52north
exploring horizons

Event-Driven INSPIRE

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Overview / Topics

- Event-Driven?
- Use Cases
- What are your use cases?
- Motivation
- Relevant Standards and Concepts
  - MQTT
  - AMQP
  - SensorThings API
- MQTT Hands-on Example
- Project and Software Solutions
  - WaCoDiS Message Broker Architecture
- Discussion: What is Up Next for INSPIRE?
- Conclusion

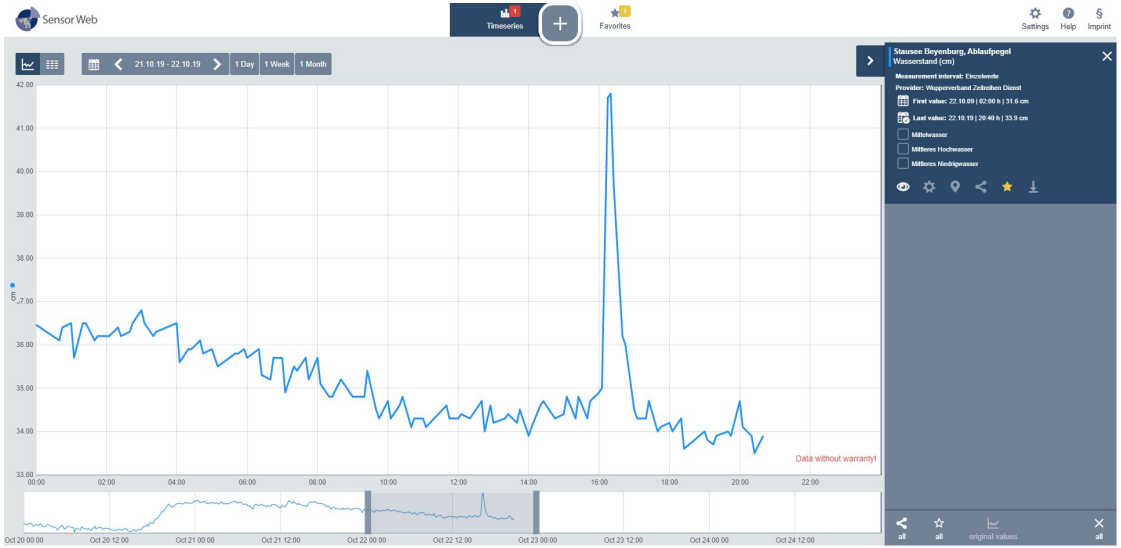
Event-Driven/Eventing?

- Traditional approach: Pull-based data access
- Event-driven: Push-based data delivery
- Deliver events to subscribers as soon as it is available!
- Events
  - A new measurement has been performed
  - A measurement has exceeded a threshold
  - No measurements were received for a certain time span
  - ...

Use Cases for Eventing

Monitoring Applications

- Monitoring of critical parameters, e.g.
  - Flooding
  - Air quality
  - …
- Deliver information as fast as possible
- Deliver only relevant information

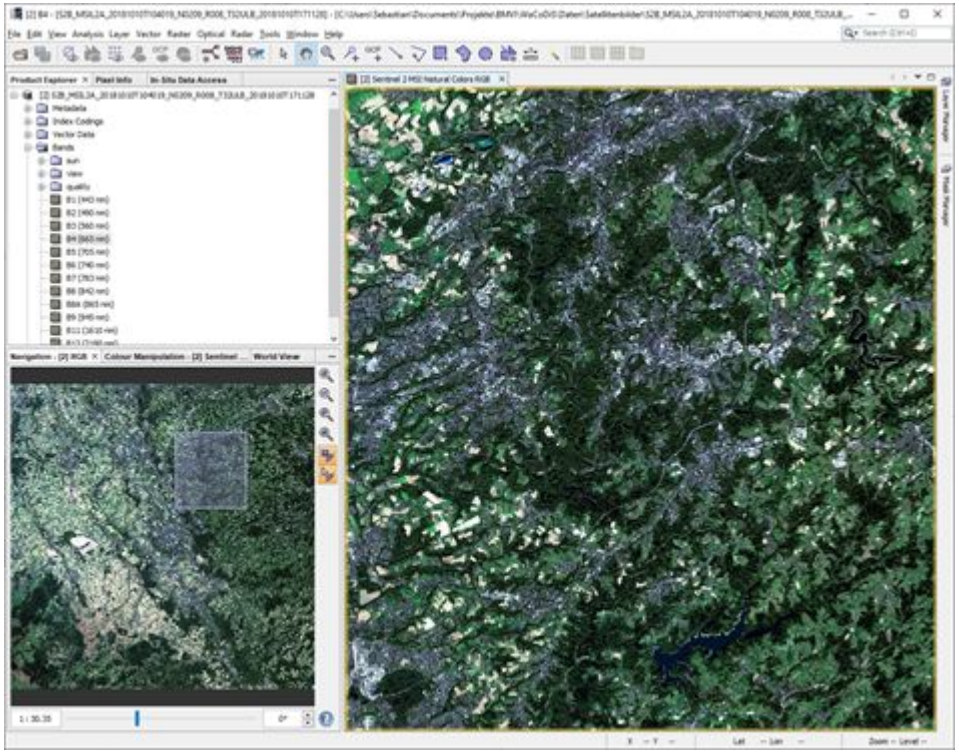


Mapping/Tracking Applications

- Creating maps of highly dynamic properties
- Examples
  - Tracking applications
  - Traffic monitoring
  - Air traffic noise
  - …
- Deliver new map when information was updated

Up-To-Date Remote Sensing Analysis Workflows

- Automated analysis of remote sensing data
- E.g. Copernicus
- Analysis has certain input requirements
  - Satellites/sensors
  - Data/image quality
  - Temporal constraints
- Initiate analysis as soon as suitable data is available



Catalogues

- Catalogues can be very helpful to discover geospatial information
- Idea: Notify users if new data of interest has been published
  - New data sets
  - Updated data sets
- Users submit their search request
- Anytime new/updated relevant catalogue entries are available → Notification

Plenary - What are your Use Cases?

What are your Use Cases for ...?

- Eventing
- Real-time data dissemination
- Automated workflows
- ...

https://board.net/p/Event-driven_INSPIRE

Motivation

Motivation

- Classic approach:
  - Continuous polling from client side
  - Ask the server again and again if new data is available
  - Post-processing of values (e.g. check water levels)
- Drawbacks:
  - Creates a lot of load on the infrastructure
    - Polling if new data is available
    - Transfer of non-relevant information
  - Artificial delay is introduced

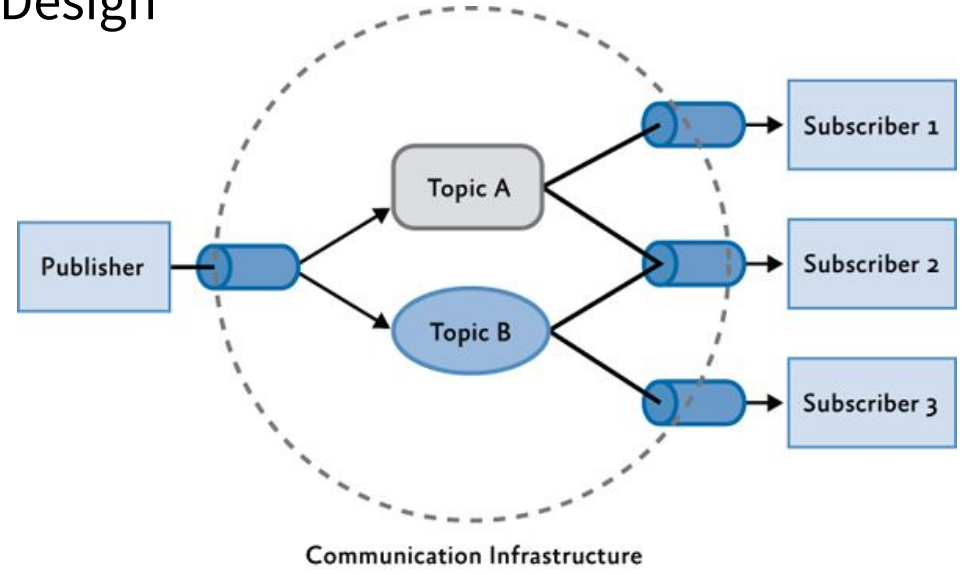
Motivation

- More efficient delivery of relevant information
- Minimize delays
- Avoid unnecessary communication
- Increase scalability

Relevant Standards and Concepts

Publish / Subscribe Pattern

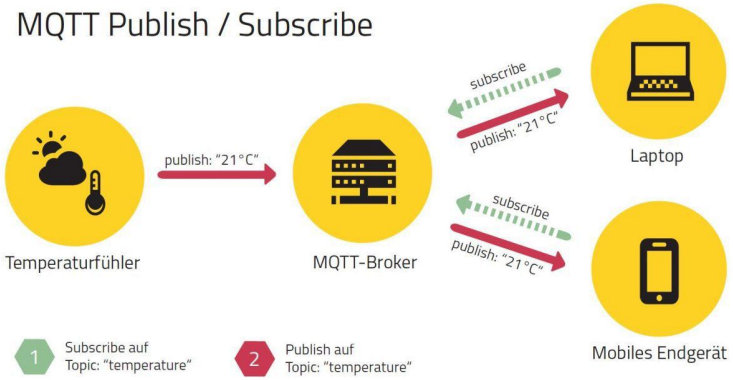
- Message Pattern in Software Design
- Actors
  - Publisher
  - Subscriber
  - Sender
  - Receiver
- Often the case:
  - Publisher = Sender
  - Subscriber = Receiver
- Topics / Channels
  - used to organize the data in a hierarchical way



Source: https://proft.me

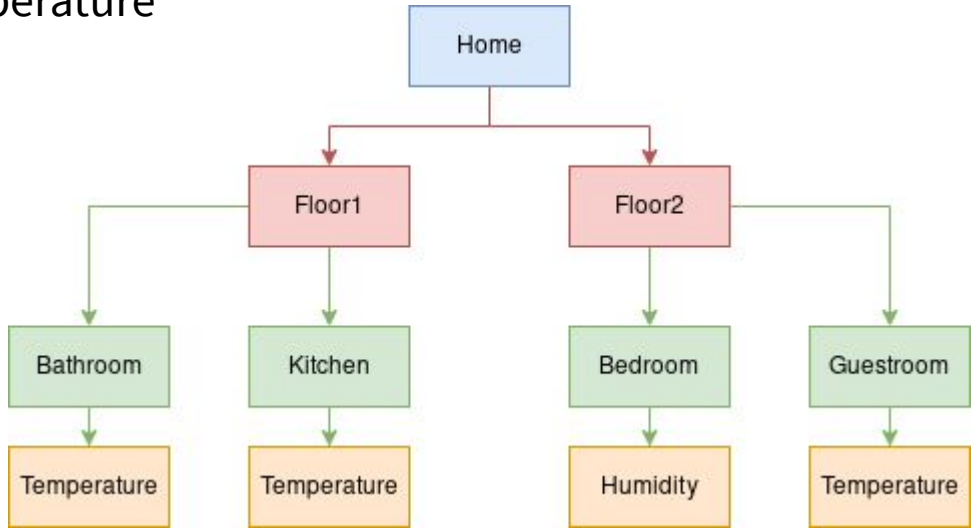
MQTT Protocol

- “Message Queuing Telemetry Transport”
- Implements Publish/Subscribe Pattern
- Broker-based architecture
- OASIS Standard (current version: 5.0)
  - New features:
    mime types for messages
    focus on security (AUTH packet)
    User Properties for Messages (KVP)
- Support for Quality of Service (QoS)
  - if a client got disconnected, a Broker persists messages until it reconnects
- Some Broker-dependent capabilities
  - WebSockets, bridges to other Messaging protocols



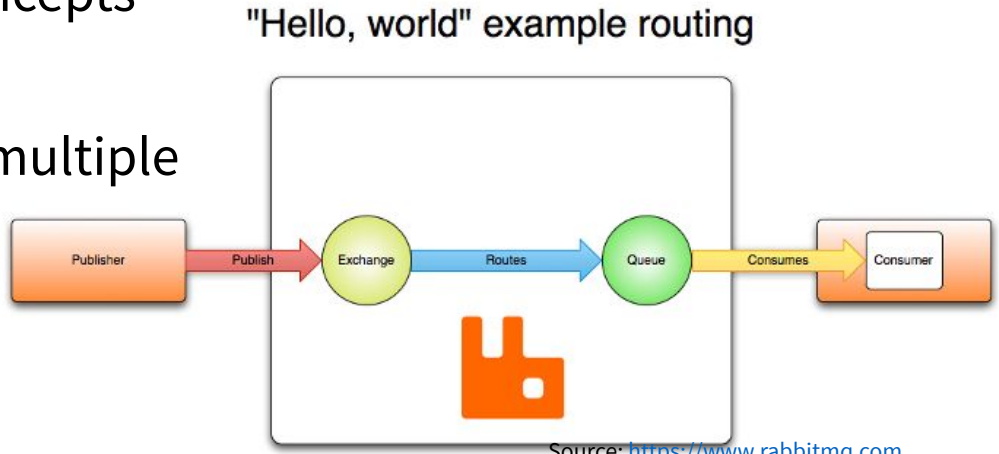
MQTT Topics

- Users can subscribe on different levels:
  - Home/Floor2/Bedroom/Temperature
  - Home/Floor1/#
    - Multi-level wildcard
    - → Messages on all Sub-Topics are received as well
  - Home/Floor1/+/Temperature
    - Single-level wildcard
    - → receive all “Temperature” Sub-Topics



AMQP Protocol

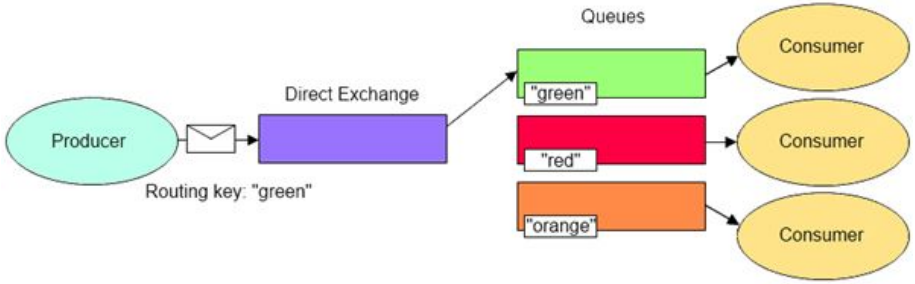
- “Advanced Message Queuing Protocol”
- Versatile Messaging Protocol
- Competing Standard revisions: “0-9-1” vs “OASIS 1.0”
- “Exchange” and “Queue” concepts
  - allow pull-based retrieval
  - supports Publish/Subscribe
- Exchanges can be routed to multiple Queues
- built-in QoS: client acknowledges message reception



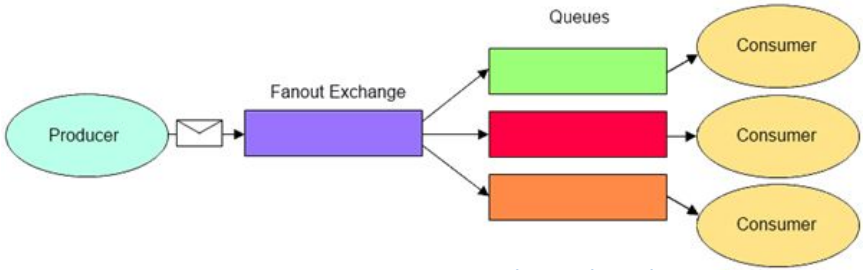
Source: https://www.rabbitmq.com

AMQP Protocol

- Different Exchange Types
  - Direct
  - Fanout
  - Topic
  - Header



Source: https://lostechies.com



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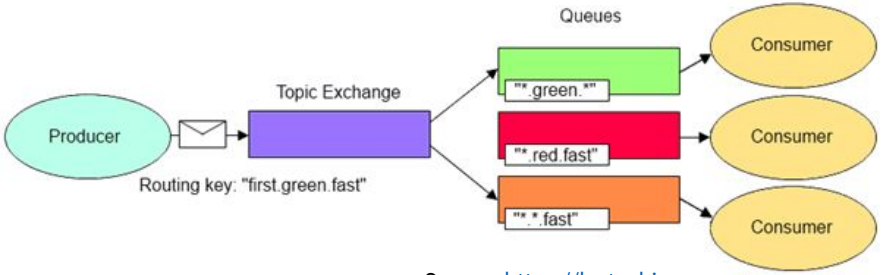


Source: https://lostechies.com

OGC SensorThings API

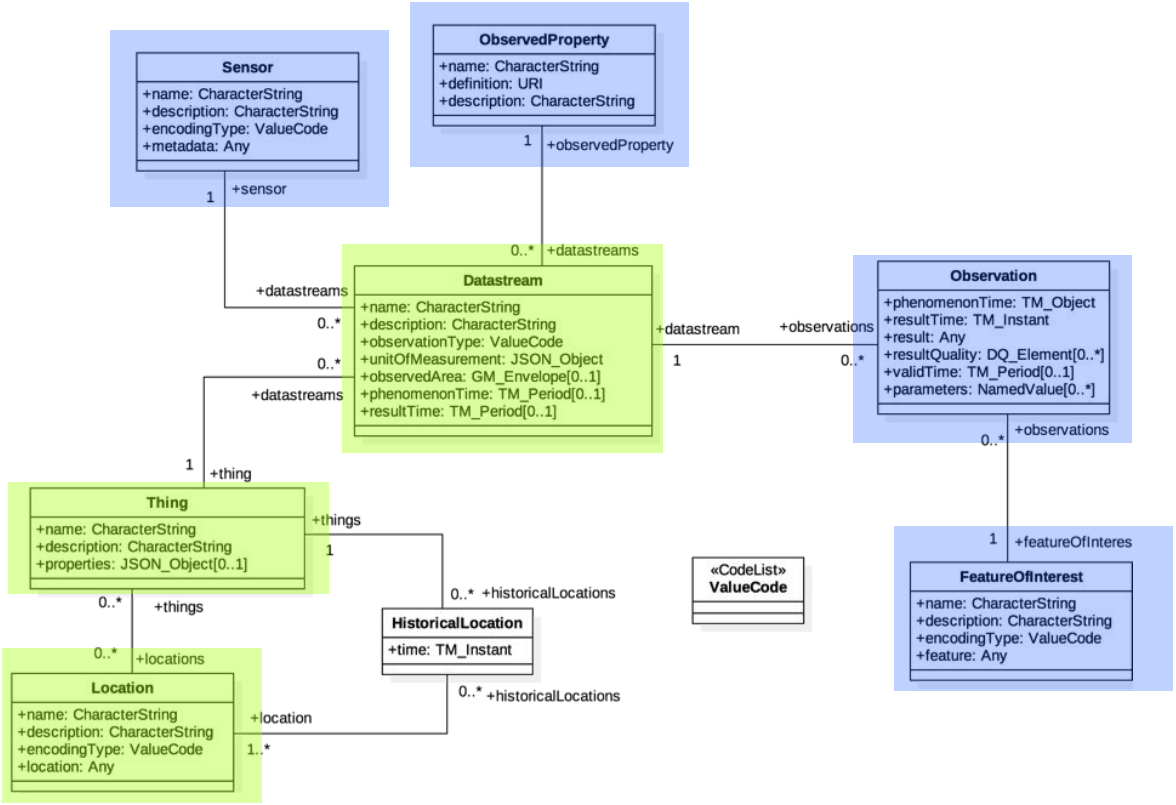
- Specification to enhance the OGC Sensor Web Enablement framework for Internet of Things applications
- Lightweight approach, based on REST and JSON

  ~ REST binding for OGC Sensor Observation Service (SOS) functionalities

  ~ JSON binding for the O&M model (with additions)

- Additional features
  - Considering the specifics of IoT applications (Things, DataStreams)
  - MQTT extension
- Two parts
  - Data access
  - Sensor tasking

OGC SensorThings API - Sensing Data Model



Source: OGC

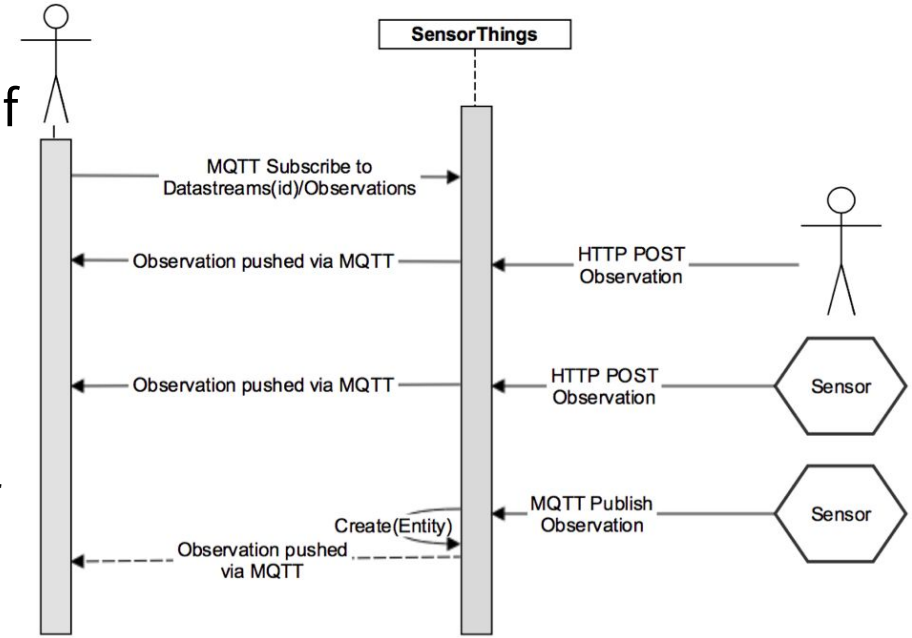
SensorThings API and MQTT

- Example from Smart Emission Project:

https://data.smartemission.nl/gost/v1.0

SensorThings API and MQTT

- SensorThings API allows usage of MQTT for
  - Publishing observations
  - Subscribing to/push delivery of updated entities (e.g. new observations in a data stream)
- Typical workflow
  - Use SensorThings API to discover relevant data streams, then
  - Use MQTT to subscribe for updates of the previously discovered data streams



Source: OGC

Hands-on Example

MQTT Data Stream for Weather Information

- Weather data for Helsinki published as JSON
- For demonstration purposes, public MQTT broker used:
  - https://test.mosquitto.org/
  - http://www.mqtt-dashboard.com/
  - Topic: `inspire-helsinki`

- Source code available: https://github.com/52North/inspire-helsinki-mqtt

MQTT Data Stream for Weather Information

- Software can easily start receiving data
  - short demo: command line
  - short demo: https://www.hivemq.com/demos/websocket-client

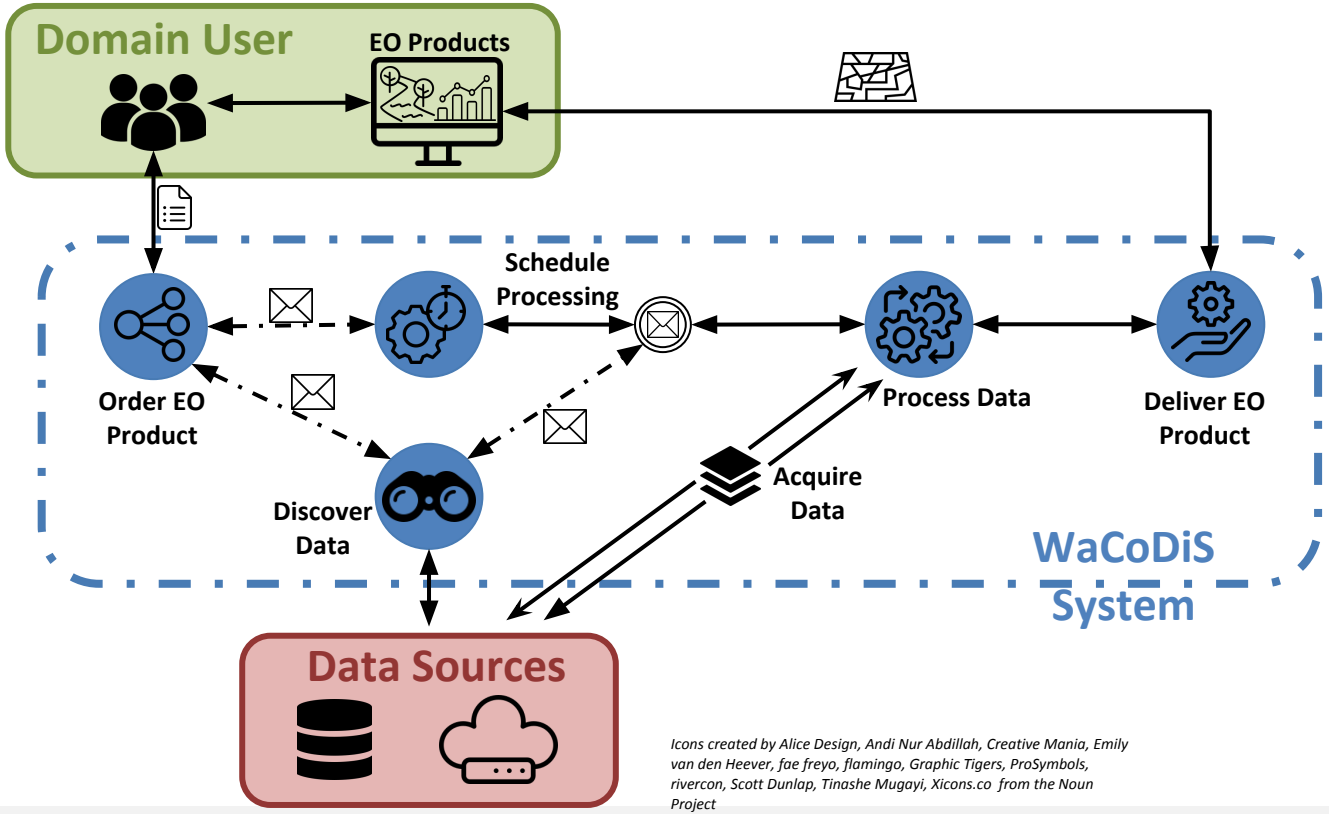
MQTT Data Stream for Weather Information

- More Complex applications:

- “Live” time series graph (short demo)
  - Source Code available: https://github.com/matthesrieke/mqtt-realtime-chart-client

Event-Driven Processing Workflows

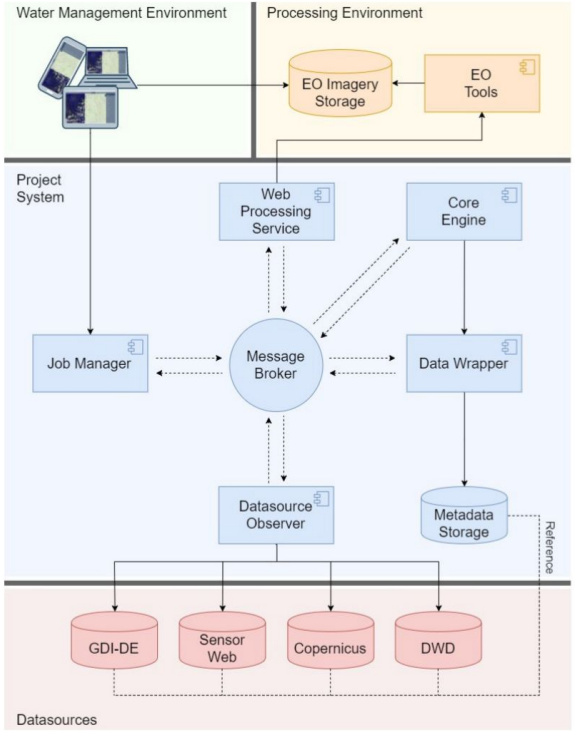
WaCoDiS - Event-Driven Processing



Icons created by Alice Design, Andi Nur Abdillah, Creative Mania, Emily van den Heever, fae freyo, flamingo, Graphic Tigers, ProSymbols, rivercon, Scott Dunlap, Tinashe Mugayi, Xicons.co from the Noun Project

WaCoDiS - Event-Based Architecture

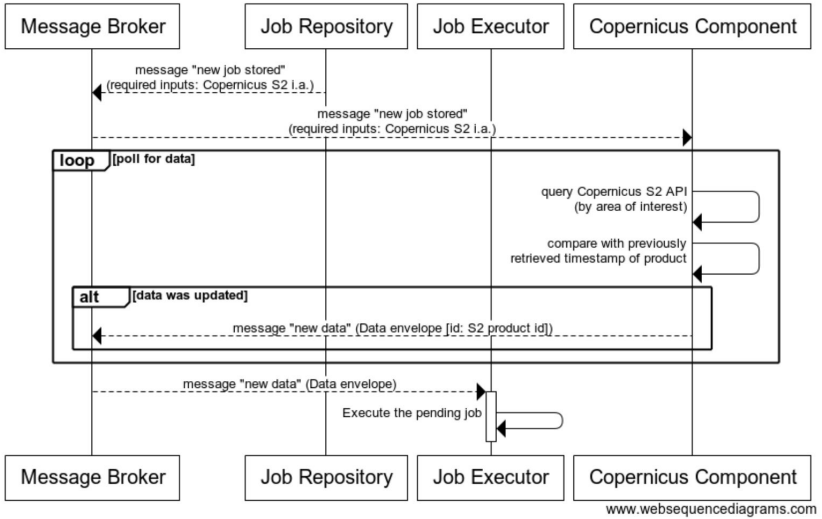
- Microservice architecture
- Extensible processing of EO data
  - **Web Processing Service**
- Operation of Microservices can be **decoupled** from Processing Components
  - important that **processing** happens **close to the data**



WaCoDiS - Event-Based Processing

- The system is designed to **observe data centres** (Sentinel Hub, Sensor Web of Wupperverband, …)
  - Configurable observation cycles (e.g. every hour)
- Data of interest is identified
  - **Metadata** (by a specific domain data model) is published on the internal Message Broker
  - Interested components (e.g. the Job Execution) catch up

→ Achieves **automatic execution**



WaCoDiS - Event-Based Processing

- „Jobs“ create products within a „collection“ recurrently
- From a domain perspective „collections“ form a **time series of a specific data** set / phenomenon
  - Allows change detection

 Logical progression: provision as a time-enabled geo dataset

- Lightweight software solutions using Open Source / free software
  - Geoserver – can serve georeferenced image raster data in various file formats
  - “Time support” – multiple images form a cohesive data set over the temporal dimension
- Example (EUMETSAT‘s approach):
  - https://eumetview.eumetsat.int/mapviewer/?product=EO:EM:DAT:MSG:MPE-JPG

WaCoDiS - Extensible Pub/Sub

- Concept of Message Broker
- New components can listen on Topics of interest
  - new data available
  - new products available
  - data pre-processed
  - …
- Message Broker provides different protocols
  - MQTT, AMQP

    → any software capable of these protocols can plug-in to the system

What is Up Next for INSPIRE?

What is up next for INSPIRE?

- How could event-driven concepts enhance INSPIRE in the future?
- What would be major benefits in your opinion?
- Do you see follow-ups that would interest you?

Conclusion