Discovering Indoor Environments and Positioning Systems

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WEB & INFORMATION SYSTEMS ENGINEERING

About me

Maxim Van de Wynckel:

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Position: Researcher at Vrije Universiteit Brussel

Interests: Indoor positioning systems, linked data, and interoperability of positioning systems

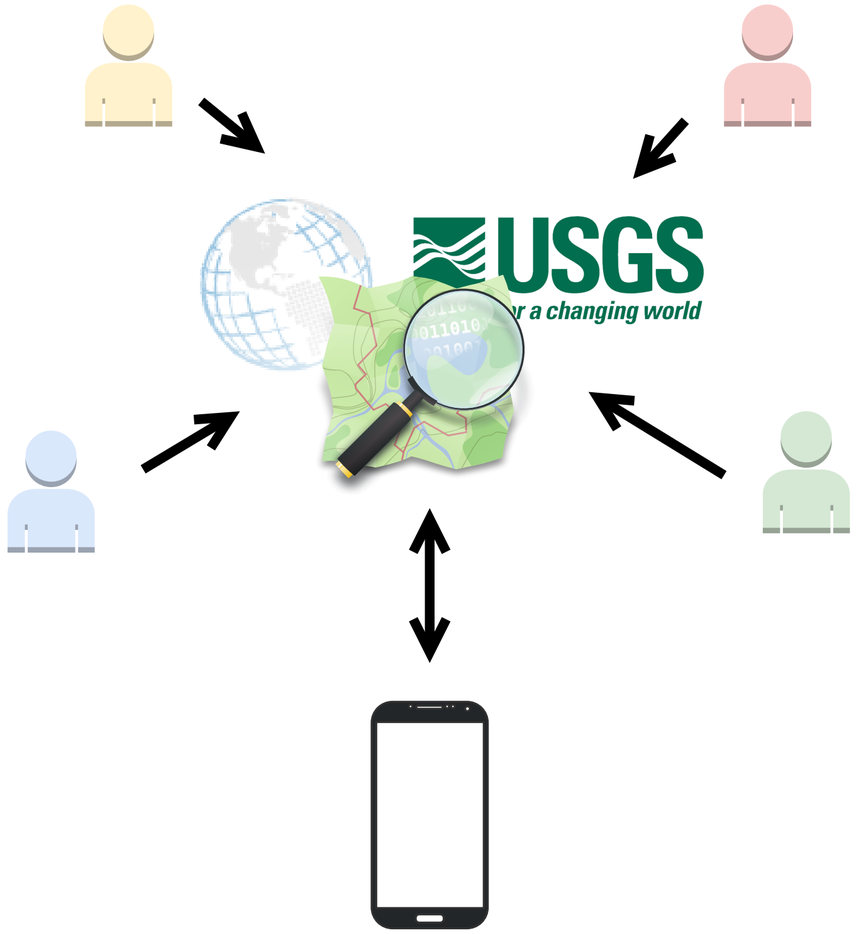
OpenHPS

POSO

SemBeacon

Current state of geospatial data

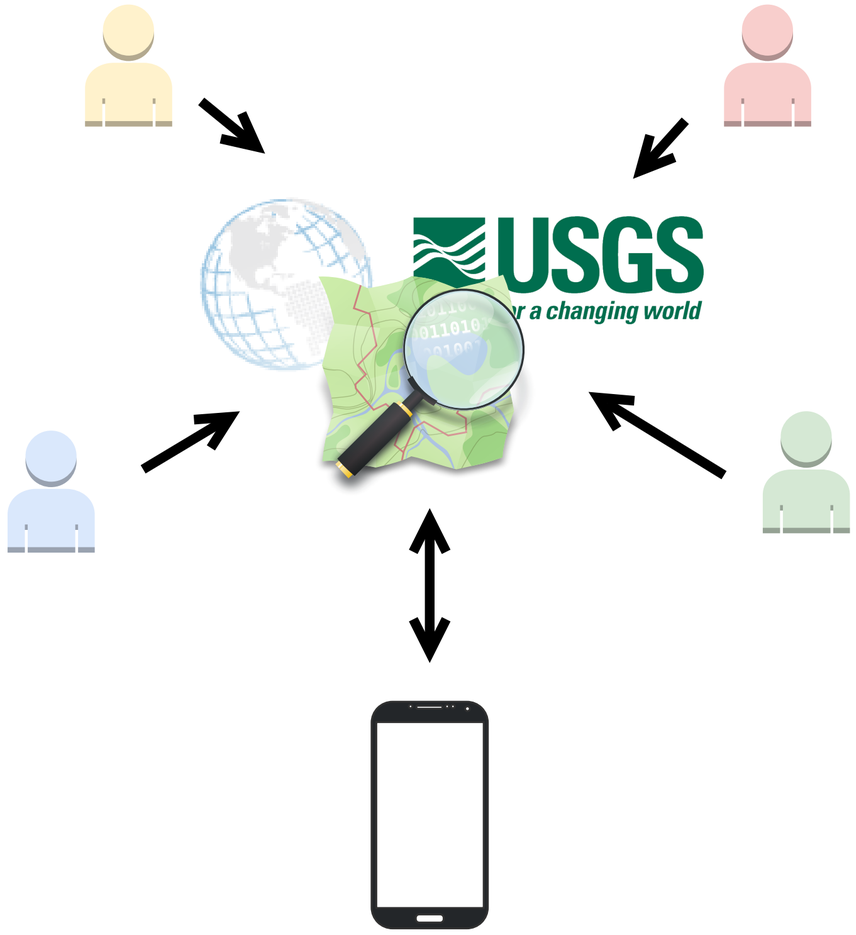
Outdoor data



Indoor data

Current state of geospatial data

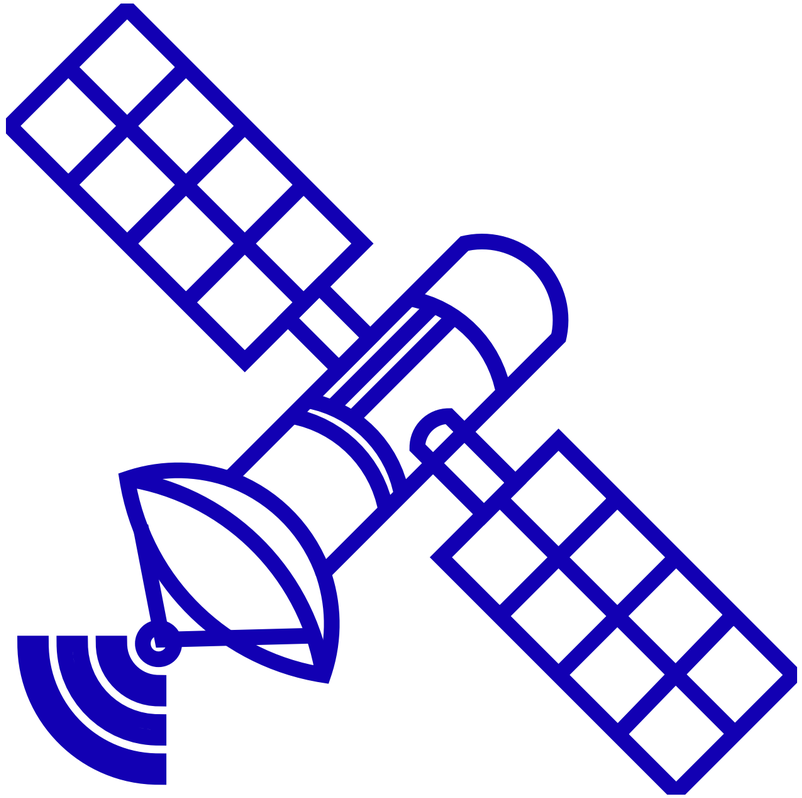
Outdoor data



Indoor data

Current state of positioning systems

Outdoor

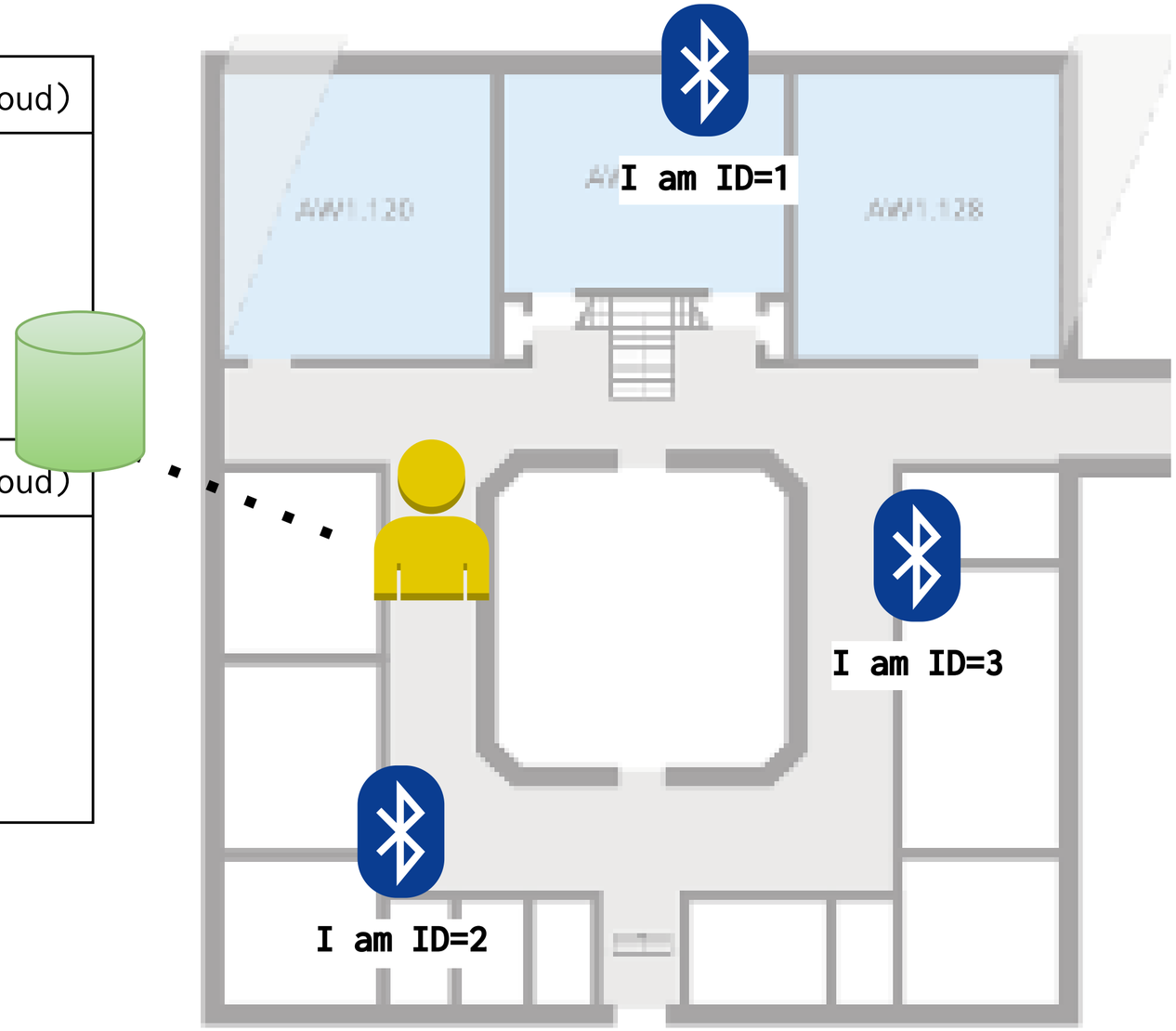


Indoor

Current state of positioning systems ...

Database (local/cloud)	
ID	**Location**
1	X=2, Y=3
...	...
3	X=4, Y=3

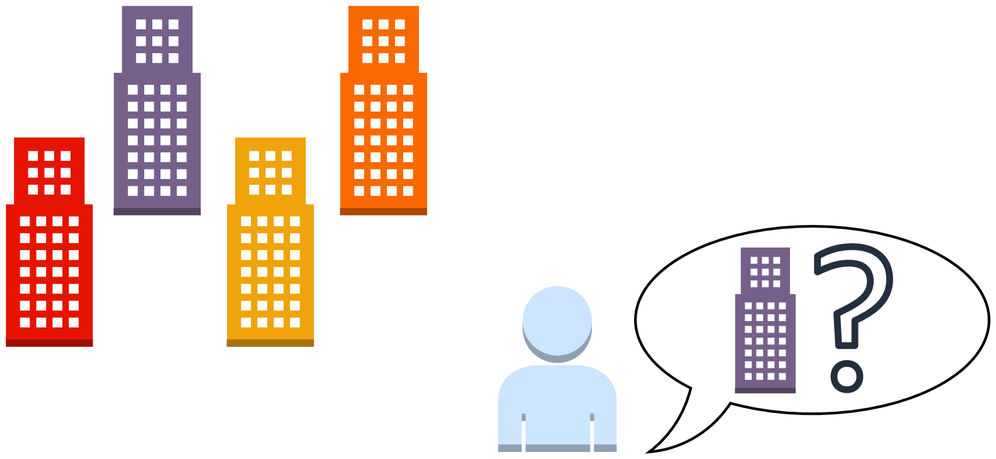
Database (local/cloud)	
Building	**Floor**
AW	1
...	...
K	2



Global and Local Geospatial Data Discovery

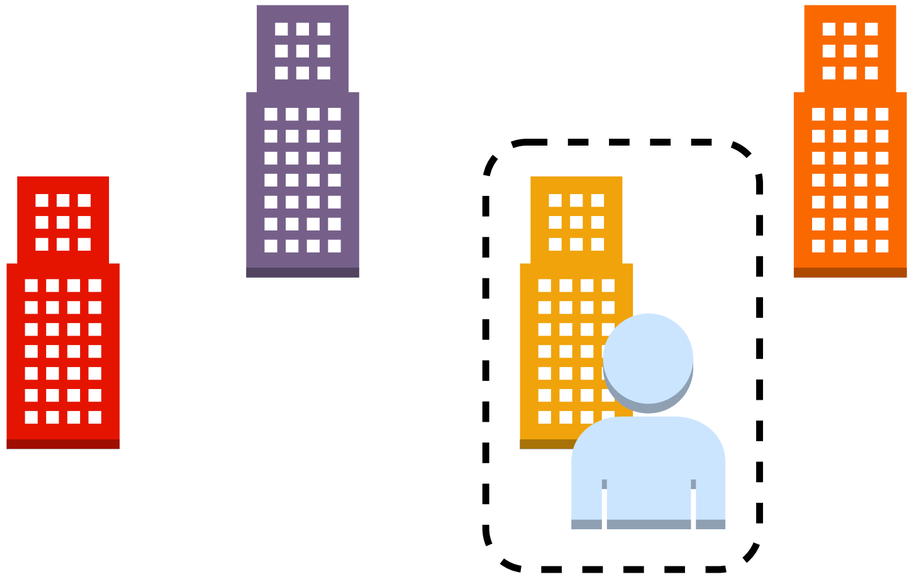
Global Discovery

Find data globally <u>about</u> a particular location



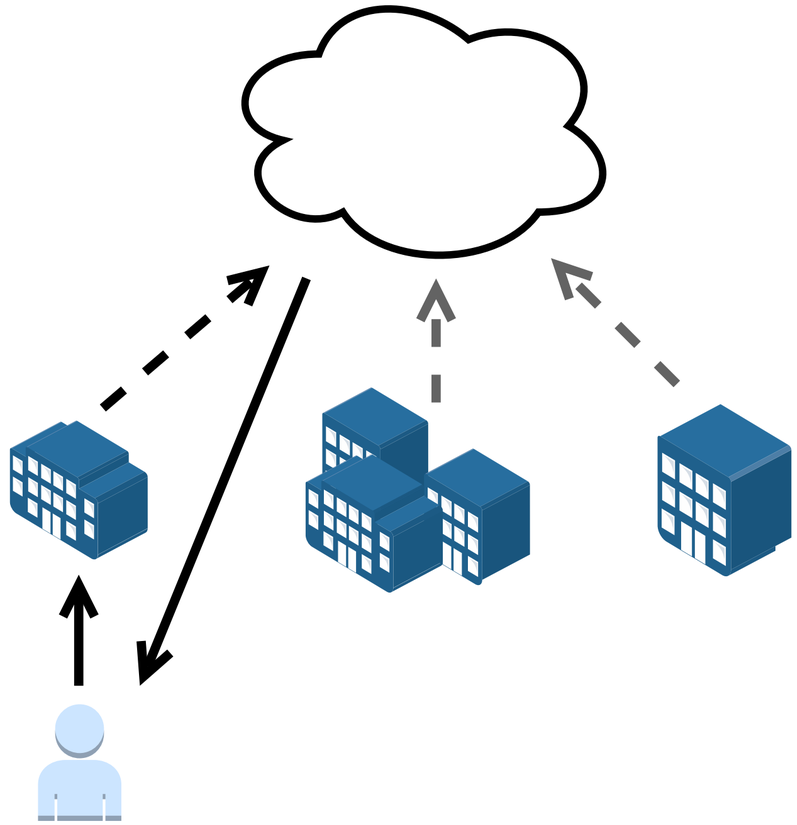
Local Discovery

Find data locally <u>at</u> a particular location



Geospatial-centric data discovery

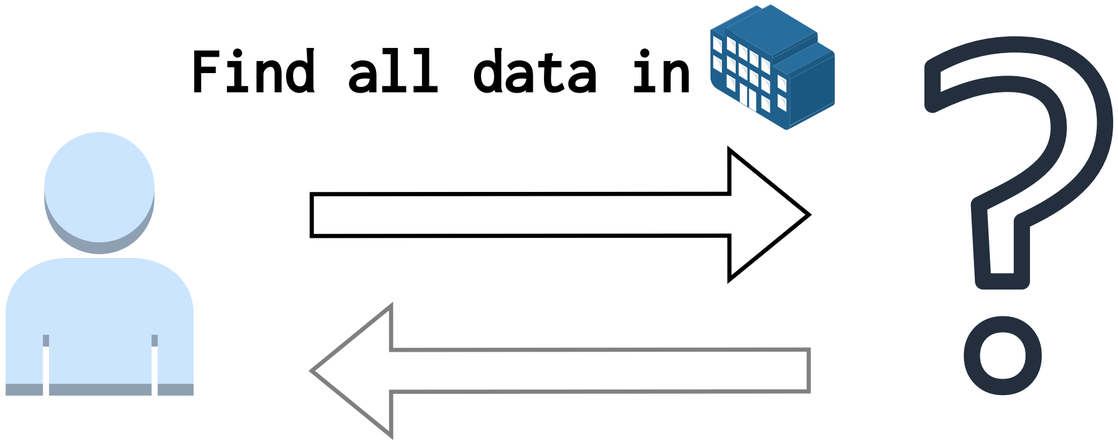
Discovery of geospatial data through the very locations it represents, rather than predefined services.



Geospatial-centric data discovery ...

Challenge 1

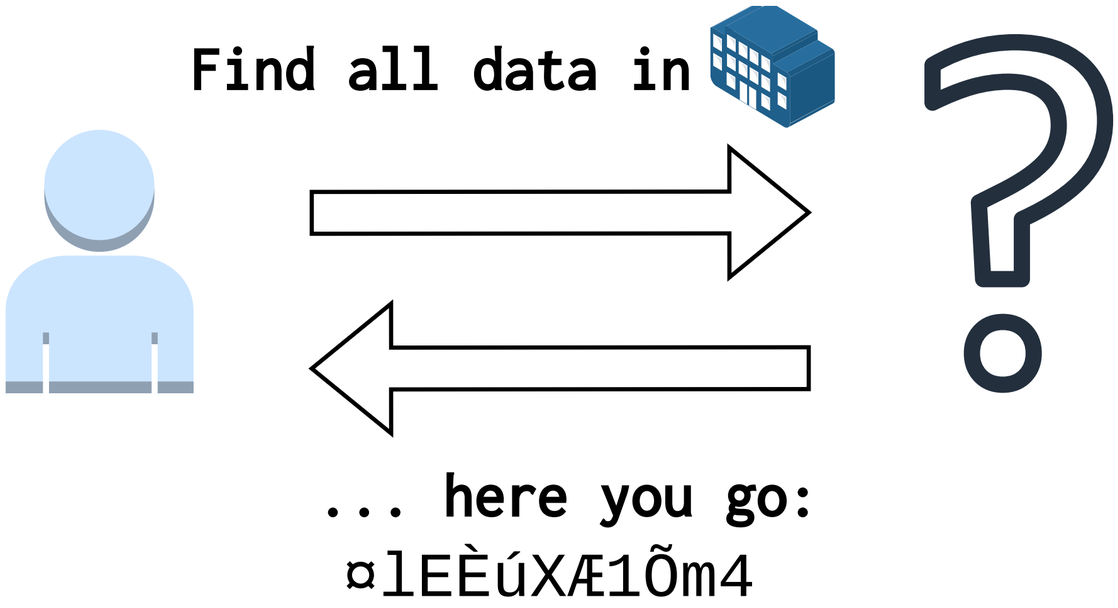
How to discover data without relying on a discovery service?



Geospatial-centric data discovery ...

Challenge 2

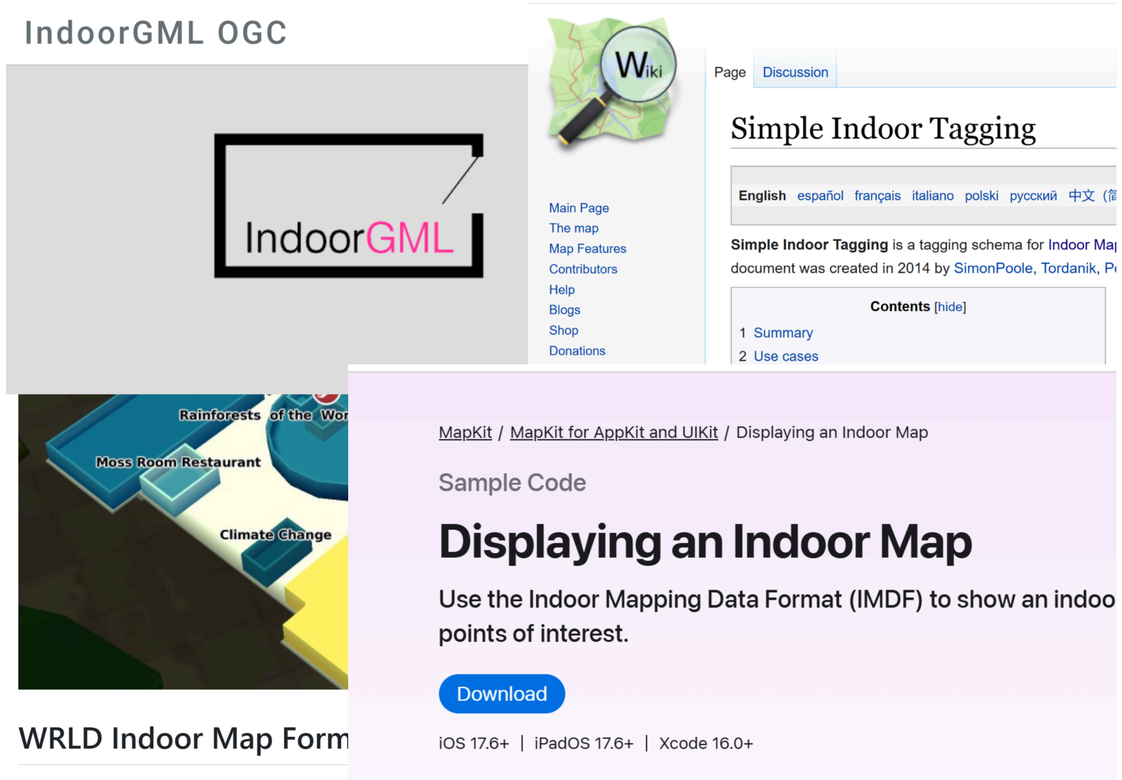
How to understand the discovered data?



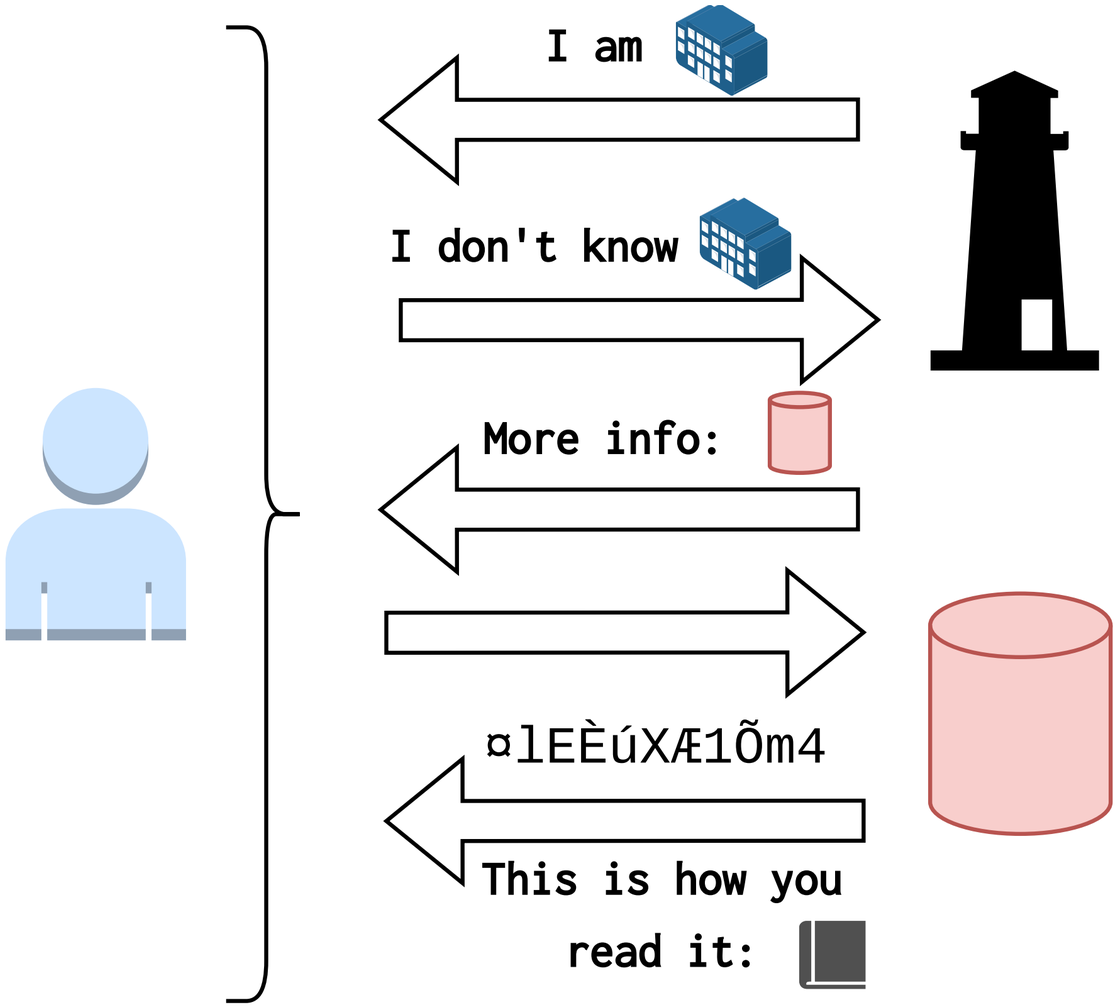
Geospatial-centric data discovery ...

Challenge 2

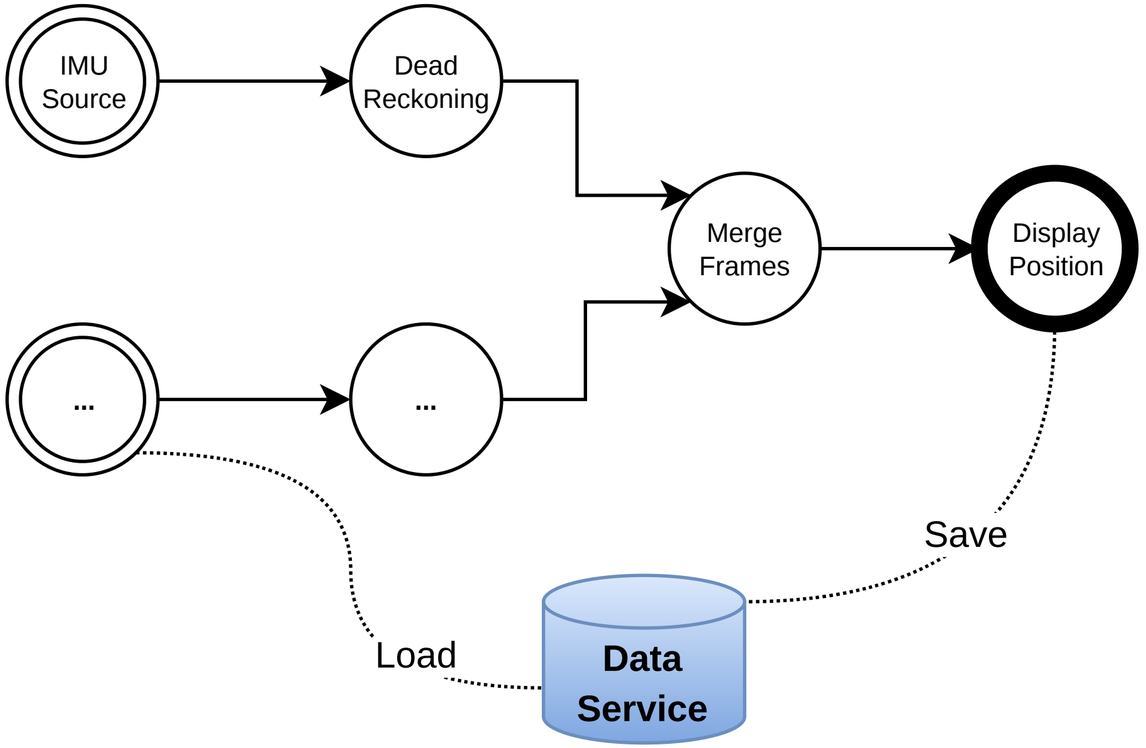
How to understand the discovered data?



Geospatial-centric data discovery ...



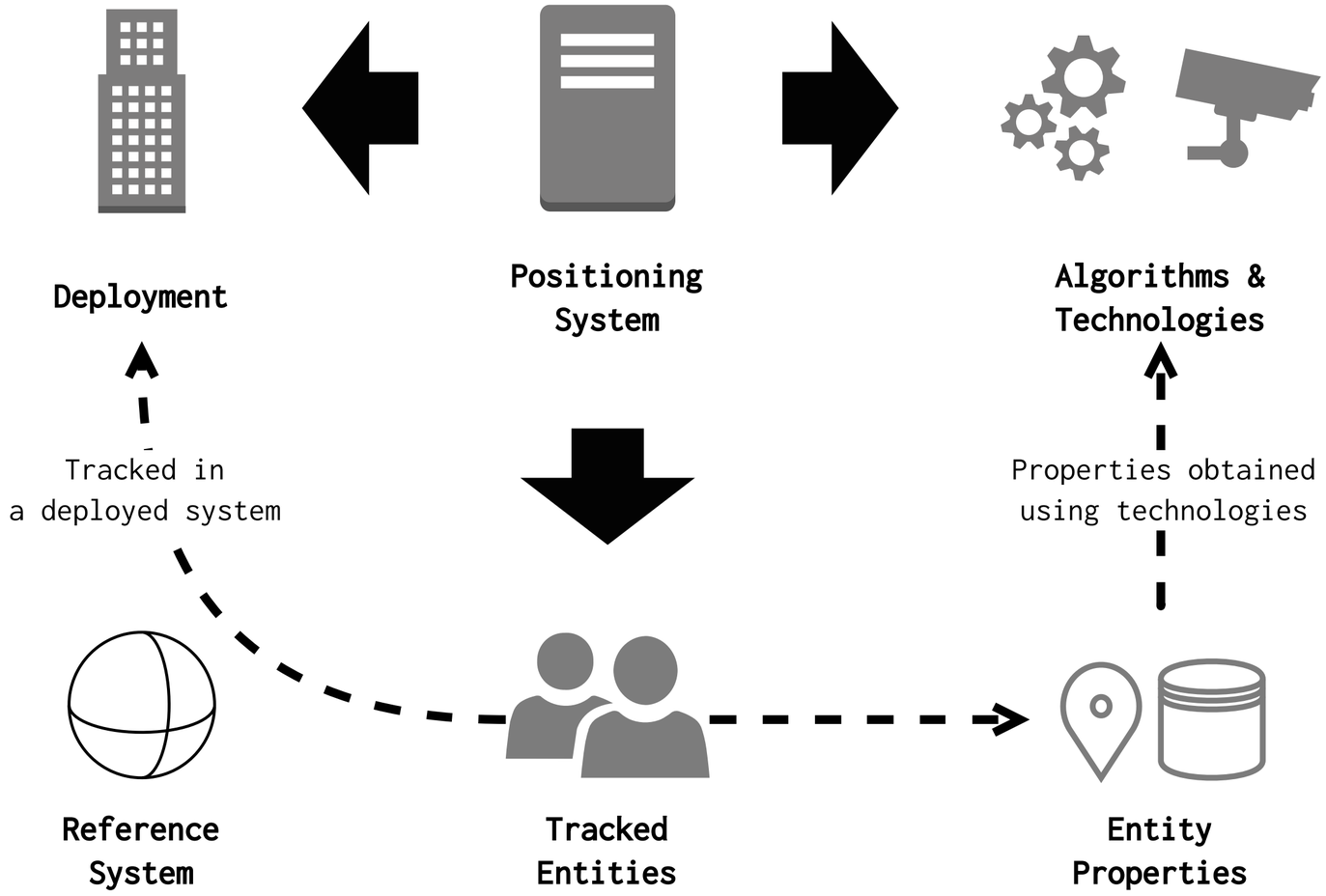
OpenHPS



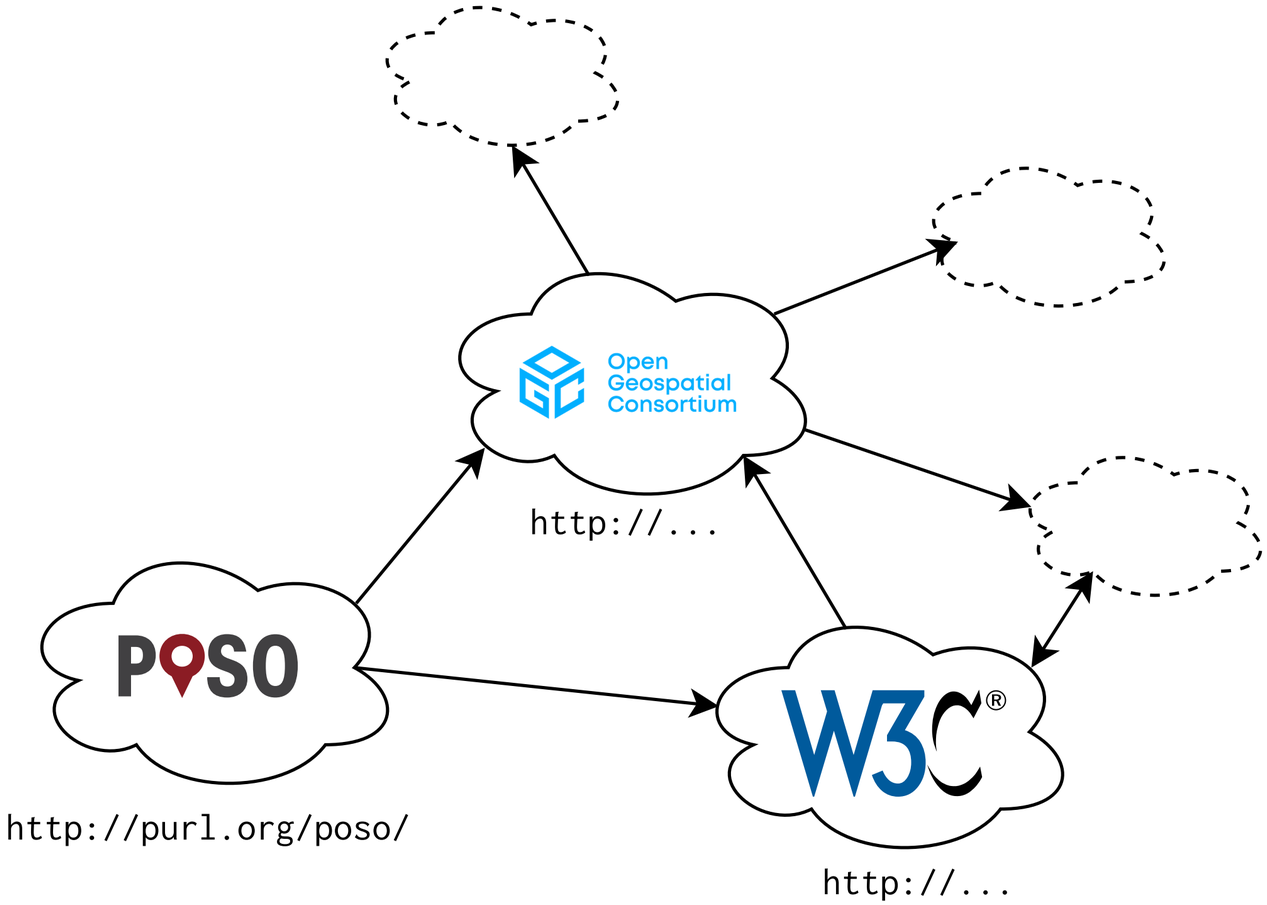
For more information, visit the FOSDEM 2022 talk of OpenHPS.

POSO

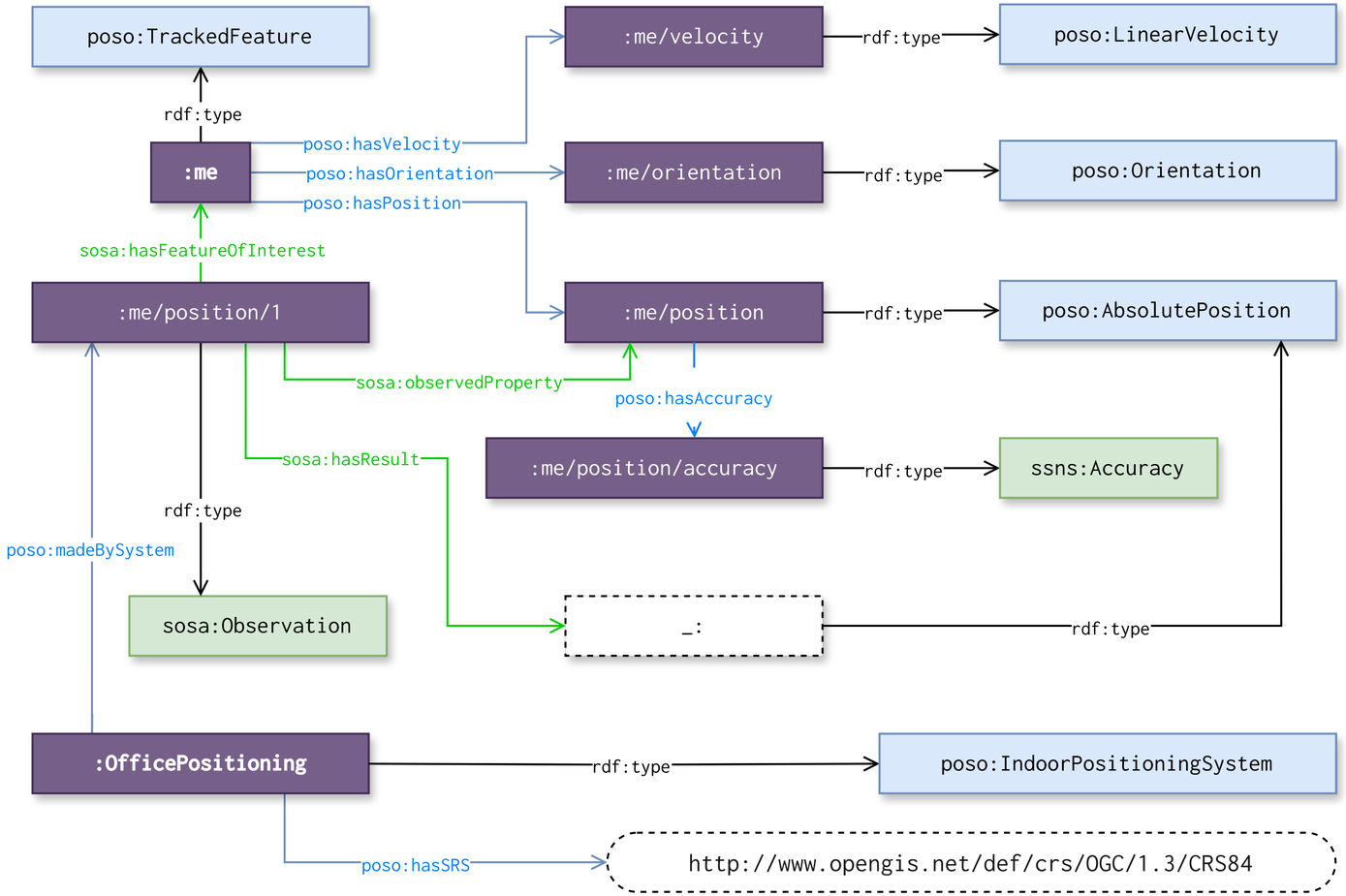
license MIT



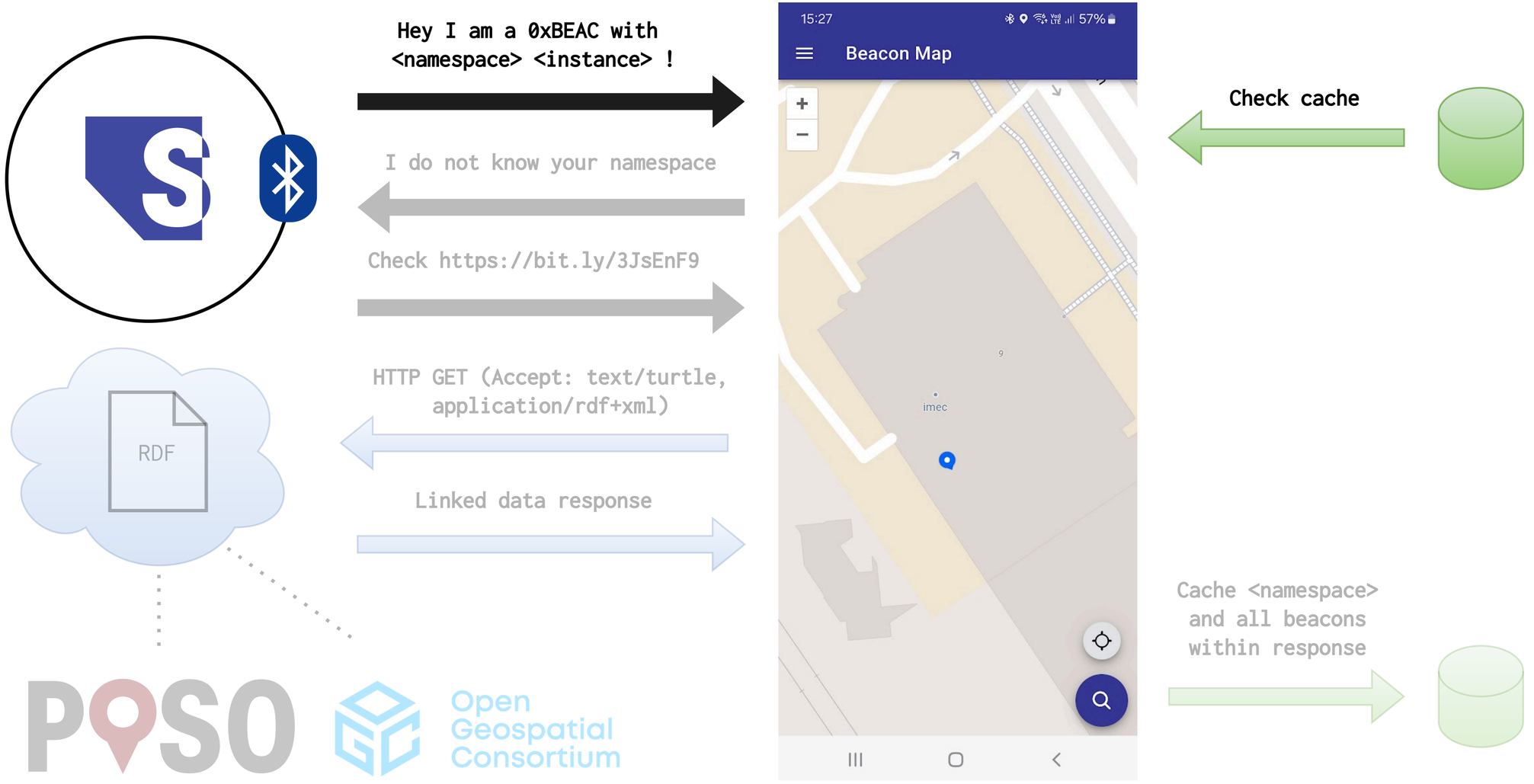
POSO


Open
Geospatial
Consortium
http://...
POSO
http://purl.org/poso/
W3C®
http://...

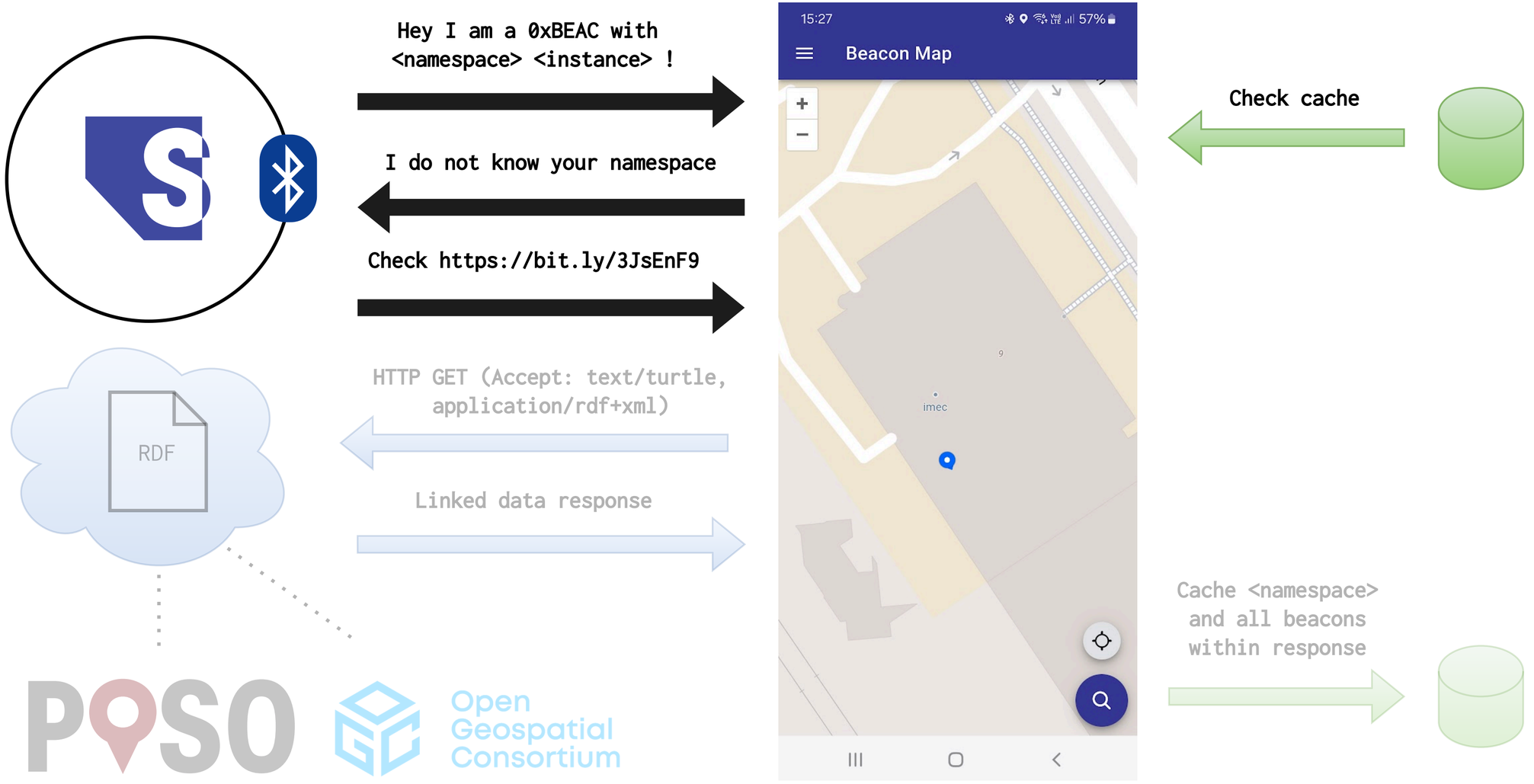
POSO


poso:TrackedFeature
:me/velocity
rdf:type
poso:LinearVelocity
rdf:type
:me
poso:hasVelocity
poso:hasOrientation
poso:hasPosition
:me/orientation
rdf:type
poso:Orientation
sosa:hasFeatureOfInterest
:me/position/1
:me/position
rdf:type
poso:AbsolutePosition
sosa:observedProperty
poso:hasAccuracy
:me/position/accuracy
rdf:type
ssns:Accuracy
sosa:hasResult
rdf:type
poso:madeBySystem
sosa:Observation
_:
rdf:type
:OfficePositioning
rdf:type
poso:IndoorPositioningSystem
poso:hasSRS
http://www.opengis.net/def/crs/OGC/1.3/CRS84

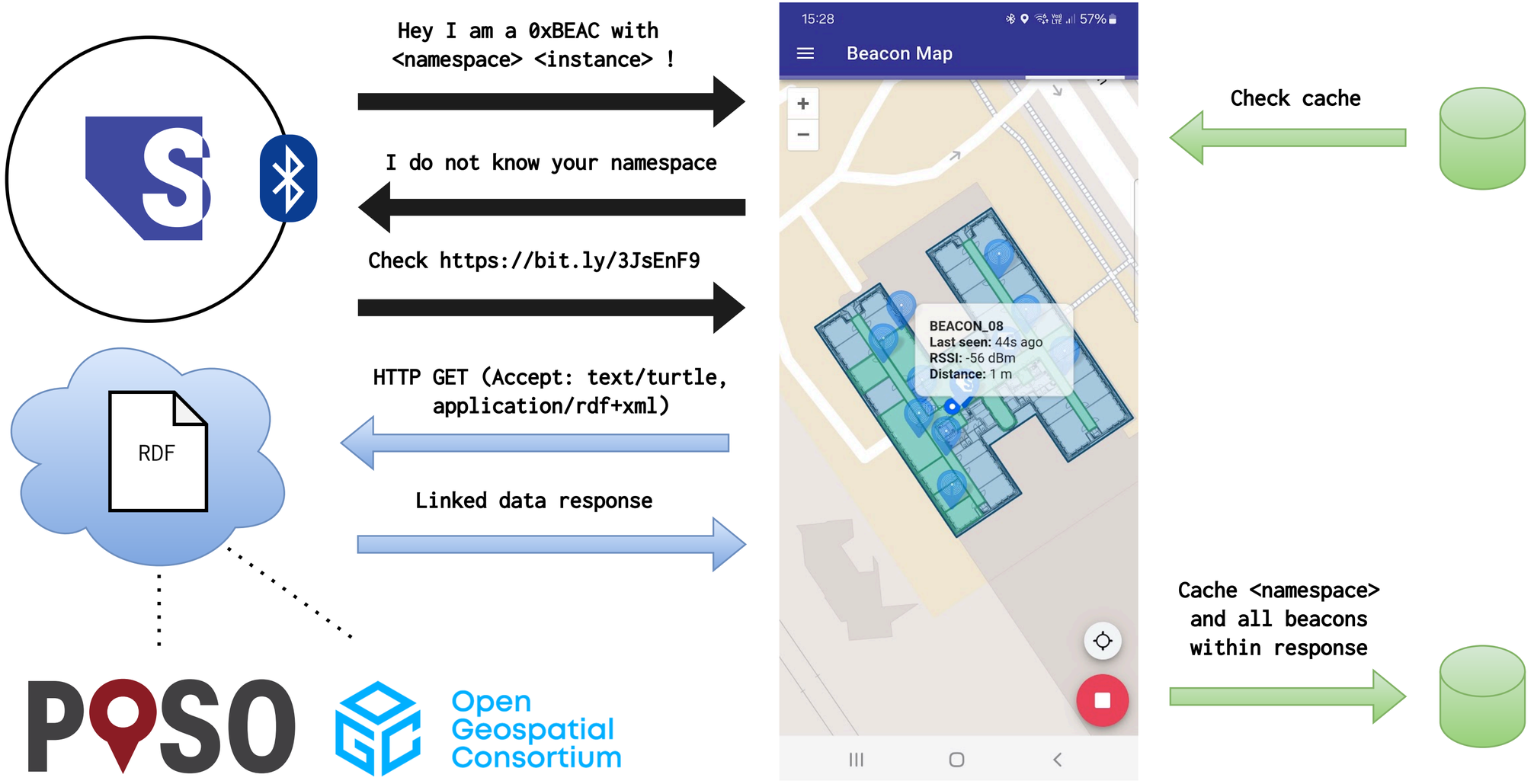
SemBeacon



SemBeacon



SemBeacon



SemBeacon > Namespace and Instance

http://example.org/beacons.ttl#

MD5("http://example.org/beacons.ttl#") =
24d72e569889db5328be761d8488688d

http://other.org/beacons.ttl#

MD5("http://other.org/beacons.ttl#") = 08483bc99d448c83bff6cb9d5bccd40d

Namespace ID: 0x24d72e569889db5328be761d8488688d
Instance ID: 0x00000001
Resource URI: http://example.org/beacons.ttl#b1
Short Resource URI: https://tinyurl.com/3u9tpt7k

Namespace ID: 0x08483bc99d448c83bff6cb9d5bccd40d
Instance ID: 0x00000001
Resource URI: http://other.org/beacons.ttl#b1
Short Resource URI: https://tinyurl.com/bdmbu7jb

Type: iBeacon
UUID: 0x24d72e569889db5328be761d8488688d
Major: 0x0000 **Minor:** 0x0003

Type: AltBeacon
ID: 0x08483bc99d448c83bff6cb9d5bccd40d00000003

SemBeacon > Bluetooth Specification

BLE 4.X

- AltBeacon + Eddystone-URL + Flags

SemBeacon Advertisement Data (31 bytes) — 4.0

Adv Flags 3B	Len 1B	Type 1B	Company ID 2B	Beacon Code 2B	Namespace ID 16B	Instance ID 4B	TX @ 1m 1B	Flags 1B
-	0x1B	0xFF	*uint16*	0xBEAC	*128-bit UUID*	*32-bit UUID*	*int8*	-

SemBeacon Scan Response Data (max 24 bytes) — 4.0

Len 1B	Type 1B	UUID 2B	Frame 1B	TX @ 0m 1B	URI Prefix 1B	Encoded Short Resource URI 0B - 17B
0x??	0x16	0xFEAA	0x10	*int8*	*uint8*	*uint8[]*

Eddystone-URL compatible service

```
0x00 'http://www.'
0x01 'https://www.'
0x02 'http://'
0x03 'https://'
0x04 'urn:uuid:'
```

US-ASCII URL

```
0x00 '.com/'     0x06 '.com'
0x01 '.org/'     0x07 '.org'
0x02 '.edu/'     0x08 '.edu'
0x03 '.info/'    0x09 '.info'
0x04 '.biz/'     0x0A '.biz'
0x05 '.gov/'     0x0B '.gov'
```

BLE 5.X

- No scan response

SemBeacon Extended Advertisement Data (max 156 bytes) — 5.0

SemBeacon Service 4B	Namespace ID 16B	Instance ID 4B	TX @ 1m 1B	Version 1B	Flags 1B	URI Prefix 1B	Encoded Resource URI 0B - 128B
-	*128-bit UUID*	*32-bit UUID*	*int8*	0x10	-	*uint8*	*uint8[]*

Len 1B	Type 1B	UUID 4B	Major 4b	Minor 4b
0x??	0x20	0x00BEAC00	0001	0000

```
...
0x05 'urn:'
0x06 'tag:'
0x06 'http://purl.org/'
0x07 'https://purl.org/'
0x08 'http://w3id.org/'
0x09 'https://w3id.org/'
```

```
...
0x0C '.rdf#'
0x0D '.ttl#'
0x0E '.rdf'
0x0F '.ttl'
0x10 '.jsonld'
```

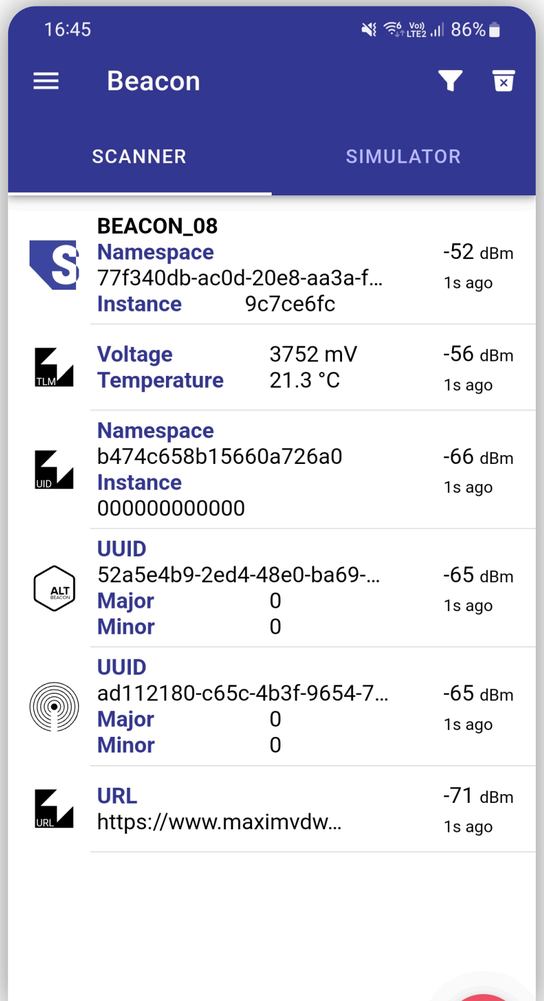
SemBeacon > Bluetooth Specification

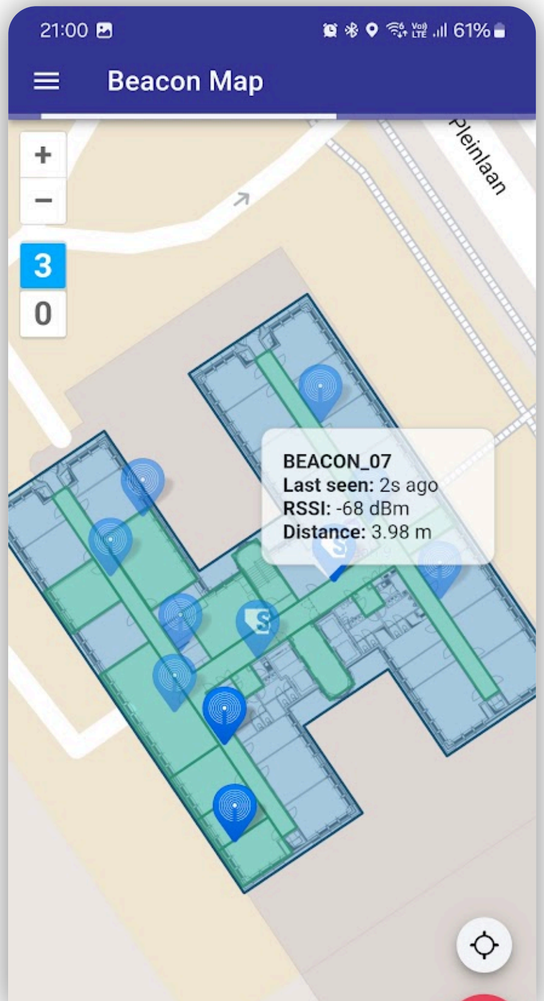
Flags

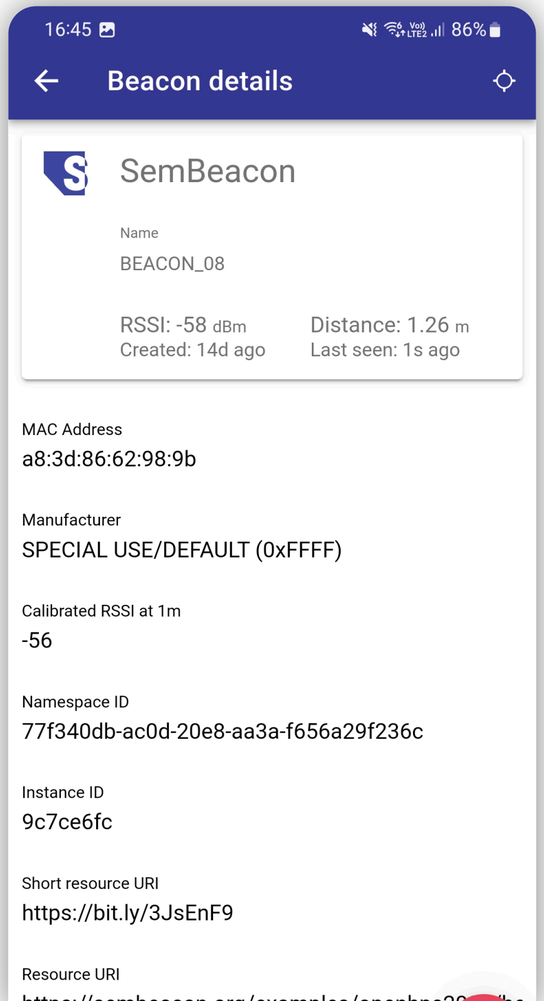
Bit (MSB)	Description	Example
0	Indicates if the beacon has a position.	0 = Unsure, 1 = Yes
1	Indicates if the beacon requires authentication.	0 = Public, 1 = Private
2	Indicates if the beacon is attached to a moving object.	0 = No, 1 = Yes
3	Indicates if the beacon has a positioning system.	0 = No, 1 = Yes
4	Indicates if the beacon has observable data.	0 = No, 1 = Yes
5	Indicates if the beacon provides actuable properties.	0 = No, 1 = Yes
6 - 7	*Reserved for future use.*	

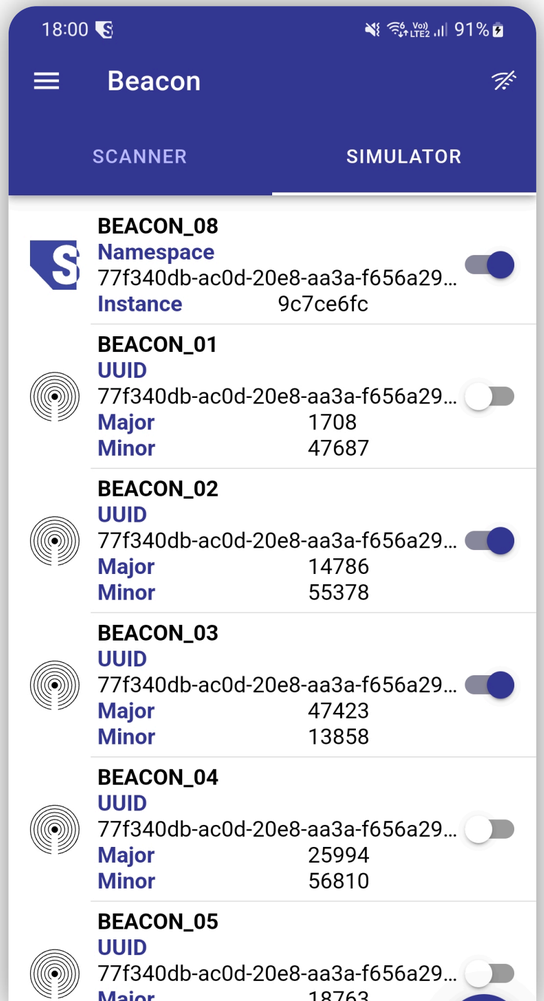
SemBeacon > Mobile Application

- **Scans** and **Simulates** SemBeacon, iBeacon, AltBeacon and Eddystone
- **Extracts** and visualises SemBeacon encoded information



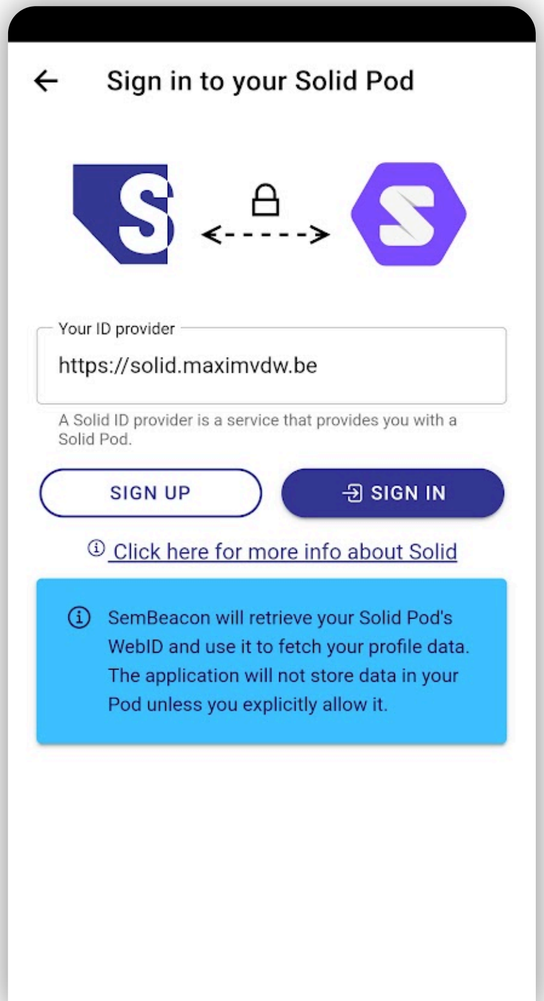


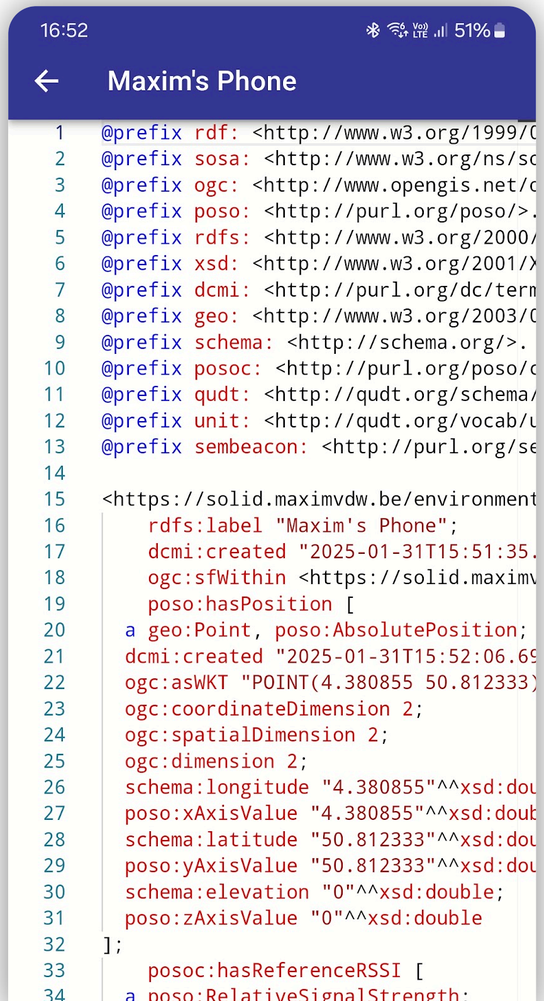


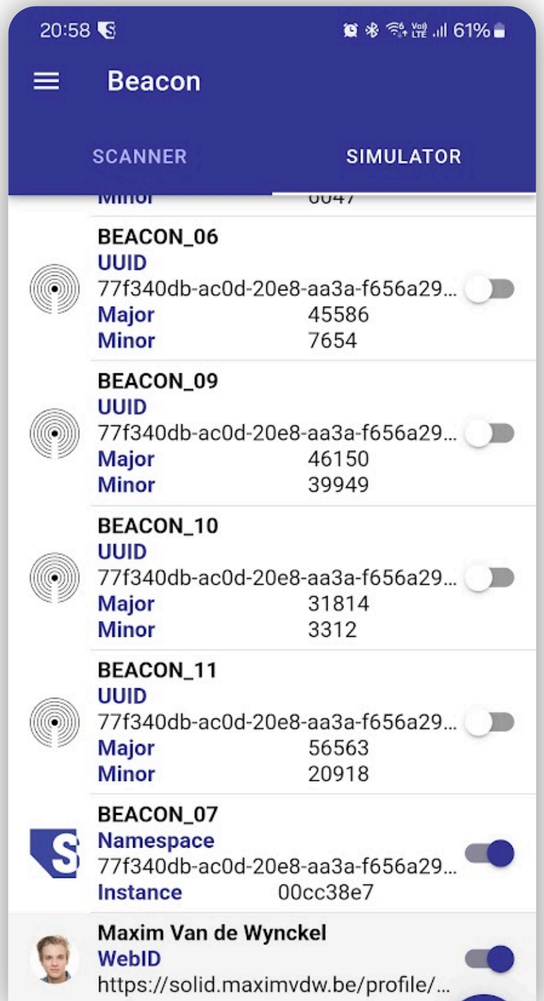


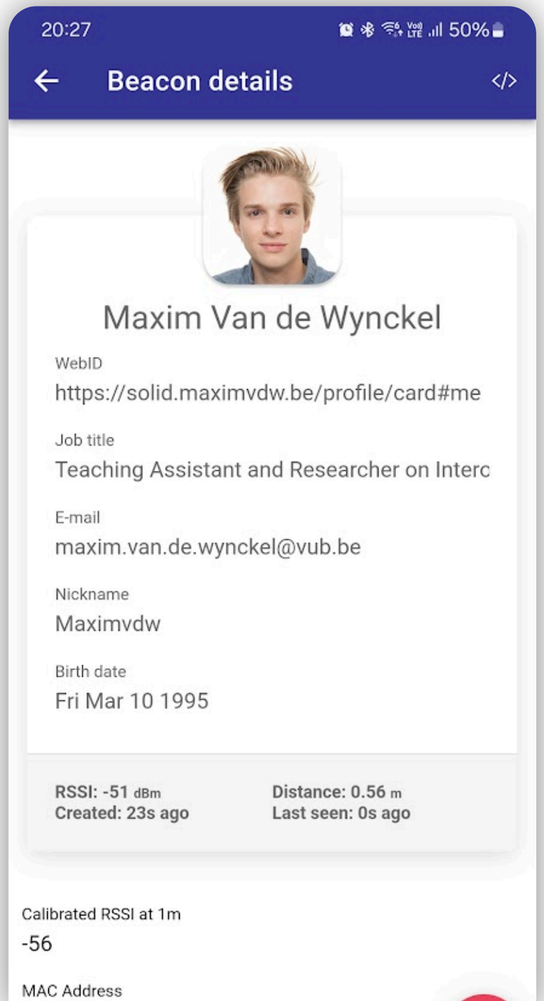
SemBeacon > Mobile Application ...

- ... authentication and authorisation to Solid Pods
- Enable **access control** to environment data









SemBeacon > Example

```
:pl9_3 a ssn:Deployment, sosa:FeatureOfInterest, ogc:SpatialObject, schema:Accommodation, seas:F
    rdfs:label "PL9.3"; ogc:sfWithin :pl9;
    schema:hasMap [ a schema:Map;
        schema:mapType "floorPlan";
        schema:image "https://static.observableusercontent.com/files/69f63f0ed4e82a459af0534c2a7
        schema:spatialCoverage [ a schema:Place;
            ogc:hasGeometry [ a ogc:Geometry;
                ogc:asWKT "POLYGON Z((4.392680949135989 50.820560314350246 91.99999999906868, 4.
                ogc:coordinateDimension 3; ogc:spatialDimension 3;
                ogc:dimension 3 ];
        ]
    ] ;
    schema:floorLevel "3";
    ogc:hasGeometry [ a ogc:Geometry;
        ogc:asWKT "POLYGON Z((4.392680949135989 50.820560314350246 91.99999999906868, 4.39251898
        ogc:coordinateDimension 3; ogc:spatialDimension 3;
        ogc:dimension 3 ];
    sembeacon:namespaceId "77f340dbac0d20e8aa3af656a29f236c"^^xsd:hexBinary.
```

Contributing & Roadmap > POSO ontology

GITHUB OPENHPS/POSO

1. Use cases for the POSO ontology usage
   https://github.com/OpenHPS/POSO/issues
2. Examples of POSO to describe positioning systems
3. Feedback on the current ontology design (1.1)
4. OpenHPS geospatial mapping to RDF
   https://github.com/OpenHPS/openhps-rdf/tree/master/src/mapping/geospatial

Contributing & Roadmap > SemBeacon

1. Mobile application
   https://github.com/SemBeacon/app
   1.1. Examples/implementations of unsupported indoor environment descriptions
   1.2. iOS support (partially implemented)
2. Arduino library (ESP32_SemBeacon)
   https://github.com/SemBeacon/arduino-esp32
   2.1. No retrieval of (important) data
3. nRF5x library (WiP)
4. Specification improvements
   https://github.com/SemBeacon/specification

Demo time!

Discovering Indoor Environments and Positioning Systems

OpenHPS

POSO

SemBeacon

https://github.com/SemBeacon/

https://sembeacon.org/

https://openhps.org/

https://poso.openhps.org/

Android App on Google Play Store