
Mastering IoT Solutions
Building Connected Systems
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IOT
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whoami

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Globalist (Living, Teaching, Research)

Estonia, USA, Germany, Austria, Kazakhstan, Singapore, Indonesia, Brazil

Research: Internet of Things, VR/AR, Digital Twins, Education, Creativity, Software Craftsmanship

About You

- Who has programming experience?
- Arduino, microcontroller anyone?
- Who likes/cares for teaching?
- Who also works with electronics (sensors, actors, MCUs, Raspberry Pis)?

IoT and Coffee

Or how to fall in love with teaching IoT

- Singapore
- William Hooi – Teacher, Maker, “Espresso Lite”
- Democratization of hardware
- Affordable hw
  =
  powerful
  motivation

Let’s Crowd Source IoT

- Results:
  - Definition of IoT
  - Challenges in your domain/project
- Every team for start (5 min – brain/internet search, LLM, from current experience):
  - 1 IoT/connectivity challenge in your own project(s)
  - 3 domains
  - 2 commonly used (data) protocols
  - 2 typical devices (appliance or micro controller)
  - Good definition
- 5 minutes sharing

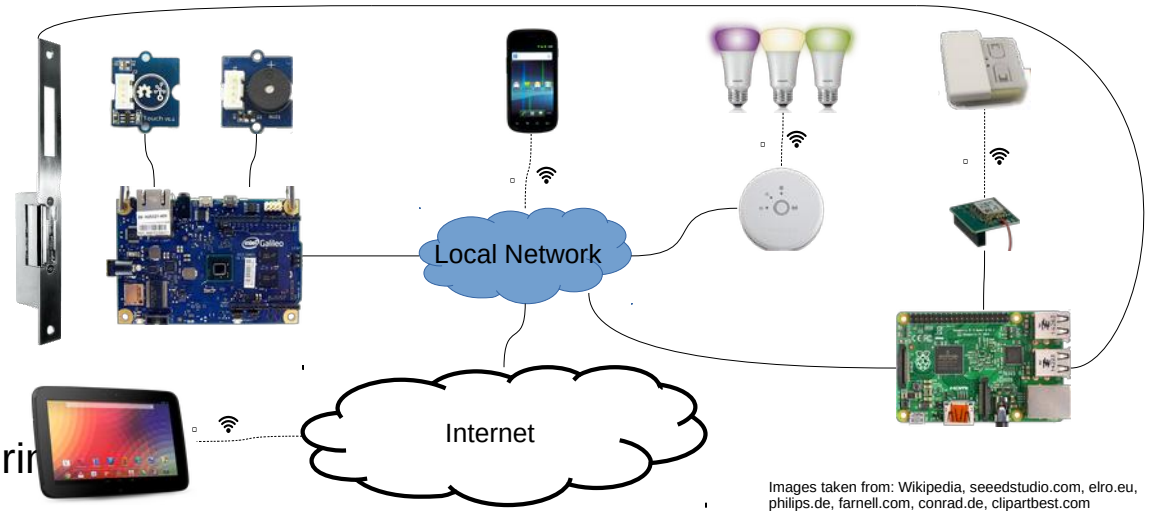
Let’s Crowd Source IoT – Result Collection

- Domains
  - Smart cities, waste management, recycling, urban monitoring public transport
  - Home and building autmation
  - Industry 4.0+5.0
  - Transport , Logistics, Warehouse management
  - Tourism
  - Building security, emergency management
  - Citizen science
- (Data) protocols
  - Coap, mqtt
- Devices (appliances or micro controllers)
  - Esp32, esp8266, raspberry pi, philips hue, alexa, hvac,nfc tag, bluetooth tags
- Challenges
  - Network coverage, coverage, security, privacy, ux design, regulations, soldering/creation/manufacturing, environmental concerns
- Definition(s) of IoT
  - Network of connected things that exchange data potentially without human intervention mixed with connectivity ideas

Internet of Things (IoT) – Own Ideas

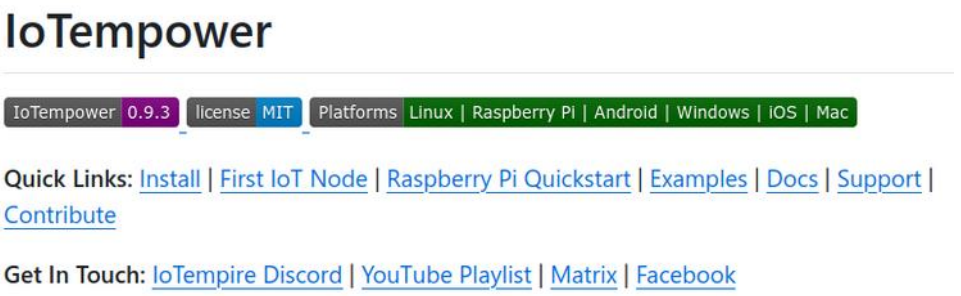
- **IoT Domains**
  - Ubiquitous Computing (Pervasive Computing)
  - Home automation
  - Urban Computing/Smart Cities
  - Embedded Computing
  - Actor/Sensor Networks
  - M2M Communication/Manufacturin
  - Mobile Computing, Wearable Computing
  - (Hacking/Making)
  - Big/Actionable Data

  → **Systems, Connectivity, Data**
- **Devices and controllers**



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

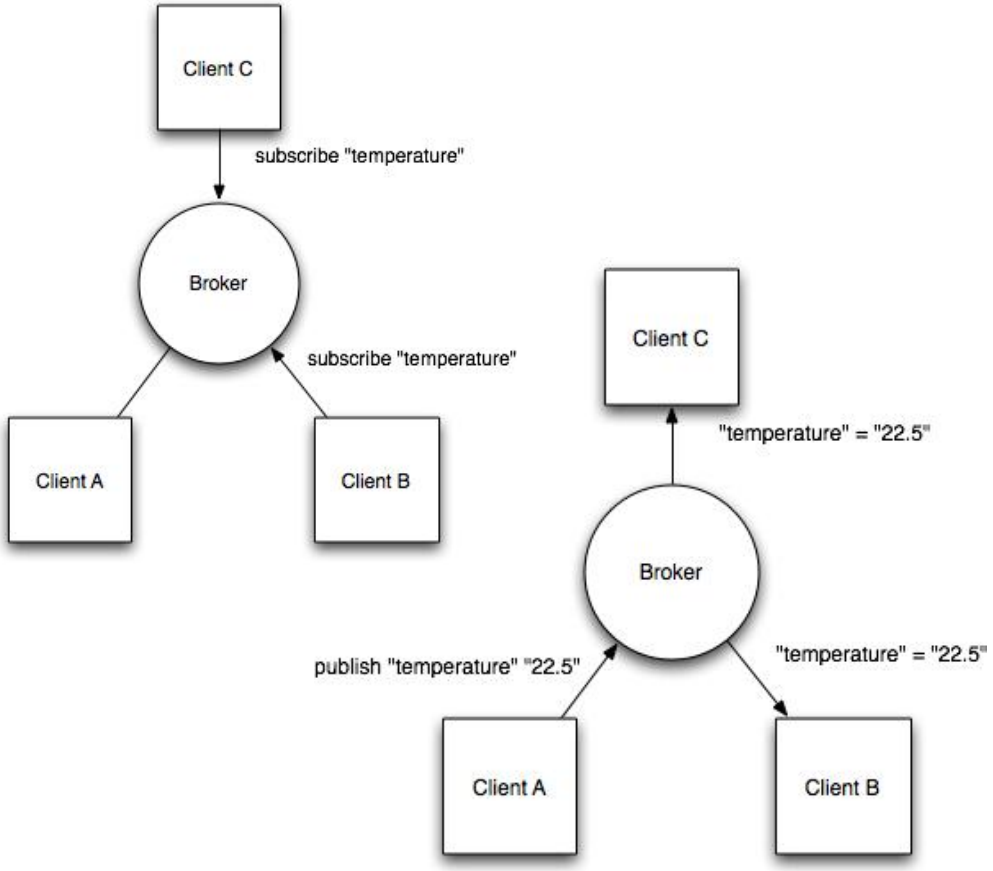
IoTempower – https://iotempower.us



- Education framework
- IoT edge framework
  - **Integration**: Node-RED + IoTknit
  - Simple **ad-hoc networks**: mqtt broker + network setup orchestration
    + easy bridging to full cloud
  - **Device management** – simple edge node management with own firmware → particularly esp8266 and esp32 devices
  - MIT licensed (**permissive** open source **license**)
- "*… packs everything you need to bring your own IoT project ideas to life*"

MQTT – M2M Communication

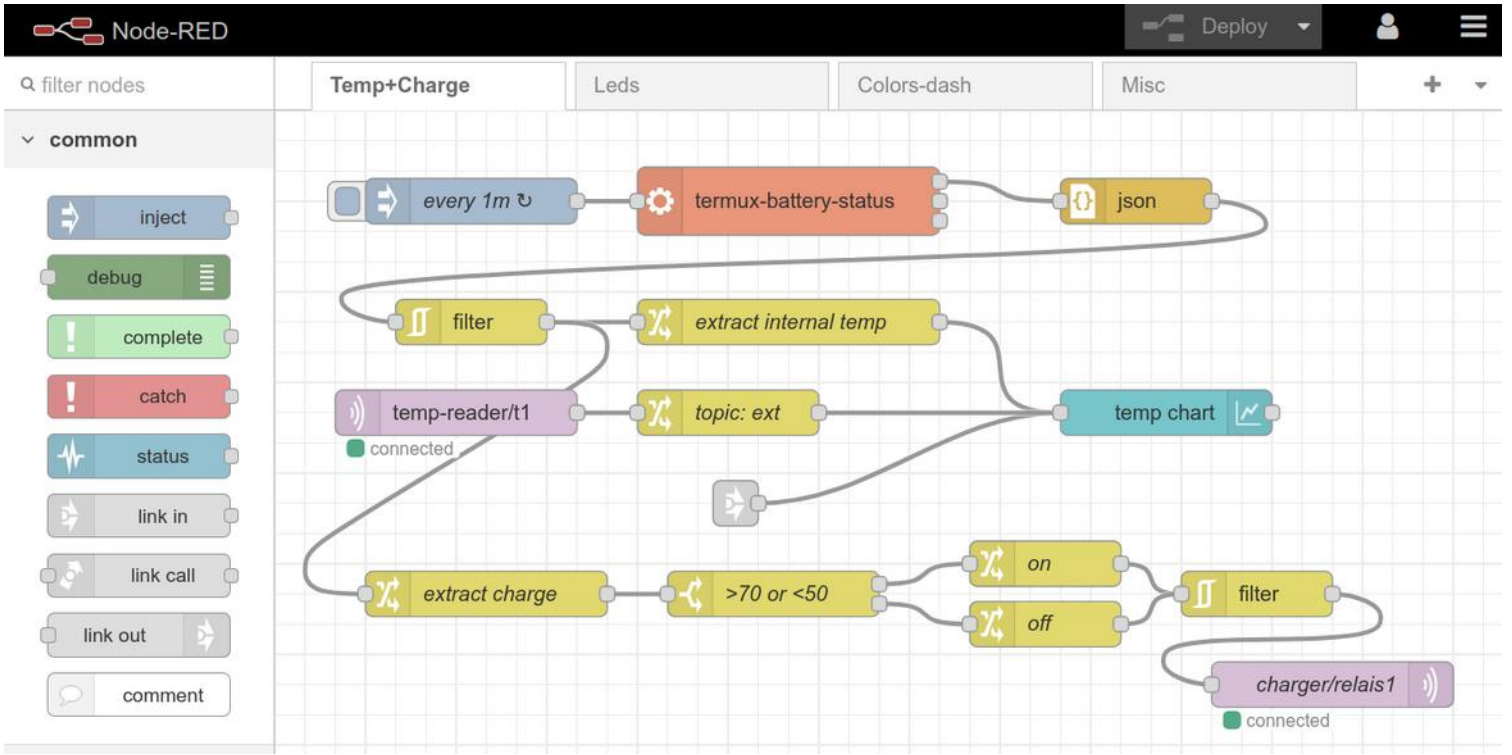
- MQ Telemetry Transport
  or Message Queue Telemetry Transport
- MQTT Gateway/Broker, star topology
- Publish Subscribe (Listener, Observer Pattern)
- ISO standard, Invented in 1999
- Runs over TCP/ any other stream-based protocol
- Very lightweight
  → runs even on slow Pis and routers
- Many implementations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



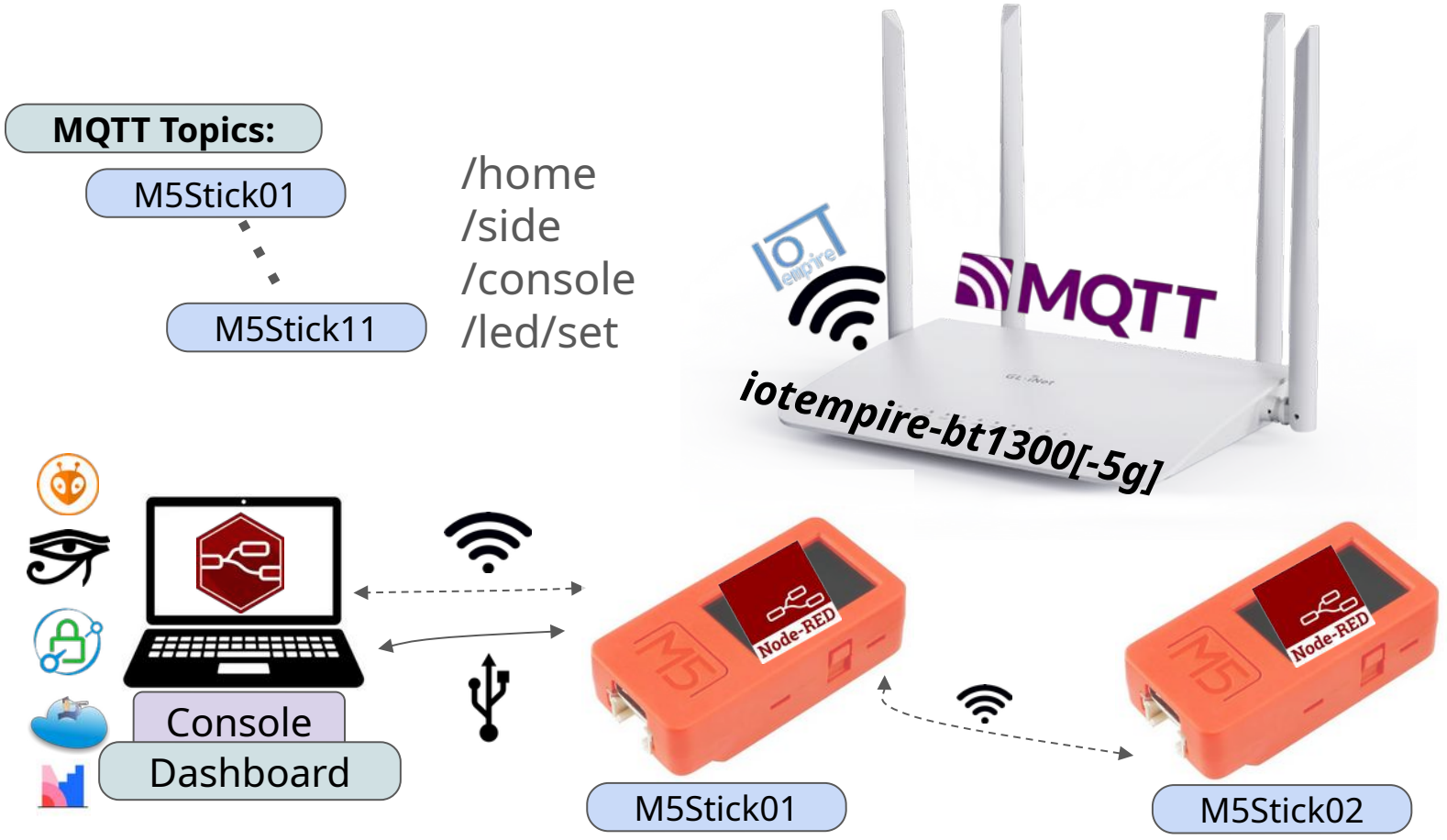
from https://eclipse.org/community/eclipse_newsletter/2014/february/article2.php

Integration with Node-RED – nodered.org

- Popular integrator/ data-flow UI in IoT
- Origin 2013 at IBM
- Open source



General Overview



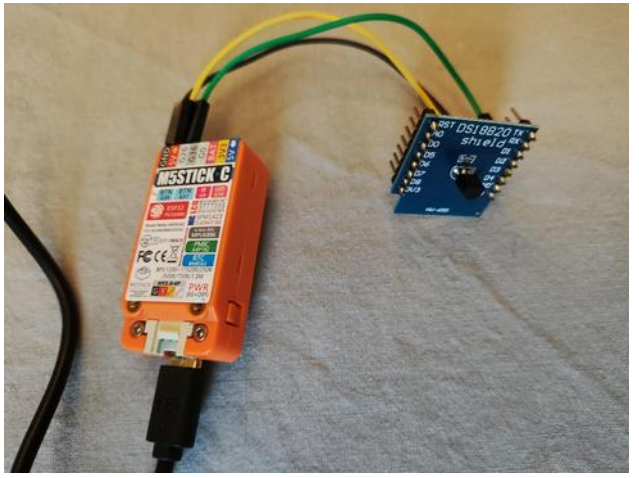
Node-RED

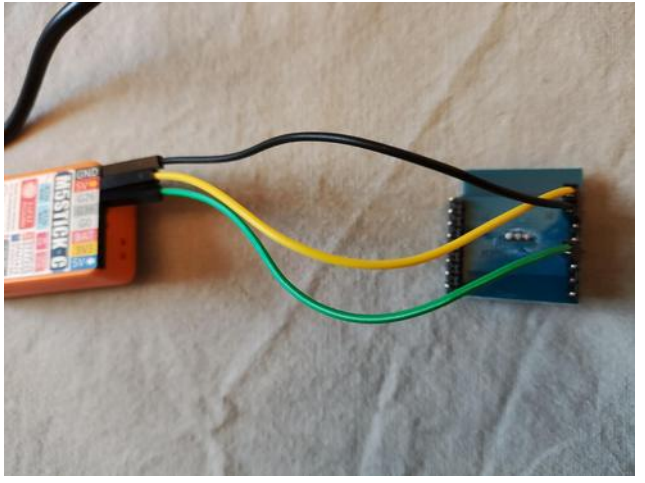
- Let’s network and integrate together
  (wifi for laptop iotempire-b1300-5g, pw: internetofthings
- Use either local node-red or once per team 1 assigned node-red instance: **http://ulno-framework:18nn** with nn given by me, different for each team
- Small basics demo
  (hello world, debug, mqtt, dashboard)
- After my basics, start sending messages to each other, integrate, and evaluate other events
  (i.e. turn on led of other stick with button, send message)

Device Management with IoTempower

- Network (also multi device) deployment
- Simple programing (one line per device, fluent interface), on device filtering!
- Let’s add temperature device

Stick → Temperature Shield
GND → GND
5V → 5V
G26 → D2





Let’s Get Creative

- Watch our IoTempower for education business pitch: https://video.iotempower.us
- While watching list touch points and ideas for your own project
- Share!

More Projects

- Use in own teaching/project
- Partner up with me to develop IoTempower further
  - Measure power of apartment complex (with 16 units) in emerging economy
  - Install and configure single MCU super easily with Android (new wifi credentials when installing, potentailly add ethernet support)
  - Secure communication (enable TLS for MQTT)
  - Simple (video) guide