Part 1: Smartphones

- Infrastructure Networking & Cloud services
- Ad-hoc Networking mechanisms
  - IEEE 802.11 (WiFi, WiFi-Direct)
  - IEEE 802.15.1 (Bluetooth)
- Network communication & control protocols
  - Dissemination (Flooding, Gossiping)
  - Agreement, Commit
  - Localization
- Open-source frameworks
  - Android
- Case-studies
  - Participatory sensing
  - Physical interaction sensing
  - Pervasive gaming

Part 2: Sensor Networks

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

Part 3: Internet of Things

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

- **Personal Mini-project**
  - Technology oriented (hardware or software)
  - Presentation of technology in class
  - Demonstration

- **Group Project**
  - 2 people per project
  - Design a Pervasive system
  - Develop the system using appropriate technologies
  - Test & Evaluate in real-world conditions

### 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)

### 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

### 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

**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 ~2ms

**TOOGOO OBD Connector**
Suitable for Smart Car products.

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

**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

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### resin.io

Linux Management Platform.

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

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### Temboo

Arduino Management Platform.

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

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### ThingStudio

Arduino Control User Interface.

**Features:**
- Application Development Environment
- Design Dynamic UI
- Collect data
### Blynk

**IoT Control User Interface.**

**Features:**
- Arduino / Raspberry Pi / Particle
- iOS / Android

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### AWS IoT

**IoT Messaging Platform.**

**Features:**
- Connectivity Protocol
- Publish/Subscribe messaging transport.

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### InfluxDB

**IoT Data Management Platform.**

**Features:**
- Store/Manage/Visualize IoT Data
- Data Queries

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### 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

![Redis Data Structure Diagram]

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**Smart Car / Traffic Monitoring**

- OBD-based / SmartPhone-based
- Statistics for average speed / road
- Statistics for average consumption
- Estimate emissions
- Eco-friendly driving
- ...

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**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
- ...

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**Smart Health - Elder Care**

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

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### 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
- ...

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Smart Garden

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