

# Pervasive Systems

Ioannis Chatzigiannakis

Sapienza University of Rome  
Department of Computer, Control, and Management Engineering (DIAG)

## Lecture 2: Projects



# Part 2: Sensor Networks

- 1 Ad-hoc Networking mechanisms
  - IEEE 802.15.4
- 2 Network communication & control protocols
  - Broadcast & Convergecast
  - Routing
  - Clustering
- 3 Open-source frameworks
  - Arduino – codebender.cc
  - TinyOS
  - Wiselib
- 4 Case-studies
  - Energy-efficient buildings
  - Monitoring Elderly



# Part 3: Internet of Things

- 1 Machine-to-machine Communication
  - ZigBee, ZWave
  - 6LowPan (RPL, COAP)
  - MQTT
- 2 Byzantine Failures & Data
- 3 Real-world Testbeds
  - Wisebed Testbed Runtime
  - Smart Santander
- 4 Open-source frameworks
  - Libelium
- 5 Case-studies
  - Air-quality monitoring
  - Traffic monitoring
  - Smart citizen kit



# Projects & Exams

- 1 Personal Mini-project
  - Technology oriented (hardware or software)
  - Presentation of technology in class
  - Demonstration
- 2 Group Project
  - 2 people per project
  - Design a Pervasive system
  - Develop the system using appropriate technologies
  - Test & Evaluate in real-world conditions



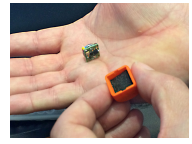
# Dialog Semiconductor's SmartBond – DA14580

Smallest, Lowest power BLE solution.

Suitable for Smart Wearables, Smart Home apps.

Specs:

- 32-bit ARM Cortex M0 microcontroller
- Complete Bluetooth Smart SoC
- Up to 32 GPIOs
- Battery charging circuitry
- Over-the-air programming

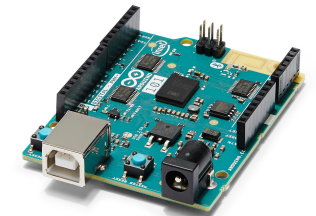
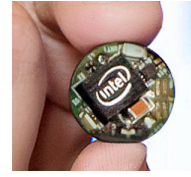


# Intel Curie

Suitable for Low-power / Smart Wearables.

Specs:

- Low-power, 32-bit Intel Quark microcontroller
  - 400Mhz ARM-M0 processor
- 384kB flash memory, 80kB SRAM
- Low-power, integrated DSP sensor hub and pattern matching technology
- Bluetooth Low Energy
- 6-axis combo sensor with accelerometer and gyroscope
- Battery charging circuitry (PMIC)



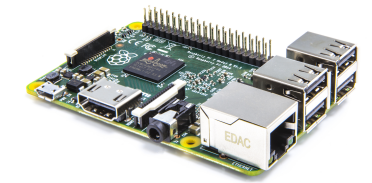
# Raspberry Pi 2 Model B Desktop

Smallest Full-scale Desktop system.

Suitable for Smart Home apps.

Specs:

- 900MHz quad-core ARM Cortex-A7 CPU
- 1GB RAM
- 40 GPIOs, 4 USB
- Ethernet
- HDMI port
- Audio
- Camera interface (CSI)
- Micro SD Card



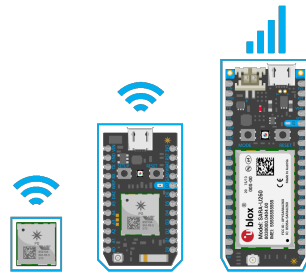
# Particle

Best Prototype-to-production platform.

Suitable for Smart Home/Business products.

Specs:

- STM32F205 120Mhz ARM Cortex M3
- 1MB flash, 128KB RAM
- Broadcom BCM43362 Wi-Fi chip
- Variety of Relay shields



# TOOGOO OBD Connector

Suitable for Smart Car products.

Specs:

- OBD-II Connector
- Bluetooth Connector
- ELM327 processor
- No Batteries, Cables, or Switches
- Android compatible



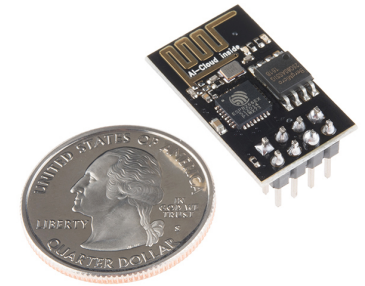
# ESP8266

Cheapest WiFi platform.

Suitable for Smart Home/Business products.

Specs:

- Wi-Fi Direct (P2P), soft-AP
- 1MB Flash Memory
- Integrated low power 32-bit CPU could be used as application processor
- SDIO 1.1 / 2.0, SPI, UART
- Wake up and transmit packets in  $\mu$  2ms



# Estimote Beacons

Indoor Localization Platform.

Suitable for Smart Home/Business products.

Specs:

- ARM M0 Cortex
- BLE
- Motion & temperature sensors
- iBeacon/Eddystone compatible



# Sensoro Beacons

Indoor Localization Platform.

Suitable for Smart Home/Business products.

Specs:

- ARM M0 Cortex
- BLE
- Light, Motion & temperature sensors
- iBeacon/Eddystone compatible



# Temboo

Arduino Management Platform.

Features:

- Code in the cloud
- Remote deploy code
- Collect data
- Supports Raspberry, Genuino, Beaglebone, ...

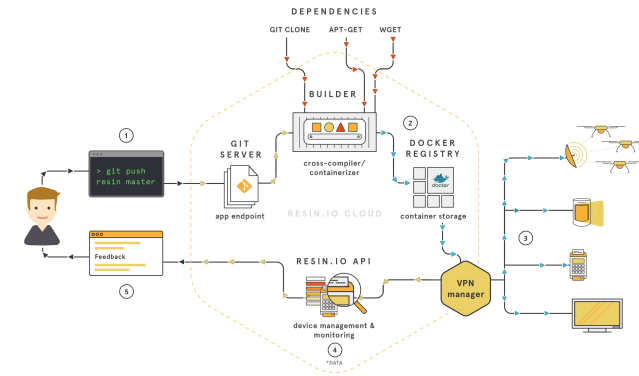


# resin.io

Linux Management Platform.

Features:

- Compilation in the cloud
- Compatible with docker, github
- Supports Raspberry, Genuino, Beaglebone, ...

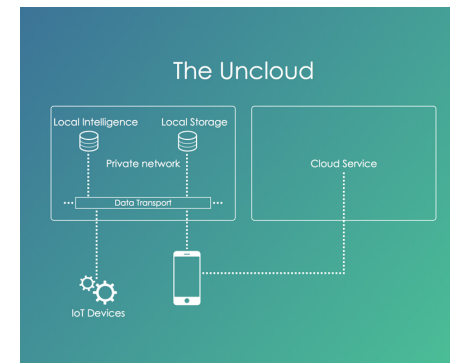


# ThingStudio

Arduino Control User Interface.

Features:

- Application Development Environment
- Design Dynamic UI
- Collect data



Software

# Blynk

IoT Control User Interface.

Features:

- Arduino / Raspberry Pi / Particle
- iOS / Android



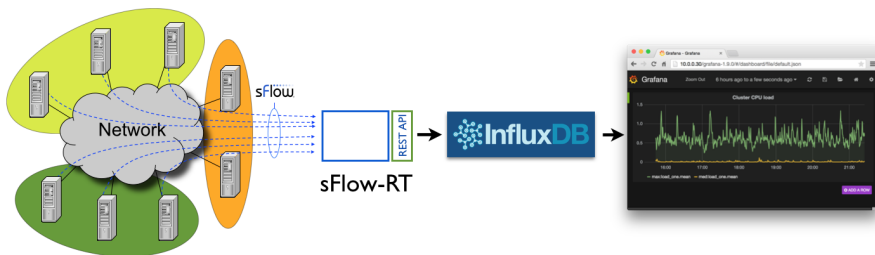
Software

# InfluxDB

IoT Data Management Platform.

Features:

- Store/Manage/Visualize IoT Data
- Data Queries



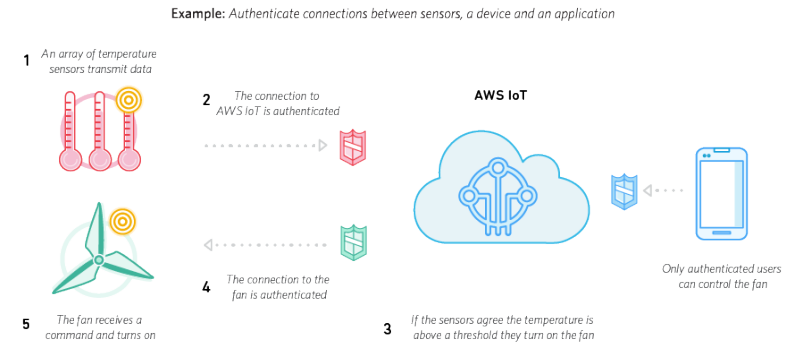
Software

# AWS IoT

IoT Messaging Platform.

Features:

- Connectivity Protocol
- Publish/Subscribe messaging transport.



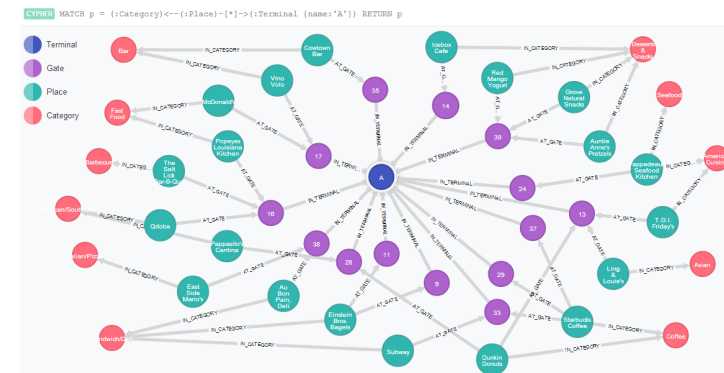
Software

# neo4J

Graph Database.

Features:

- Store/Manage/Visualize Graph-based Data
- Cypher Query Language

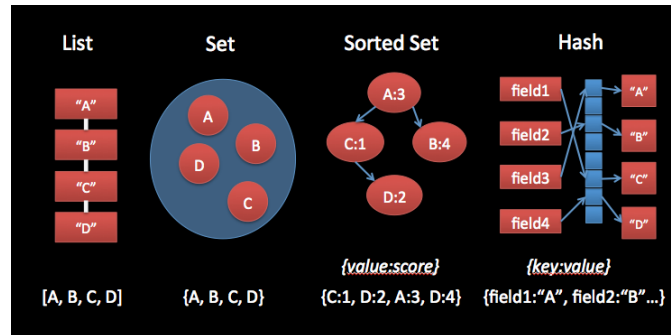


## Redis

Data Structure Store.

Features:

- strings, hashes, lists, sets, sorted sets with range queries, bitmaps, hyperloglogs and geospatial indexes with radius queries



## Smart Building Control

- Accurate indoor localization
- Switch on/off lights to conserve energy
- Configure rooms based on user preferences
- Estimate energy consumption
- Eco-friendly usage of building
- ...



## Smart Health - Elder Care

- Accurate indoor localization
- Notify caregiver about location of elder
- Detect cases when elder needs help
- Monitor drug adherence
- ...



## Smart Kitchen

- Accurate inventory control
- Control of appliances
- Monitor air conditions
- Act upon critical event
- ...



## Smart Store

- Accurate indoor localization
- Notify consumer about products
- Integration with social media
- ...



## Smart Museum

- Accurate indoor localization
- Notify visitor about exhibits
- History of exhibits visited for off-site browsing
- ...



## Smart Mensa

- Local restaurants
- Employees/Students
- NFC
- Monitor eating behavior – healthy proposals
- ...



# Smart Garden

- Monitor soil moisture
- Control watering
- Identify watering needs per plant type
- Monitor weather conditions
- ...

