Smart Energy Meter (SEM)

Practice Enterprise

2021 - 2022

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1 Embedded Software

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Preface

I'm Sander Speetjens, a first year student Electronics Embedded Software at Thomas More - Campus De Nayer.

This bundle will be a summary of all of the information that I gathered over the course of half a semester about my project Smart Energy Meter (SEM) or making our digital electricity meter more smart with a separate observation station. I had chosen this subject, because recently our energy supplier installed one of their new energy meters at home and I wanted to know our energy consumption. The system had to be reliable in the long term, but also consume little energy. This was quite challenging in terms of software, because there was a design constrained that we couldn't use any pre-written libraries or platforms like Arduino. With this practice enterprise, I want to demonstrate that I can apply my knowledge gained in secondary school and university to both the Electronic and Mathematical parts. Moreover, this was the perfect moment to focus on my favourite subjects, namely the combination of hardware, software and mathematics.

Because I could not have achieved all this without help from others, I would like to thank a few people. First and foremost, I would like to thank my teachers for assisting me with the technical and mathematical aspects of my practice entry. I would also like to thank my friends who have worked together with me to make this possible. Finally, I would also like to thank my parents, who have always supported me and helped me review my assignments. I would also like to explicitly thank my father, Tim Speetjens, for helping me develop a MySQL interface written in PHP.

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Figure 1: The new "Smart Meter" from Sagemcom

1 — Theory

1.1 The Smart Meter

1.1.1 Introduction

The digital meters for electricity and gas were introduced in Flanders on 1 July 2019. Since then, they have replaced the old, mechanical meters that are no longer in circulation. Fluvius automatically installs them at new housing developments or renovations where the electricity connection is renewed. In addition, Fluvius launched a major geographical roll-out this spring to install such meters at every household and small business in Flanders. This will be organised by region, town or municipality. The roll-out aims at a complete conversion by 2029, with the main acceleration in the next three years. By the end of 2024, 80% of homes should have digital meters.

1.1.2 User-Ports

These digital meters contain 2 User ports, which you are able to read you're consumption/production statistics from. One of the ports is a HAN port and you can use this to connect another device to your smart meter. For example, a device that provides more insight into your energy consumption.

2 — Project specifications

2.1 Components used

- 2 x Arduino (Pro) Micro

- Raspberry Pi

- Waveshare e-paper display 3.7 inch 480x280px

- 2x ESP01 & logic shifting board

- MAX3107 protocol translator (UART => SPI)

- TSS721A M-bus to UART converter

2.2 Project Specifications

The project is composed out of 3 parts: The sensor, the database and an observation unit.
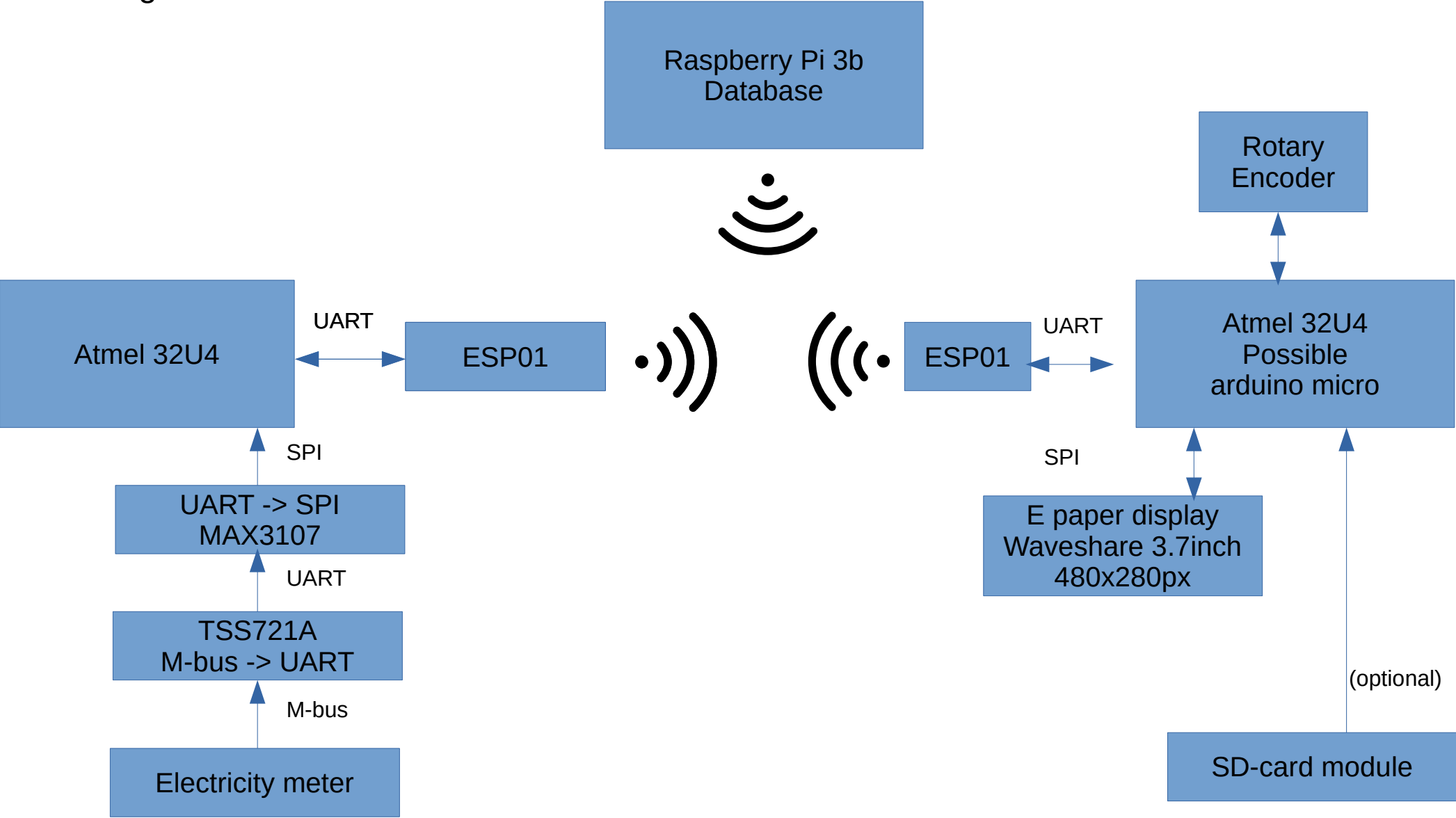
The sensor side of the project contains all of the hardware that converts the data from the digital energy meter and sends that data to the database over WIFI once every couple of minutes (1-5 min).

The database stores all of the records in a table. The data is received and send via a web-interface written in PHP and can be received via http requests. There will also be a dashboard that can be accessed via a web browser. But this is not important for this project.

The display is the most important part of this project because it is the only visible part and has to be eye catching. It contains a graphical e-paper display to display the graph, a rotary encoder to select the data format (day, week, month or year) and you are able to ask for a specific format as example date format "week, -2" that will be two weeks prior to now.

All of the parts are powered by a 5V wall adapter.

Blockdiagram

Raspberry Pi 3b
Database

Rotary
Encoder

Atmel 32U4

UART

ESP01

ESP01

UART

Atmel 32U4
Possible
arduino micro

SPI

UART -> SPI
MAX3107

SPI

E paper display
Waveshare 3.7inch
480x280px

UART

TSS721A
M-bus -> UART

M-bus

(optional)

Electricity meter

SD-card module

Sander Speetjens 1 (E)EH

ATMEGA 32U4
(C/C++)

Raspberry Pi
(PHP / SQL)

Reading data
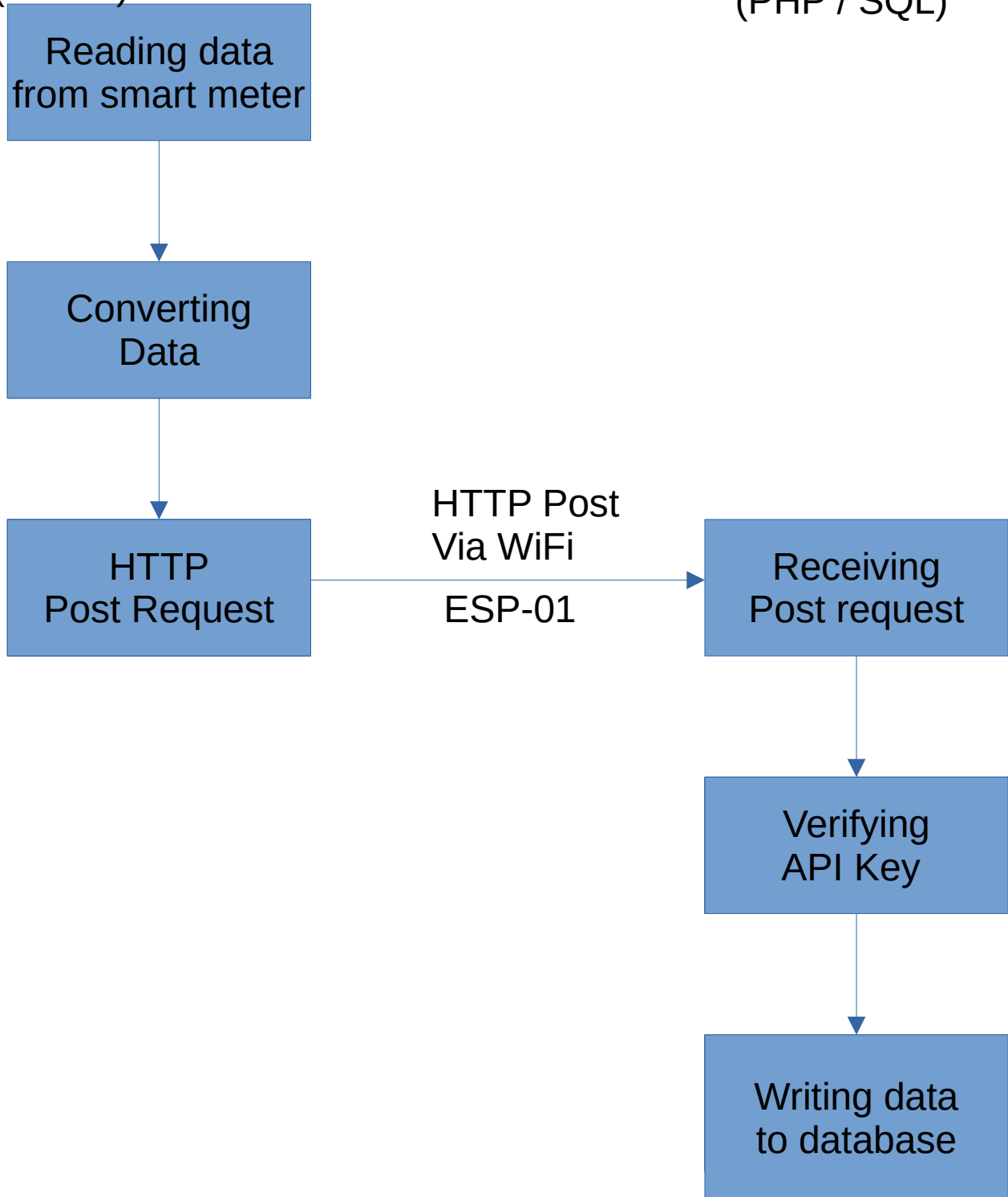from smart meter

Converting
Data

HTTP
Post Request

HTTP Post
Via WiFi

ESP-01

Receiving
Post request

Verifying
API Key

Writing data
to database

Raspberry Pi
(PHP / SQL)

WiFi display

Wait 1 minute
or change
in mode

Receiving
HTTP
Get request

HTTP GET
Via WiFi

Selector
Parameter

Selector
To
Query

Run
Query

HTTP GET
return
Payload

Edge Case
Detector

Payload String
to Int array

Drawing Graph