Sensor Technology

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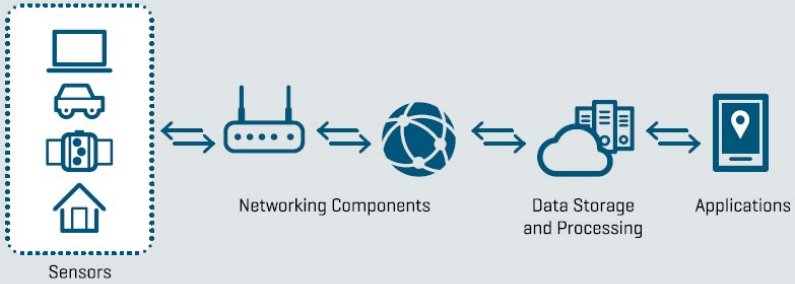
Session Outline

1. Overview of Sensor Technology
2. Things
3. Sensors & Actuators
4. Microcontrollers
5. RFID Device
6. Other Devices

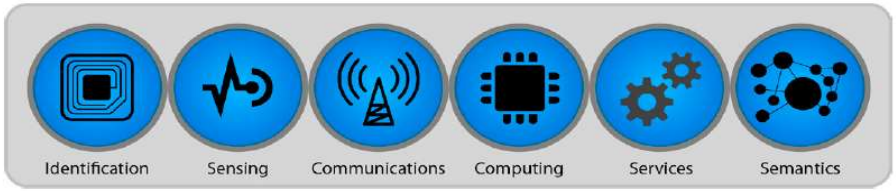
Overview of Sensor Technology

IoT Building Blocks

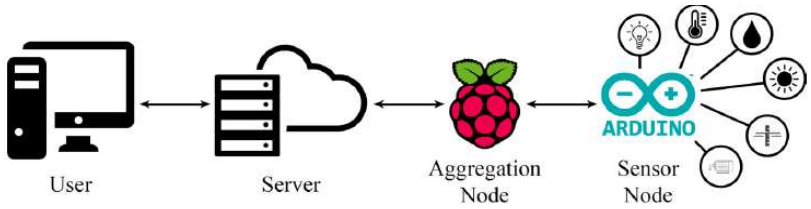


Components/Technologies of IoT

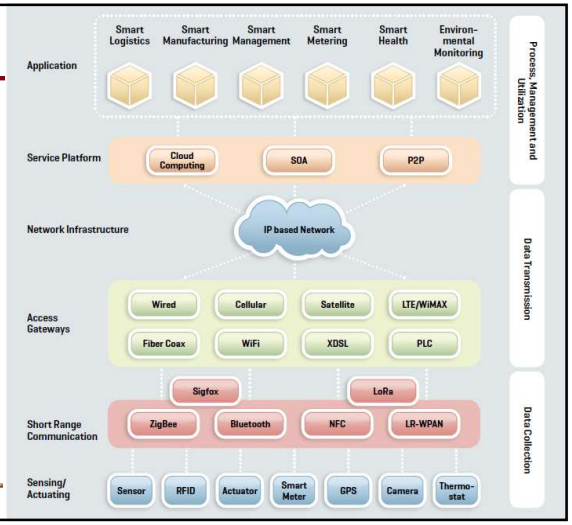
- Sensor Technologies
- Communication Technologies
- Computing Technologies
- Service/Middleware Technologies
- Application Domain



Example



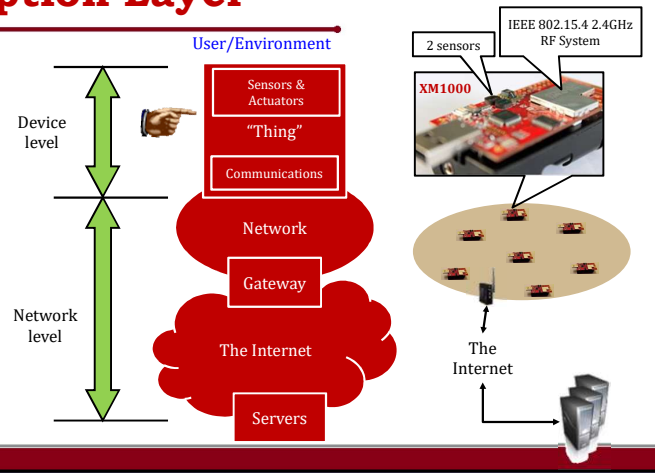
Data Flow in IoT Environment



Challenges

- Sensor and actuator networks
- Device-to-Device (D2D) integration (Wireless Senor Networks)
- Cloud-to-Cloud (C2C) integration
- Device and Sensor-to-cloud (D2C) integration

Perception Layer



Objects Layer/Device Layer

Objects Layer/Device Layer

- **Objects Layer**, also known as **Devices Layer,**
  - ✓ The **Physical Devices** are used to **collect the data**
  - ✓ **Physical devices** include **different types of sensors**
    - **Optical Sensors,**
    - **Light Sensors,**
    - **Pressure Sensors, and More.**
    - **Gesture and Proximity Sensors,**
    - **Touch and Fingerprint Sensors,**

Objects Layer/Device Layer

- An **Object (or Things)** of the **physical world (or physical Things)** or the **information world (or virtual things)** that can be **identified and integrated** into **communication networks.**
- We can turn almost **Every Object into a "Thing".**

What is Things?

- A **Piece of Equipment** with the mandatory **capability of communication** and the optional capabilities of **Sensing, Actuation, Data Capture, Data Storage And Data Processing.**




Device

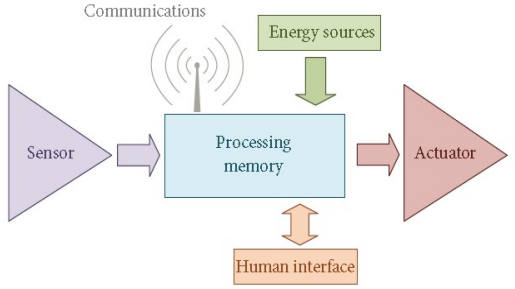
- A **Device** is a **hardware component** which
  - ✓ is connected to **Sensors and/or Actuators** by wire or wirelessly
- A **Device** integrates all these **components- processor, storage capacity to run software, Communication**

Some of the Devices in IoT

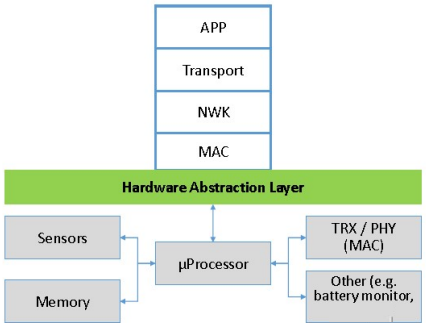
- **Thing**
- **Device**
- **Data-Carrying device**
- **Data-Capturing device**
- **Data Carrier**
- **Sensing Device**
- **Actuating Device**
- **General Device**

Components of the Device Cont....

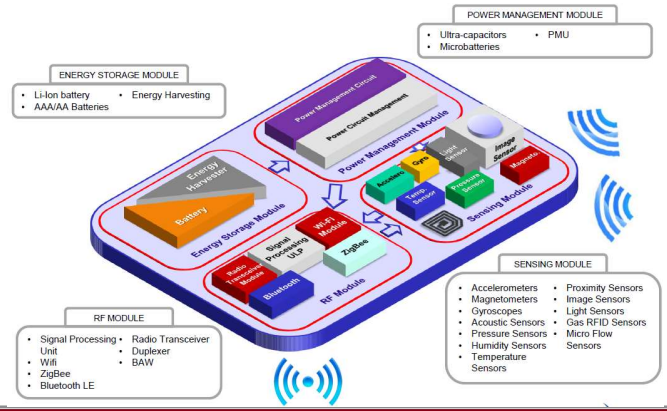
- A "Thing" generally consists of **Four Main Parts:**
  - ✓ **Sensors & Actuators**
  - ✓ **Microcontroller**
  - ✓ **Communication unit**
  - ✓ **Power supply**



Components of the Device



IoT Wireless Sensors



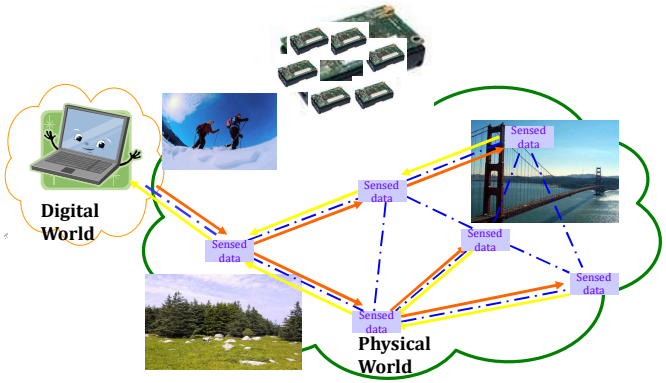
Properties of Devices/Things

- A **"Thing"** has the **following properties:**
  - ✓ It's usually powered by **battery.** This implies **limited source of energy.**
  - ✓ It's generally **small in size** and **low in cost.** This **limits their computing capability.**
  - ✓ It **doesn't** usually **perform complicated tasks.**
  - ✓ **Power consumption** is the **main design issue.**

Observation

- The **Thing must communicate** through the **Internet** to be considered an **IoT node.**
- In the past, the **Internet** has historically **connected resource-rich devices** with **lots of power, memory, and connection options**.

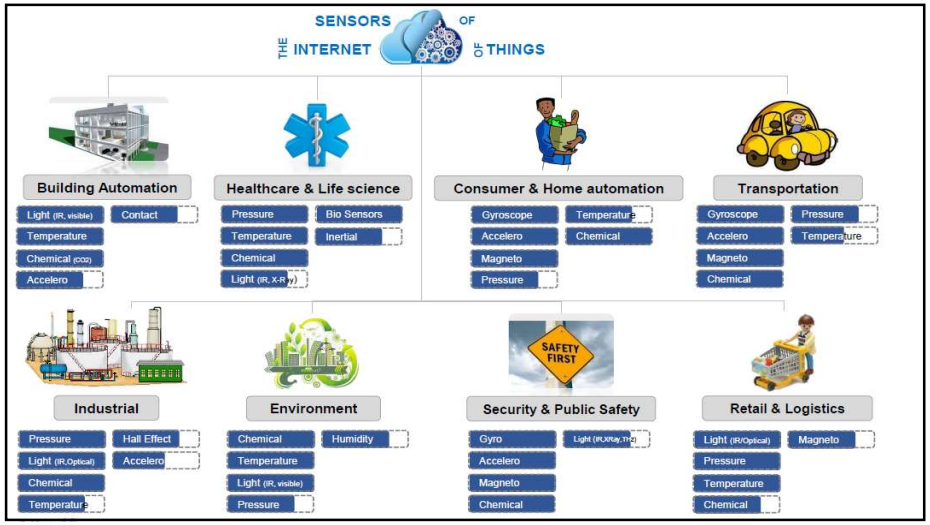
To Connect Digital World and Physical World



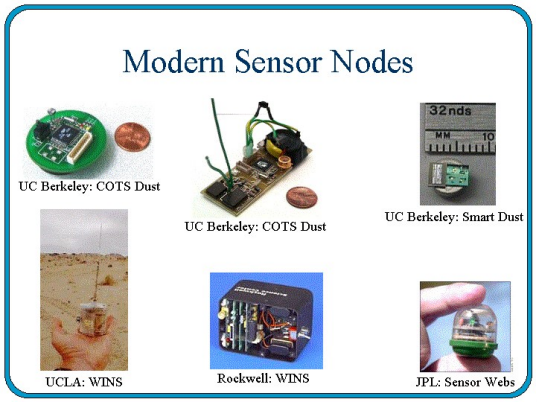
To Connect Digital World and Physical World

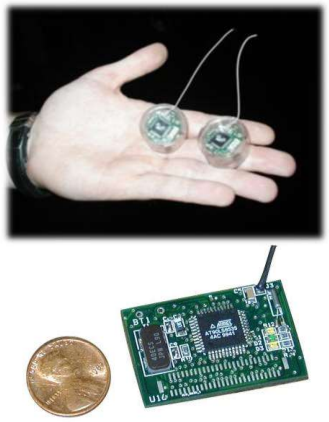
- Requires the **standardized mechanisms** for the objects layer
  - ✓ To **integrate and configure** the **heterogeneous types of sensors** of the IoT device ecosystem.
- The **device data** that are collected at this **object layer** are transferred to the **object abstraction layer (Communication Layer)** using secure channels.

Sensors & Actuators



Sensors

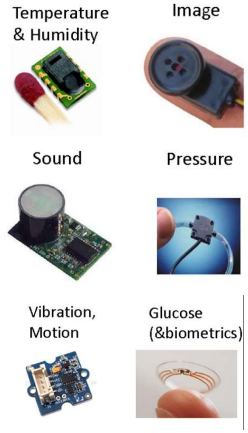




Sensor Classifications

- **Physical property** to be monitored determines type of required sensor

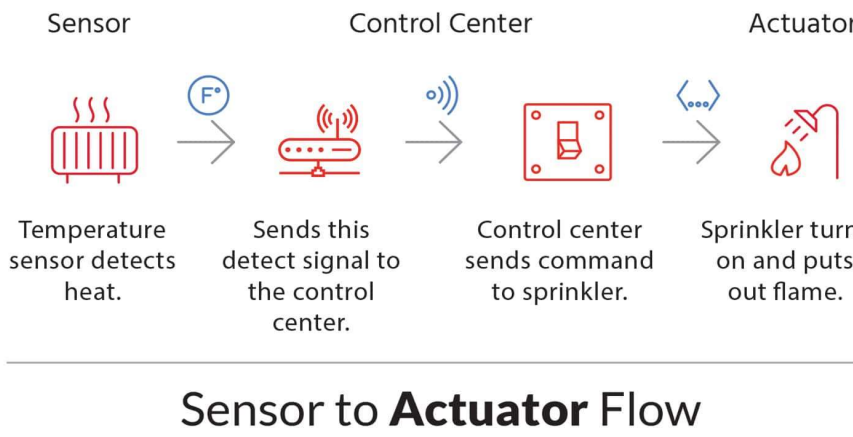
Type	Examples
Temperature	Thermistors, thermocouples
Pressure	Pressure gauges, barometers, ionization gauges
Optical	Photodiodes, phototransistors, infrared sensors, CCD sensors
Acoustic	Piezoelectric resonators, microphones
Mechanical	Strain gauges, tactile sensors, capacitive diaphragms, piezoresistive cells
Motion, vibration	Accelerometers, mass air flow sensors
Position	GPS, ultrasound-based sensors, infrared-based sensors, inclinometers
Electromagnetic	Hall-effect sensors, magnetometers
Chemical	pH sensors, electrochemical sensors, infrared gas sensors
Humidity	Capacitive and resistive sensors, hygrometers, MEMS-based humidity sensors
Radiation	Ionization detectors, Geiger-Mueller counters



Actuators

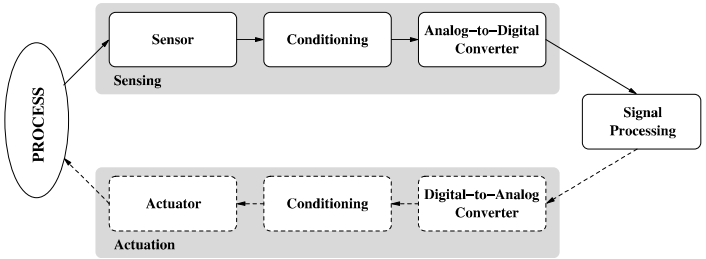
- An **Actuator** is a **hardware component** which **manipulates the physical environment.**
- **Actuators**
  - ✓ Receive commands from their connected device and
  - ✓ Translate the electrical signals into some kind of physical action.

Actuators

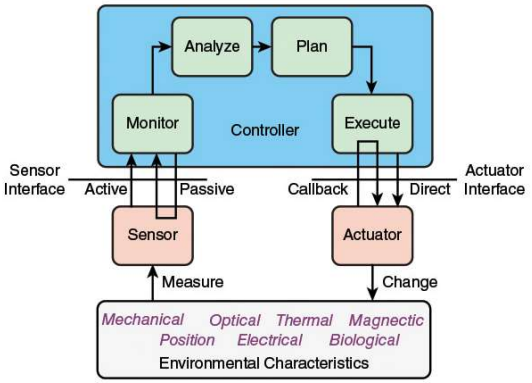


Sensing (Data Acquisition)

- **Sensing :** is a technique to **gather information** about **physical objects or areas**



Interfaces for Sensors and Actuators



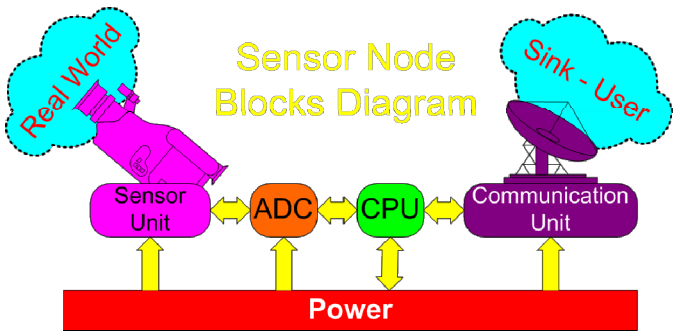
Sensor with Software Capability

- A **Sensor** is a **hardware component** which **captures information** on the **physical environment**
- A **Sensor** may be **configured** using **software**, but **cannot run software** by itself.

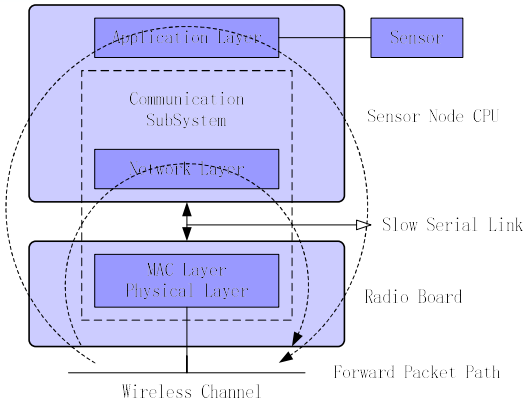
Actuator with Software Capability

- An **Actuator** is a **hardware component** which **manipulates the physical environment.**
- An **Actuator** may be **configured using software**, but **cannot run software** by itself.

General Architecture of a Sensor Node



Overall Architecture of a Sensor Node



Sensor Node Specification

- The overall architecture of a sensor node consists of:
  - ✓ The sensor node processing subsystem running on sensor node main CPU
  - ✓ The sensor subsystem and
  - ✓ The communication subsystem
- The processor and radio board includes:
  - ✓ TI MSP430 microcontroller with 10kB RAM
  - ✓ 16-bit RISC with 48K Program Flash
  - ✓ IEEE 802.15.4 compliant radio at 250 Mbps
  - ✓ 1MB external data flash
  - ✓ Runs TinyOS 1.1.10 or higher
  - ✓ Two AA batteries or USB
  - ✓ 1.8 mA (active); 5.1uA (sleep)

Crossbow Mote
TPR2400CA-TelosB

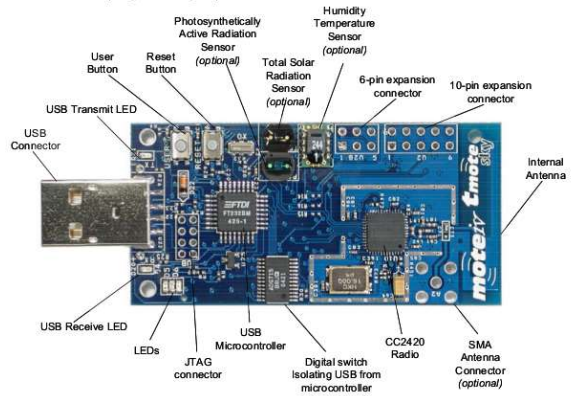
Definition of Mote

- **Mote** is **Sensor Node**,
  - ✓ **Mote** is a **node** in a **sensor network** that is capable of performing some **processing, gathering sensory information** and **communicating with other connected nodes** in the **network.**

Type of Motes

- There are **Various Types of Motes**. Few of them are
  1. **Sky Mote**
  2. **Z1 Mote**
  3. **WiSMote**
  4. **Zolertia Zoul**
  5. **RE-Mote**

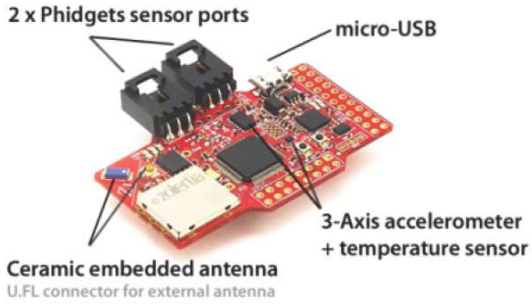
Sky Mote



Sky Mote

- **Sky Mote low power wireless sensor**. It is **high reliability** and **ease of development .**
- These **kind of sensors** usually include measuring of **relative humidity, temperature and light via sensors.**

Zolertia Z1 Mote



Z1 Mote

- **Z1 Mote** is a **general purpose development platform** for **wireless sensor networks (WSN)** designed for **researchers and developers.**
  - ✓ Equipped with **two on board digital sensors** (**accelerometer and temperature**),

WiSMote

WiSMote

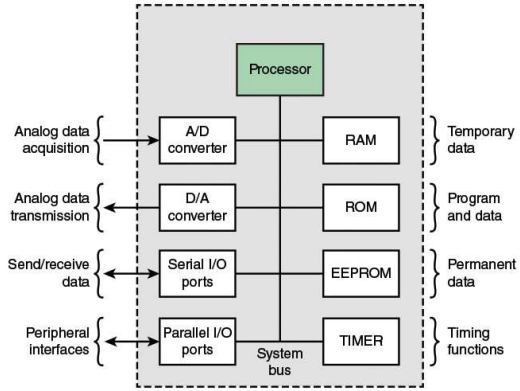
- **WiSMote** is a **sensor module** well adapted to **Wireless Sensor Network (WSN) applications.**
  - ✓ The wireless link operates over the **2.4GHz ISM**
- **WiSMote** is able to **monitor** any **kind of physical measurements** in fields like **environment, healthcare, smart building, logistics or industrial applications.**

Microcontrollers

Microcontrollers

- The **"smart"** in a **smart device** is provided by a **deeply embedded microcontroller.**
- A **microcontroller chip** makes a substantially different use of the **logic space available**.

Typical Microcontroller Chip Elements



Microcontrollers

- A **Microcontroller** is a **single chip** that contains
  - ✓ **The Core,**
  - ✓ **The Nonvolatile memory for the program (ROM),**
  - ✓ **Volatile memory for input and output (RAM),**
  - ✓ **A Clock, and**
  - ✓ **An I/O Control Unit.**

Transceivers

- A Transceiver contains the **electronics needed to transmit and receive data.**
- Most IoT devices contain a **wireless transceiver**, capable of communication using **Wi-Fi, ZigBee**, or some other wireless scheme.

Other Device in IoT

Data-Carrying Device

Data-Carrying Device

- A device attached to a **physical thing to indirectly connect the physical thing with the communication networks.**

- **Radio-frequency Identification** (**RFID**) tags are the example.

- A **data-carrying device** is capable of communication and may include other **electronic capabilities.**

Data-Capturing Device

Data-Capturing Device

- A **reader/writer device** with the **capability to interact with physical things.**

- The **interaction** can happen **indirectly** via **data-carrying devices, or directly via data carriers attached to the physical things.**

General Device

General Device

- A **general device** has **embedded processing and communication capabilities** and may **communicate with the communication networks** via wired or wireless technologies..

- General devices include **equipment and appliances for different IoT applicator domains,** such as **industrial machines, home electrical appliances, and smartphones**

Data Carrier

Data Carrier

- A **battery-free data carrying object** attached to a **physical thing** that can provide **information to a suitable data capturing device.**

- This category includes **bar codes and QR codes** attached to physical things.

Thank U