

Building a Better Thermostat

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

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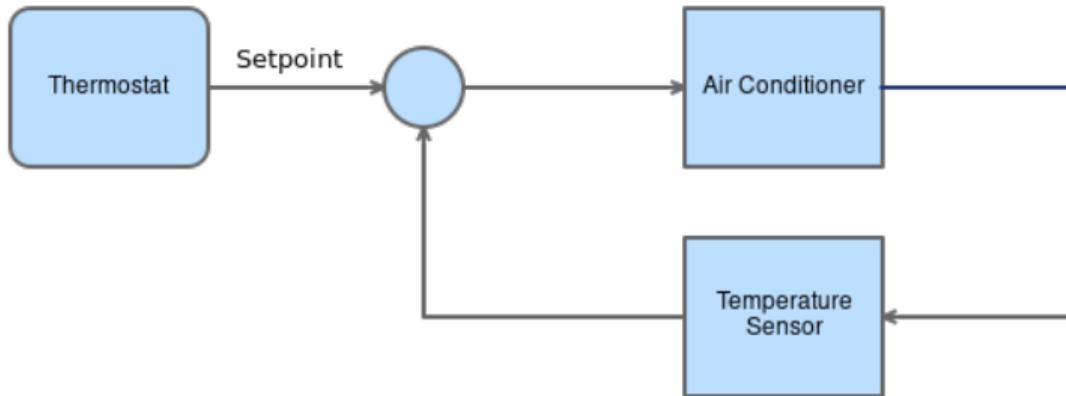
Room Layout



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 ideal



Solution for controlling the AC

- ▶ Control via power (use a relay to turn on and off)
- ▶ Used Z-Wave power switch



What is Z-Wave

Sensing the Temperature

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



Using Z-Wave

- ▶ Setup a Z-Wave network with Aeotec Z-Stick and OpenZWave
- ▶ Used Z-Wave outlet switch to control power to AC Units
- ▶ The same Z-Wave network can be used to add additional sensors and control 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_smartswitch_6_switch_2
12        state: 'on'
13    for:
14        minutes: 20
15 action:
16     service: switch.turn_off
17     entity_id: switch.aeotec_zw096_smartswitch_6_switch_2
```

this doesn't work

Setting up a proper thermostat in Home Assistant

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

 ecobee Ecobee Thermostat climate	 MAX! eQ-3 MAX! Cube climate	 MAX! eQ-3 MAX! Cube binary sensors climate	 MAX! eQ-3 MAX! Cube binary sensors climate
 eQ3 eQ3 Bluetooth Smart Thermostats climate	 Generic Thermostat climate	 heatmiser Heatmiser Thermostat climate	 HomeMatic Homematic Thermostats climate
 Honeywell Honeywell Thermostat climate	 MySensors MySensors HVAC climate	 nest Nest Thermostat climate	 netatmo Netatmo Thermostat climate
 OEM OpenEnergyMonitor WiFi Thermostat climate	 Proliphix Thermostat climate	 Radio Thermostat Radio Thermostat Company of America climate	 Sensibo A/C controller climate
 tado° Tado Thermostat climate	 Vera Thermostat climate	 Wink Thermostat climate	 Z-Wave Climate climate

- ▶ Many thermostat modules depending on hardware
- ▶ My use case requires the generic thermostat component to run it in software
- ▶ In Home Assistant config define generic thermostat devices with a temperature sensor and switch pair

Home Assistant Web Dashboard

Home Assistant Web Dashboard showing various sensors and automation rules.

Sensors:

- Living Room:**
 - Aeotec ZW096 Smart Switch 6 Current: 0.0 A
 - Aeotec ZW096 Smart Switch 6 Energy: 289.87 kWh
 - Aeotec ZW096 Smart Switch 6 Power: 0.0 W
 - Aeotec ZW096 Smart Switch 6 Previous Reading: 289.87 kWh
 - Aeotec ZW096 Smart Switch 6 Voltage: 122.63 V
 - Aeotec ZW100 MultiSensor 6 Burglar: 0
 - Aeotec ZW096 Smart Switch 6 Switch
 - Aeotec ZW100 MultiSensor 6 Luminance: 0.0 lux
 - Aeotec ZW100 MultiSensor 6 Relative Humidity: 21.0 %
 - Aeotec ZW100 MultiSensor 6 SourceNodeId: 0
 - Aeotec ZW100 MultiSensor 6 Temperature: 21.2 °C
 - Aeotec ZW100 MultiSensor 6 Ultraviolet: 0.0
 - Living Room: Idle 25 °C, Currently: 21.2 °C
- Bedroom:**
 - Bedroom Temperature Sensor: 19.937 °C
 - Aeotec ZW096 Smart Switch 6 Current: 0.0 A
 - Aeotec ZW096 Smart Switch 6 Energy: 147.44 kWh
 - Aeotec ZW096 Smart Switch 6 Power: 0.0 W
 - Aeotec ZW096 Smart Switch 6 Previous Reading: 147.44 kWh
 - Aeotec ZW096 Smart Switch 6 Voltage: 230.0 V
 - Aeotec ZW096 Smart Switch 6 Switch
 - Bedroom: Idle 25 °C, Currently: 21.2 °C
- Data Closet:**
 - Data Closet Temperature Sensor: 20.75 °C
 - UPS Battery: 100.0 %
 - UPS Battery Voltage: 27.2 V
 - UPS Input Voltage: 123.0 V

Automation:

- Set Bedroom AC to 25 C when arriving home
- Set Living Room AC to 25 C when arriving home
- Set Living Room AC to 26 C when leave starbucks on 44
- Set Living Room AC to 26 C when leave starbucks on 44
- Set Living Room AC to 26 C when leaving starbucks rou...
- Set Living Room AC to 28 C when leave home
- Set Living Room AC to 28 C when leave home
- Set Living Room AC to 30 C when asleep

Graph: Living Room Temperature over time (16 minutes ago to Currently: 21.2 °C). The graph shows a sharp drop from approximately 24°C at 8:00 to around 21.2°C by 12:00, followed by a fluctuating pattern between 21 and 22°C.

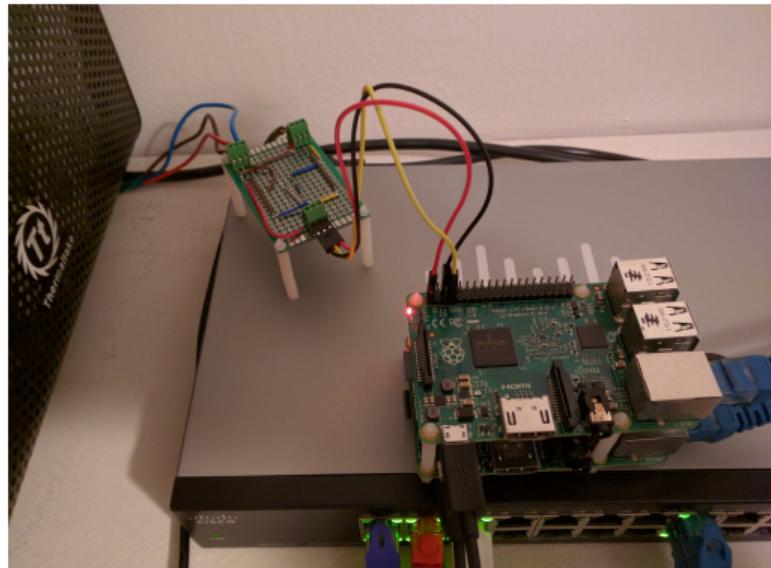
Target Temperature: 25 °C

Problems with this...



Bedroom Temperature Sensing

- ▶ Track both bedroom and “data” closet temperatures
- ▶ Leverage spare raspberry pi sitting in “data” closet
- ▶ DS18B20 Dallas 1 wire temperature sensors used



DallasMQTT

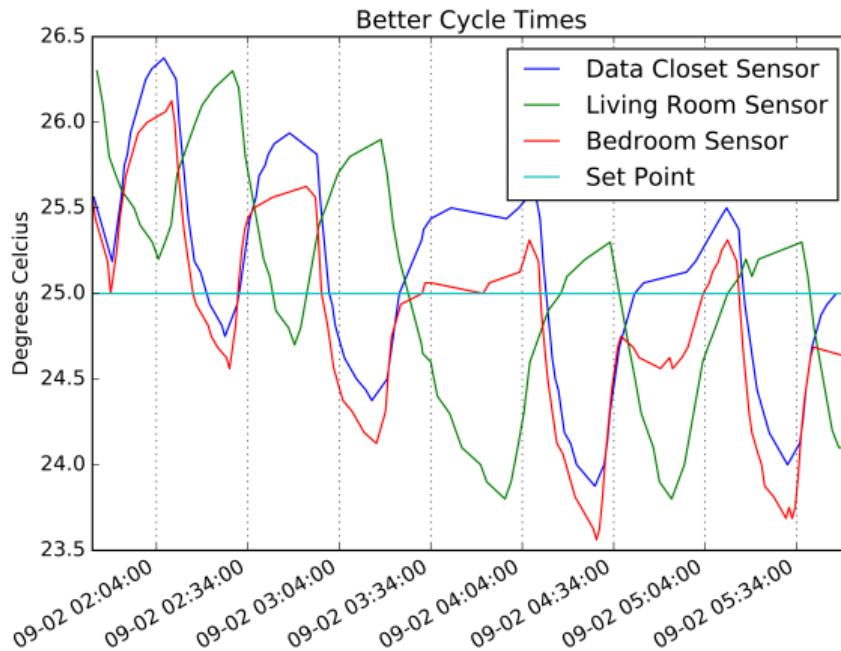
- ▶ Framework for polling sensors and pushing results on MQTT
- ▶ Handles an arbitrary number of sensors
- ▶ Currently only supports Dallas 1 wire temperature sensors from w1_therm linux driver
- ▶ Written in python

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

Where to get more information

- ▶ Blog Post <http://blog.kortar.org/?p=319>
- ▶ <https://home-assistant.io/>
- ▶ <https://github.com/mtreinish/dallasMQTT>
- ▶ <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