2017 政大金融科技創新訓練營

物聯網與區塊鏈整合應用

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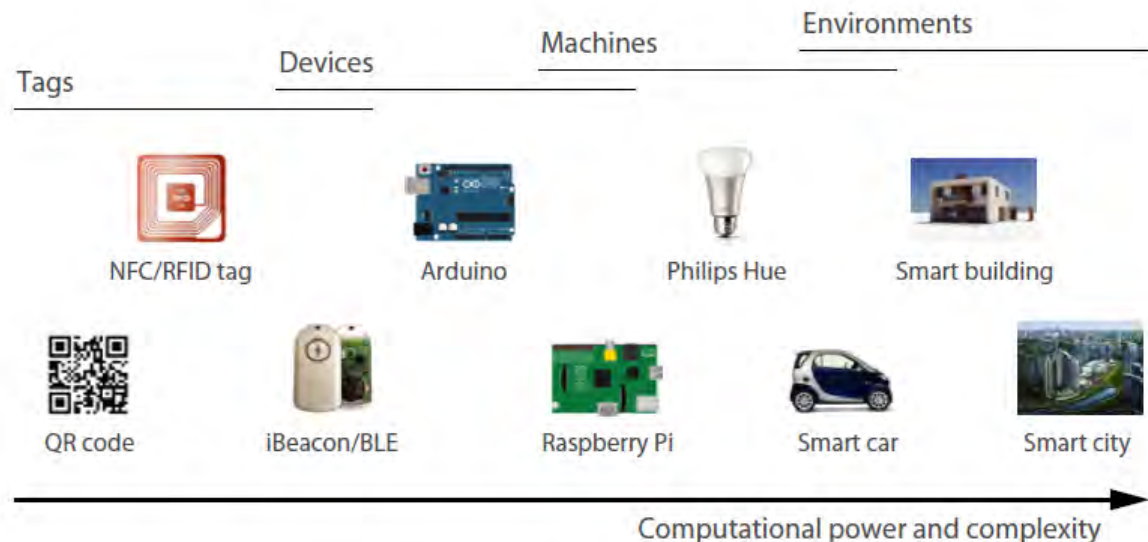
國立政治大學

Outline
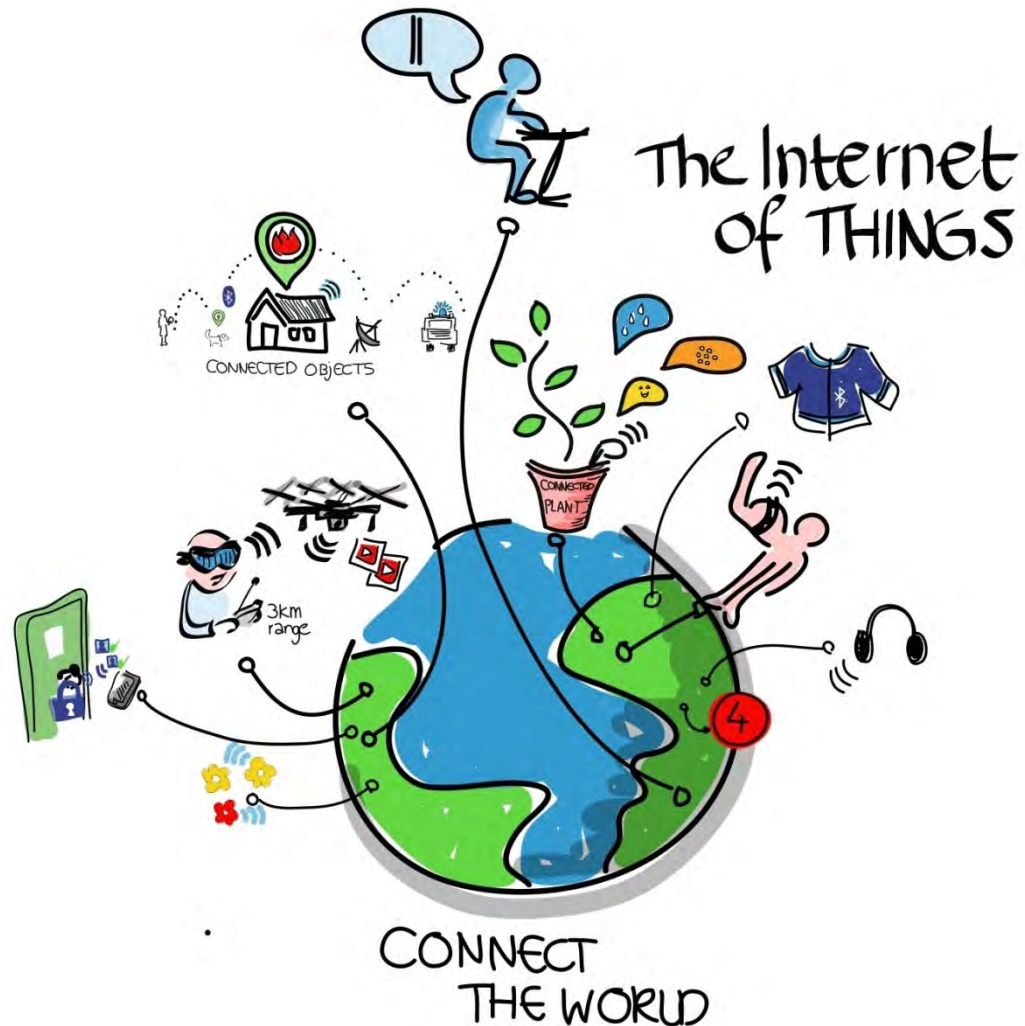
- IoT Introduction

  – Foundations and Challenges of IoT

- B-IoT: Blockchain-based IoT Services

  – Case study: smart lock

- Design issues of B-IoT

  – Case study: smart motorcycle renting service
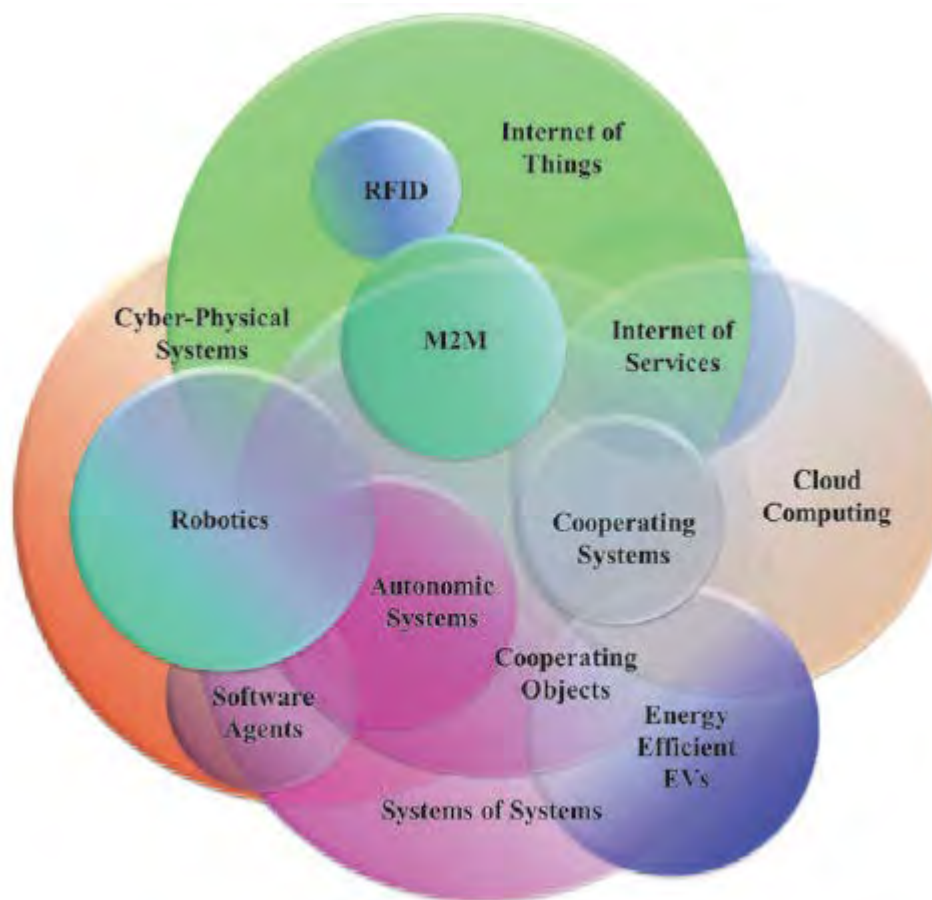
- Conclusion

Smart Things

- Smart Things
  - 具有計算能力的日常物品
- 具備「計算能力」的意涵
  - 感測能力
  - 致動能力
  - 邏輯與運算能力

圖片來源: D.D. Guinard & V. M. Trifa, Building the Web of Things, Manning, 2015   3

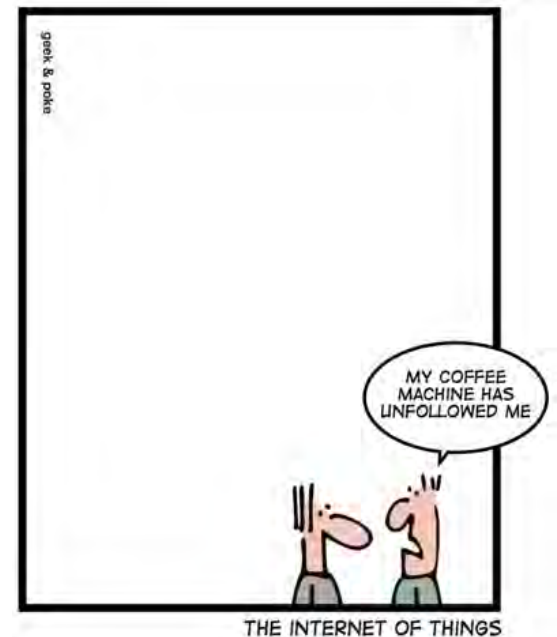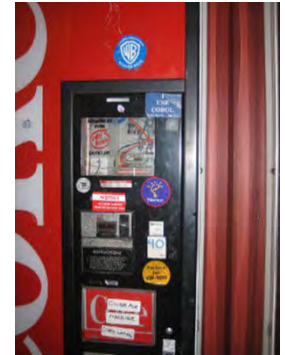# IoT = Connected Smart Things

IoT並非全新領域

Internet of Things

- 願景
  - 所有實體裝置和網頁一樣，能透過網路互連
- 定義
  - 一群智慧物件(Smart Things)，它們
    - 除設置時期之外，不需要人為操作
    - 可透過Internet互連
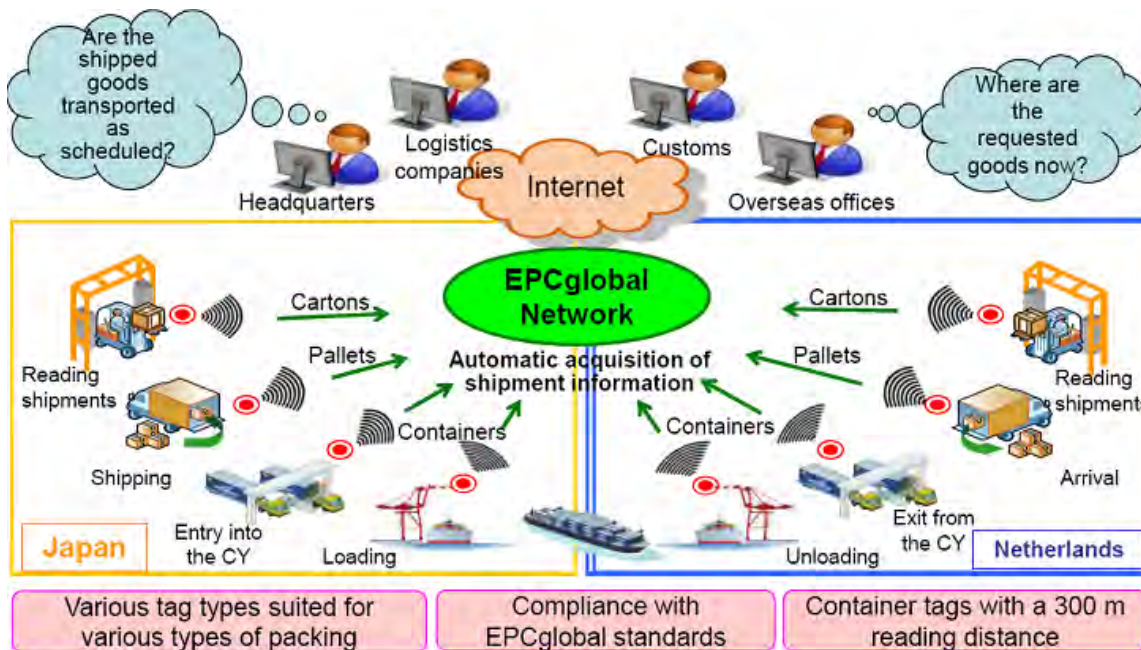   - 可透過ICT技術被發現、監控、互動

起源

- **最早的連上Internet的物品其實是1982年在CMU製作的可口可樂販賣機**
  - 使用Finger protocol

- **Ashton在1999年一場演講中提出IoT概念**
  - 使用RFID 透過 EPCglobal架構在供應鏈上的應用

K. Ashton is the co-founder of MIT Auto-ID Center (now Auto-ID Labs)

NEST

2014年，Google以960億併購NEST

https://youtu.be/L8TkhHgkBsg

重要設計概念:
- 能基於現有設施運作
- 能回報進度
- 有能力學習preference
- 能透過網路被控制

Philips Hue

PC Home就買得到!

PHILIPS

任何氣氛一指搞定
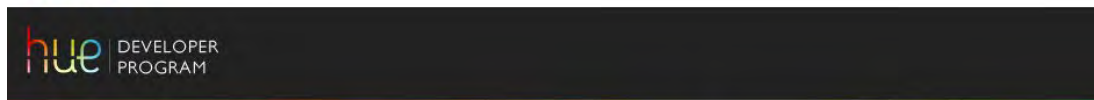
最新款相容所有智慧手機
1600萬色彩真實絢麗
閃爍變色氣象預報員
遠端遙控警示防盜
一組橋接器控制50顆燈泡

| 3期 0 利率 31家 | 10期 0 利率 5家 |
| 6期 0 利率 31家 | 12期 分期 13家 |

VISA ATM ibon 說明
信用卡紅利折抵刷卡金 多家銀行

建議售價 $8580
網路價 $7399

1 ▼ 加入購物車

有提供SDK!

Home
Getting started
Application Design Guidance
Philips hue API
Tools and SDKs
Find Answers
Philips hue developers & apps
Forum

https://youtu.be/yVlPM3FajuA
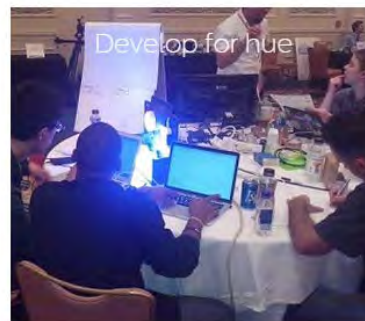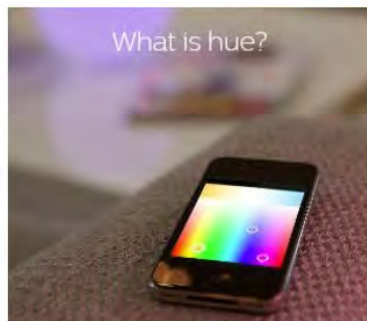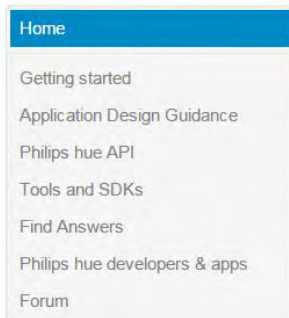
IoT核心技術領域

- Things
  - Sensors, actuators, and other devices
  - 嵌入式系統、SOC
- Network
  - 通訊協定: BLE, Zigbee, MQTT, HTTP, CoAP, XMPP
- Middleware
  - 自主管理的軟體技術
  - Self-organizing, self-healing, self-learning, self-description, self-configuration…

<<Network>>
感測資訊搜集

<<Middleware>>
情境感知技術

<<Things>>
感測器設計

情境感知

<<Middleware>>
自主學習及推論

<<Network>>
控制命令發送

隨需應變

異質裝置控制與調節
<<Things>>
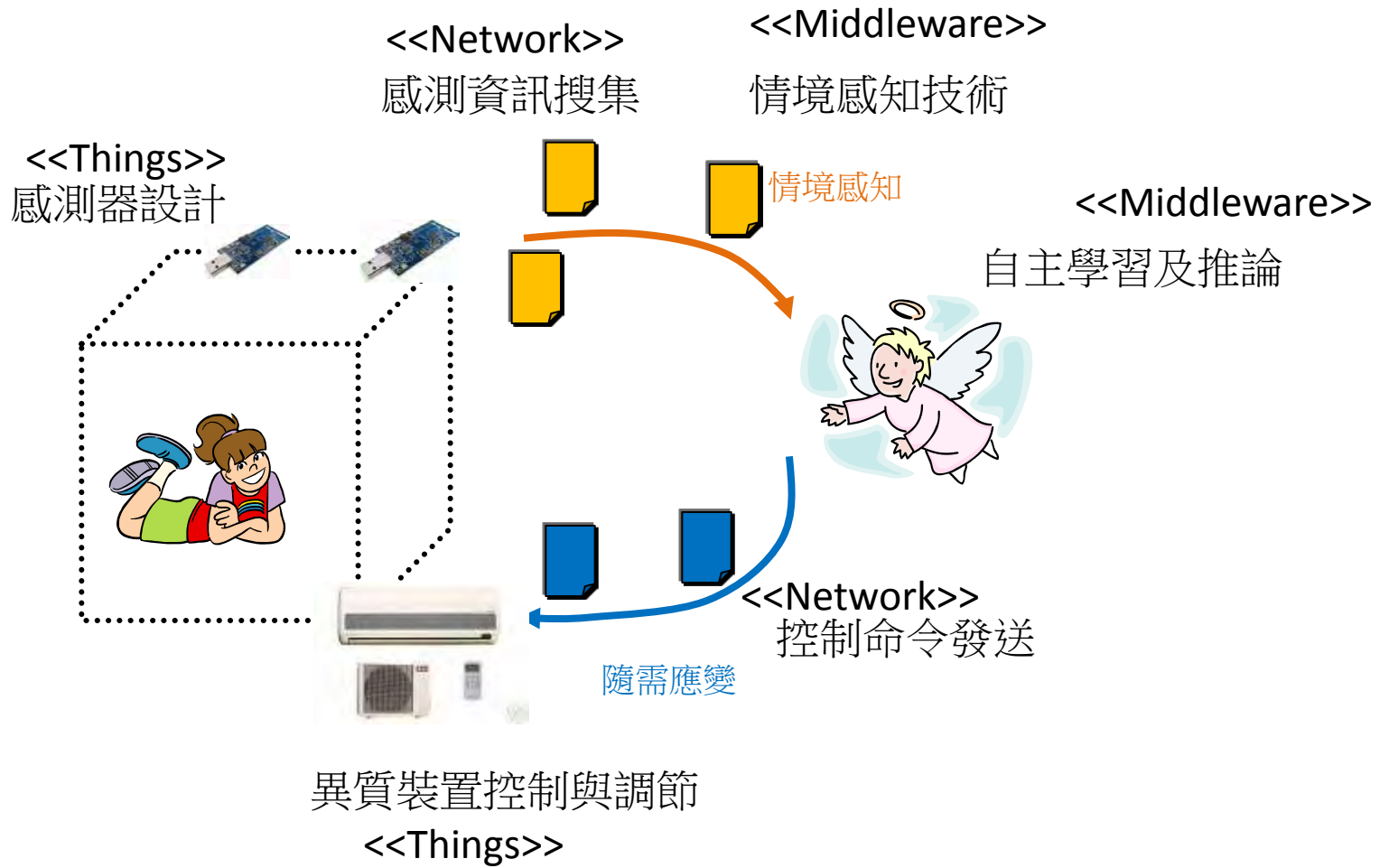
為何需要感測器

第一手資料
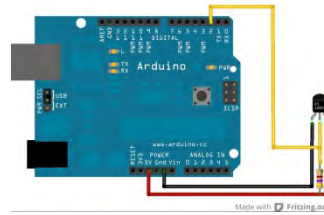
Sensor (Smart Thing)

Human input

第二手資料

物聯網關鍵技術

感測器

感測器是電腦了解現實世界的媒介

camera

sensors

GPS 超音波感測 CO$_2$ 循線感測

聲音感測 溫溼度感測 震動感測 壓力感測
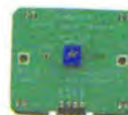
三軸加速度 動作感測 電子羅盤 陀螺儀

CCD 紅外線感測 氣壓感測 色彩感測器

電子式感測器

- 定義
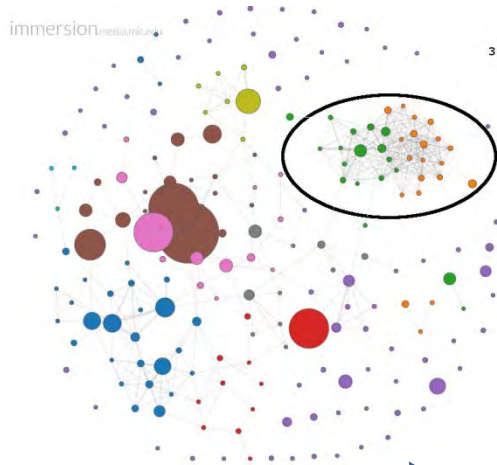 - 一種電子裝置，能探測外界的信號、物理條件（如光、熱、濕度）或化學組成（如煙霧），並將探知的信息傳遞給其他裝置
  - 感測對象和輸出電壓成線性關係的時候，稱為「完美」感測器

- 理想感測器還應該遵守以下原則：
  - 只受被測因素的影響；
  - 不受其他因素的影響；
  - 感測器本身不會影響被測因素

LM35: 一種溫度Sensor

物聯網關鍵技術

感測器與控制板

控制板+感測網路晶片

- # Mote
  - MSP430
  - CC2420-802.15.4
  - 250kbps 2.4GHz
  - Low energy consumption
  - Radio transmission range:
    20m~30m

  單價約12,000元

Various sensor modules can be attached

光感測器

溫濕

物聯網關鍵技術

感測器與控制板

Digital In/Out Pins
USB to Serial
USB Port
Power Supply
Atmega328p
Power Pins
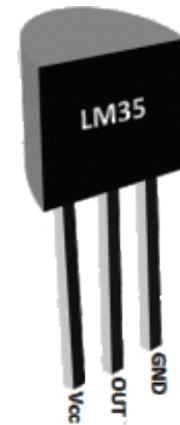Analog Input Pins
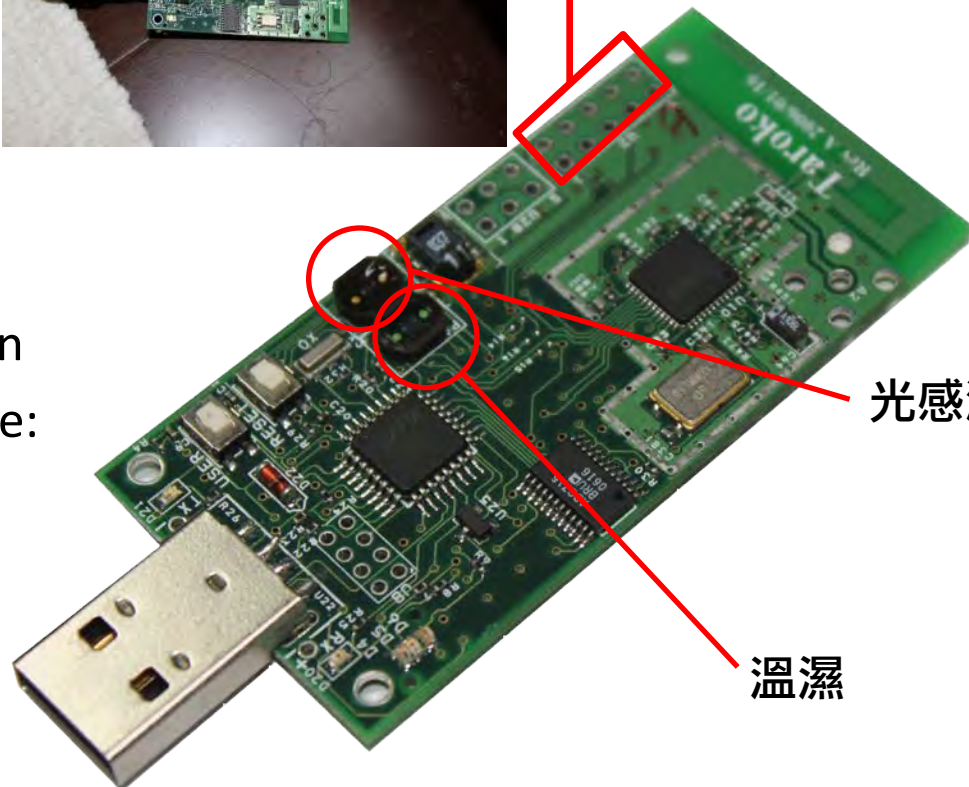
- # Arduino
  - ATmega328
  - **無線感測網路實作**
    - (IEEE 802.15.4) Uno+Zigbee (約2000元)
    - (IEEE 802.11) Arduino WiFi (1260元)
    - (BLE) Arduino 101 (約1400元)
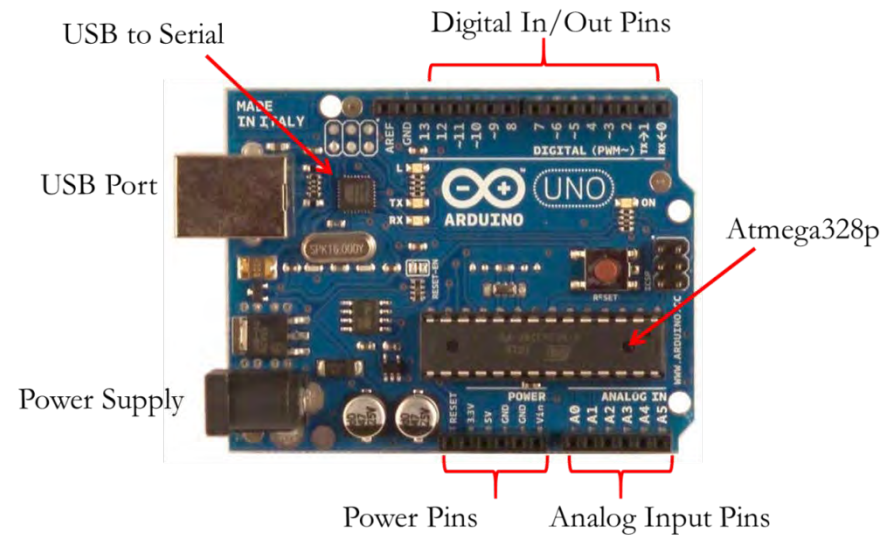
Arduino 101 工業版

Arduino WiFi

LilyPad
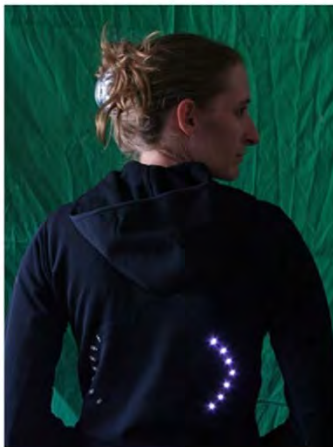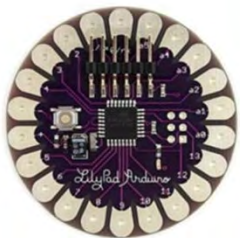
Zigbee Shield

Arduino 101

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物聯網關鍵技術

適合初學者的有線控制板

- Phidget
  - 所有感測器均模組化，不需焊接
  - 支援幾乎所有平台與語言，完整的API支援
  - 不含感測器單價約2850元

17
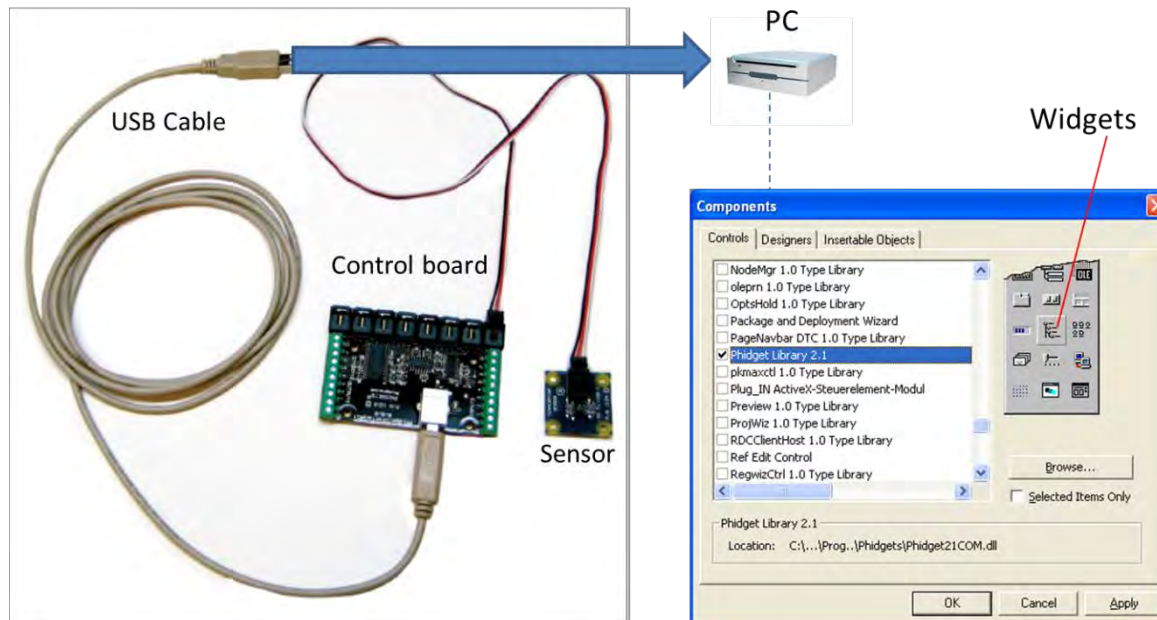
範例:LM35+Arduino

得出感測電壓: 電壓是分佈在0V-5V，訊號是0~1023，可依訊號值推算電壓值

$$\frac{r}{1023} = \frac{v}{5} \Rightarrow v = \frac{5}{1023} \cdot r$$

由電壓算出溫度: LM35的特性是1度/0.01V

$$\frac{1}{0.01} = \frac{c}{v} \Rightarrow c = 100 \cdot v = 100 \cdot \frac{5}{1023} \cdot r = 0.49 \cdot r$$

範例:LM35+Arduino

Data

Vcc   Gnd
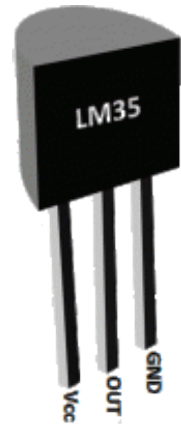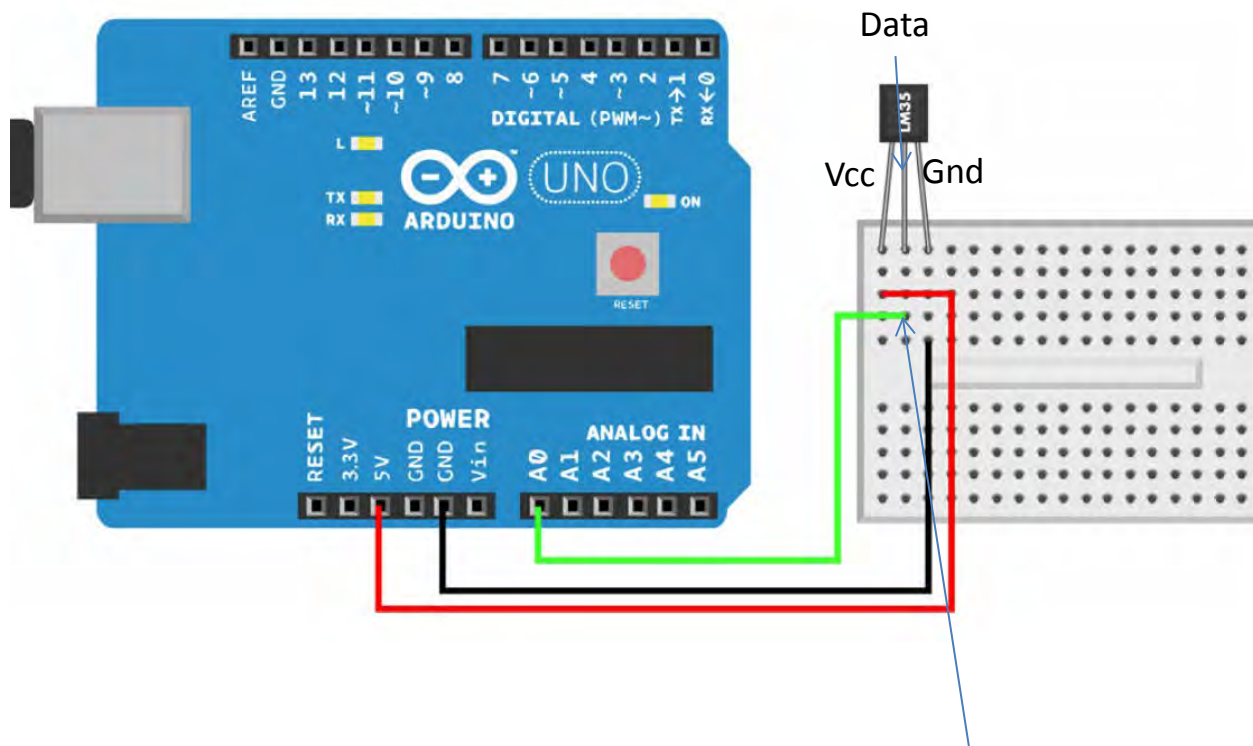
OUT: 輸出0-1023的類比訊號(電壓值)

```
int lmPin = A0; // ❶

void setup()      // ❷
{
  Serial.begin(9600);    // ❸
}

float tempC()     // ❹
{
  float raw = analogRead(lmPin);   // ❺
  float percent = raw/1023.0;  // ❻
  float volts = percent*5.0;  // ❼
  return 100.0*volts;   // ❽
}

void loop()       // ❾
{
  Serial.println(tempC());   // ❿
  delay(200); // ms        // ⓫
}
```
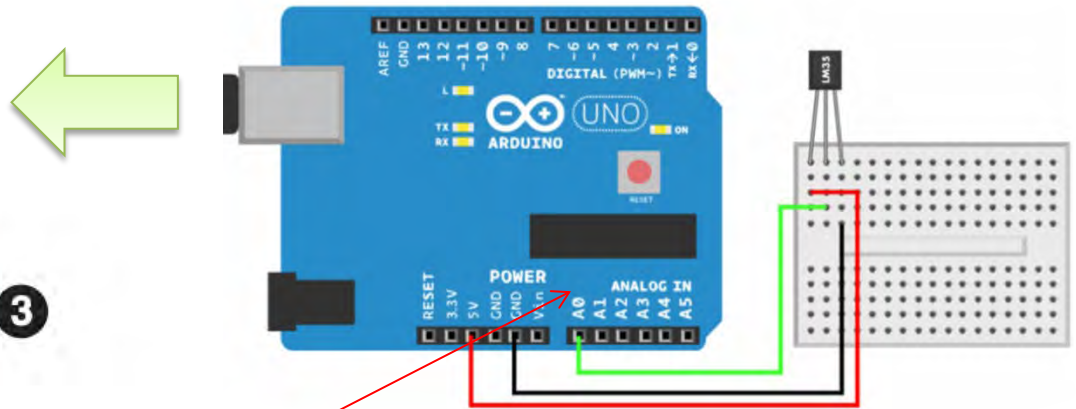
A0

$$100 \cdot \frac{5}{1023} \cdot r = 0.49 \cdot r$$

也可以寫成 return raw*0.49;

物聯網關鍵技術

感測器 與 感測網路

無線感測網路
Zigbee / 802.15.4

溫度感測器

控制板+感測網路晶片
(Sensor nodes)

基地台節點
(Base station)

無線電

USB/RS-232

PC
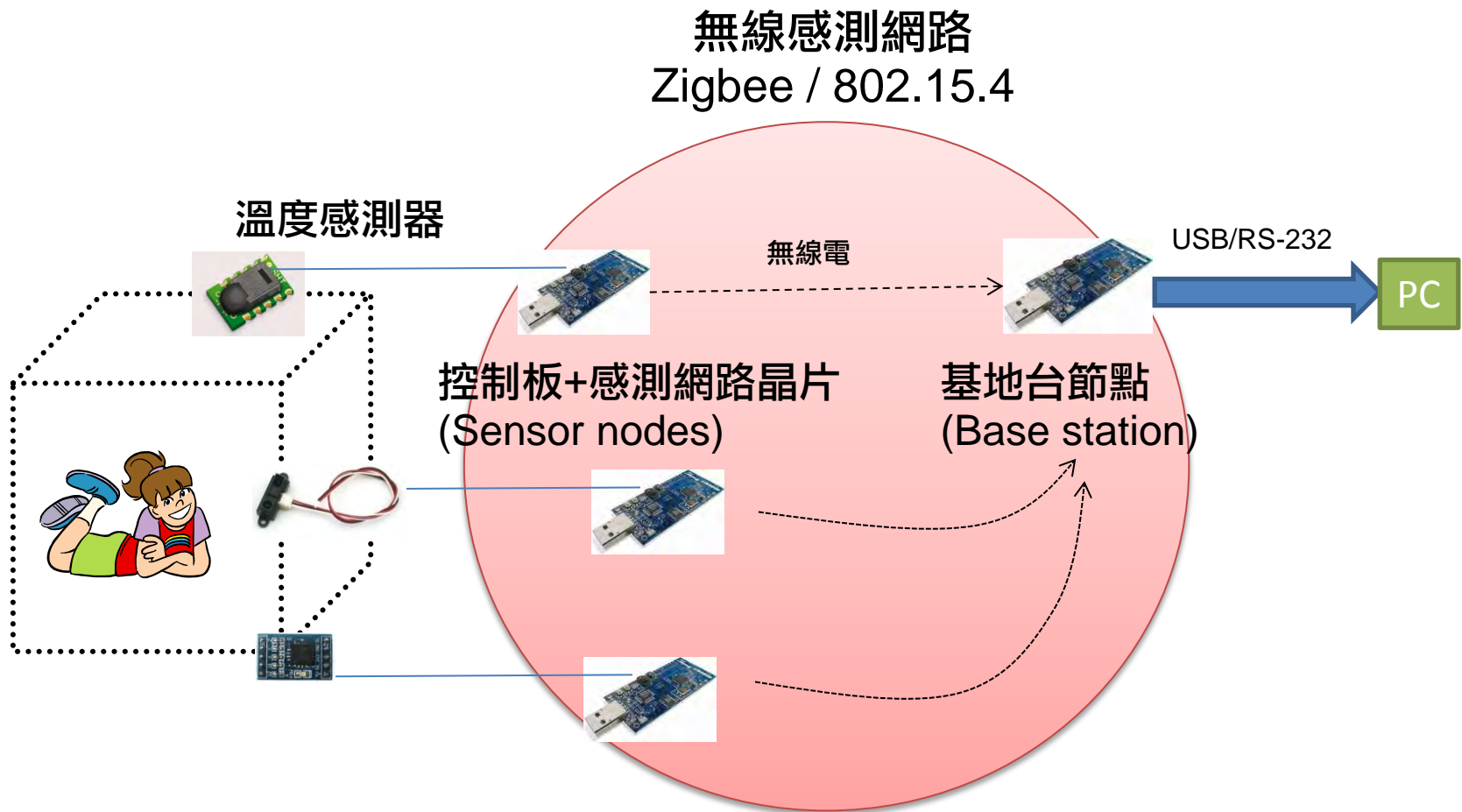
應用案例: 數位娛樂

- Symbol of the Brave
  - 政大數位內容學士學程1052畢展作品

https://youtu.be/WozfH9LOaek

IoT技術應用面臨問題

- Success only in high-value applications
  - Jet engine monitoring
  - Smart metering
  - Healthcare management
- Demands are slow to take off in other areas
  - Not so good: heavy industrial and home automation
  - Failed: consumer electronic
    - smart toothbrushes and refrigerators
- The market expects 10-20 times revenue!

IoT技術應用面臨問題

- ## 五大挑戰

Cost of connectivity

IoT lacks compelling and sustainably profitable business models

The cost of supporting and serving billions of smart devices will be substantial – even something as simple as maintaining centralized servers that distribute regular software updates.

What is the difference (for users) between a traditional toaster and a "smart" toaster?
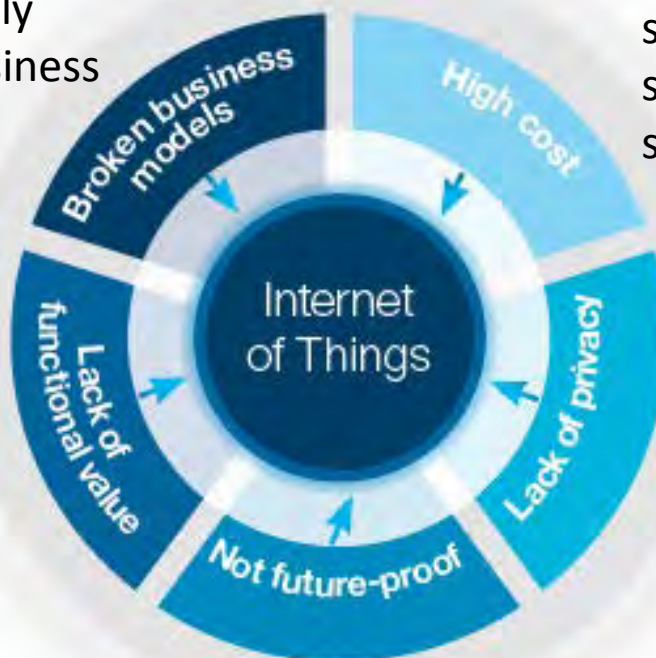
Now, the trust in the internet is over;
A trend from security through obscurity to security through transparency

Smart Phones and PC: 18-36 months
"Things": years or decades

P2P and Trustless IoT

- Device democracy
  - Trustless p2p messaging
  - Secure distributed data sharing
  - Robust and scalable form of consensus

Before 2005

Closed and centralized
IoT networks

Today

Open access IoT networks,
centralized cloud

2025 and beyond

Open access IoT networks,
distributed cloud

"Blockchain is quite revolutionary as a transaction processing tool"

Blockchain as the framework facilitating transaction processing and coordination among interacting devices

Universal digital ledger

Registration of new device

Authentication of remote users

Contract to barter power with other appliances

Checklist for automobile safety
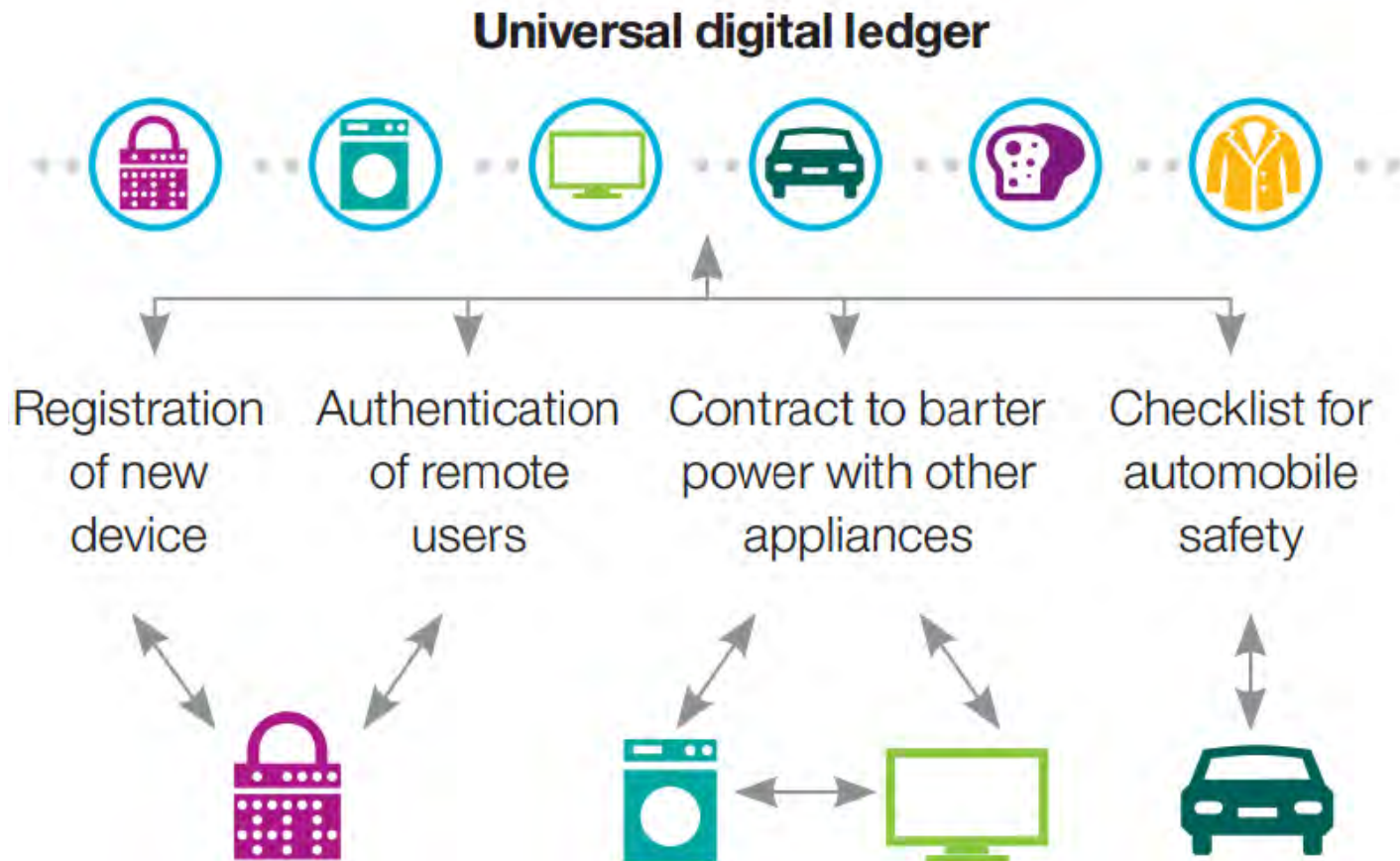
Blockchain-based IoT Services (B-IoT)

- Unlocking excess capacity of physical assets
  - IoT
    - Enables the digitization of sell and deliver of physical assets
  - Blockchain
    - Three key elements of e-commerce became instant and comprehensive : search、use、pay

- Creating liquid, transparent marketplaces
  - Identify and match supply and demand for physical assets and services in real-time

- Radical re-pricing of credit and risk
  - personalized risk and credit profiles

Case Slock.it

- 一個基於Blockchain與Smart Contract的電子鎖系統

Contract

```
Contract {
    Owner_address
    User_address

    deposit
    price

    open()
    close()
    rent()
    returnLock()

    ...
}
```

Owner_address：為鎖的擁有者address。
User_address：租借人(能夠控制鎖的人)的address

deposit：擁有者要求使用者需預先付的押金。
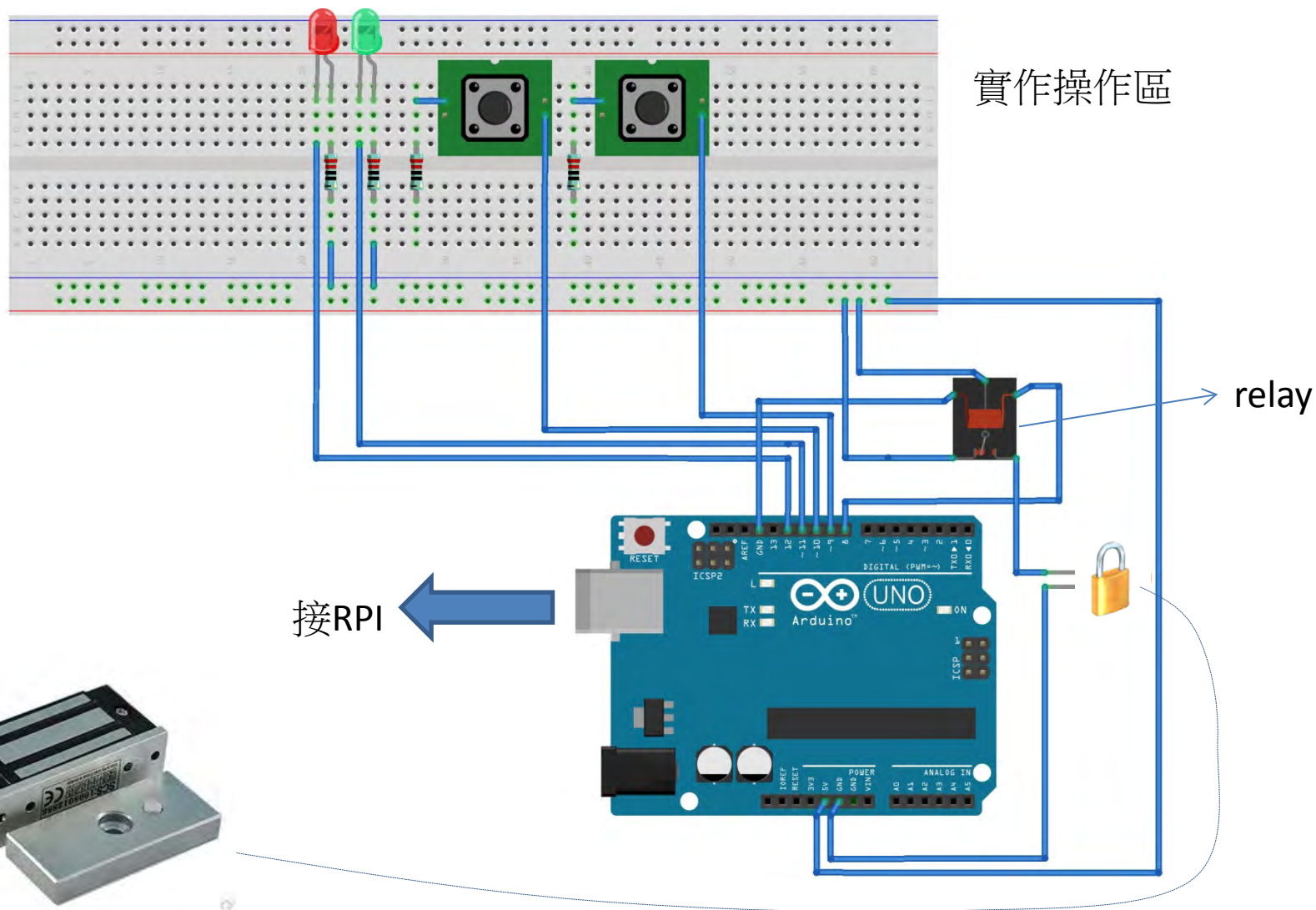price：租用價格

open()：打開鎖(僅限使用者)
close()：鎖住鎖(僅限使用者)

rent(address)：提供使用者的address與押金並租借鎖。如果支付的押金足夠就將租借人記為此人。

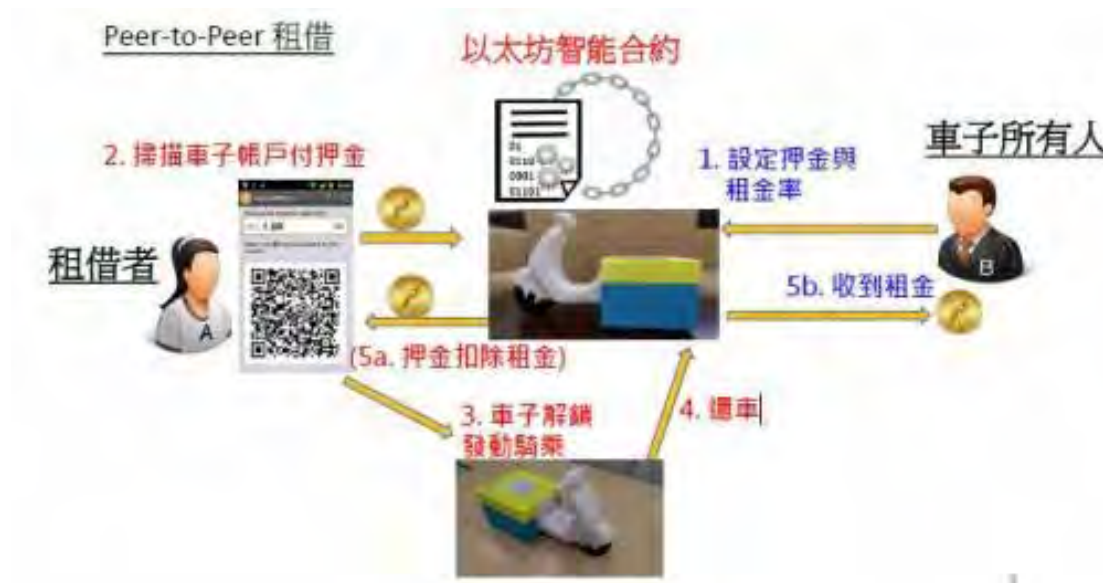returnLock()：將鎖的擁有權還給擁有者(僅限使用者)

Demo: 自製可控計時電子鎖

完整的原始碼和電路圖: https://github.com/rubycheng121/LockProject

實作操作區

relay

接RPI

Demo

- Internet of Things Renting Platform based on Smart Contracts on Blockchain

https://youtu.be/CbsAFStbyBg

Design Issues of B-IoT

- The locations of blockchain endpoints (eNode)

  - Blockchain endpoints keep track of blocks and are responsible for verifying transactions

  - the place to deploy blockchain endpoints has a significant impact on the bandwidth, computation and space requirements
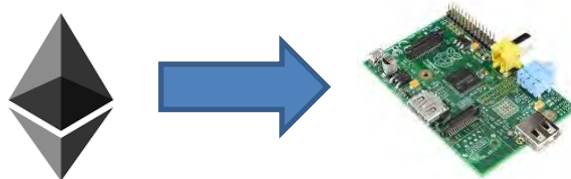
Design Issues of B-IoT

- The distribution of business logic and data

  - In a B-IoT service, we can implement the business logic is the smart contract

  - This new alternative raises a new design consideration: Which parts of logic and data are suitable for placing in the blockchain?

    - On chain: lower performance

    - Off chain: (can be) unsecured and centralized

Design Issues of B-IoT

- The boundary of cyber-physical integration
  - In a renting service, what is the objective of the payment?
    - Each smart thing is correlated to a smart contract
    - All smart things are correlated to the same contract
  - How to control things?
    - On chain: contract events
    - Off chain: Websock

結語

- IoT
  - 重要技術: 環境與家電控制、感測器與網路建置、情境資訊搜集與即時分析
  - 挑戰: 連網成本、附加價值、營運模式、安全隱私
- "Things" Democracy
  - Trustless p2p messaging
  - Secure distributed data sharing
  - Robust and scalable form of consensus
- B-IoT有機會成為IoT進一步發展的解決方案
  - 降低了營運成本 (避免集中的大server)
  - 提高安全與隱私 (DDos)
  - 提供原生Billing layer