Intro to Internet of Things

with ESP/Arduino

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Outline I

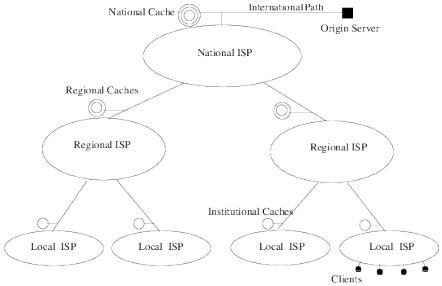
What is the internet?

A network connecting an enormous number of computing devices.
How to operate a network like this?

- Wire them all toghether?
- Who connect to whom?
- How many steps to send a message?

Hierachy+Protocol

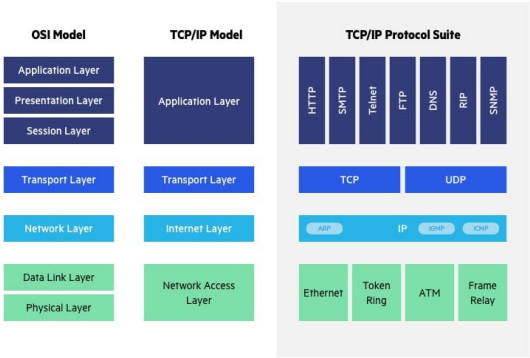
- Devices are connected by hierachy.
- Different devices are connected via different protocols.
- Data is coded according to the layers of the internet model.



(Hu, Rodriguez, and Biersack 2000)

Layers of the internet

1. HTTP request
2. TCP port
3. IP address
4. MAC address
5. Wireless LAN

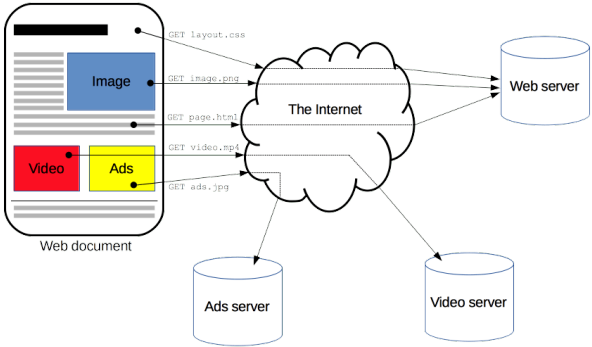


(Imperva)

(Almost) Everything is a HTTP request

HTTP follows a client-server model.

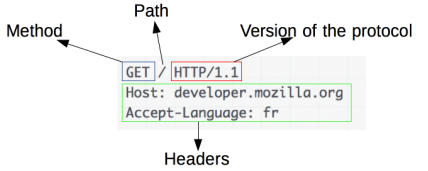
- Client request
- Serve respond



(Mozilla)

HTTP request

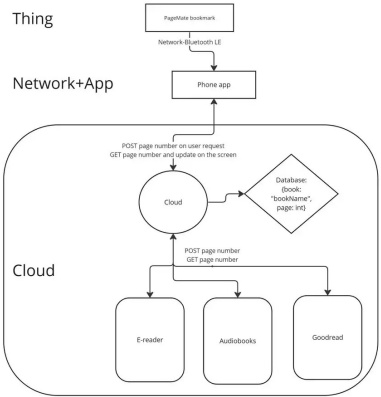
- Method: GET, POST
- Path
- Header
- Body



(Mozilla)

Components

1. Node
2. Gateway
3. Cloud
4. Database



Example: Power Cable Monitoring

- Long distance between towers
- Connection hard/dangerous to install

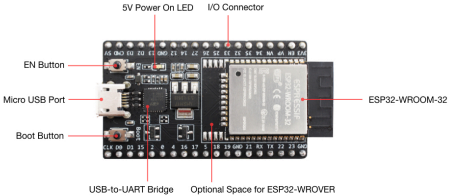
What's covered today?

- Node
- ~~Gateway~~: your phone
- ~~Cloud~~: a basic Express app
- ~~Database~~: MangoDB, mySQL

What is a computer?

1. Processing Unit: ALU
   - Arithmetic operation
   - Signal processing
   - Conditional decision
2. Memory: hierachy
3. I/O
   - ADC
   - USB
   - Wireless

ESP32 is a system on chip (SoC).



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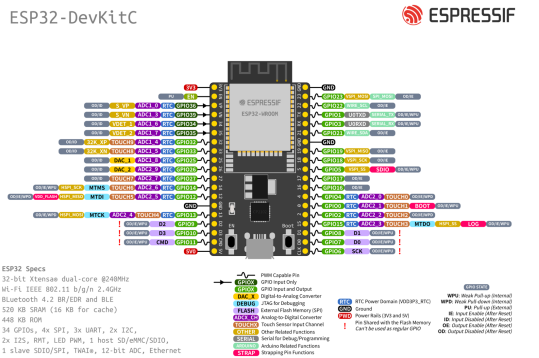
Embedded Computer

- Does not have operating system.
- Application is embedded into the firmware.



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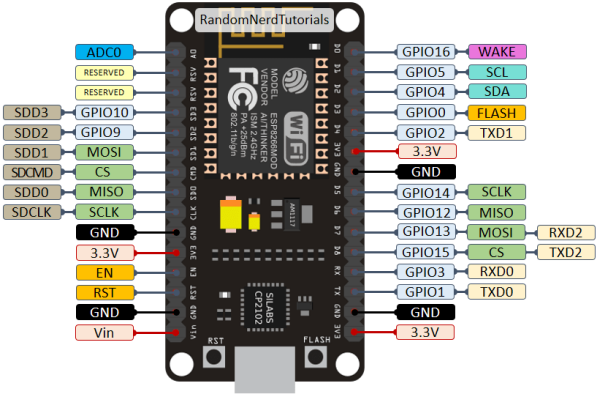
ESP8266



(Random Nerd Tutorials)

Checking and Basic Code Structure

1. Connect ESP8266 to your computer and open Arduino IDE
2. Select board NodeMCU 1.0 (ESP12E) and choose the right port in Tools
3. Open File>Example>ESP8266>Blink and uplaod

```
1  void setup() {
2    pinMode(LED_BUILTIN, OUTPUT);
3  }
4
5  // the loop function runs over and over again forever
6  void loop() {
7    digitalWrite(LED_BUILTIN, LOW);
8    delay(1000);
9    digitalWrite(LED_BUILTIN, HIGH);
10   delay(2000);
11 }
```

Servo Motor

- Small
- Powered by internal 3.3V
- Easy to control
- Only rotate 180 degree

(ElectronicWings)

Sweep

- Orange to GPIO14=D4, red to 3V3, brown to GND

```
1  #include <Servo.h>
2  Servo myservo;
3  void setup() {
4      myservo.attach(14);
5  }
6  void loop() {
7      int pos = 0;
8      for (pos = 0; pos <= 180; pos += 1) {
9          myservo.write(pos);
10         delay(30);
11     }
12     for (pos = 180; pos >= 0; pos -= 1) {
13         myservo.write(pos);
14         delay(30);
15     }
16 }
```

Ultrasonic Sensor

- Includes an emitter and a receiver.
- Calculate distance by time taken to travel from emitter to receiver.
- Ultrasonic is a mechanical wave

```
1  #include <Servo.h>
2  Servo myservo;
3  const int trigPin = 0; //connect trig pin to GPIO0=D3
4  const int echoPin = 4; //connect echo pin to GPIO4=D2
5
6  float duration, distance;
```

Setup and Serial Communication

- Serial sends text to your computer
- Tools>Serial Monitor>Set correct baud rate

```
 7  void setup() {
 8      myservo.attach(14);
 9      pinMode(trigPin, OUTPUT);
10      pinMode(echoPin, INPUT);
11
12      Serial.begin(115200);
13      Serial.println("Hello␣World!");
14  }
```

Calculate distance and send via serial

```
1  void loop() {
2      digitalWrite(trigPin, LOW);
3      delayMicroseconds(2);
4      digitalWrite(trigPin, HIGH);
5      delayMicroseconds(10);
6      digitalWrite(trigPin, LOW);
7
8      duration = pulseIn(echoPin, HIGH);
9      distance = (duration*.0343)/2;
10     Serial.print("Distance: ");
11     Serial.println(distance);
12 }
```

DHT22

- An integrated temperature and humidity sensor
- Easy to use with complete library

```
1  #include <Servo.h>
2  #include "DHT.h"
3
4  #define DHTPIN 4 //GPPIO4=D2
5  #define DHTTYPE DHT22
6
7  Servo myservo;
8  DHT dht(DHTPIN, DHTTYPE);
```

Setup

```
1  void setup() {
2      myservo.attach(14);
3      dht.begin();
4
5      Serial.begin(115200);
6      Serial.println("Hello World!");
7  }
```

Loop

```
 8  void loop() {
 9      float t = dht.readTemperature(true);
10      if (isnan(t)) {
11        Serial.println("DHT failed");
12      }
13      else {
14        Serial.println("Temp: " + String(t));
15      }
16  }
```