Electricity meter readout with RIOT using DSMR

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Our electric meter cabinet

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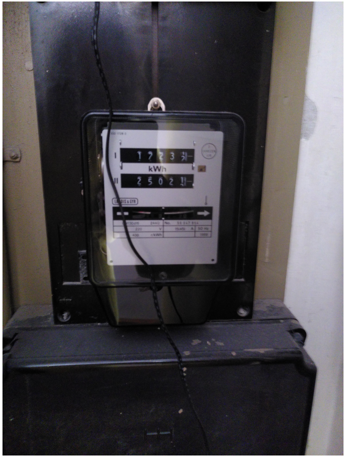

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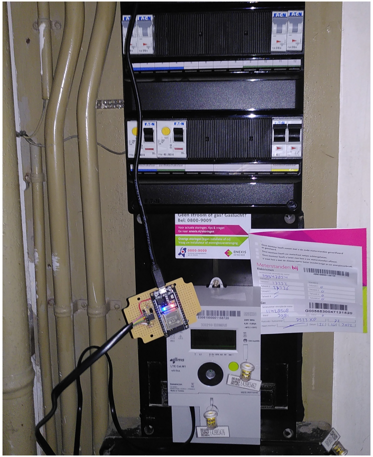
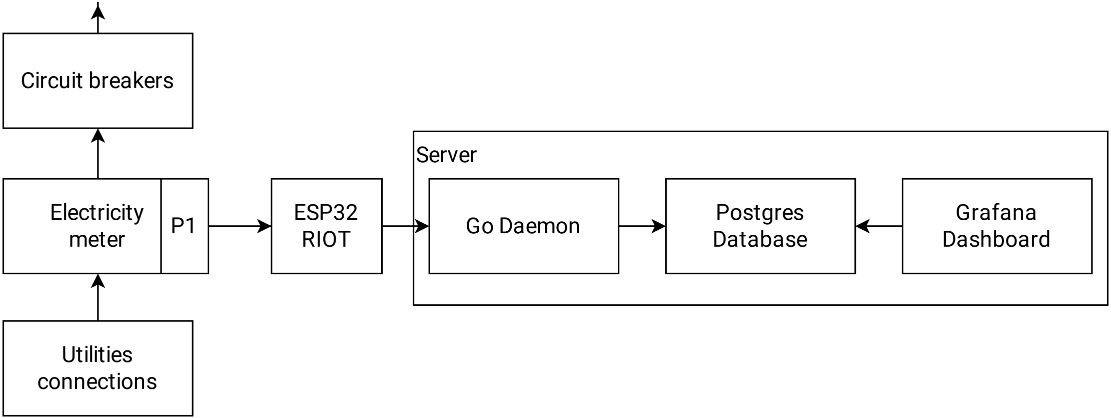


Overview


Circuit breakers
Electricity meter
P1
Utilities connections
ESP32 RIOT
Server
Go Daemon
Postgres Database
Grafana Dashboard

Why do I want this

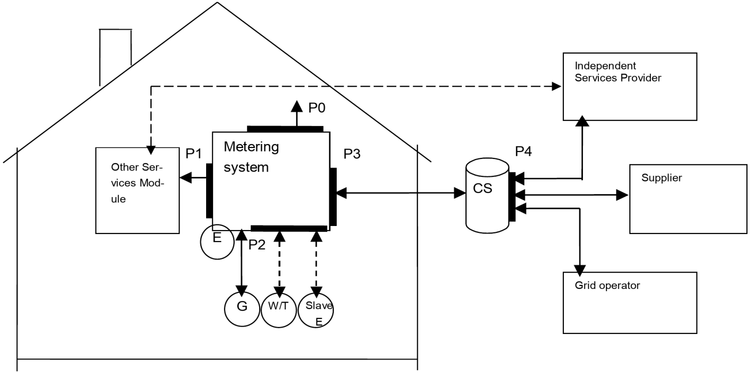
Mostly to get insights:

- Power consumption insights.
- Gas usage insights.

Because it sounds fun.

Electricity meter

So called *smart meter* with a Dutch **DSMR P1 port**



DSMR

Dutch Smart Meter Requirement

Open specification from Netbeheer Nederland

- Combined effort of Dutch grid operators
- Based on *IEC 62056*

P1 port for Automatic Meter Reading for consumers

Multiple specifications

All industry specifications with varying levels of openness:

- **DLMS**: Original specification for communication with smart meters
- **IEC 62056**: IEC spec for smart metering derived from DLMS
- **EN 62056**: European Union standard
- **DIN/NEN 62056**: Country-local specifications, between 100 - 400 euro per chapters
- **DSMR**: Dutch Smart Meter Requirements, derived specification (*open*)

IEC 62056

Standards for electricity meter data exchange

24 documents on specifications…

IEC 62056-6-1

OBIS: Object identification system

```
1-0:1.8.1(123456.789*kWh)
```

One OBIS maps to one property. Register values can include the unit

IEC 62056-21

Direct local exchange of data for meter reading (Serial over …)

Multiple protocol modes supported.

Focus on **Protocol mode D**

- Push button -> receive data

DSMR

Combines these specification into DSMR

Currently at version 5.0.2

- Added error checking
- Increased message baud rate
- Decreased interval (10 seconds -> 1 second)

DSMR (Physical)

RJ12 connector (6 pins, 6 connected):

- 5V power supply line
- Data request
- Data ground
- Data
- Power ground

Data request line acts as 'button'

5V provided and not included in the metering registers (free power)

DSMR: Example

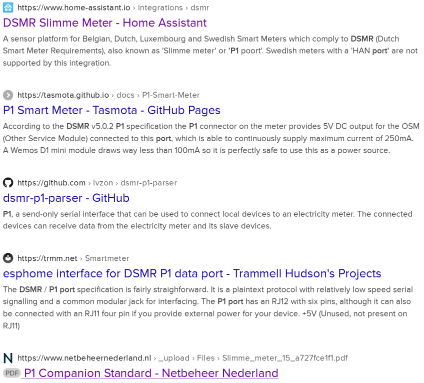
```
/Ene5\\XS210 ESMR 5.0

1-3:0.2.8(50)
0-0:1.0.0(230104215905W)
0-0:96.1.1(4530303631303030303031313638373230)
1-0:1.8.1(000233.793*kWh)
1-0:1.8.2(000300.631*kWh)
1-0:2.8.1(000000.043*kWh)
1-0:2.8.2(000000.000*kWh)
0-0:96.14.0(0002)
1-0:1.7.0(00.416*kW)
1-0:2.7.0(00.000*kW)
0-0:96.7.21(00003)
0-0:96.7.9(00001)
1-0:99.97.0(0)(0-0:96.7.19)
```

```
1-0:32.32.0(00001)
1-0:32.36.0(00000)
0-0:96.13.0()
1-0:32.7.0(237.0*V)
1-0:31.7.0(001*A)
1-0:21.7.0(00.416*kW)
1-0:22.7.0(00.000*kW)
0-1:24.1.0(003)
0-1:96.1.0(4730303538353330303437313231353230)
0-1:24.2.1(230104215500W)(00079.660*m3)
!3216
```

DSMR implementations

Multiple implementations available:
HomeAssistant, Arduino, Libraries, …



https://www.home-assistant.io › integrations › dsmr
DSMR Slimme Meter - Home Assistant

A sensor platform for Belgian, Dutch, Luxembourg and Swedish Smart Meters which comply to **DSMR** (Dutch Smart Meter Requirements), also known as 'Slimme meter' or '**P1** poort'. Swedish meters with a 'HAN **port**' are not supported by this integration.

https://tasmota.github.io › docs › P1-Smart-Meter
P1 Smart Meter - Tasmota - GitHub Pages

According to the **DSMR** v5.0.2 **P1** specification the **P1** connector on the meter provides 5V DC output for the OSM (Other Service Module) connected to this **port**, which is able to continuously supply maximum current of 250mA. A Wemos D1 mini module draws way less than 100mA so it is perfectly safe to use this as a power source.

https://github.com › lvzon › dsmr-p1-parser
dsmr-p1-parser - GitHub

P1, a send-only serial interface that can be used to connect local devices to an electricity meter. The connected devices can receive data from the electricity meter and its slave devices.

https://trmm.net › Smartmeter
esphome interface for DSMR P1 data port - Trammell Hudson's Projects

The **DSMR** / **P1 port** specification is fairly straighforward. It is a plaintext protocol with relatively low speed serial signalling and a common modular jack for interfacing. The **P1 port** has an RJ12 with six pins, although it can also be connected with an RJ11 four pin if you provide external power for your device. +5V (Unused, not present on RJ11)

https://www.netbeheernederland.nl › _upload › Files › Slimme_meter_15_a727fce1f1.pdf
PDF P1 Companion Standard - Netbeheer Nederland

RIOT integration

Goal: Convert the data from DSMR into a periodic CoAP POST request.

- DSMR: UART wrapper to IEC 62056 parsing
- IEC 62056: One module handling the OBIS register parsing (#19168)

Glue:

- Translate IEC 62056 into CBOR-encoded SenML metrics.
- Small GCoAP wrapper to periodically send the metrics

Experience

Parsing DSMR is rather tricky

- COSEM IDs are very flexible in their representation
- Registers *might* contain a unit
- Some registers have multiple data units associated

```
1-2:3.4.5.6
2:3.4.5
3.4
```

All together increases the number of edge cases.

RIOT integration

Result:

- DSMR: Handles and buffers a full telegram
- IEC 62056: Parses the telegrams with OBIS values and register values

Glue:

- Buffer all received values of interest
- Periodically send the latest metrics to the server of CoAP

List of metrics end up at the server!

Server side

Receive the measurements and store them into a database

Go application

- CoAP registry
- SenML parsing
    - Translate SenML fields into metric labels, including unit
- Database interface
    - Postgres with TimescaleDB for storing time series data
    - Alternatives possible

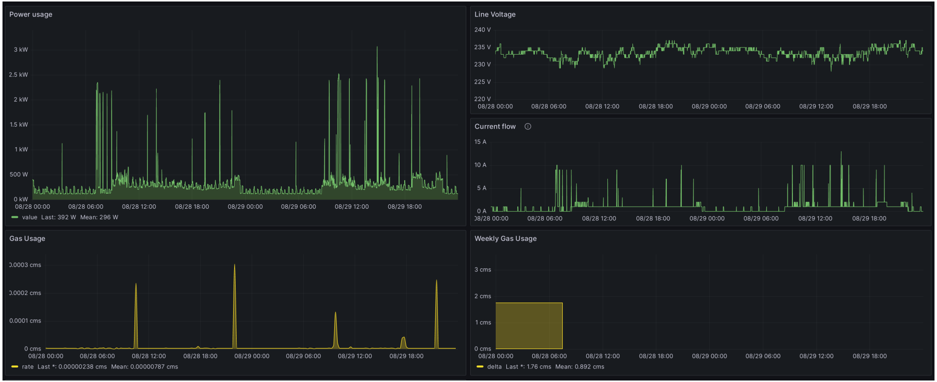
Database

PostgreSQL relational database

- **Realms**: A region of nodes
  - **Nodes**: A single device
    - **Series**: A single series of measurements
      - **Labels**: Labels associated
      - **Measurements**: The values

Display

Grafana with PostgreSQL plugin



Results

230 V is not 230 V: Swings between 226 V and 240 V

Power consumption consist of a background draw with scattered peaks:

- Background: Computers, refridgerators and lamps
- Peaks: Water boiler, Coffee machine, dishwasher.

Gas only used for hot water and cooking:

- Could be used to track shower and cooking durations.

Future work

DSMR data rate greatly exceeds database sampling rate:

- Extend metrics with extra info: High, low, average

Add 802.15.4 / 6LoWPAN capabilities:

- Fixed powered device as intermediate router

Conclusion

- Could be done within a weekend but …
- Overengineered applications
  - Most components generic enough for any sensor network