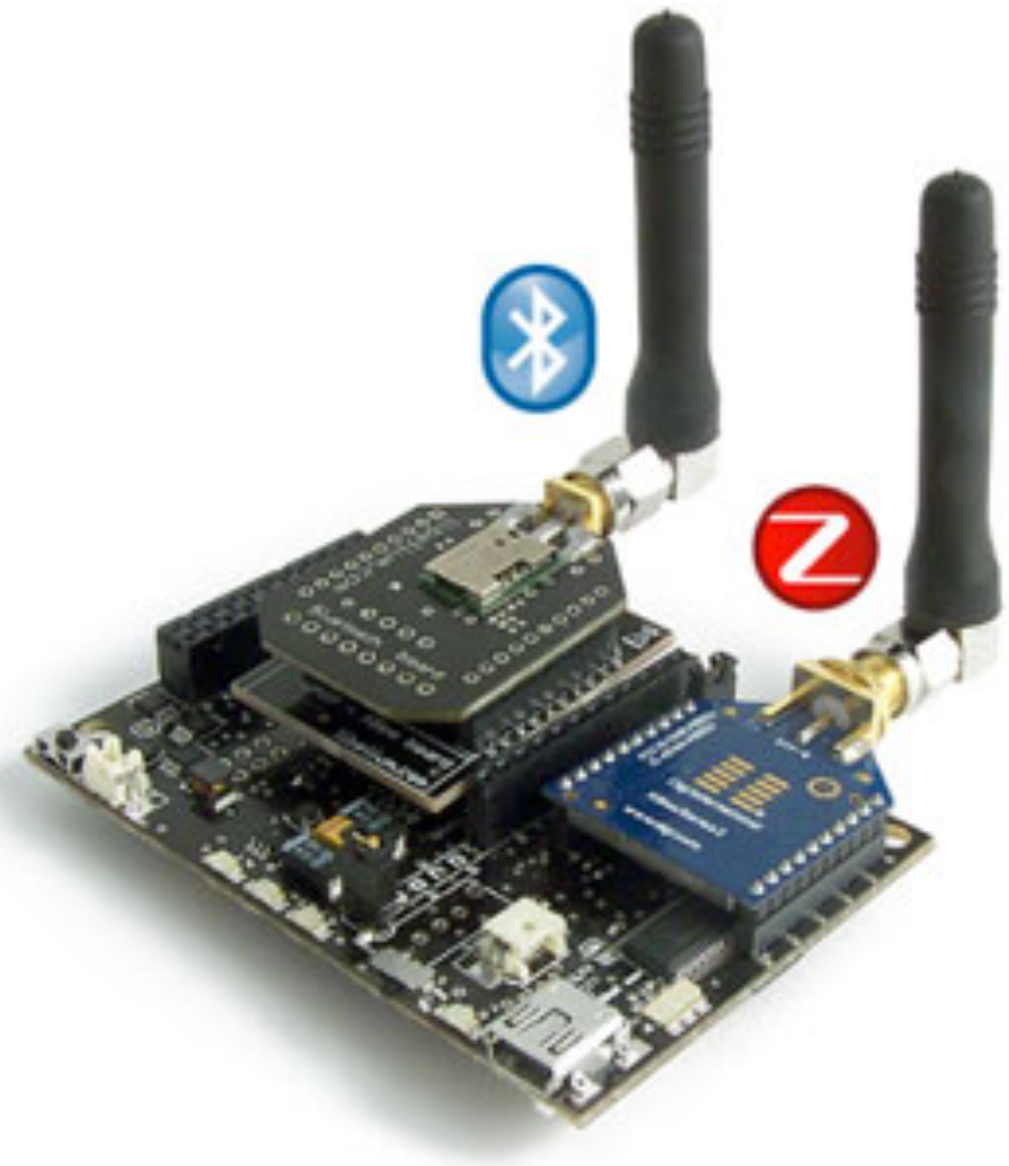
Zigbee



XBee Shield



Motes



See: Waspmote

Core Concerns

- Connectivity and communications
- Device Management
- Data collection, analysis, and actuation
- Scalability
- Security

Why do we need a Ref. Architecture?

- IoT devices are inherently connected. We need a way to interact with them.
- There are billions of these devices. We need a scalable architecture that is highly available and allows Disaster recovery
- Management of devices - automatic updates, remote management
- Security is a concern since these devices collect sensitive data
- Provides a starting point for architects looking to create IoT solutions as well as a strong basis for further development

Web / Portal

Dashboard

API Management

Event Processing and Analytics

Aggregation / Bus Layer

ESB and Message Broker

Communications

MQTT / HTTP

Devices

Device Manager

Identity & Access Management

WSO2 User Engagement Server

Web / Portal

Dashboard

WSO2 API Manager

API Management

WSO2 Business Activity Monitor

WSO2 Complex Event Processing Server

Event Processing and Analytics

WSO2 Enterprise Service Bus

WSO2 Message Broker

Aggregation / Bus Layer

ESB and Message Broker

Communications

MQTT / HTTP

Devices

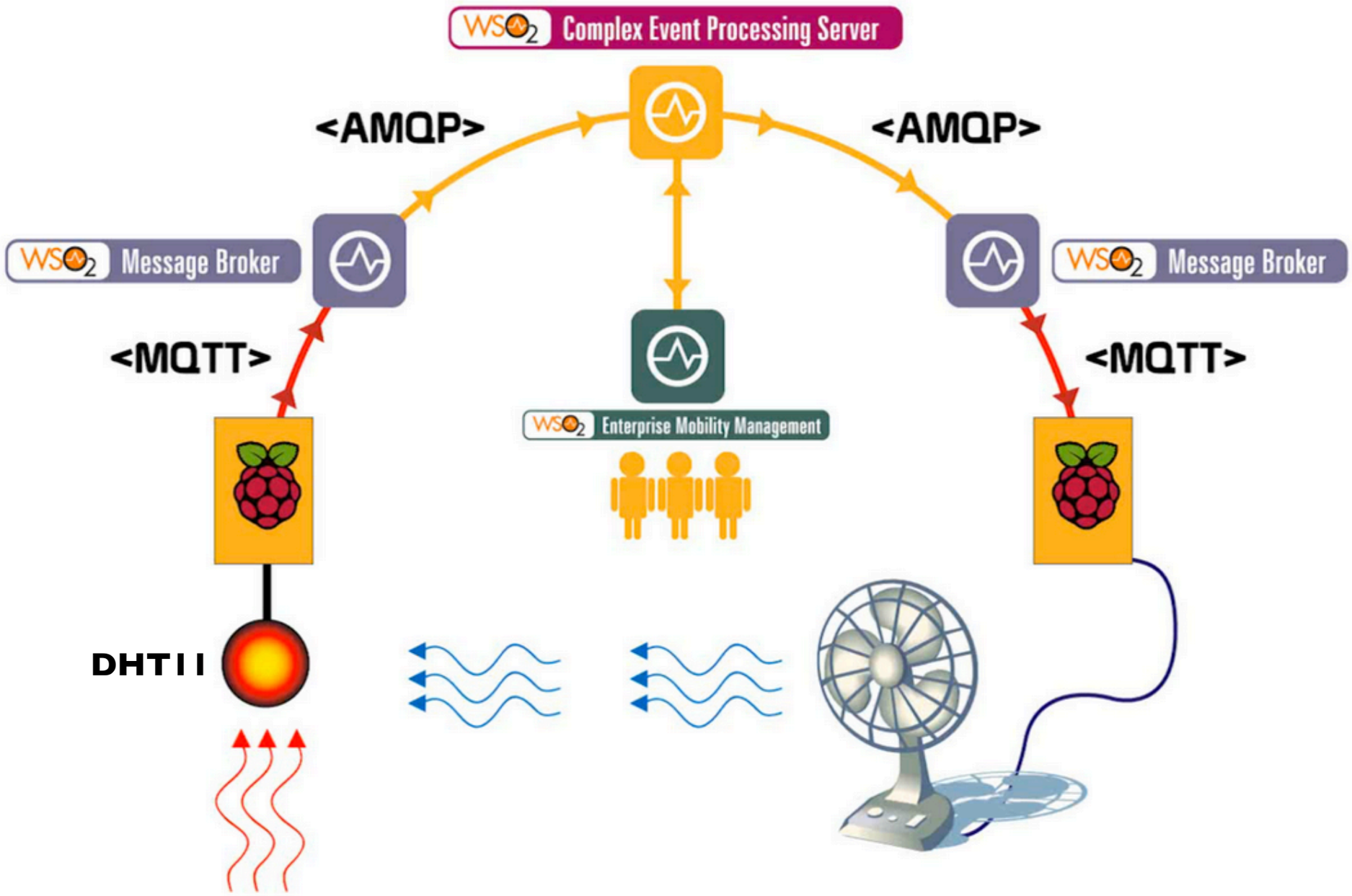
Device Management

WSO2 Enterprise Mobility Management

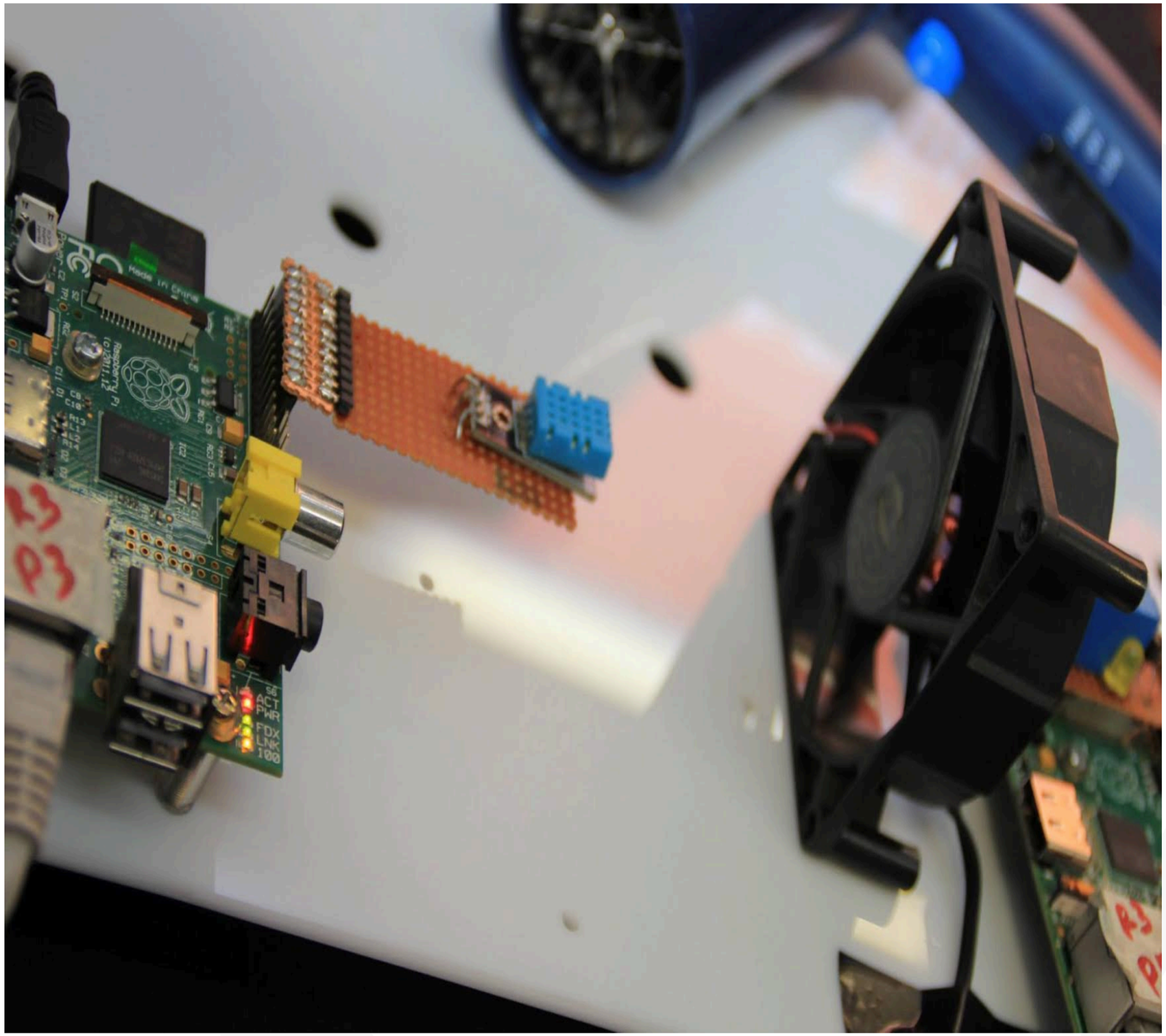
Identity & Access Management

WSO2 Identity Server

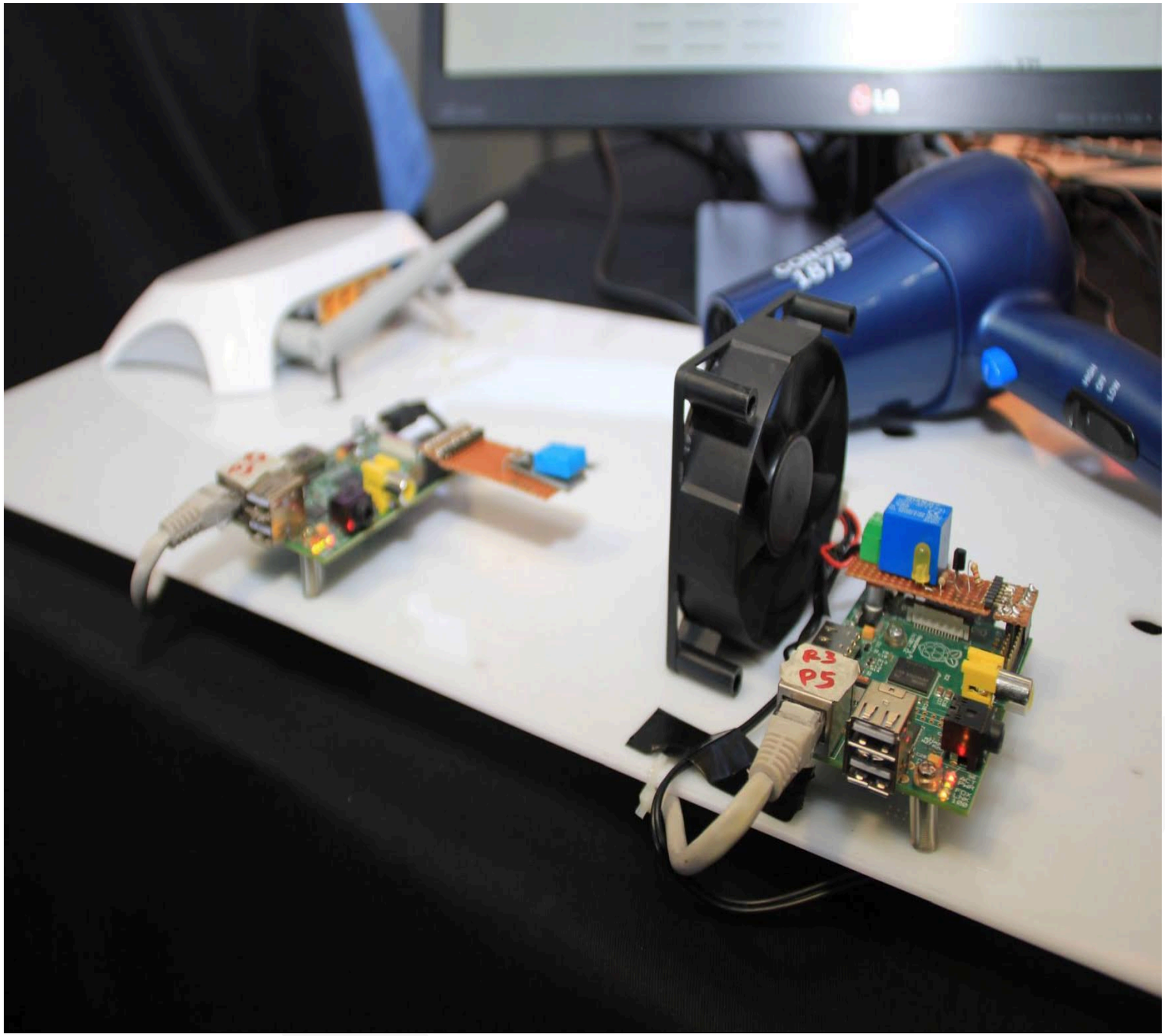
Example Implementation



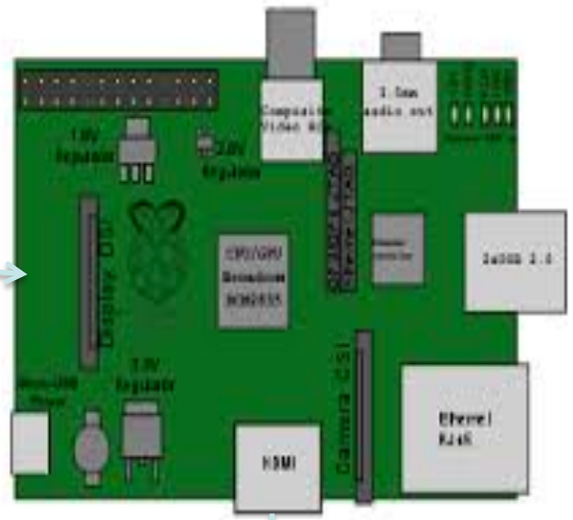
Example Implementation

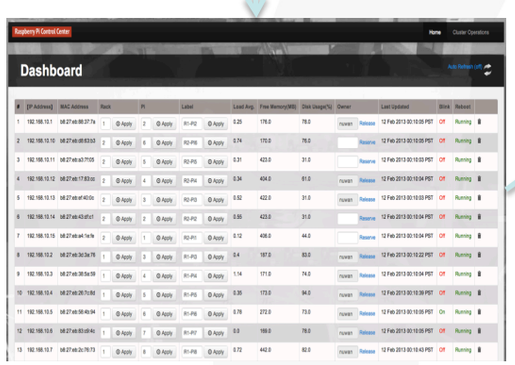


Example Implementation



RFID Attendance Tracker





Device Manager

Mobile App

WSO2 API Cloud

API Manager

WSO2

LDAP

WSO2 App Cloud

{ jaggery.js }

UserReg App

{ jaggery.js }

Conference App

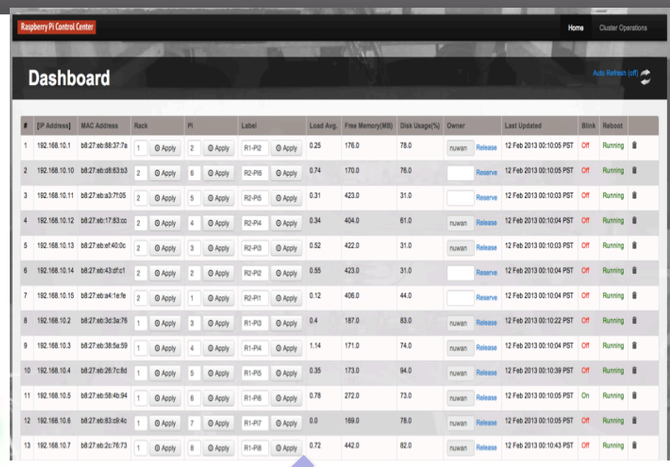
Data Services Server

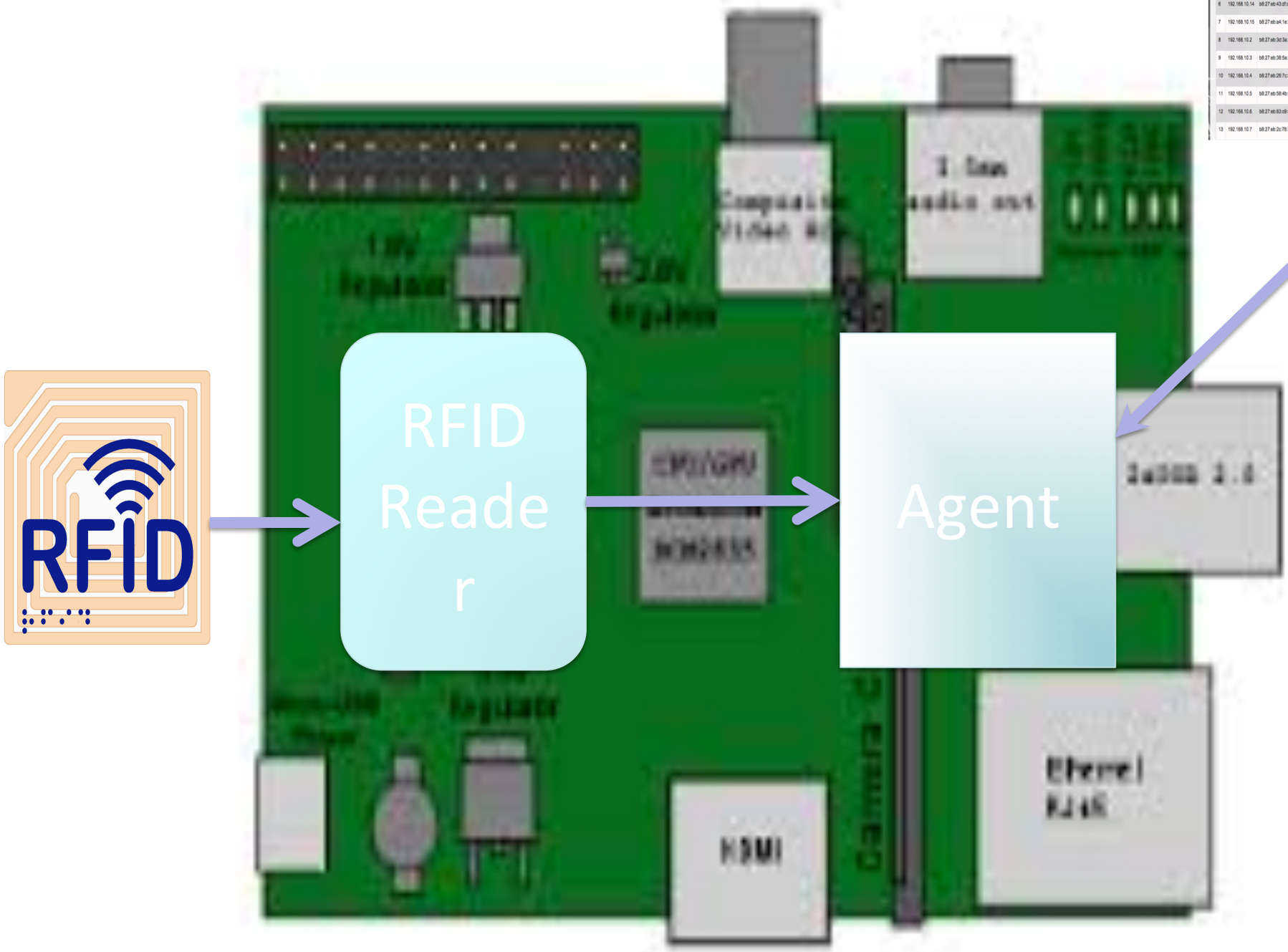
WSO2

GSpread

User Engagement Server

WSO2


Raspberry Pi Control Center
Home
Cluster Operations
Dashboard
Auto Refresh (off)


RFID
RFID Reade r
Agent

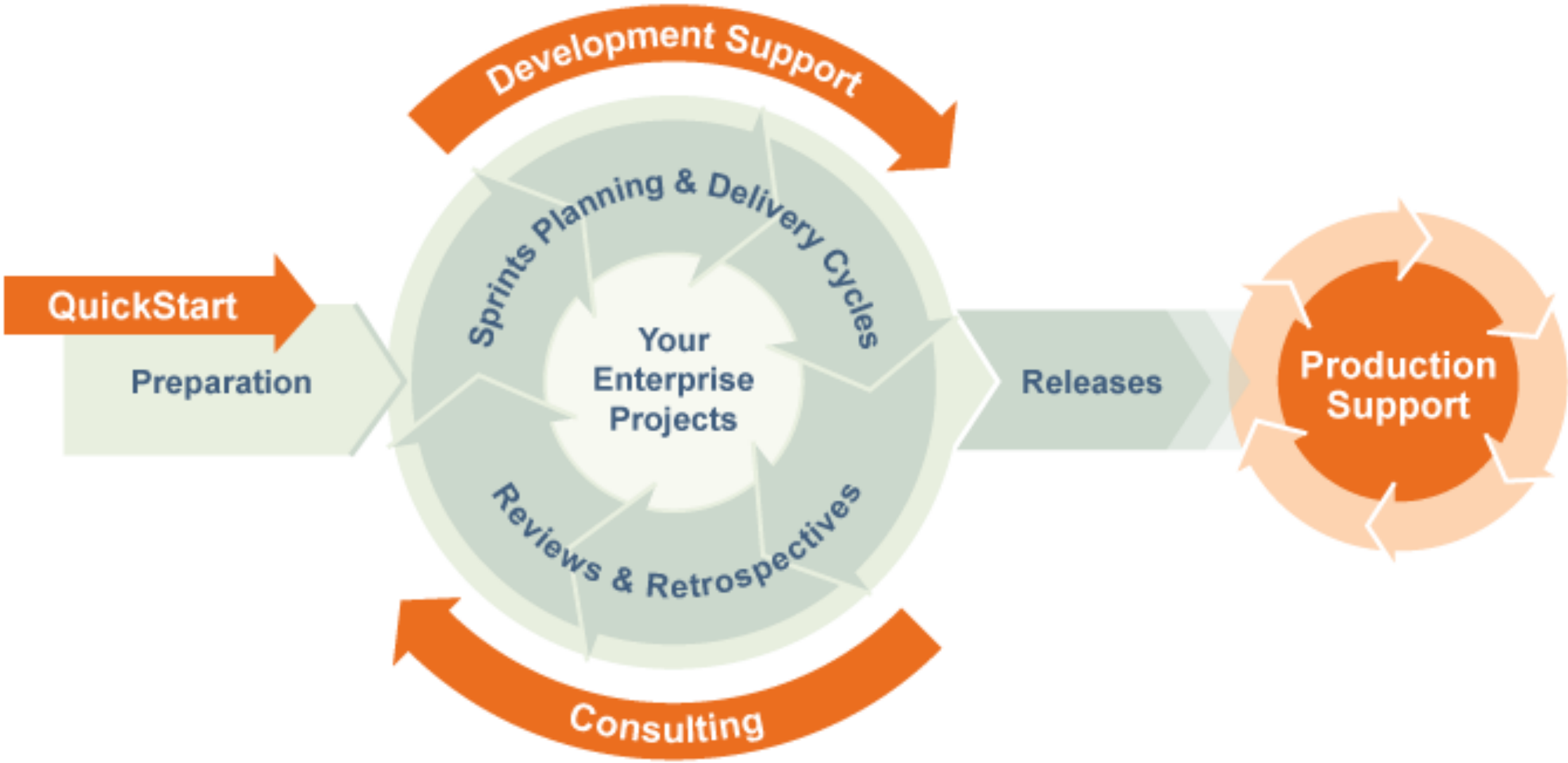
Summary

- Fundamentals of IoT
- Why a reference architecture is valuable
- The requirements on the RA
- The instantiation of the RA and how it meets those requirements
- A mapping of that RA into the WSO2 platform

References

- A reference architecture for the Internet of Things
  http://wso2.com/whitepapers/a-reference-architecture-for-the-internet-of-things/
- MQTT
  https://www.ibm.com/developerworks/community/blogs/c565c720-fe84-4f63-873f-607d87787327/entry/tc_overview?lang=en

Business Model



North America

CISCO, ATC, ACQUITY GROUP, AMERICAN FAMILY INSURANCE, Children's Hospital Boston, CAA, SAIC, Institut national de santé publique Québec, MEMC, Concur, Trimble, UMUC, JPMorganChase, Prudential, VERIO, AAA, Blue Cross of Idaho, BNY MELLON, Intermountain Healthcare, FRONT PORCH DIGITAL, imshealth, BOEING, StubHub!, KAISER PERMANENTE, UBS, NOEL GROUP, Expedia, TRACTOR SUPPLY CO, eBay, FLEXERA, REGIONS, barclaycard, neustar, SPECTRUM HEALTH, west, NATO OTAN, GSA, Capital Group Companies, intel, GE, Rakuten Global Market, FRONT PORCH DIGITAL

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Middle East and Asia-Pacific

COMMERCIAL CREDIT, Sri Lanka Telecom Mobitel, Cognizant, ICTA ideas actioned, ODEL, Dialog, Sapura, ELH, onesteel, Australian Government Department of Health and Ageing, JESAI 杰赛科技, VIB

South America

SIF, BI&P Banco Industrial & Partners

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