UNIVERSITY OF Southampton
School of Electronics and Computer Science

Web Services & The Internet of Things

ELEC6017

29 November 2013

Last edit 29 November

Enrico Costanza

UNIVERSITY OF Southampton
School of Electronics and Computer Science

The Internet of Things (IoT)

- Everything is connected to the internet
- Not just computers, smart phones and tablets
- ..but also printers, cars, electricity meters, washing machines, refrigerators, thermostats, medicine containers…
  - Future or present?

UNIVERSITY OF Southampton
School of Electronics and Computer Science

The Internet of Things & UbiComp

- Formal definition? Seems not to be available, yet
- Ubiquitous Computing (UbiComp): computational power is everywhere
  - Research theme started in the 90s

UNIVERSITY OF Southampton
School of Electronics and Computer Science

IoT and Web Services

- Can we use existing web services architectures for the IoT?
- Take advantage of available and well understood infrastructure
- Easier integration with web applications running on computers, phones and tablets

UNIVERSITY OF Southampton
School of Electronics and Computer Science

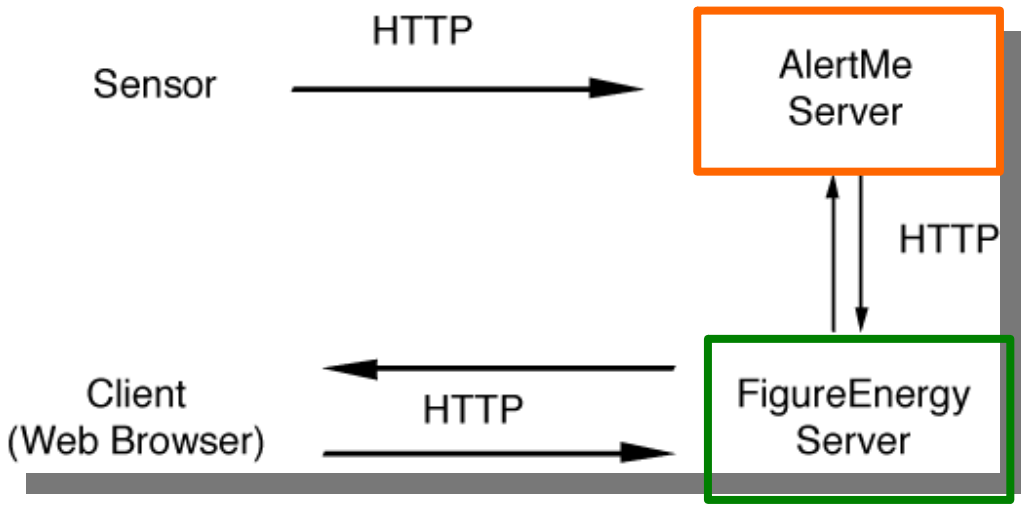
IoT in Practice

- A number of existing "things" are already connected to the Internet
  - Examples: AlertMe energy monitor, CurrentCost energy monitor, some ambient displays (e.g. Philips multi-colour lamp)
  - Use existing APIs
- Prototyping new devices using **microcontrollers** (uControllers) and **network modules**

UNIVERSITY OF Southampton
School of Electronics and Computer Science

Example: Networked Electricity Sensor

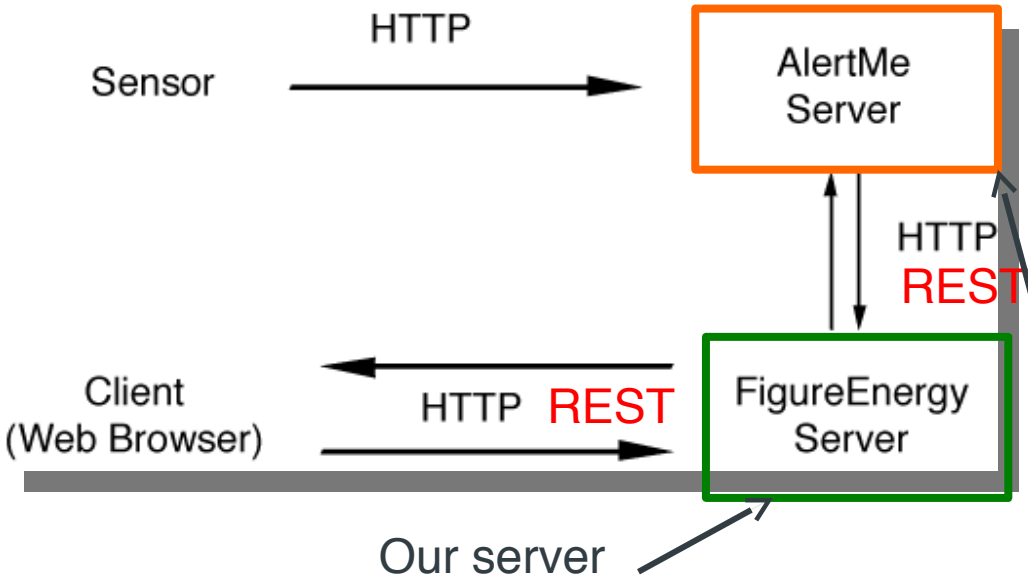
- AlertMe Energy Monitoring kit
- Price tag about £50



UNIVERSITY OF Southampton
School of Electronics and Computer Science

Example: Networked Electricity Sensor

- AlertMe Energy Monitoring kit
- Price tag about £50



UNIVERSITY OF Southampton
School of Electronics and Computer Science

Interfacing with AlertMe

- Use existing HTTP API defined by AlertMe
- Cache and expose the data again in a format that is more compatible with what we need

UNIVERSITY OF Southampton
School of Electronics and Computer Science

Prototyping New IoT: Microcontrollers

- Small embedded computational devices
- Include CPU, RAM and a number of peripherals

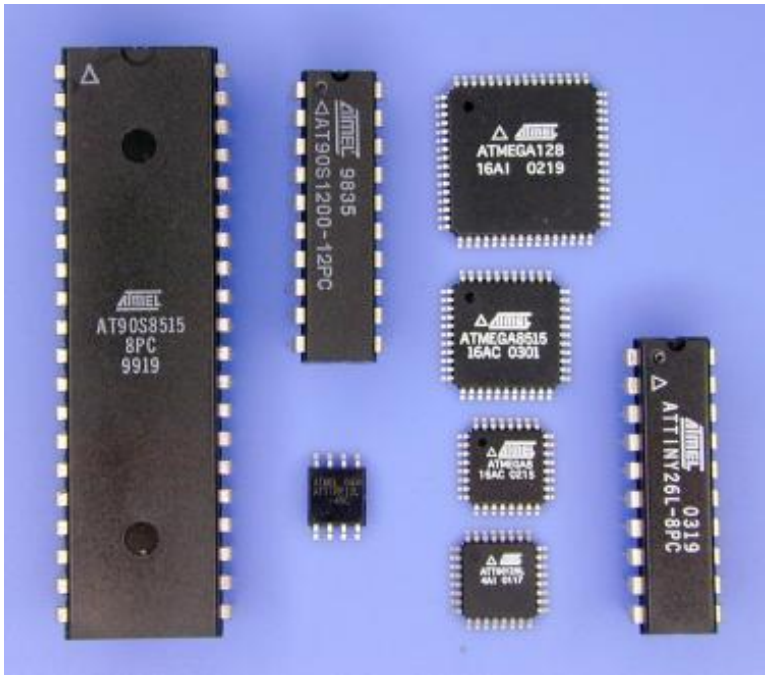


Image from
http://elm-chan.org/works/avrx/rc/avrs.jpeg

UNIVERSITY OF Southampton
School of Electronics and Computer Science

uController vs. Your Usual Computer

	Standard Computer	uController
Needs to be plugged to power	Plug to wall socket: AC at 220V or 110V	DC at 2.7V to 5.5V (typically) 3.3V convenient
Built-in peripherals	Video card, audio card, network card, …	Analog-to-digital converter (ADC), timers, PWM, …
Ports	USB, FireWire, VGA, HDMI, audio jack sockets, …	Serial, I2C, TWI, …
External peripheras	Printer, Scanner, External monitor, speakers, …	WiFi module, other radio module (BT, ZigBee, ..), Ethernet module, display, motor controllers, relays, …

More about uControllers

- Several brands and models
  - Differences in 8-, 16- or 32-bits architecture, computational power, RAM, physical size, built-in peripherals, cost, popularity (=community support?), …
- Several programming languages
  - Assembly, C, C++, …
  - Abundance of open source libraries
- My personal experience: Atmel AVR in plain C (8bits)

How to Learn More?

- Guess what? ..search on the Internet!
- Look at the "instruction manual" of the microcontroller, AKA "datasheet"
  - Large document, but don't be intimidated
  - For example, Atmel AVR ATMega48/88/168 datasheet

UNIVERSITY OF Southampton
School of Electronics and Computer Science

Arduino as a Prototyping Framework

- Open Source prototyping platform, both software and hardware (including IDE) http://arduino.cc/
- Originally built around the AVR ATMega168, now expanding to other platforms
- C++ based "language" – in reality a collection of libraries
- Collection of prototyping boards and extensions ("shields")
  - Boards include USB to serial converter
- Great online community!

UNIVERSITY OF Southampton
School of Electronics and Computer Science

Wi-Fi Module

- Microchip (was Rovio) RN-XV WiFly Module, around £24
- Just one example of a radio module, very convenient because it leverages existing ubiquitous infrastructure
- Very low power (supposed to run 2 years on 2 AA batteries)

Images from:
http://www.iaacblog.com/mai/2013/01/beat-glove-proto_2-wifly-osc/ and
http://www.antratek.com/rn-xv-wifly-module

UNIVERSITY OF Southampton
School of Electronics and Computer Science

Wi-Fi Module (cont.)

- Serial port interface with simple API (yet temperamental..)
- Documented in the module manual
- We can use the serial port interface to connect to a uController

Images from:
http://www.iaacblog.com/mai/2013/01/beat-glove-proto_2-wifly-osc/ and
http://www.antratek.com/rn-xv-wifly-module

UNIVERSITY OF Southampton
School of Electronics and Computer Science

Let's look at one example!

- Connect the WiFi module to the computer
  - Arduino board used simply as a USB to Serial converter
- Try different commands on the WiFi module and see the response
  - Join a wireless network
  - Connect to a server (opens TCP socket)
  - Make HTTP requests to a Node.js web service
- Think about how this task could be done programmatically

UNIVERSITY OF Southampton
School of Electronics and Computer Science

Raspberry Pi?

- It is "a tiny and cheap computer for kids"
- Somewhere between a uController board and a standard computer
  - Simplicity vs. complexity
  - Power consumption
  - Cost
- http://www.raspberrypi.org

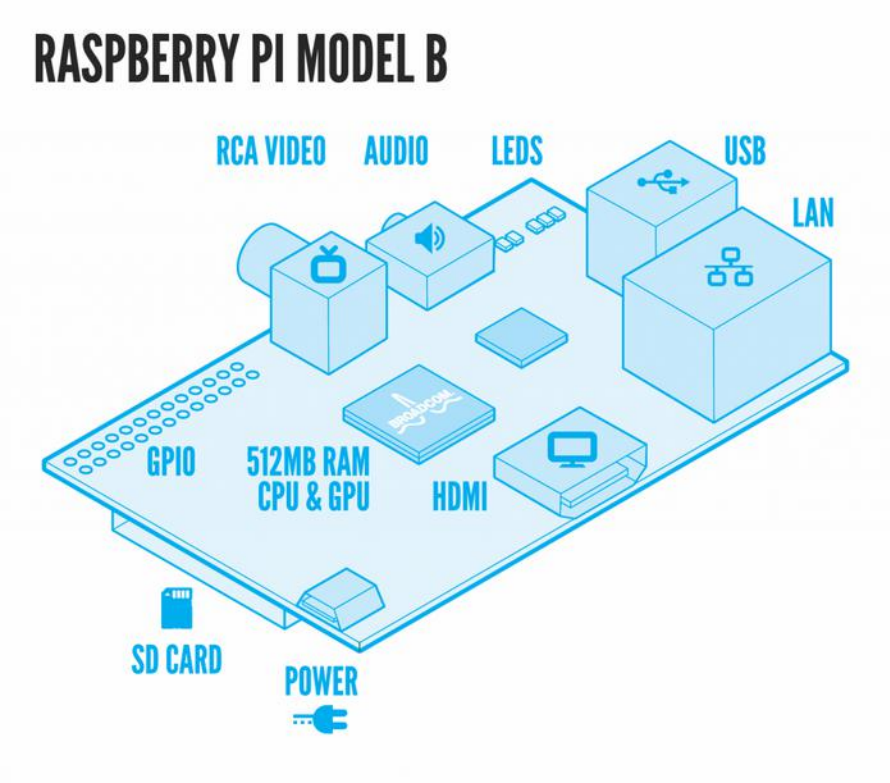


Image from http://www.raspberrypi.org/faqs

Summary

- RESTful web services can be used to implement IoT services and applications
- Some existing networked devices ("things") already offer RESTful-ish APIs (e.g. Alertme electricity sensor)
- To prototype new connected devices we can use uControllers equipped with WiFi modules
- Briefly looked at example requests to existing web service implemented in Node.js