

# **Introduction to Arduino boards**

## **(Day I)**

**Dr. Serge Stinckwich  
USTH 2021**

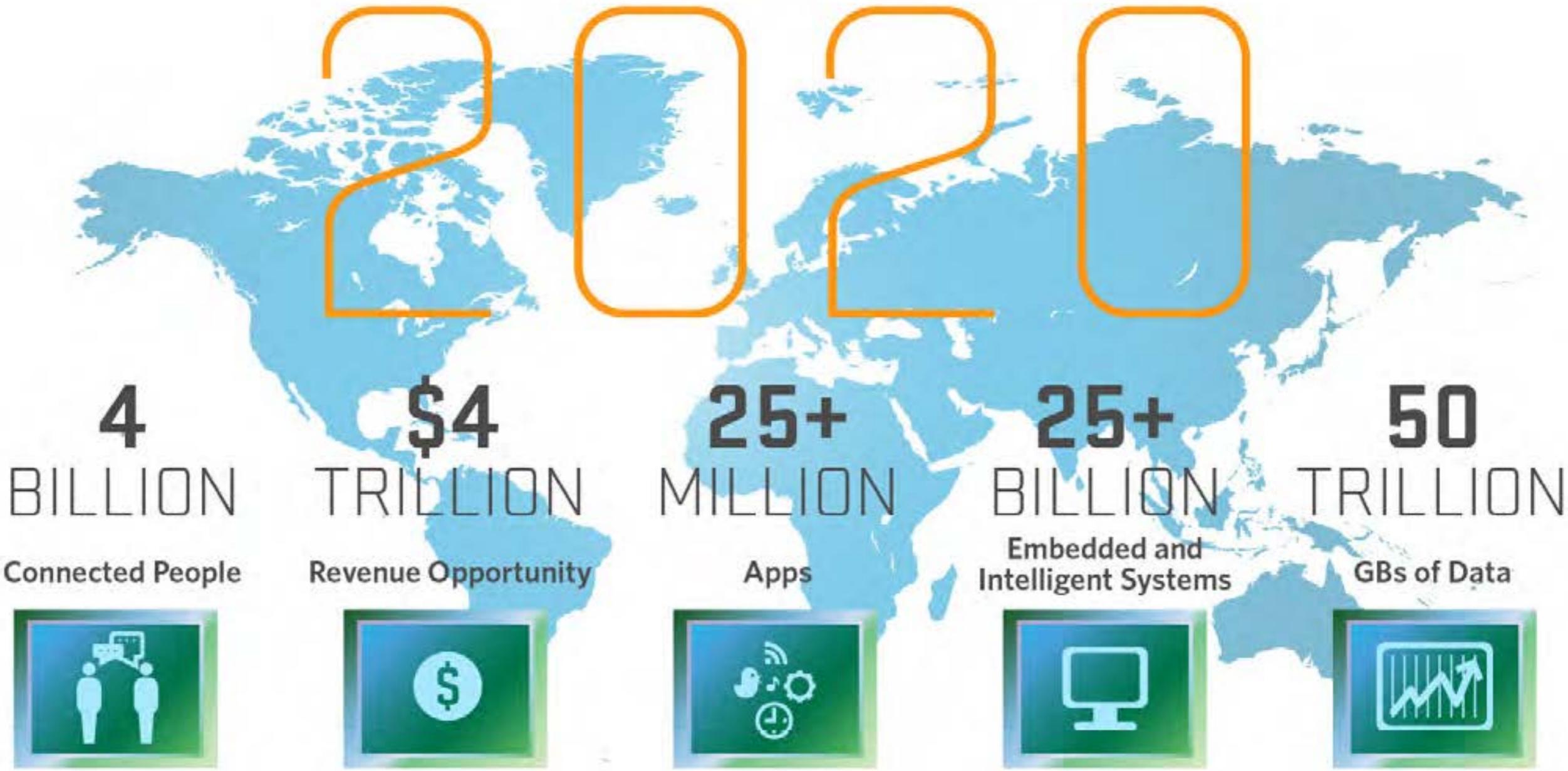


SergeStinckwich



**UNITED NATIONS  
UNIVERSITY**

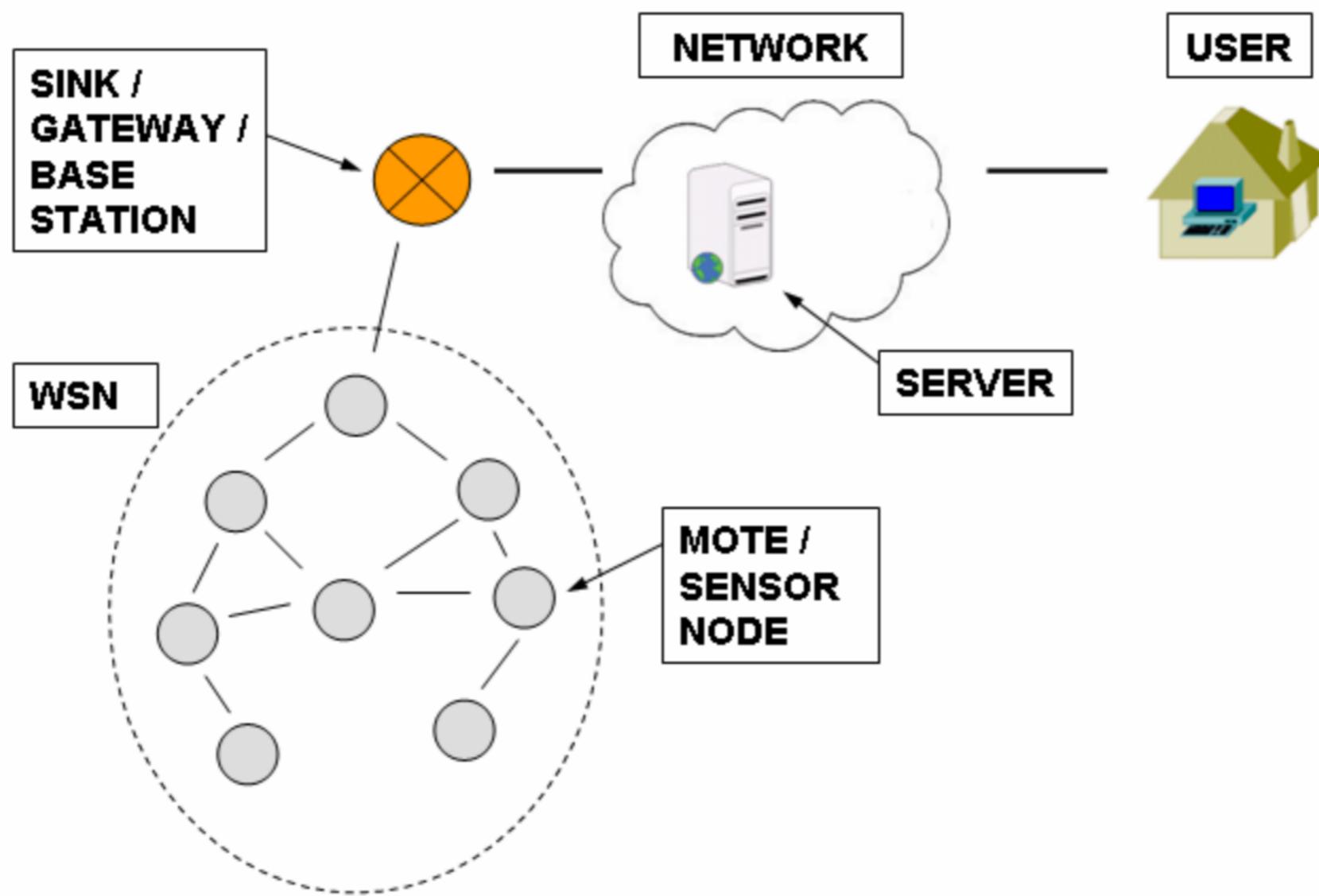
**Institute in Macau**



Source: Mario Morales, IDC

# What is WSN ?

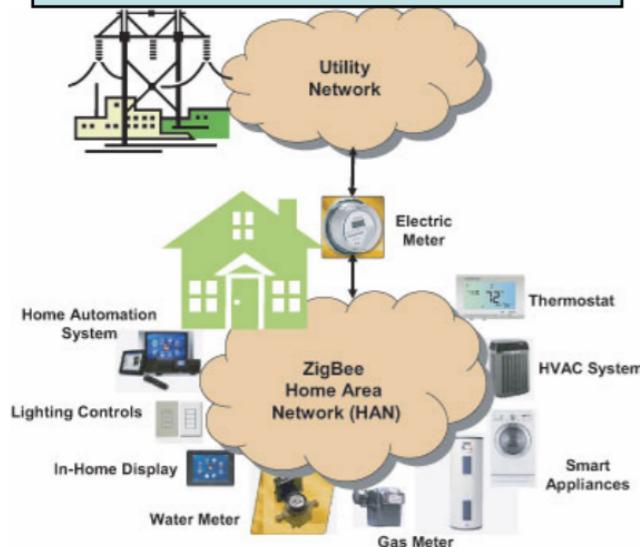
A **WSN** (Wireless Sensor Network) is a wireless network composed by elements which are able to make measurements, elaborate and send them to a sink point.



# WSN Possible Applications

## DOMESTIC:

- Home Automation
- Smart Metering



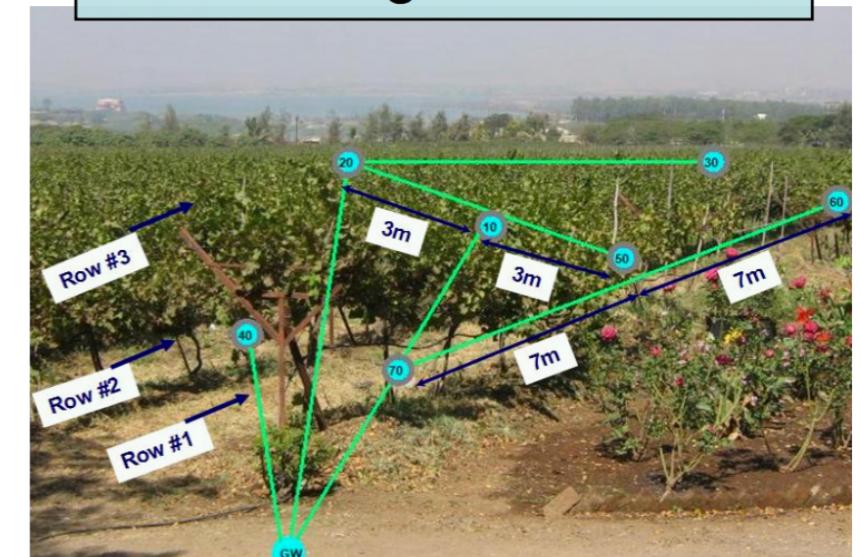
## INDUSTRIAL:

- Automation
- Supply Chain



## ENVIRONMENTAL:

- Precision agriculture
- Monitoring



## MILITARY:

- Surveillance
- Targets Tracking



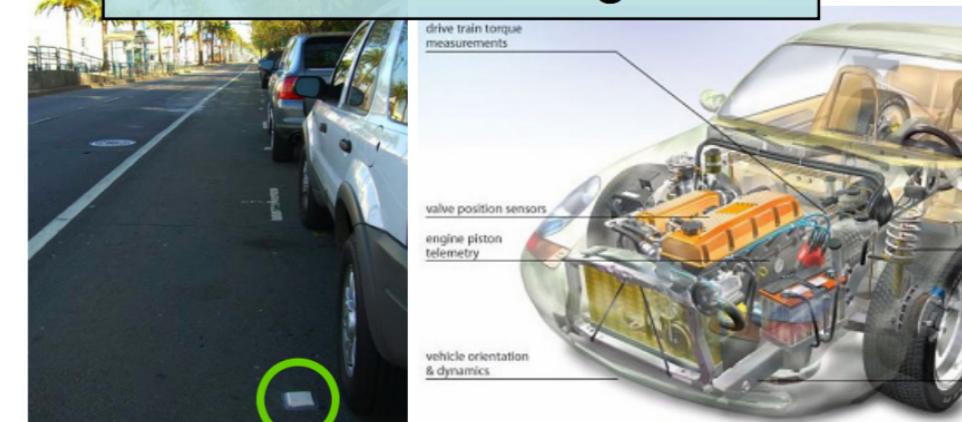
## BIOMEDIC:

- Biological data monitoring



## TRANSPORTS:

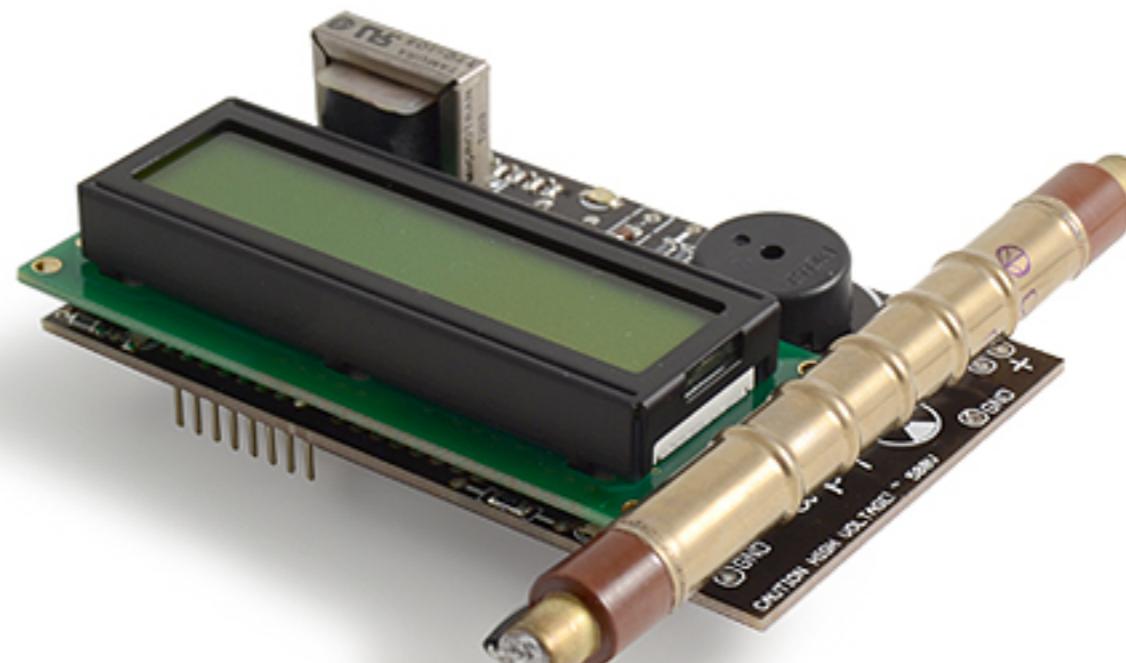
- Intra-vehicle sensors
- Traffic monitoring



# **Environmental Applications**

- Forest fire detection
- Environment mapping
- Flood detection
- Precision Agriculture
- Air/Water Pollution
- Landslide, avalanche prevention

# Detecting Radiation Levels in Fukushima: an example of crowdsourcing



[http://www.libelium.com/  
fukushima\\_crowdsourcing\\_radiation\\_social\\_project/](http://www.libelium.com/fukushima_crowdsourcing_radiation_social_project/)

# Physical Computing

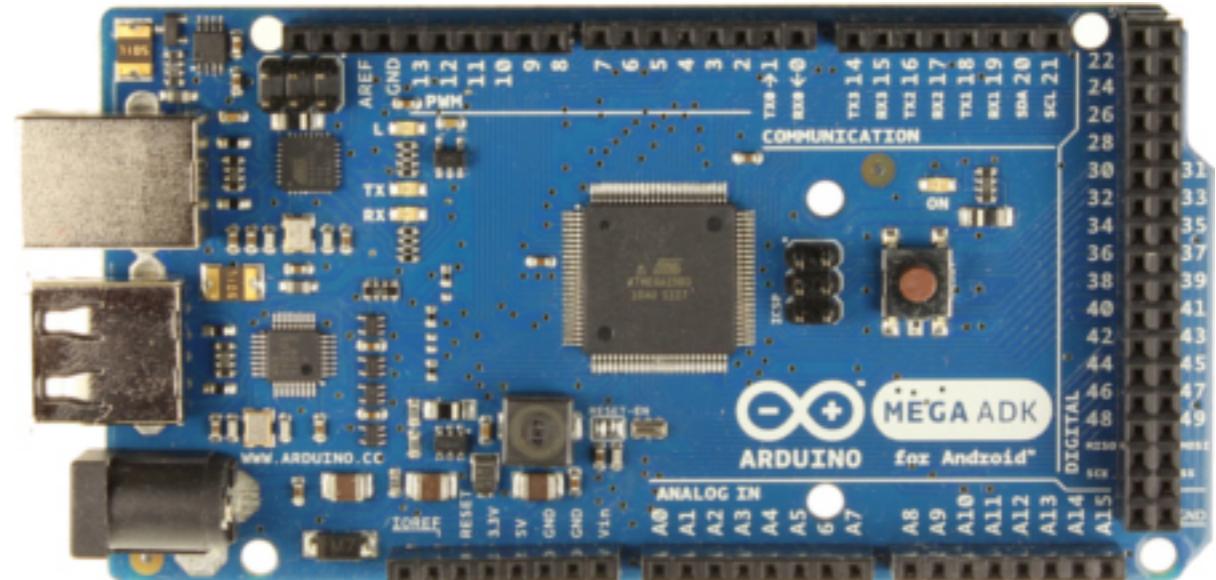
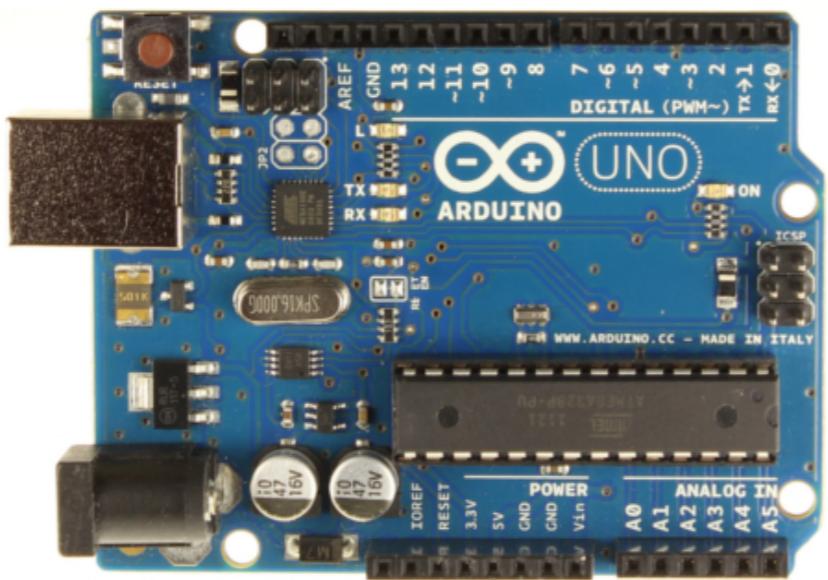
- “Physical computing is about prototyping with electronics, actuators and microcontrollers into material for designers and artists.”
- “It involves the design of interactive objects that can communicate with humans using sensors and actuators controlled by a behavior implemented as software running inside a microcontroller”,  
**Arduino co-founder**

# What is Arduino ?

- Open Source Physical Computing platform: a **physical board**, a **programming environment**, a **community**
- Modular platform based on shields
- More on: <http://arduino.cc/>



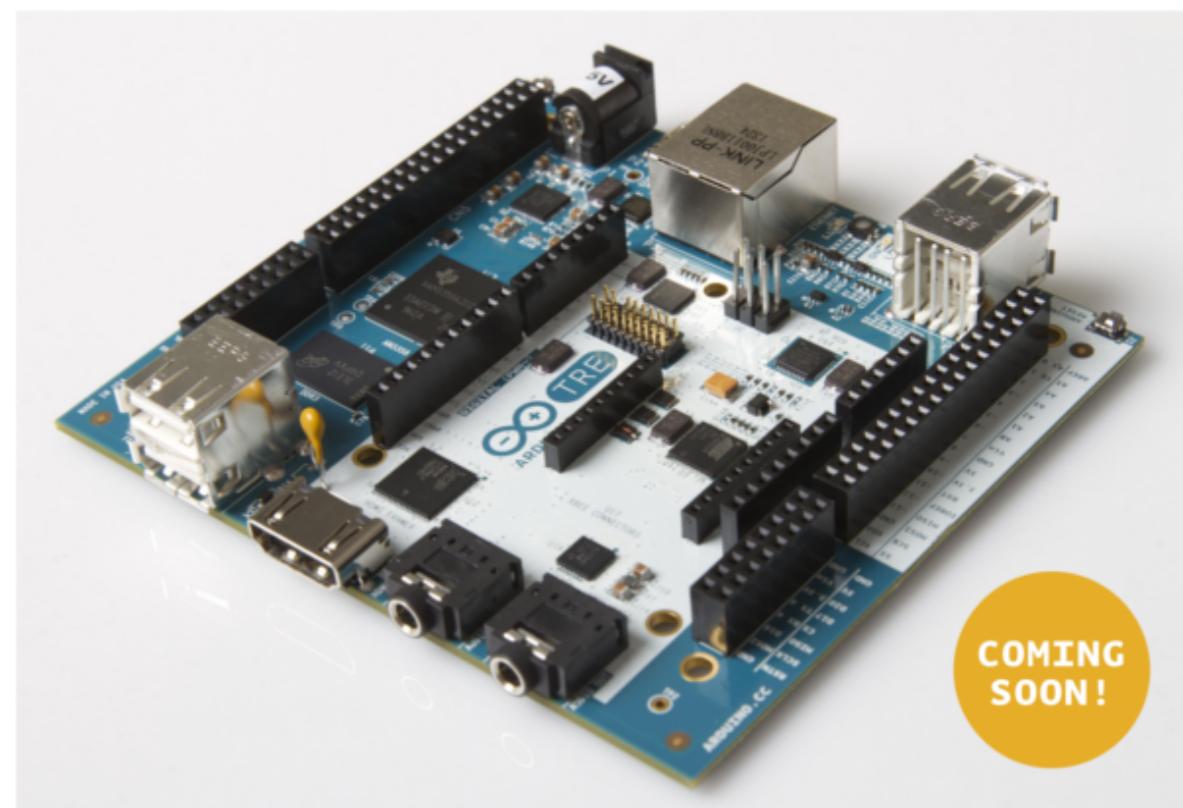
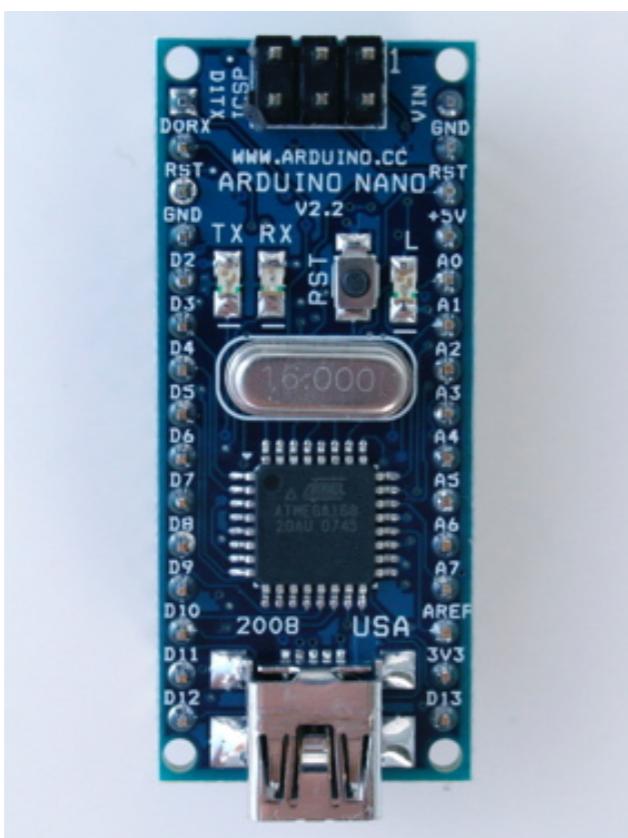
# Arduino boards



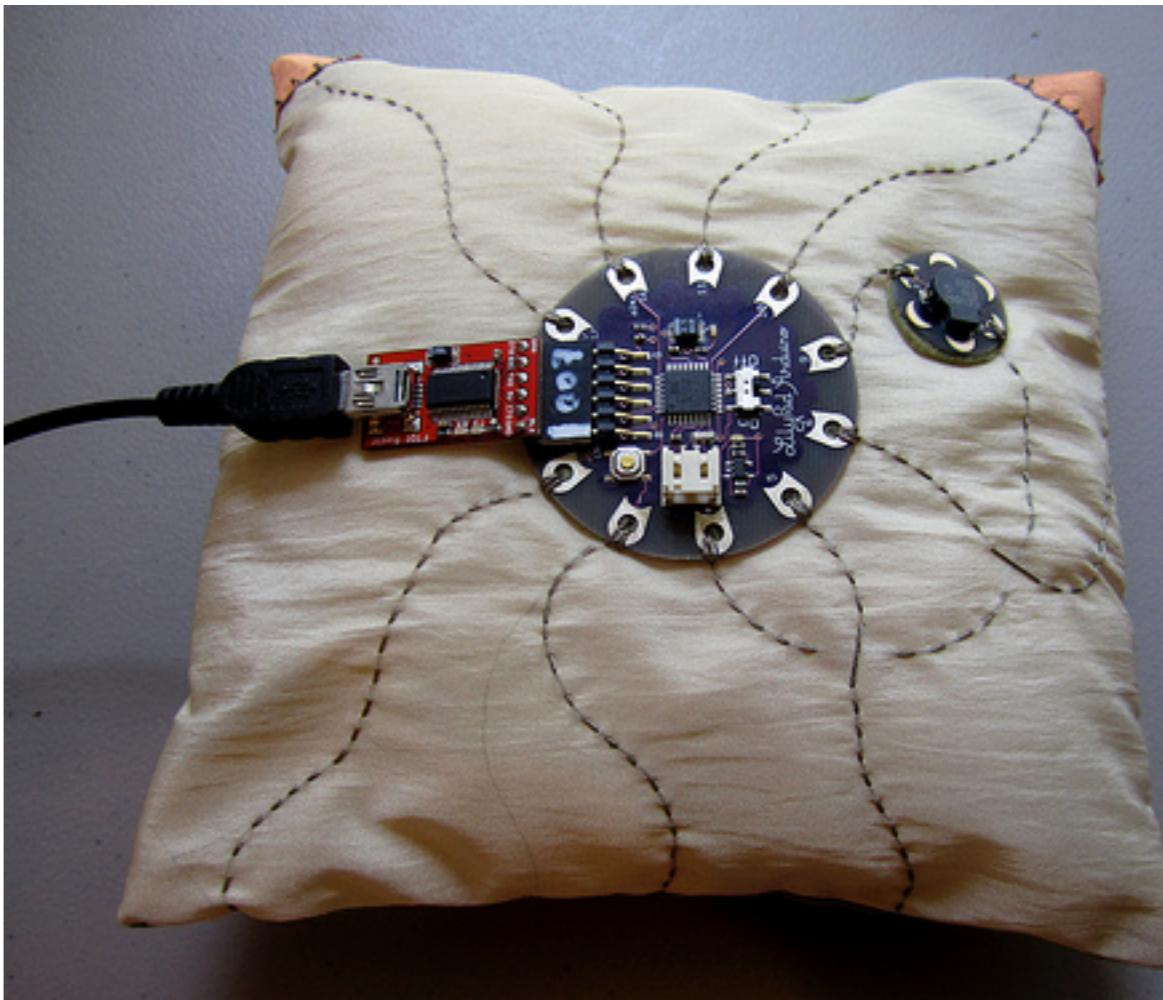
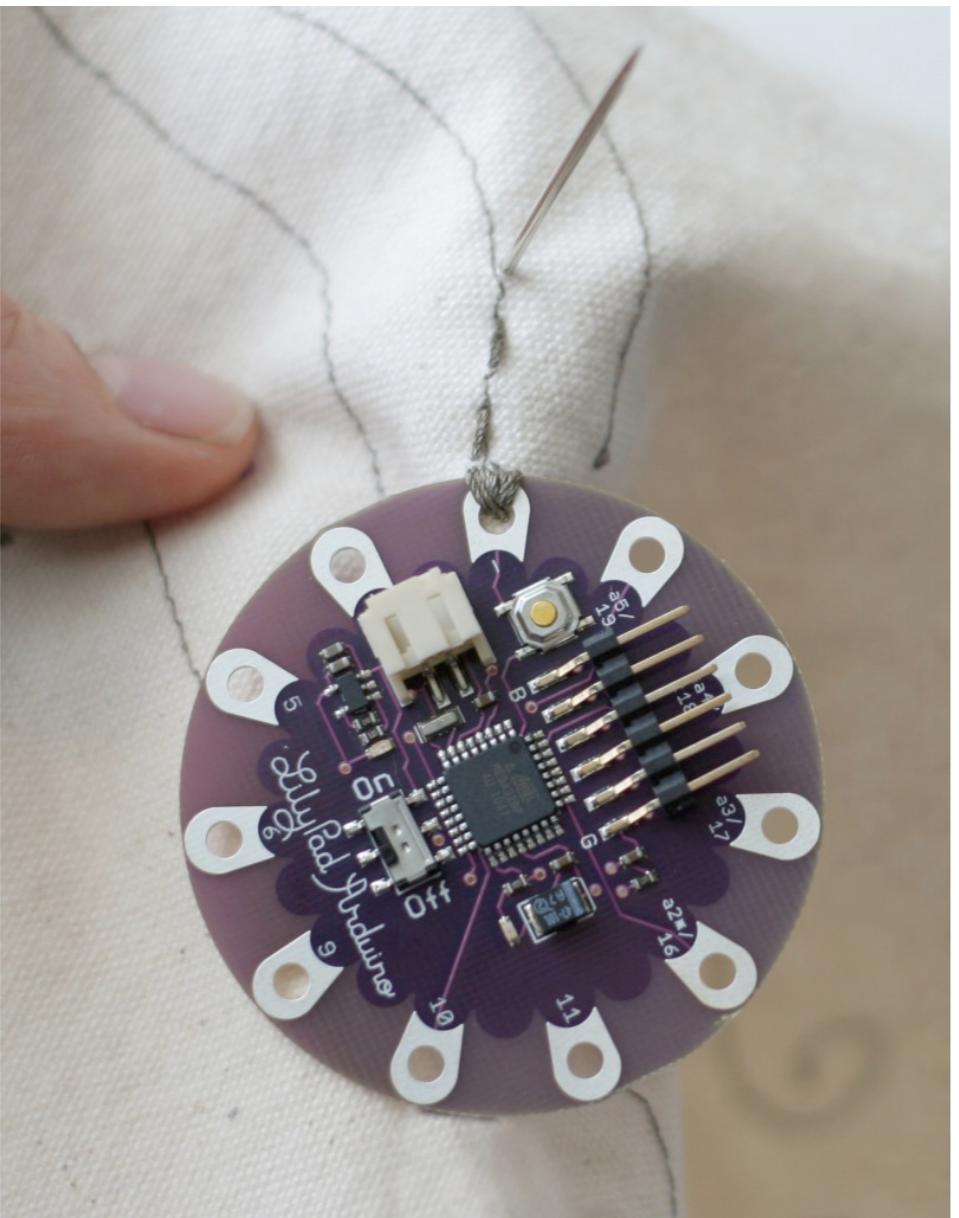
# Basic characteristics

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

# Other Arduino Boards



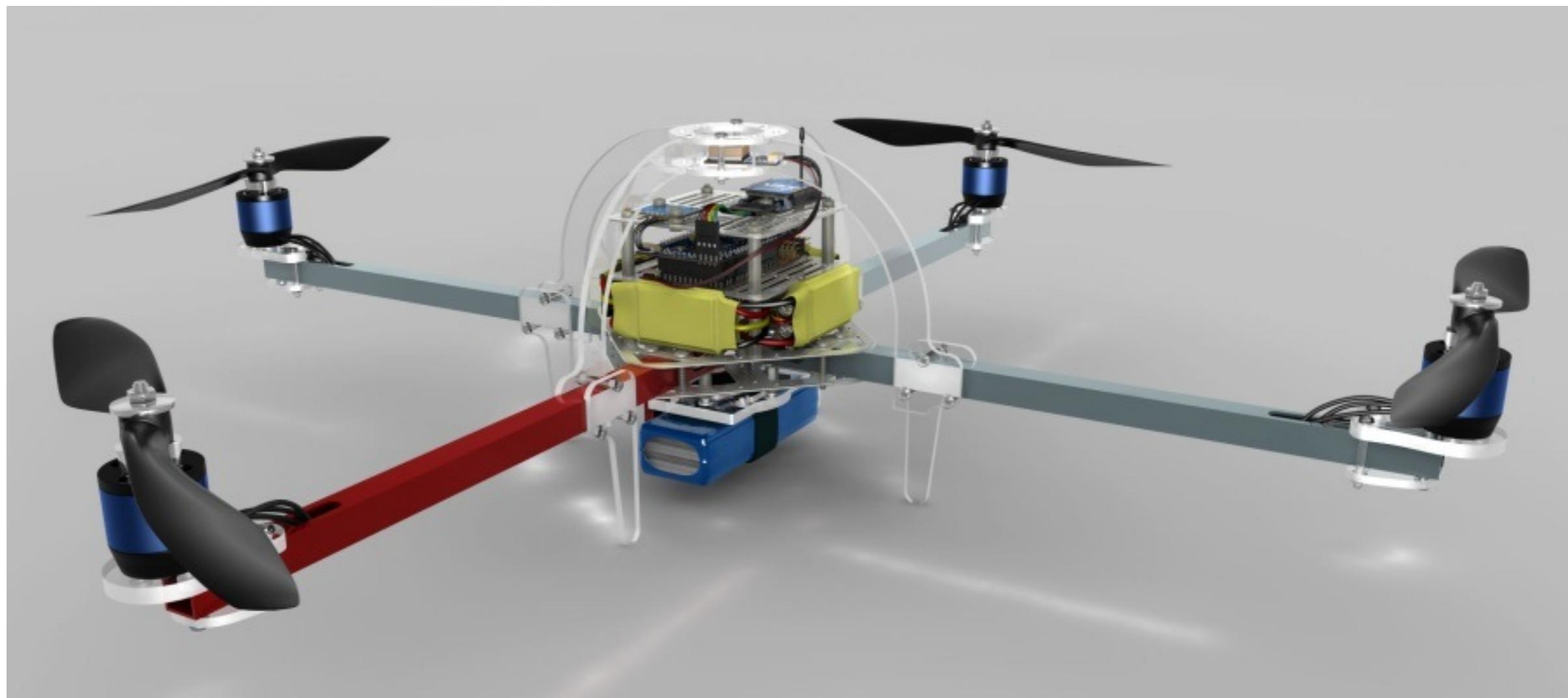
# Arduino Lilypad (aka Sewable Arduino)



# Robot Arduino



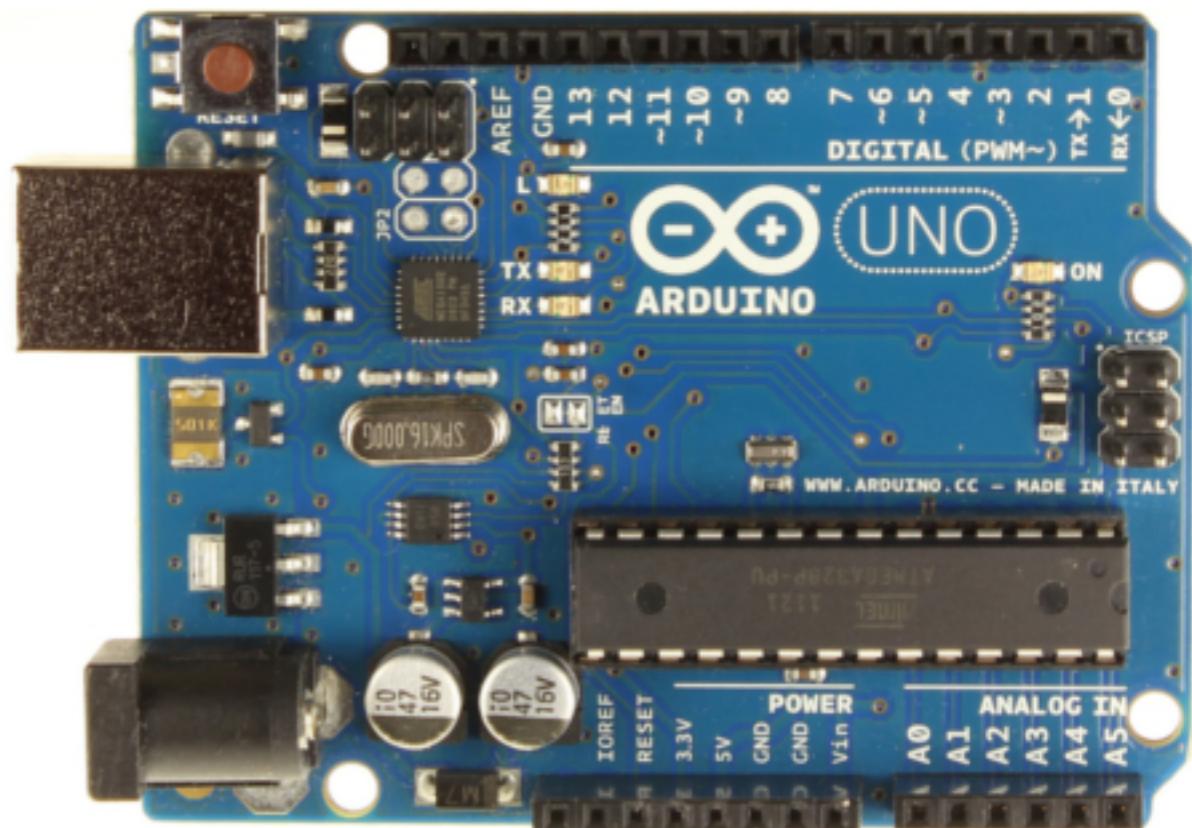
# ArduCopter



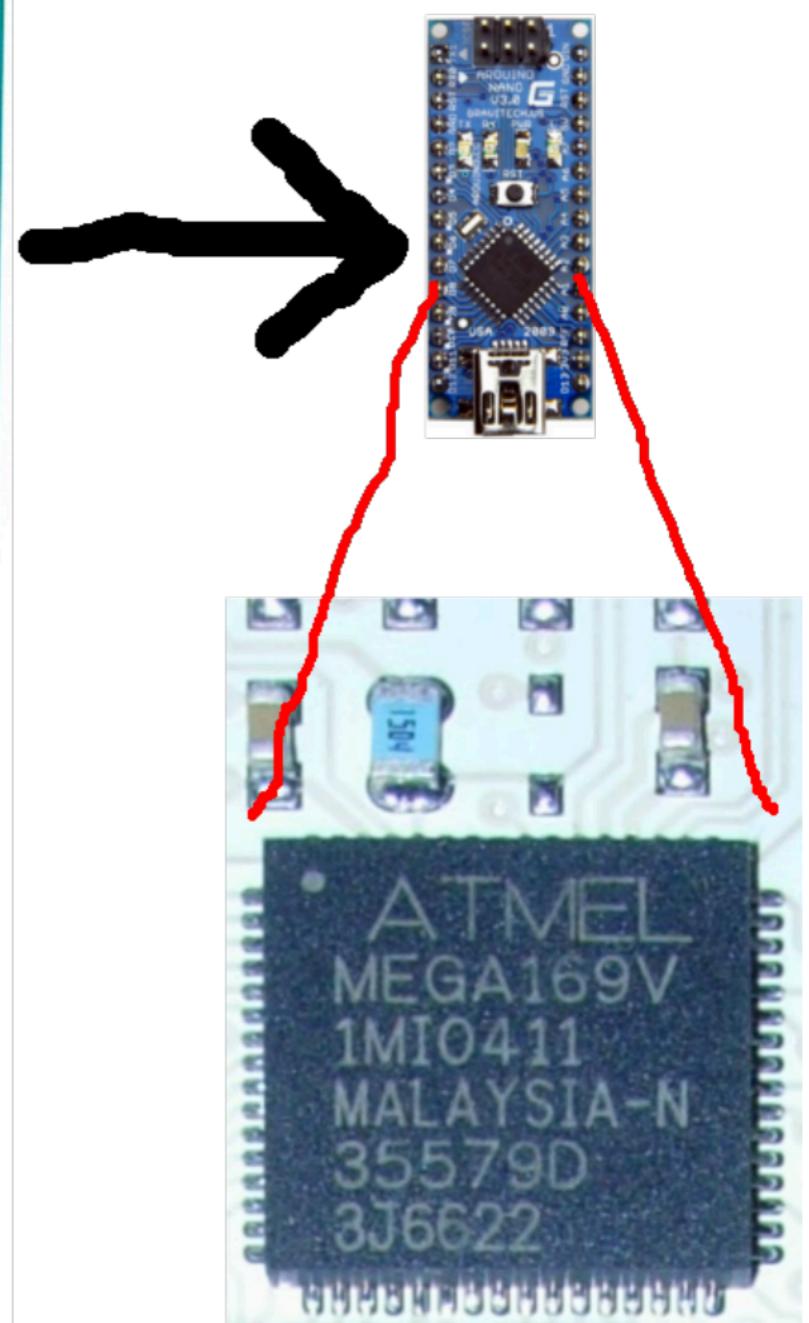
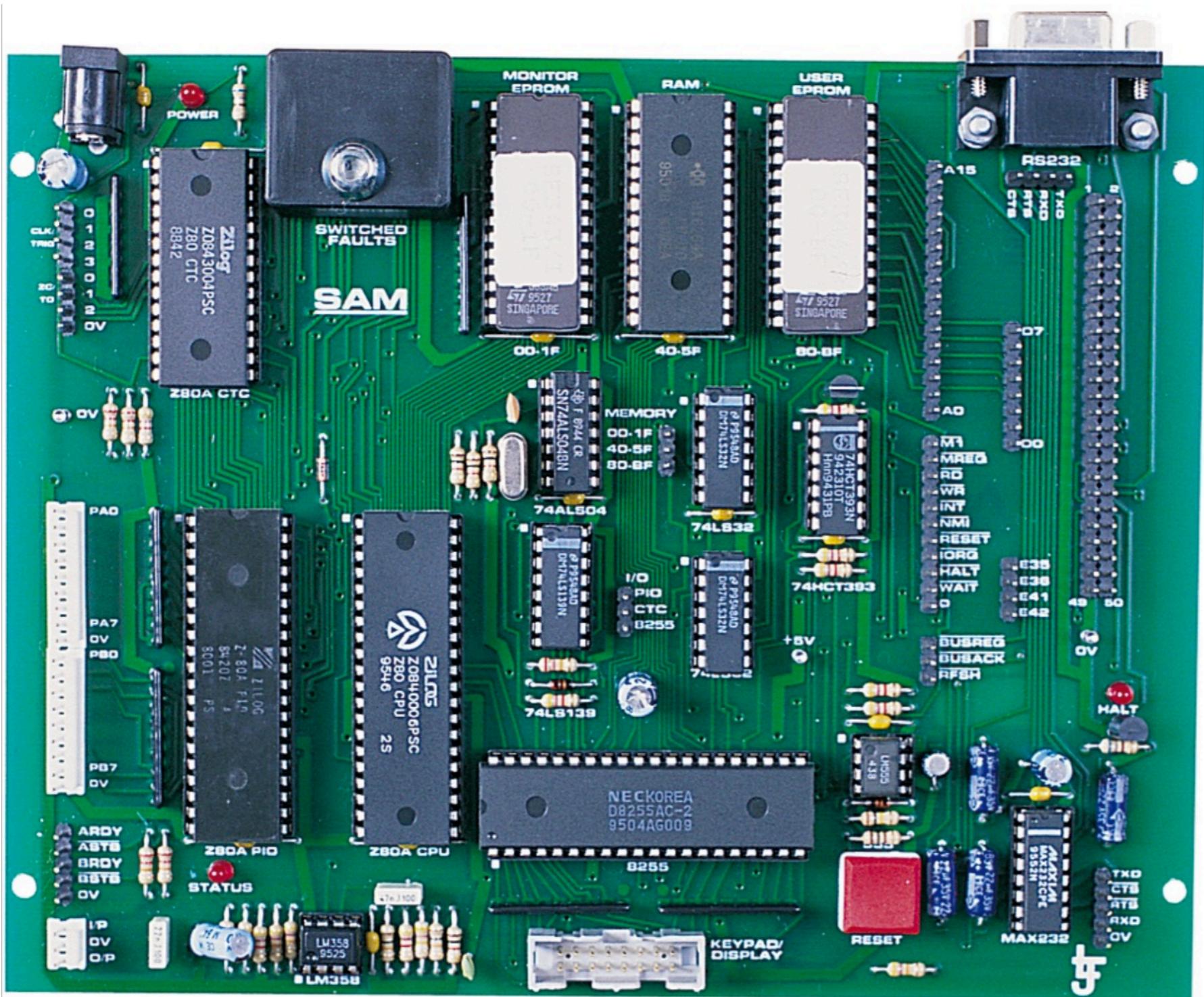
# Arduino Capabilities



Intel 286 (1982)

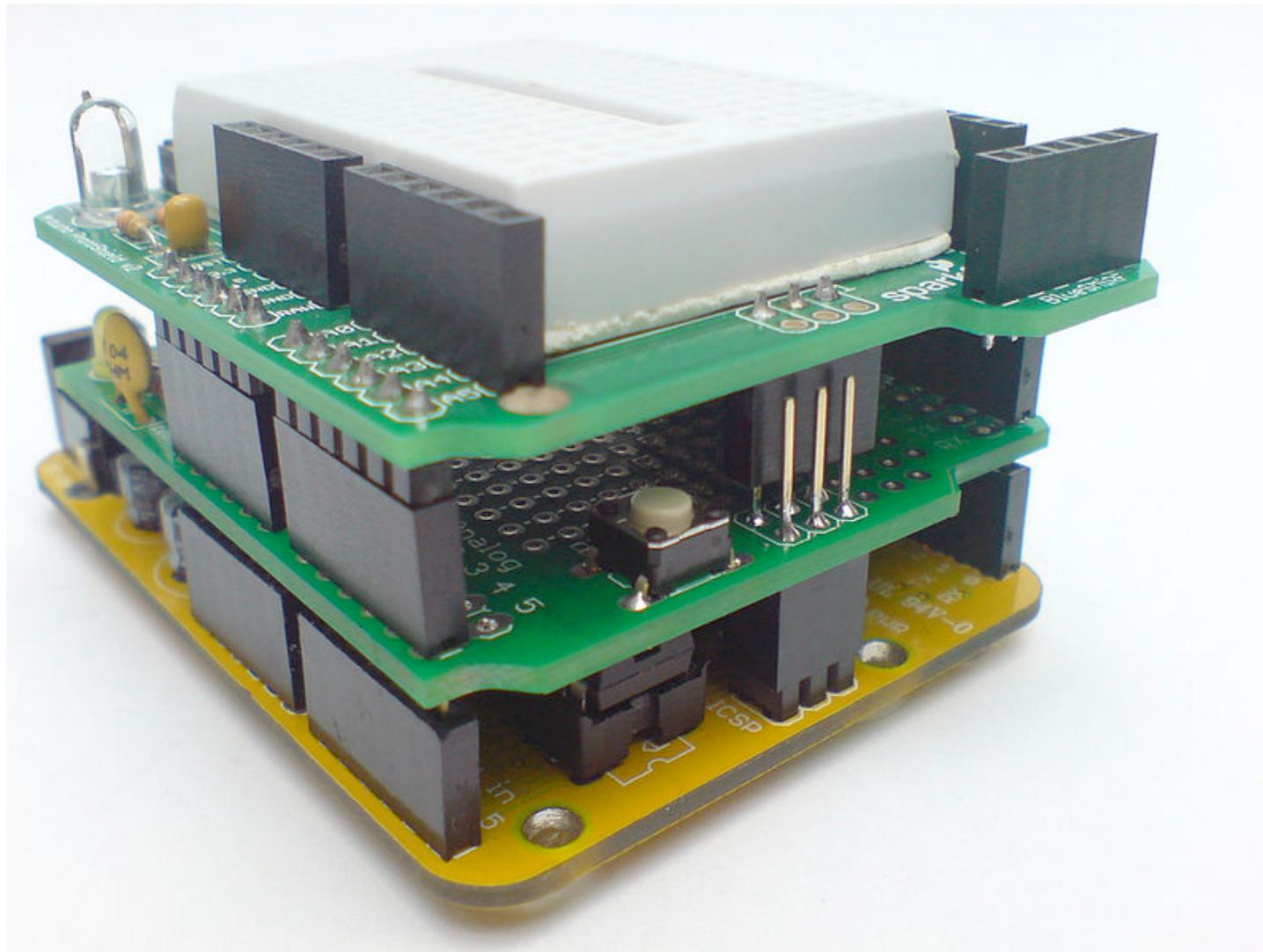


architecture similar to 1980s, but *very large scale integration* (VLSI)....



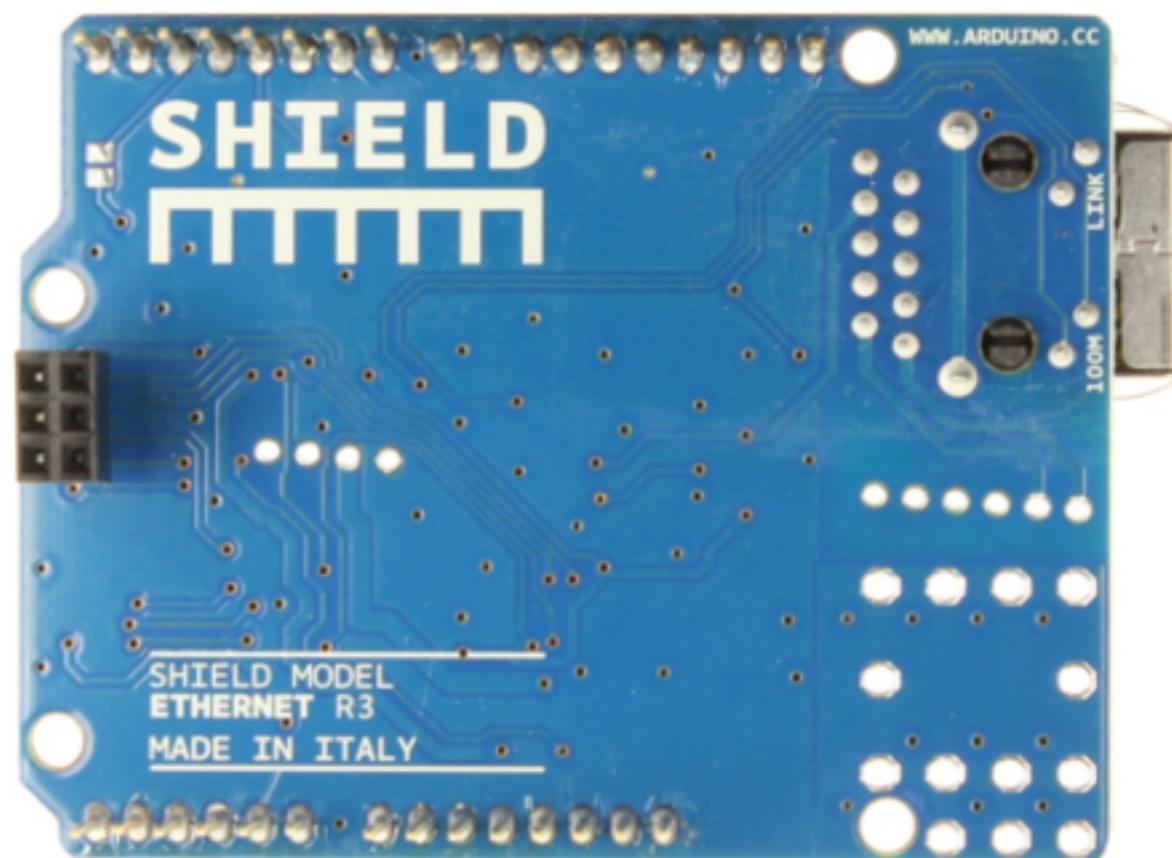
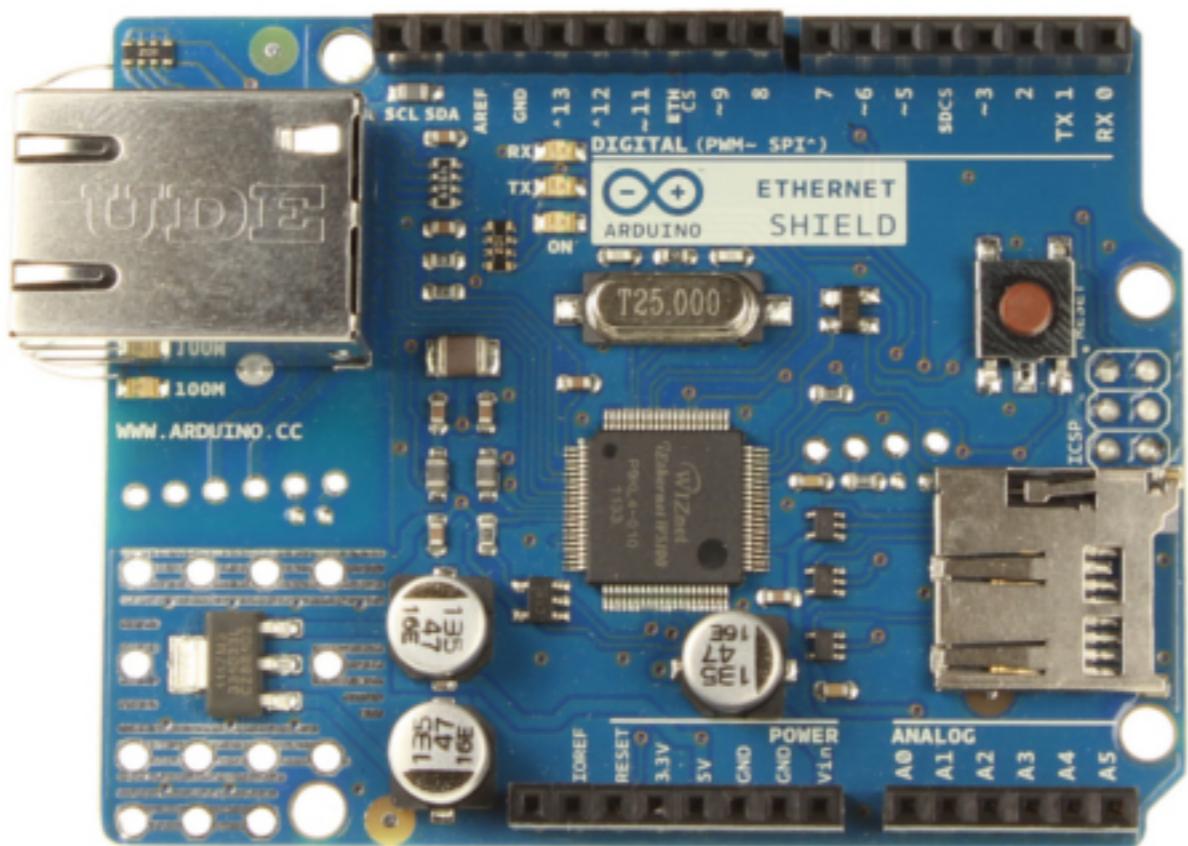
300×250 mm (12×10 in) board → 12×12 mm (0.5×0.5 in) chip

# Stackable Shields

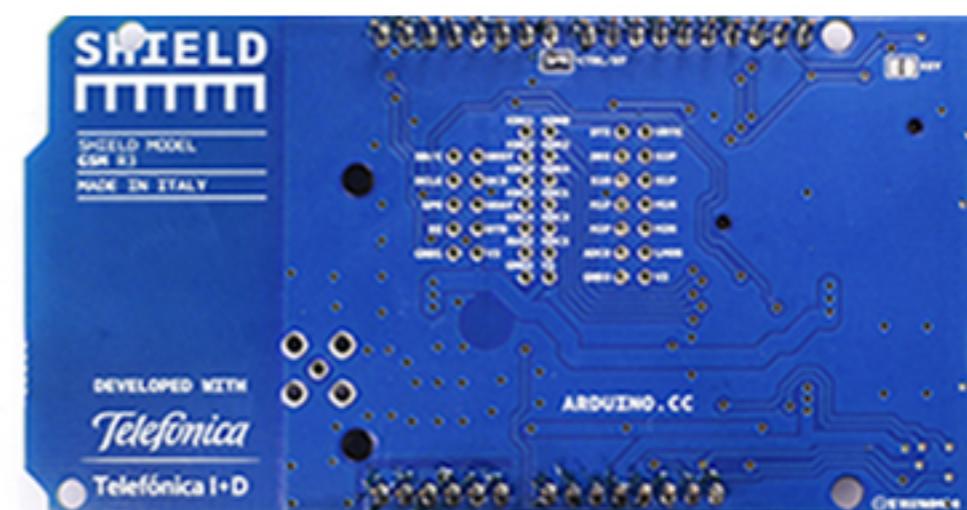


More than 500 available:  
audio, speech, GSM, video  
camera, SD card, WiFi,  
accelerometer, RFID, compass,  
GPS, LCD display, ...

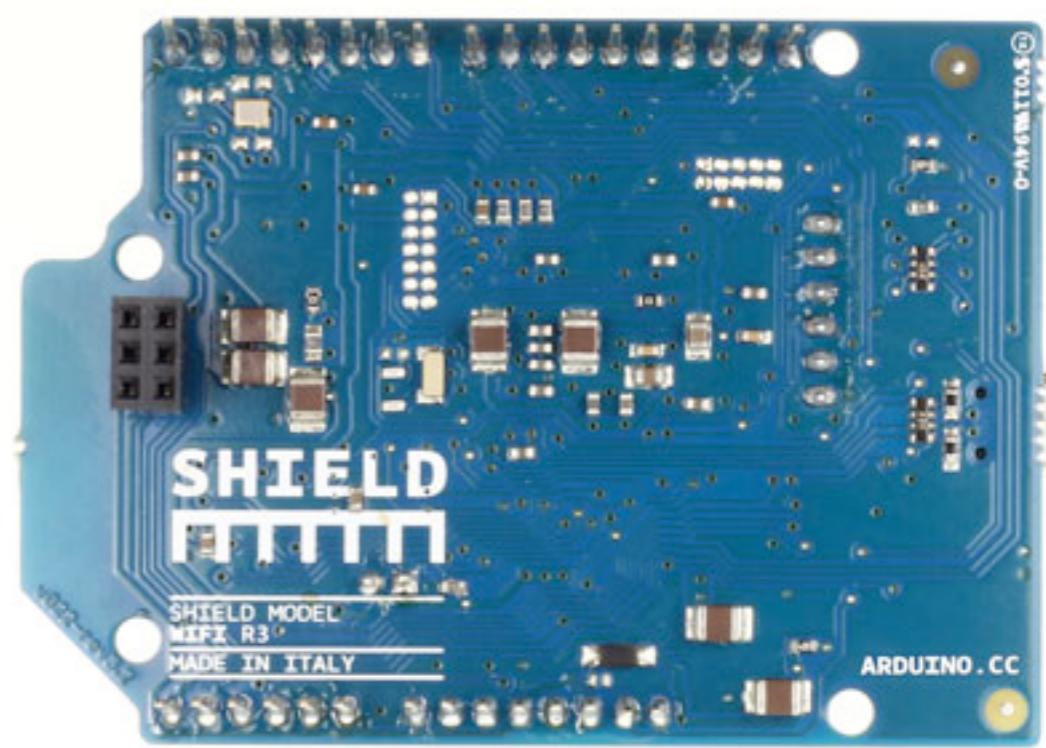
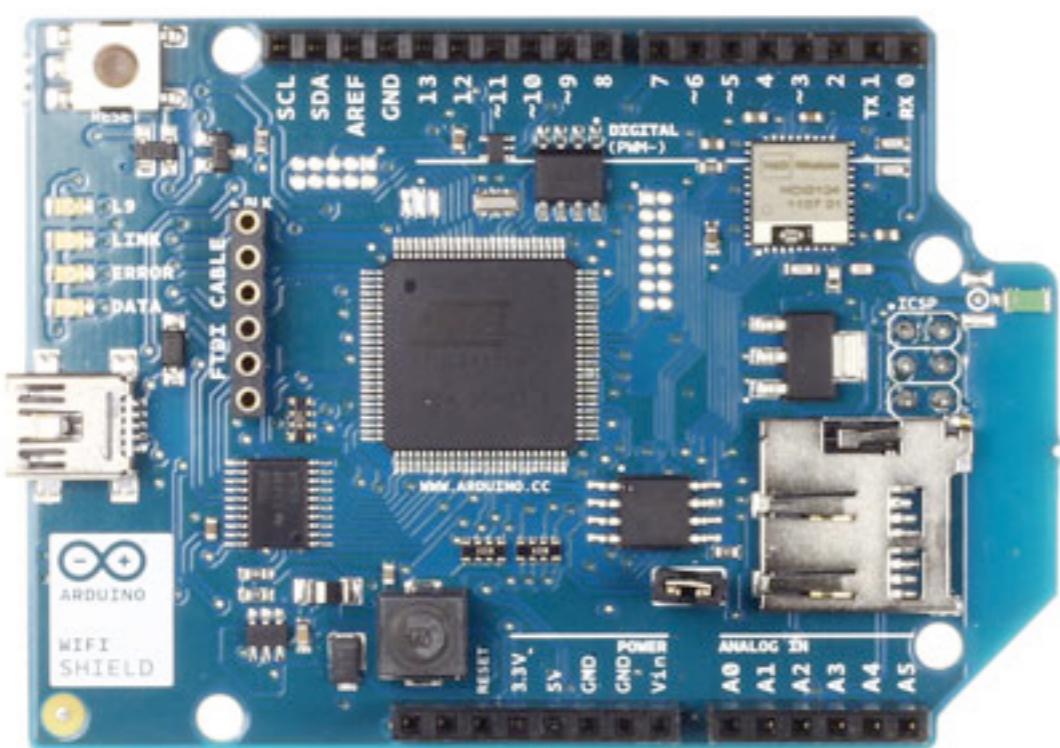
# Arduino Ethernet Shield



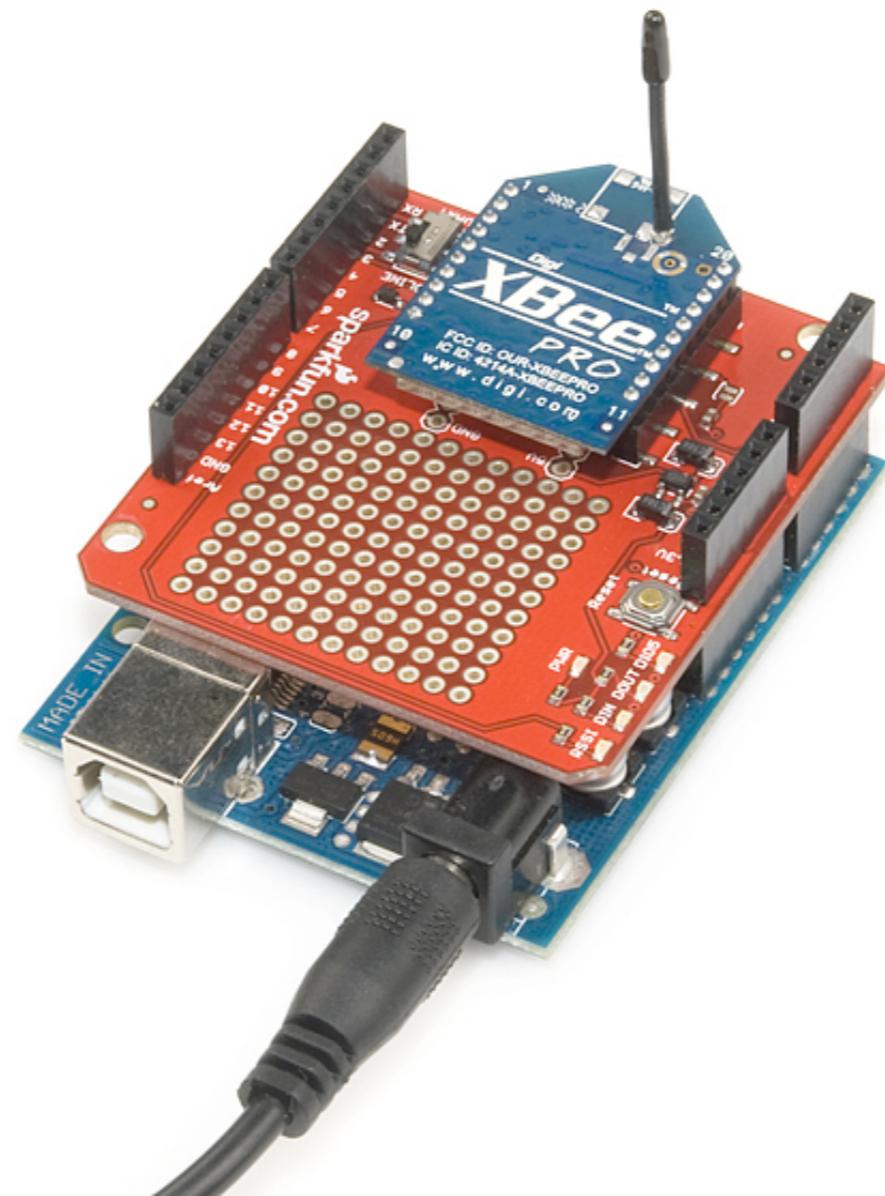
# Arduino GSM Shield



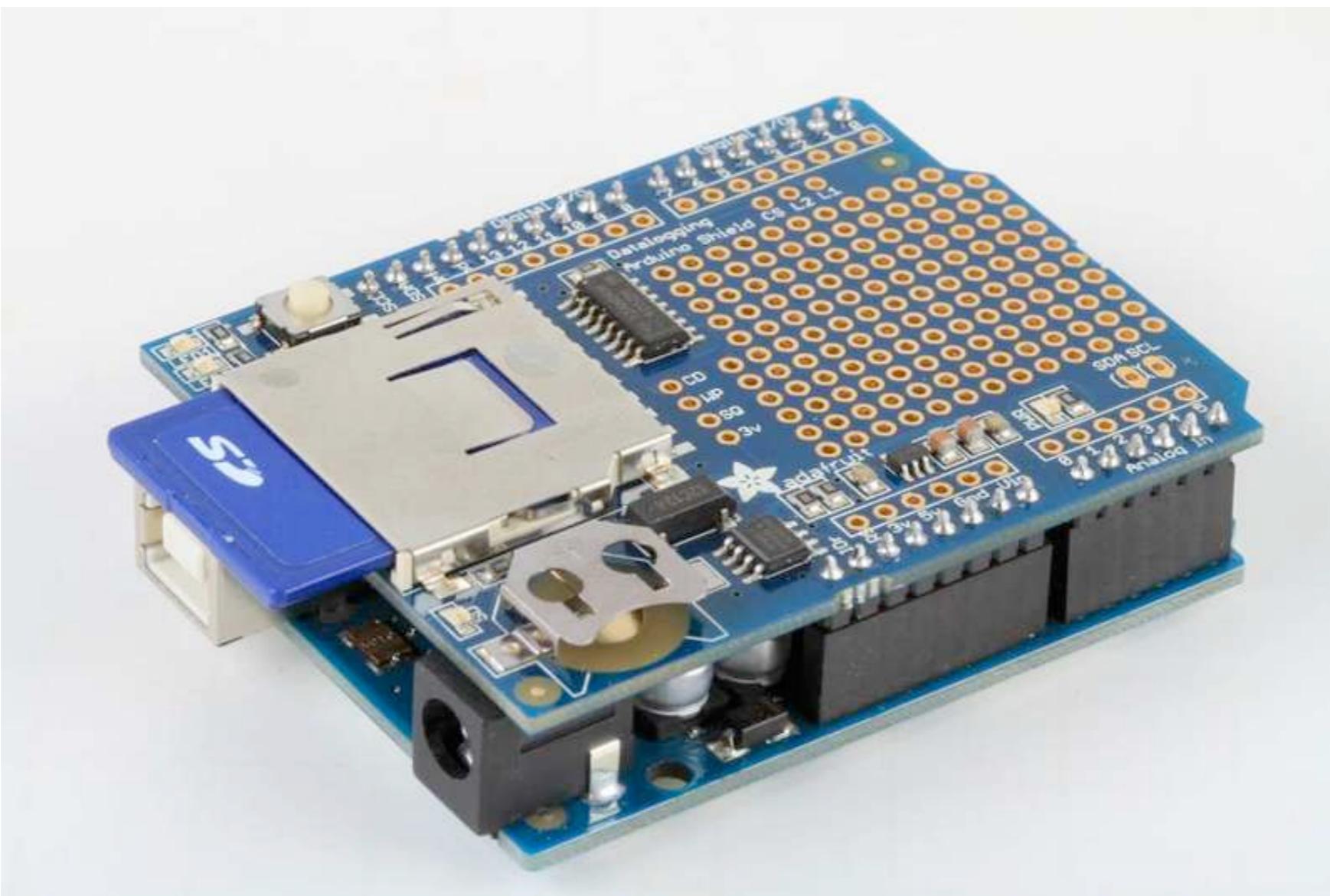
# Arduino WiFi Shield



# XBee Shield



# AdaFruit Data Logger Shield



## PRODUCTS

## New Products [106]

Android (6)

▼Arduino (67)

Boards &amp; Packs [19]

Shields [36]

Accessories [12]

BeagleBone (24)

Bunnie Studios (9)

FLORA (25)

FPGA (2)

mbed (12)

NETduino (14)

►Raspberry Pi (95)

Trinket (3)

XBee (9)

►More Dev Boards (30)

BoArduino (8)

Brain Machine (1)

Clocks &amp; Watches (19)

Drawdio (4)

Game of Life (1)

Microtouch (5)

MiniPOV (3)

MintyBoost (2)

SIM reader (3)

SpokePOV (4)

TV-B-Gone (2)

HOME ⇒ Arduino ⇒ Boards &amp; Packs ⇒ Arduino Uno R3 (Atmega328 - assembled)

## Arduino Uno R3 (Atmega328 - assembled) -

ID: 50

Manufactured by: Smart Projects



\$29.95

Qty.	Discount
1-9	\$29.95
10-99	\$26.96
100+	\$25.46

Add to Cart: 

ADD TO CART

IN STOCK

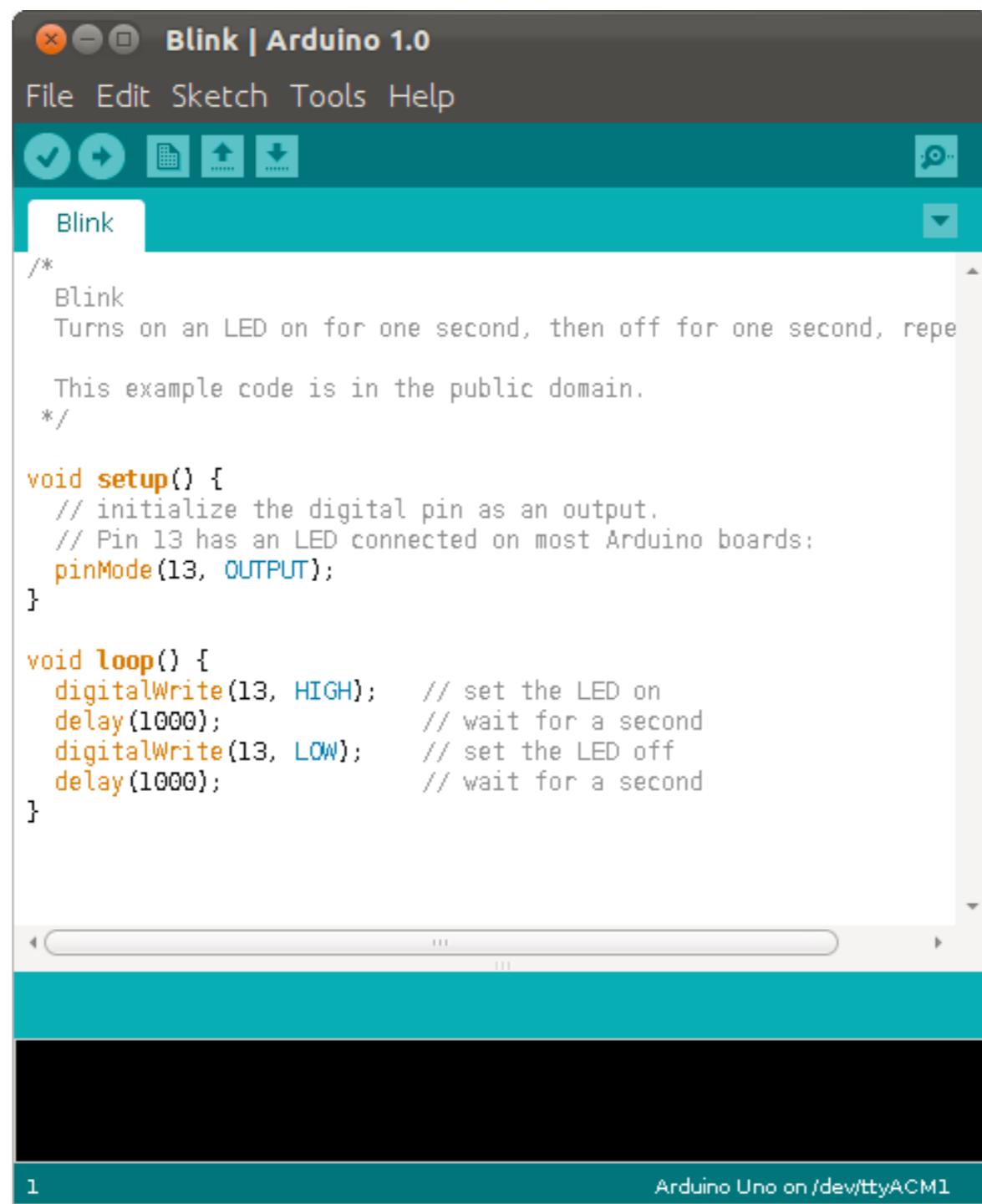
ADD TO WISHLIST

# **How does it work ?**

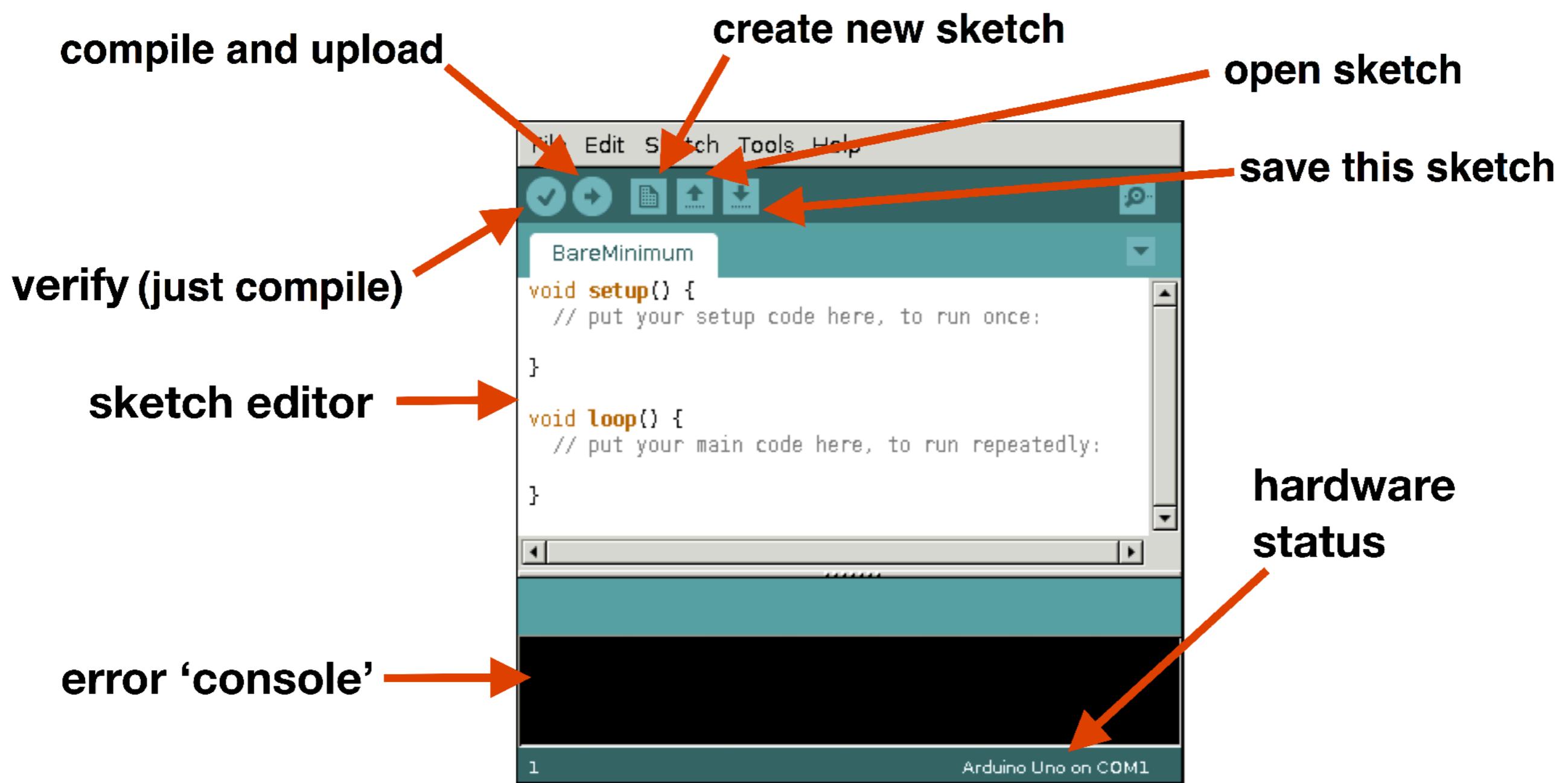
- Write code on your computer
- Upload it to the Arduino board
- Arduino can be used standalone

- Install IDE on your computer from: <http://www.arduino.cc/>
- Runs on MacOS, Windows, Linux

# Arduino IDE



# Arduino IDE



- You need an USB cable to connect your Arduino board to your PC
- Arduino board is powered by the USB cable and is also used to transmit information between your PC and the board
- For windows users: sometimes you need to download some specific driver to access your Arduino board

- Micro-controller programs are called “sketches” in Arduino world.
- The language is a dialect of C (aka C without pointers)

# How to design a program ?

- Users only need to define two functions to make a runnable cyclic executive program:
  - **setup()**: a function run once at the start of the program that can initialize settings
  - **loop()**: a function called repeatedly until the board power off

# Hello World program

```
void setup() {  
    // put your setup code here, to run once:  
    Serial.begin(9600);  
}  
  
void loop() {  
    // put your main code here, to run repeatedly:  
    Serial.print("Hello World");  
}
```

# Let's there be Light

- Blink: this example shows the simplest thing you can do with an Arduino to see physical output
- Hardware required:
  - Arduino

```
/*
Blink
Turns on an LED on for one second, then off for one second, repeatedly.

This example code is in the public domain.
*/
// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;

// the setup routine runs once when you press reset:
void setup() {
    // initialize the digital pin as an output.
    pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
    digitalWrite(led, HIGH);      // turn the LED on (HIGH is the voltage level)
    delay(1000);                // wait for a second
    digitalWrite(led, LOW);       // turn the LED off by making the voltage LOW
    delay(1000);                // wait for a second
}
```

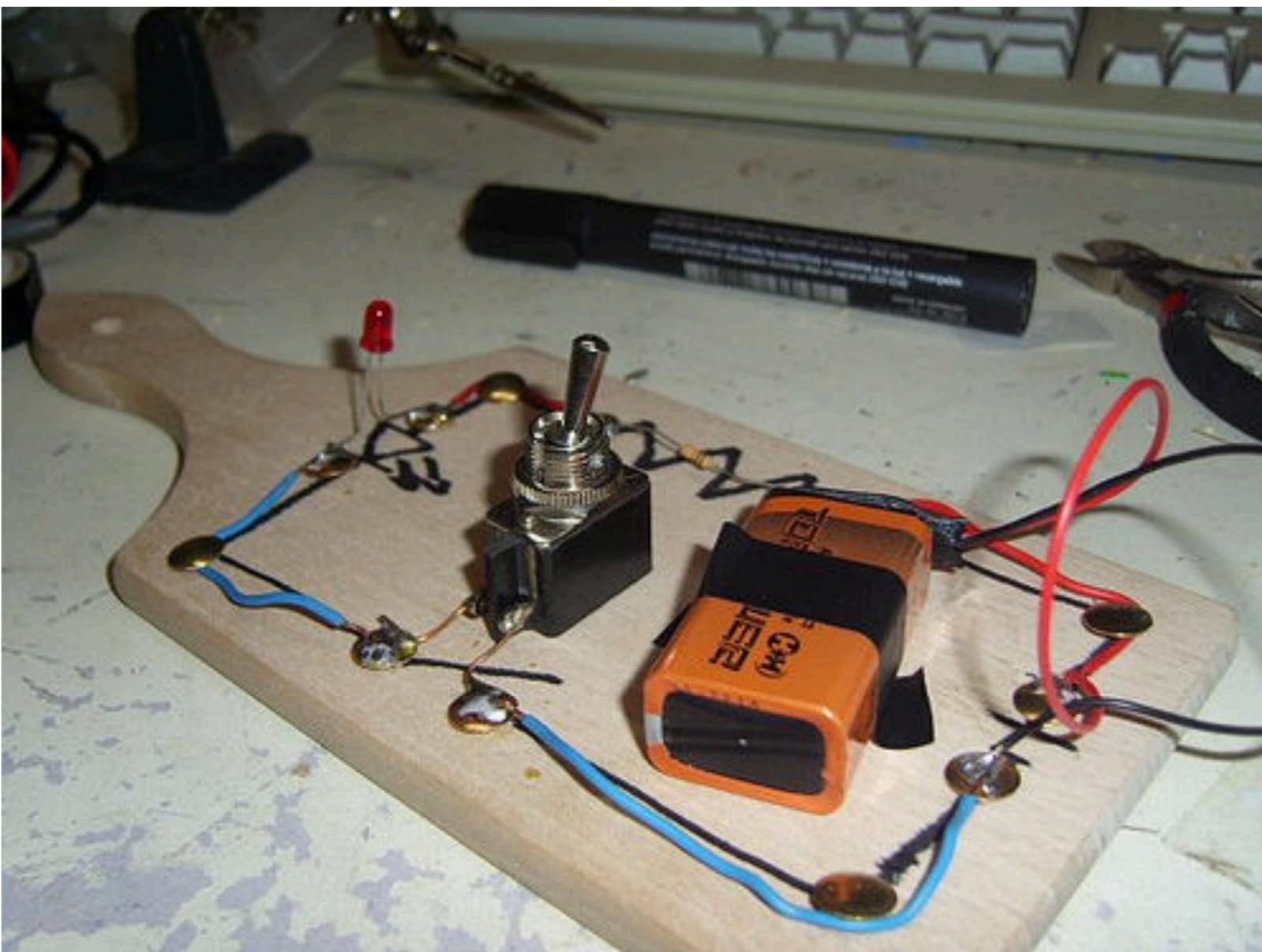
<https://www.arduino.cc/en/Tutorial/Blink>

# **Do it yourself challenge**

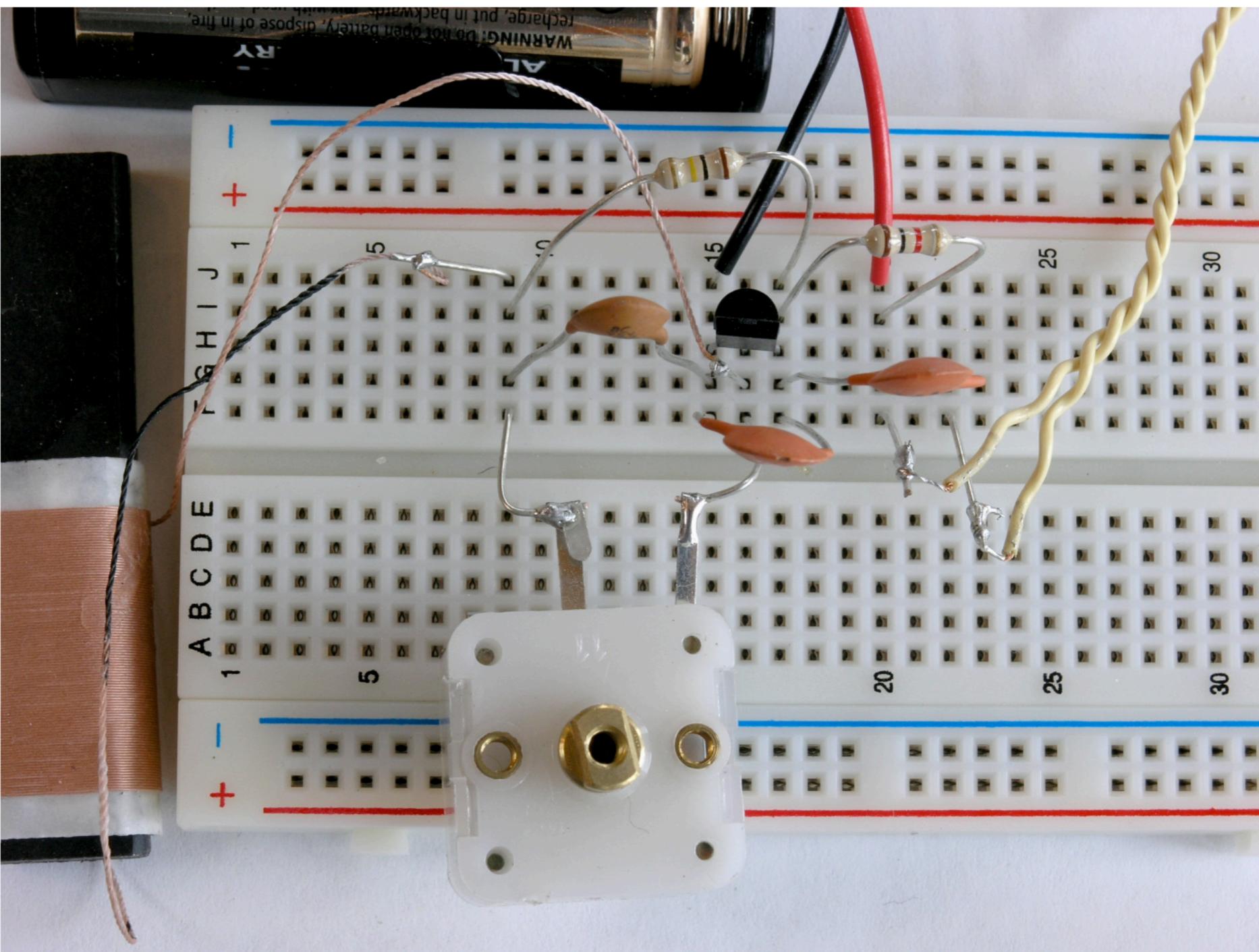
- Make an emergency beacon !
- Change the previous program so that the LED send a message using MORSE code
- For example send the message SOS repeatedly

- a dot = 1 unit of time
- a dash = 3 units of time
- a space between dots and dashes within a letter should be 1 unit of time
- a space between letters is 3 units of time
- space between sentences is 7 units of time

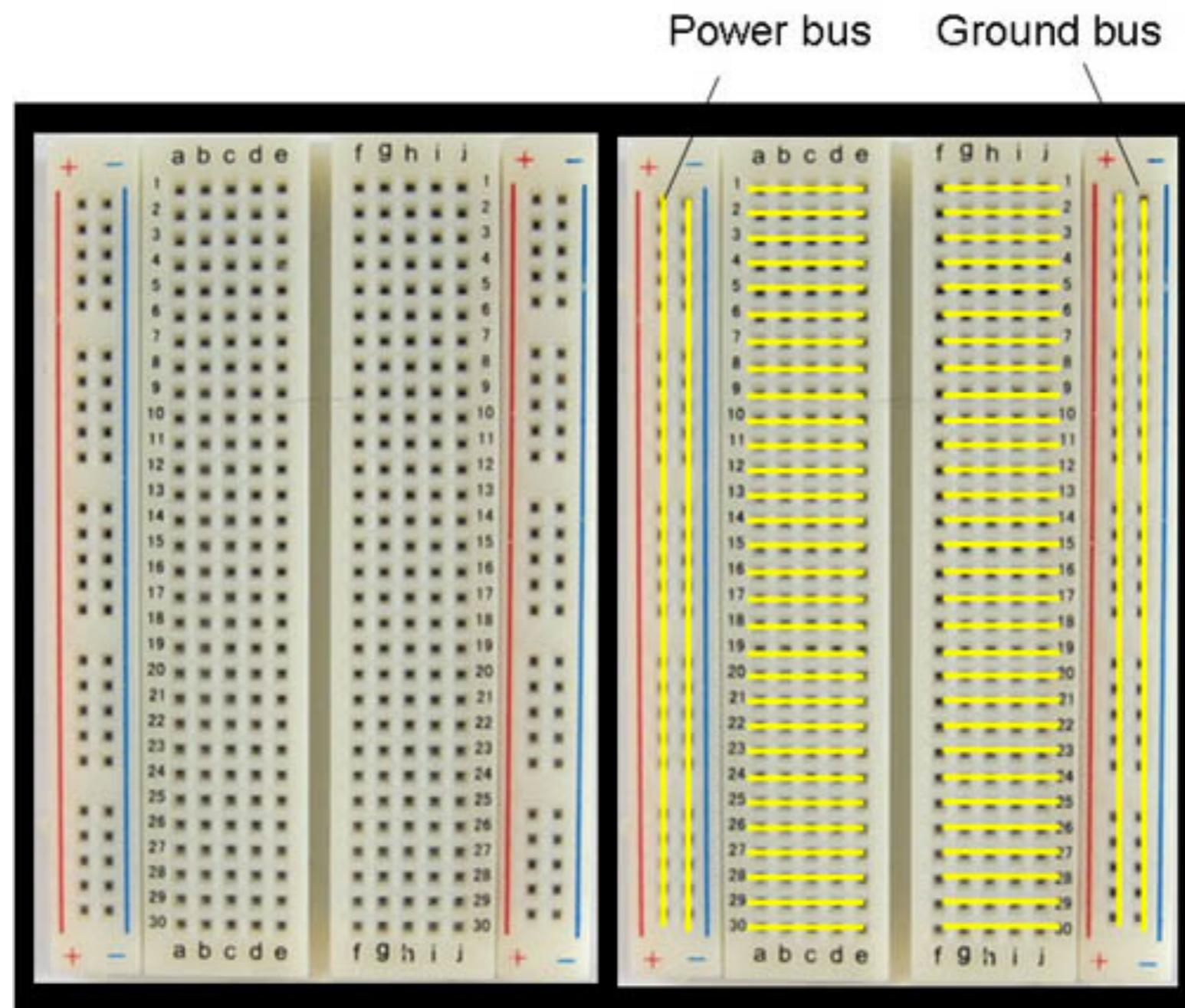
# Prototyping electronic circuits

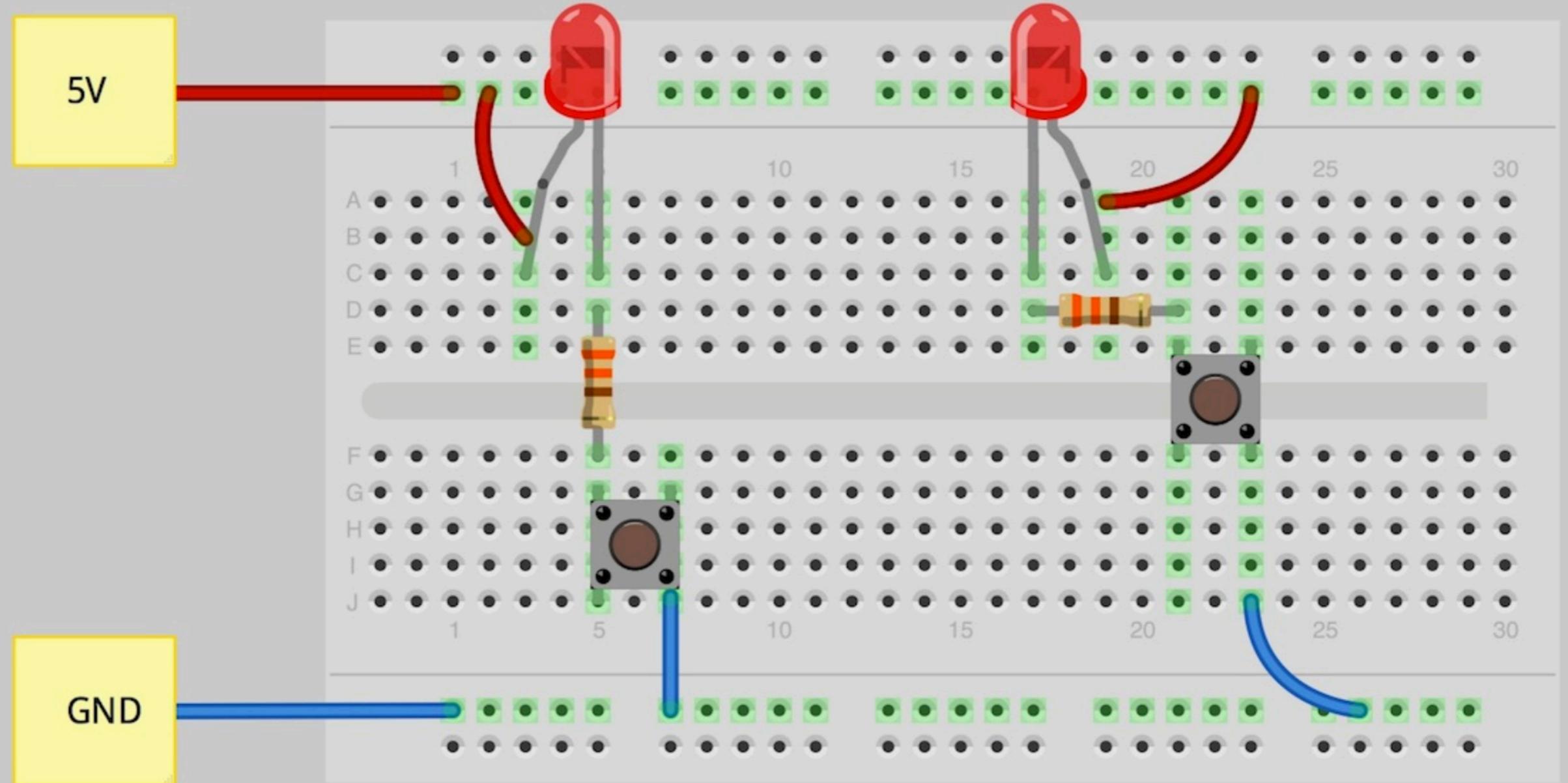


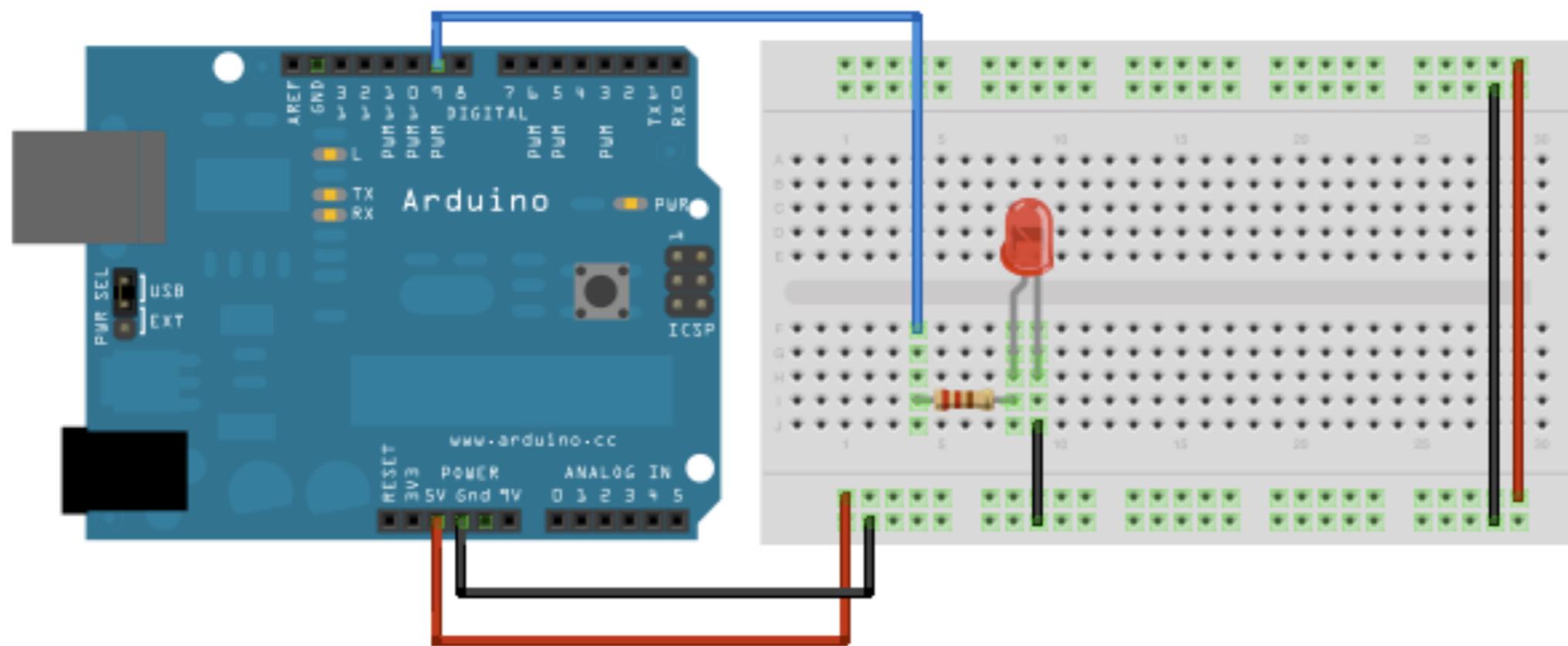
# Prototyping electronic circuits



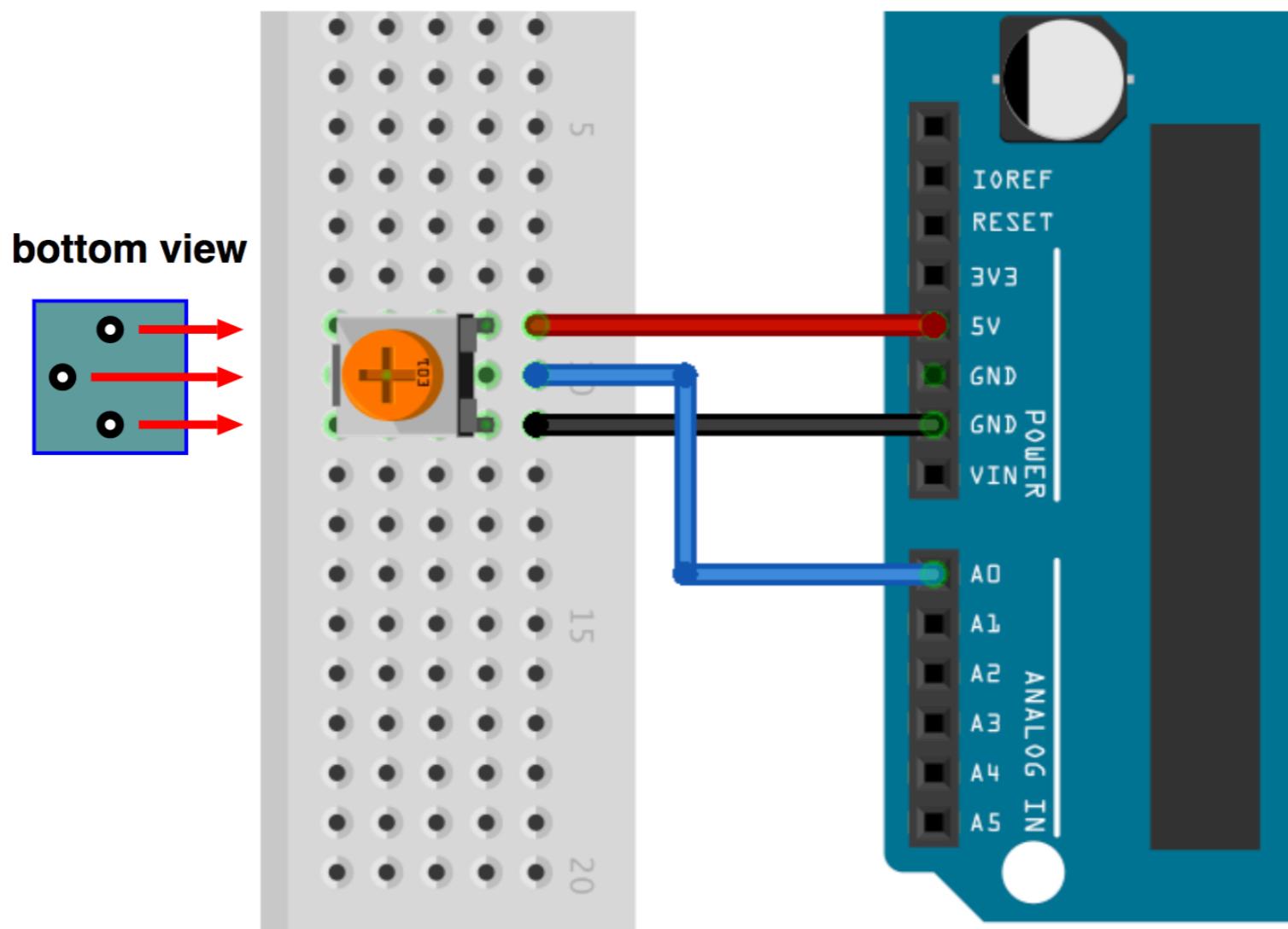
# Solderless Breadboard







# Analogue input: creating a variable voltage



the *middle* pin of the potentiometer connects to A0

```
void setup()
{
    Serial.begin(9600);
}
```

```
void loop()
{
    int value = analogRead(A0);
    Serial.println(value);
    delay(250);
}
```

```
void loop() {  
    // ...  
    int value = analogRead(A0); // 0..1023  
    float percent = (float)value * (100f / 1023f);  
    float voltage = (float)value * (5f / 1023f);  
    // ...  
}
```

a useful function:

```
void loop() {  
    int in;  
    // ...  
    int out = map(in, inLo, inHi, outLo, outHi);  
    // ...  
}
```

maps the `in` value from the range `[inLo...inHi]` to the range `[outLo...outHi]`

# **Example 2: LED Fading**

- Fade a LED on and off slowly
- Hardware required
  - Arduino board
  - breadboard
  - a LED
  - a 300 ohms resistor

**Hint: use analogWrite()  
function**

**See: [http://arduino.cc/en/  
Reference/AnalogWrite](http://arduino.cc/en/Reference/AnalogWrite)**

```
/*
Fade
```

*This example shows how to fade an LED on pin 9 using the analogWrite() function.*

*This example code is in the public domain.*

```
*/
```

```
int led = 9;           // the pin that the LED is attached to
int brightness = 0;    // how bright the LED is
int fadeAmount = 5;    // how many points to fade the LED by

// the setup routine runs once when you press reset:
void setup() {
  // declare pin 9 to be an output:
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  // set the brightness of pin 9:
  analogWrite(led, brightness);

  // change the brightness for next time through the loop:
  brightness = brightness + fadeAmount;

  // reverse the direction of the fading at the ends of the fade:
  if (brightness == 0 || brightness == 255) {
    fadeAmount = -fadeAmount ;
  }
  // wait for 30 milliseconds to see the dimming effect
  delay(30);
}
```

- `analogWrite` (on pin 9) use PWM (Pulse With Modulation), this is not a real analog signal, but a simulation.
- We will explain more about this later :-)

EVENTS	APPLICATIONS	SENSORS
 <p>The Events Board is a specialized microcontroller board designed for monitoring various physical events. It features a central microcontroller (likely an Arduino Uno or similar) with several pins and a white PIR motion sensor module mounted on top. The board is labeled "Events Board v2.0" and includes various component markings like "2008-022" and "libelium.com".</p>	<ul style="list-style-type: none"> <li><b>Security</b> Hall effect (doors and windows), person detection PIR</li> <li><b>Emergencies</b> Presence detection and water level sensors, temperature</li> <li><b>Control of goods in logistics</b></li> </ul>	<ul style="list-style-type: none"> <li>Pressure/Weight</li> <li>Bend</li> <li>Hall Effect</li> <li>Temperature (+/-)</li> <li>Liquid Presence</li> <li>Liquid Flow</li> <li>Luminosity</li> <li>Presence (PIR)</li> <li>Stretch</li> </ul>

Figure 22: Events Board

## GASES



Figure 21: Gases Board

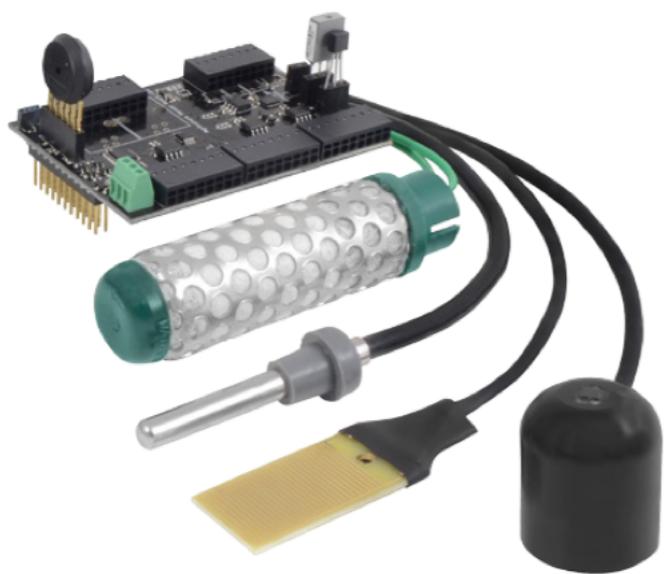
## APPLICATIONS

- **City pollution**  
 $\text{CO}$ ,  $\text{CO}_2$ ,  $\text{NO}_2$ ,  $\text{O}_3$
- **Emissions from farms and hatcheries**  
 $\text{CH}_4$ ,  $\text{H}_2\text{S}$ ,  $\text{NH}_3$
- **Control of chemical and industrial processes**  
 $\text{C}_4\text{H}_{10}$ ,  $\text{H}_2$ , VOC
- **Forest fires**  
 $\text{CO}$ ,  $\text{CO}_2$

## SENSORS

- Carbon Monoxide –  $\text{CO}$
- Carbon Dioxide –  $\text{CO}_2$
- Oxygen –  $\text{O}_2$
- Methane –  $\text{CH}_4$
- Hydrogen –  $\text{H}_2$
- Ammonia –  $\text{NH}_3$
- Isobutane –  $\text{C}_4\text{H}_{10}$
- Ethanol –  $\text{CH}_3\text{CH}_2\text{OH}$
- Toluene –  $\text{C}_6\text{H}_5\text{CH}_3$
- Hydrogen Sulfide –  $\text{H}_2\text{S}$
- Nitrogen Dioxide –  $\text{NO}_2$
- Ozone –  $\text{O}_3$
- Hydrocarbons – VOC
- Temperature
- Humidity
- Atmospheric pressure

## AGRICULTURE



## APPLICATIONS

- **Precision Agriculture**  
Leaf wetness, fruit diameter
- **Irrigation Systems**  
Soil moisture, leaf wetness
- **Greenhouses**  
Solar radiation, humidity, temperature
- **Weather Stations**  
Anemometer, wind vane, pluviometer

## SENSORS

- Air Temperature / Humidity
- Soil Temperature / Moisture
- Leaf Wetness
- Atmospheric Pressure
- Solar Radiation - PAR
- Ultraviolet Radiation - UV
- Trunk Diameter
- Stem Diameter
- Fruit Diameter
- Anemometer
- Wind Vane
- Pluviometer
- Luminosity

Figure 25: Agriculture Board