# Build Your Own Data Collection IoT Devices

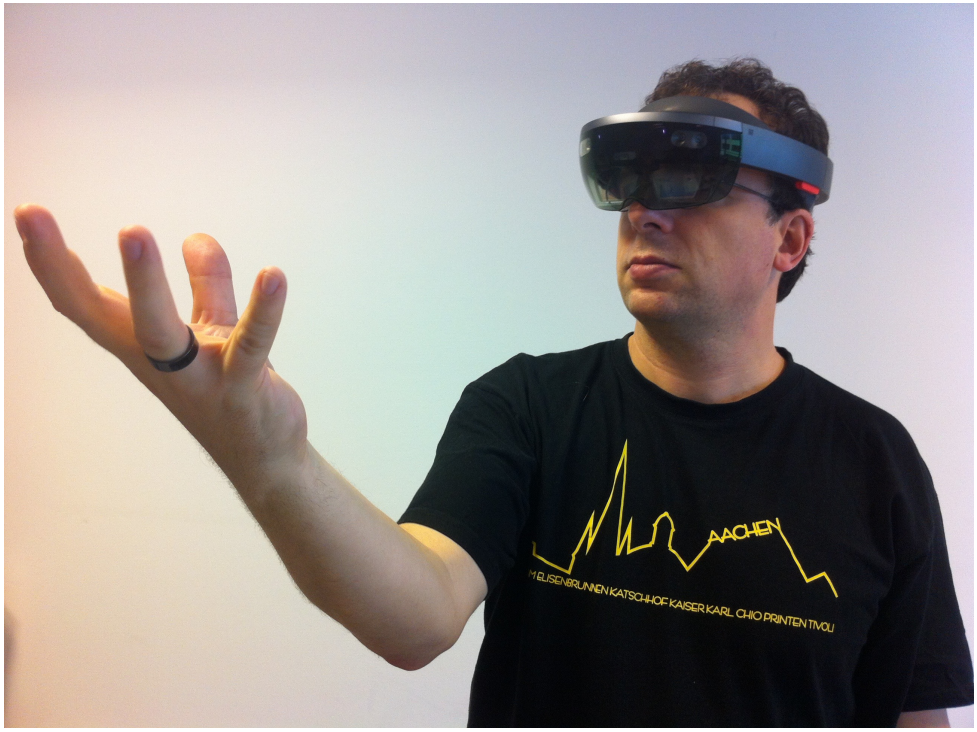
Inspirations for (even) more data

Analytics Seminar at Georgetown University

Ulrich Norbisrath

2017-05-03

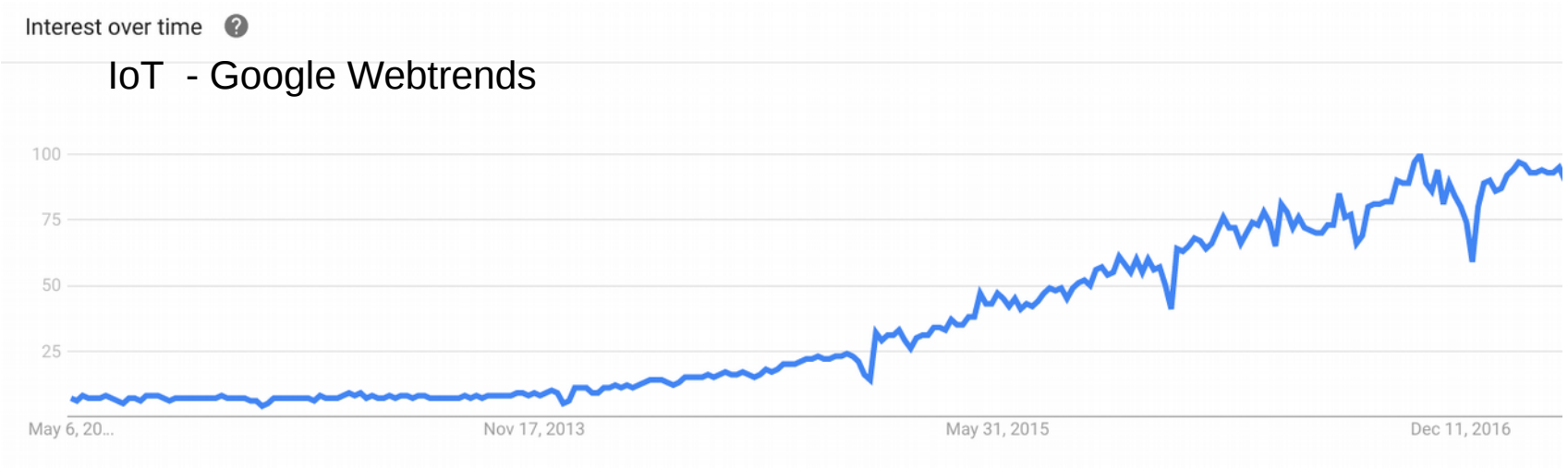
# whoami




- http://ulno.net, Ulrich Norbisrath
  **email:** replace http:// with ulno@
- **Adjunct Professor**
  - George Mason University
  - FH Upper Austria
- **Independent IoT Consultant**
- **PhD** from RWTH Aachen University:
  “Configuring eHome Systems”
- **Research:** ubiquitous computing, story driven modeling, search
- **Teaching:** H&B Automation, SE, Systems
- **International teaching experience:**
  Germany, Austria, Estonia, Kazakhstan, Indonesia, US

# Who are U?

- Programming experience?
- Micro controllers? Arduino? ESP8266?
- Maker community?
- Teacher/student?
- IoT?




Personal statistic: 20 talks: IoT and Making since 2015, 5 classes: H&B Automation since 2014

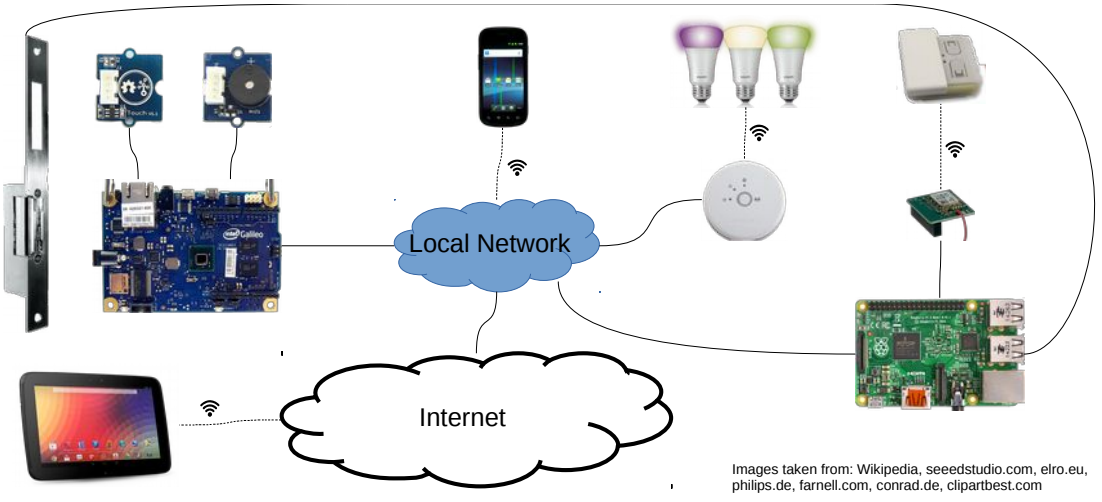
# Outline

- IoT – my interpretation
- Paradigm shift through affordable IoT
- Ecosystem to build wireless sensors and actors
- Devices and data
- Perspectives

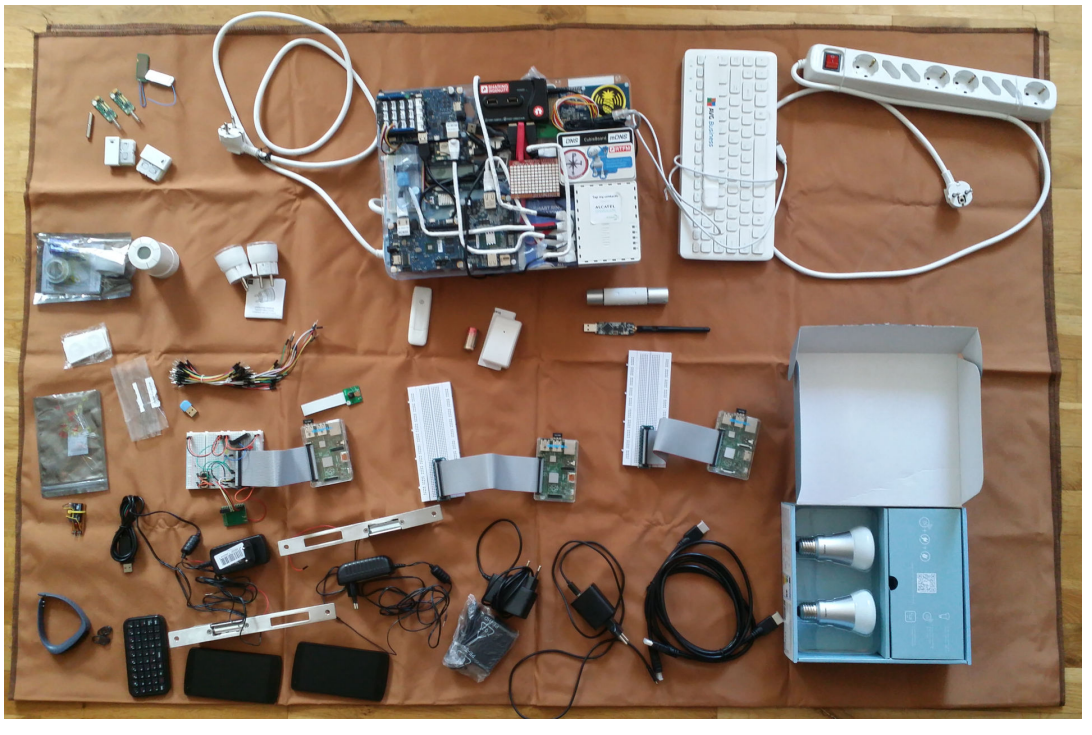
# Internet of Things (IoT)

- **Cloud Computing**
  - Client/Server
  - Distributed computing
  - Grid computing
  - Software as a network service
- **IoT**
  - Ubiquitous Computing (Pervasive Computing)
  - Home automation
  - Urban Computing/Smart Cities
  - Embedded Computing
  - Actor/Sensor Networks
  - M2M Communication
  - Mobile Computing, Wearable Computing
  - (Hacking/Making)
  - Big/Actionable Data

  → **Connectivity and data**

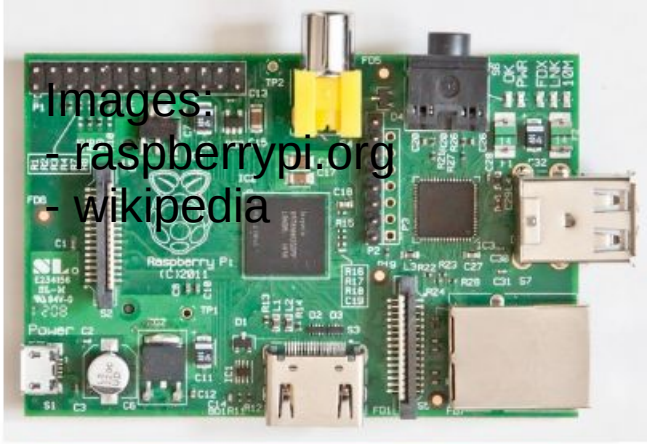



Images taken from: Wikipedia, seeedstudio.com, elro.eu, philips.de, farnell.com, conrad.de, clipartbest.com



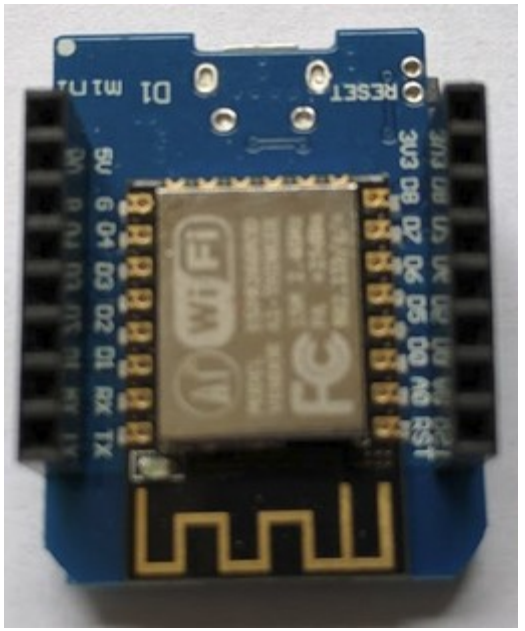
# Trending IoT Devices, You Know

- Pi 1
  - The first, slowish (better server)
  - 1 core, 512MB, 700MHz, now $20 (used)
- Pi 3
  - Current, fast (also Desktop), not very availbl
  - 4 cores, 1GB, 1GHz, WiFi, now $35
- Pi Zero
  - Slowish (better server), not at all available
  - 1 Core, 512MB, 1GHz, $5 if available
- Pi Zero W
  - Slowish (better server), not at all available
  - 1 Core, 512MB, 1GHz, WiFi, $10 if available




# Trending IoT Devices, You Might Not Know?

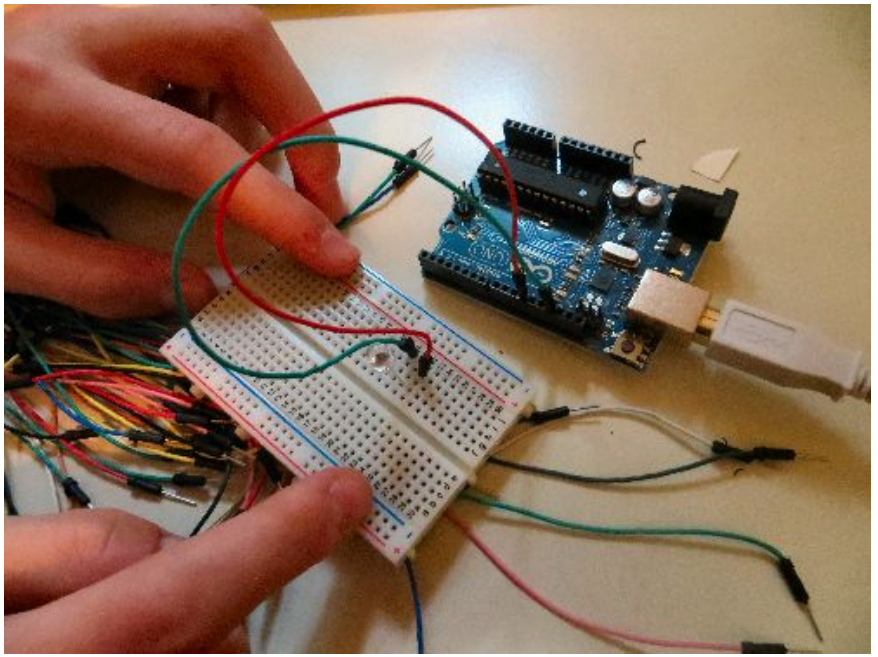
- ESP8266 ($1-$3)
- Arduino on steroids
  - 160 MHz
  - GPIO ports (I2C, Onewire, SPI)
  - 10 bit analog port
  - 0.5-16 MB
  - Ram 64k + 92k
  - Wifi on board
  - Deep sleep power management
    - Simple sensor with lipstick battery (like in class) → 1 year
    - Runs easily on solar energy
  - Python, Lua, C, C++, Java-Script

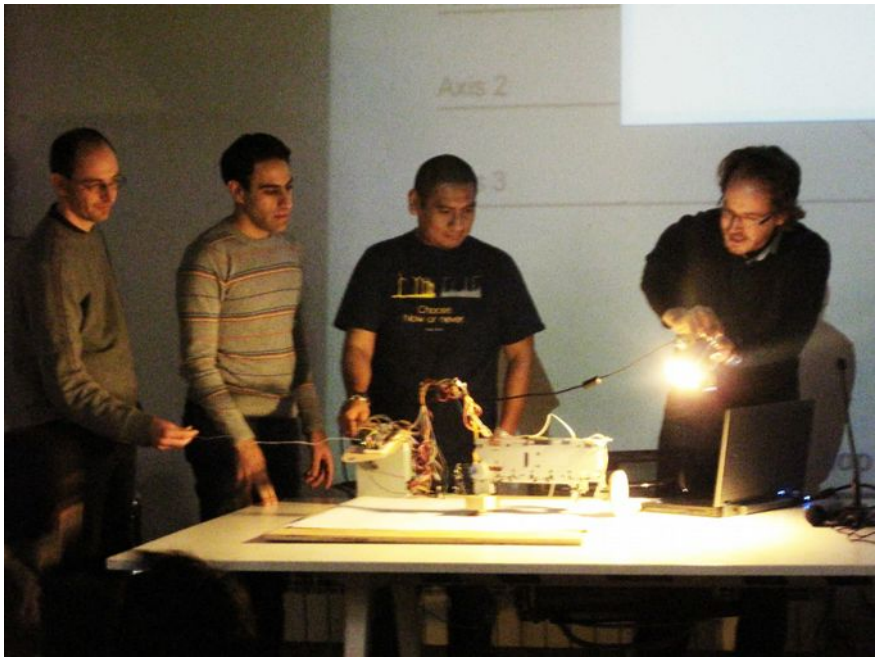


Personal favorite: Wemos D1 Mini ($3)

# Students With Their First IoT Projects

- Discovery during “Home and Building Autmation” classes
- Different type of motivation than “Hello World”
- Change or measure something in the real/physical world

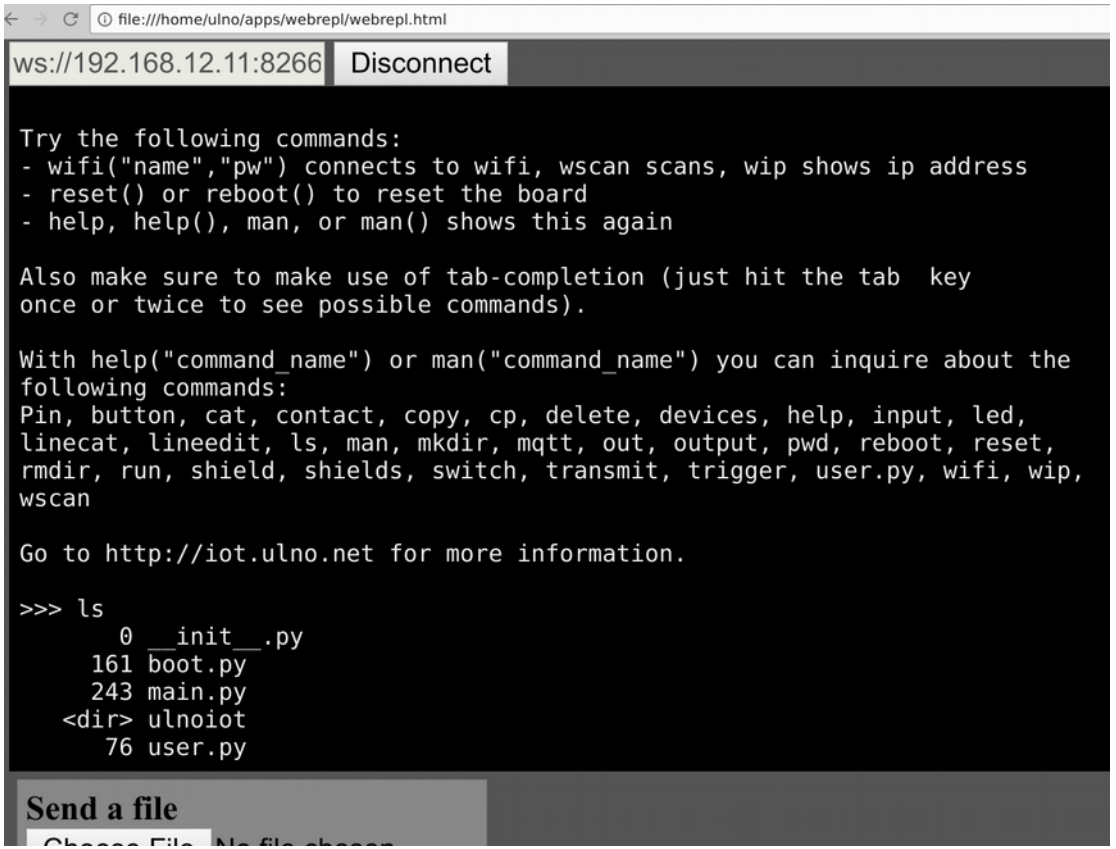




Images from:
- http://www.trycomputing.org/lesson-plans/arduino-blink-challenge-lesson
- http://www.iaacblog.com/blog/2011/arduino-workshoprs3-session/

# ulnoiot: Ecosystem → Mini OS

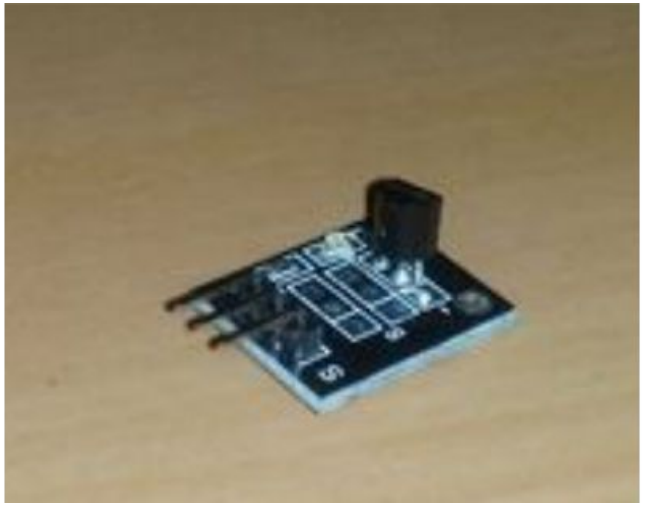
- Remote shell access
- Based on Micropython




- For more info:
  - Ecosystem: http://iot.ulno.net, http://github.com/ulno/ulnoiot
  - Buy here: http://hardware.iot.ulno.net
    - China/Shenzhen much cheaper than sourced from US

# Paradigm Shift Through Affordability

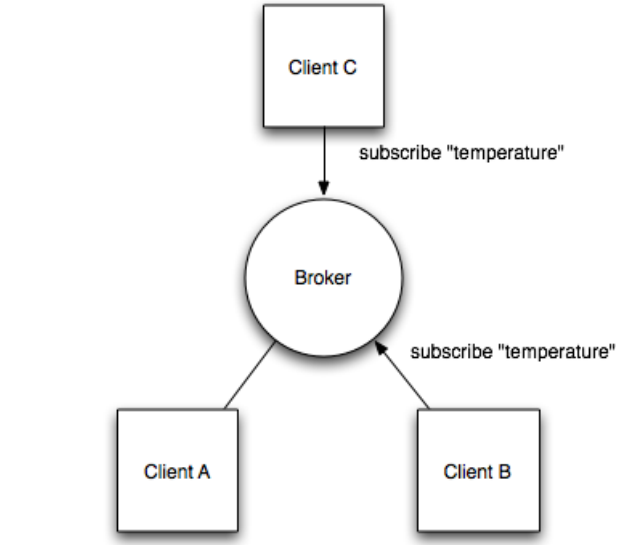
- Since using ESP8266 → students go out and buy to explore themselves
- Why am (not only) I even more excited about this than about the Raspberry Pi ($10-$50)?
- Sensors for both, often <$2 per piece
- No soldering required to wire up

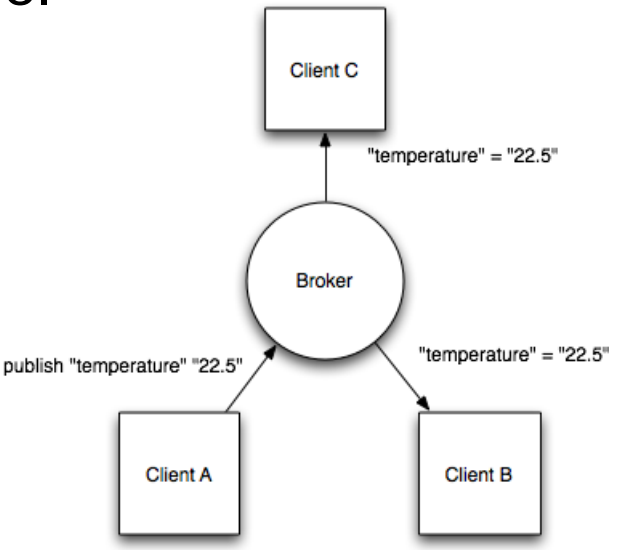


last two pictures from http://www.instructables.com/id/Arduino-37-in-1-Sensors-Kit-Explained/

# MQTT – M2M Communication

- MQ Telemetry Transport
  or Message Queue Telemetry Transport
- MQTT Gateway/Broker, star topology
- Publish Subscribe (Listener, Observer Pattern)
- ISO standard, Invented in 1999
- Runs over TCP/ any other stream-based protocol
- Very lightweight
  → runs even on slow Pis and routers
- Many implementations
- Built in security
  - Allows layered security/stacked gateways
  - User access management
  - End to end encryption possible

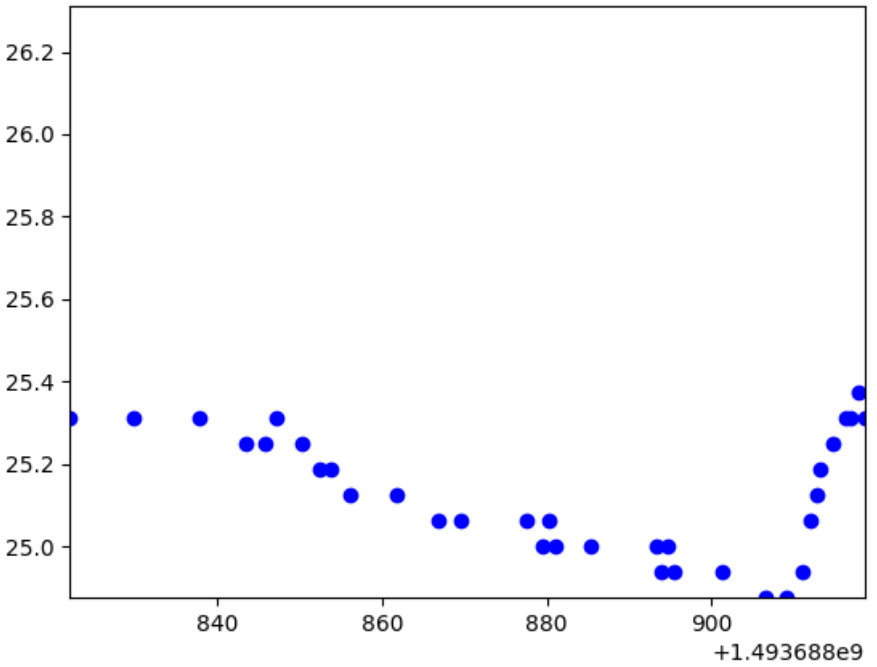



from https://eclipse.org/community/eclipse_newsletter/2014/february/article2.php

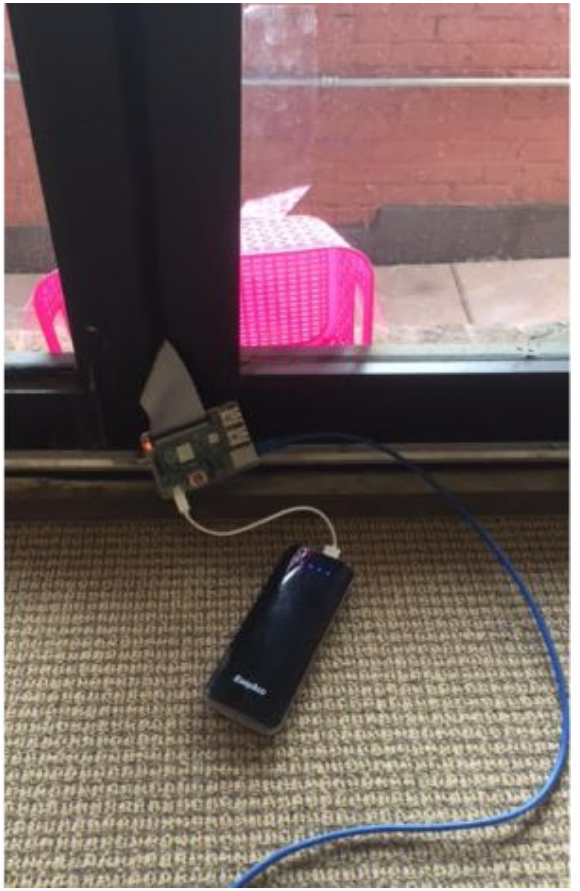
# Devices in Class

- Temperature/Humidity 1 (“ht1”)
- Temperature precise (“temp2”)
- Tilt “drink frequency” sensor (“tilt1”)
- Noise sensor (“noise1”)
- Obstacle detection (“obstacle1”)
- Knock sensor (“knock1”)



# Device Outside

- Raspberry Pi
  (oversized because of university network)



# Perspectives?

- Can you already imagine the potential?
- What could you build?
- What would you wish for in terms of software support?

# Other potential devices

- Rain/flood water detector
- Water flow detector
- Power meter
- Dust/polution/air quality detector
- Fitness/Health sensors (also accelerometer, gyro)
  - Monitor running
  - Monitor movement
- Home automation

# Summary

- Iot for wide audience
- Make anything wireless
- State of the art research on important ingredient of analytics:
  - Data source
  - Everybody can now build their own
- Community and growing project repository
  - Help and criticism appreciated
- References:
  - IoT start page: http://iot.ulno.net
  - Follow for updates: http://blog.ulno.net
  - Twitter: ulno
  - Subscribe to ulno.net on Youtube
  - File issues and help building repository at http://github.com/ulno/ulnoiot