LeonR&Do testbed: A scalable IoT platform for facility automation and energy control

Dr. Konstantinos Filis
Senior Researcher
COSMOTE - Mobile Communications SA
cfilis@cosmote.gr

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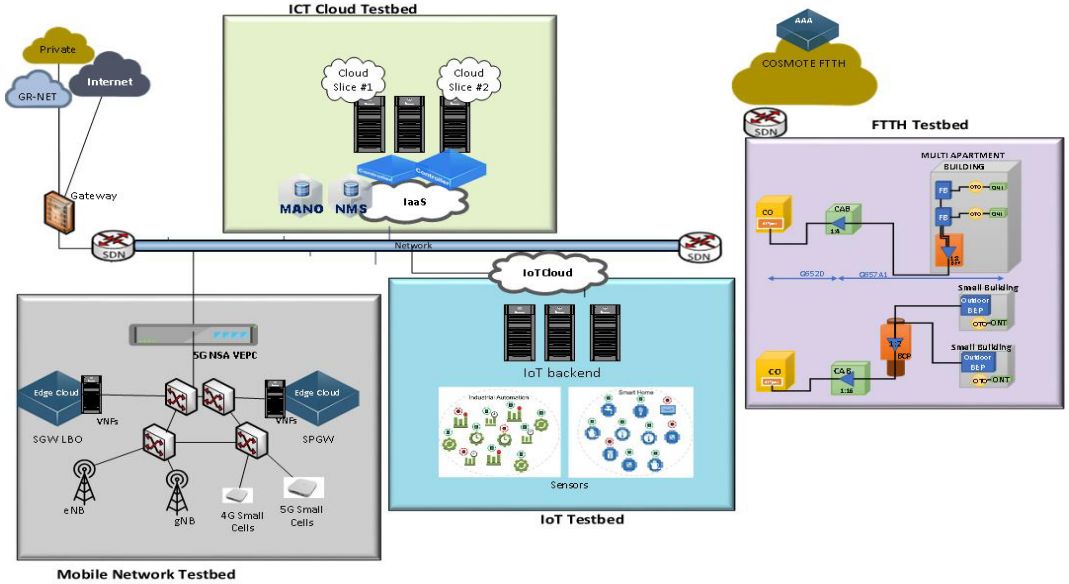
“LeonR&Do” Lab Infrastructure Overview



Four (4) interrelated Domains

- **ICT Cloud**
  hosting Ubuntu, Linux & Centos OS VMs
- **4G/5G NSA Testbed**
  gNB/eNB, MEC & core network nodes
- **IoT Platform**
  e2e solution developed in-house
- **FTTH Testbed**
  multi-apartment building, small buildings simulations

Interconnected with Research Institutes/Centers

- NCSR DEMOKRITOS (and other academic institutions) over 1G GRNET
- NTUA over dark fiber (10G)

The LeonR&Do IoT Platform General Overview

The LeonR&Do IoT platform is a flexible, scalable and secure e2e solution - *developed from scratch-* that can integrate any sensor (commercial or custom) and any technology, supported by a common backend/cloud infrastructure

The LeonR&Do IoT testbed is accessible from anywhere.
Any sensor can be integrated (through a common API), while data monitoring/visualization, alerting, data retrieval, etc. services are available.

- **Currently Utilized in INTERCONNECT, AEOLUS, LIFE SAFE-CROSSING, Int5Gent, and 5G-COMPLETE EU Projects and @Telco Sites**
- **Continuous Expansions (@sensor, @GW, @backend level)**

The LeonR&Do IoT Platform Aim: Smart Buildings

Energy monitoring
[1/3 phase energy meters, smart plugs, socket energy meters]

Energy Management
[@phase, relay, plug/socket, lights switch, device level]

Advanced Automation
[based on events/rules, scenes, etc.]

Home Comfort
[cooling/heating, boiler, TV, Music Player, Lights, air-quality, temperature, humidity, etc.]

Alerting
[push notifications @smartphone, e-mail, etc. based on rules/events]

Security
[cameras, motion detection, flood, fire detection, door/window, siren]

Other
[voice commands, WOL, wifi/location presence, etc.]

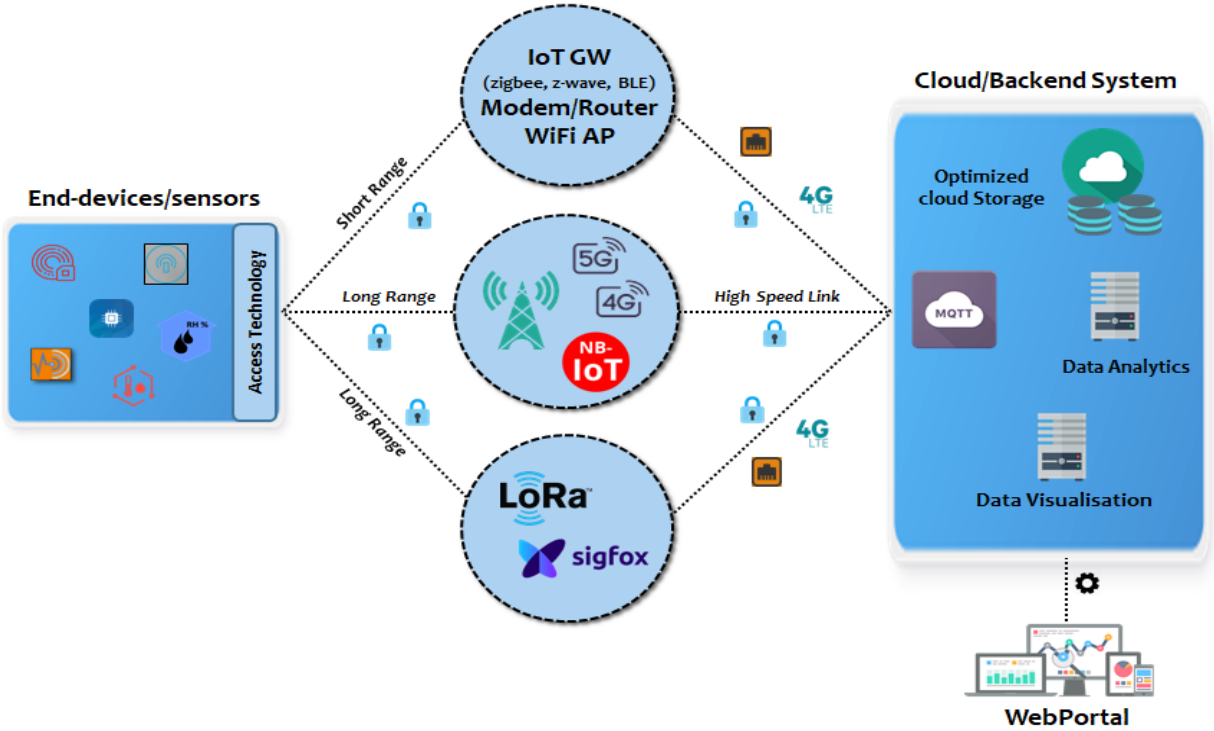
LeonR&Do IoT Platform HW/SW

Custom and commercial end-devices/sensors such as, power/energy-related (relays, power meters, smart plugs, etc.), air-quality, temperature, humidity, pressure, activity/motion, luminance, smoke/fire, etc.

IoT hubs/gateways supporting multiple access technologies/protocols incl. WiFi, z-wave, zigbee, BLE, LoRaWAN, 2G/3G/4G/4G+, NB-IoT.

Common backend for data storage, processing and visualization (MQTT, InfluxDB, Grafana, Kapacitor)

Docker deployments and remote configuration device management.



SENSORS: Energy Monitoring/Management

Wireless energy meters

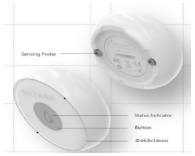
Wireless sockets / plugs

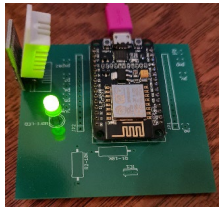
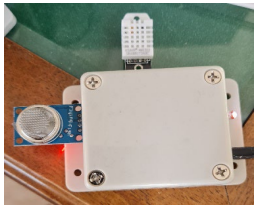
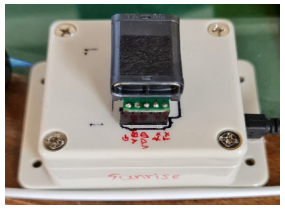
Wireless energy switches

Smart light switches

SENSORS: Environmental & Security Related

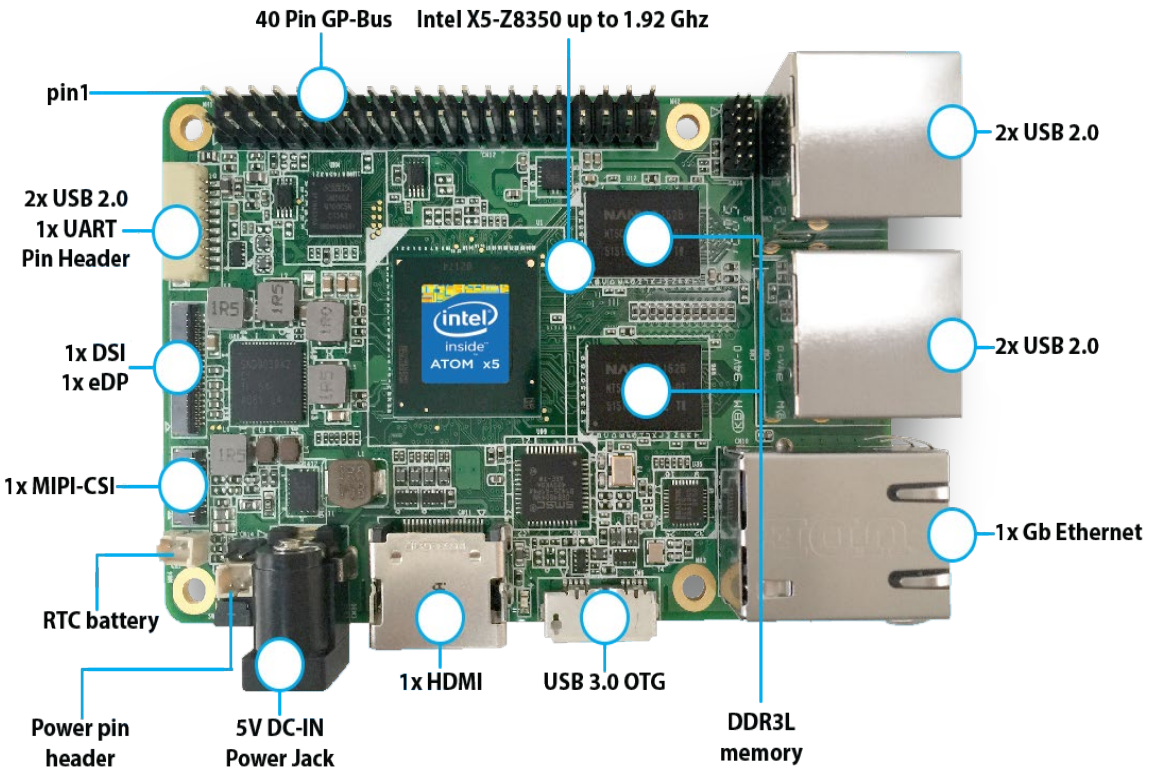
Temperature, Humidity, Pressure, Smoke, wireless sensors



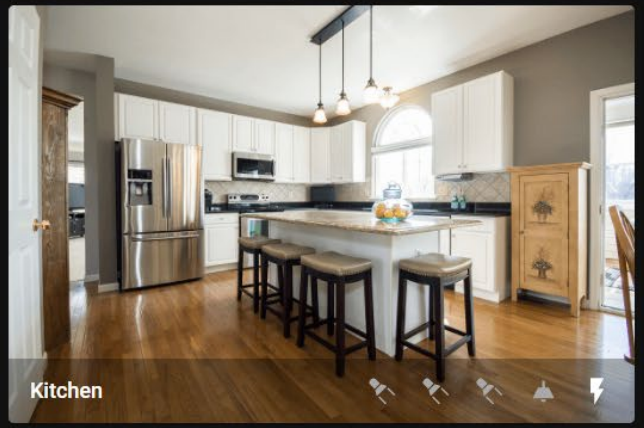
Wireless cameras, sirens, door and motion sensors

IoT Gateway



- z-wave controller
- zigbee controller
- BLE controller
- WiFi hotspot
- 3G/4G USB dongle

Home Assistant User Interface



Smart Plugs (z-wave)

- LR Floor Lamp — off
- LR Table Lamp — off
- Attic_Yeelight — on
- Attic Ceiling Lights — off
- Washing Machine — on

Smart Plugs / Lights (WiFi)

- Sonoff01 Bulb (LR) — off
- 1st_floor Corridor Lights — off
- 1st_floor Bathroom Lights — off
- 1st_floor Bathroom Fan — off
- BW-SHP2 (Bedroom) — off
- Front Yard Light — off
- shelly 1PM (LR) — off
- BW SHP8-1 (Attic) — on
- Kitchen Plug (SHP8) — on
- sonoff TH16 (Office) — off
- Sonoff POW for Strobe — off
- Shelly1L (balcony) — off

Kitchen Lights (z-wave)

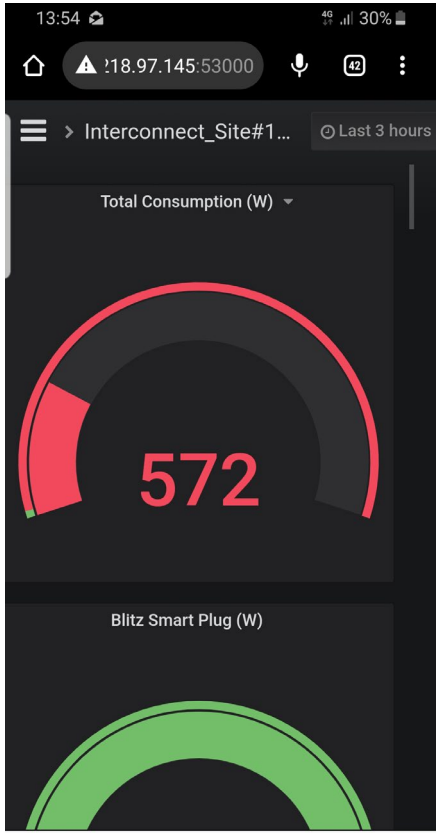
- Ceiling Lights — off
- Pi Lights — off
- Countertop Lights — off
- Hidden Lights — off
- Back Yard Lights — off

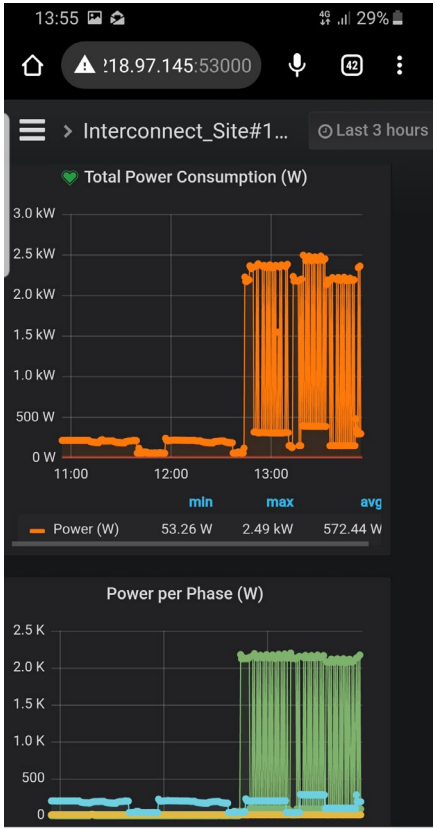
Fusebox (relays)

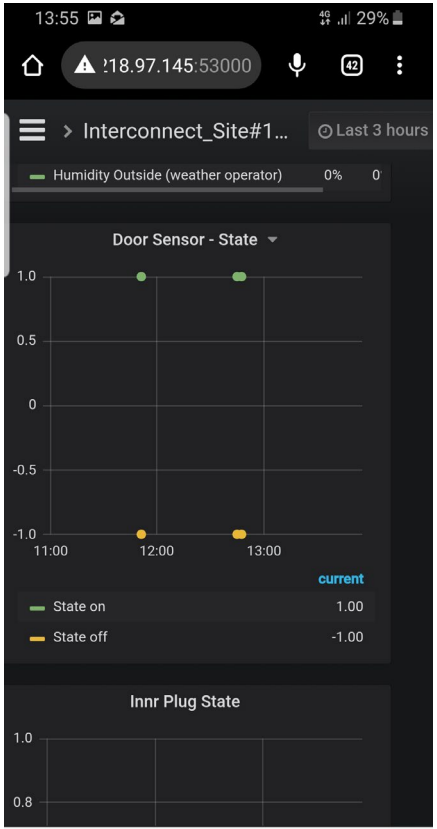
- R0-nothing (off) — off
- R1-plugs (on) — on
- R2-plug_panel (off) — off
- R3-boiler (on-off) — off
- R4-boiler-timer (on) — on

Accessible via smartphone, tablet, laptop/PC or even smartwatch from anywhere, anytime

Data Visualization







Accessible via smartphone, tablet, laptop/PC from anywhere, anytime

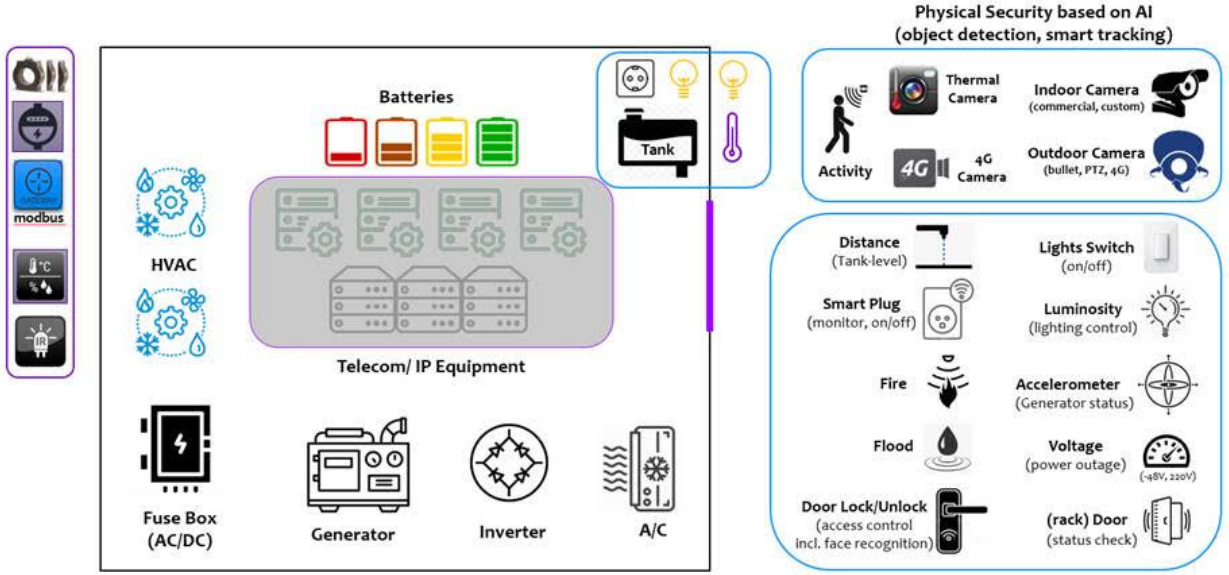
Internal Apps/Solutions/Tools for Telco Site Buildings (1/2)

- AC/DC Power Energy Monitoring (@phase level, total) | Modbus-based solution
- Energy Management (manual & rules/events-based)
- Remote management of any Modbus enabled node/element (HVACs, Inverters, power generators, etc.).
- A/C splits remote control @telco sites:
  - Change A/C temp, fan speed, … remotely (+massive commands)
  - Change A/C temp automatically based on local temp and/or HW temp thresholds Remote configuration of eNBs (NOKIA 4G) | automated "script" for specific actions (e.g., switch-off radios)
- Temperature, humidity, air-quality (CO_2, CH_4, CO, LPG, dust, etc.) monitoring. Sensors for fire, flood, door/window/rack door status, etc. are available too.

Internal Apps/Solutions/Tools for Telco Site Buildings (2/2)

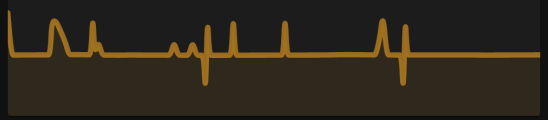
- e2e physical security
  - (any, custom) object detection using AI -> combined with PIR/MW activity detectors @perimeter
  - object tracking [virtual fence] +alerting + visualization + visual/audio alerts (incl. voice announcements)
  - Supports any wired/wireless camera from any vendor (HIKVISION, DAHUA, REOLINK, etc.), both commercial and custom indoors/outdoor ones

- Access Control -> Face recognition, NFC -> door lock /unlock
- Antenna/MW dish tilt module (NB-IoT) | alerting | powered by -48V, PV, battery
- Voltage (220V, -48V DC) monitoring NB-IoT module for microBS sites alerting



SWITCHES | CLIMATE | ALARM | AIRQ | INDOOR_SENSORS | OUTDOOR_WEATHER | POWER & ENERGY | CAMERAS | CASTING | AUTOMATIONS | SYSTEM | MISC

Indoor Temp Aqara@LR (zigbee)
24.9 °C



Temp @Sonoff TH01_Attic (zigbee)
27.9 °C

Temp @ZW100-Hallway (z-wave)
25.0 °C

shelly H&T temp
28.2 °C

shellyUni#2_DS18B20 @Attic
27.7 °C

26.6 °C
zigbee_outdoor

25.7 °C
FrontYardDoor

25.0 °C
Hallway

24.9 °C
zigbee_LR

26.9 °C
FibEye_LR

26 oC
Custom_LR

Environmental (zigbee)

AqaraPIR_Front_Yard Temperature	32.0 °C
Indoor Temp Aqara@LR (zigbee)	24.9 °C
Indoor Humi Aqara@LR (zigbee)	60.5 %
Indoor Pressure Aqara@LR (zigbee)	970 hPa
DoorToBasement Temperature	27.0 °C

Sonoff TH01 Attic (zigbee)

Temp @Sonoff TH01_Attic (zigbee)	27.9 °C
Humi @Sonoff TH01_Attic (zigbee)	50.4 %

Nest Thermostat

Nest Temperature (Hallway)	25.73999 °C
Nest Humidity (Hallway)	54.0 %

Luminosity

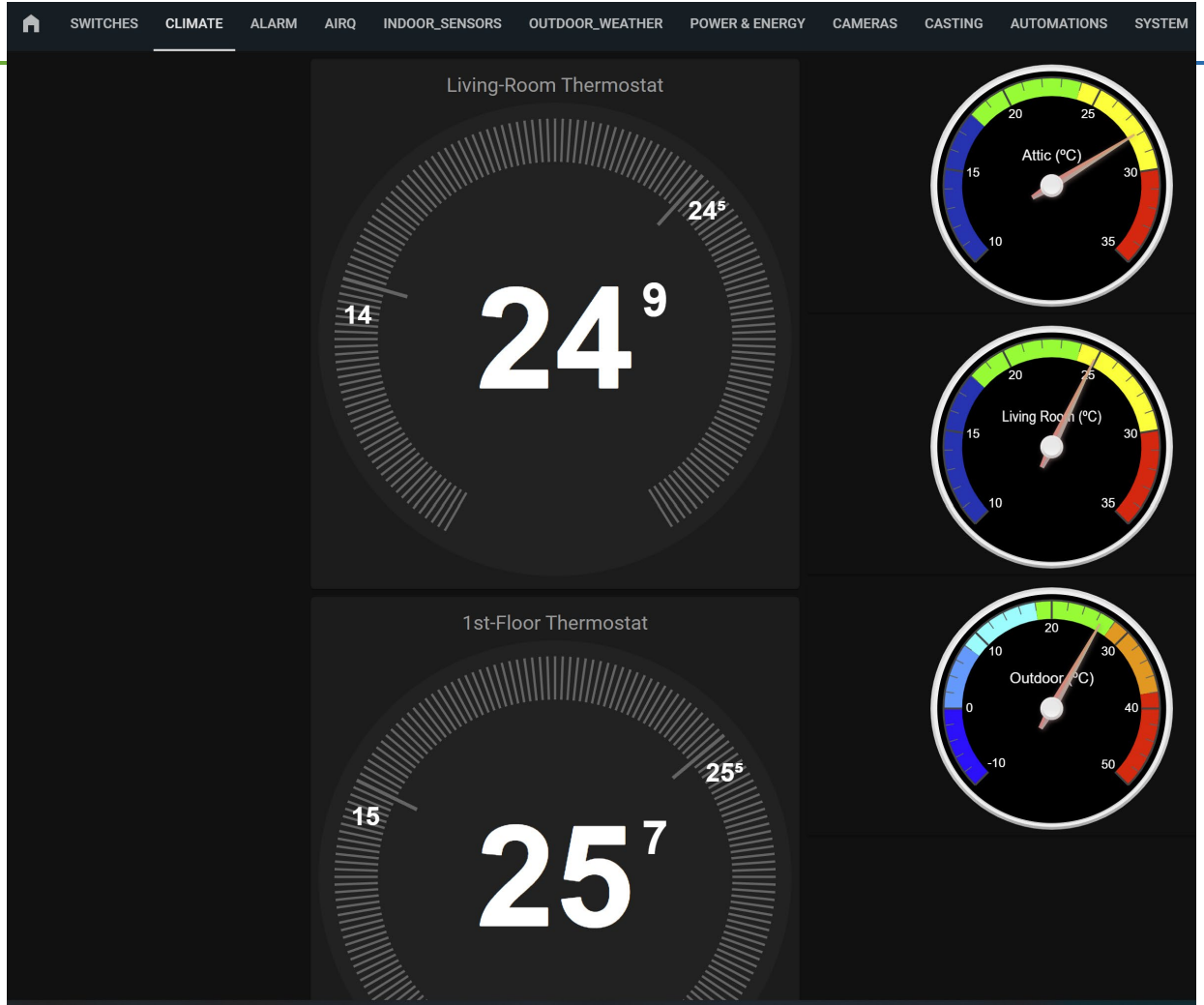
AqaraPIR_Front_Yard	1,000.0 lx
Lux @PIR-LR (zigbee)	203.0 lx
Lux @PIR-Kitchen (zigbee)	43.0 lx

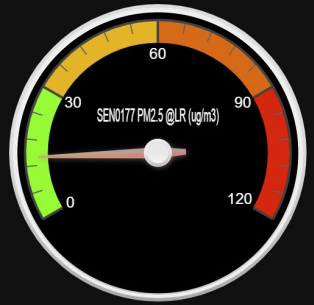
Environmental (WiFi)

LRtemp	26 oC
LRhumi	61.2 %
shelly H&T temp	28.2 °C
shelly H&T humi	43.5 %
myShelly_1PM Temperature	44.1 C
Shelly1L Temperature (balcony)	42.46 oC

Environmental (z-wave)

Temp @Front-Yard Door (z-wave)	25.7 °C
Temp @ZW100-Hallway (z-wave)	25.0 °C
Temp @FibaroEye-LR (z-wave)	26.9 °C


SWITCHES
CLIMATE
ALARM
AIRQ
INDOOR_SENSORS
OUTDOOR_WEATHER
POWER & ENERGY
CAMERAS
CASTING
AUTOMATIONS
SYSTEM
Living-Room Thermostat
24.5
14
24.9
1st-Floor Thermostat
25.5
15
25.7
Attic (°C)
Living Room (°C)
Outdoor (°C)



SEN0177 (PM 2.5)
14 ug/m3

SEN0177 (PM 1.0)
11 ug m3

SEN0177 (PM 10)
17 ug m3

IKEA PM2.5
28 µg/m3

SWITCHES CLIMATE ALARM AIRQ INDOOR_SENSORS OUTDOOR_WEATHER POWER & ENERGY CAMERAS CASTING AUTOMATIONS SYSTEM MISC

AWAY inter69 | Sun | 192.1... local_ip | Off homealar... | UNAVAI Updater

idle
Washing-Machine
Powered Down

Washing-Machine
0.3 W

Basement
74.30 W

Alarm / Alert / Siren

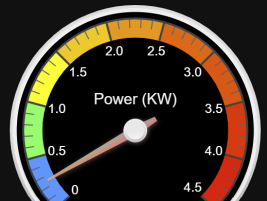
homealarm	
BW-IS5@1stFloor	Dry
BW-IS9@1stFloor	Dry
BW-IS5@Basement#1	Dry
BW-IS5@Basement#2	Dry
shellyflood_ac9f51_fridge	Dry
Heiman Siren @Attic (On/Off)	
Heiman Siren (LR) (On/Off)	

Who's @Home

Family	Away
george_phone	Away
maria_phone	Away
lambros_phone	Away

Motion / Status

AqaraPIR_Front_Yard	Clear
SonoffPIR@Attic (zigbee)	Clear
AqaraPIR_BackYard	Unavailable
Dahua@BackYard Motion	Detected
HIK@LR Motion	Clear
AqaraPIR@LR (zigbee)	Detected
FibaroEyeMotion@LR (z-wave)	Off
FibaroEyeBurglar@LR (z-wave)	0
AqaraPIR@Kitchen (zigbee)	Clear
AeotecZW100@Hallway Status (z-wave)	Off
AeotecZW100@Hallway Burglar (z-wave)	0
Sonoff-MS01-corridor	Unavailable

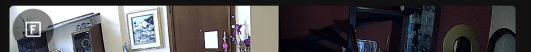


Door/Window Status

YardDoorSensor (εξώπορτα)	Closed
Aqara@MainEntranceDoor (zigbee)	Closed
DoorToBasement	Closed
Fibaro@FrontYardDoor (23=closed)	23
Fibaro@FrontYardDoor (z-wave)	Off
Sonoff_DS01_rightAtticWindow	Open
Sonoff_DS01_leftAtticWindow	Open
Sonoff-DS01-1stFloorDoor	Open
Sonoff_DS01_bedroom2	Unavailable
Sonoff_DS01_bedroom1	Closed
Sonoff_DS01_bedroom3	Unavailable

Total Power Consumption

0.258722 KW



SWITCHES | CLIMATE | ALARM | AIRQ | INDOOR_SENSORS | OUTDOOR_WEATHER | POWER & ENERGY | CAMERAS | CASTING | AUTOMATIONS | SYSTEM | MISC

Kitchen — Ceiling | Pi | Countertop | Hidden

Plugs — Floorlamp | Tablelamp | innr-220

Fusebox (relays)

- R0-nothing (off)
- R1-plugs (on)
- R2-plug_panel (off)
- R3-boiler (on-off)
- R4-boiler-timer (on)

Switchbot-WashingMachine

Attic — Leds | LEDback | CO2 | LEDstrip

Yard — Entrance | BackYard | FrontYard | Balcony

Blanket — Maria | George

Smart Plugs (z-wave)

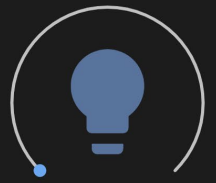
- LR Floor Lamp
- LR-Table-Lamp
- Attic_Yeelight
- Attic Ceiling Lights
- Washine-Machine (new)

Shelly1PM@FrontDoor

- EntranceDoorLight
- Shelly 1PM Status: Off
- Shelly 1PM Power: 0.00 W
- Shelly 1PM Energy: 0.61 KWh
- Shelly 1PM Temperature: 43.98 oC

Smart Plugs / Lights (WiFi)

- Sonoff01 Bulb (LR)
- 1st_floor Corridor Lights
- BW-SHP2 (Bedroom)
- shelly 1PM (LR)
- BW SHP8-1 (Attic)
- Kitchen Plug (SHP8)
- Sonoff POW for Strobe
- Shelly1L balcony
- Aqara_T1_lights_switch on_off



Yeelight (attic)

What's "on"

- BW-SHP2 (Bedroom)
- Washine-Machine (new)

SWITCHES | CLIMATE | ALARM | AIRQ | INDOOR_SENSORS | OUTDOOR_WEATHER | POWER & ENERGY | CAMERAS | CASTING | AUTOMATIONS | SYSTEM | MISC

- WelcomeHomeGeorge
- WelcomeHomeMaria
- Door Locked? @GHome
- SpeakHubMax_EntranceDoorOpened
- Notify_EntranceDoorOpened
- Notify_NestCAM_on_person_detection
- Notify_LowBattery_YeelightRED
- Temperature_Daily
- Weather_Report_GoogleHome
- SayAlarmOFF@ALEXA
- Have_a_Nice_Week
- GeoBlanket-On-Off
- MariaBlanket-On-Off
- Maria Left the House
- Unavailable entity detection & notification

BasementLights

- ShellyButton1-basementLightsON
- ShellyButton1-basementLightsOFF

- Auto_Alarm_ON
- Auto_Alarm_OFF
- Intrusion_Snapshots_All_CAMs_Pushover_Alarm_on
- Intrusion_Snapshot_BackYardCAM_night
- Intrusion_AnnouceGH_Lights_Alarm_on
- ALERT_any_WindowDoorOpen_ALARM_ON
- Intrusion_Wyze_FrontYard_Snapshot_ALARM_ON
- Intrusion_DAHUA_BackYard_Snapshot_ALARM_ON
- Siren_Notify_on_Water_Leakage or Fire
- Trigger alarm (alert) while armed away
- AnnounceGH_Lights_Snapshots_Siren when ALARM tri...
- Notify when alarm is Armed in Away mode
- Notify when alarm is Armed in Home mode
- Notify when alarm is Disarmed
- Trigger alarm (alert) while armed at home
- Disarm at Home Alarm everyday morning
- Auto Arm at Home Alarm at night

- Dryer is ON and DONE
- Notify_when_Washing_Machine_Done

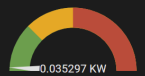
- Alert_if_Fibaro_MotionEye_triggered_when_Alarm_ON
- Alert_if_Fibaro_MotionEye_status_changed_when_Alar...
- Alert_if_Fibaro_FrontYardDoor_Open_Alarm_ON
- Alert_if_PIR@Kitchen_on_when_ALARM_on
- Alert_if_PIR@LR_on_when_ALARM_on
- Alert_FibaroEye_Moved
- Alert_Yard_Door_Opened (z-wave)

- Motion_FrontYardPIR_Strobe_ON
- Motion_BackYardPIR_Strobe_ON
- On_Motion_Kitchen_Lights_On
- On_No_Motion_Kitchen_Lights_Off
- On_Motion_Corridor_Lights_ON
- FrontDoorLights_ON_Sunset
- FrontDoorLights_OFF_Sunrise
- FrontYardLights_ON_Sunset
- FrontYardLights_OFF_Sunrise
- Command_Switch_Sonoff_LR_on_off_everyday
- Command_Switch_Shelly_1PM_on_off_everyday
- CorridorLights_Off_After_3min

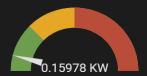
SWITCHES | CLIMATE | ALARM | AIRQ | INDOOR_SENSORS | OUTDOOR_WEATHER | POWER & ENERGY | CAMERAS | CASTING | AUTOMATIONS | SYSTEM | MISC

Total Power Consumption
15,341.13 KWh

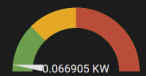
Total Power Consumption
0.260605 KW



L1_power



L2_power



L3_power

Basement (Shelly-EM)

Shelly 1EM Status	On
Shelly 1EM Power	73.81 W
Shelly 1EM Reactive	-23.27 W
Shelly 1EM Energy	695.35 KWh
Shelly 1EM Voltage	227.77 V

Fibaro Plugs' Power

LR-Floor-Lamp-power	0.0 W
LR-Table-Lamp-power	0.0 W
Attic-Yeelight-power	0.0 W
Attic-Ceiling-Lights-power	0.0 W
Washing-Machine-power (new)	0.3 W

Attic (Shelly-EM)

shellyEM_Attic	
ShellyEM_ch1_power	173.2 W
ShellyEM_ch1_Voltage	236.5 V
ShellyEM_ch1_Energy	3,250.0 kWh
ShellyEM_overpowering	OK

Shelly-4-Pro@Attic

Shelly 4Pro power1	0.00 W
Shelly 4Pro power2	2.33 W
Shelly 4Pro power3	2.67 W
Shelly 4Pro power4	0.00 W
Shelly 4Pro energy1	0.0 KWh
Shelly 4Pro energy2	0.14 KWh
Shelly 4Pro energy3	0.16 KWh

SHP8@Kitchen

myBW-SHP8 Power	0 W
myBW-SHP8 Energy Total	64.296 kWh
myBW-SHP8 Energy Today	0.0 kWh
myBW-SHP8 Energy Yesterday	0.0 kWh
myBW-SHP8 Current	0.0 A
myBW-SHP8 Voltage	263 V

Fibaro Plugs' Energy

LR-Floor-Lamp-energy	62.11 kWh
LR-Table-Lamp-energy	251.34 kWh
Attic-Yeelight-energy	46.91 kWh
Attic-Ceiling-Lights-energy	14.98 kWh
Washing-Machine_energy (new)	82.54 kWh

SHP8@Attic

myBW-SHP8-2 Power	0 W

FRIGATE

Cameras

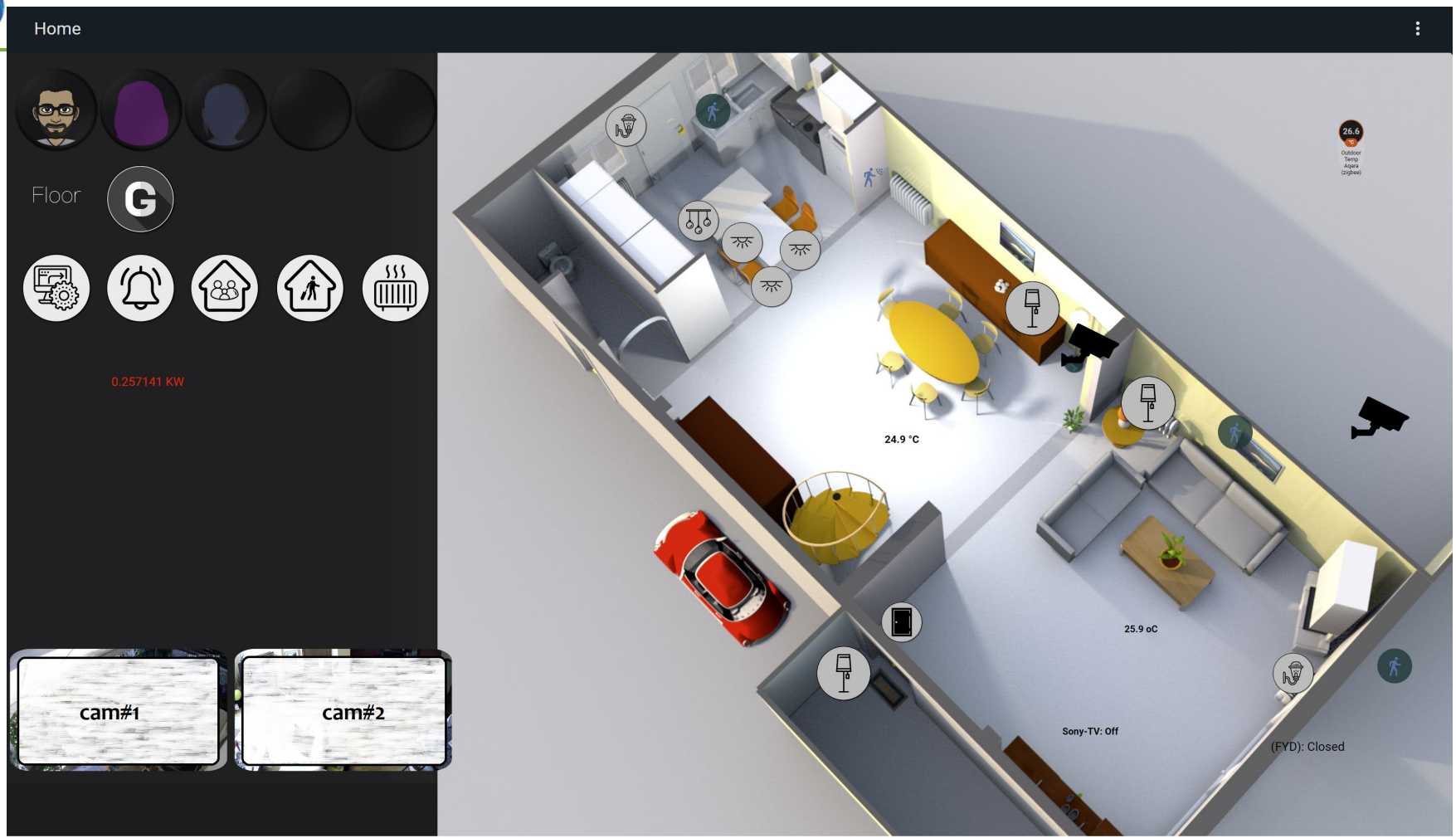
Events

Debug

Documentation

GitHub

	attic_outdoors	car	71.09%	6/14/2022	6:49:46 AM	6:50:05 AM
	attic_outdoors	car	73.44%	6/14/2022	6:41:07 AM	6:41:14 AM
	attic_outdoors	car	70.70%	6/13/2022	1:05:57 PM	1:06:04 PM
	attic_outdoors	car	74.02%	6/12/2022	8:34:29 PM	8:34:44 PM
	attic_outdoors	car	72.66%	6/11/2022	6:51:43 PM	6:51:56 PM


Home
Floor
G
0.257141 KW
cam#1
cam#2
26.6
Outdoor Temp Aqara (zigbee)
24.9 °C
25.9 oC
Sony-TV: Off
(FYD): Closed

Thank You!

cfilis@cosmote. gr