# Building a “Smart House” and You Want to Do It Yourself?

a.k.a. - my IOT/home-automation experiments and some random thoughts… v.3

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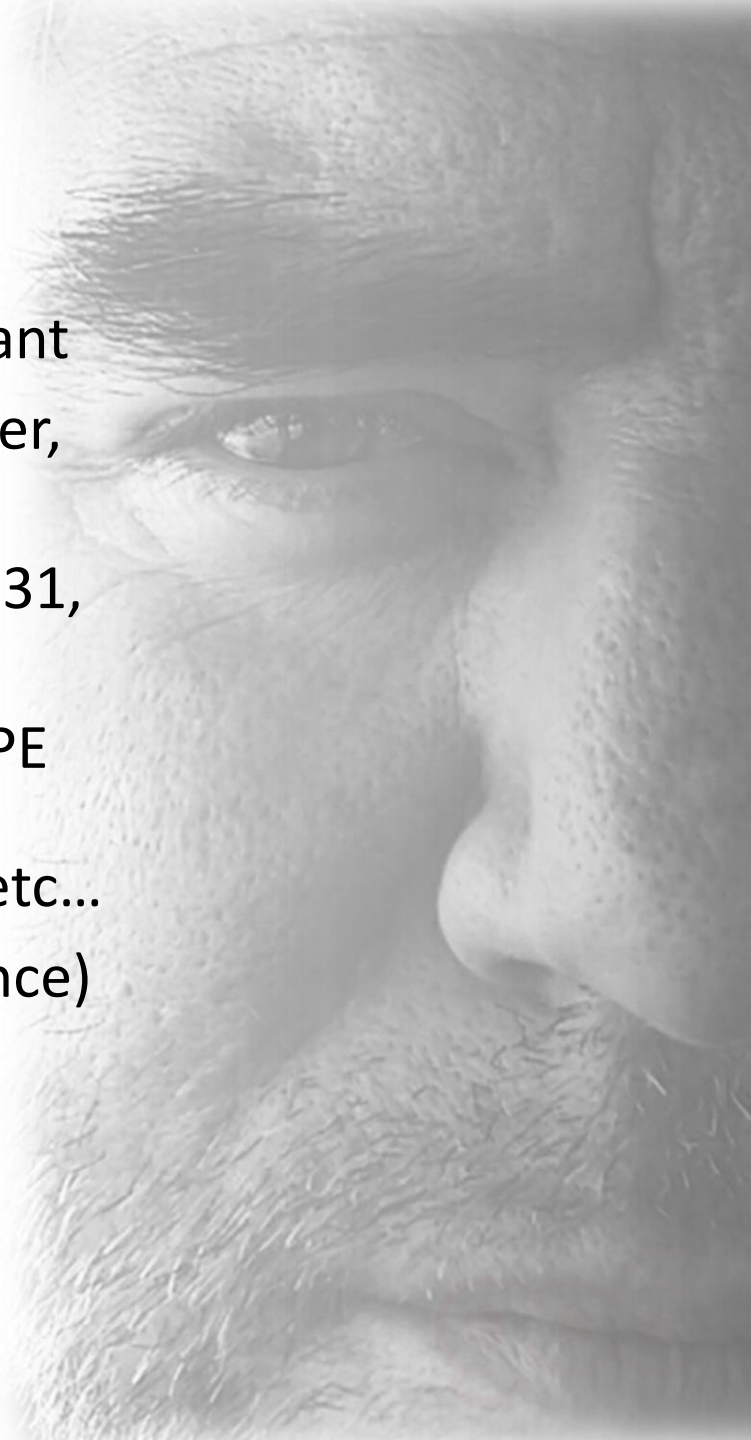
# Who is Jan Žorž ?

- VP of 6connect Labs
- CEO of Go6 Institute and IPv6 consultant
- Networker and system admin (old timer, since VAX VMS times ;) )
- Primary co-author of RIPE-554, RIPE-631, RIPE-690, RFC 6346, etc...
- RIPE Program Committee member, RIPE NomCom member, SEE RIPE regional meeting chairman, SINOG chairman, etc…
- Co-founder of GNA (Global NOG Alliance)
- Maintainer of Go6lab, place of IPv6 experiments ;)
- Lives and works in Slovenia.



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# My IOT lab that looks pretty much like a house ☺

# Smart house? IOT?

- If you would like to build a “smart” house or “IOT enabled”, then you have two options:
  - You outsource it, vaguely describe what your wishes are, pay a lot of money and voila – you have some smarts in your house, but it works the way the vendor envisioned it.
  - Or you decide that your technical and experimental skills are up to the task, you start learning and experimenting and build the whole system by yourself.

# Home brewing the IOT

- I decided to build it myself.
- It’s much more fun and you learn a lot.
- Also consumes a lot of your time while you learn and experiment. Be aware of that.
- IOT world is a Wild West. It takes time before you start distinguishing what is what there.

# Easy and non-private or not easy and private?

- First thing that I had to decide was the architecture of a system that I'm building:
  - Buy cheap sensors and actuators that connects over Internet to unknown cloud intelligence somewhere in the world and let my home environment be controlled and measured by random folx from the Internet?
  - Or design sensors and actuators around home gateway that doesn't talk to the cloud, but uses local intelligence and keeps control and data in my home environment?

# Home gateway dilemma…

- I decided for home gateway.
- Next question: Some home gateways are not very smart and uses remote intelligence in the cloud to control your home environment. Should I use them?
  - **YES**
  - **NO**

# Home gateway dilemma…

- The answer was **NO**. Obviously.
- I really like my home environment private and not controlled by random people from around the planet.
- What to use then?
  - Raspberry PI or any Linux system with open source home automation control system software
  - Some vendors boxes that supposedly don’t talk to the cloud

# Home gateway dilemma…

- Decision was to use something Linux based.
- For first experiments I used Raspberry PI with Z-wave and Zigbee USB controllers
- For “production” use – DeskMini PC with i5 processor, two disks in mirror, 32GB ram and Ubuntu Linux (still on 18.04 LTE).

# Home automation “cloud” ☺

# Automation software dilemma…

- What exactly do we expect from this IOT stuff?
- What are we going to do with it?
- How are we going to program the rules and intelligence?
- What kind of interface do we expect?
- Are we doing it just because it’s cool and other people have it?
- Test couple of known solutions and then decide!

# Automation software dilemma…

- Before testing the software – decide on sensors and actuators and what protocols you are going to use.
- I tested Z-wave, Zigbee and MQTT
- Without some test sensors and controllers you'll not be able to test automation software - as by default it does nothing and is pretty useless without any sensors to read/control.

# Test “thingies”…

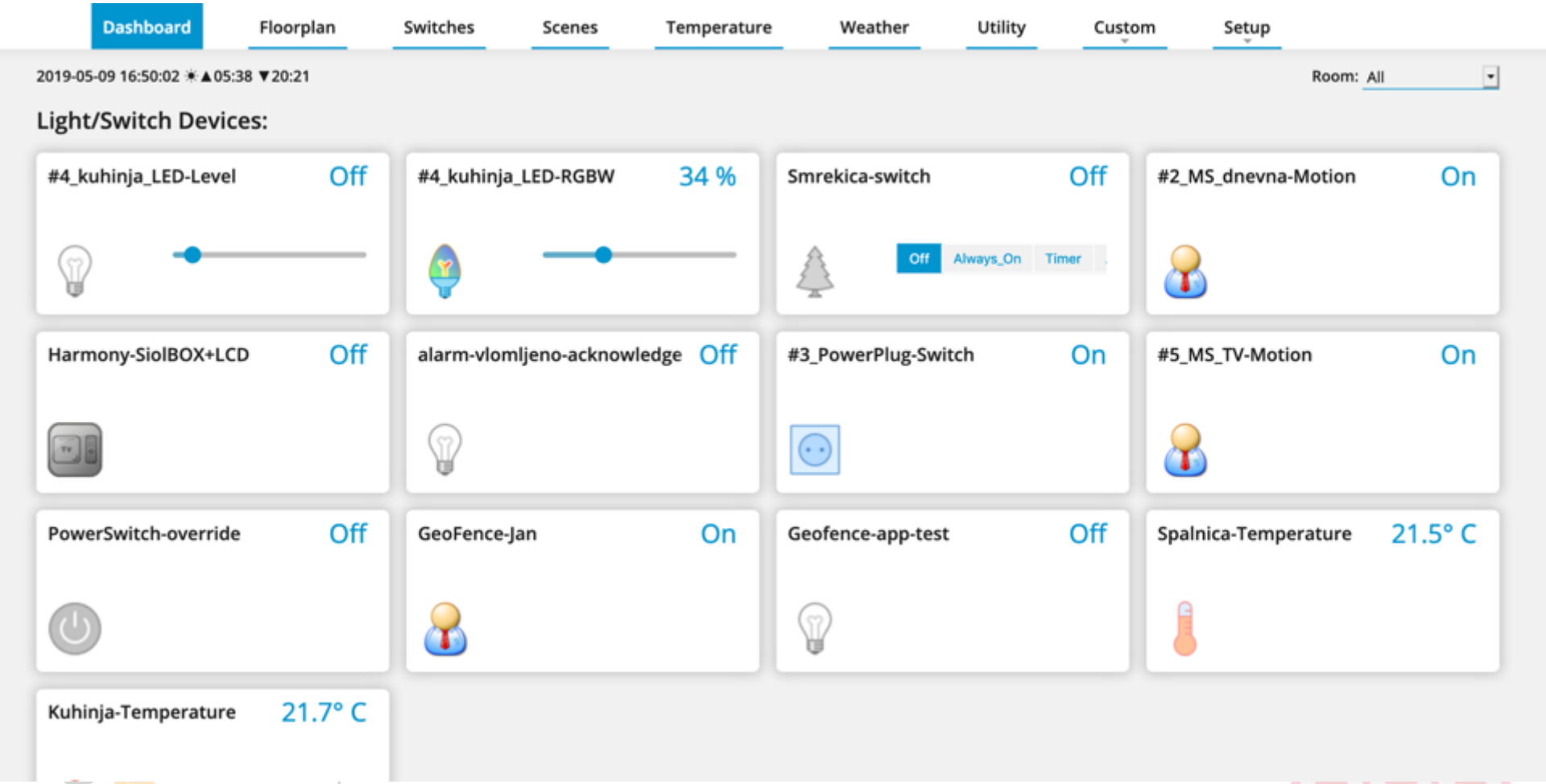
# Automation software dilemma…

- I tested over 10 of them, including:
  - Domoticz
  - OpenHAB
  - Mozilla WebThings gateway
  - Home assistant
  - MisterHouse
  - OpenMotics
  - ioBroker
  - OpenNetHome
  - SeerHome (not open source, not free)

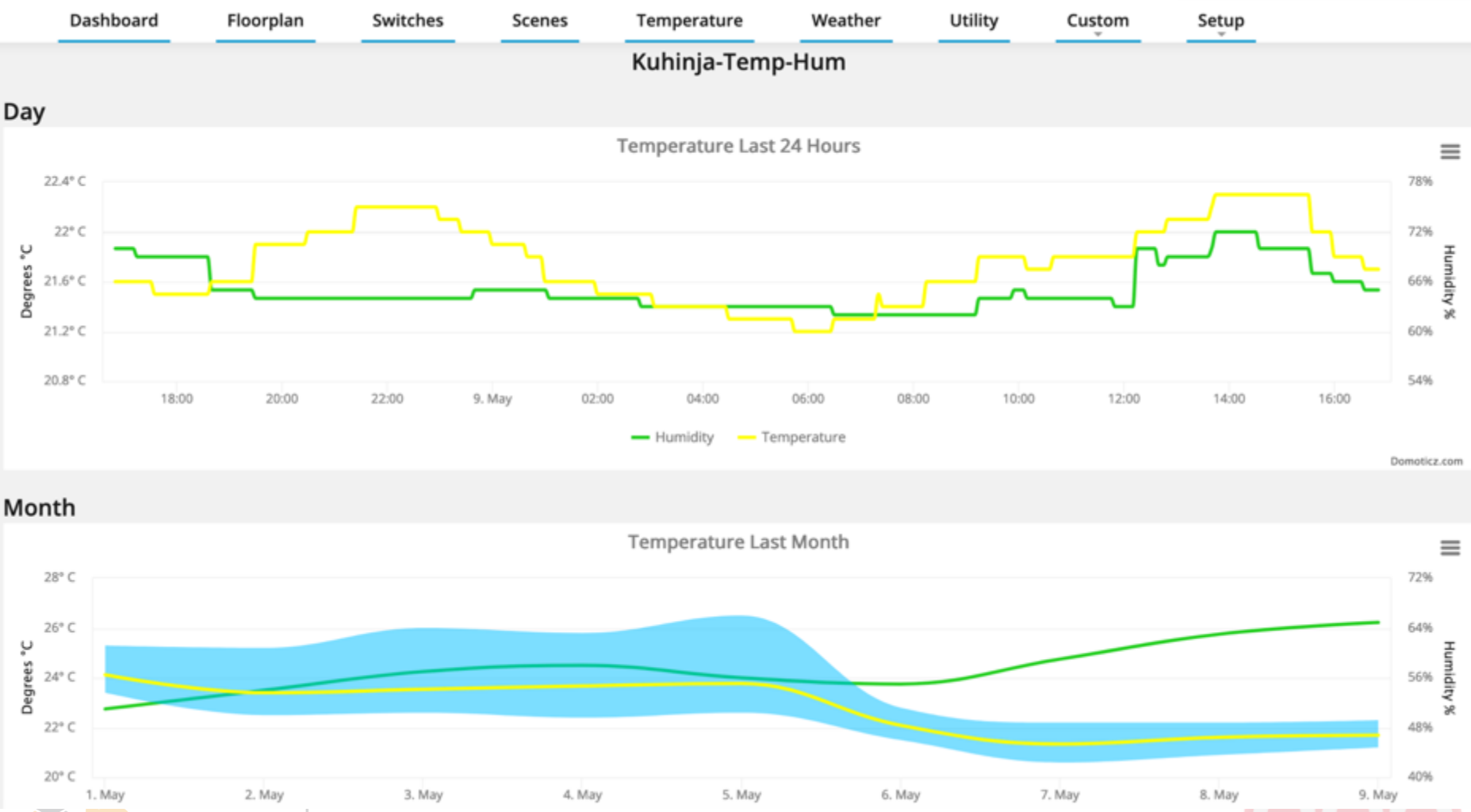
# Automation software dilemma…

- Which one to choose?
- It depends on what you are looking for, but after you'll install and test all of them – you'll get a pretty good idea of what you need ☺
- I was torn between OpenHAB and Domoticz, but then decided for Domoticz
- Better rules creation engine and programming, but a bit older user interface.
- Can't have it all, apparently ☺

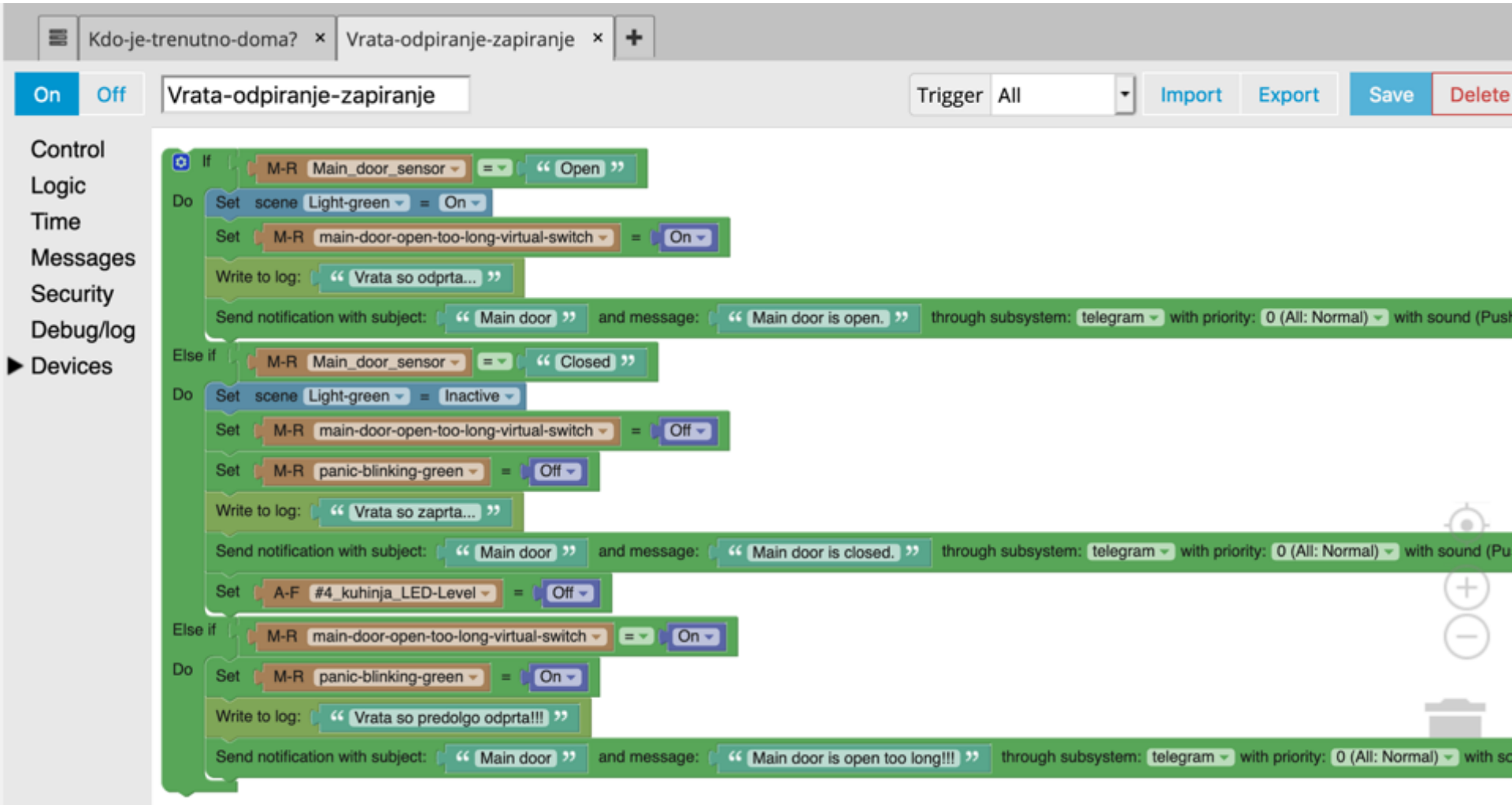
# Domoticz with Machinon skin



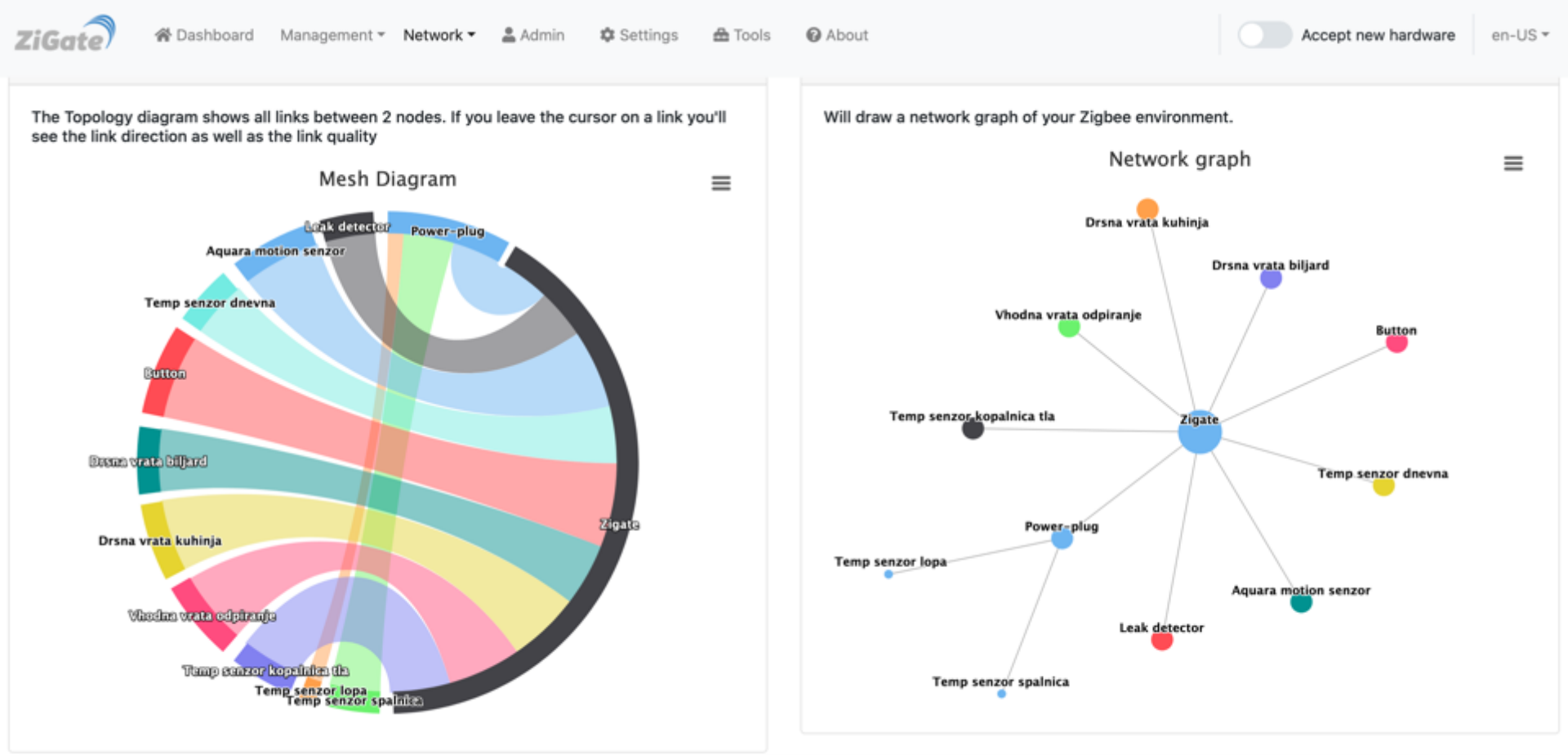
# Domoticz with Machinon skin



# Domoticz – rules – Blockly way

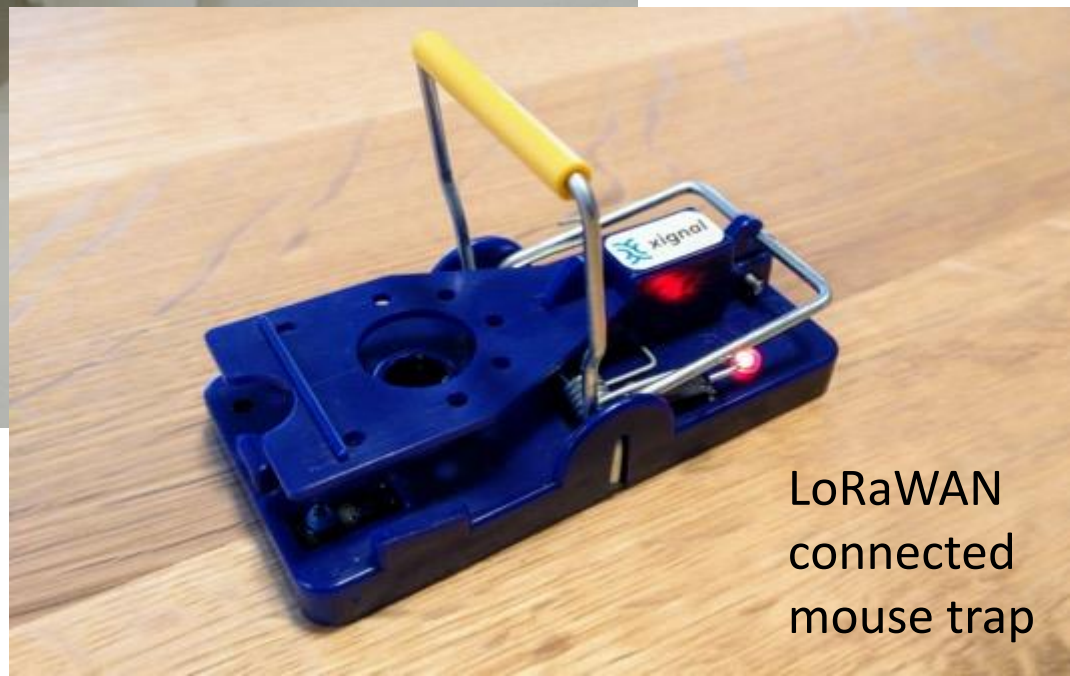


# Zigate (Zigbee controller) management



# LoRaWAN – because 3 other wireless protocols is clearly not enough… :)

TTIG LoRaWAN gateway


LoRaWAN connected mouse trap

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# LoRaWAN – because 3 other wireless protocols is clearly not enough… :)

- Gateway connected after 3 or 4 days…
  - Despite the fact that TTN folx gave me the gateway at their conference and should work
- Mouse trap also connected after I was able to register on their web portal
  - It's a lock-in product. It joins with it's EUI on TTN and with their dedicated app ID, so you can use it only through their web portal…
- Couple of thoughts on LoRaWAN network (TTN way):
  - Clearly built with "cloud intelligence first" in mind
  - You can have the whole stack at home ( network _server + app_server + gateway), but then things become rather complex
  - If you want to setup your own independent network in your house that would talk to other networks you need to be a member of LoRa alliance ($$$) and/or implement a newly thought out mechanism to exchange traffic with other entities. We should not be building  traffic exchange mechanisms with telephone mentality from '80s ;)

19:04:34 868.5 4/5 SF 7 BW 125 61.7 app eui: 70 B3 D5 AF 70 16 00 01 dev eui: 70 B3 D5 AF 7F 16 02 59

**Join Request**

Join request to TTN, as seen on the gateway

**Dev EUI**

70 B3 D5 AF 7F 16 02 59

**App EUI**

70 B3 D5 AF 70 16 00 01

**Physical Payload**

00 01 00 16 70 AF D5 B3 70 59 02 16 7F AF D5 B3 70 0B 38 02 59 7B F6

**Event Data**

```
1 {
2   "gw_id": "eui-58a0cbfffe8022a3",
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Trapname** | Jan's mouse trap | **Collection** | Jan | **Battery** | 2,80 V | **Last updated** | 4. 02. 2020 19:04:44 |
| **Status** | Trap armed | | | **Temperature** | 19,55 °C | | |

Vendors web portal...

| Date | Status | Battery | Temperature |
|---|---|---|---|
| 4. 02. 2020 19:04:44 | Trap armed | 2,80 V | 19,55 C |
| 4. 02. 2020 19:04:24 | Trap closed with no catch | 2,90 V | 19,84 C |

# Now what?

- Well testing, testing and more testing.

- …until you are happy with your decision and you get enough experience to properly understand what you need and expect from your system.
- Reading about it doesn’t bring you any experience.

# Experience and stories…

- Z-Wave sensors can store settings, scenes and things that you would not imagine.
- Z-Wave sensors/actuators that are not directly reachable by controller tend to be slower to respond due to not very optimal mesh network
- Zigbee sensors are not so complicated to setup and read/control
- Zigbee uses 2.4GHz radio and penetrates better through walls
- With Z-Wave sometimes you have issues connecting to a next room (depending on wall structure…)
- Z-Wave sensors/actuators have lots of controls and settings about their behavior
- Zigbee devices are not very configurable, they very much depend on profiles in zigbee stack on controller.
- Xiaomi Aqara temp/humidity sensors have an issue on Zigbee protocol… Its rejoin procedure doesn't work. So you have to have a really good Zigbee network with router devices (power sockets or lights). With this, you can ensure that data transmissions arrive to your Zigbee controller.

# Experience and stories…

- Z-Wave sensors are much more expensive than Zigbee (Z-Wave protocol is licensed)
- If you are using Z-Wave DIN Light Dimmers – make sure you get your electrical wiring correctly ☺

# Experience and stories…

- Start creating rules and scenes and you'll learn how the whole thing works during the process. For a start you can use Blockly to easily put rules together, later you may switch to Python or LUA for more complex rules.
- Every rules engine has its own ways of interpreting commands, so – test, test  test.
- Start observing "life at home" process and transform it into the code
- Automation is there to help you, not to dictate you how to live.
- It should be your "good ghost" from the back, making your life easier and perform everyday tasks instead of you.
- Be attentive to architecture - manual mode of operation must be always possible. Imagine your grandmother coming to stay at your house ☺

# Ventilation/recuperation system controls ;)

- We've got a ventilation/recuperation system in house (Nilan) with CTS700 controller that can talk MODBUS-TCP (and normal MODBUS).
- Why not talking to this device and figure out what it is doing?
- When we got data – we can understand how to setup the heating in the house in a best, most comfortable and cheapest way.
- Lession learned: Passive house – you can heat it up easily, but it takes time before if cools back down to comfortable temperature ☺
- I still have no courage to write over MODBUS to the device, but that time will maybe come…


Temperature (°C)
Temperature (°C)
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
Sun 15:00
Sun 18:00
Sun 21:00
Mon 00:00
Mon 03:00
Mon 06:00
Mon 09:00
Mon 12:00
Rekuperacija moc
Temp. vsesani zunanji zrak
Temp po rekuperaciji
Temp. v prostorih
Temp izpihanega zraka v zunanjost
Temp bojler zgoraj
Temp bojler spodaj
Bypass valve
4way valve
RRDTOOL / TOBI OETIKER

# Battery powered motion sensor?

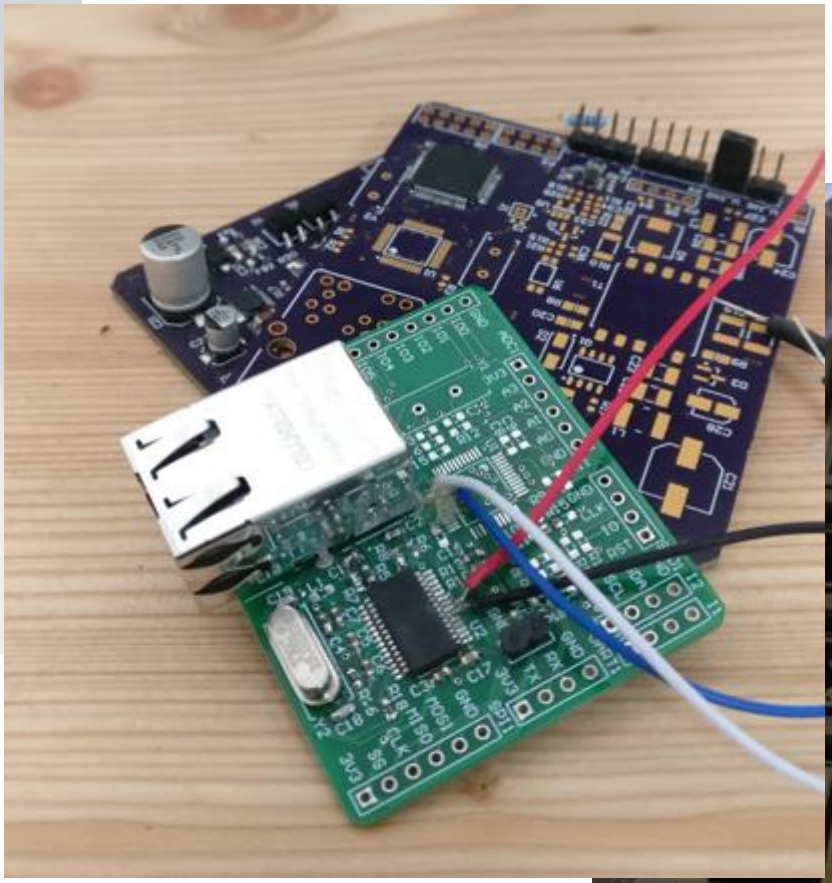
- Property of wireless sensors is that they drain battery. This is not a very comfortable property when you have many of them.
- We have PoE available. We have UTP cables everywhere. Why not using PoE for powering all this sensors?
- Couldn’t find any motion/temp/humidity/light sensor that would be powered over PoE, communicate over Ethernet and MQTT or WOT and support IPv6(-only) environment.

# Motion sensor – home brewed

## So we decided to develop and build our own POE powered IPv6 sensor ☺

- CPU: STM32F030CC
  - Enough ram (32kB) for so cheap MCU
- ETH: ENC424J600
  - Factory pre-set MAC, SPI connection for cheaper MCU
- POE: Si3404
  - Most integrated solution, less possibility for mistakes

# Motion sensor – home brewed



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# Motion sensor – home brewed

- After couple of versions - first boards are now showing the sign of life ☺
- Magic smoke tends to escape from electronic devices – proven fact.
- Just put magic smoke back in and try again.
- IPv6-only, POE powered and with MQTT/WOT? Lot's of work ahead.
- Prototypes works to some extent:
  - MQTT session is not as stable as we would like it to be yet
  - It's IPv6-only and we like that ;)
  - …

# IOT and AI

- Rules creators and LUA/Python programming works when you have small amount of rules and actions on your home gateway.
- Rules start interfering with each other rather quickly when number of rules grows.
- I wish that I would have a smart and intelligent box that would login to my home gateway as myself, observe the environment through sensors and learn when a manual action is done (like switching the light on or off) and then slowly start executing actions…

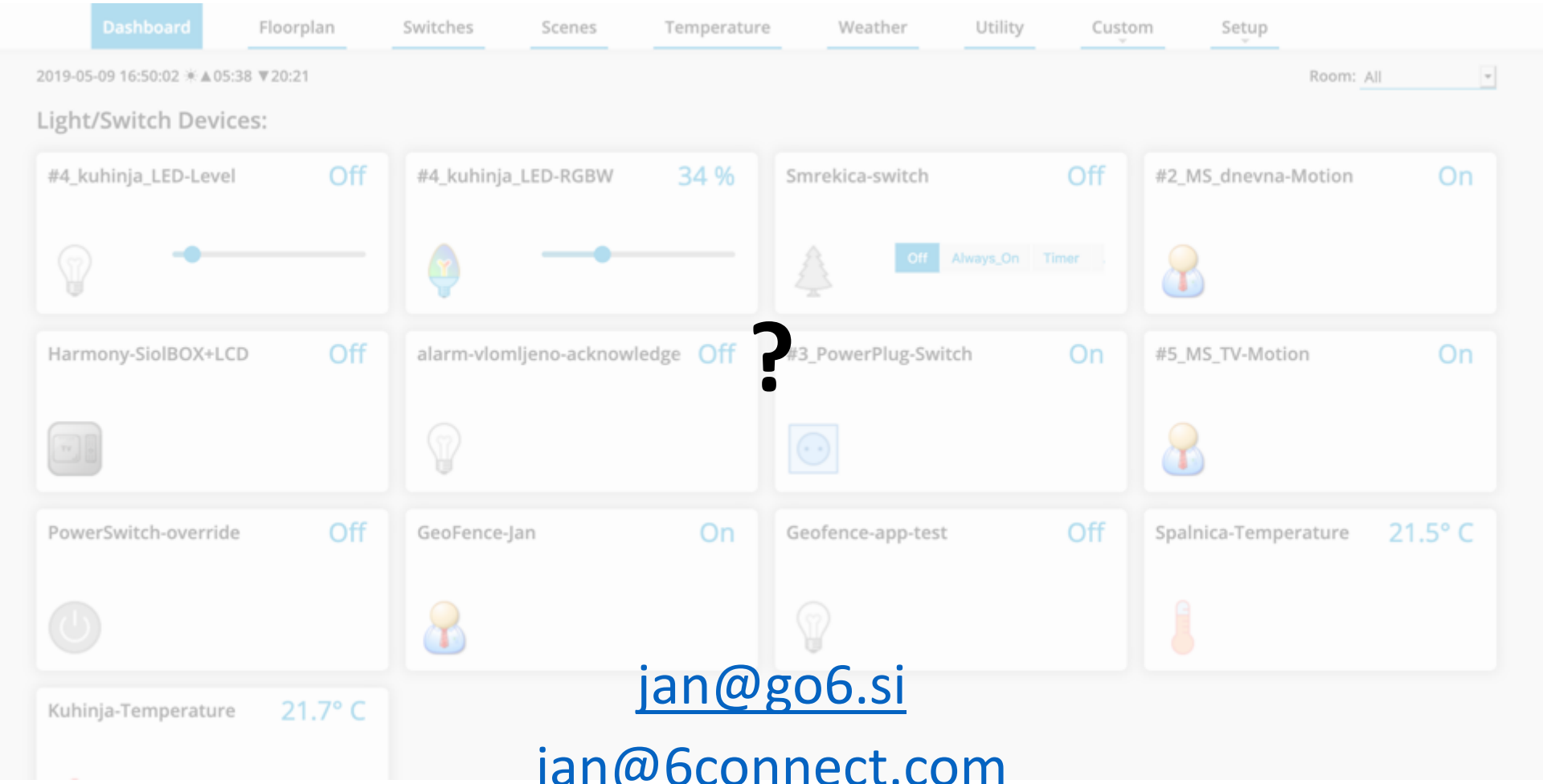
# Thoughts…

- Because of simplicity – people tend to connect whatever they can buy cheaply and allow this devices to talk to the Internet or other app/IOT providers (like TTN, for example).
- Who has control of data on the other side?
- What is this data being used for?
- Who has taken the control of your environment away from you? Do we want this? Cloud connected front door locks? Come on…

# Thoughts…

- If we can unlock our front door through “the cloud” then anyone that gains access to that cloud can unlock your door. Scary.
- **Local AI** learning about your everyday life?
- IOT world is a Wild Wild West. Huge number of vendors selling products of various quality – who can tell you what is what? How secure it is? Will it breach your privacy?
- Don’t just read about IOT stuff – buy one or two examples of various things that you would consider using and test test test test. That’s the way you’ll learn.

# *Questions? Suggestions?*

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