OGC SensorThings API
Rest API

Dr. Hylke van der Schaaf
Reinhard Herzog

Fraunhofer
IOSB

Do It Yourself

- Docker Quick-Start:
  - Go to https://github.com/FraunhoferIOSB/FROST-Server
  - → Wiki
  - → Docker-Quick-Start
- Demo service:
  http://akme-a3.iosb.fraunhofer.de/FROST-Server/v1.0
  (As long as nobody deletes everything)
  (Or the server catches fire)
- Alternative guide:
  https://github.com/phertweck/iscram-hands-on

Getting to your data

- Based on OASIS OData
- Base URL: http://server.de/FROST-Server/v1.0
- Read: GET
  - V1.0 → Get collection index
  - v1.0/Collection → Get all entities in a collection
  - v1.0/Collection(id) → Get one entity from a collection
- Create: POST
  - v1.0/Collection → Create a new entity
- Update: PATCH
  - v1.0/Collection(id) → Update an entity
- Update: PUT
  - v1.0/Collection(id) → Replace an entity
- Delete: DELETE
  - v1.0/Collection(id) → Remove an entity

Query URL patterns: Index

- GET http://192.168.11.2/FROST-Server/v1.0
- Response:

```
{
  "value" : [
    {
      "name" : "Datastreams",
      "url" : "http://server.de/SensorThingsService/v1.0/Datastreams"
    },
    {
      "name" : "FeaturesOfInterest",
      "url" : "http://server.de/SensorThingsService/v1.0/FeaturesOfInterest"
    },
    {
    …
    …
    },
    {
      "name" : "Things",
      "url" : "http://server.de/SensorThingsService/v1.0/Things"
    }
  ]
}
```

Query URL patterns: Get Collection

Get All Things

- GET http://192.168.11.2/FROST-Server/v1.0/Things
- Response:

```
{
  "value" : [
    {
      "name" : "My camping lantern",
      "description" : "camping lantern",
      "properties" : {
        "property1" : "it’s waterproof",
        "property2" : "it glows in the dark"
      },
      "Locations@iot.navigationLink" : "Things(1)/Locations",
      "HistoricalLocations@iot.navigationLink": "Things(1)/HistoricalLocations",
      "Datastreams@iot.navigationLink" : "Things(1)/Datastreams",
      "@iot.id" : 1,
      "@iot.selfLink" : "/SensorThingsService/v1.0/Things(1)"
    },
    {
      a second thing…
    }, { … }, { … }, { … }
  ]
}
```

Query URL patterns: Get Entity

Get Specific Thing

- GET http://192.168.11.2/FROST-Server/v1.0/Things(1)
- Response:

```
{
  "name" : "My camping lantern",
  "description" : "camping lantern",
  "properties" : {
    "property1" : "it’s waterproof",
    "property2" : "it glows in the dark"
  },
  "Locations@iot.navigationLink" : "Things(1)/Locations",
  "HistoricalLocations@iot.navigationLink" : "Things(1)/HistoricalLocations",
  "Datastreams@iot.navigationLink" : "Things(1)/Datastreams",
  "@iot.id" : 1,
  "@iot.selfLink" : "/SensorThingsService/v1.0/Things(1)"
}
```

Query URL patterns: Get related Entities

Get all Datastreams of a specific Thing

- GET http://192.168.11.2/FROST-Server/v1.0/Things(1)/Datastreams
- Response:

```
{
  "value" : [
    {…},
    {…},
    {…}
  ]
}
```

Query URL patterns: Pagination

GET only 4 Observations and the total count of Observations

- GET …/v1.0/Observations?
  $top=4&
  $count=true
- Response:

```
{
  "@iot.count" : 16,
  "@iot.nextLink" : "/SensorThingsService/v1.0/Observations?$top=4&$skip=4",
  "value" : [
    { … },
    { … },
    { … },
    { … }
  ]
}
```

Query URL patterns: $select

Get only description und id for all Things

- GET …/v1.0/Things?
  $select=@iot.id,description
- Response:

```
{
  "value" : [
    {
      "description" : "camping lantern",
      "@iot.id" : 1
    },
    {
      "description" : "camping stove",
      "@iot.id" : 2
    }
  ]
}
```

Query URL patterns: Sorting

GET all Observations sorted by phenomenonTime, newest first

- GET …/v1.0/Observations?
  $orderby=phenomenonTime desc

- Functions work for Ordering
  GET …/v1.0/Datastreams?
  $orderby=length(name) desc

Query URL patterns: Filtering

GET only Observations with result (value) > 5

- GET …/v1.0/Observations?
  $filter=result gt 5
- Response:

```
{
  "@iot.nextLink" : "/v1.0/Observations?$filter=result gt 5&$top=4&$skip=4",
  "value" : [
    {
      "phenomenonTime" : "2016-06-22T13:21:31.144Z",
      "resultTime" : null,
      "result" : 10,
      "@iot.id" : 34,
      "@iot.selfLink" : "/SensorThingsService/v1.0/Observations(34)"
    }, {
      …
    }, {
      …
    }, {
      …
    }
  ]
}
```

Query URL patterns: Functions 1

- Comparison:
  - gt: >
  - ge: >=
  - eq: =
  - le: <=
  - lt: <
  - ne: !=
- Logical:
  - and
  - or
  - not
- Mathematical:
  - add
  - sub
  - mul
  - div
  - mod

- String Functions:
  - substringof(p0, p1)
  - endswith(p0, p1)
  - startswith(p0, p1)
  - substring(p0, p1)
  - indexof(p0, p1)
  - length(p0)
  - tolower(p0)
  - toupper(p0)
  - trim(p0)
  - concat(p0, p1)
- Mathematical:
  - round(n1)
  - floor(n1)
  - ceiling(n1)

Query URL patterns: Functions 2

- Geospatial:
  - geo.intersects(g1, g2)
  - geo.length(l1)
  - geo.distance(g1, g2)
  - st_equals(g1, g2)
  - st_disjoint(g1, g2)
  - st_touches(g1, g2)
  - st_within(g1, g2)
  - st_overlaps(g1, g2)
  - st_crosses(g1, g2)
  - st_intersects(g1, g2)
  - st_contains(g1, g2)
  - st_relate(g1, g2)
- Date and Time:
  - now()
  - mindatetime()
  - maxdatetime()
  - date(t1)
  - time(t1)
  - year(t1)
  - month(t1)
  - day(t1)
  - hour(t1)
  - minute(t1)
  - second(t1)
  - fractionalseconds(t1)
  - totaloffsetminutes(t1)

Query URL patterns: Encoding in URLs

- Strings: in single quotes
  - $filter=name eq 'Living room'
  - Single quotes are doubled: 'Hylke''s Living room'
- ISO 8601 DateTimes: not quoted
  - $filter=phenomenonTime gt 2018-03-09T08:14:54+00:00
  - Don’t forget to URLEncode:
    2018-03-09T08:14:54**%2B**00:00
- ISO 8601 Durations
  - duration'<…>'
  - duration'P1WT1H'

Query URL patterns: Filtering examples

- All observations with an even result
  - Observations?$filter=result mod 2 eq 0
- Observations of the last hour
  - Observations?$filter=phenomenonTime gt now() sub duration’PT1H’
  - https://en.wikipedia.org/wiki/ISO_8601#Durations
- Datastreams that measure temperature (ObservedProperty id 1)
  - Datastreams?$filter=ObservedProperty/@iot.id eq 1
- Filtering on JSON properties
  - Things?$filter=properties/style eq 'Cozy'
  - Observations?$filter=result gt Datastream/Things/properties/max

Query URL patterns: $expand

GET the Thing with id=17 and its Datastreams

- GET …/v1.0/Things(17)?
  $expand=Datastreams
- Response:

```
{
  "name" : "My camping lantern",
  "description" : "camping lantern",
  "Datastreams" : [
    { … },
    { … },
    { … }
  ],
  "@iot.id" : 17
}
```

Query URL patterns: $expand(…)

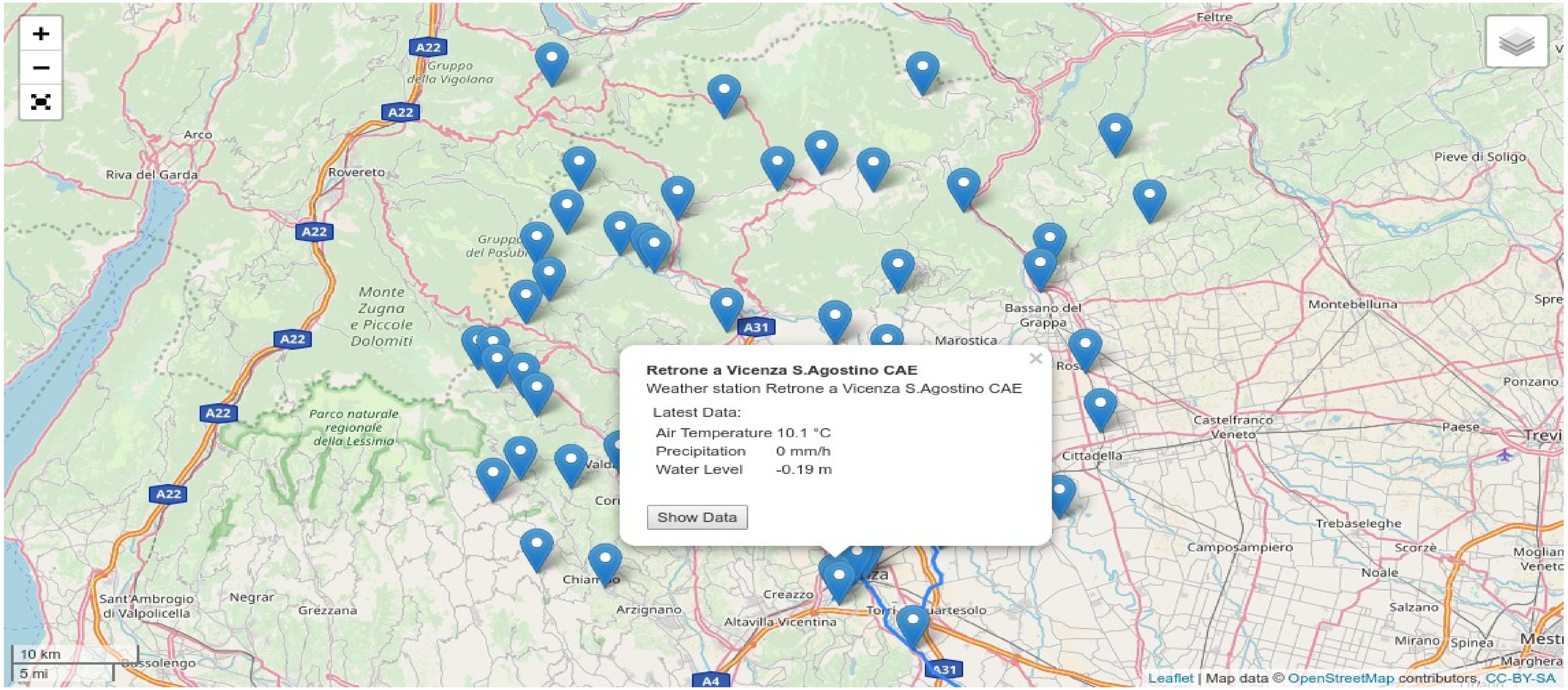
GET only description, id and Datastreams for Thing 17 and for the Datastreams only id and description:

- GET …/v1.0/Things(17)?
  $select=@iot.id,description&
  $expand=Datastreams($select=@iot.id,description)
- Response:

```
{
  "description" : "camping lantern",
  "@iot.id" : 17,
  "Datastreams" : [
    {
      "description" : "Temperature measurement",
      "@iot.id" : 19
    },
    {
      "description" : "Humidity measurement",
      "@iot.id" : 21
    }
  ]
}
```

Query URL patterns: $expand example

Overview Map (Italy)



Retrone a Vicenza S.Agostino CAE
Weather station Retrone a Vicenza S.Agostino CAE

Latest Data:

Air Temperature	10.1 °C
Precipitation	0 mm/h
Water Level	-0.19 m

Show Data

Fraunhofer IOSB

Query URL patterns: $expand example

```
v1.0/Things?
   $select=id,name,description,properties
   &$top=1000
   &$filter=properties/type eq 'station'
   &$expand=
      Locations,
      Datastreams(
         $select=id,name,unitOfMeasurement
         ;$expand=
            ObservedProperty($select=name),
            Observations(
               $select=result,phenomenonTime
               ;$orderby=phenomenonTime desc
               ;$top=1)
      )
```

Creating new Entities

Create a new Thing

- POST …/v1.0/Things

```
Content-Type: application/json;charset=UTF-8

{
  "name" : "Office",
  "description" : "My Work Room",
  "properties" : {
    "style" : "Business",
    "balcony" : false
  },
  "Locations" : [
    {
      "@iot.id" : 1
    }
  ]
}
```

- Response:

```
Location: http://localhost:8080/FROST-Server/v1.0/Things(2)
```

Creating new Entities

POST a new Thing with a new Location

- POST …/v1.0/Things

```
{
  "name" : "Office",
  "description" : "My Work Room",
  "properties" : {
    "style" : "Business",
    "balcony" : false
  },
  "Locations" : [
    {
      "name" : "My Office",
      "description" : "The office room of Fraunhoferstr. 1",
      "encodingType" : "application/vnd.geo+json",
      "location" : {
        "type":"Point",
        "coordinates":[8.425548,49.015196]
      }
    }
  ]
}
```

- Response:

```
Location: http://localhost:8080/FROST-Server/v1.0/Things(2)
```

Creating new Observations

Create a new Observation

- POST .../v1.0/Observations

```
{
  "result" : 123,
  "Datastream" : {
    "@iot.id" : 1
  }
}
```

- POST .../v1.0/Datastreams(1)/Observations

```
{
  "result" : 123
}
```

- phenomenonTime and FeatureOfInterest are generated automatically if not provided.

Creating new Observations – HTTP vs MQTT

	+	–
MQTT	• Efficient for subsequent Observations	• Connection management • Can only create Observations • Persistent connection makes load balancing tricky
HTTP	• Simple requests • Can create all entities • Works through firewalls & proxies • Simple load balancing	• New connection per request

Changing Entities

Update an existing Thing

- PATCH …/v1.0/Things(1)

```
{
  "description" : "A new description"
}
```

  Changes only the specified fields

- PUT …/v1.0/Things(1)

```
{
  "name" : "A new name",
  "description" : "A new description"
}
```

  Replaces all fields.
  Fields that are not set are removed (properties in this case)!

Deleting Entities

Delete a Thing

- DELETE …/v1.0/Things(1)
- Deletes the Thing and all objects depending on the thing
    - Datastreams
        - Observations

Managing your data

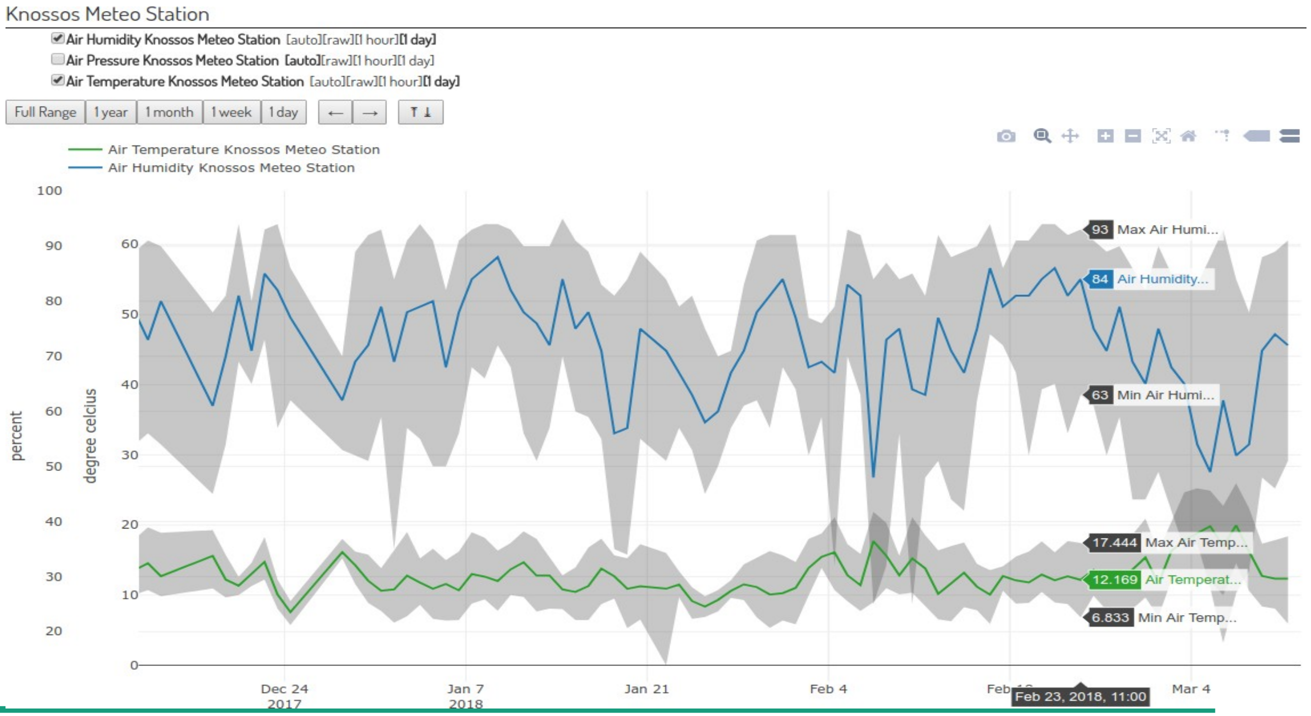
- Base URL: http://server.de/SensorThingsService/v1.0
- Read: GET
  - v1.0 → Get collection index
  - v1.0/Collection → Get all entities in a collection
  - v1.0/Collection(id) → Get one entity from a collection
- Create: POST
  - v1.0/Collection → Create a new entity
- Update: PATCH
  - v1.0/Collection(id) → Update an entity
- Update: PUT
  - v1.0/Collection(id) → Replace an entity
- Delete: DELETE
  - v1.0/Collection(id) → Remove an entity

Extensions

- MQTT
    - Receive push notification on Entity create or update
        - Subscriptions as in urls
            - v1.0/Datastreams
            - v1.0/Datastreams(1)
            - v1.0/Datastreams(1)/name
            - v1.0/Datastreams(1)/Observations
        - ?$select to reduce message size
        - For all entity types
    - Create Observations using MQTT messages

Extensions

- MultiDatastream
  - Datastream with multiple ObservedProperties
  - Observations with multiple result values
    - Observation/result is a JSON Array
  - Useful for
    - Wind
      - Speed
      - direction
    - Aggregates
      - Average
      - Minimum
      - Maximum
      - std-deviation



Knossos Meteo Station
Air Humidity Knossos Meteo Station [auto][raw][1 hour][1 day]
Air Pressure Knossos Meteo Station [auto][raw][1 hour][1 day]
Air Temperature Knossos Meteo Station [auto][raw][1 hour][1 day]
Full Range
1 year
1 month
1 week
1 day
Air Temperature Knossos Meteo Station
Air Humidity Knossos Meteo Station
percent
degree celcius
93 Max Air Humi...
84 Air Humidity...
63 Min Air Humi...
17.444 Max Air Temp...
12.169 Air Temperat...
6.833 Min Air Temp...
Dec 24 2017
Jan 7 2018
Jan 21
Feb 4
Feb 18
Mar 4
Feb 23, 2018, 11:00

Extensions

- Data Array
  - More efficient Observation encoding
  - GET …/v1.0/Observations?&resultFormat=DataArray
  - For Get & POST
- Batch requests
  - Multiple actions in 1 request

FROST Extensions

- Filtered Delete
  - If you can GET it, you can DELETE it
  - More efficient
  - DELETE v1.0/Observations?$filter=phenomenonTime lt now() sub period'P1D'
- Time interval functions
  - before / after / starts / finishes / overlaps / contains

Client Implementations

- FROST-Client (Fraunhofer IOSB)
  - Java
  - https://github.com/FraunhoferIOSB/FROST-Client
- Sensorthings-net-sdk (Geodan)
  - .NET
  - https://github.com/gost/sensorthings-net-sdk
- GOST Dashboard
  - JavaScript
  - https://github.com/gost/dashboard-v2
- SensorThings-Dashboard (KIT)
  - JavaScript
  - https://github.com/SensorThings-Dashboard/SensorThings-Dashboard