RUNTIME VERIFICATION FOR SPATIO-TEMPORAL PROPERTIES OVER IOT NETWORKS

Partial release of the project

DEGREE IN COMPUTER ENGINEERING

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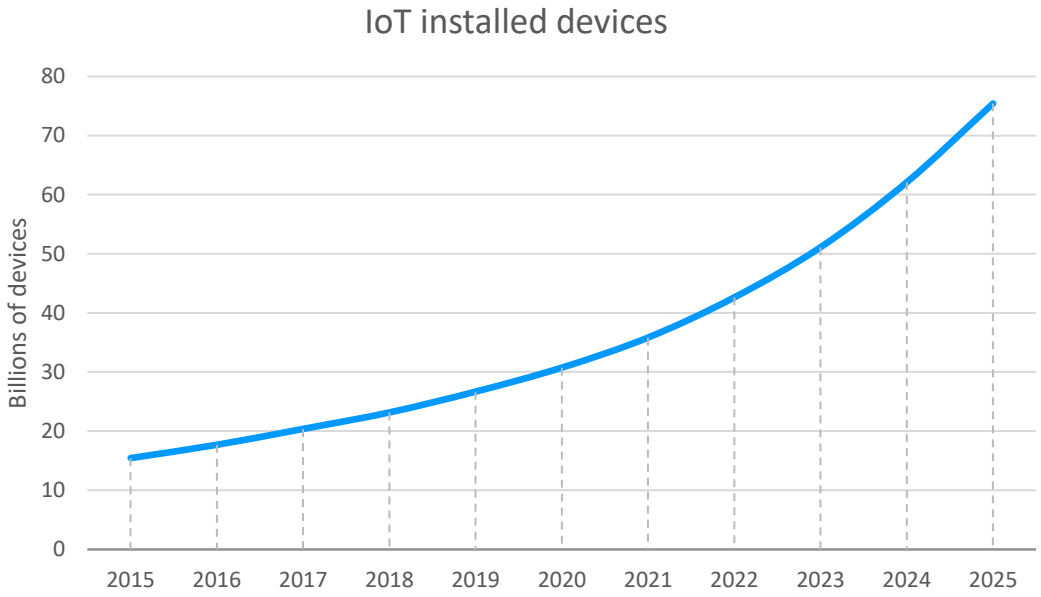
Introduction

- IoT (Internet of Things): Connecting millions of smart devices and sensors and making them accessible via internet.
- This field is growing rapidly: In 2022 it is estimated that there will be 42.56 billion connected devices.



Introduction

- Cyber Physical Systems (CPS): Can exploit an IoT infrastructure, physical systems are monitored and/or controlled by a computational core.

> *"Cyber-Physical Systems are engineering, physical and biological systems whose operations are integrated, monitored, and/or controlled by a computational core. Components are networked at every scale. Computing is deeply embedded into every physical component, possibly even into materials. The computational core is an embedded system, usually demands real-time response, and is most often distributed. The behavior of a cyber-physical system is a fully-integrated hybridisation of computational (logical) and physical action."*
>
> *(Helen Gill, US National Science Foundation)*

- Monitoring is an activity related to the wider category of Runtime Verification (RV).

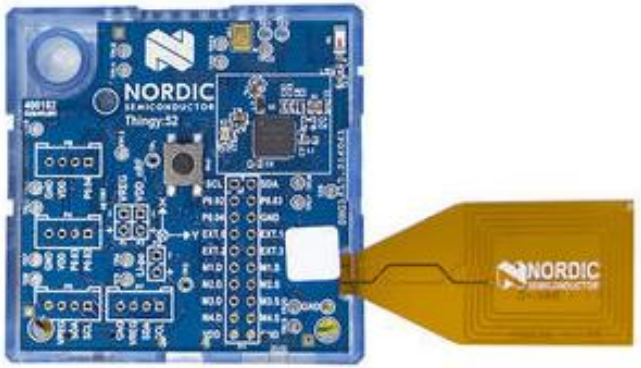
Project goals

- IoT devices (Thingy52) are spatially distributed.
- Set up an MQTT broker for the communication
- Fully develop the middleware.
- Feed live data into moonlight and monitor it in real-time
- Analyze and comprehend STREL and the MoonLight monitor

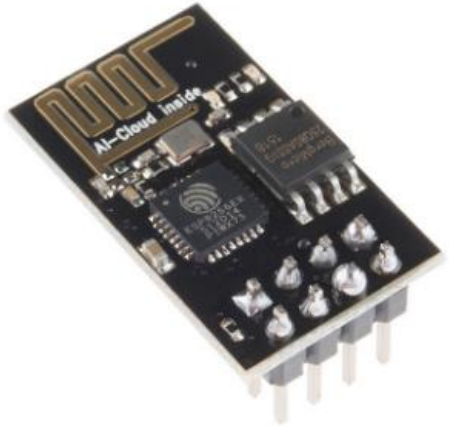
Resources and materials

- Main resources:

Thingy52



ESP 01



MoonLight monitor

Project information

The project duration is eight months, from November 2021 to June 2022.

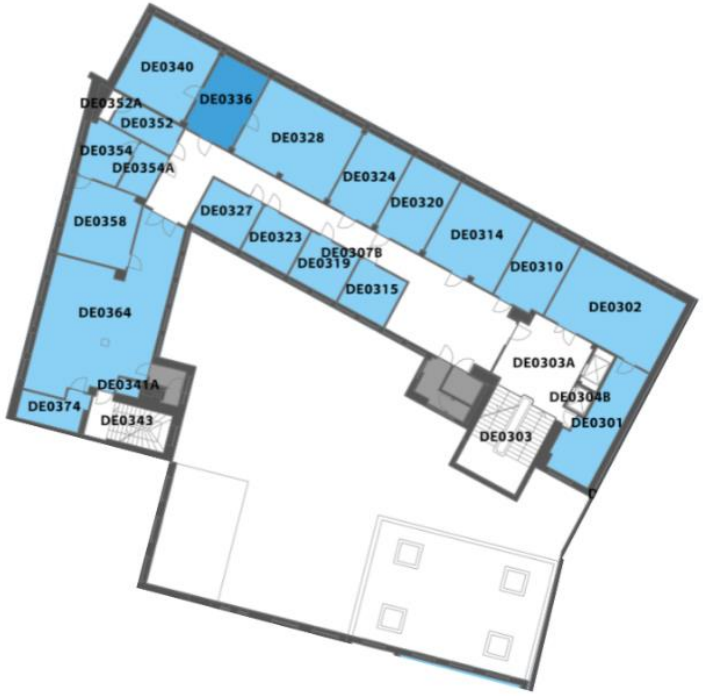
These are some milestones of the project:

11/11/2021	First follow up meeting
10/01/2022	Middleware first aproximation
10/02/2022	Partial release
04/04/2022	Project beta release
30/06/2022	Final

Use case - Domotics / Smart Home Automation

Environmental data that can be collected in the department:

1. Temperature
2. Humidity
3. Air pressure
4. Air quality (CO2 and TVOC)
5. Light intensity
6. Sound



Use case - Domotics / Smart Home Automation

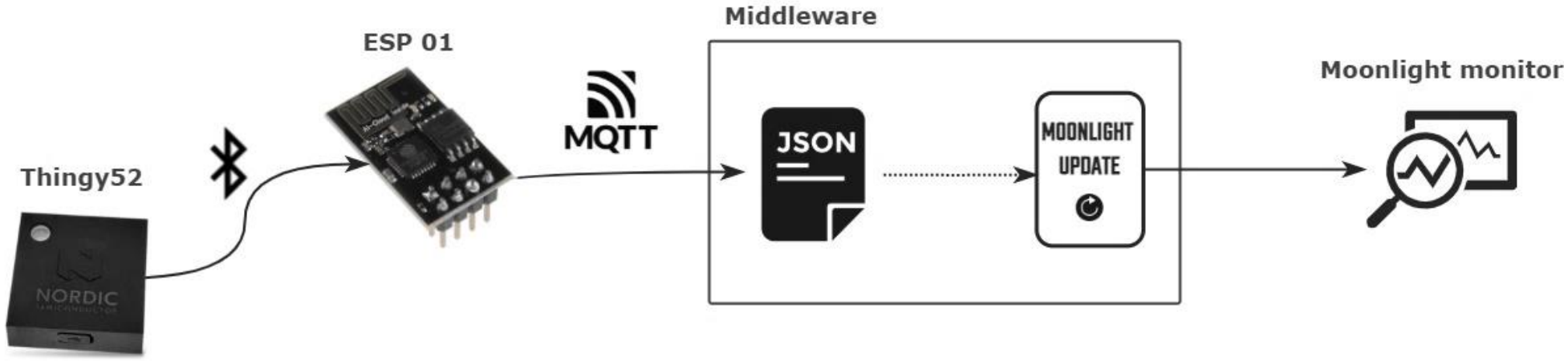
The environmental conditions must be adequate:

1. The temperature must be lower than 22ºC and higher than 15ºC
2. If the CO2 level is higher than X, after some time interval it must decrease to an adequate level (lower than X).
3. If the sound in one room is higher than X, the sound in the adjacent rooms should be less than X

$$(\mathrm{CO2} > x) \rightarrow F_{[0,t]}(\mathrm{CO2} < x)$$

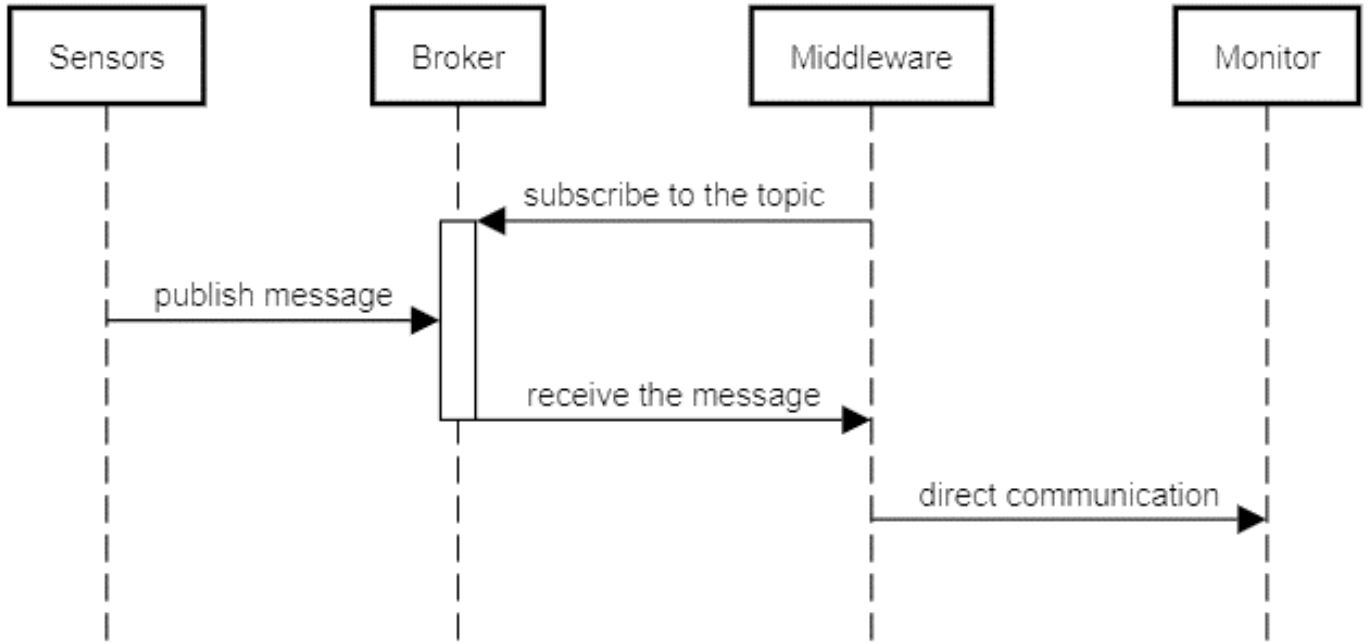
Communication and monitor

- In the physical part, there are two types of devices:
  1. Thingy52's sensors collect data from the environment
  2. ESP01 receives the file, and it publishes to the MQTT broker
- Regarding the monitoring segment:
  1. The middleware converts the JSON files to a moonlight signal
  2. The monitor will consist of an online monitoring (i.e., the monitoring is performed incrementally)



MQTT prototype

- MQTT protocol will be in charge of transporting messages between the middleware and sensors.



Work done until now

1. Literature review (Internet of Things, Runtime Verification, Cyber-physical systems and STREL).
2. Start developing the moonlight interface and the middleware.
3. Start developing the Thingy52.

- In conclusion, I have the base and the structure of the project well defined. This should make the development go faster to achieve the objectives.

Problems and solutions

- Past problems:

Problem	Problems with Zephyr and Windows. I kept hitting obstacles and the initialization process was dragging on.
Solution	Used a Linux Virtual Box Machine

- Future problems: This is the first time moonlight will be working end-to-end.
  We expect some bugs in the moonlight monitor.

Future developments of the project

Adding other use cases will do the project more complete.

- The domotics/office use case:
  - ✓ Interaction with the hardware.
  - ✗ Properties do not allow interesting observations

- Wiener Linien use case: They have an API that makes the public data accessible in real-time.
  - ✓ Adds additional value to the project.
  - ✓ Interesting data to monitor and there are more diverse specifications to use.
  - ✓ See that with minor changes the monitor can handle a completely different use case.

Contributions of the traineeships to studies

One competence to be acquired is:

T1IT06	Ability to create and develop centralized or distributed computer systems or architectures integrating hardware, software and networks.

The project involves all the processes from the hardware to the monitor, so I can gain a lot of knowledge and experience

Thank you

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