

Building a Better Thermostat

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<https://github.com/mtreinish/building-a-better-thermostat/tree/linuxcon-china>

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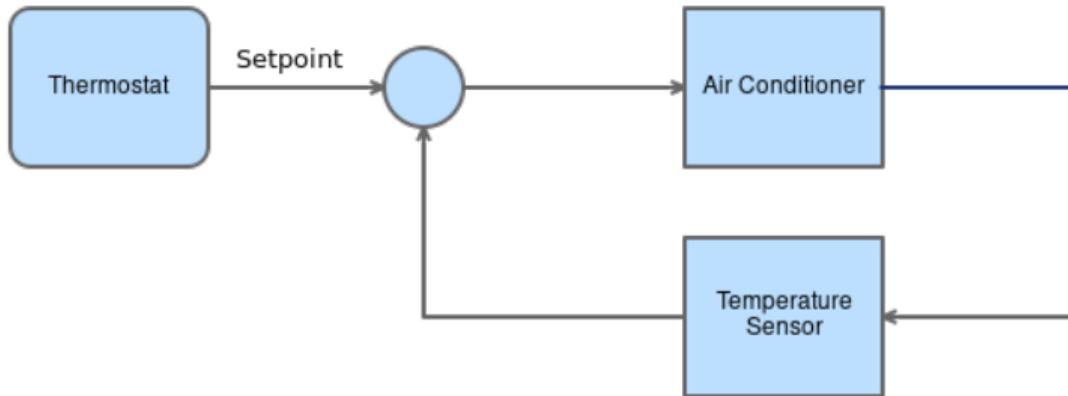
Room Layout



Air Conditioner Units



Thermostat



- ▶ Closed Loop control device
- ▶ 1 input temperature sensor
- ▶ 1 output for controlling heating and/or cooling system

Constraints for controlling the AC



- ▶ Can't take apart the Air Conditioner (I don't own it)
- ▶ No identifying information for the AC
- ▶ Wireless control is ideal

Solution for controlling the AC

- ▶ Control via power (use a relay to turn on and off)
- ▶ Measured current draw with clamp meter
- ▶ Purchased a Z-Wave power switch



What is Z-Wave

- ▶ Low power mesh network for sensors and devices
- ▶ Licensed by Sigma Designs
- ▶ Interoperability tested for all devices by Z-Wave Alliance
- ▶ Software API and protocol docs in the public domain
- ▶ Over 1700 certified devices
- ▶ OpenZwave is an Open Source library to interface with a Z-Wave network



Sensing the Temperature

- ▶ Wireless sensor
- ▶ Leverage the new Z-Wave network
- ▶ Purchased a Z-Wave multi sensor which included temperature



Using Z-Wave

- ▶ Setup a Z-Wave network with Aeotec Z-Stick
- ▶ Register each device on the network
- ▶ Leverage OpenZWave to provide an API to interact with devices



Home Assistant

- ▶ Open Source Home Automation Platform
- ▶ Written in Python 3
- ▶ Has support for over 600 different components
- ▶ Runs locally (with all data locally)



First Attempt at a thermostat

```
1 alias: Turn off Living Room AC when Home and below 25 C
2 trigger:
3     platform: numeric_state
4     entity_id: sensor.aeotec_zw100_multisensor_6_temperature_4
5     below: 25
6 condition:
7     - condition: state
8         entity_id: device_tracker.computertreker_sword_of_kahless
9         state: 'home'
10    - condition: state
11        entity_id: switch.aeotec_zw096_smart_switch_6_switch_2
12        state: 'on'
13    for:
14        minutes: 20
15 action:
16     service: switch.turn_off
17     entity_id: switch.aeotec_zw096_smart_switch_6_switch_2
```

Issues with this approach

- ▶ Requires writing a separate rule for every possible condition
- ▶ Some trigger rules were edge triggered
- ▶ Switching became unreliable
- ▶ Adjusting the set point required a configuration update

Setting up a thermostat device in Home Assistant

<https://home-assistant.io/components/#climate>

 Ecobee Thermostat climate	 eQ-3 MAX! Cube climate	 eQ-3 MAX! Cube binary sensors climate	 eQ-3 MAX! Cube binary sensors climate
 eQ3 Bluetooth Smart Thermostats climate	 Generic Thermostat climate	 heatmiser Heatmiser Thermostat climate	 HomeMatic Homematic Thermostats climate
 Honeywell Thermostat climate	 MySensors HVAC climate	 nest Nest Thermostat climate	 netatmo Netatmo Thermostat climate
 OpenEnergyMonitor WiFi Thermostat climate	 Proliphix Thermostat climate	 Radio Thermostat (3M Filtrete) Thermostat climate	 Sensibo A/C controller climate
 Tado Thermostat climate	 Vera Thermostat climate	 Wink Thermostat climate	 Z-Wave Climate climate

- ▶ Many thermostat modules depending on hardware
- ▶ The generic thermostat component exists to run it in software
- ▶ In the component configuration define a generic thermostat devices with a temperature sensor and switch

Home Assistant Web Dashboard

The screenshot displays a Home Assistant dashboard with four main sections: Living Room, Bedroom, Data Closet, and Automation.

- Living Room:** Shows sensor values for Aeotec ZW096 Smart Switches, Aeotec ZW100 MultiSensors, and Aeotec ZW100 MultiSensor 6 Ultraviolet.
- Bedroom:** Shows sensor values for Aeotec ZW096 Smart Sensors and Aeotec ZW096 Smart Switches.
- Data Closet:** Shows sensor values for Data Closet Temperature Sensor, UPS Battery, UPS Battery Voltage, and UPS Input Voltage.
- Automation:** Lists several automation rules for setting AC temperatures based on sensor values and user presence.

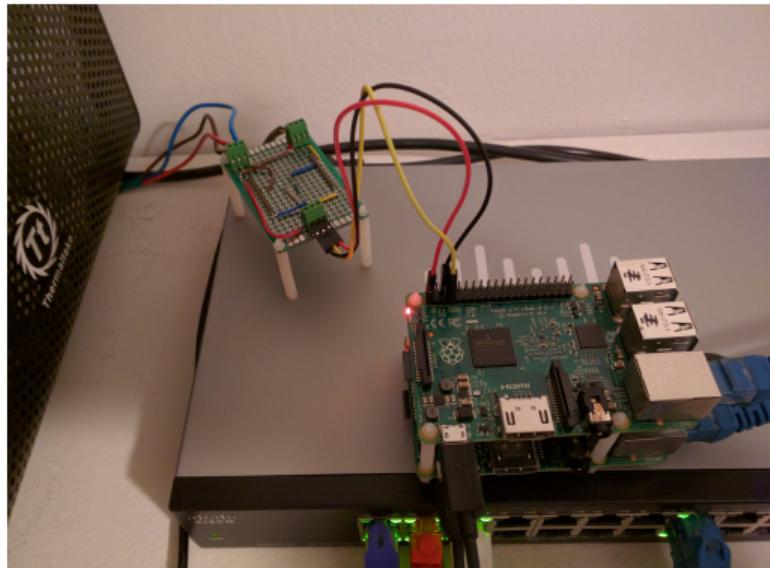
A central modal window provides detailed information about the Aeotec ZW096 Smart Switch in the Bedroom, including its current status (Idle 25 °C), previous reading (Currently: 21.2 °C), and a graph showing the temperature trend over the last 16 minutes. The graph shows a significant drop from approximately 24.5 °C at 00:00 to around 21.2 °C by 12:00, followed by a fluctuating period between 21.2 °C and 22.5 °C.

Problems with this...



Bedroom Temperature Sensing

- ▶ Track both bedroom and “data” closet temperatures
- ▶ Leverage spare Raspberry Pi sitting in “data” closet
- ▶ 2x DS18B20 Dallas 1 wire temperature sensors used



Data Closet



DallasMQTT

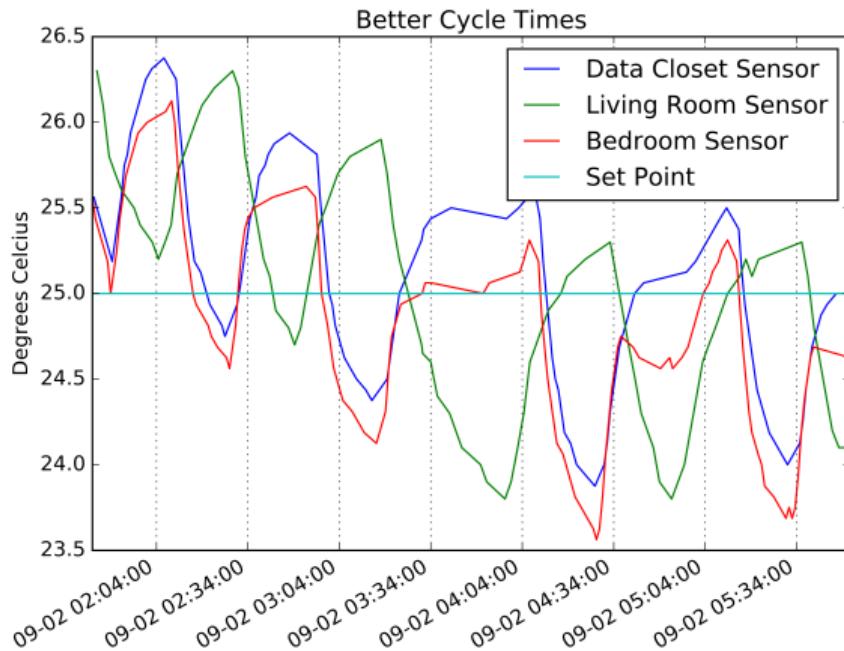
- ▶ Framework for polling sensors and pushing results on MQTT
- ▶ Handles an arbitrary number of sensors
- ▶ Currently only supports Dallas 1 wire temperature sensors from w1_therm linux driver
- ▶ Written in python

Short Cycle Time



- ▶ Bedroom on for 8 min. and off for 4 min.
- ▶ Living Room on for 4 min. off for 2 min.

Corrected Cycle Time



- ▶ Bedroom on for 20 min. and off for 21 min.
- ▶ Living Room on for 17 min. off for 29 min.

Starting to Automate

```
1 alias: Set Living Room AC to 30 C when asleep
2 trigger:
3     platform: time
4     after: '12:30:00'
5 condition:
6     - condition: time
7     before: '09:30:00'
8 action:
9     service: thermostat.set_temperature
10    entity_id: thermostat.living_room
11    data:
12        temperature: 30
```

Location Tracking

- ▶ Start writing rules based on my location
- ▶ Set temperature higher when I'm not home
- ▶ Pre-cool apartment when I'm heading home

Owntracks

- ▶ Open Source iOS and Android app for reporting location over MQTT
- ▶ Enables you to use either a private MQTT broker or public service
- ▶ Home Assistant component available



Location Based Automation Rules

```
1 alias: Set Living Room AC to 26 C when leaving starbucks route 9
2 trigger:
3     platform: state
4     entity_id: device_tracker.myphone
5     from: 'Starbucks Route 9'
6 action:
7     - delay:
8         minutes: 5
9     - service: climate.set_temperature
10    entity_id: climate.living_room
11    data:
12        temperature: 26
```

Future Work

- ▶ More Sensors
- ▶ More automation
- ▶ Fix power usage collection
- ▶ Additional Power monitoring
- ▶ Adjust/tune switching parameters

Where to get more information

- ▶ Blog Post <http://blog.kortar.org/?p=319>
- ▶ <https://home-assistant.io/>
- ▶ <https://github.com/mtreinish/dallasMQTT>
- ▶ <http://zwavepublic.com/>
- ▶ <http://owntracks.org/>
- ▶ <https://github.com/openzwave/>
- ▶ W.J. Mulroy, "The Effect of Short Cycling and Fan Delay on the Efficiency of a Modified Residential Heat Pump", *ASHRAE Transactions*, Vol. 92, No. Part 1, pp. 813-816, January 1986