Motivation for Individual Live Updates

- Millions of sensors record very many different aspects

- You want to build a Monitoring System of particular purpose

- You probably don't need all data from all sensors

- What you need is **fit-for-purpose live updates** from **different sensors** from **many organizations**

How to achieve individual and fit-for-purpose live updates across platforms?

- You need interoperability
    - Data model
    - API

- You need flexibility
    - When querying the base data
    - When subscribing for continuous updates

- You do **NOT** want to use **polling**!

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Fetching the Base Data via SensorThings API or STAplus

- The Data Model is fit-for-purpose

- The API supports OData queries
  - You get well-defined responses
  - You get a flexible query language

- You get MQTT
  - Sensor can publish data
  - You can subscribe to updates

- Et voilà – N'est-ce pas?

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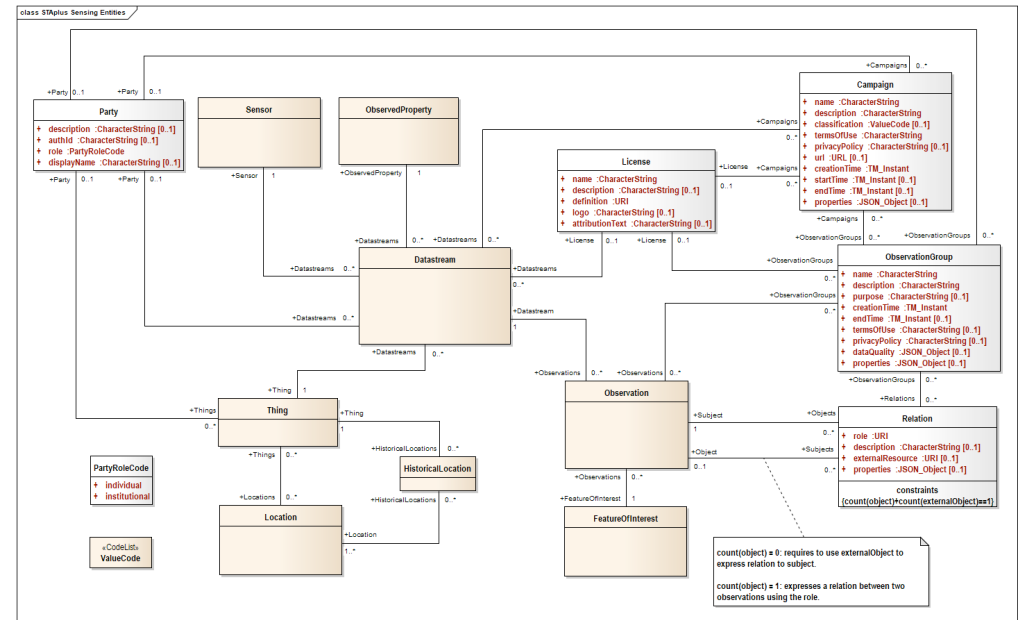
MQTT is not quite it…

- SensorThings API supports subscription to predefined topics
  - SERVICE_VERSION/RESOURCE_PATH/COLLECTION_NAME*
  - SERVICE_VERSION/RESOURCE_PATH_TO_AN_ENTITY**
  - SERVICE_VERSION/RESOURCE_PATH_TO_AN_ENTITY/PROPERTY_NAME***

- So what's missing?
  - The ability to include the QData query into the subscription

*: https://docs.ogc.org/is/18-088/18-088.html#mqtt-subscribe-entity-set
**: https://docs.ogc.org/is/18-088/18-088.html#mqtt-entity-updates
***:https://docs.ogc.org/is/18-088/18-088.html#mqtt-subscribe-entity-property

Let's say you want to monitor Temperature and Noise

- STAplus endpoint:
  - https://citiobs.demo.secure-dimensions.de/staplus/v1.1

- All Observed Properties
  - https://citiobs.demo.secure-dimensions.de/staplus/v1.1/ObservedProperties
  - Temperature: http://vocabs.lter-europe.net/EnvThes/22035
  - Noise: https://qudt.org/vocab/quantitykind/SoundExposureLevel

- SensorThings API ODATA query for
  - $filter=Datastream/ObservedProperty/definition eq '<Definition>'

MQTT Topics including ODATA Query for Temperature and Noise

- ## Temperature
  - https://citiobs.demo.secure-dimensions.de/staplus/v1.1/Observations? $select=phenomenonTime,result&$filter=Datastream/ObservedProperty/definition eq 'http://vocabs.lter-europe.net/EnvThes/22035'

- ## Noise
  - https://citiobs.demo.secure-dimensions.de/staplus/v1.1/Observations? $select=phenomenonTime,result&$filter=Datastream/ObservedProperty/definition eq 'https://qudt.org/vocab/quantitykind/SoundExposureLevel'

- ## Somehow, we need to keep the red with the subscription…

MQTT vs. Cloud-based Systems

- MQTT
  - TCP based communication on ports 1883 or 8883 (SSL)
  - Nothing like "HTTP" headers
  - lightweight protocol
  - fit-for-purpose for sensors pushing data to a SensorThings API service
- Cloud-based systems using HTTP(S)
  - Headers are used to transport meta information, incl. security
  - Communication over standard HTTP ports (80, 443) -> firewall friendly

- What we need is to bridge from MQTT to HTTP…

W3C WebSub

- W3C [Recommendation](#) since 2018
- WebSub provides a common mechanism for communication between publishers of any **kind of Web content** and their **subscribers**, based on **HTTP web hooks**.
- Subscription requests are **relayed** through hubs, which validate and verify the request.
- Hubs then **distribute new and updated content to subscribers** when it becomes available.
- Right – Great! But it's not MQTT!?

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W3C WebSub Hub

WebSub Flow Diagram

SensorThings API Service

Subscription via MQTT
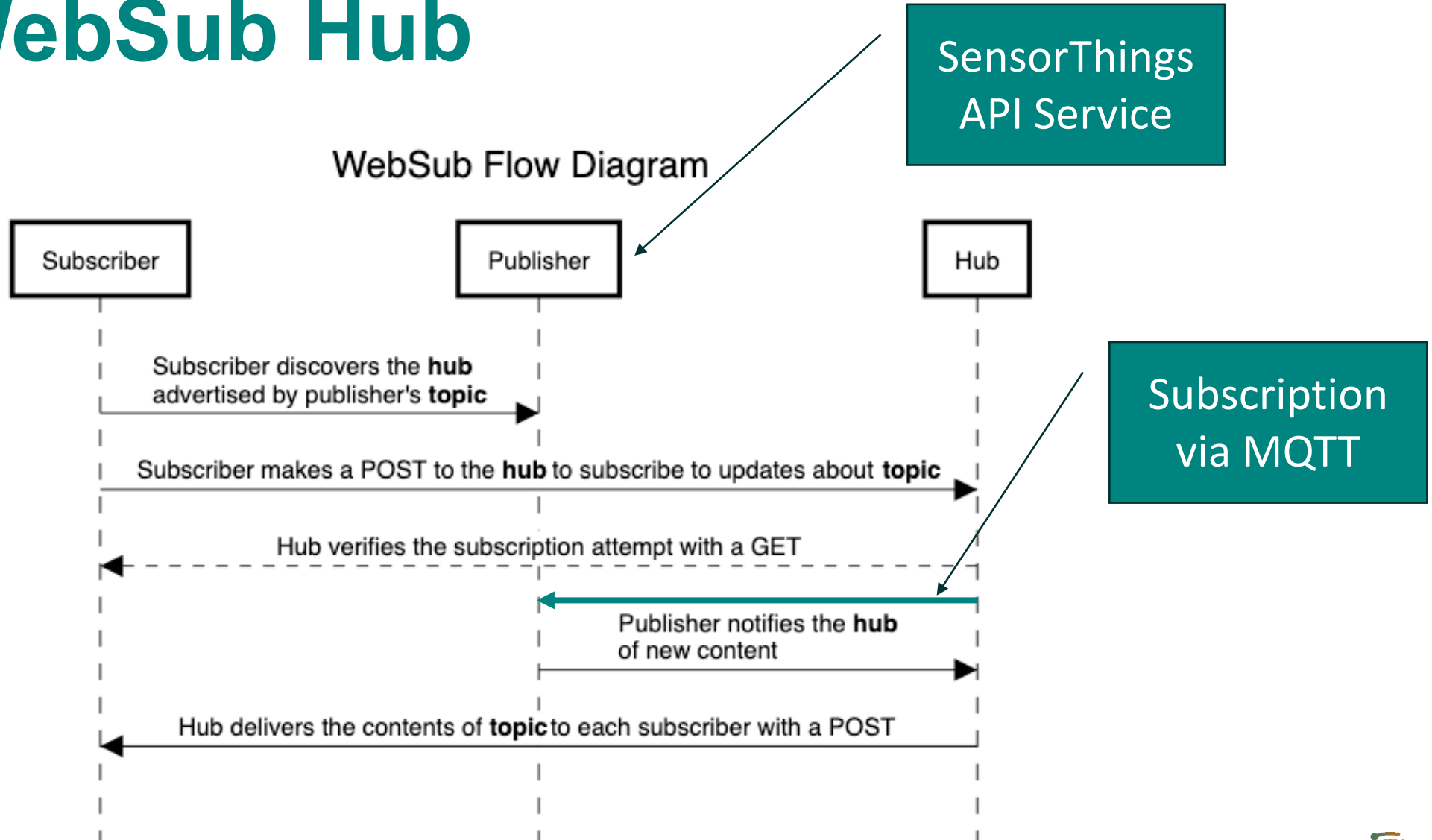
SensorThings API WebSub Extension

- Define a SensorThings extension that supports
    - W3C WebSub Discovery
    - Subscription for MQTT + ODATA query
- WebSub Discovery support in SensorThings API service
    - For GET and HEAD requests return HTTP header Link
        - <Link/>; rel="hub"
        - <Link/>; rel="self"
- rel="hub" -> The URL for the associated Hub
- rel="self" -> The MQTT topic URL to be used for subscription
    - Hub must translate topic URL into MQTT topic

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SensorThings API MQTT

WebSub Flow Diagram
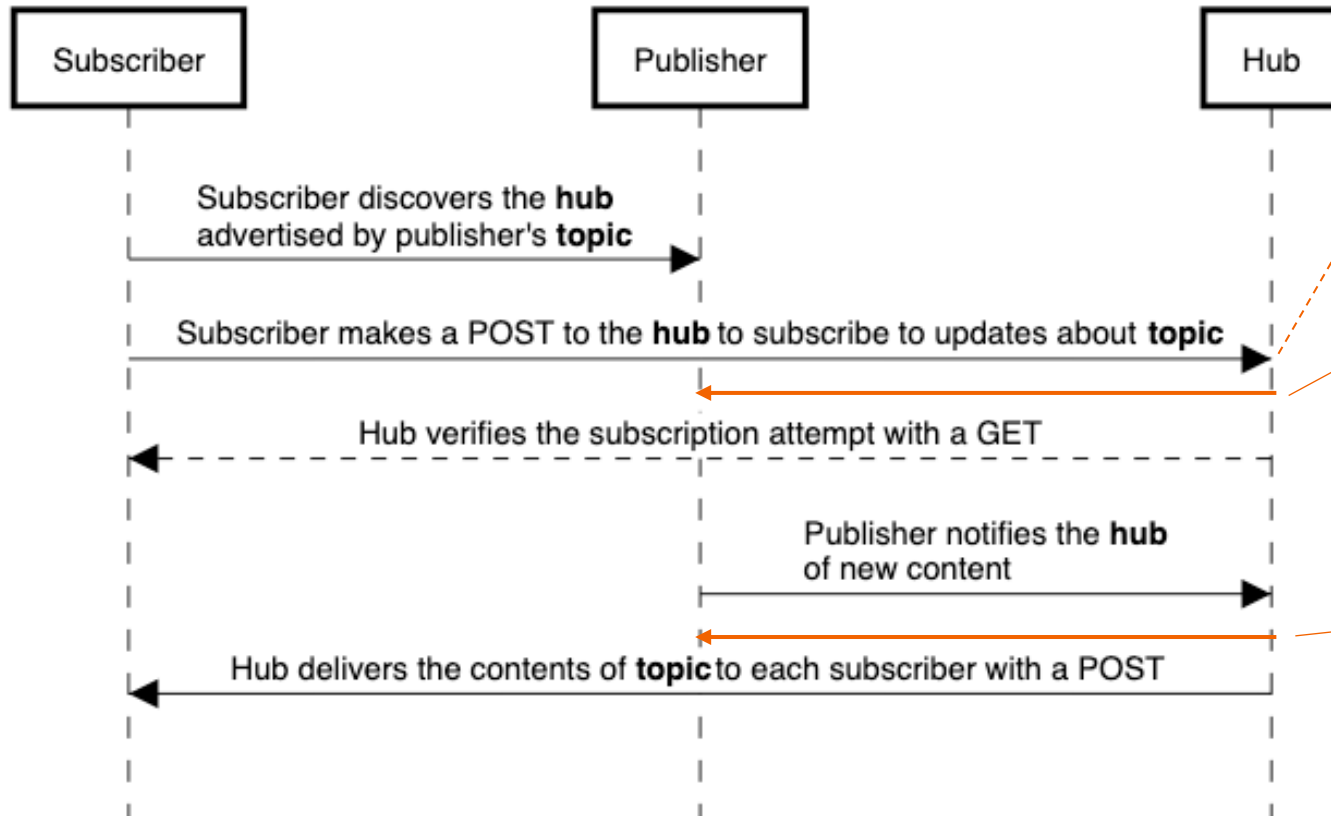
```
https://citiobs.demo.secure-
dimensions.de/staplus/
v1.1/Observations
$select=phenomenonTime,result&$filter=Datastream/
ObservedProperty/definition eq
'http://vocabs.lter-europe.net/EnvThes/22035'
```


Register for Topic
EXCLUDING
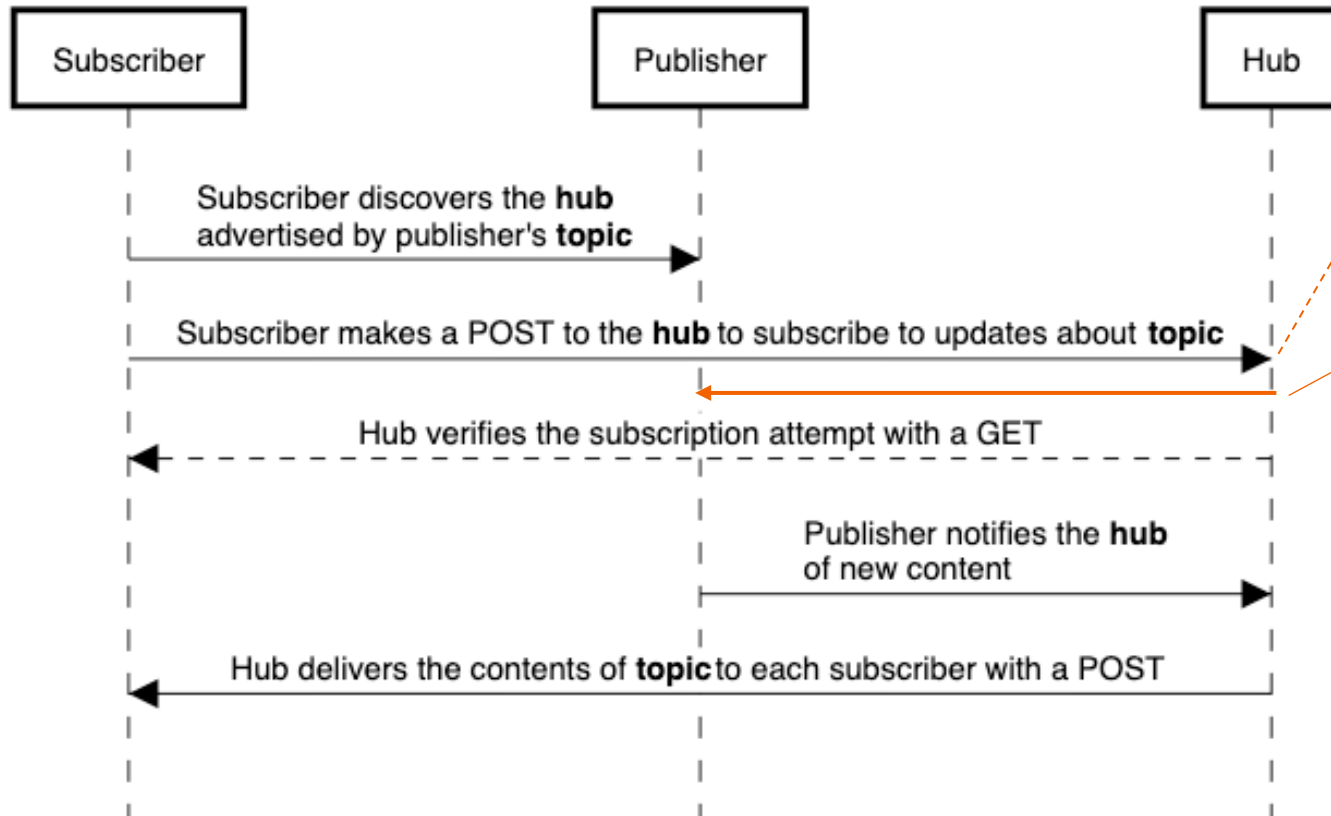the OData query)
`v1.1/Observations`

Do HTTP request
INCLUDING
the OData query
`$select=…&$filter…`

https://www.w3.org/TR/websub/#x2-high-level-protocol-flow

SensorThings API MQTT + ODATA

WebSub Flow Diagram

```
https://citiobs.demo.secure-
dimensions.de/staplus/
v1.1/Observations
$select=phenomenonTime,result&$filter=Datastream/
ObservedProperty/definition eq
'http://vocabs.lter-europe.net/EnvThes/22035'
```

Register for Topic
EXCLUDING
the OData query)
`v1.1/Observations`

https://www.w3.org/TR/websub/#x2-high-level-protocol-flow

Demo with Temperature and Noise

WebSub Receiver Demonstration

Temperature Channel

On this page, you will see updates the this SensorThings API request: https://citiobs.demo.secure-dimensions.de/staplus/v1.1/Observations?$select=phenomenonTime,result&$filter=Datastream/ObservedProperty/definition eq 'http://vocabs.lter-europe.net/EnvThes/22035'

Control

Please click a button to start / stop the subscription with the WebSub Hub. A subscription will expire after 5 mins.

`start` `stop`

Results

phenomenonTime: 2024-03-23T14:23:05Z
message:
{"phenomenonTime":"2024-03-23T14:23:05Z","result":23.06}

WebSub Receiver Demonstration

Noise Channel

On this page, you will see updates the this SensorThings API request: https://citiobs.demo.secure-dimensions.de/staplus/v1.1/Observations?$select=phenomenonTime,result&$filter=Datastream/ObservedProperty/definition eq 'https://qudt.org/vocab/quantitykind/SoundExposureLevel'

Control

Please click a button to start / stop the subscription with the WebSub Hub. A subscription will expire after 5 mins.

`start` `stop`

Results

phenomenonTime: 2024-03-23T14:23:57Z
message:
{"phenomenonTime":"2024-03-23T14:23:57Z","result":28.39}

SensorThings API WebSub Extension

- The SensorThings API WebSub Extension has been presented
  - OGC MM in Delft and OGC MM in Montreal – Architecture DWG, Citizen Science DWG, SensorThings DWG
- The draft OGC Standard work has already started (#24-032)
- CitiObs project has already implemented a proof-of-concept
  - WebSub Hub
  - WebSub Webhook 1
  - WebSub Webhook 2
  - Regular SensorThings API service
  - SensorThings API service with MQTT + ODATA support

- Demo of the entire system during this Codesprint

Thank you!

Dr. Andreas Matheus

Secure Dimensions