

Considerations for a cloud-based system for IoT data acquisition from heterogeneous sensors

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Introduction

- Motivation
 - Air pollution is a rising concern
 - There is a need for low cost air quality monitoring systems
- NanoSen-AQM project
 - Collect data from heterogeneous air quality sensors
 - Process collected air quality data
 - Make data available to the public
 - Make data available to other AQM platforms
 - Manage sensor nodes

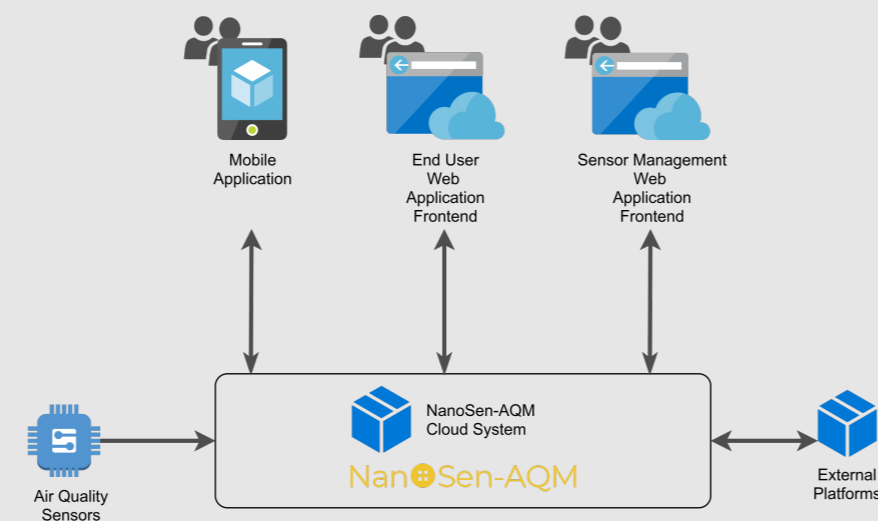


Figure 1: NanoSen-AQM Cloud System

Data Upload Protocols

- MQTT
 - Machine-to-machine (M2M)/"Internet of Things" connectivity protocol
 - Lightweight publish/subscribe messaging transport
 - Specific client to publish values
 - Can be a problem for micro-controllers very low resources: Arduino Uno
- RESTful Web Service
 - Web service architecture
 - "Provide interoperability between computer systems"
 - No need for specific clients HTTP Client
 - HTTP Client

System Overview

System Overview

- Collection of Sensors
- Data Aggregation Modules
- Central System
- Client Applications
 - End User (Mobile and Web) Application
 - Sensor Management Web Application
- External Applications
 - Liquens Platform
 - Others (future)

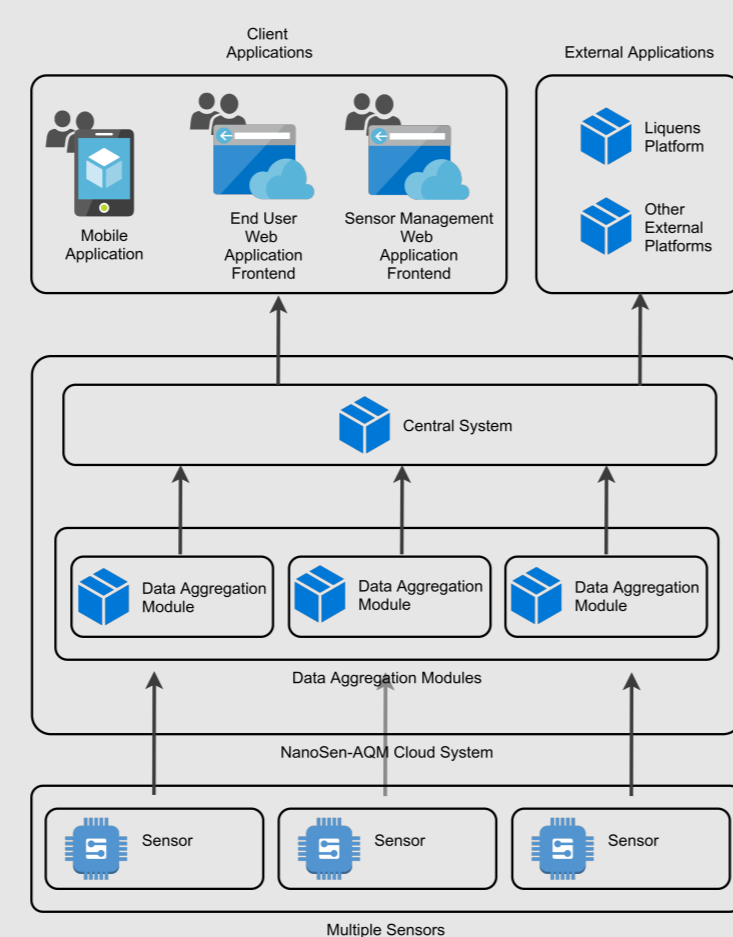


Figure 2: System Overview

Data messages

- We assume that:
 - A device can be made of one or more sensors
- Each message contains:
 - Data from a single device
 - Data from one or more sensor
 - Single or multiple sensor records
- Messages in JSON format
 - Set of key/value pair

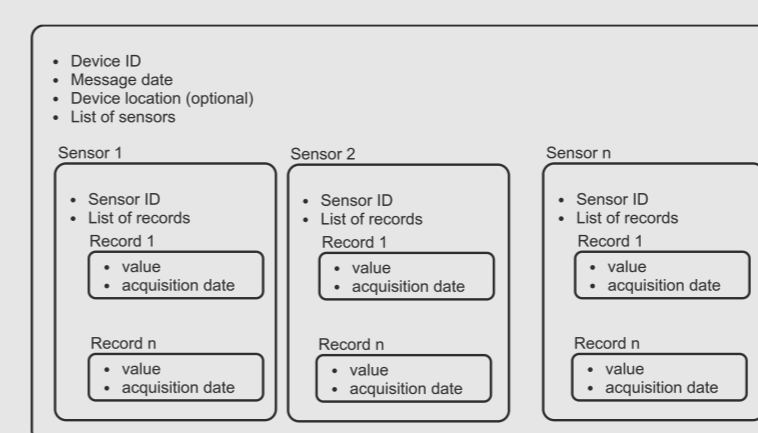


Figure 5: Data message contents

```

1 {
2   "device_id": "123456789",
3   "date": "2019-07-10T13:46:59+00:00",
4   "latitude": "-38.5714",
5   "longitude": "-7.9135",
6   "sensors": [
7     {
8       "sensor_id": "123456781",
9       "data": [
10        {
11          "date": "2019-07-10T13:46:59+00:00",
12          "value": "24.90"
13        }
14      ]
15    }
16  ]
17 }
    
```

Listing 1: Example of message

Data Aggregation Module

- Collect data from sensors
- One or more instances
- Components
 - Data collection: MQTT (VerneMQ)
 - Data validation
- Data publisher: to Central System

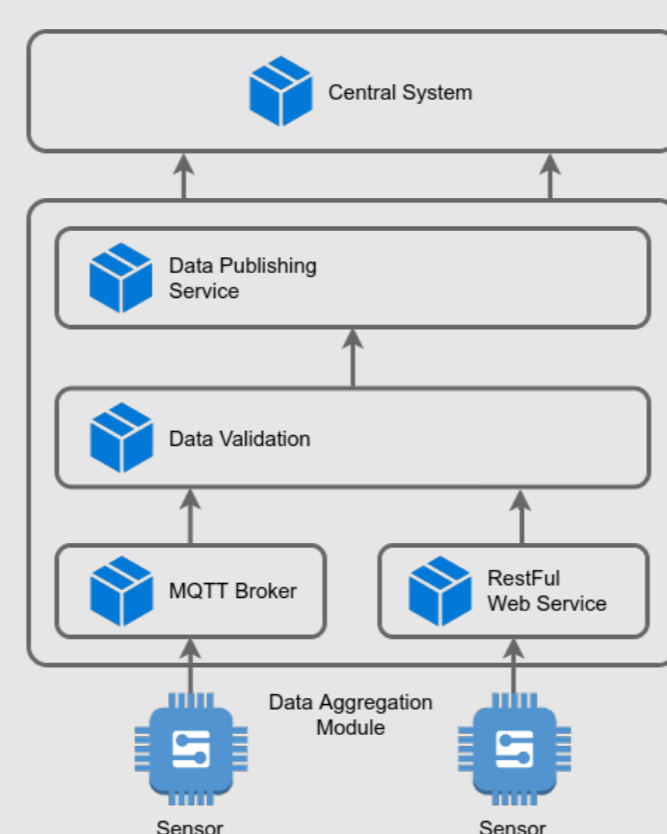


Figure 3: System Overview

Security aspects

- Messages are authenticated
 - Not encrypted
 - Mechanisms based on Message Authentication Code (MAC)
 - Easy to implement on low resource devices, e.g.: Arduino Uno
 - Prevents unauthorized users to upload (fake) data
- Data messages are signed together with a secret key
 - Secret key is shared between client (sensor) and server (cloud system)
- Message signature
 - signature = md5sum(sensor data + secret key)

Central System

System Components:

- Data Processing Module:
 - Data loader: Loads raw sensor values into data bases;
 - Sensor Calibration: Calibrates sensor values;
 - Air Quality Prediction: Predicts AQ based on previous sensor values
- Data Storage:
 - Time Series DB from sensor data (raw and calibrated)
 - Relational DB for system data (e.g.: user data, etc...)
- Data Access:
 - RESTful or GraphQL service
 - Primary data access method (and also data upload)
- Web Server:
 - Web and Mobile Application (progressive web app)
 - Sensor management web application

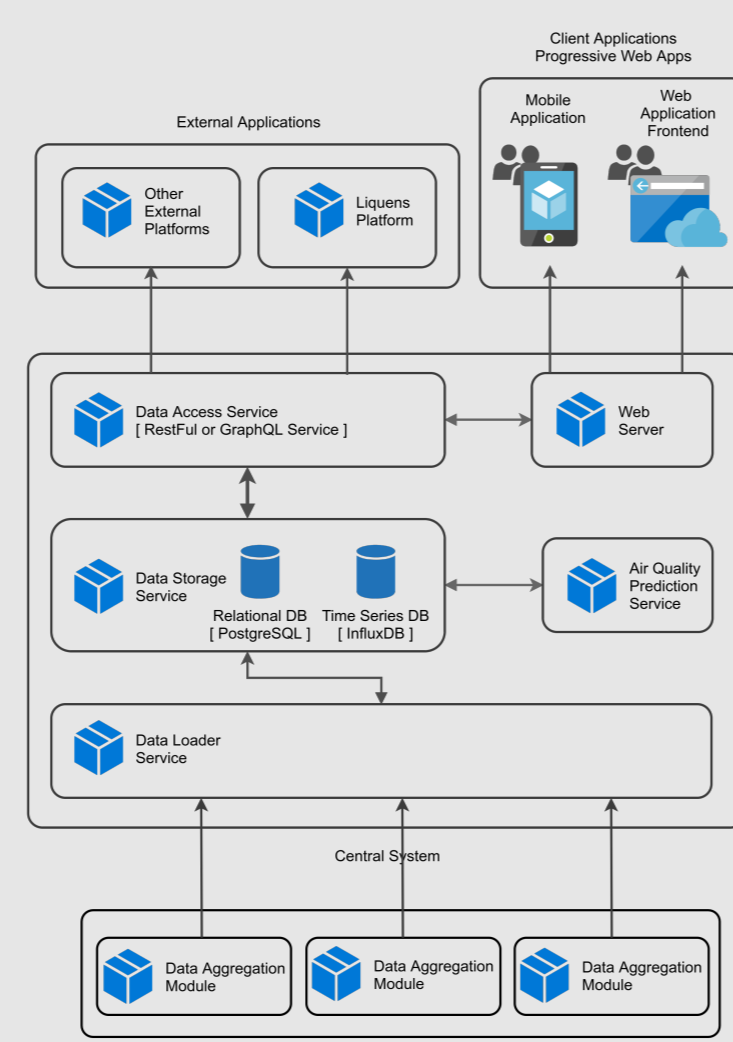


Figure 4: Central System

Conclusions

- Multiple mechanisms to upload sensor data
 - Same data message
- Heterogeneous sensors
 - Independent of the sensor type
 - Low resource devices (very low cost sensors)
 - High resource devices (reference/official sensors)
 - "Operating system" independent
 - Upload single data records or set of data records
 - Upload data from single or multiple sensors
- Simple security mechanisms
 - Authenticity of the data is ensured

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