Lappeenranta University of Technology

Department of Industrial Management

Computer Science

Sustainability Code Camp

# PROJECT REPORT Group 1: Home automation scenario


| | | |
|---|---|---|
| Lassi Riihelä | 0353705 | lassi.riihela@student.lut.fi |
| Niklas Nygren | 0387975 | niklas.nygren@student.lut.fi |
| Joni Herttuainen | 0387836 | joni.herttuainen@student.lut.fi |
| Sinan Kaplan | 0458134 | Sinan.kaplan@lut.fi |
| Tatu Kosonen | | |

TABLE OF CONTENTS


- Introduction
- Fhem
- Z-Wave
- Scenario
  - Idea
  - Motivation
  - Implementation
  - Benefits
- Conclusions

# Introduction

The topic of the code camp was “HomeAutomation .. save energy (and the world) by home automation”. The problem was to find ways to save energy by automating some home controls. We were given different kinds of home automation equipment to use including light dimmers, automatic / remote controlled radiator thermostats, and RF (radio frequency) sender/receiver devices, and energy consumption meters. We were to choose some of the devices and automate some kind of scenario, and show the possible savings in energy and money usage. And the best part, all of this using open source software!

We chose to look at the problem from two different perspectives: from a sustainable perspective and from a comfort perspective. We wanted to automate a home in way that increases comfort while saving money and energy.

# Z-Wave

Z-Wave is a RF(radio frequency) control protocol designed to achieve reliable communication and operation between different products from different manufacturers [1]. Z-Wave has following characteristics:

- uses low power sub 1 GHz RF and works within a mesh topology
- Operates in the 900MHz band which is impervious to interference from Wi-fi and other wireless technologies like Bluetooth
- Enables the control of lighting, electrical outlets, fans, shades, drapes, irrigation, thermostats, security systems, door locks and more,
- Control available from various platforms: wireless keyfob, wall mounted keypad, internet connected tablet/phone/computer
- Z-Wave is ideal for homes and small businesses
- Over 1400 interoperable products available from over 330 manufacturers, over 40 million products in use worldwide.


The protocol has four layers [2], which are:

- MAC layer → controls the RF media,
- Transfer Layer → controls the transmitting and receiving of frames,
- Routing Layer → controls the routing of frames in the network,
- Application layer → controls the payload in the transmitted and received frames.

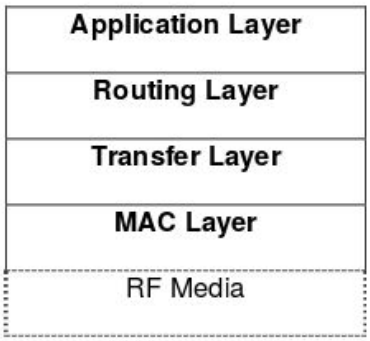


**Figure X.** The Layers of Z-Wave Protocol

## Scenario

# Idea

The idea was to save money by increasing comfort. The way we chose to increase comfort was to automate what happens when a person leaves home. We started by thinking what are some mundane tasks we all have to do when leaving the house. The answer: turn off all the lights and all possible standby devices. We also figured that the radiator doesn't have to be warming the house when no one is present, for example during working hours.

## Motivation

First motivation was to save money by minimizing the cost of utilities by turning them off when no one's around to use them. That includes everything that is plugged to power sockets for example TV's, computers and phone chargers. Heating and air conditioning is also unnecessary when noone is home. Leaving lights on when you're in a hurry is a common occurrence and also consumes unnecessary energy and reduces their lifespan. By turning off every device when they are not used also increases the lifespan of the devices. We noticed that even when a device is itself turned off but still connected to a power socket, it still consumes power. We wanted to eliminate all this wasted energy by implementing our automation system for the scenario.

## Implementation

In our scenario all the standby devices and lights are to be turned off when the resident leaves the house. The home automation system uses the resident's mobile phone's WiFi connection to determine whether the resident is home or not. As soon as the resident leaves the house and the WiFi connection is lost, the home automation system turns off the standby devices and the lights.

The home automation system uses a FHEM-server to control the home automation devices. The actual FHEM-server is on a dedicated server, which in our case was a laptop. The

FHEM-server pings the resident's mobile phone to check if the resident is present. If the resident is not at home, the FHEM-server tells the switch (which in our scenario is the HomeMatic light dimmer) to turn off all the lights and standby devices. The power comes back to the standby devices and the lights turn back on when the resident comes back home.

There is also an override switch, HomeMatic Wireless Display Push-Button, which can be used to force the lights and the devices on, when the resident wants to disconnect oneself from the home's WiFi connection. The Push-Button can also be used to manually control the lights and to prevent the default actions (power on / off) based on presence. The homeowner can now turn the lights off and still be connected to the WiFi.

The resident can also see graphs from the FHEM-server, which show the current power consumption and the cost for that consumption. By showing the user how much money is being spent, we hope to motivate the homeowner to use less power.

Devices used in the system:

- HomeMatic Wireless configuration adapter LAN
- HomeMatic Wireless dimming actuator
- HomeMatic Wireless Display Push-Button

## Benefits

We calculated the monetary benefit of being able to turn off all unnecessary devices when you leave the house for work and at nights. Calculations were done assuming you're out of the house for 9 hours during work which includes working hours and the trip from home to work and back. 8 hours were added as an average or sleep per night which amounts to 17 hours on working days and 8 hours on weekends that the devices can be turned off. We used average electricity price in Finland for the calculations which is 15.5c/kWh [3].

Saved energy in 5 days of work with devices turned off in a year:
17(h) x 5(days) x  40.8W x 52(weeks in a year) = 180.336 kWh
Saved energy in weekends with devices turned off at night in a year.
8(h) x 2(days) x 40.8W x 52(weeks in a year) = 33.946 kWh
Total in a year: 214.3 kWh
Savings in euros in a year:

15.5 c/kWh x 214.3 kWh = 33.22 e

| **Device** | **Power consumption on standby** |
|---|---|
| TV | 0.3w |
| Audio system | 10w |
| Desktop computer + screen | 4w |
| Laptop | 9w |
| Speakers(computer) | 1.8w |
| Microwave oven | 3w |
| Coffee maker | 1w |
| Phone charger | 0.3w |
| Printer(inkjet) | 1.3w |
| Induction cooker tops | 7.1w |
| Washing machine | 3w |
| **Total:** | **40.8w** |

Average standby power consumption of home devices.

By turning off the ventilation unit during working hours from monday to friday results in 75€ savings per year [4]:

- Ventilation is off 8 h during workdays (the ventilation unit restarts 1 h before getting home)
- 5 days a week
- $\frac{8h}{24h} \times \frac{5d}{7d} \times 315.36\ €/year\ =\ 75.10\ €/year$

## Conclusions

By implementing the presented automation, any homeowner can start saving energy, money, and the world. The initial cost of the equipment is around 230€, and just by turning off the standby devices results in 33€ savings a year. Once the ventilation is also automated as described, the savings go up to over a 100€ per year. So the devices pay themselves back in roughly two years.

However this took three days from engineering students to accomplish. We argue that it could take a lot longer (even an eternity) for non-technical people. So easier configuration is definitely needed for home automation to become mainstream among normal customers. Does this present a good business opportunity? Yes.

From the sustainability point-of-view, are we saving the world with these savings? Hmm.... Maybe, if every household would implement some kind of automation, which saves energy. Big change comes in small steps.

## References

[1] About Z-Wave - Sigma Designs,[online] Available at: http://z-wave.sigmadesigns.com/about_z-wave , [Accessed: 03.03.2016].

[2] Z-Wave Protocol Overview, [online] Available at: https://wiki.ase.tut.fi/courseWiki/images/9/94/SDS10243_2_Z_Wave_Protocol_Overview.pdf , [Accessed : 02.03.2016].

3. Ec.europa.eu, (2016). Electricity price statistics - Statistics Explained. [online] Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_price_statistics [Accessed 2 Mar. 2016].

4. Vattenfall.fi, (2016). Sähkölaitteiden keskimääräinen sähkönkulutus - Vattenfall. [online] Available at: http://www.vattenfall.fi/fi/keskimaarainen-kulutus.htm [Accessed 3 Mar. 2016].