

Smart home model

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Abstract—This article deals with the smart home and technology stack behind for properly secure and reliable system. Clarify different approaches to communication protocols and consider obstacles to these protocols. The model shows the cooperation of devices of multiple brands. The main benefit of the model is the expansion of awareness of the general public and the possibility of inclusion in students' teaching.

Keywords— smart home, MQTT, Home Assistant, ZigBee, home automation, IoT

1. INTRODUCTION

This article provides an introduction to home automation and introduces the technologies used for communication between devices. It also discusses the issue of compatibility of devices from different manufacturers on the Home Assistant platform. This platform is the most widely used open-source platform for home automation and IoT(Internet of Things). Many manufacturers officially support integration into Home Assistant and those that have not done this are often covered by the community with their support.

2. HOME AUTOMATIONS PLATFORMS

In today's market is a lot of options to choose from. Some manufacturers developing own platforms, but if you choose one of these platforms, you are vendor-locked probably for the rest of your life. And thus you are forced to buy all the equipment from one manufacturer. Another key difference between home automation platforms is where services are hosted. A lot of these systems are cloud-based, meaning that once your internet goes down you lose all the smart features. Sometimes even the actual functionality of switches and other smart devices is affected. Another downside to these cloud-based systems is the legitimate privacy concerns about these very personal data, with all of these devices providing information about your behaviour in the home, from data like when you usually come home to when you turn off the last light and head to bed. That's why our chosen system is Home Assistant, which, unlike cloud solutions, runs on a local device, so all the data doesn't need to leave your private network. Another indisputable advantage of Home Assistant is its ability to be completely customised to the user's requirements and the countless official integrations and add-ons.

2.1. Home Assistant

Home Assistant is free open-source software for creating and controlling home automation. It is a complete hub for smart home. The main application is written in python and the first version was released in 2013. According to the GitHub State of the Octoverse¹, in 2020 it became the second largest open-source project by number of contributors that is written in python. Home assistant also has apps on android, iOS and watchOS. Most commercial IoT and Home automation products have an official add-on available for this system, there are over 1700 of these official add-ons available. Home assistant's biggest focus is on security. It is a local solution therefore the data is not stored anywhere but on your device, this

¹Based on statistics published on <https://octoverse.github.com/>

is one of the biggest advantages over cloud services and other proprietary systems. It can also connect to well-known home automation ecosystems such as Google Home, Apple HomeKit, Mi Home, IKEA Smart Home. With an emphasis on security, it is possible to set which entities will be available for each of these services. UI (User interface) of home assistant is named Lovelace and an example of dashboard created in Lovelace you can see in Figure 1.

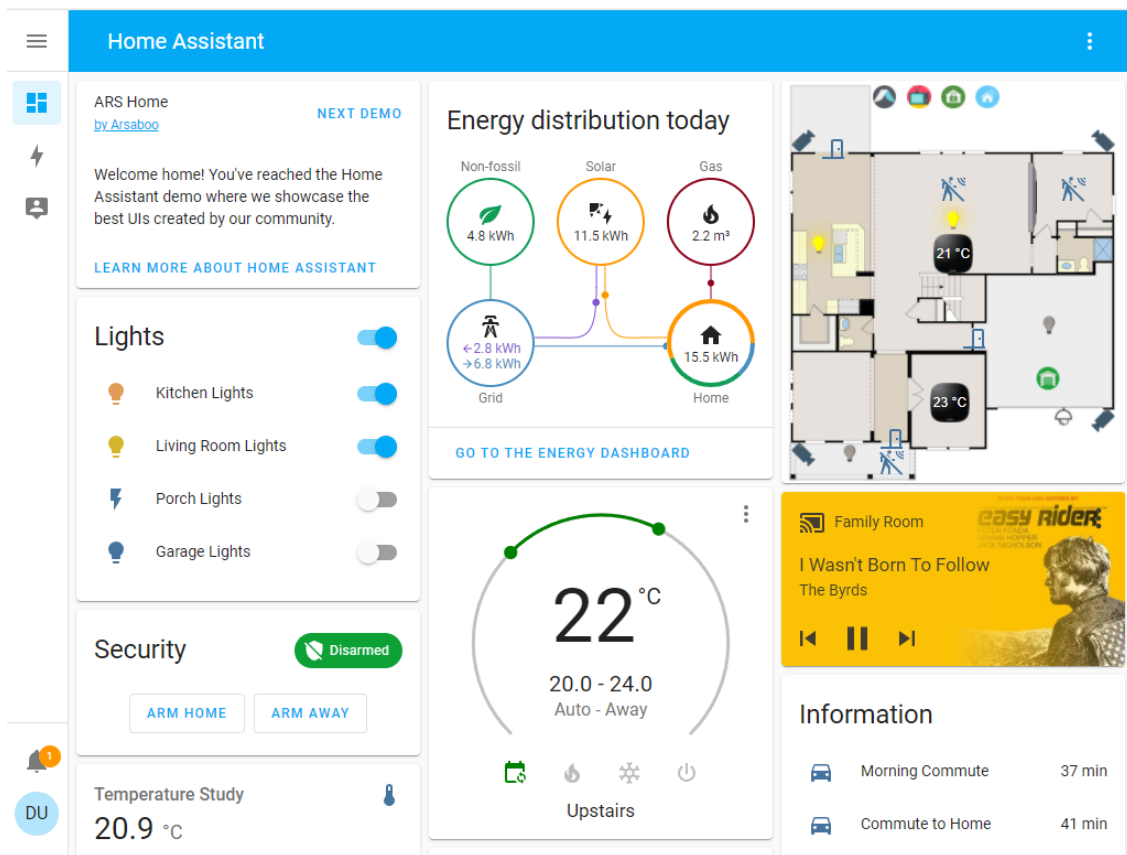


Figure 1: Home Assistant UI Lovelace[1]

3. COMMUNICATION TECHNOLOGY

This section describes the communication technology that is used on the smart home model.

3.1. MQTT

MQTT (Message Queuing Telemetry Transport) is a communication protocol originally developed by Andy Stanford-Clark and Arlen Nipper in 1999 for the transmission of oil pipeline monitoring data from the desert, so it emphasizes efficient use of the data stream, overall lightweighting and low battery requirements. The name is historically derived from the IBM MQ product line. IBM standardized this protocol with the OASIS (Organization for the Advancement of Structured Information Standards) standard, then version 3.1 also received ISO (International Organization for Standardization) standardization. MQTT is a publish/subscribe protocol that introduces the concepts of client and broker as shown in Figure 2. The broker receives all messages from each client and then forwards them according to the subscription topic to the clients. The information is organized by "topic". MQTT is based on the TCP (Transmission Control Protocol) protocol, which can be encrypted using TLS(Transport Layer Security)/SSL(Secure Sockets Layer). Both client and broker must have a TCP/IP stack. [2]

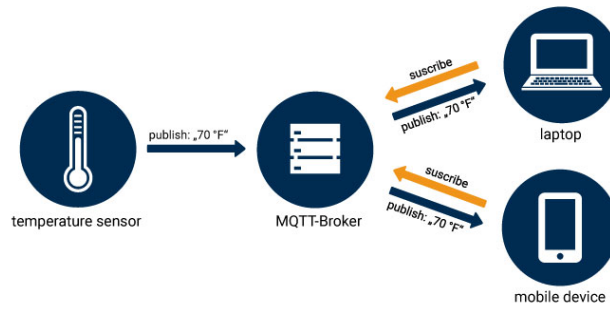


Figure 2: Schema of MQTT communication protocol [3]

The main advantages of MQTT [4]

- Lightweight protocol with the main focus on data minimization
- Topic based protocol for controlling scope of recipients
- Easy scalability up to millions of devices
- QoS (Quality of Service) specifying the importance of the messages sent
- TLS provides communications security over a computer network.

3.2. ZigBee

Zigbee is a mesh wireless protocol. It strengthens and expands the network by using a device to relay a signal to other devices. When compared to Wi-Fi, the advantage is lower energy consumption. The most recent version, ZigBee 3.0, promises improved device and version interoperability.

ZigBee2MQTT is the layer that translates ZigBee device messages to the MQTT broker and vice versa. The main advantage is then a unified communication platform. Schema of communication through Zigbee2MQTT and broker with the home assistant you can see in Figure 3.

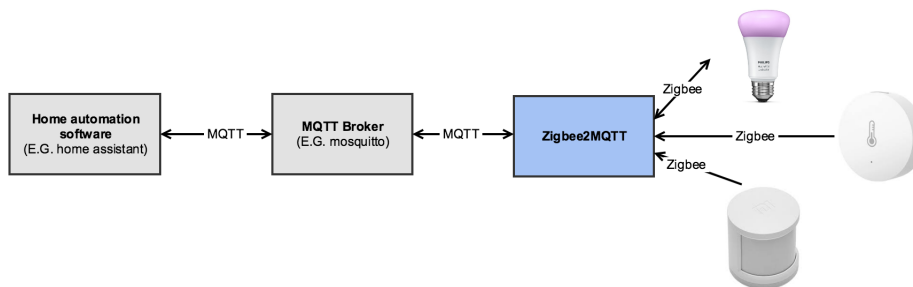


Figure 3: Schema of ZigBee2MQTT [5]

3.3. Wi-Fi

Wi-Fi is a set of wireless network protocols based on the IEEE 802.11 standard family. The 2.4 gigahertz (120 mm) UHF (Ultra High Frequency) and 5 gigahertz (60 mm) SHF (Super High Frequency) radio bands are the most often used for Wi-Fi, and both bands are split into several channels. In our case, Wi-Fi devices will use a some proprietary protocol or directly MQTT as a communication protocol.

4. SMART HOME MODEL

This section is describing the construction and used communication technologies in our model.

4.1. Communication

Our smart home model uses a combination of these communication protocols. The main gate of communication between devices and the backend is the MQTT broker. For ZigBee devices, we use translating layer of ZigBee2MQTT which translate messages between these two layers of communication. Some devices use proprietary protocol on Wi-Fi, with device manufacturer integration to communicate.

4.2. Construction

The frame structure itself is aluminium and is divided into six rooms, each representing a different segment of the house. For example, in the utility room there is a water meter, a water leak sensor and a light bulb simulating a valve to close the main water supply. In programmed automation, when a water leak is detected, the water supply is stopped and a notification is sent to the owner.

4.3. Devices used in model

The model combines Sonoff, Aqara, IKEA and our ESP32 device. Different types of switches are used such as fully wireless, wired without neutral. Furthermore, the combination of bulbs both via Wi-Fi and ZigBee. Smart sockets built directly into the installation box, smart attachments to existing sockets or switches for existing sockets. Camera system with motion detection and motion detector itself.

5. CONCLUSION

The aim of this article is to improve the overall availability of Smart home systems, with the desired result being an increased number of smart homes practising effective energy management.

The second section is sum up home automation platforms and introduces the chosen one the Home Assistant The Home Assistant platform is rapidly evolving and keeping up with the trends of the times, which is why the current emphasis is on energy management. It includes pre-made dashboards and charts for solar panels and other sustainable sources.

The third section shows a variety of communication technology and shows their advantages. The model shows the possibility of interconnecting devices from different manufacturers into one platform using MQTT with multiple end-to-end communication sources.

This model will be used as a demonstrator of a smart home and will create space for the implementation of new final theses on this topic.

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