MyBabyMonitor

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The idea

SIDS [1]

The most significant cause of infant mortality during the first year of life

Causes

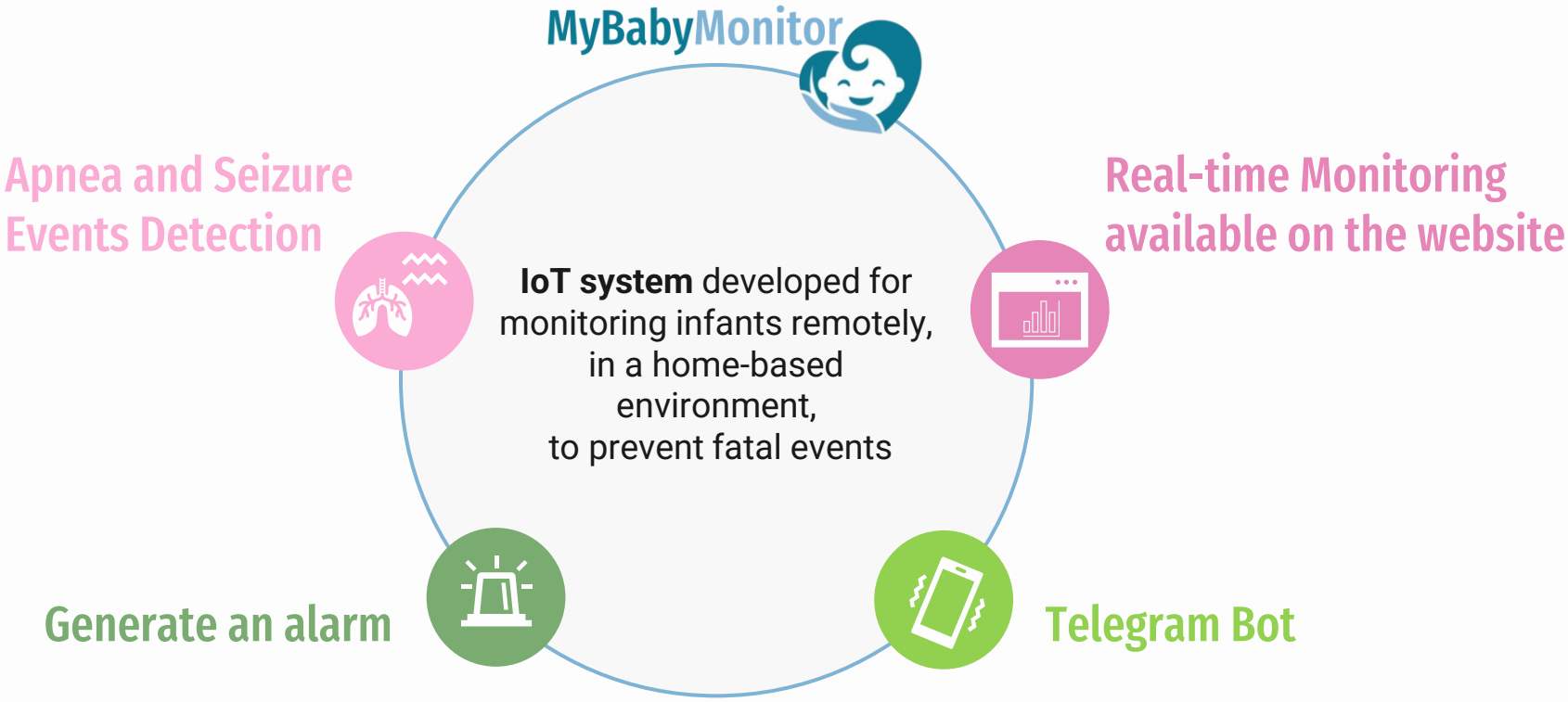
- Seizure
- Apnea

Solution

MyBabyMonitor

A continuous monitoring system for evaluation of vital signal monitoring can help *reduce* premature infant mortality rate.

Features


MyBabyMonitor
Apnea and Seizure Events Detection
Real-time Monitoring available on the website
IoT system developed for monitoring infants remotely, in a home-based environment, to prevent fatal events
Generate an alarm
Telegram Bot

Software characteristics

Integration

External services can be integrated throught APIs

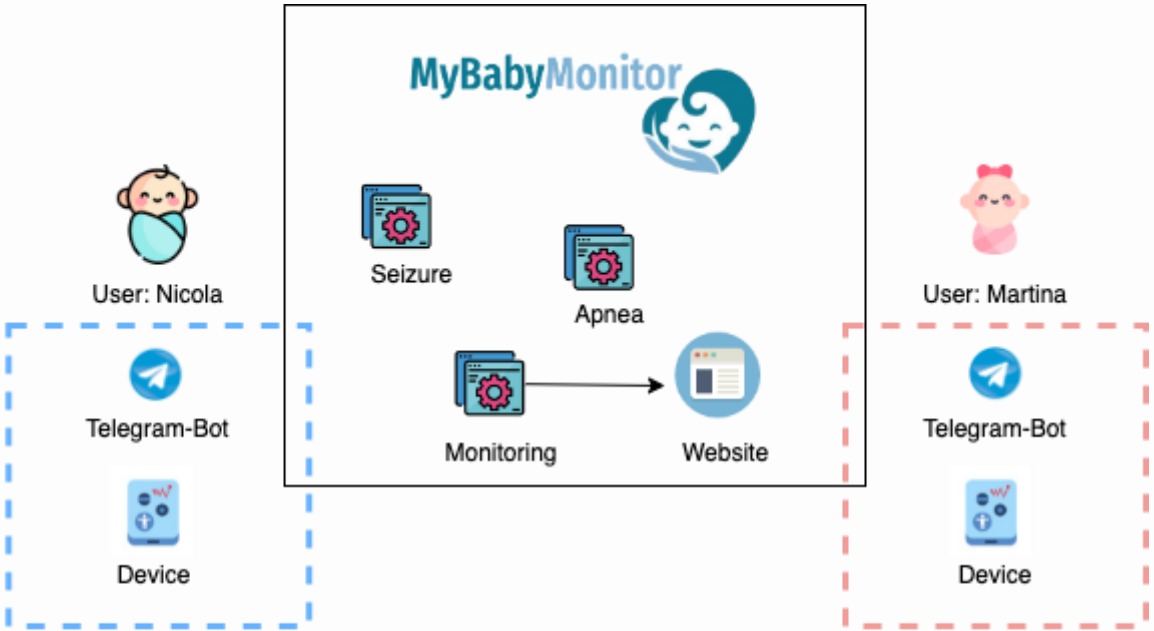
Modularity and Scalability

- Registration of multiple devices and users
- Simultaneously handling of data coming from different devices
- Simple integration of new functionalities

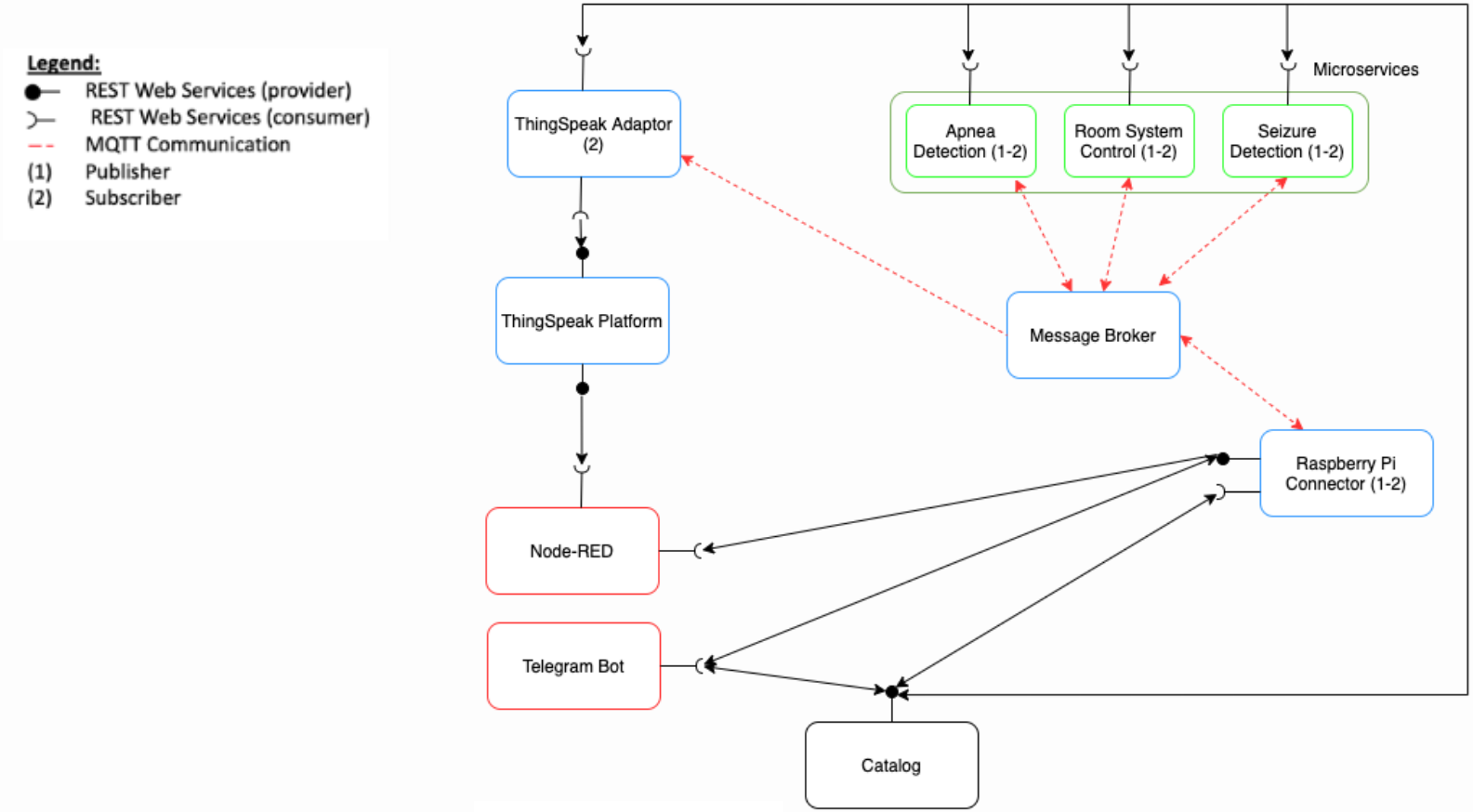
Microservices Architecture

Services run independently

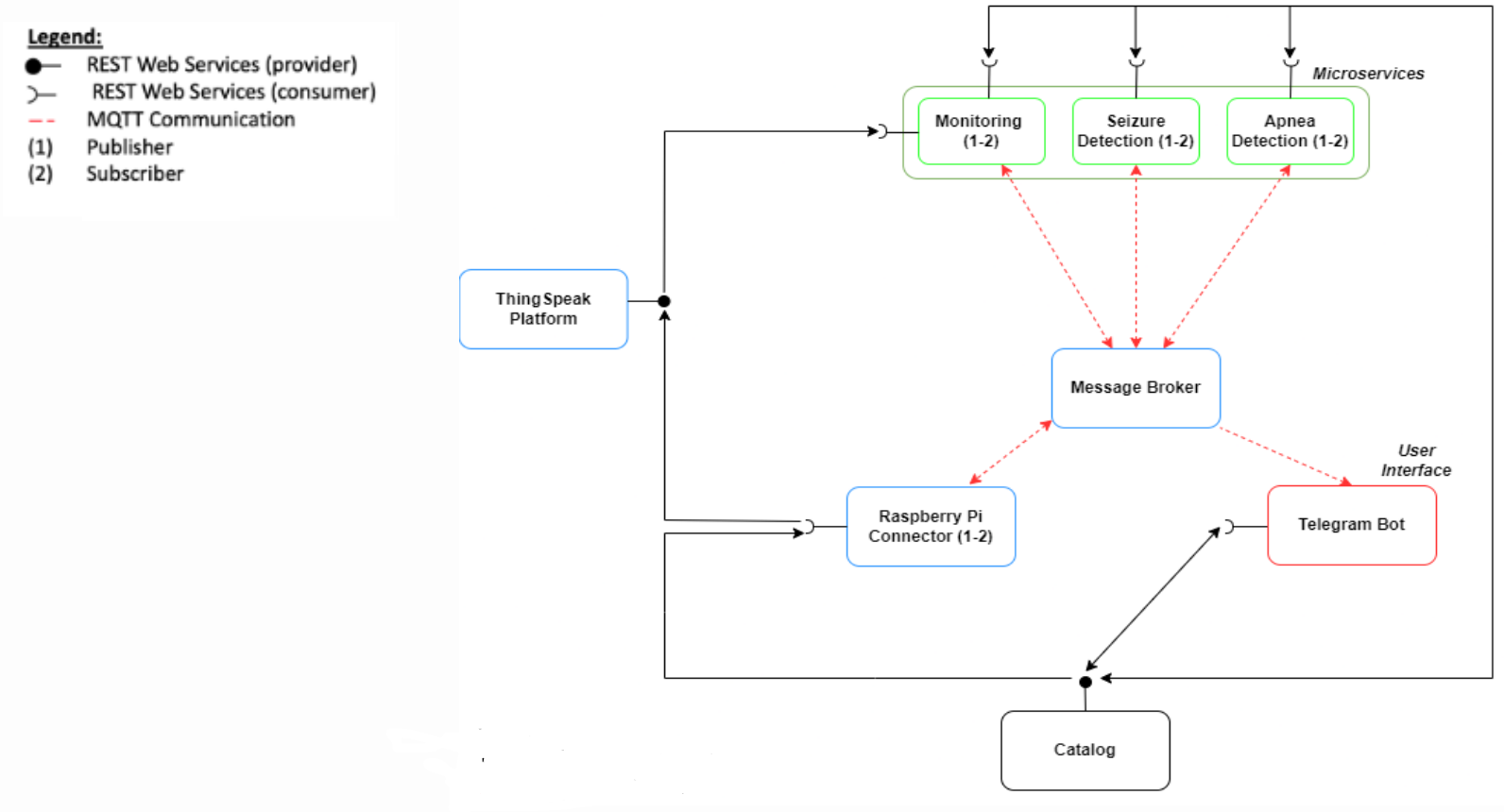
System Overview



Use Case Diagram: proposed



Use Case Diagram: modified



Device

Sensors

- Heartrate sensor
- Pulsossimeter: oxygen level
- Microphone
- MIMU sensor: seizure

simulated in .txt files

Device

1

MQTT: Publish

- Publish messages relative to the measurements using SenML format to the microservices with the topic " *MyBabyMonitor/**Service**/**DeviceID*** "
- Publish the event with the topics *"MyBabyMonitor/Alarm/**DeviceID**"* and *"MyBabyMonitor/Alarm/**DeviceID**/Duration"*

2

MQTT: Subscribe

Subscribes to the topic *"MyBabyMonitor/Event/**DeviceID**"* to receive events from the microservices

3

REST

The Blood Level Oxygen and Heart Rate data are sent to the Thingspeak personal channel using REST protocol

SenML format

```
apneaMessage={
    "bn": deviceID,
    "e":[
    {
        "n": "respiration",
        "u": "",
        "t": time.time(),
        "v": resp
    },
    {
        "n": "oxylevel",
        "u": "",
        "t": time.time(),
        "v": oxy
    }
    ]
}
```

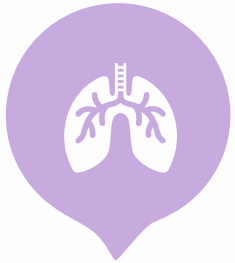
Catalogs

Main Catalog

- Information of registered users and devices
- System configuration data
- List of online available services

Seizure Catalog

- Seizure events for each user



Apnea Catalog

- Apnea events for each user

Monitoring Catalog

- Apnea and Seizure events data for each user

Catalog Manager

Central unit of the system

Main functions:

- Setting services online
- Obtaining status info about services
- Updating and removing services
- Working as interface between the database and the rest of the System.
- Managing users' registration and account settings

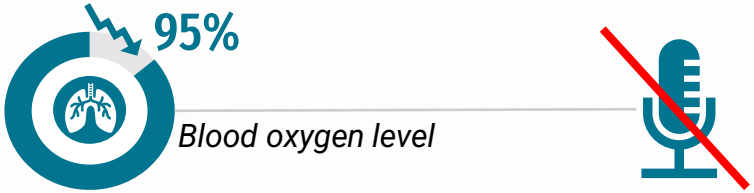
Using its functions, it can be retrieved:

- Microservices URLs
- Thingspeak configuration
- Broker configuration (Mosquitto)
- MQTT topics used by other services

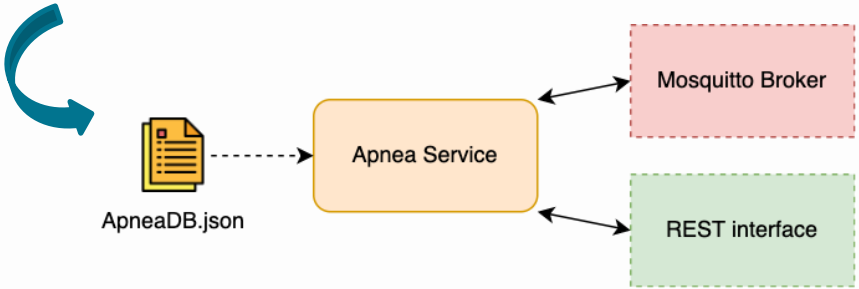
The main catalog, which serve as database, is exposed to microservices through REST

Apnea

Apnea microservice detects an event when for 5 seconds the following conditions occur:



Using **REST** interface, the service communicates to the server that is online and gets information to configure Mosquitto.

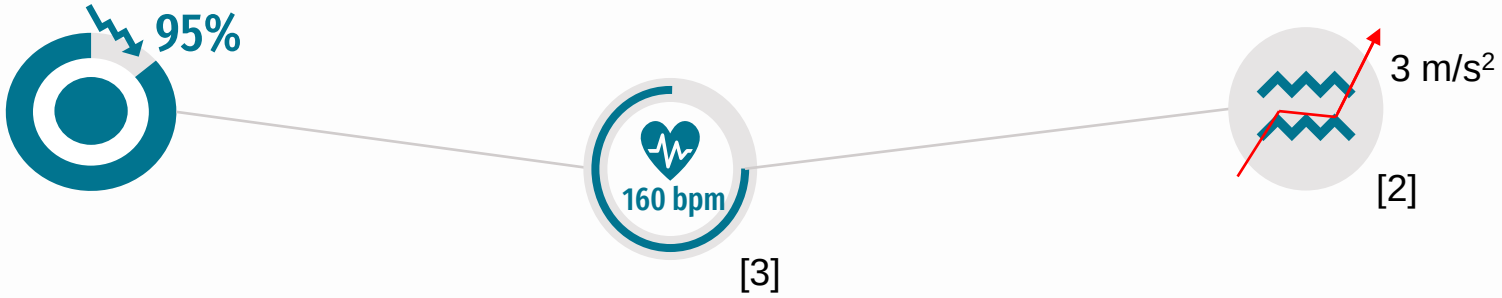


MQTT protocol is used:

- to receive messages about sensor measurements from the Raspberry device
- sort the data according to the origin using DeviceID
- to communicate to the Raspberry if an event has been detected

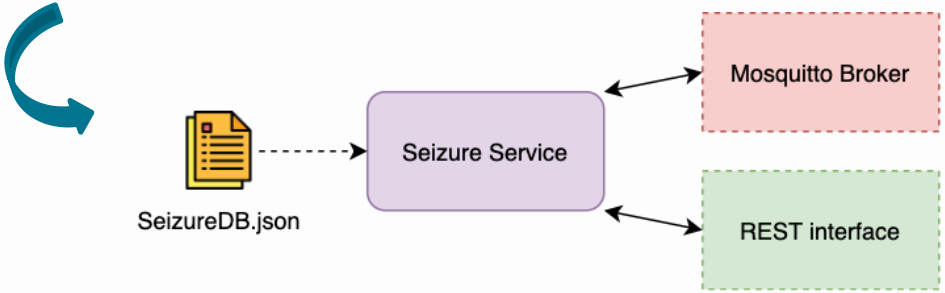
Seizure

Seizure microservice detects an event when for 5 seconds the following conditions occur:



[3] [2]

Using **REST** interface, the service communicates to the server that is online and gets information to configure Mosquitto.



MQTT protocol is used:

- to receive the messages about sensor measurements from the Raspberry device
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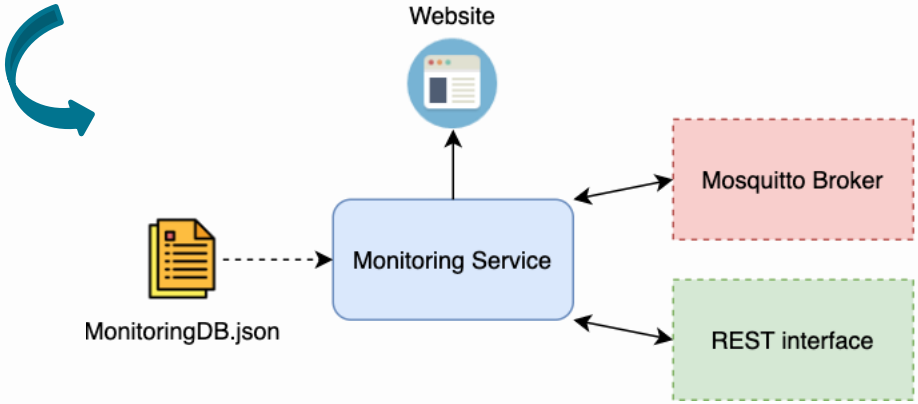
- to communicate to the Raspberry if an event has been detected

Monitoring

Monitoring microservice handles visualization of:
- real-time acquired data
- stored data events

Using **REST** interface, the service communicates to the server that is online and gets information to configure Mosquitto.

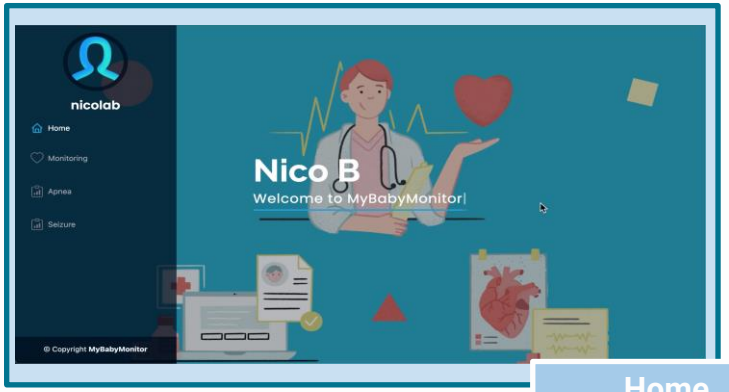


MQTT protocol is used to receive alarm messages that are stored in the MonitoringDB.

It subscribes to the topic:
“MyBabyMonitor/Alarm/#”

The information stored in the MonitoringDB can be visualized through the website

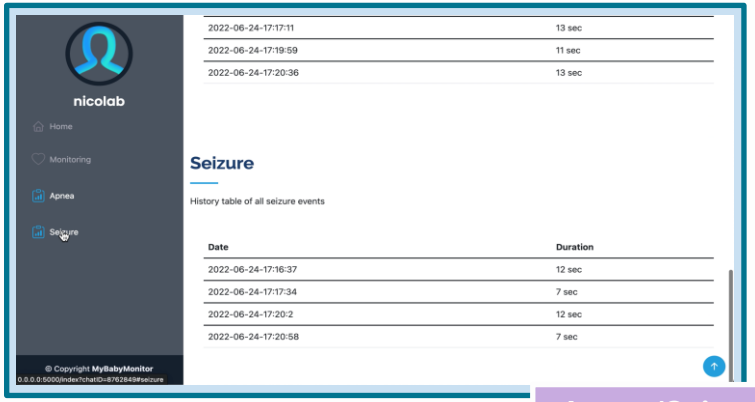
Monitoring: Website



Home

Flask + B

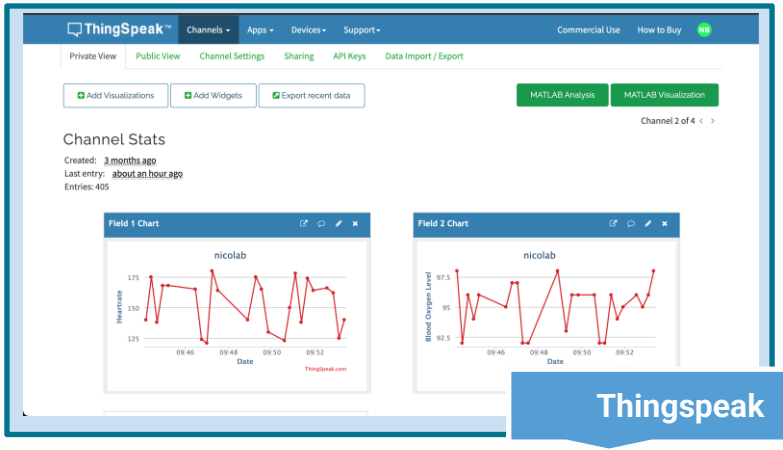
Website is built using Flask and Bootstrap Framework



Apnea/Seizure

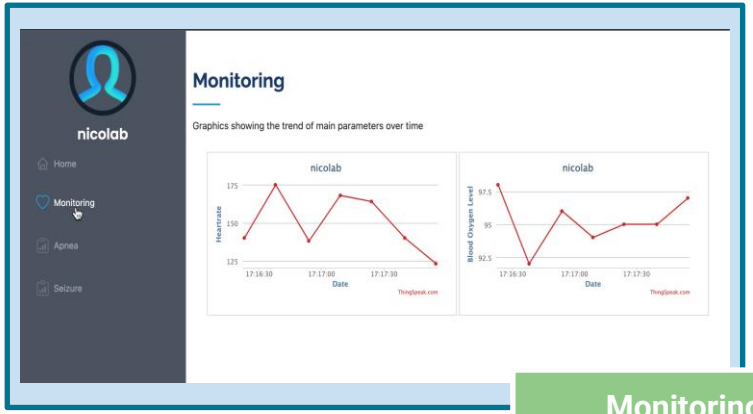
Website retrieves data of events and shows them in two tables

Monitoring: Thingspeak



Thingspeak

Thingspeak collects data received from the user's device, store them and creates graphs in the personal channel

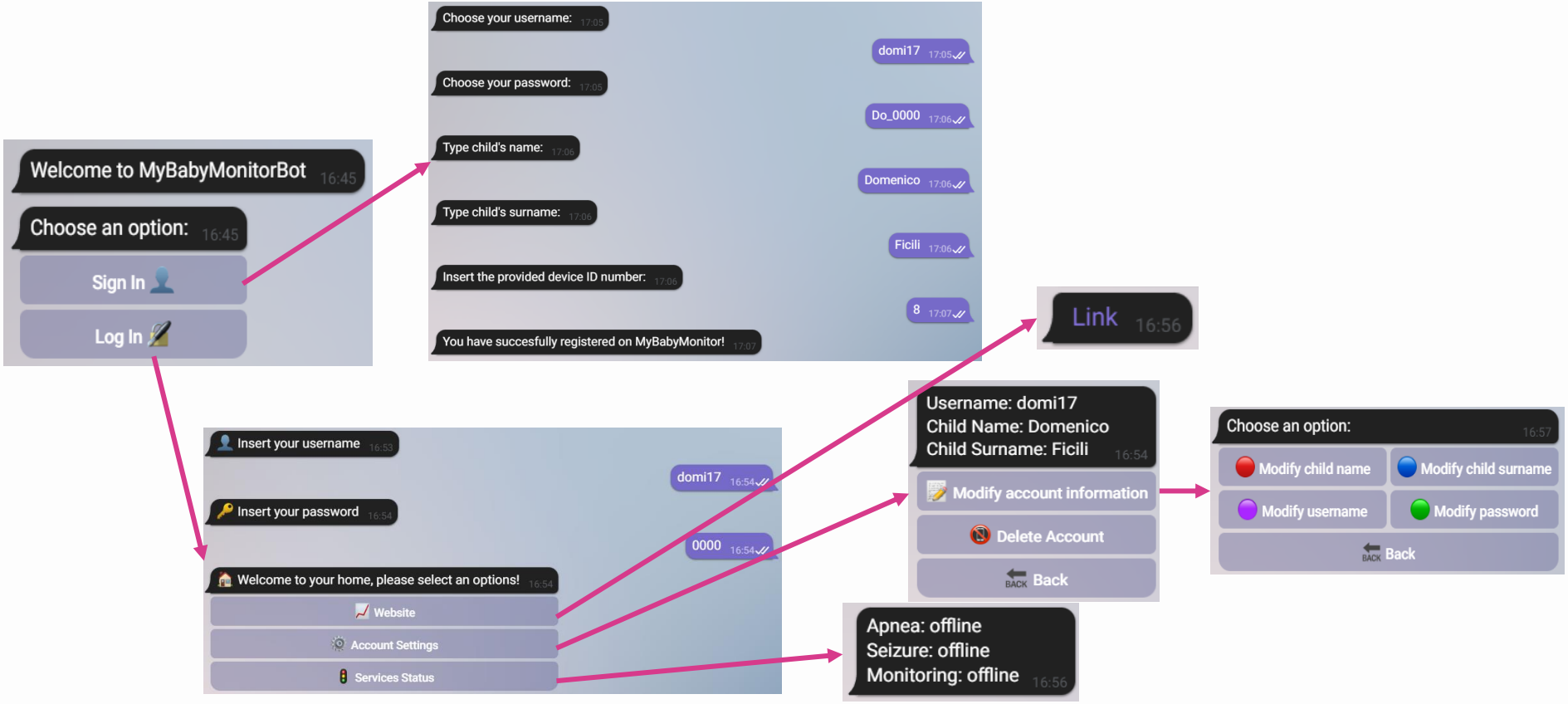


Monitoring

The Monitoring service retrieves graphs from the user's Thingspeak channel and shows them in the personal webpage

Telegram Bot: User Interface

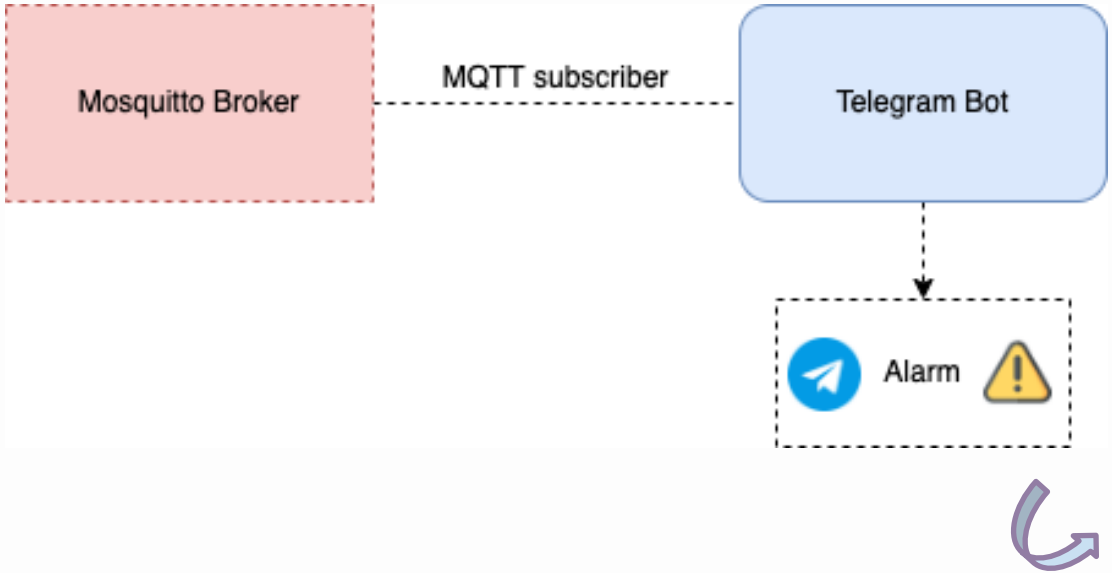
MyBabyMonitorBot *serves as User Interface to register and manage users' account*



Telegram Bot: Notification

MQTT protocol is used to receive alarm messages and send a notification to the user using Telegram Bot.

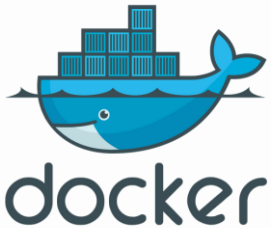
It subscribes to the topic:
"MyBabyMonitor/Alarm/#"



***Notification** alarm*

Docker

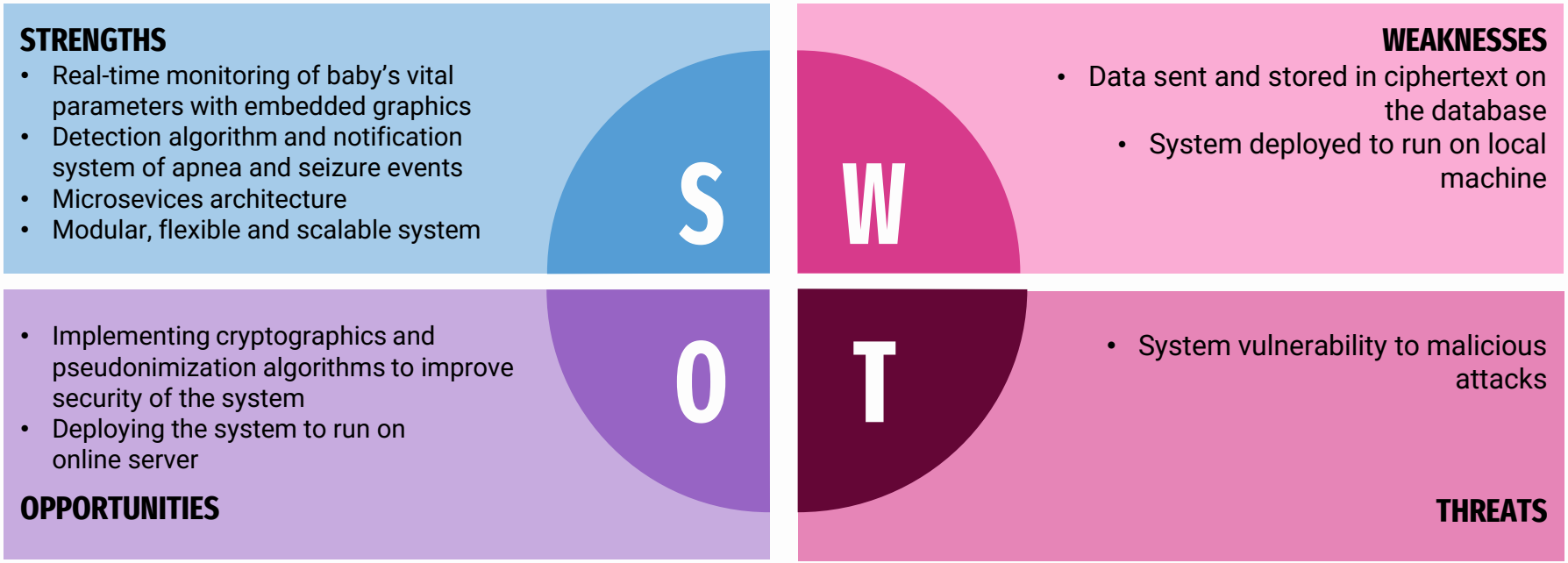
Containers



Docker containers are used to:

- Deploy system microservices
- Run each service in an independent container
- Distribute the workload and speed up the system implementation

Conclusion


STRENGTHS
• Real-time monitoring of baby's vital parameters with embedded graphics
• Detection algorithm and notification system of apnea and seizure events
• Microsevices architecture
• Modular, flexible and scalable system
S
W
WEAKNESSES
• Data sent and stored in ciphertext on the database
• System deployed to run on local machine
• Implementing cryptographics and pseudonimization algorithms to improve security of the system
• Deploying the system to run on online server
O
OPPORTUNITIES
T
• System vulnerability to malicious attacks
THREATS

Bibliography

[1] S. Shamsir, O. Hassan and S. K. Islam, "Smart Infant-Monitoring System with Machine Learning Model to Detect Physiological Activities and Ambient Conditions," 2020 IEEE International Instrumentation and Measurement Technology Conference (I2MTC), 2020, pp. 1-6, doi: 10.1109/I2MTC43012.2020.9129295.

[2] Gravem, D., Singh, M., Chen, C., Rich, J., Vaughan, J., Goldberg, K., Waffarn, F., Chou, P., Cooper, D., Reinkensmeyer, D., and Patterson, D. (May 14, 2012). "Assessment of Infant Movement With a Compact Wireless Accelerometer System." ASME. J. Med. Devices. June 2012; 6(2): 021013. https://doi.org/10.1115/1.4006129

[3] Breathing and heart rates in unwell children site: https://www.northlondonpaediatrician.co.uk/wp-content/uploads/2014/07/NLP-heart-and-resp-rates.pdf

Thanks for the attention!

Any question?