Srednja poklicna in tehniška šola Murska Sobota

SmartBin

Monitoring fullness of smart trash bins
with headless IoT devices

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Srednja poklicna in tehniška šola Murska Sobota

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Srednja poklicna in tehniška šola Murska Sobota

- Secondary school for Vocational and Technical Education was established more than 115 years ago
- Now it is visited by more than 800 students and there are 77 staff members, out of which 59 teachers.

Srednja poklicna in tehniška šola Murska Sobota

- We educate our students in these major programs:
- **3-year-programs:**
  - Carpenters
  - Electricians
  - Car mechanics
- **4-year-programs:**
  - Computer technician
  - Electro technician
  - Mechanics technician
  - Environmental technician

The Problem

Inefficient garbage transport

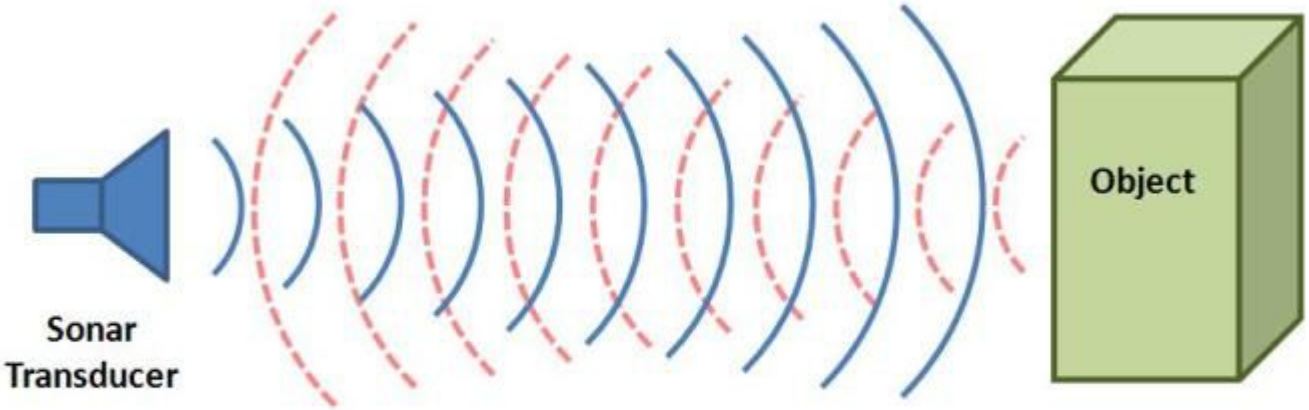
Unnecessary trips to empty trash bins

No monitoring

The Solution

- A device
- Trash bins fitted with sensors
- Continuous monitoring
- Reporting to the company
- Remote monitoring

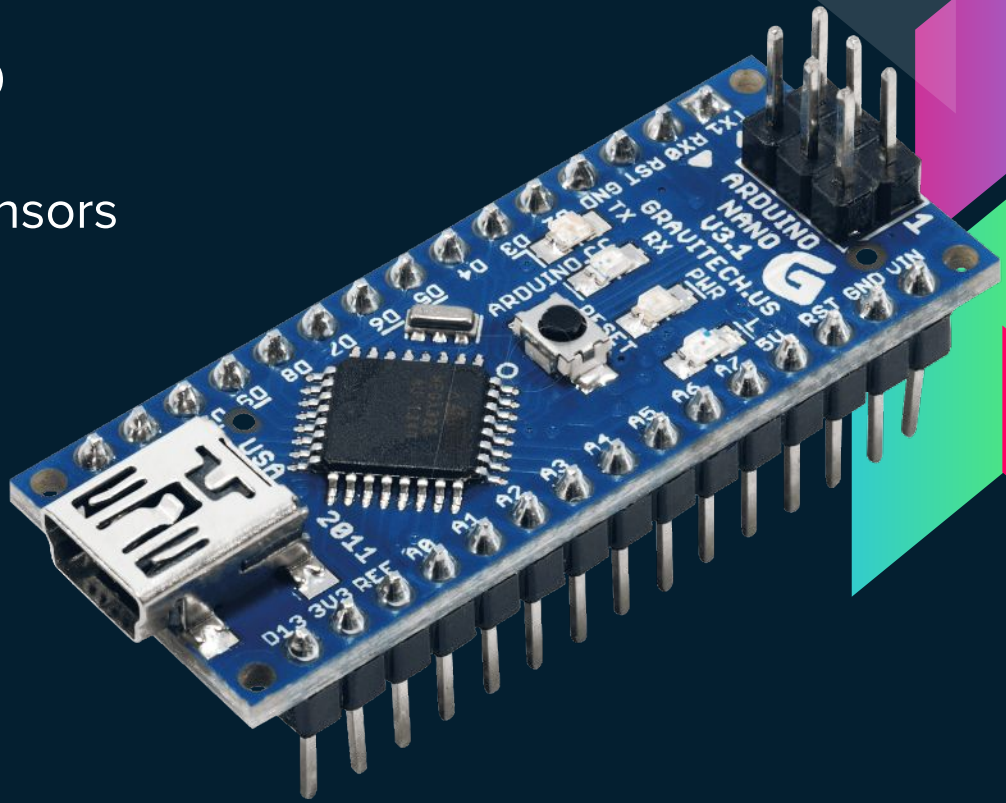
How ultrasonic sensors work



Basic sonar illustration – a transducer generates a sound pulse and then listens for the echo.

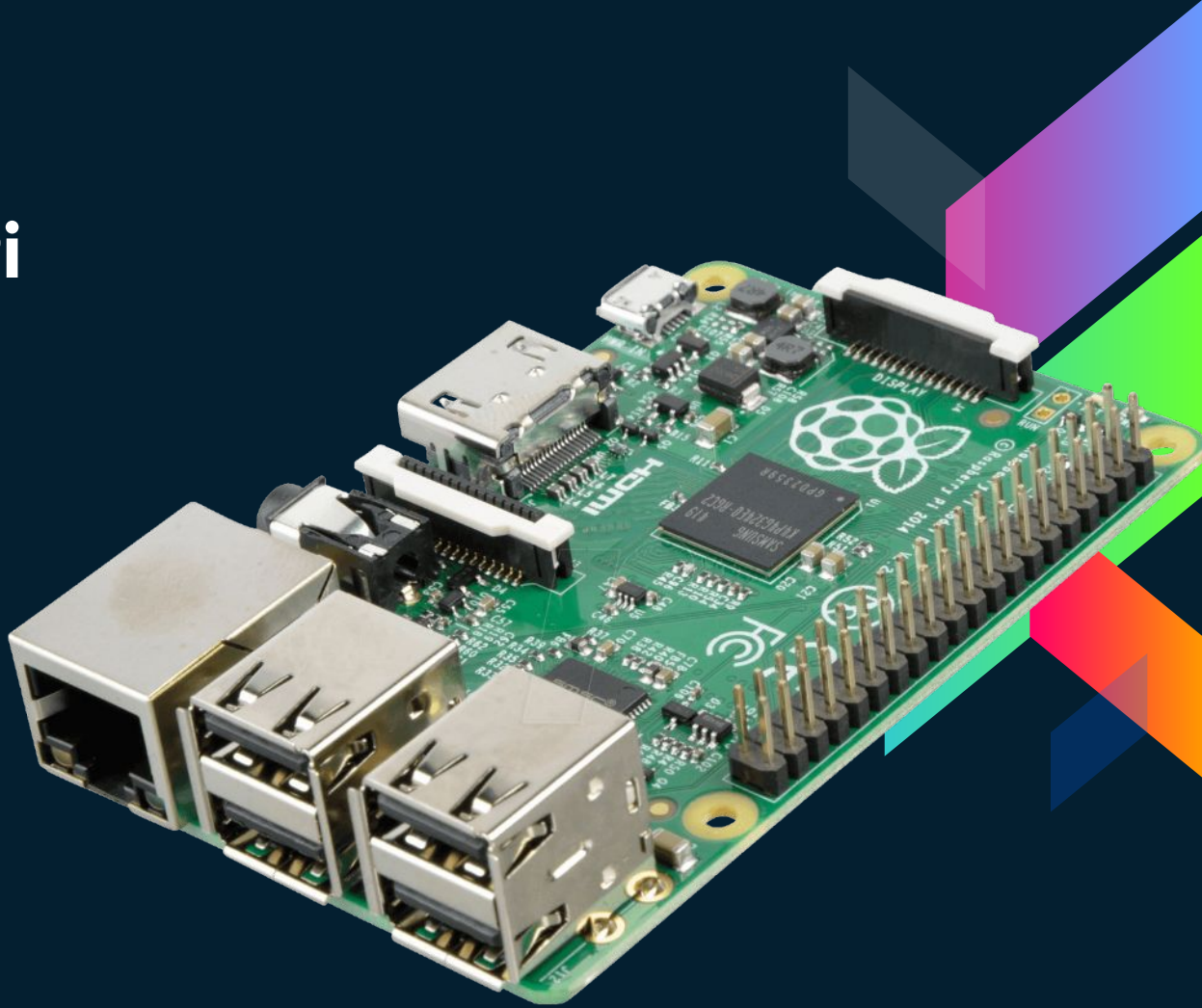
Arduino Nano

Supports different sensors
USB connectivity
Open Source
Inexpensive



Raspberry Pi

40 GPIO ports
4 USB ports
1 Ethernet port
Runs **Linux** !

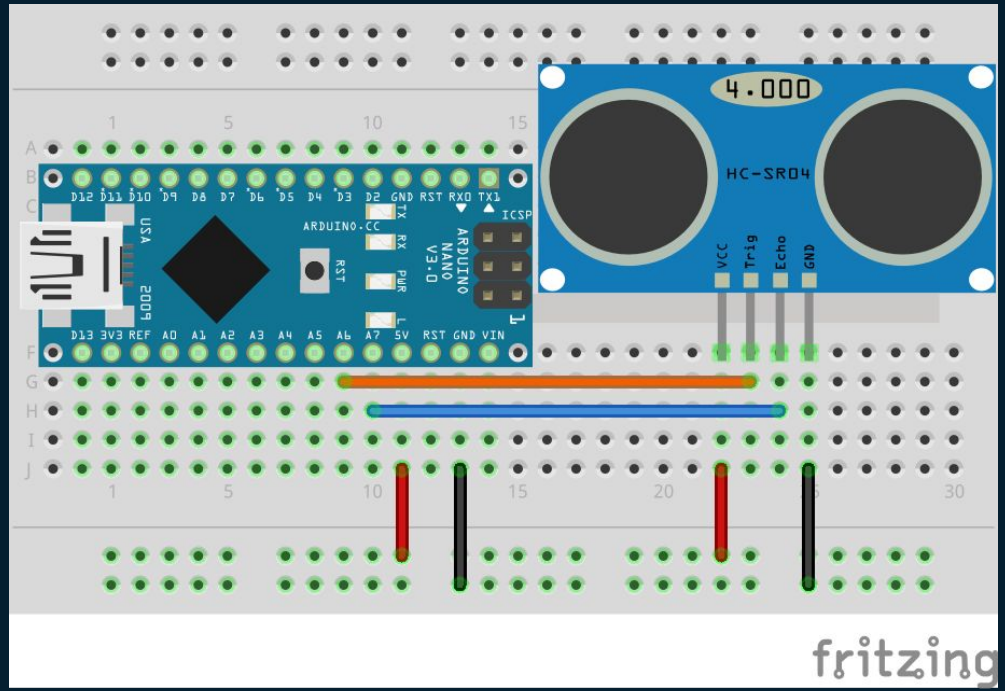


USB 3G Modem

1. Arduino collects reading from sensor

```
75  uint16_t US_getDistanceCm(){
76    US_trig();          //Trigger ultrasonic sensor
77
78    while(waitingEcho){       //Wait until ECHO pin goes LOW
79      _delay_us(10);
80    }
81
82    uint32_t ticks = TCNT1 / 2;
83    uint32_t ticks_per_us = F_CPU / 1000000;
84    uint32_t us = ticks / ticks_per_us;
85    uint32_t sound_um_per_us = 340;     // um = micrometer
86    uint16_t mm = us * sound_um_per_us / 1000;
87    uint16_t cm = mm / 10;
88
89    TCNT1 = 0;       //Reset Timer 0 tick count
90
91    return cm;       //Return distance in centimeters
92  }
93
94  void US_init(){
95    US_DDR  |=   1 << US_TRIG;  //Set TRIGGER pin as output
96    US_PORT &= ~(1 << US_TRIG); //Set TRIGGER pin LOW
97
98    US_DDR  &= ~(1 << US_ECHO); //Set ECHO pin as input
99    US_PORT &= ~(1 << US_ECHO); //Disable ECHO pin pull-up resistor
00  }
01  void US_trig(){
02    US_PORT |= 1 << US_TRIG;  //Set TRIGGER pin HIGH
03    _delay_us(20);
04    US_PORT &= ~(1 << US_TRIG);
05  }
```

2. Readings are sent to RPi



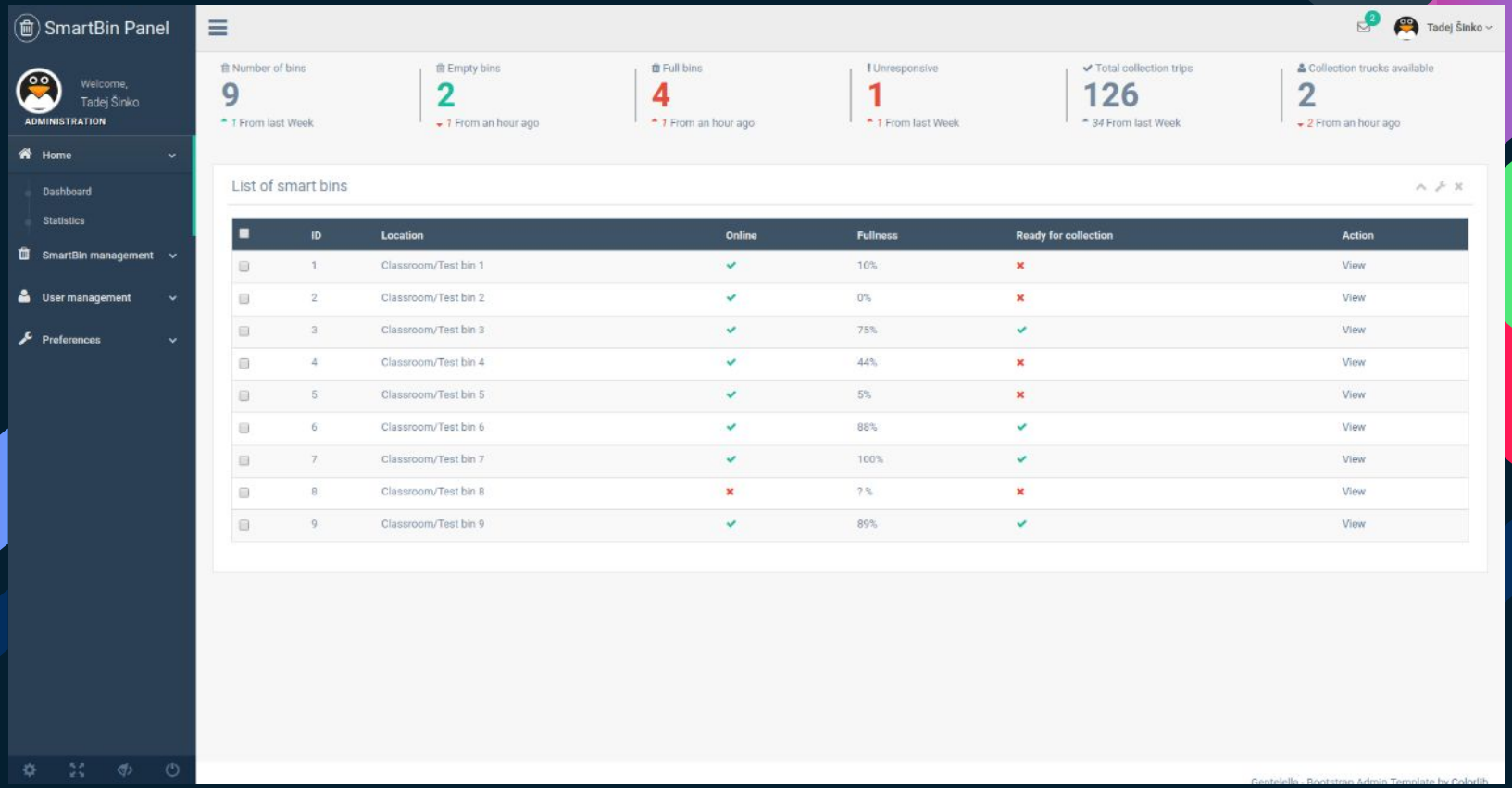
3. Report is sent to the server

```
while True:
    for i in range(0, measurements_per_report):
        time.sleep(tBetweenMeasurements)
        measure()

    average = sum(measurements) / float(len(measurements))
    percentage = average / bin_depth * 100
    measurements = []

    print(" => Reporting {} %".format(round(percentage)))
    try:
        fullURL = endpoint + "/api/stats/bin/{id}/report"
        report = requests.post(fullURL.format(id=bin_id), {
            'value': round(percentage)
        })
    except:
        print("error")
```

4. Data is displayed in a web application



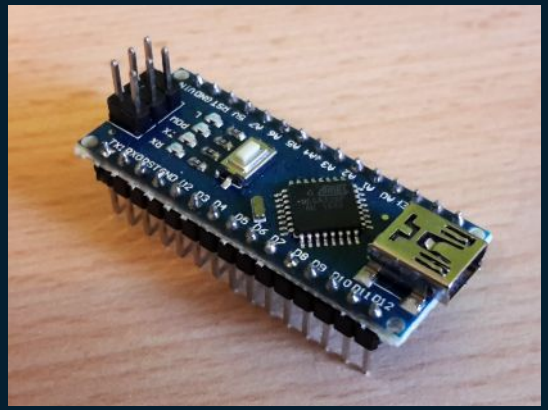
Software

Operating System

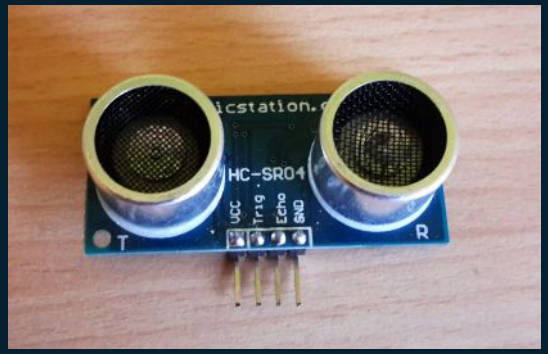
Database

Web application

Our Hardware



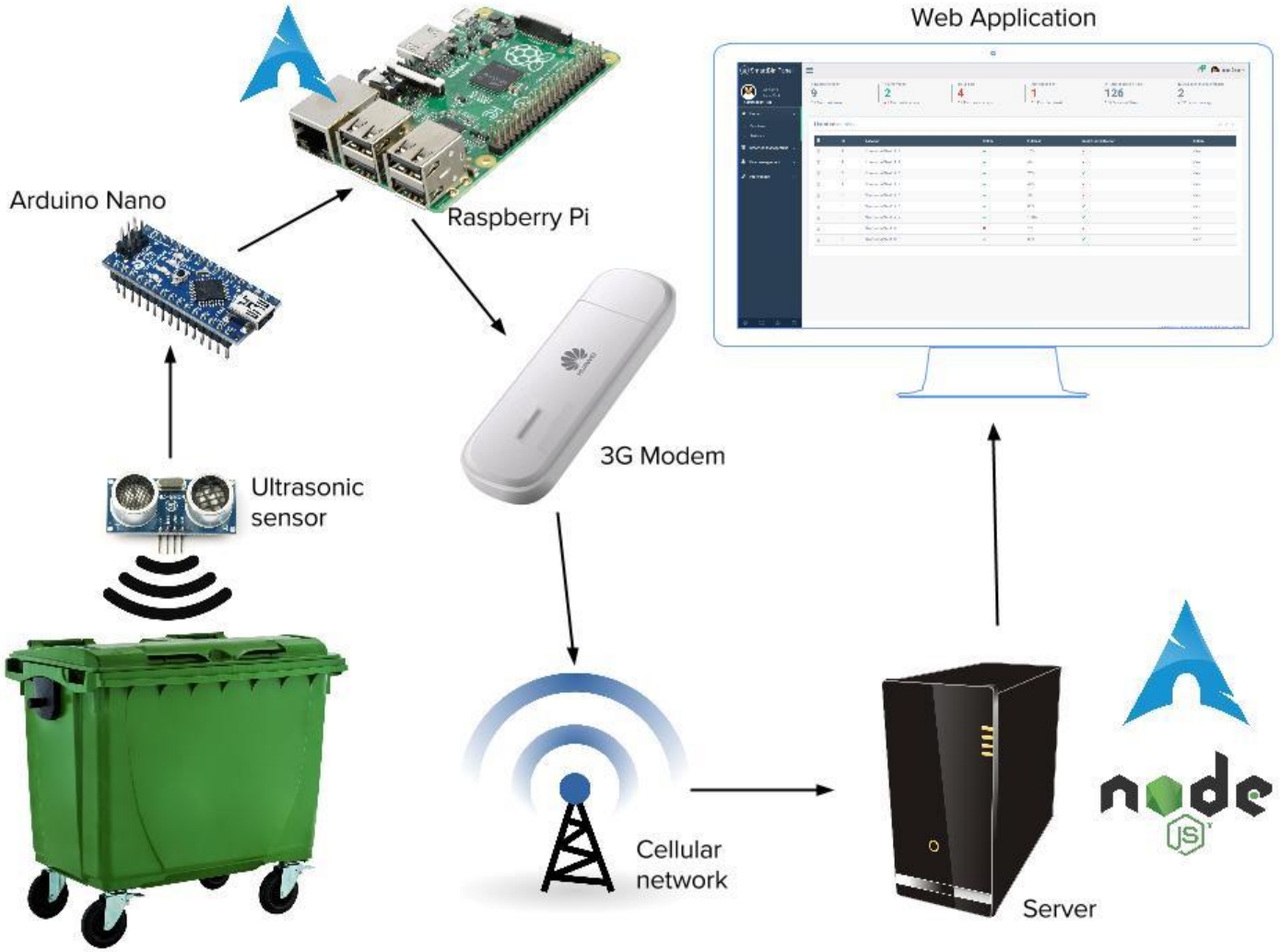
Arduino Nano



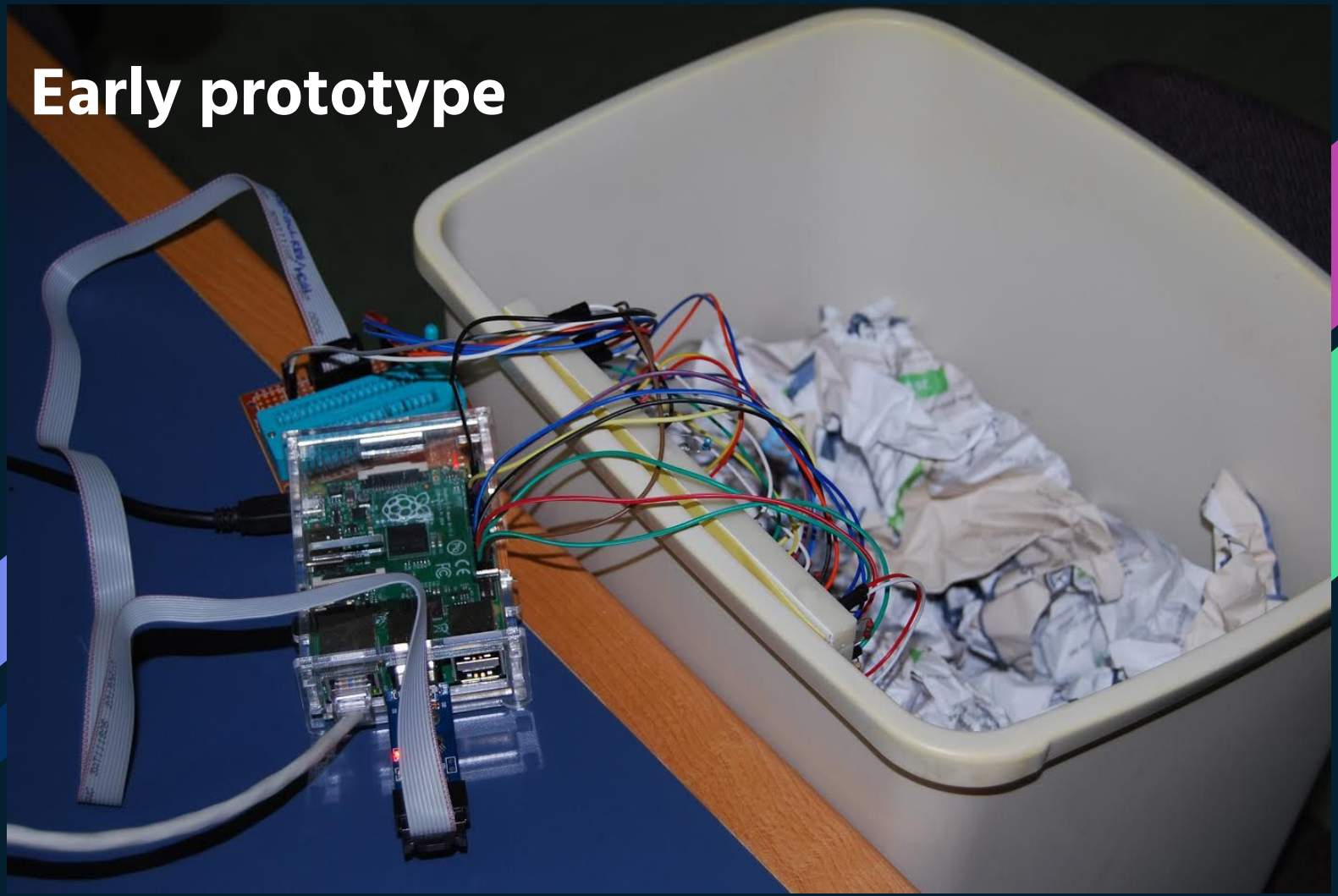
Ultrasonic Sensor

Raspberry Pi Model B+

Huawei 3G Internet Modem


Web Application
Arduino Nano
Raspberry Pi
3G Modem
Ultrasonic
sensor
Cellular
network
Server
node
JS

Early prototype



Questions ?

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