IoT Architecture & Technologies

IoT Technologies

IoT Technologies

❖ WSN (Wireless Sensor Networks)

- Efficient, low cost, low power devices for use in remote sensing applications
  - Low power integrated circuits and wireless communications
- A large number of intelligent sensors collect raw data, and create valuable services by processing, analyzing, and spreading data
- Challenges are related to limited processing capability and storage, and sensor data sharing for multiple device/system cooperation

IoT Technologies

❖ IoT Cloud Computing Support

- For Advanced IoT services, IoT networks may need to collect, analyze, and process segments of raw data and turn it in into operational control information
- Advanced IoT services will need support of Cloud computing
  - Numerous IoT connections will be made to various devices and sensors
  - Many IoT devices will not have (PC or smartphone level) sufficient data processing capability or interoperability functionality

IoT Technologies

❖ Cloud Computing

- IoT applications will need support from a reliable, fast, and agile computing platform
- IoT devices can overcome lack of Software, Firmware, Memory Storage, Hardware, Data Processing capability through Cloud computing
- Cloud service models
  - SaaS (Software as a Service)
  - PaaS (Platform as a Service)
  - IaaS (Infrastructure as a Service)

IoT Technologies

❖ IoT R&D (Research & Development)

- Many IoT devices have small memory and limited processing & communication functionalities and are also battery operated
- IoT requires integration of multi-technology networks to a common IP network platform
  - IPv4 & IPv6 protocols support addressing, management, and scalability requirements
  - IoT will have significant influence on the future Internet architecture

IoT Technologies

❖ IoT R&D

- IoT services must guarantee the security, privacy, integrity of information and user confidentiality
- Key Features
  - 'Thing' Authentication & Authorization
  - User Authentication & Authorization
  - IoT Public & Private Key Management
  - 'Thing' to 'Thing' Access Control
  - IoT Low Overhead Protocols
  - IoT Low Complexity Processing

IoT Technologies

❖ IoT R&D

- Mobility Support
  - Mobility support increases the applicability of Internet to new areas
- Mobile platform based IoT enables an enormous range of future applications
  - LBS (Location based Service)
  - Social Networking
  - Environment Monitoring & Interaction

IoT Technologies

❖ IoT R&D

- Energy and Resource Management
  - Energy issues are related to optimization of energy harvesting, conservation, and usage, and are essential to the development of IoT
- It is important to consider resource restrictions
  - Wake-Up Delays
  - Power Consumption
  - Battery Capacity
    Packet sizes

IoT Technologies

❖ IoT R&D

- Identification Technology
  - IoT devices produce their own contents
  - Contents are shared by any authorized user
  - Identification and authentication technologies need to be converged and interoperated at a global scale
  - Management of unique identities for ‘things’
  - Handling of multiple identifiers for people and locations

IoT Technologies

❖ IoT Hardware Technologies

- In ecosystem of IoT, IoT hardware platform takes charge of collecting, storing, and processing data based on the connection of the Internet
- IoT Hardware Components
  - **Sensor**
    - Detect events or changes in its near physical environment
      - Temperature, Image, Infrared, etc.

IoT Technologies

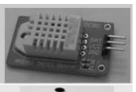
❖ IoT Hardware Technologies

- IoT Hardware Components
  - **Actuator**
    - Motors that is responsible for controlling or taking action in a system
  - RFID
    - Transmit pre-embedded 'information' directly to the RFID Reader
  - Processor & Microcontroller
    - Connects sensor and actuator to the Internet
    - Operates corresponding instructions

IoT Technologies

❖ Sensors

- Sensor Types

Type	Detect	Model	Measurement	Shape
Temperature/ Humidity sensor	Actual Temp. and humidity	DHT11, DHT22	Temperature: -40 ~ 80 ℃ Humidity: 0 ~ 100% RH	
Pressure sensor	Pressure w. r. t. atmospheric pressure	SPD005G SPD100G	SPD005G: 0 kPa ~ 35 kPa SPD100G: 0 kPa ~ 650 kPa	
Flow sensor	Rate of fluid flow	YF-S201	1 to 30 Liters/Minute	
Imaging sensor	Conversion of variable attenuation of image into signal	OV7670	Maximum 30 fps, 640 x 480 VGA resolutions (= 0.3 Megapixels)	
Ultrasonic sensor	Presence of an object by ultrasonic wave	HC-SR04	2 ~ 400 cm non-contact measurement @ 40 Hz	

IoT Technologies

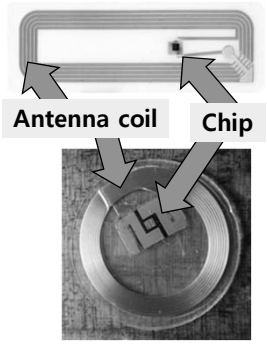
❖ Actuators

- Actuator Types
  - Electrical actuator
    - Converts energy to mechanical torque
  - Mechanical linear actuator
    - Converts rotary motion to linear motion
  - Hydraulic / Pneumatic actuator
    - Convert fluidal (liquid / gas) compression to a mechanical motion
    - Motion Types: Linear, Rotary, Oscillatory, etc.

IoT Technologies

❖ RFID (Radio Frequency Identification)

- RFID chip (tag) holds information about a 'thing'
- RFID chip is attached and transfers data to the reader
- Antenna is used to receive energy from the Reader that is used to operate the RFID device
- RFID tag transmits its information back to the reader



IoT Technologies

❖ RFID (Radio Frequency Identification)

- RFID types

Type	Working frequency	Read range	Standard
Low frequency RFID	125 ~134.3 kHz	10~ 30 cm	ISO 14223 ISO/IEC 18000-2
High frequency RFID	13.56 MHz	10 cm ~ 1 m	ISO 15693 ECMA-340, ISO/IEC 18092 NFC (Near Field Communication)
Ultra-high Frequency RFID	860 ~ 960 MHz	12 m	ISO 18000-63

IoT Technologies

❖ RFID (Radio Frequency Identification)

- RFID enables efficient management, tracking, and monitoring processes
  - Logistics and supply chain applications
- RFID R&D
  - Streams of data support
  - Chip design
  - Energy usage optimization
  - Automatic meter reading
  - Home automation applications
  - Vehicle & transportation applications

IoT Technologies

❖ Processors & Microcontrollers

- IoT Device Platform
  - Processors & Microcontrollers
  - HW, SW, Sensors, and Interfaces
  - Networking Modules (WAN, LAN, WLAN, PAN)
- Provides HW interfaces (USB, GPIO, UART etc.) to connect User ↔ Sensor ↔ Actuator
- OS (Operating System) supports a SW interface to control HW resources
  - Power, Memory, File I/O, etc.

IoT Technologies

❖ Arduino

- Open-source microcontroller & hardware
  - May also refer to an 'Open-source Arduino hardware and software project'
- Single-board microcontrollers and kits
  - Enables easy sensing and controlling objects
  - Popular for IoT development

IoT Technologies

❖ Arduino

- Arduino board circuit design and the IDE (Integrated Development Environment) are available on the Arduino website
- User-specific programs can be developed and uploaded using the IDE
  - Uses USB connection to an Arduino board

IoT Technologies

❖ Arduino

- Arduino Product Types
  - Arduino Uno R3 (Entry and General purpose)

  - Arduino Yun (IoT)

  - Arduino Lilypad (Wearable)


Author: leah buechley
https://commons.wikimedia.org/wiki/File:Flexible_Lilypad_Arduino.jpg

IoT Technologies

❖ Atmel

- IoT Hardware
  - megaAVR (ATmega) series are adopted as a **Arduino** physical computing platform

Arduino board	Description	Atmel AVR
Arduino Uno	Entry level	**ATmega328P**
Arduino Leonardo		ATmega32u4
Arduino Yun	IoT	ATmega32u4
Arduino Ethernet		**ATmega328**
Arduino Lilypad (USB, Mainboard, Simple)	Wearable	ATmega32u4 ATmega168 **ATmega328**

IoT Technologies

❖ Atmel

- IoT Hardware
  - **ATmega328** specifications

Parameter Name	Value
CPU speed	20 MIPS
RAM	2048 bytes EEPROM
Program Memory	32 KB, ISP flash memory
Data EEPROM	1024 bytes
I/O	1-UART, 2-SPI, 1-I2C
Timers	2 x 8-bit, 1 x 16-bit
Temperature range	-40 ~ 85 °C
Operating Voltage Range	1.8 to 5.5 V

IoT Technologies

❖ Atmel

- IoT hardware
  - **ATmega328P**
    - Supports low power consumption mode
      - Other specifications are the same
    - Adopted the main line of Arduino, Arduino Uno
    - Operates at 1 MHz, 1.8 V
      - Active mode: 0.2 mA
      - Power-save mode: 0.75 μA
      - Power-down mode: 0.1 μA

IoT Technologies

❖ Raspberry Pi

- Developed by Raspberry Pi Foundation in the UK
- Developed as a low cost single-board computer to promote basic computer science skills in schools
- Supports general computations and basic web server functions
- Specifications
  - HW: Broadcom SoC, ARM CPU, On-chip GPU
  - SW: Raspbian OS

IoT Technologies

❖ Raspberry Pi

- Product Series
  - Mainline: Raspberry Pi 3 Model B

    - 1.2 GHz ARM Cortex CPU based micro computer for general IoT functionality
  - Subline: Raspberry Pi Zero W

    - Smaller size and restricted I/O, GPIO capabilities

IoT Technologies

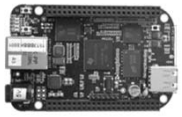
❖ BeagleBoard

- Open-source single-board computer produced by Texas Instruments
- Fully functional basic computer
- Supports various OSs
  - Linux, Android
- Includes advanced features
- Little more expensive than other single-board computers

IoT Technologies

❖ BeagleBoard

- Key features
  - Very low power requirements (~2W)
  - PRU (Programmable Real-time Unit)
    - Used for deterministic latency (5ns per instruction) and delay-sensitive applications
    - Enhanced processor with image and 3D graphics processing



Beaglebone black

IoT Technologies

❖ IoT Device Platforms

	Arduino Uno	Raspberry Pi 3 Model B	Beaglebone Black
Category	Microcontroller	Single-board micro computer	Single-board micro computer
SoC/CPU	16 MHz ATMega 328	• Broadcom BCM2837 SoC • 1.2 GHz ARM Cortex-A53 Quad-core @ 700 MHz	• Sitara AM3358 • 1 GHz ARM Cortex-A8 Single core @ 1000 MHz + Dual PRU @ 200 MHz
Memory	2 KB SRAM / 32 KB Flash	1 GB LPDDR2 / Micro SDHC support	512 MB DDR3 / 4GB Micro SDHC
I/O	14 (Digital GPIO) 6 (10-bit analog Input)	40 (Digital GPIO), 4 USB 2.0	69 GPIO 4 UART Serial, 8 PWM
Size	68.6 x 53.4 mm, 25 g	85.60 x 56.5 mm, 45 g	86.40 x 53.3 mm, 39.68 g

IoT Technologies

❖ IoT Device Platforms

	Arduino Uno	Raspberry Pi 3 Model B	Beaglebone Black
Operating System	n/a, Arduino IDE for IDE	Linux (Raspbian)	Linux (Ubuntu, Devian, Android), Windows
Audio	n/a	3.5 mm analog, HDMI	Micro-HDMI
Video	n/a	HDMI	Micro-HDMI
Network	n/a, Extra shield required	Bluetooth 4.1 Classic, BLE 10/100 Mbps Ethernet 2.4 GHz Wi-Fi 802.11n	10 / 100 Mbps Ethernet
Price	$ 29.95	$ 35	$ 55

IoT Architecture & Technologies

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