HOME NETWORK

Smart and centralized

Content

This document is used to list and elaborate all possibilities for a smart home network. A Home Network in this context is the network used to connect all sensors and actuators to the central Home Automation system which in this case is Home Assistant.

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Contents

Preambule

The current setup of my Home Automation system consists of one Raspberry Pi 3B+ running Home Assistant and a MQTT Broker. Furthermore, there is one very powerful sensor and actuator node consisting of a Wemos D1 Mini (160MHz) with an Infrared transmitter, 433MHz transmitter, RGB-Led, buzzer and motion sensor.

This node controls several 433MHz sockets and the speaker for the television. Since I have been tinkering with and developing my Home Automation system I was reaching the current limits. That's the reason I wanted to create several battery powered sensor nodes. Furthermore, the large amount of wifi conntected devices was taking its toll on my router.

Hence, the goal is to setup a wireless network to which low power devices can be connected. Since they have to be low power, and wifi generally isn't low power, we'll assume there has to be one master node that communicates with the Home Automation system.

Communication possibilities

There are several standards being used for communicating with sensor and actuator nodes. These will all be listed in this chapter.

Message Queue Telemetry Transport

Since I am wanting to create several battery powered devices, this protocol does not apply. The ESP8266's don't consume a lot of power when in deep sleep, but they need to connect to the router, setup the connection with the broker and then transmit the message. This takes quite a lot of time and consumes a lot of power.

HTTP

The HTTP POST and GET requests have more overhead, more latency and less reliability than MQTT Messages[1]. Furthermore HTTP is made for large amounts of throughput; that's not what we're after. And since this also requires internet connection, a lot of power is wasted while connecting.

Zigbee

Since Zigbee modules are pretty available, have low standby power consumption (30 uA) and are fire-and-forget, these are pretty usable modules. However, they come at a price of roughly €20,-. For a network of nodes this can get expansive very quickly…

Bluetooth

Having worked with Bluetooth and knowing it can be used in a fire-and-forget manner, this immediately came to my mind. The range is not that good, but should be enough to remain paired and transmit data. However, *retain paired*, sounds like power consuming. I grabbed my multimeter, and yes, it is…

State	Current draw (mA)
Pairing	40
Pared	20
Standby	2.0

This is not an option; 2mA standby current is way to much.

NRF24

This module is also worth mentioning since it has an IRQ pin that turns high when data is received; this creates the possibility to wake the microcontroller on data reception. However, for the module to listen, it has to be turned on. It then uses 13mA. We actually don't necessarily have to be listening though; only transmitting is needed. Unfortunately even the NRF24L01+ with external antenna can't reach the attic.

ASK

Our goal perfectly matches with what Amplitude Shift Keying is made for; low power small data transmission. Furthermore, these modules are very cheap and have a good range. Well… Actually, the SRX882 has a good reception range. Every transmitter is good.

Since they barely use any current while in standby and de protocol is fire-and-forget, this is going to be our choice.

Sensors

Since this node is meant as multi-sensor in as much rooms as possible we have to think of what sensors to use.

Climate

One very useful thing to monitor is the climate; temperature and humidity specifically. The DHT11 consumes about 50uA and the DHT22 20uA. However the BME280 only uses 0.2uA when in sleep mode.

I'd really like to monitor air quality too, but that would make the module more expensive. Furthermore, if you really want accurate readings (which I do), you should actually go for something in the PMS series; for example the PMS5003 or PMS7003. These consume a lot of power though. That's more something for the master module.

Movement

It's also useful to measure movement to, for example, turn lights on when there is movement and it's dark. Hence an LDR would also be convenient.

When extended for alarm system use, a vibration sensor can be useful to determine whether or not the device has been picked up or moved.

Windows

It can be useful to monitor the state of windows as well. Let's assume it's 24 degrees Celsius in a room and the windows are opened. After 2 hours of cooling it's 18 degrees Celsius so now the windows can be closed. Then a message can be sent to one of the inhabitants.

And when everyone leaves the home, a message can be sent that a window has been left open.

Actuators

Since actuators are most likely being controlled by the Home Automation system and the module then has to continuously listen, we aren't going to embed any actutators.

Nodes

Living room

The living room node consists of the following components:

Type	Component
Temperature	BME280
Humidity	BME280
Air pressure	BME280
Movement	AM312
Vibration	HDX
Light	LDR
Transmitter	STX882
Battery	CR2032
Button	Button
OLED	SSD1306

The movement sensor is used to alert the Home Automation system in case of movement. Based on the current state of the alarm, the alarm triggers or doesn't. Furthermore, based on the state of the light intensity, the Home Automation system determines if the lights should turn on.

The Home Automation system is notified when the vibration sensor detects movement. If the alarm is enabled, it now triggers.

Furthermore, it's wanted to measure the battery voltage and thus percentage.

A button could come in handy for single short actions; maybe to light up an OLED to show climate information?

Hallway/Stairs

Actually the only reason the node should be near the stairs is to turn on the light when someone is trying to go down the stairs. Hence, it should only consist of an AM312, microcontroller, STX882 and CR2032.

But, if the AM312 could be facing the stairs and the rest of the node towards the hall maybe a BME280 could be of use as well? *I don't really think so; they're also in the bedrooms…*

Bedrooms

Temperature and humidity are interesting in bedrooms since they have a significant impact on the quality of sleep. So let's throw in a BME280.

Type	Component
Temperature	BME280
Humidity	BME280
Air pressure	BME280
Movement	AM312
Light	LDR
Battery	CR2032
Transmitter	STX882
Window sensor	Reed switch
OLED	SSD1306

Since this climate is so important, the node can help control this climate. Telling when the window should be opened and closed and notifying when the window has been left open and everyone's gone.

Assuming that I'm going to make a bed occupancy sensor in the future, it's also interesting to measure movement and light to turn the light on if there's movement, no one is in the bed and it's dark.

This node assumes there's a smart alarm clock with weightsensors (load cells with HX711) and button to operate the (by a sonoff switched) light.

Bridge

As discussed, we need to have a bridge between the STX882 and the Home Automation system. This can essentially be done in two ways; one could add an SRX882 to receive the 433MHz signals directly to the device running the Home Automation system. One could also create a separate device that functions as a bridge between 433MHz and some popular other (possibly Wi-Fi enabled) protocol.

In this case the choice has been made to use some kind of ESP that listens for 433MHz signals and forwards these to the Home Automation system using Message Queue Telemetry Transport (MQTT).

References

1- Naik, N. (2017). *Choice of Effective Messaging Protocols for IoT Systems: MQTT, CoAP, AMQP and HTTP*. Geraadpleegd van https://researchportal.port.ac.uk/portal/files/12197128/IoT_Messaging_Protocols_Naik.pdf