Internet of Things

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Internet-of-Things

- "Things" connected through the Internet
- The "things" may be remotely controlled
- The "things" can provide data
- New business models / smarter solutions
- Teaching philosophy:
 - Combination of theory and practical experience
 - Learning by doing

Contemporary Use of ICT Systems

System of Insight

- System of Record
 - Traditional databases, ERP, CRM
- System of Engagement
 - Social media, blogs
- System of Automation
 - Internet-of-things



Internet of Things in Context



Internet-of-Things - Overview

Microcontrollers

Processes input to make output (*Computational capacity*)

Sensors

Collect input data

Actuators

Makes things happen

Communication

Communicates with the outside world through Internet



Laboratory assignments

- Measure temperature, humidity, distance
- Detect movement
- Store data on SD-card
- Use real-time clock
- Detect smoke
- Output data through displays (LED/LCD/OLED)
- Control the outside world through relays, motors and servo
- Read and write RFID tags
- Capture data from infrared remote controls, play back data on infrared transmitter
- Transfer wireless data through radio, WiFi and Bluetooth

Example



Components and modules

- ESP8266 (NodeMCU)
- Arduino Uno
- Prototyping board
- Breadboard 400 pins
- Battery holder (4xAA)
- Photoresistor
- DHT11 temperature/humidity
- Passive iInfrared (PIR) sensor
- MQ2 gas sensor
- Ultrasonic sensor
- Joystick
- Rotary encoder
- 12 button panel
- Passive buzzer
- LED display (I2C)

- LCD display (I2C)
- OLED display (I2C)
- DC Motor
- Micro-servo
- Step-motor with controller
- IR transmitter
- IR receiver
- RFID sensor
- Bluetooth module
- 2 x RF module NRF24L01
- RTC module
- Relay
- Sound detector module
- SD-card module

Transistors, diodes, resistors

- Transistors
 - 2x 2N2222
- Diodes
 - 1x 1N4001

- Resistors
 - 5 x 100 ohm
 - 2 x 150 ohm
 - 5 x 220 ohm
 - 2 x 300 ohm
 - 5 x 1.000 ohm (1K)
 - 2 x 2.000 ohm (2K)
 - 2 x 10.000 ohm (10K)

What is ESP8266

- ESP8266 is a microcontroller with built-in WiFi
- Has an embedded TCP/IP protocol stack
- Can be used as a web server, web client and for many other applications



Different Versions of ESP8266

- The ESP8266 is the microcontroller with built-in WiFi
- The ESP8266 itself does not communicate through USB
- This is necessary for hooking up with a PC
- Therefore, a lot of circuit boards have been made to:
 - Host the ESP8266
 - Provide an USB adapter circuit (e.g., CH340)
 - Provide power for the ESP8266 from the USB connection

First Example

- This is a typical example of an ESP8266 card
- It has an ESP8266, a USB interface, and a few components handling power requirements



The USB Interface

CH340 is a low cost USB interface circuit often used in Chinese produced microcontollers

Some operating systems detect CH340, if not a driver must be installed



Witty

- A two layer ESP8266 board with the ESP8266 on the upper level, and the CH340 on the lower level.
- To program, connect USB cable to connector on the lower level
- The two levels may be separated
- In that case, the connector on the upper lever is just for power supply



Witty







The upper level with the ESP8266 The lower level with the CH340 USB interface

The Arduino IDE

The official Arduino site is: https://www.arduino.cc

- Information about the Arduino versions
- Software downloads
- Resources, e.g. tutorials
- Forum

The Arduino IDE is used for many IoT-devices, such as ESP8266

• • •	sketch_jur	n23a Arduino 1.8.12		
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sketch_jun23a				
<pre>void setup() { // put your setu</pre>	p code here, to r	un once:		
}				
<pre>void loop() { // put your main</pre>	code here, to ru	n repeatedly:		
}				
		٥		
lløtr), All SSL ciphers (most compatible)	, 4MB (FS:2MB OTA:~1019KB), v2 Lo	wer Memory, Disabled, None	e, Only Sketch, 115200 on /de	v/cu.wchusbserial14110

How to Add ESP8266 to the Arduino IDE

- Open Arduino -> Preferences
- In the field "Additional Boards Manager URLs" add the following URL: https://arduino.esp8266.com/stable/package_esp8266com_index.json

How to Add ESP8266 to the Arduino IDE



Selecting the Board

In the Tools menu select NodeMCU 0.9 (ESP12 module) This works for both Witty and the Lolin boards

The next step is to select the port

Tools		
Auto Format Archive Sketch Fix Encoding & Reload Manage Libraries Serial Monitor Serial Plotter WiFi101 / WiFiNINA Firmware Updater	躲ፐ ዕዝ ዕዝ ዕዝ	AI Thinker ESP32-CAM SparkFun LoRa Gateway 1-Channel TTGO T-Watch WEMOS DI MINI ESP32 Pycom GPy VintLabs ESP32 Devkit
Board: "NodeMCU 0.9 (ESP-12 Module)" Upload Speed: "115200" CPU Frequency: "80 MH2" Flash Size: "4MB (FS:2MB OTA:~1019KB)" Debug port: "Disabled" Debug Level: "None" IWIP Variant: "v2 Lower Memory" VTables: "Flash" Exceptions: "Legacy (new can return nullptr)" Erase Flash: "Only Sketch" SSL Support: "All SSL ciphers (most compatible)" Port Get Board Info Programmer: "AVRISP mkll" Burn Bootloader	* * * * * * * * * *	ESP8266 Boards (2.7.1) Generic ESP8286 Module Generic ESP8285 Module ESPDuino (ESP-13 Module) Adafruit Feather HUZZAH ESP8266 Invent One XinaBox CW01 ESPresso Lite 1.0 ESPresso Lite 2.0 Phoenix 1.0 Phoenix 2.0 ✓ NodeMCU 0.9 (ESP-12 Module) NodeMCU 0.9 (ESP-12 Module) Olimex MOD-WIFI-ESP8266(-DEV) SparkFun ESP8266 Thing SparkFun ESP8266 Thing SparkFun ENP8266 Thing
		SweetPea ESP-210 LOLIN(WEMOS) D1 R2 & mini LOLIN(WEMOS) D1 mini Pro LOLIN(WEMOS) D1 mini Lite WeMos D1 R1 ESPino (ESP-12 Module) ThaiEasyElec's ESPino Wifinfo Arduino AD Systems gen4 IoD Range Digistump Oak WiFiduino Amperka WiFi Slot Seeed Wio Link ESPectro Core Schirmilabs Eduino WiFi ITEAD Sonoff DOIT ESP-Mx DevKit (ESP8285)

Selecting the Port

The other important thing is to select the port. Sometimes, this requires installation of a separate driver for CH340.

Make sure that the USB cable is OTG (On-The-Go). This allows devices to communicate through the cable. Some cables are just for power, and can not be used.

Common problems:

- 1. Missing drivers
- 2. Wrong cable (no OTG)

Tools			
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Arch	ive Sketch	
Fix E	ncoding & Reload	
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WiFi101 / WiFiNINA Firmware Updater

Board: "NodeMCU 0.9 (ESP-12 Module)" Upload Speed: "115200" CDL/ Exercise 180 Mile"	*
Flash Size: "4MB (FS:2MB OTA:~1019KB)"	
Debug Level: "None" wIP Variant: "v2 Lower Memory"	
VTables: "Flash" Exceptions: "Legacy (new cap return pullptr)"	
Erase Flash: "Only Sketch"	
Port	
Get Board Info	
Programmer: "AVRISP mkII" Burn Bootloader	•

Serial ports

/dev/cu.Bluetooth-Incoming-Port /dev/cu.HC-06-SPPDev /dev/cu.HC-06-SPPDev-1 /dev/cu.LassesAirPods-Wirelessi /dev/cu.SLAB_USBtoUART /dev/cu.SSDC /dev/cu.usbserial-0001

Setting Up GPIO Pins

- An ESP8266 device has a number of GPIO (General Purpose Input Output) pins
- These can read and write digital signals (zeros and ones)
- A GPIO pin can not be used for reading and writing at the same time
- The mode is selected by: pinMode(pin, OUTPUT) or pinMode(pin, INPUT)

Output

 Output is done by using: digitalWrite(pin, HIGH) or digitalWrite(pin, LOW)

Video

- Please take a look at the video named: ESP8266_Example1_Blink_Internal.mp4
- This recording shows how to program the first ESP8266 sketch
- The sketch makes the internal LED blink at given intervals

The Result

