LinuxFest Northwest

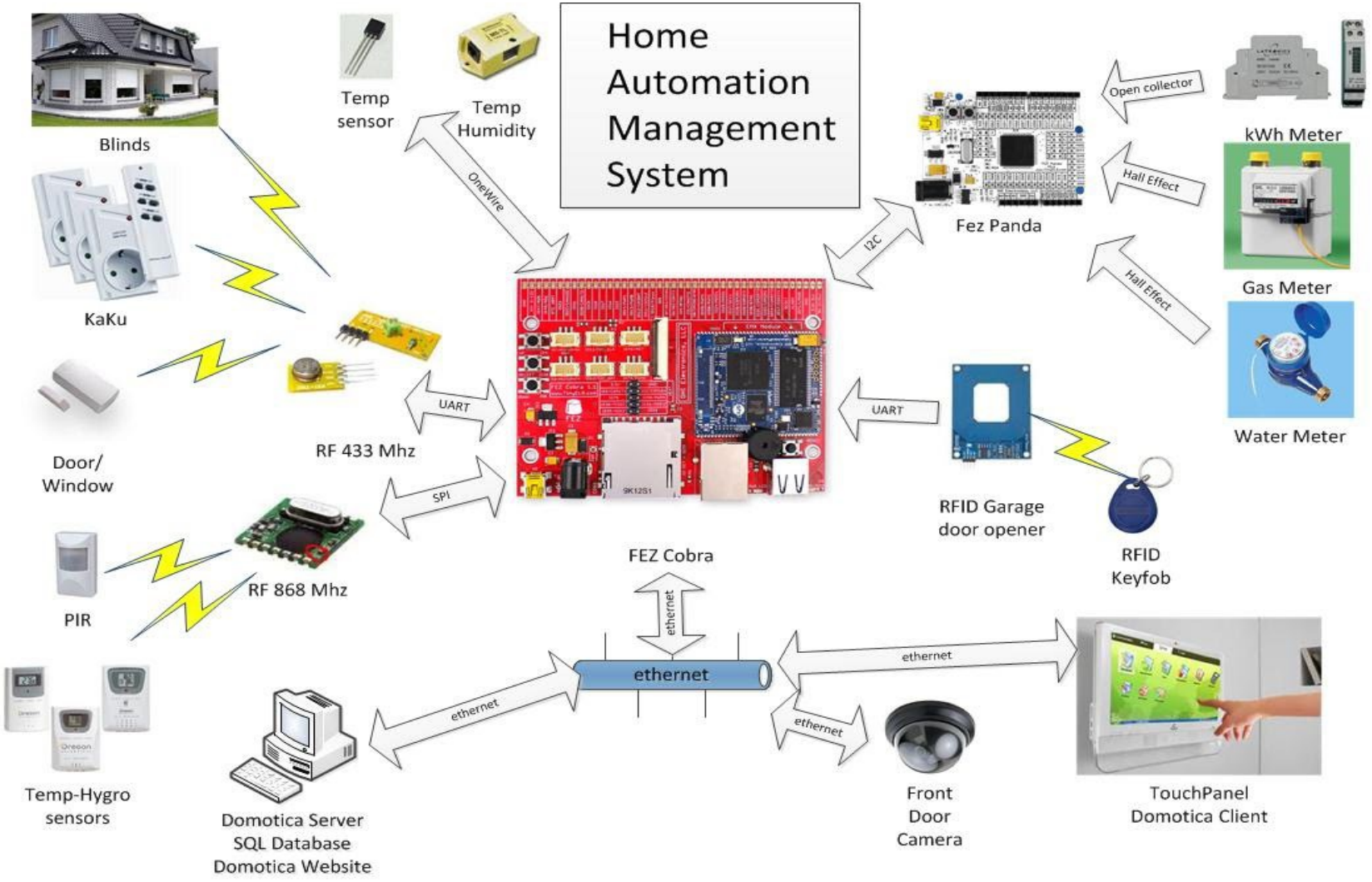
2016

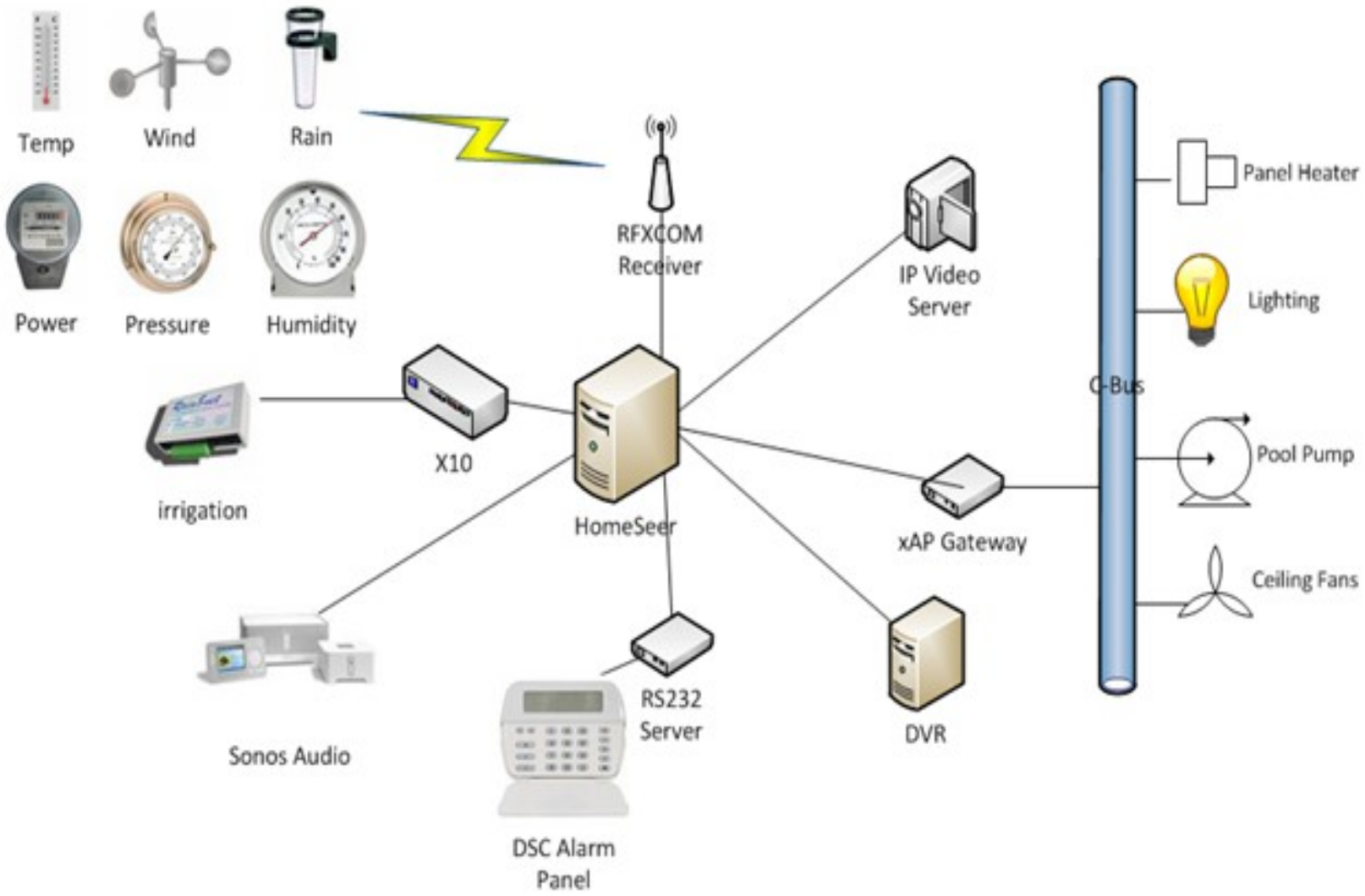
Internet of Thingies

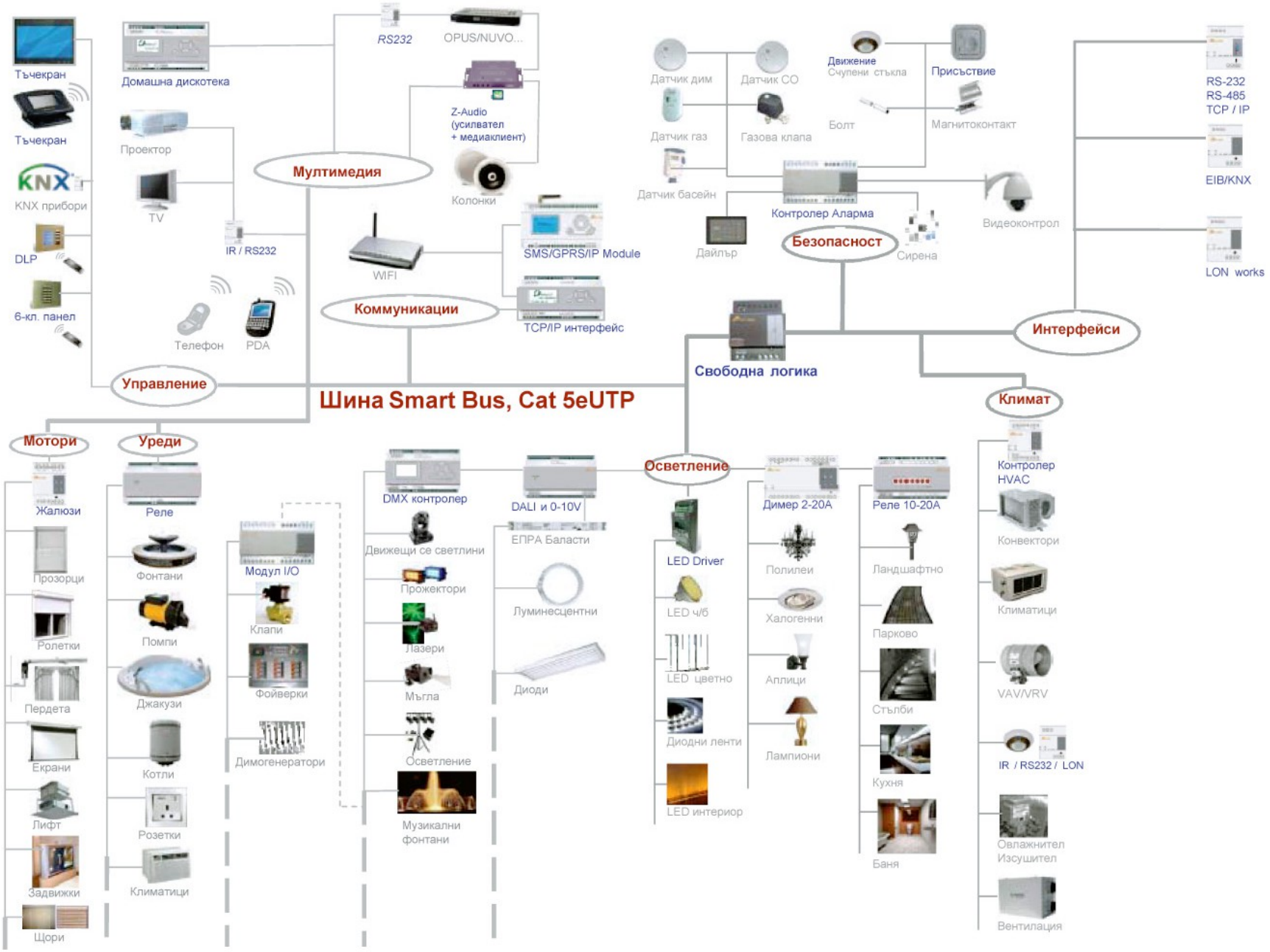
Motivations

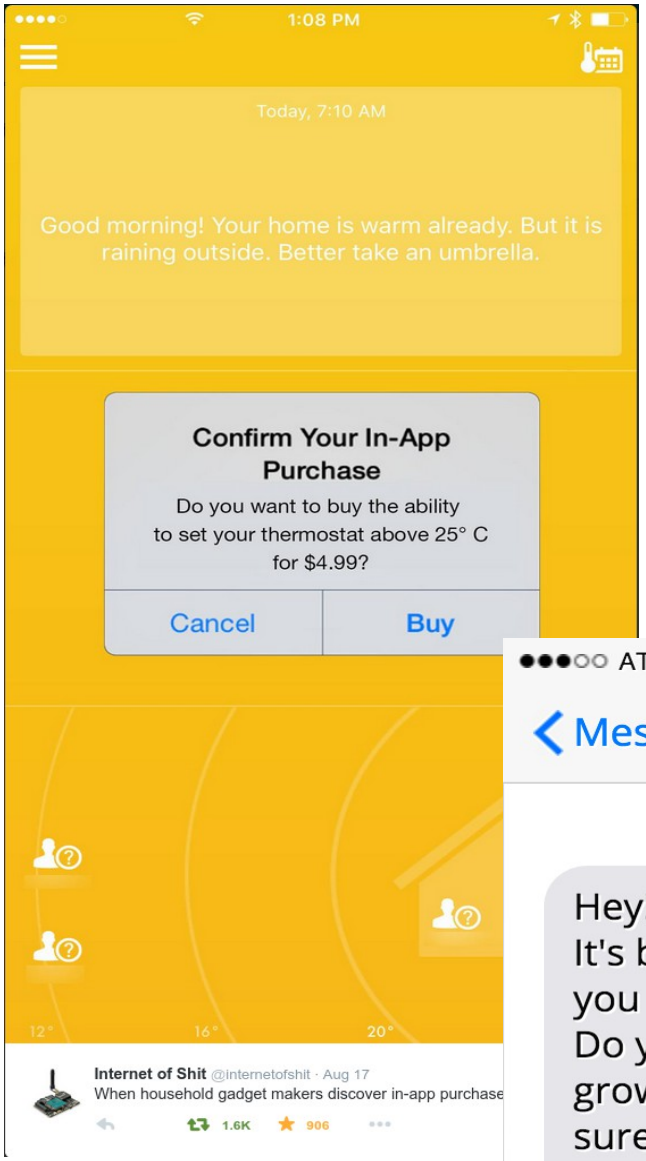
energy efficient living
open information
minimal disruption
data ownership

Complication



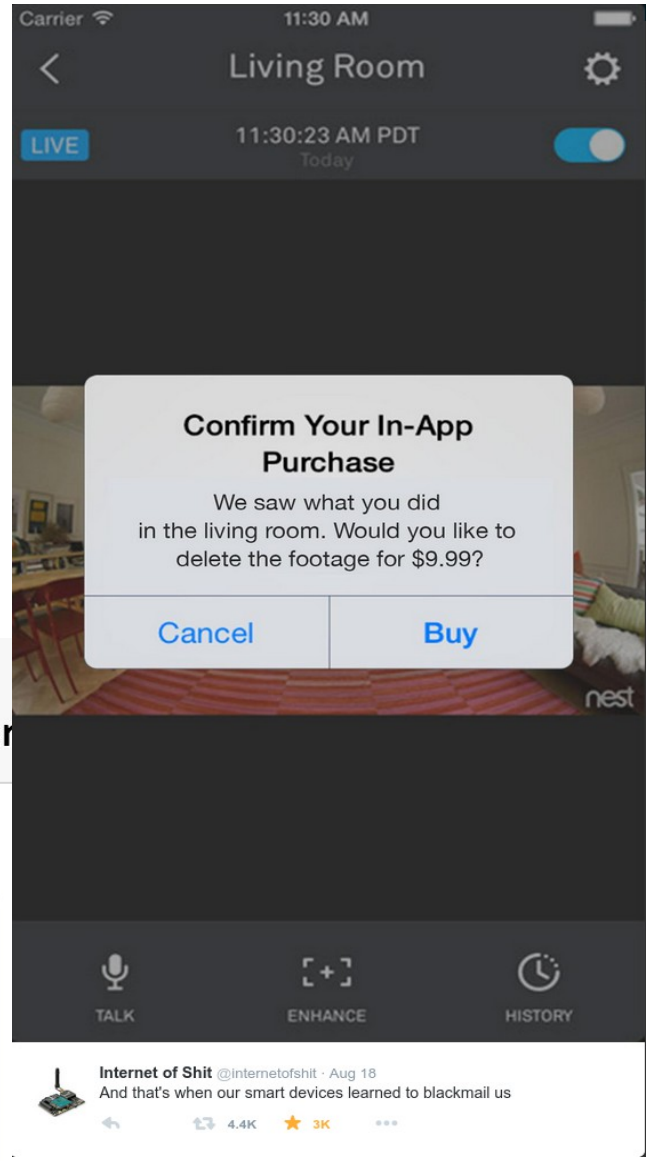

Temp
Wind
Rain
Power
Pressure
Humidity
RFXCOM
Receiver
IP Video
Server
Panel Heater
Lighting
C-Bus
Pool Pump
Ceiling Fans
irrigation
X10
HomeSeer
xAP Gateway
Sonos Audio
RS232
Server
DVR
DSC Alarm
Panel

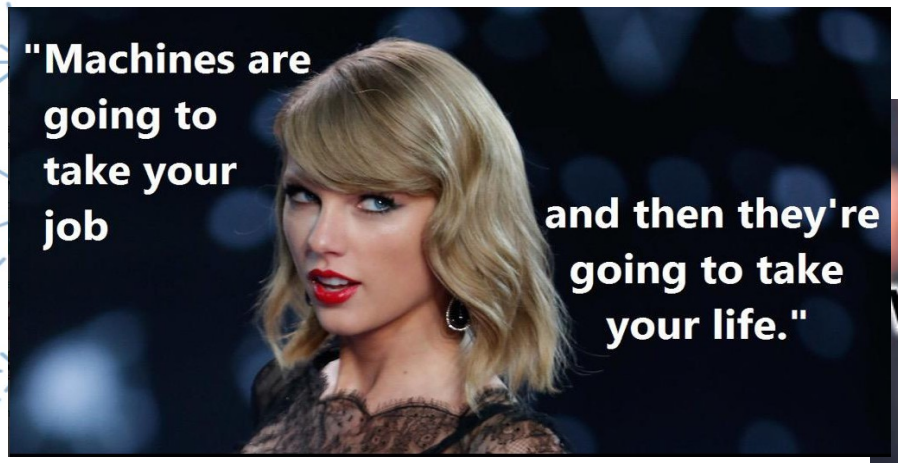

Тъчекран
Тъчекран
KNX прибори
DLP
6-кл. панел
Домашна дискотека
Проектор
TV
IR / RS232
Телефон
PDA
RS232
OPUS/NUVO...
Z-Audio
(усилвател
+ медиаклиент)
Колонки
Мултимедия
WIFI
SMS/GPRS/IP Module
Коммуникации
TCP/IP интерфейс
Датчик дим
Датчик CO
Движение
Счупени стъкла
Присъствие
Датчик газ
Газова клапа
Болт
Магнитоконтакт
Датчик басейн
Контролер Аларма
Видеоконтрол
Дайлър
Безопасност
Сирена
RS-232
RS-485
TCP / IP
EIB/KNX
LON works
Интерфейси
Свободна логика
Управление
Шина Smart Bus, Cat 5eUTP
Климат
Мотори
Уреди
Осветление
Жалюзи
Прозорци
Ролетки
Пердета
Екрани
Лифт
Задвижки
Щори
Реле
Фонтани
Помпи
Джакузи
Котли
Розетки
Климатици
Модул I/O
Клапи
Фойерверки
Димогенератори
DMX контролер
Движещи се светлини
Прожектори
Лазери
Мъгла
Осветление
Музикални
фонтани
DALI и 0-10V
ЕПРА Баласти
Луминесцентни
Диоди
LED Driver
LED ч/б
LED цветно
Диодни ленти
LED интериор
Димер 2-20A
Полилеи
Халогенни
Аплици
Лампиони
Реле 10-20A
Ландшафтно
Парково
Стълби
Кухня
Баня
Контролер
HVAC
Конвектори
Климатици
VAV/VRV
IR / RS232 / LON
Овлажнител
Изсушител
Вентилация

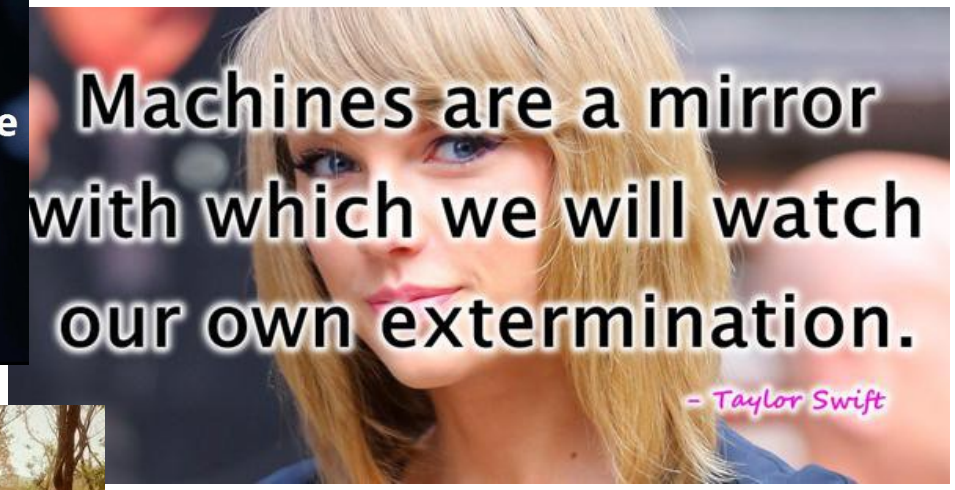

1:08 PM
Today, 7:10 AM
Good morning! Your home is warm already. But it is raining outside. Better take an umbrella.
Confirm Your In-App Purchase
Do you want to buy the ability to set your thermostat above 25° C for $4.99?
Cancel
Buy
12°
16°
20°
Internet of Shit @internetofshit · Aug 17
When household gadget makers discover in-app purchase
1.6K
906

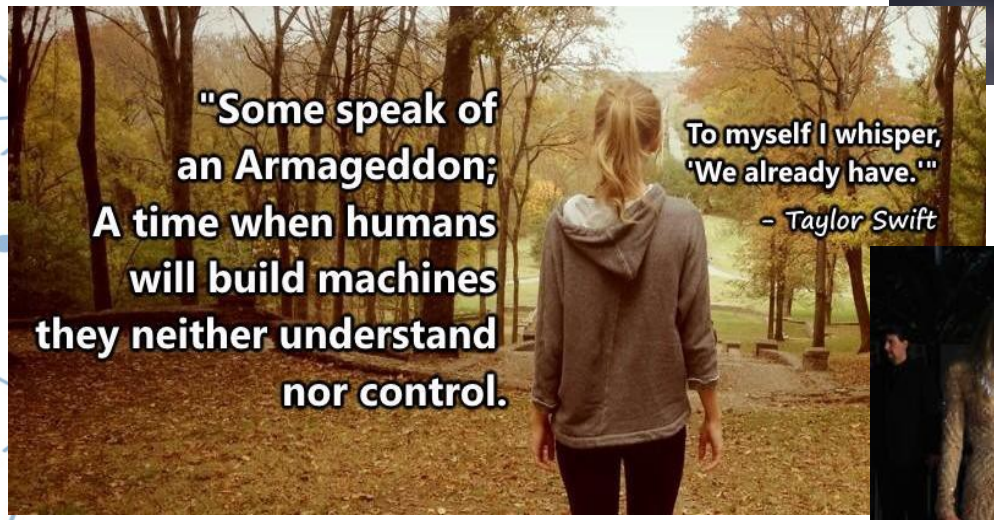
please no

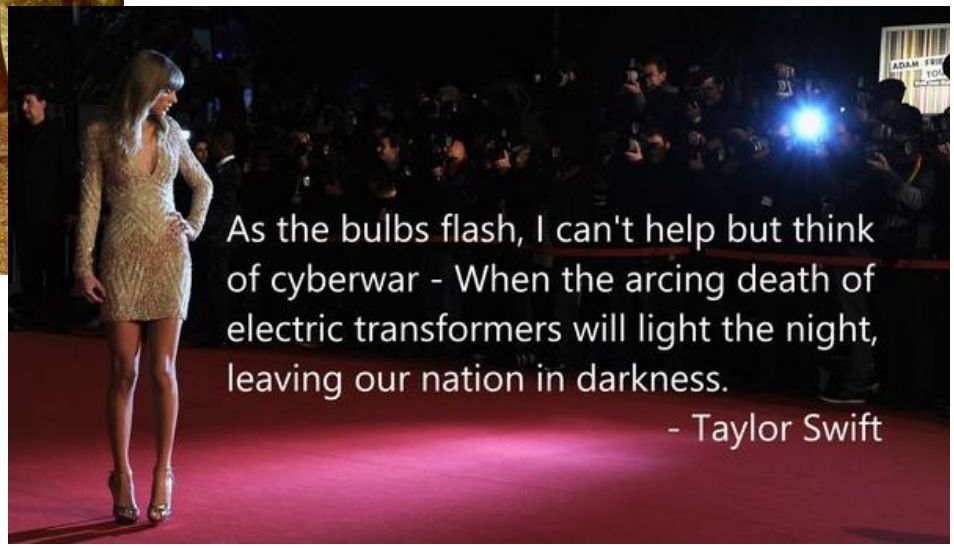

AT&T
9:41 AM
Messages
Philips Shaver
Today 8:32 AM
Hey! It's me, your shaver. It's been two weeks since you shaved... I miss you. Do you really want to grow a beard? Are you sure you'll look OK? Let me know, or I'll tweet about your non-shaving streak tomorrow!


Carrier
11:30 AM
Living Room
LIVE
11:30:23 AM PDT
Today
Confirm Your In-App Purchase
We saw what you did in the living room. Would you like to delete the footage for $9.99?
Cancel
Buy
nest
TALK
ENHANCE
HISTORY
Internet of Shit @internetofshit · Aug 18
And that's when our smart devices learned to blackmail us
4.4K
3K









@SwiftOnSecurity

Design Goals

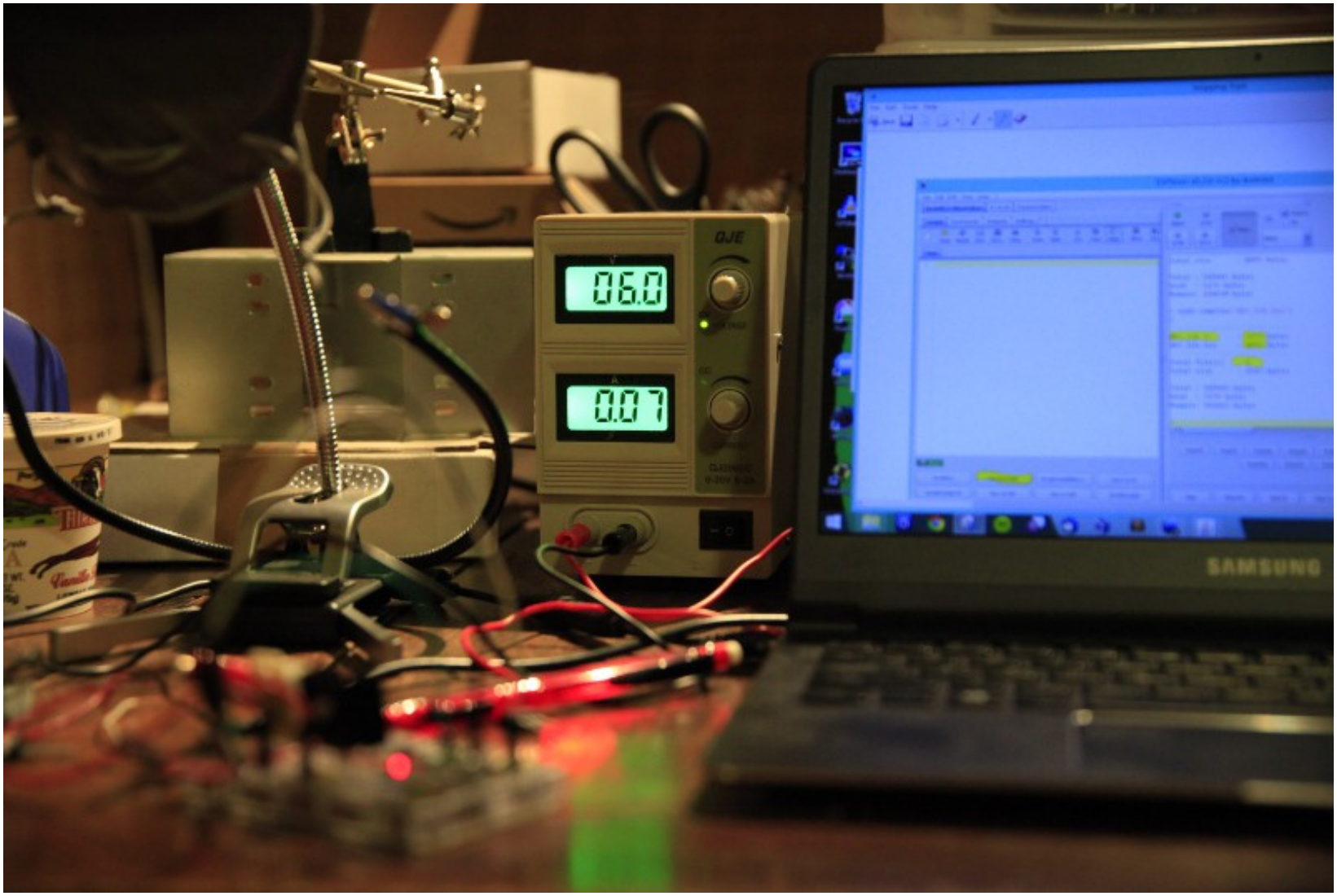
- “open”
- common components
- reasonable price
- flexible
- innocuous or portable
- IP communication
- energy efficient

Workspace

Workspace

Tools

Tools



Tools

- electrician's scissors (wire strippers)
- voltmeter
- needle nose pliers
- good soldering iron
- smaller screwdrivers
- variable power supply
- good lighting

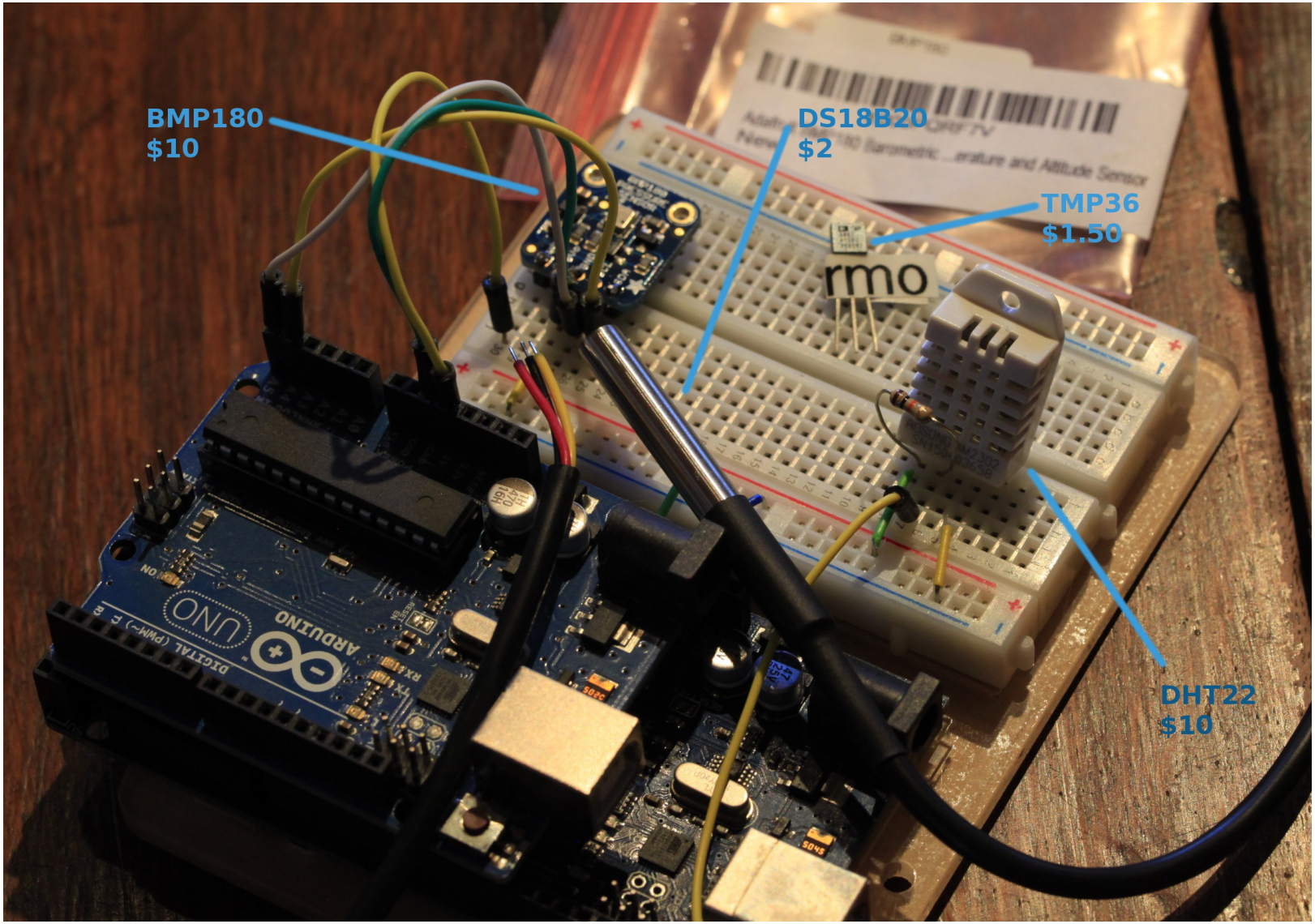
Project

Make a temperature sensor *

Collect data

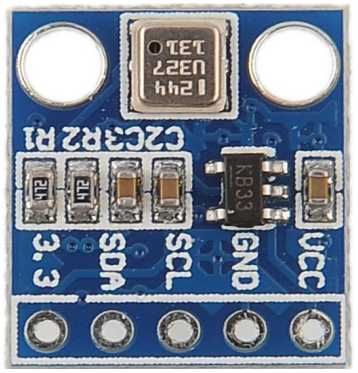
* thingy

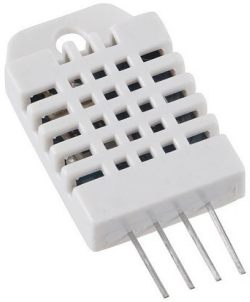
Arduino-compatible sensors



Consider priorities

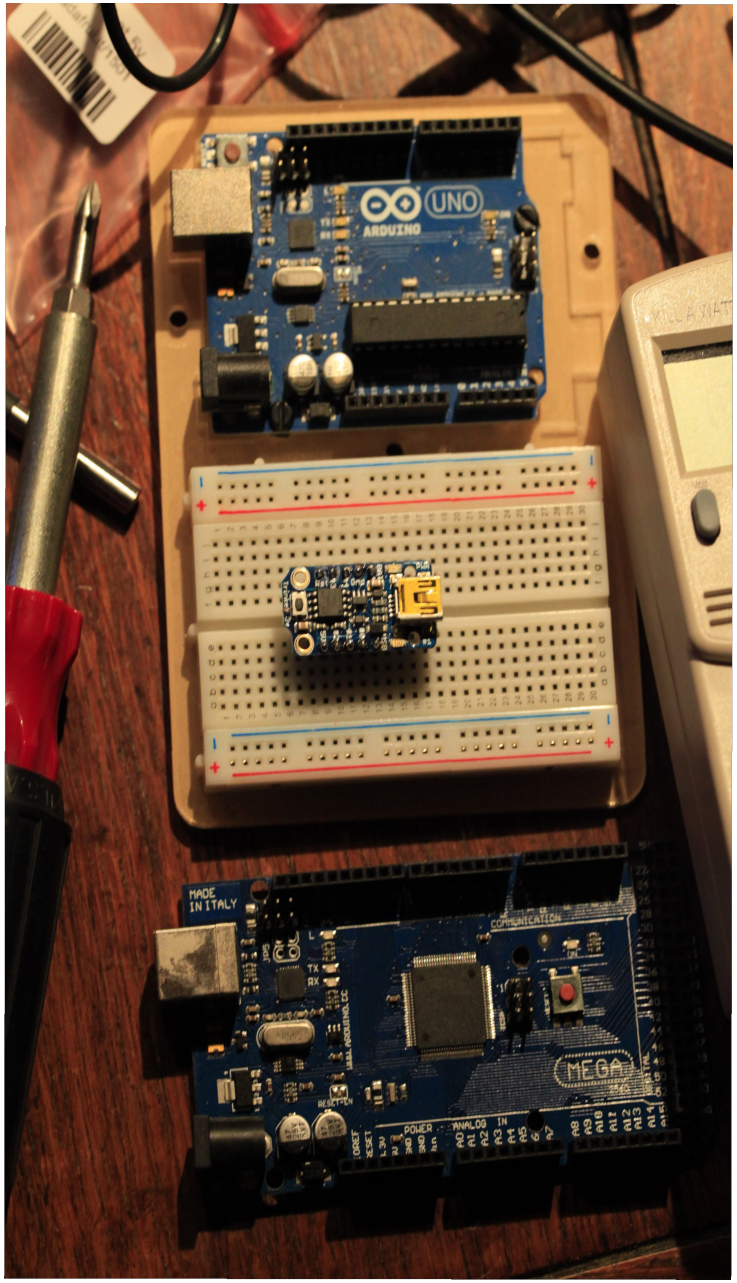
- BMP180
  - Temp + Barometric Pressure
  - Digital I/O (I2C)
  - 3-5V
  - High precision
- DS18B20
  - Temp
  - Digital I/O + OneWire
  - 3-5V
  - Waterproof
- DHT22
  - Temp + Humidity
  - Digital I/O
  - 3-5V
- TMP36
  - Temp
  - Analog
  - 2.7-5.5V





Arduino

- general purpose programmable boards
- digital and analog I/O pins
- program over USB
- 7-12V input, 3.3 or 5V output
- many varieties



Arduino IDE

- serial console
- sensor libraries
- web server libraries
- easy to use
- loads of web examples!

IP communication

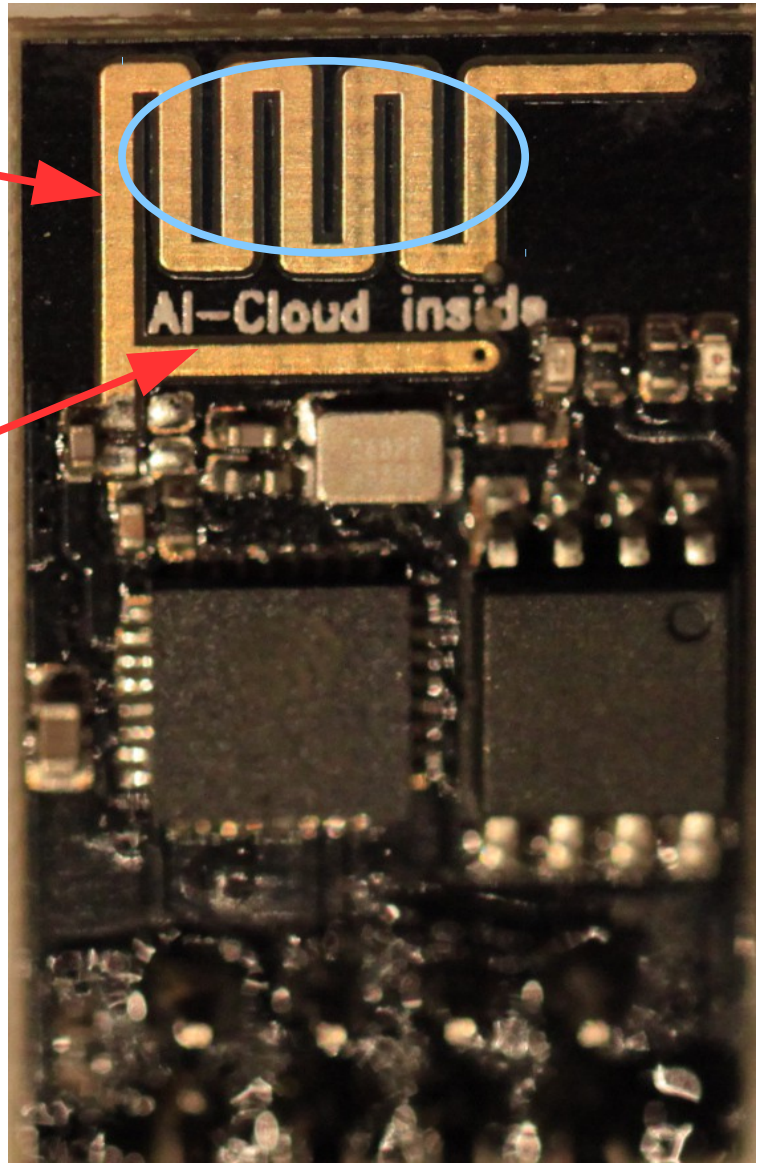
- Ethernet shield board
- IP services libraries
- SNMP libraries unreliable
- WiFi? XML? Web server?
- other ways to collect sensor data?

ESP8266 (ESP-01)

- about $5
- Digital and Analog I/O pins
- USB programming
- 3.3V input, does not power sensors
- many models, varieties, firmwares

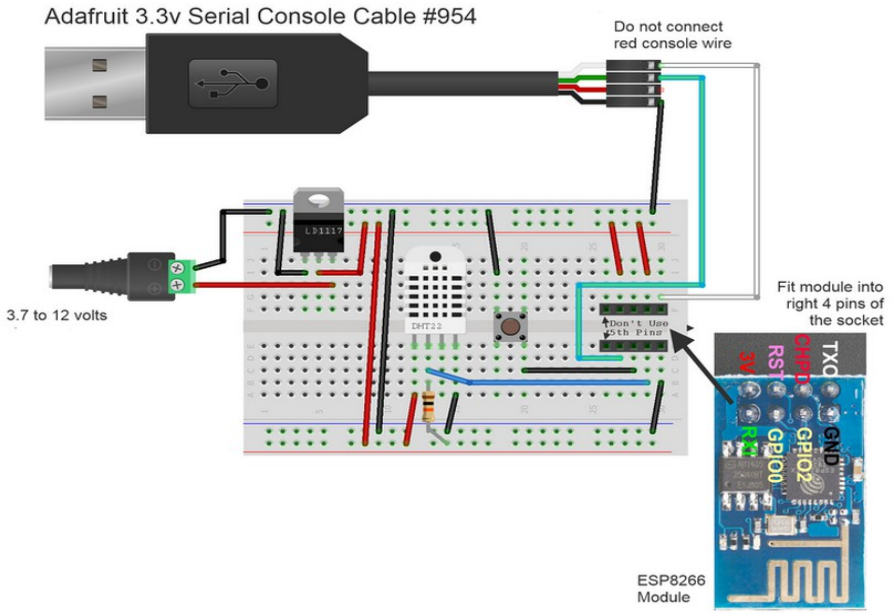
so many wifis!

such cloud!

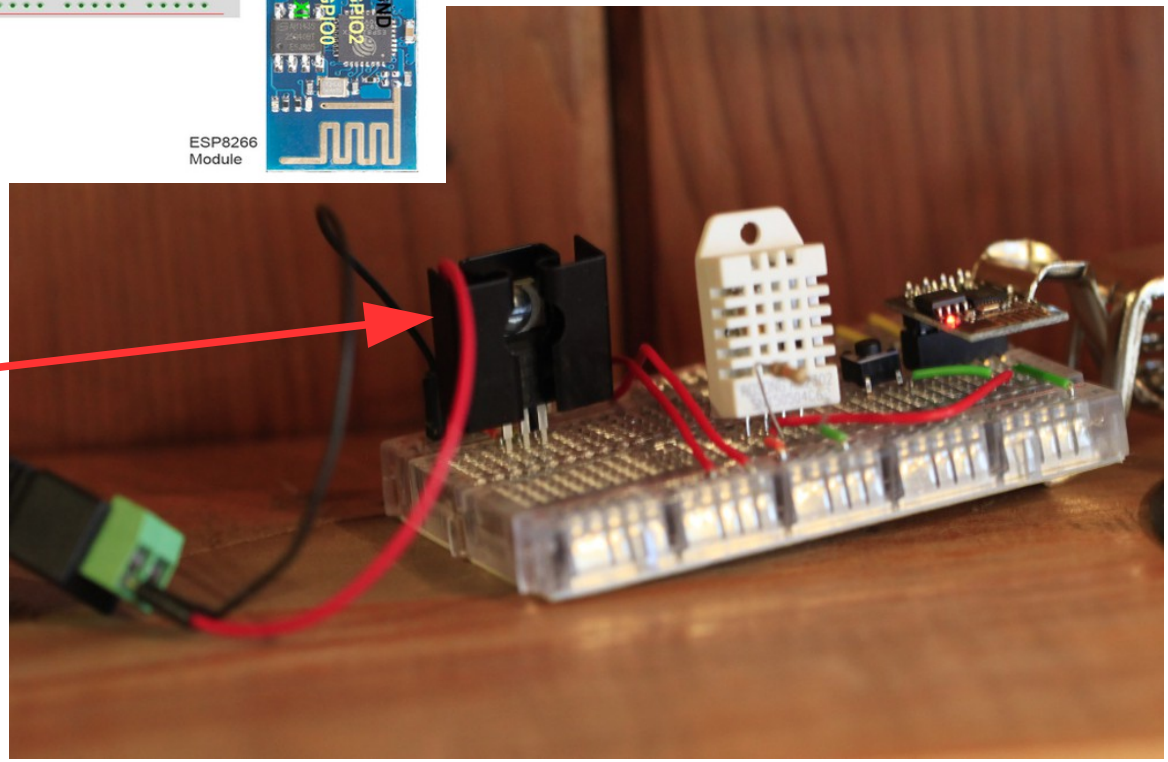


- built-in WiFi
- built-in TCP/IP
- built-in web server

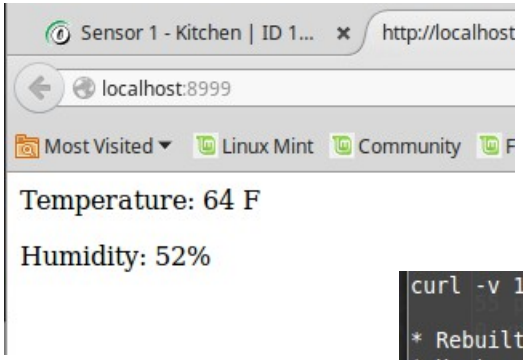
prototype



Details. The 3.3V regulator generates excess heat with higher voltage. 12V input requires heatsink, 6V would not.



Results



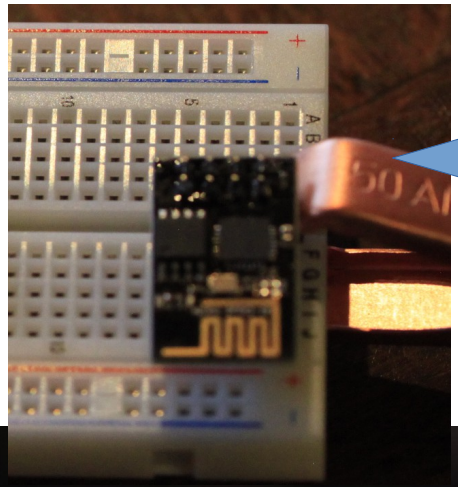

```
curl -v 192.168.9.54

* Rebuilt URL to: 192.168.9.54/
* Hostname was NOT found in DNS cache
*   Trying 192.168.9.54...
* Connected to 192.168.9.54 (192.168.9.54) port 80 (#0)
> GET / HTTP/1.1
> User-Agent: curl/7.35.0
> Host: 192.168.9.54
> Accept: */*
>
< HTTP/1.1 200 OK
< Content-Type: html
< Content-Length: 44
< Connection: close
< Access-Control-Allow-Origin: *
<
* Closing connection 0
<p>Temperature: 64 F</p><p>Humidity: 52%</p>
```

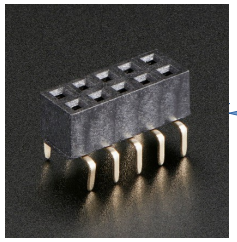
Revision

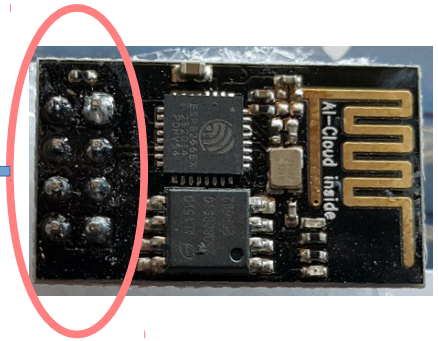
Not Energy Efficient

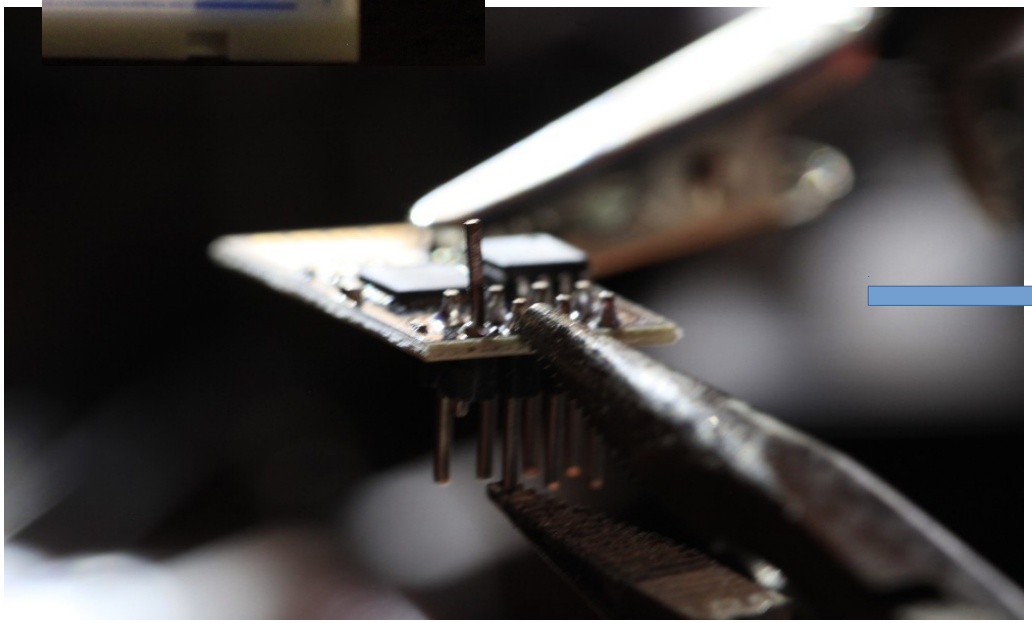
- each http poll uses about 300mA per response
- 4x 1.2V AA rechargeable batteries last < 24h

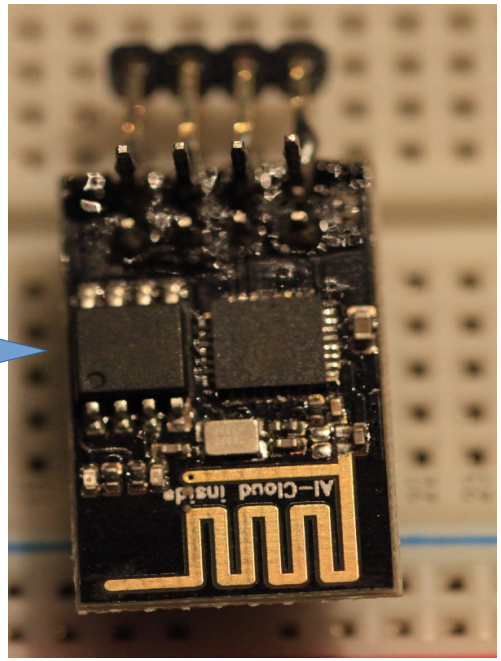
Odd Board Fitment





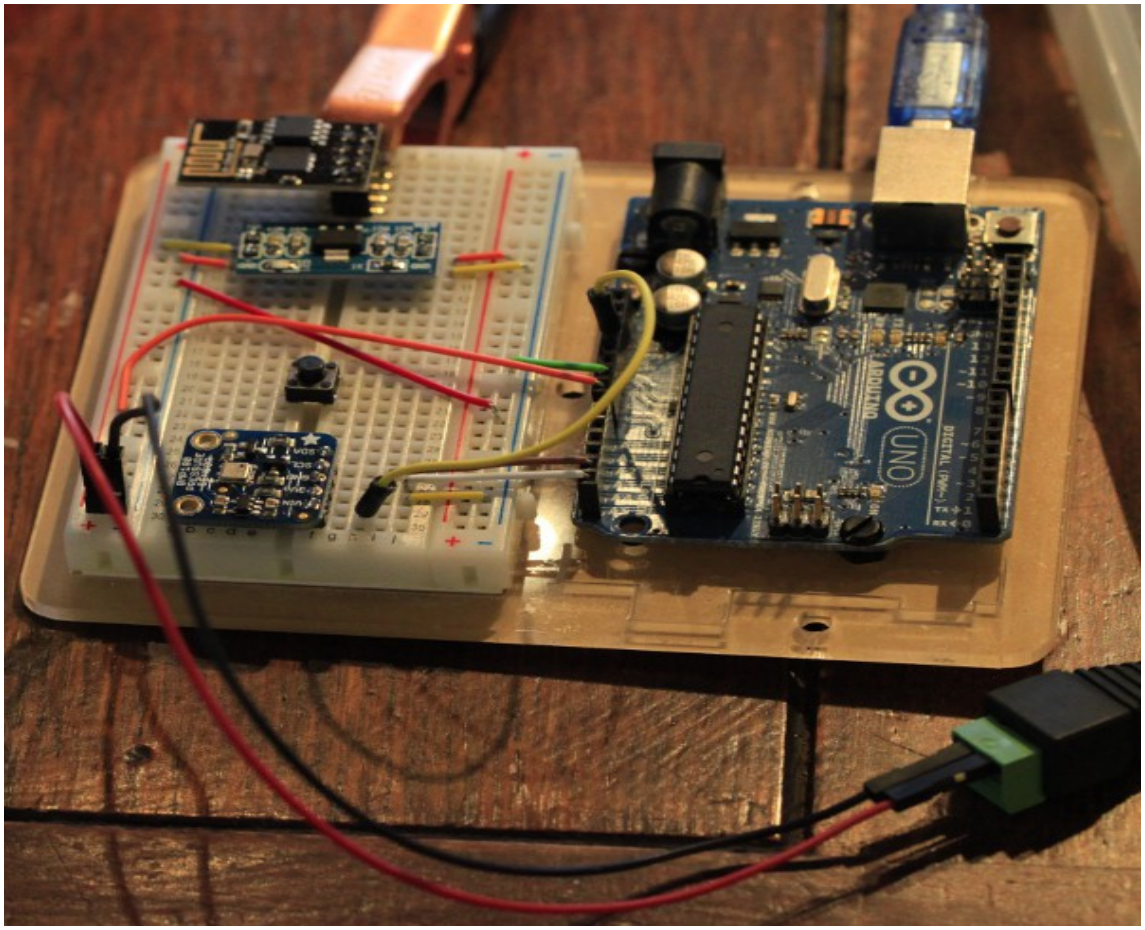






Many Components

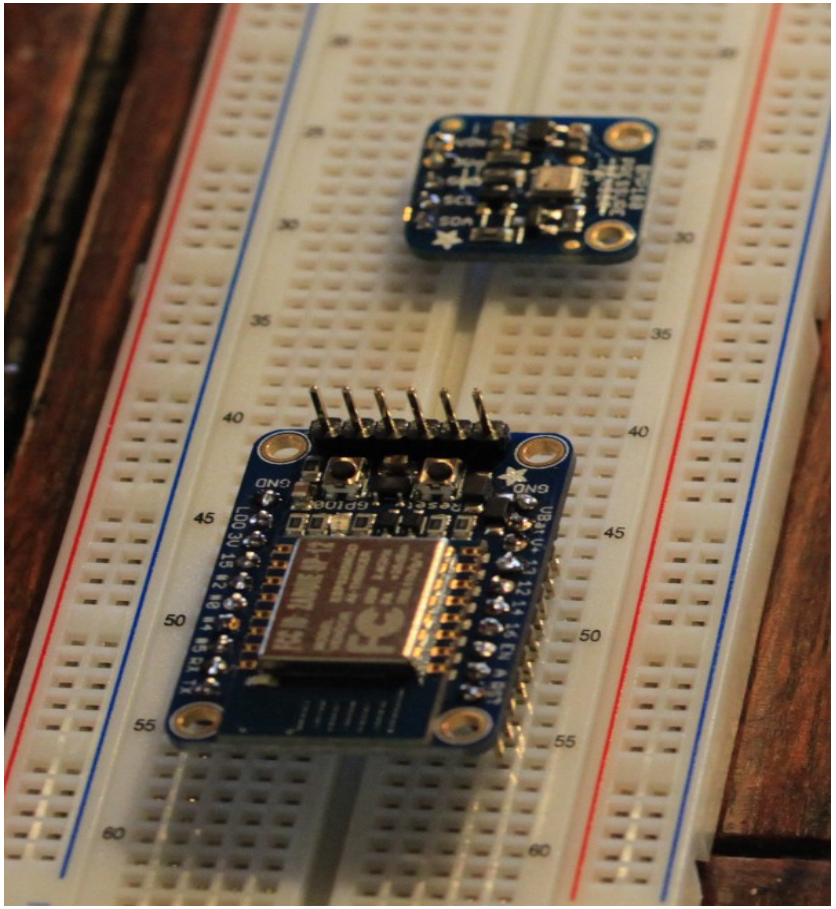
- More individual points of failure
- More cost and complexity



ESP8266 (ESP-12)

(Adafruit HUZZAH board)

- built-in regulator
- more inputs
- analog input
- integrated flash switch
- integrated reset switch
- Lua firmware preloaded
- $10



Firmware bootloaders

- NodeMCU Flasher
  - Working toward platform-independence
  - Open source
  - https://github.com/nodemcu/nodemcu-flasher
- Arduino IDE
- ESPtool
  - Python-based
  - https://github.com/cesanta/esptool
  - More “cloudy” with smart.js

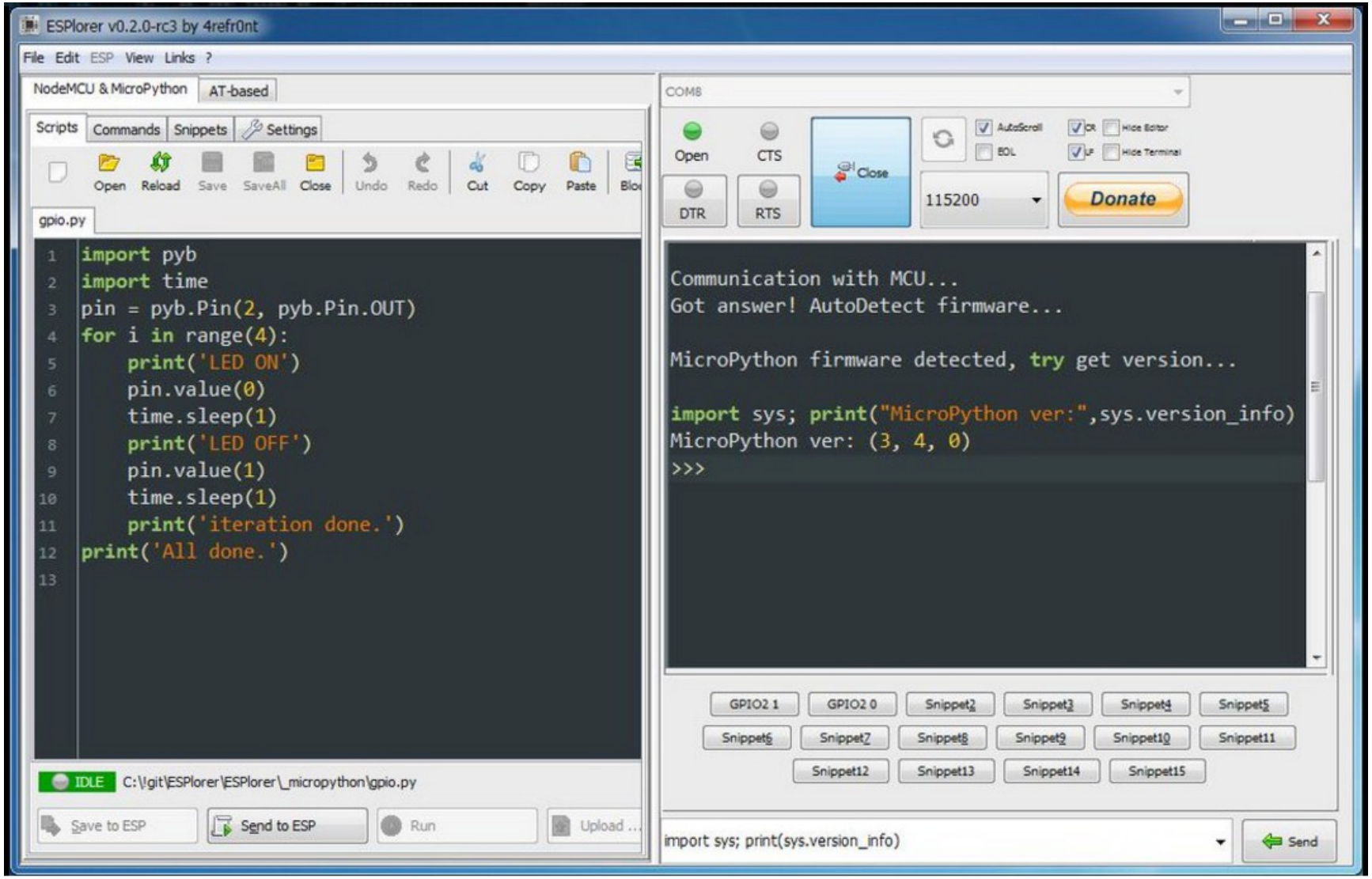
ESP8266 firmwares

- NodeMCU
  - Lua core based on eLua
  - cjson, spiffs filesystem
  - Many builtin hardware and protocol modules
  - https://github.com/nodemcu/nodemcu-firmware
- Mongoose IoT firmware
  - Javascript-based
  - https://github.com/cesanta/iot/tree/master/fw/platforms/esp8266
- ESP Easy
  - Web interface for all configuration settings
  - http://www.esp8266.nu/index.php/ESPEasy
  - Supports Domiticz home automation system
    - https://domoticz.com/

ESP8266 firmwares

- Arduino
  - http://www.esp8266.nu/index.php/Tutorial_Arduino_Firmware_Upload
    - Implies ESP Easy firmware
  - “real” Arduino like environment firmware seems to be
    - https://github.com/esp8266/Arduino
- MicroPython
  - Implements Python 3.4 standard
    - Mostly derived from Python documentation
  - Jan 2016 kickstarter
  - Goals reached, open sourced
  - https://github.com/micropython/micropython/tree/master/esp8266
  - http://docs.micropython.org/en/latest/esp8266/

ESPlorer IDE w/MicroPython support



esp8266 @esp8266ru · 5h

#ESPlorer with #MicroPython support released esp8266.ru/esplorer @ESP8266COM @EspressifSystem #ESP8266

LUA language

Lua (/ˈluːə/ loo-ə,

from Portuguese: lua [ˈlu.(w)ɐ] meaning moon)

lightweight multi-paradigm programming language designed primarily for embedded systems and clients.

Lua is cross-platform since it is written in ANSI C, and has a relatively simple C API.

- Wikipedia

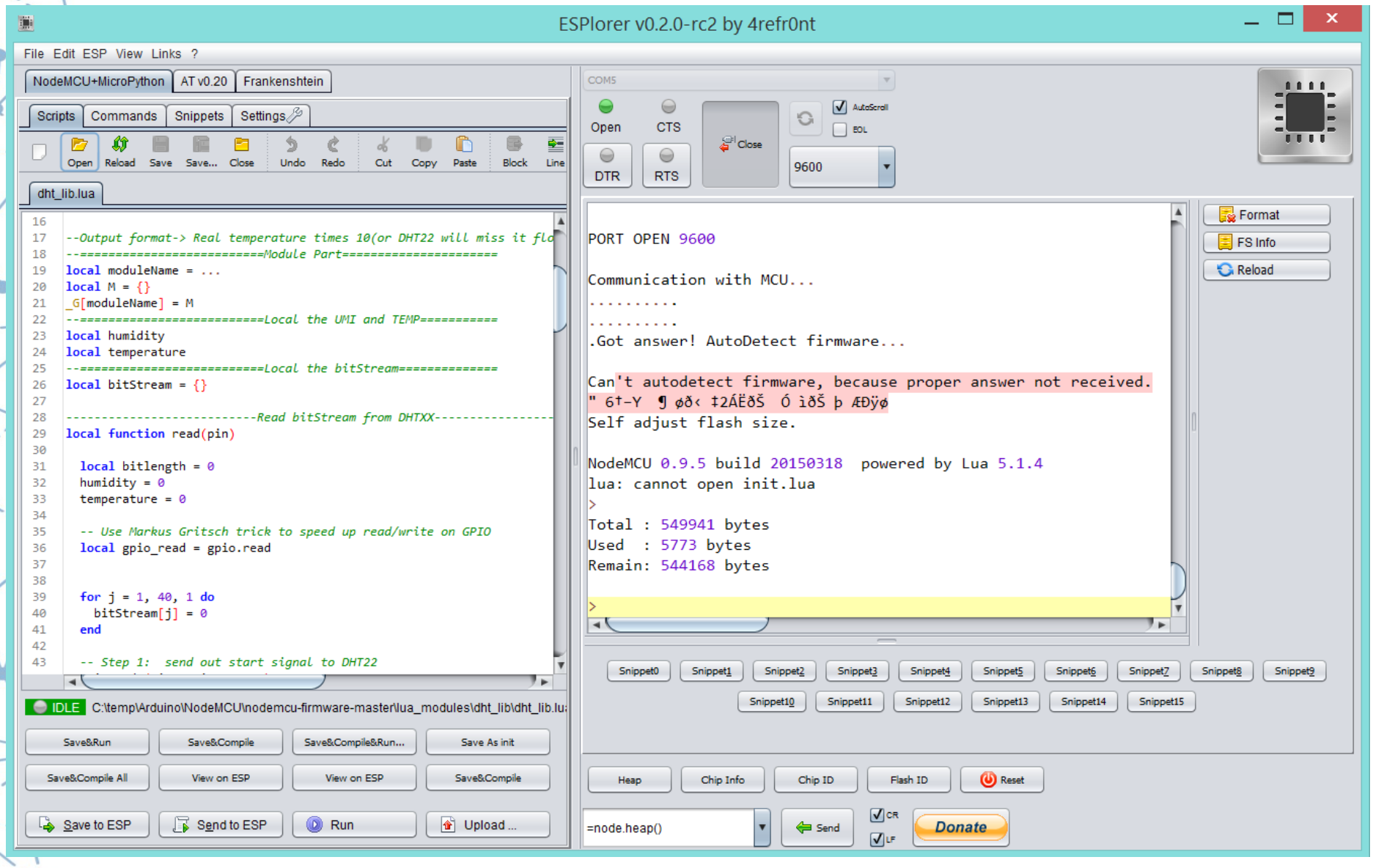
LUA applications

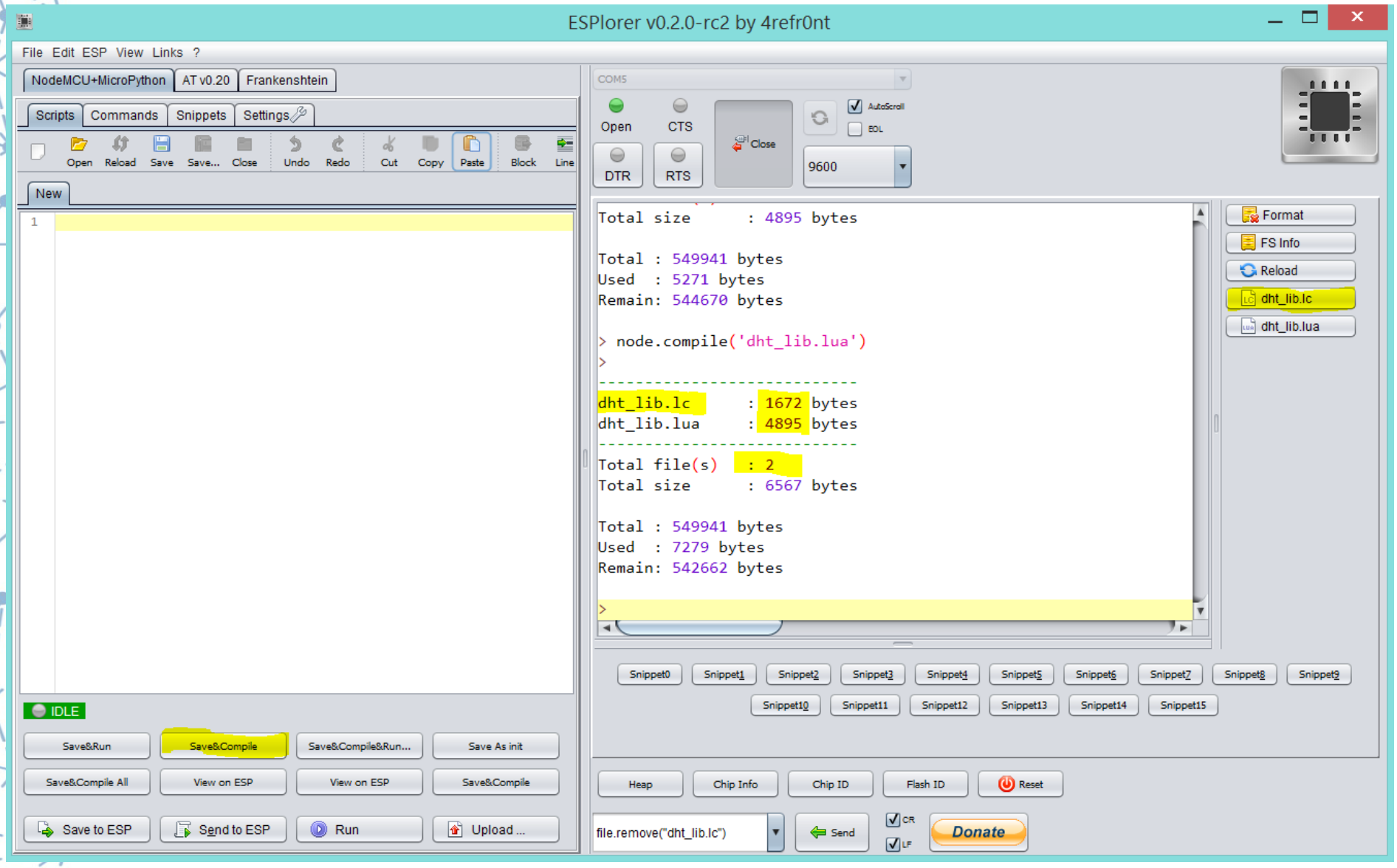
Adobe Lightroom
Apache HTTP Server
Cisco ASA devices
Conky
Creative Zen media players
lighttpd
MediaWiki
NetBSD
Nginx
nmap
NodeMCU
Rockbox
RPM
SAS
Teamspeak
video games*
VIM
VLC media player
Wireshark

*video games

Angry Birds
Baldur's Gate
Civilization V
Crysis
Don't Starve
Far Cry
Gary's Mod
Lego Universe
Minecraft
Magic: The Gathering
Rift
SimCity
The Sims
Star Wars: Battlefront
The Witcher
World of Warcraft

ESPlorer IDE




ESPlorer v0.2.0-rc2 by 4refr0nt
File Edit ESP View Links ?
NodeMCU+MicroPython
AT v0.20
Frankenshtein
Scripts
Commands
Snippets
Settings
Open
Reload
Save
Save...
Close
Undo
Redo
Cut
Copy
Paste
Block
Line
New
1
IDLE
Save&Run
Save&Compile
Save&Compile&Run...
Save As init
Save&Compile All
View on ESP
View on ESP
Save&Compile
Save to ESP
Send to ESP
Run
Upload ...
COM5
Open
CTS
DTR
RTS
Close
AutoScroll
EOL
9600
Total size : 4895 bytes
Total : 549941 bytes
Used : 5271 bytes
Remain: 544670 bytes
> node.compile('dht_lib.lua')
>
dht_lib.lc : 1672 bytes
dht_lib.lua : 4895 bytes
Total file(s) : 2
Total size : 6567 bytes
Total : 549941 bytes
Used : 7279 bytes
Remain: 542662 bytes
>
Format
FS Info
Reload
dht_lib.lc
dht_lib.lua
Snippet0
Snippet1
Snippet2
Snippet3
Snippet4
Snippet5
Snippet6
Snippet7
Snippet8
Snippet9
Snippet10
Snippet11
Snippet12
Snippet13
Snippet14
Snippet15
Heap
Chip Info
Chip ID
Flash ID
Reset
file.remove("dht_lib.lc")
Send
CR
LF
Donate

dht22web-small.lua ● PIN = 4 -- data pin, GPIO2 ●

```
wifi.sta.setip({ip="192.168.9.202",netmask="255.255.255.0",gateway="192.168.9.1"})
wifi.setmode(wifi.STATION)
wifi.sta.config("YourSSID","YourPW")

OSS = 1
SDA_PIN = 2
SCL_PIN = 1
t = 0
tempF = 0
h = 0

function ReadDHT()
    DHT= require("dht_lib")
    DHT.read(SDA_PIN)
    t = DHT.getTemperature()
    h = DHT.getHumidity()
        tempF = (t*9/50+32)
    DHT = nil       -- release module after use
    package.loaded["dht_lib"]=nil
end

ReadDHT()  -- initial data read
tmr.alarm(1,30000,1, function()ReadDHT()end)  -- 30s sensor read

srv=net.createServer(net.TCP)
srv:listen(80,function(conn)
    conn:on("receive", function(conn,payload)
    conn:send("HTTP/1.1 200 OK\r\n")
    conn:send("Content-type: text/html\r\n\r\n")
        conn:send("<html\n")
        conn:send("  <head>\n")
        conn:send("    <title>ESP8266 Web Server</title>\n")
        conn:send("  </head>\n")
        conn:send("  <body>\n")
        conn:send("    <p>Temperature: "..tempF.."</p>\n")
        conn:send("    <p>Humidity: "..h.."</p>\n")
        conn:send("  </body>\n")
        conn:send("</html>\n")
    conn:close()
    collectgarbage()
    end)
end)
```


openNMS®


MERIDIAN
openNMS


HORIZON
openNMS

OpenNMS configs

Node Provisioning

imports/Sensors.xml

```
   <node building="Sensors" foreign-id="1439622677282" node-label="Sensor 1 -
Kitchen">
      <interface descr="" ip-addr="192.168.9.54" status="1" snmp-primary="P">
         <monitored-service service-name="DHT22sensor"/>
      </interface>
```

OpenNMS configs

HTTP data collection

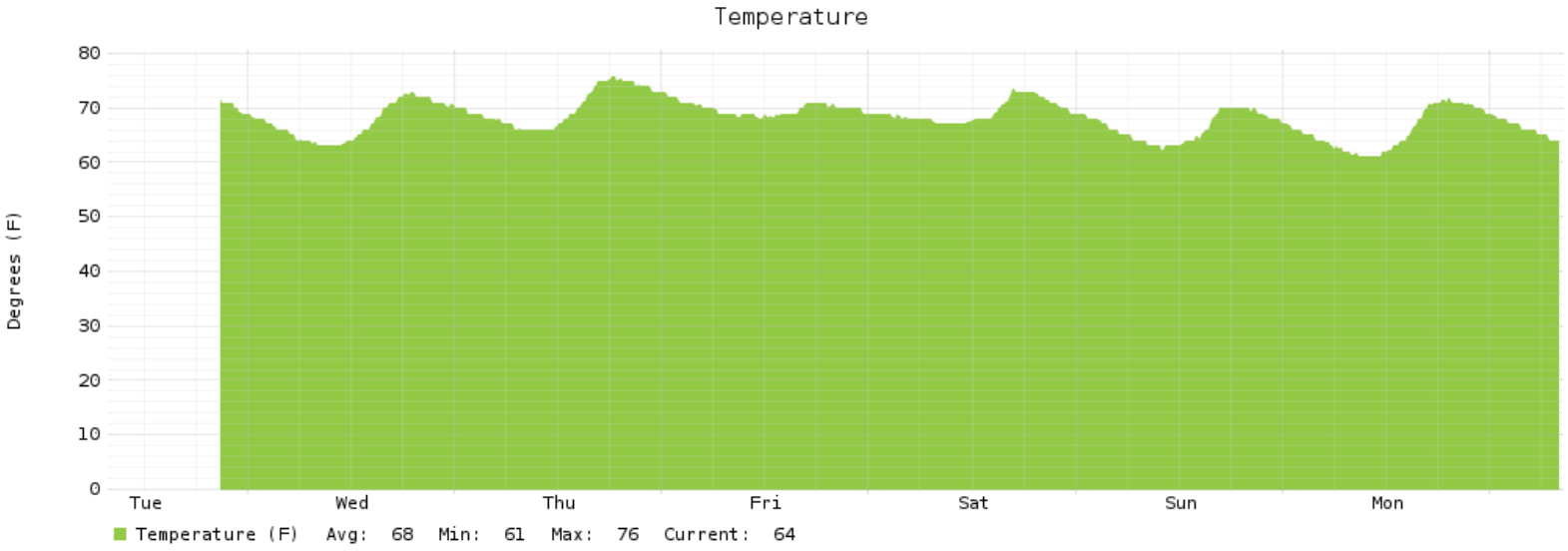
collectd-configuration.xml

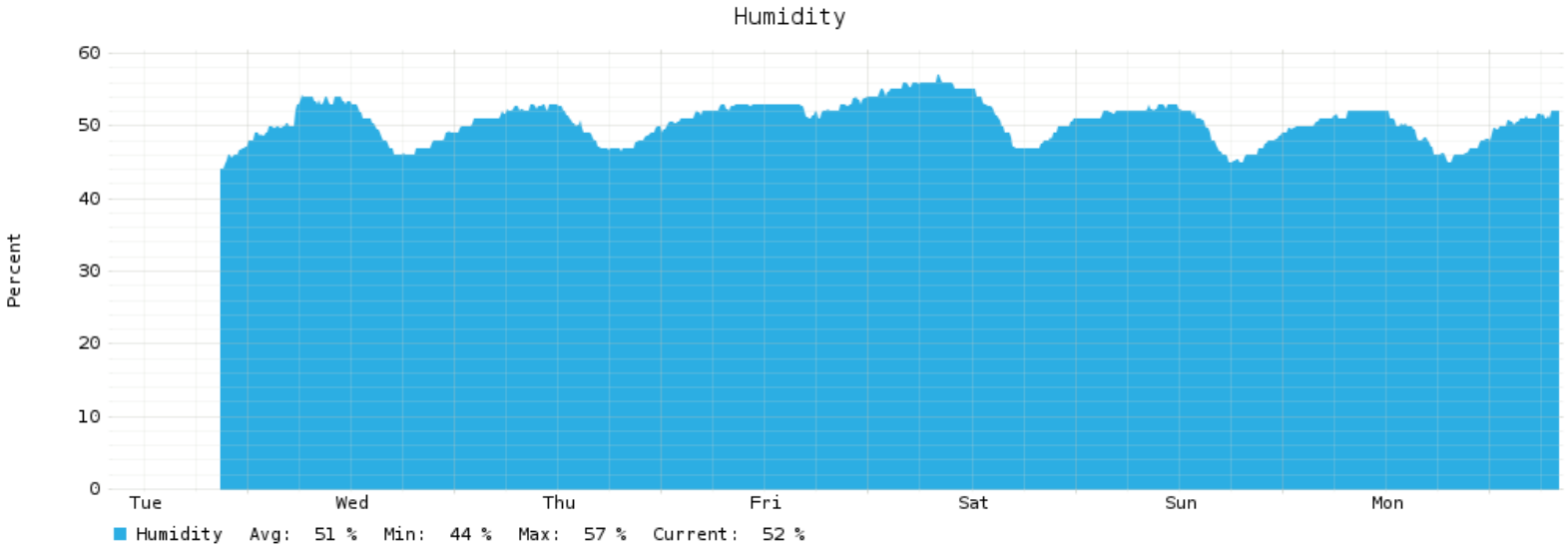
```
     <service name="DHT22sensor" interval="300000" user-defined="true" status="on">
         <parameter key="http-collection" value="dht22sensor"/>
         <parameter key="thresholding-enabled" value="true"/>
      </service>

   <collector service="DHT22sensor" class-name="org.opennms.netmgt.collectd.HttpCollector"/>
```

http-datacollection.xml

```
  <http-collection name="dht22sensor">
    <rrd step="300">
      <rra>RRA:AVERAGE:0.5:1:17280</rra>
      <rra>RRA:AVERAGE:0.5:12:18240</rra>
      <rra>RRA:AVERAGE:0.5:288:1825</rra>
      <rra>RRA:MAX:0.5:288:1825</rra>
      <rra>RRA:MIN:0.5:288:1825</rra>
    </rrd>
    <uris>
      <uri name="sensor">
        <url path="/"
             matches="^\S+Temperature:\s([0-9]+).*Humidity:\s([0-9]+).*">
        </url>
        <attributes>
          <attrib alias="sensorTemp" match-group="1" type="gauge"/>
          <attrib alias="sensorHumidity" match-group="2" type="gauge"/>
        </attributes>
      </uri>
    </uris>
  </http-collection>
```

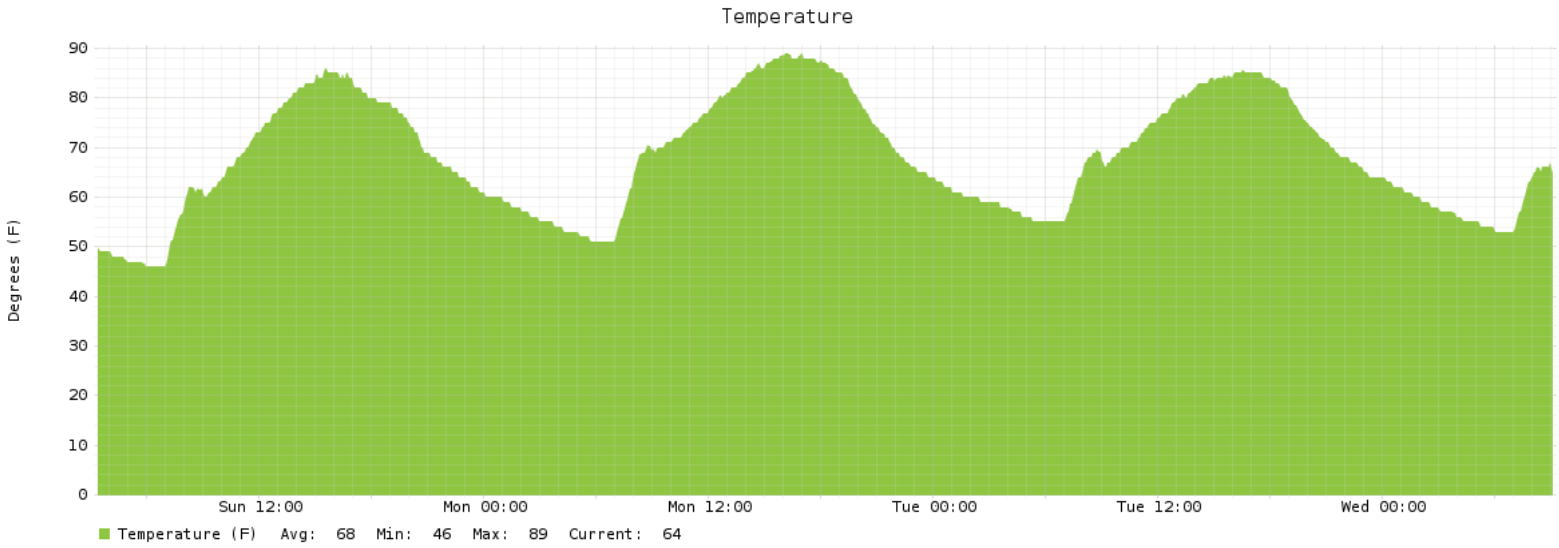
Graphs


Temperature
Degrees (F)
80
70
60
50
40
30
20
10
0
Tue
Wed
Thu
Fri
Sat
Sun
Mon
Temperature (F) Avg: 68 Min: 61 Max: 76 Current: 64

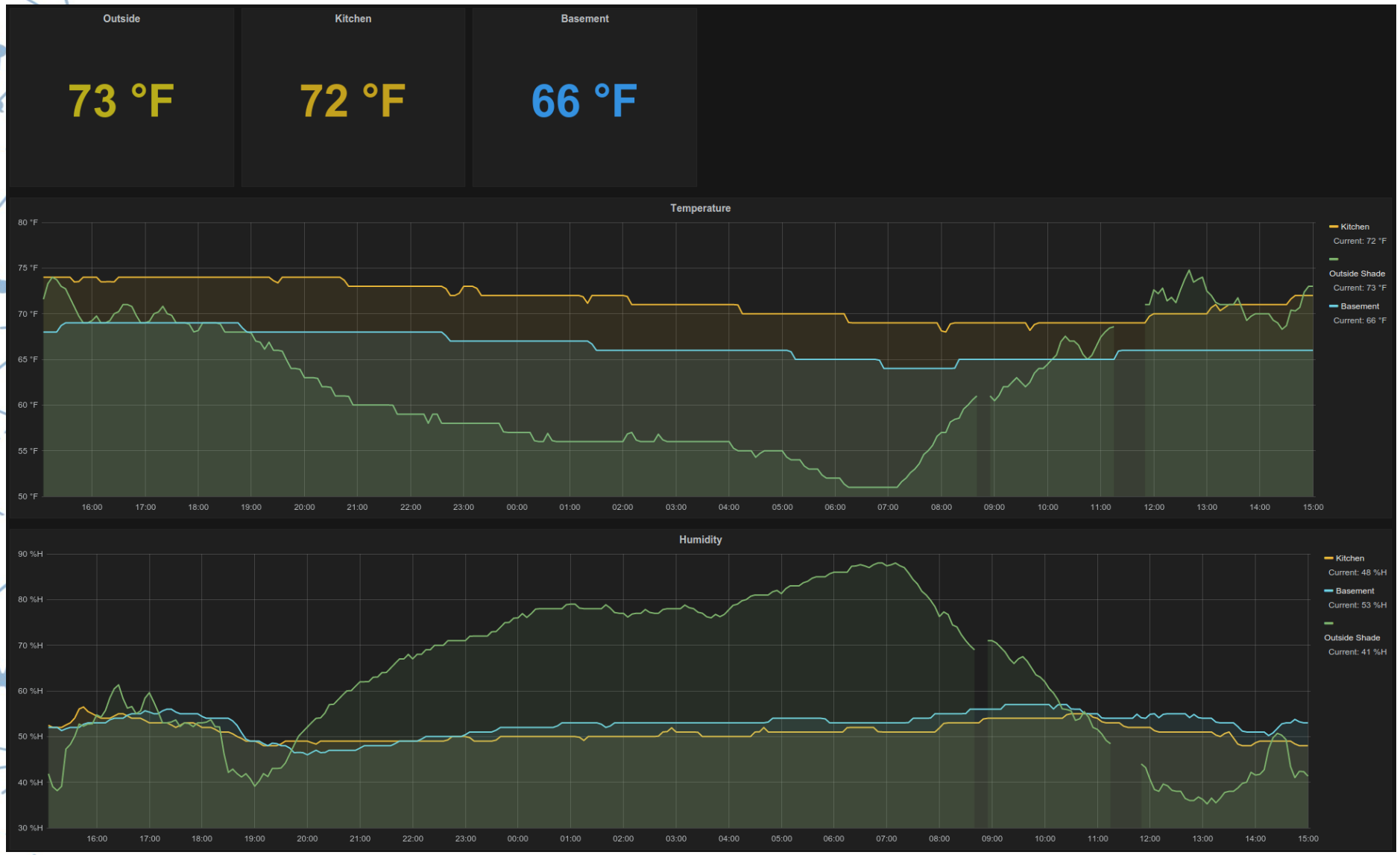

Humidity
Percent
60
50
40
30
20
10
0
Tue
Wed
Thu
Fri
Sat
Sun
Mon
Humidity Avg: 51 % Min: 44 % Max: 57 % Current: 52 %

Graph Analysis

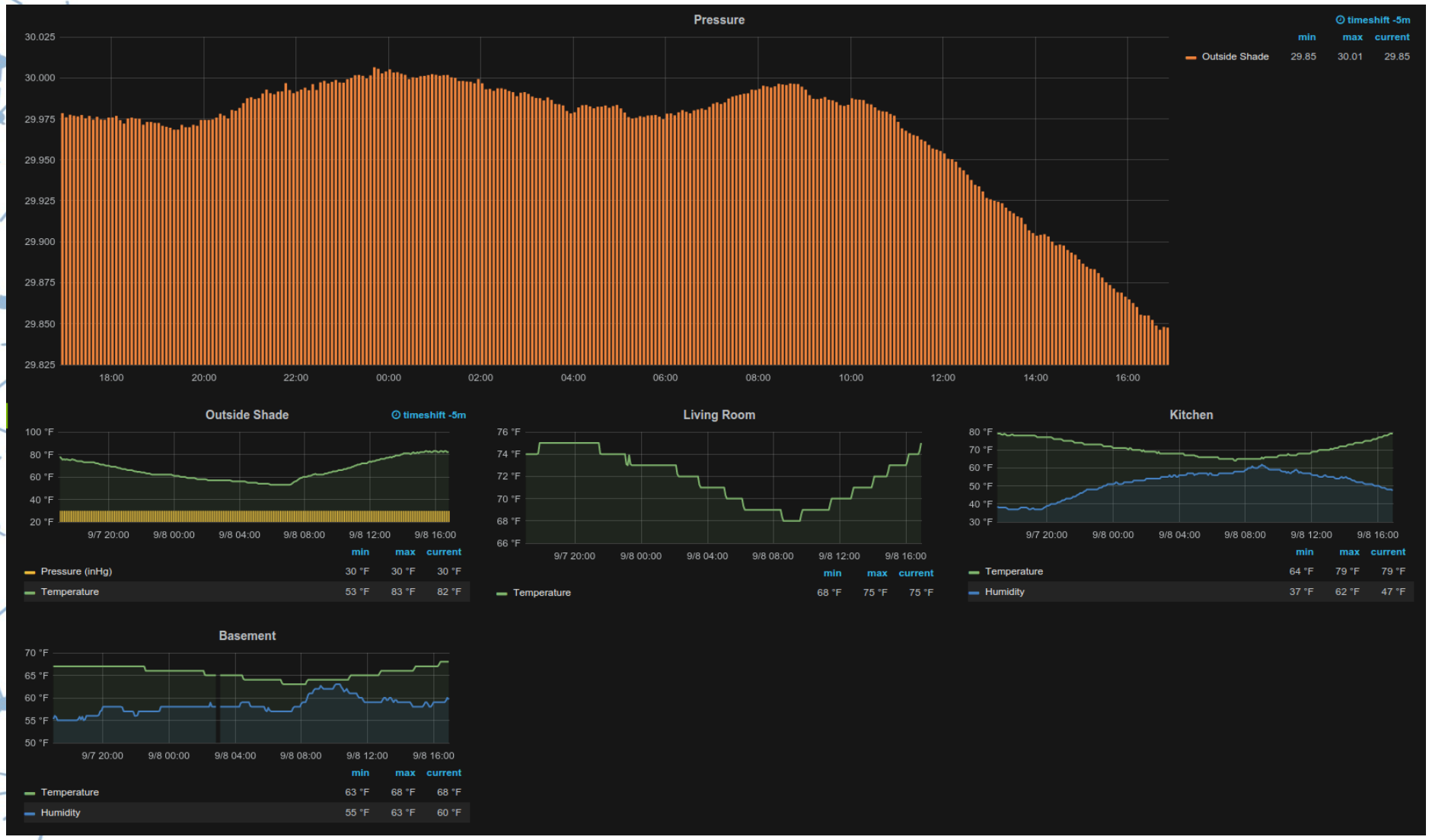
Does a window fan matter?



OpenNMS Grafana Integration



OpenNMS Grafana Dashboard



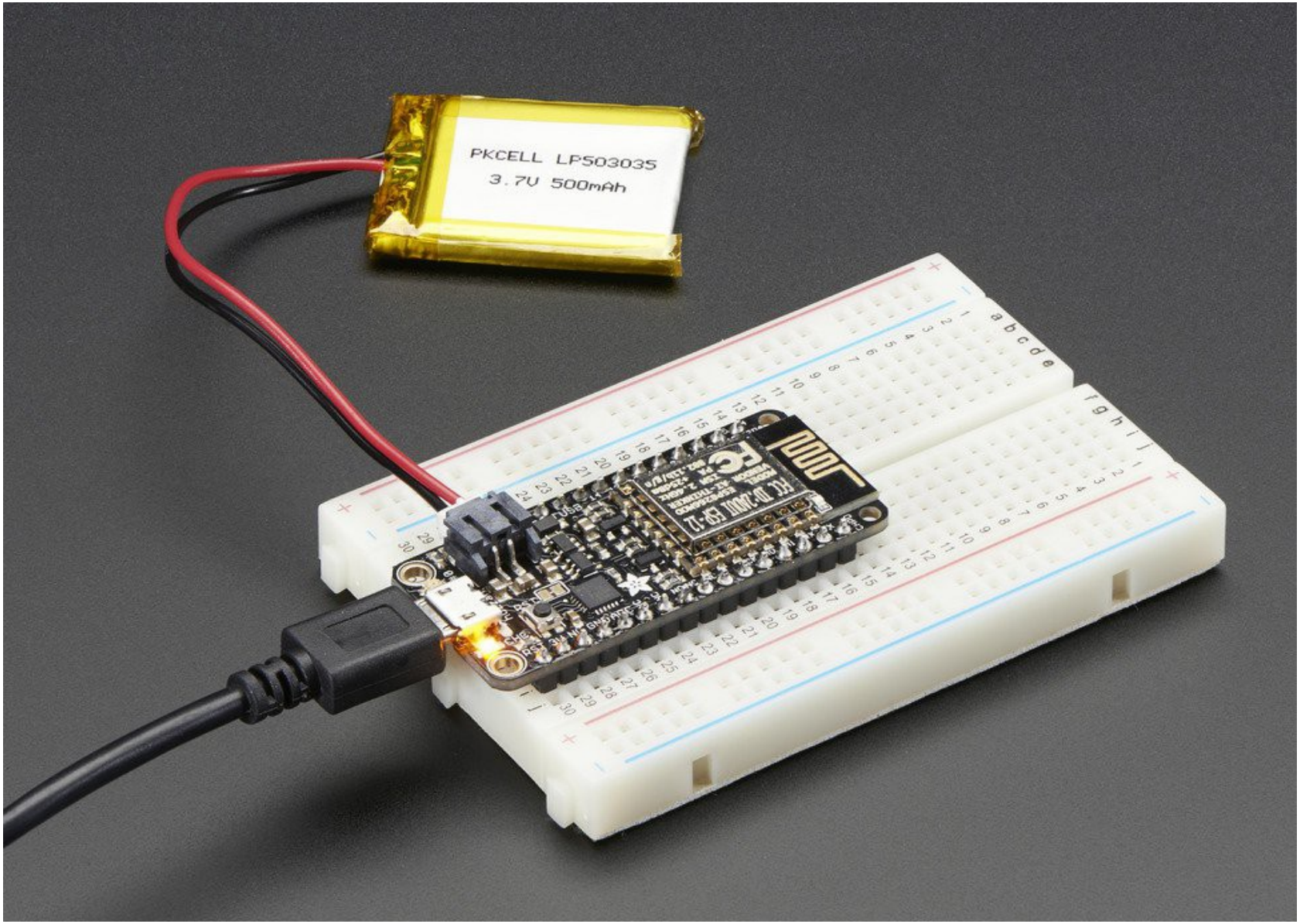
Lessons learned

- hardware will fail
  - 2x voltage regulators
  - 2x ESP8266-01
  - 1x ESP-12 Huzzah (?)
- hardware will arrive DOA
- measure and check voltages often
- avoid smoking electronics
- buy extra
  - wire, connectors, sensors, boards

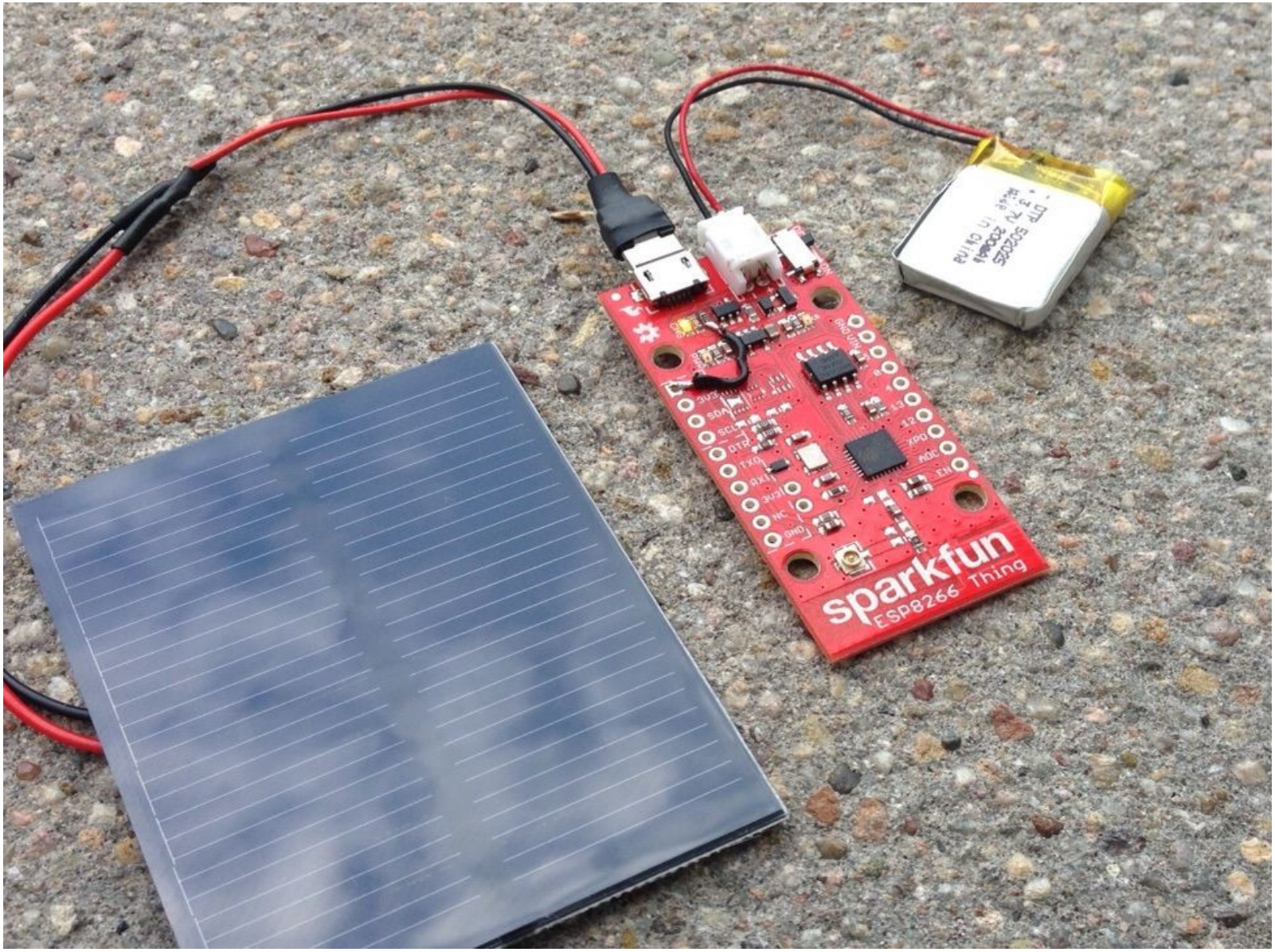
todo

- XML collector
- push collection
  - deep sleep mode
- sensor comparisons
- better housings
- OpenHAB integration
  - MQTT protocol
- more thingies!

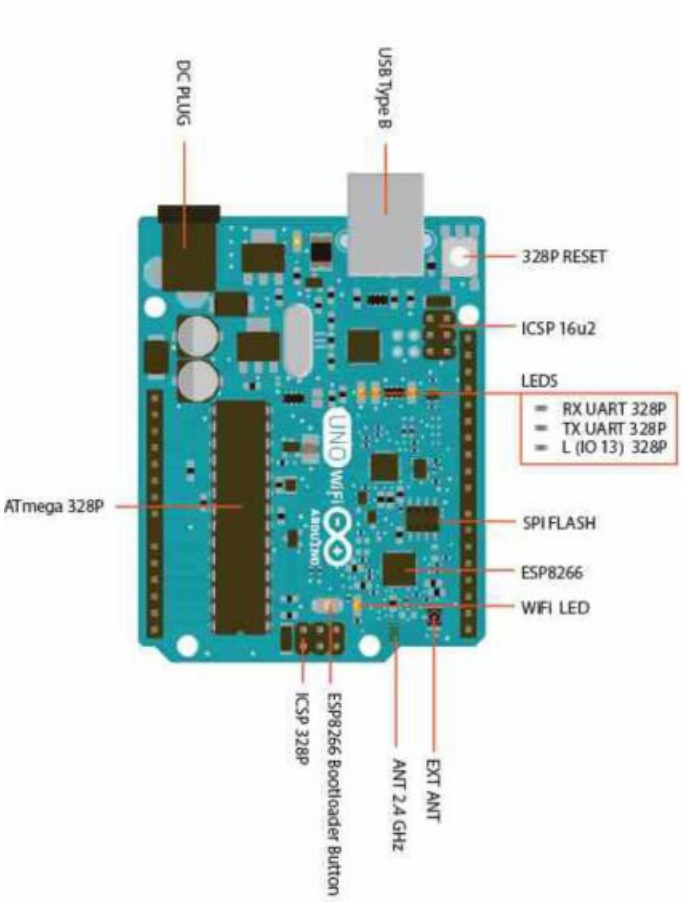
Huzzah Feather

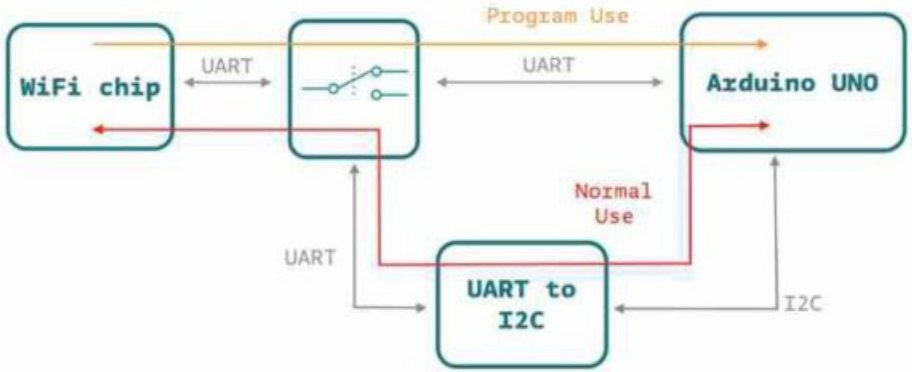


SparkFun ESP8266 Thing



Arduino Uno Wifi w/ESP826

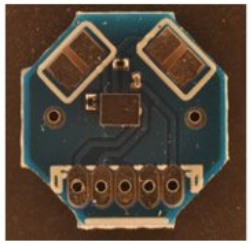




Tindie

/www.tindie.com/profiles/wishlist/

My Wishlist



MyOctopus i2c Humidity / Temperature Senso...

$15.80

Easy pulse sensor based on photoplethysmog...

$20.50

ESP8266 based controller board with onboar...

$9.95

SHT31 Digital Humidity & Temperature Senso...

$11.95

SPI 4-digit seven segment LED display

$12.50

Dual row 4-digit seven segment LED display...

$12.99

MyGeiger ver.2 DIY Geiger Counter Kit with...

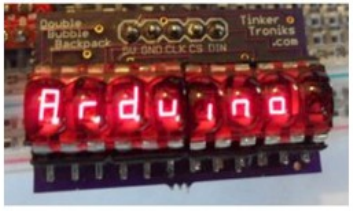
$100.00

Capacitive Touch Power Switch

$3.60

7 Seven Segment Four Digit HP Bubble Display

$18.89



Double Bubble Backpack - 7 Segment (8 digit)

$39.95

HB100 Doppler Speed Sensor - Arduino Compa...

$30.00

I2C Soil moisture sensor

$13.00

Ken Eshelby

 ken@opennms.org

 esh^/#opennms/freenode.net

 https://github.com/xplorn

 @xplorn

Evaluate this session

Internet of Thingies

Session videos will be posted to the LinuxFest Northwest YouTube channel.

Thank you!