

SmartRegisters & SmartThermostats

CS498 Internet of Things Final Project

Rick Bischoff

May 15, 2021

Introduction

- ① Heating your whole house for one cold room is a waste of energy.
- ② Two-staged furnaces are nice, but only houses designed for them benefit.
- ③ What if we could retrofit old houses with a low cost alternative that provides the same benefits?

Outline

- 1 Heating Systems
- 2 Conceptual Overview
- 3 SmartRegister Design
- 4 SmartThermostat Design
- 5 Network and Code
- 6 Demo
- 7 Design Faults
- 8 Conclusion

Heating Systems

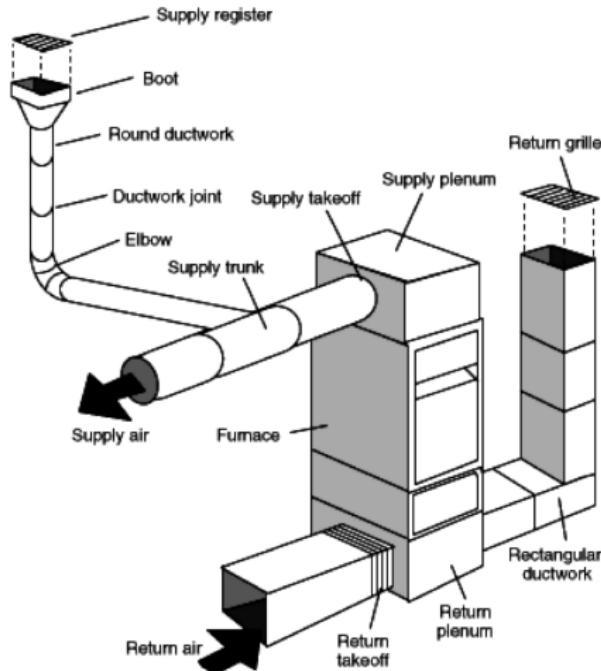
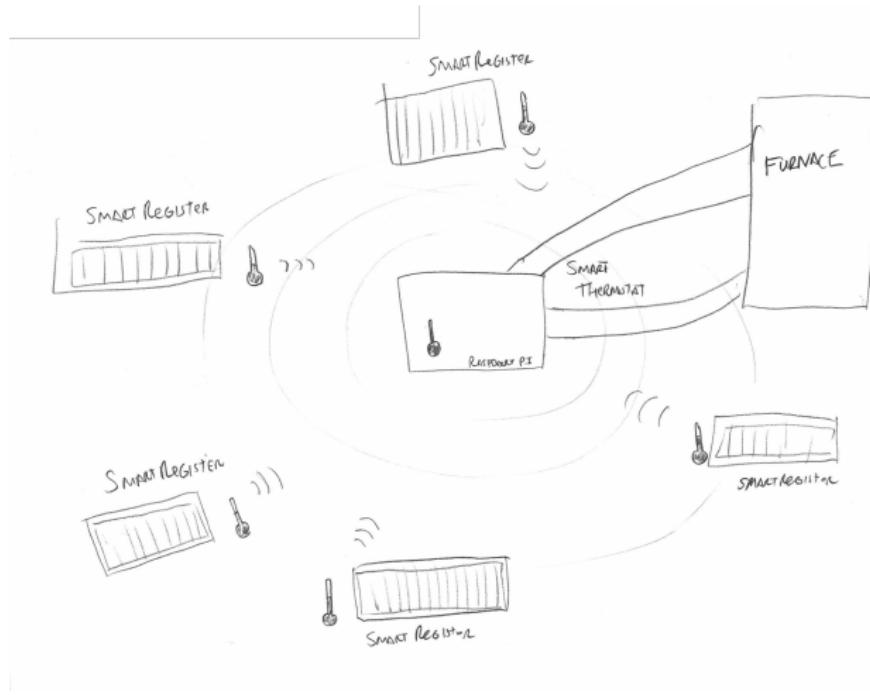


Figure: A typical forced air system. See [1].

Conceptual Overview

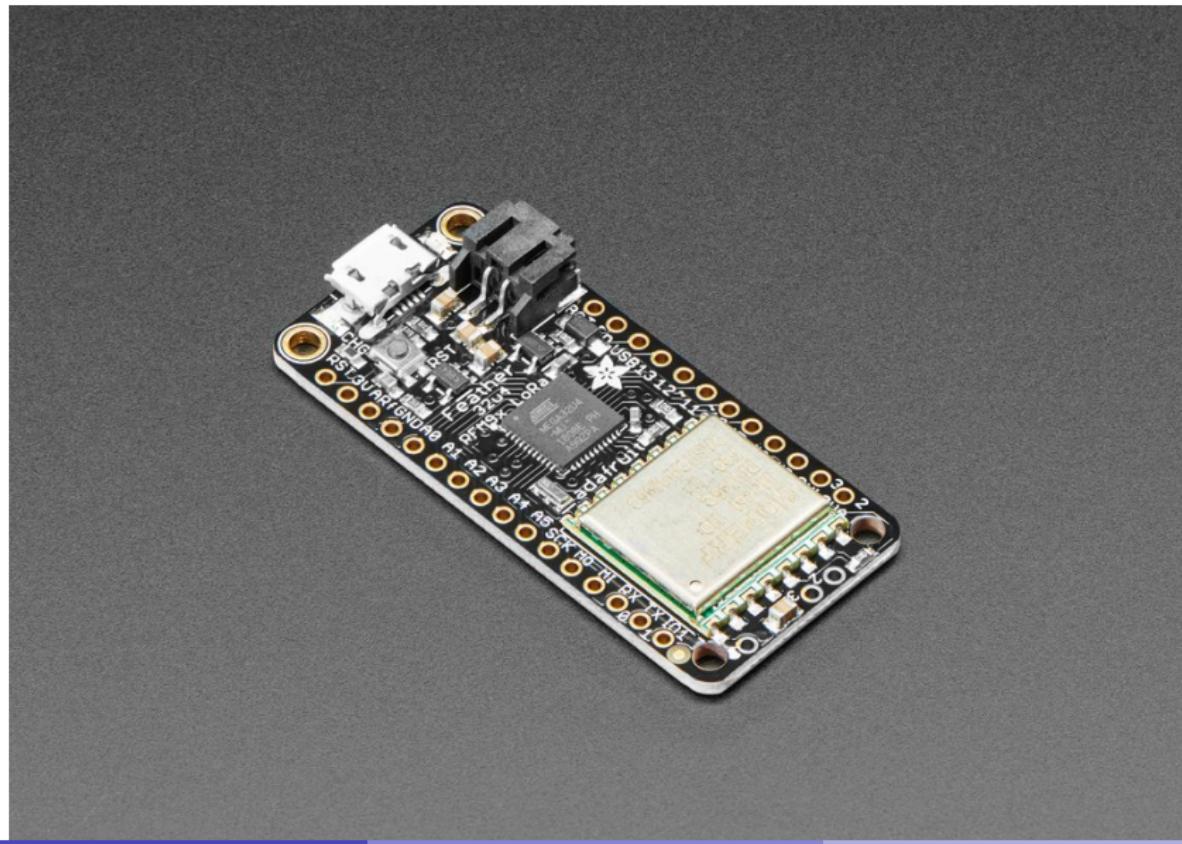


SmartRegister Design Considerations

- ① Size constrained
- ② Power constrained
- ③ Needs a temperature sensor
- ④ Needs a way to open and close the vent

SmartRegister Hardware

32u4 Arduino RFM95 LoRa Radio 915 MHz



SmartRegister Hardware

SG92 Servo. DB18S20.

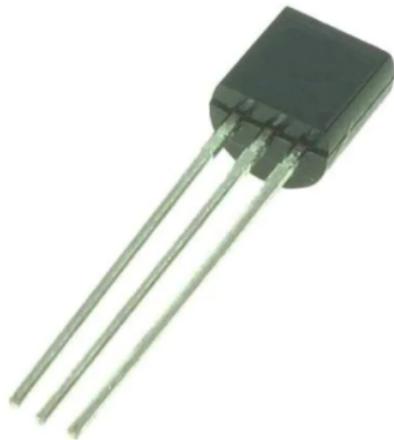
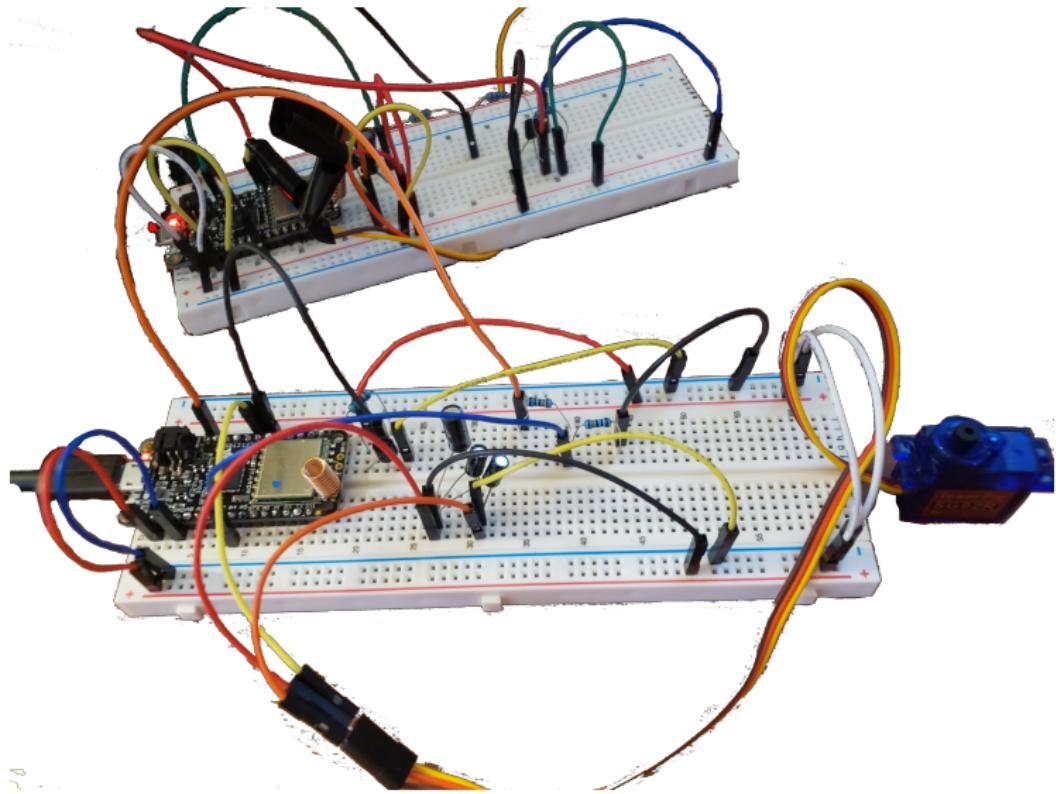
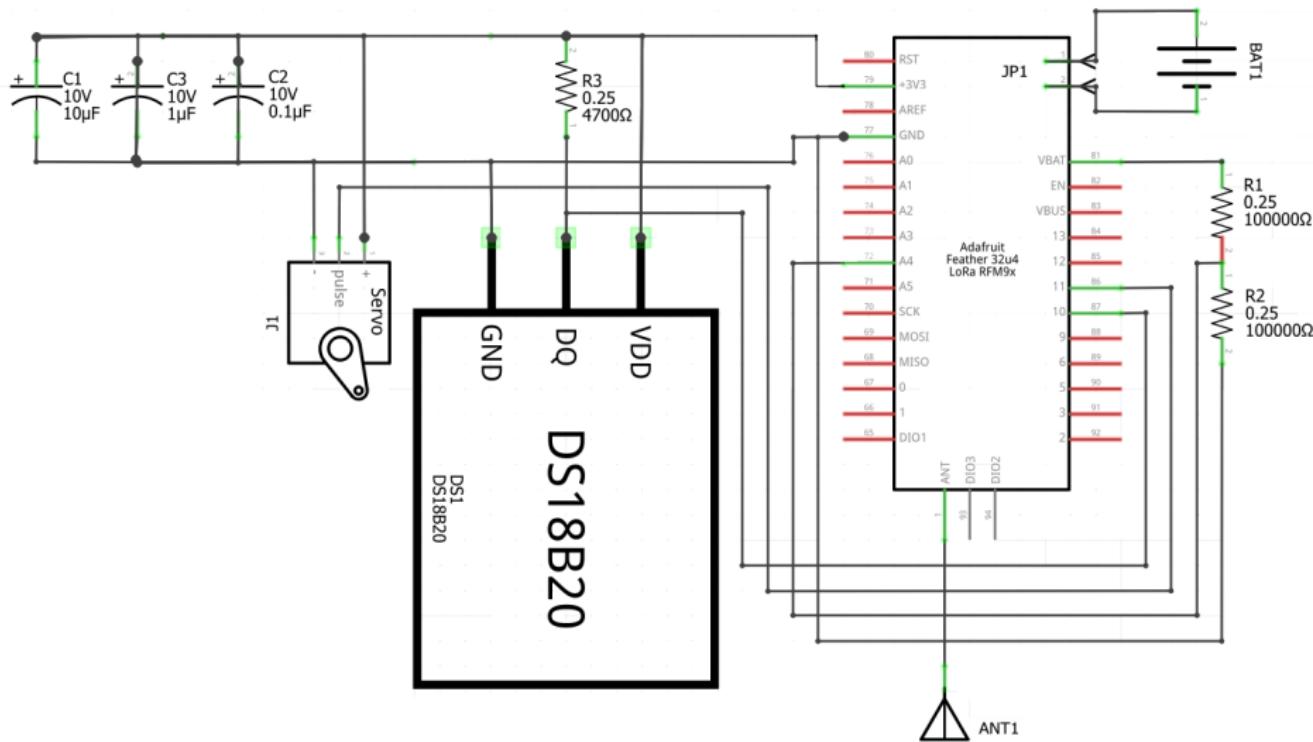


Figure: DS18B20 and SG92R Microservo

SmartRegister Hardware



SmartRegister Schematic



SmartThermostat Design

- ① Originally contemplated a stand-alone controller, but eventually realized we need to control furnace too.
- ② The central controller will have power at the wall, so low-energy not a problem.
- ③ Needs to communicate to the registers.
- ④ Should mimic a typical thermostat.

Easiest path forward was to reuse Raspberry Pi, with a matching LoRa RFM9x breakout, and matching temperature sensor.

SmartThermostat Design

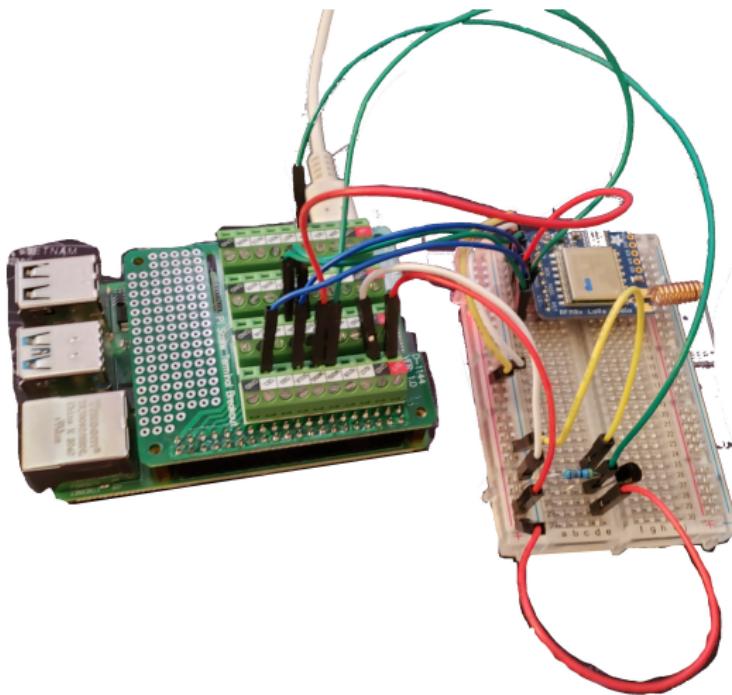
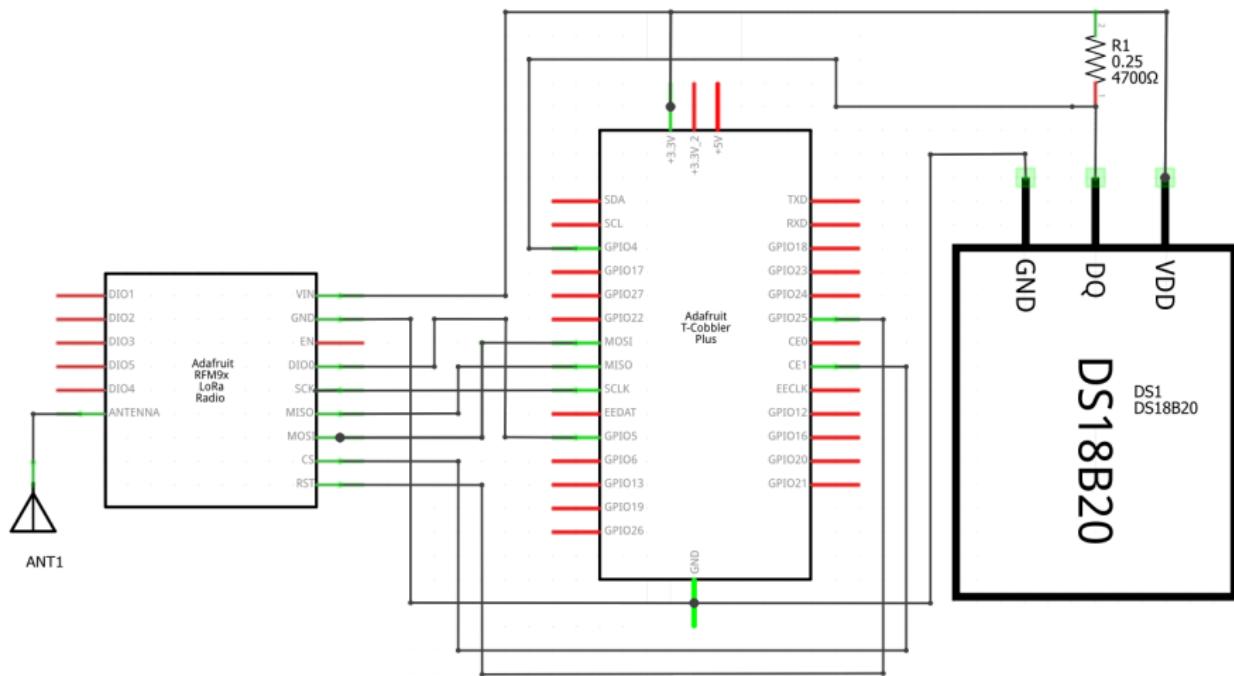


Figure: Raspberry Pi Prototype

SmartThermostat Schematic



Network

Since we used a very low level radio package, there wasn't the usual networking features available, such as:

- ① Addressing. Each Arduino is indistinct!
- ② Error Checking.

Based on these constraints, “invented” a simple protocol for the specific thermostat application.

Network Protocol

- ① SmartRegisters are assigned random 16-bit addresses on boot.
SmartThermostat is assigned special address 1.
- ② Message format is

```
<addr> <command> <arg1> <args2>? <arg3>?
```

- ③ Commands are like POST, SETFLAG, BAFFLE
- ④ What happens on a failure?

Code Structure

- ① SmartRegisters periodically send a POST and listen.
- ② SmartThermostat collects all data from POST for later analysis.
- ③ SmartThermostat periodically flushes data to disk.
- ④ SmartThermostat periodically checks to see if the main system should turn on, and adjusts the vents by broadcast BAFFLE command.

Live Demo

Design Faults

- ① Servos
- ② Sensors
- ③ Device Design

References



- "Home heating alternatives to traditional forced air,"
<http://advancedhomeenergy.com/articles/heating-alternatives/>,
accessed: 2021-05-10.