

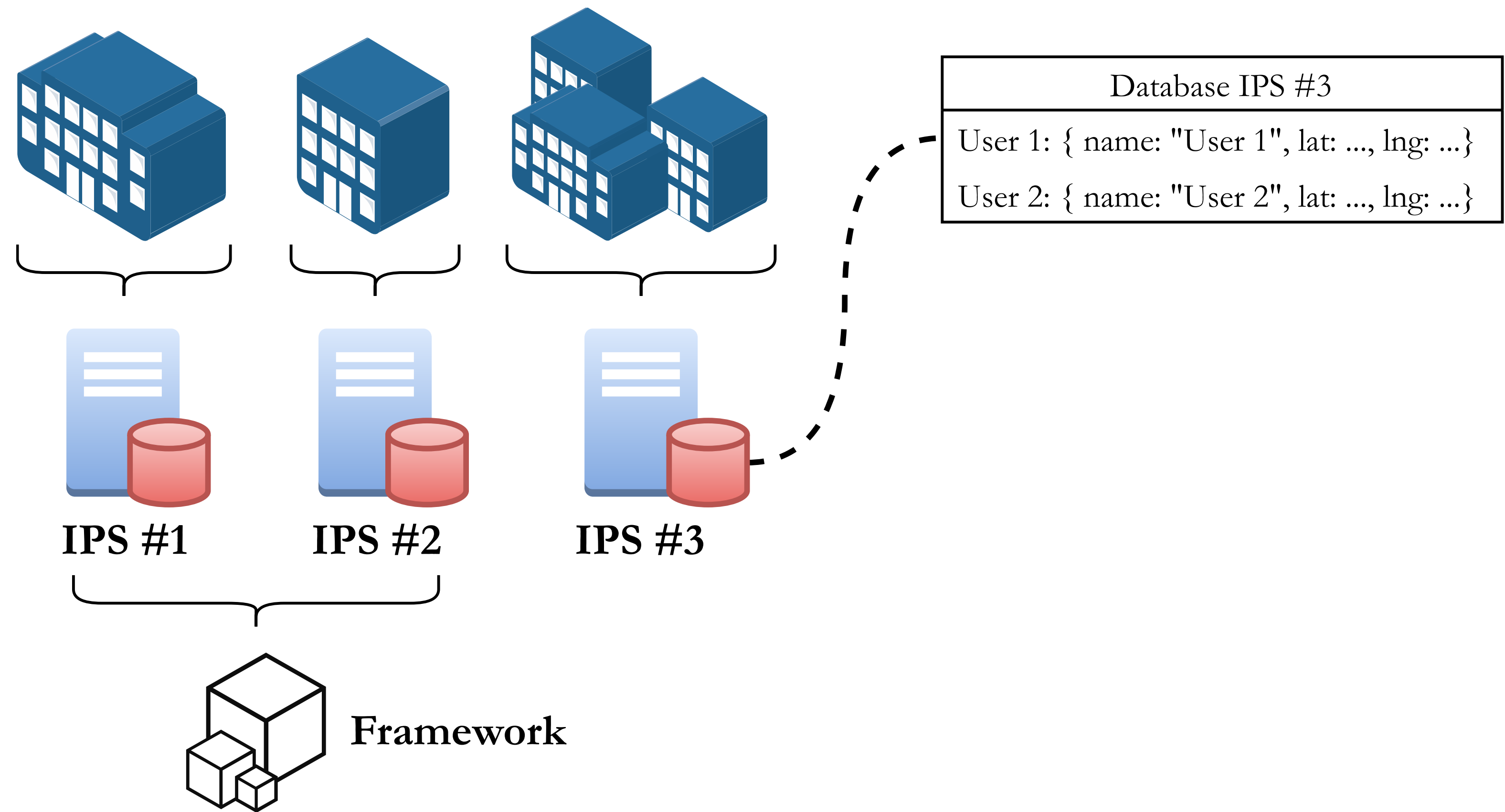
A Solid-based Architecture for Decentralised Interoperable Location Data

Maxim Van de Wynckel and Beat Signer

*Web & Information Systems Engineering Lab
Vrije Universiteit Brussel*

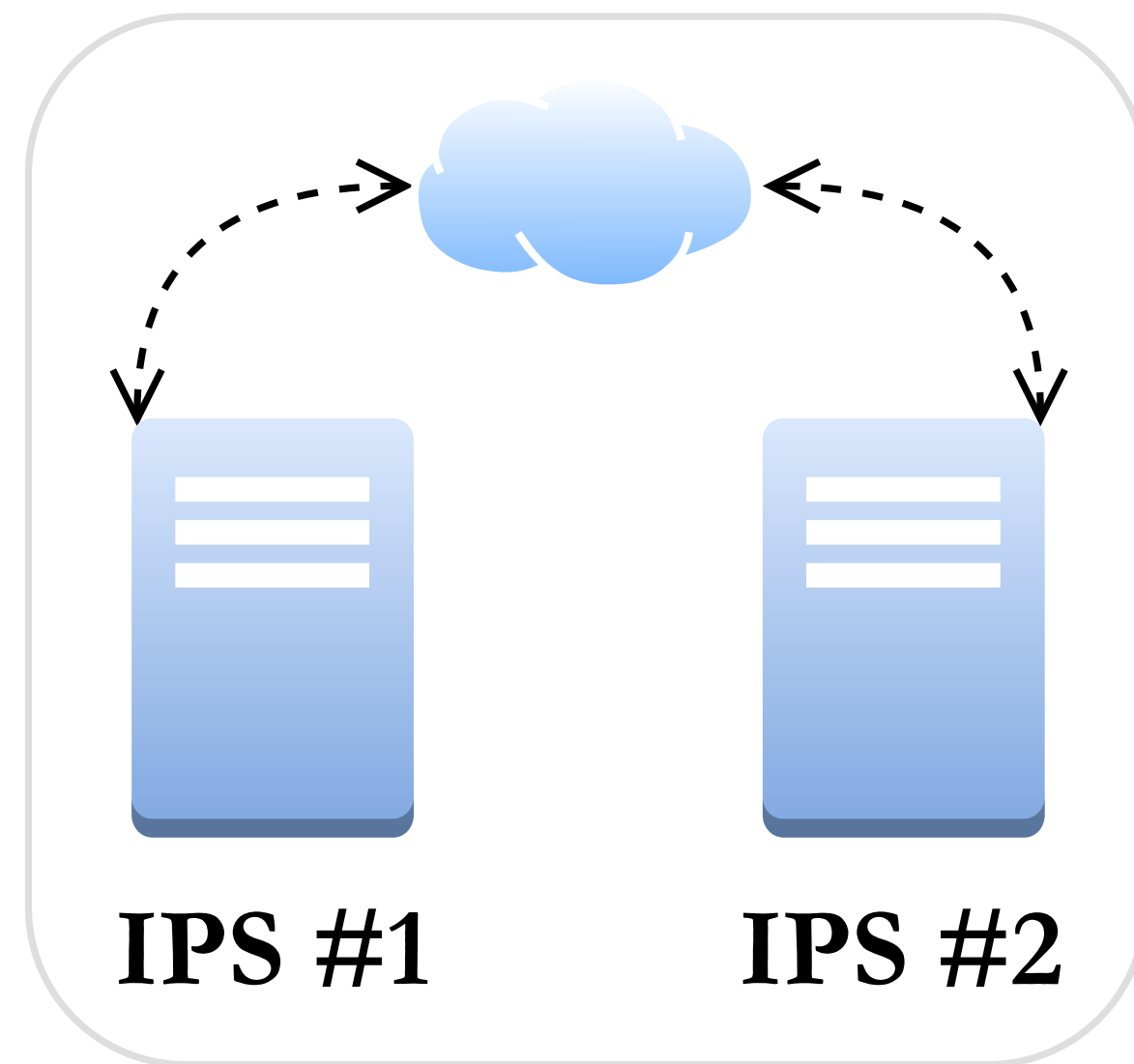


Current Indoor Positioning Systems (IPS)



Problems With Current IPSs

1. Users not in **control** of their **data**
2. No **interoperability** between positioning **systems** and **applications**



Accessibility



Readability

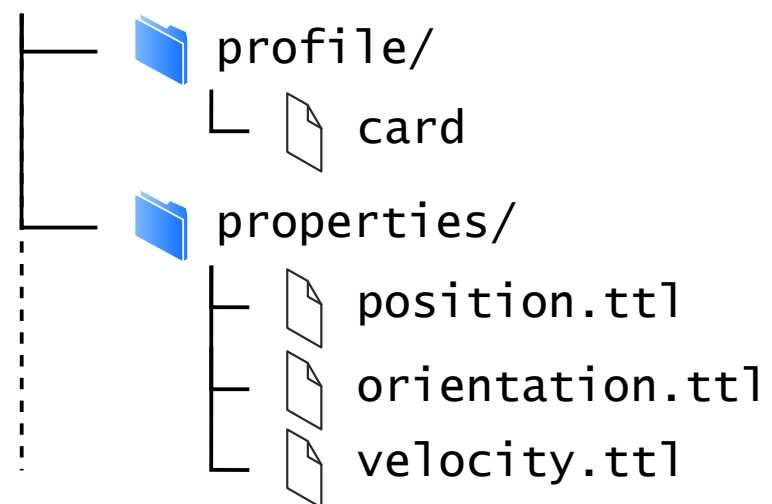


Understandability

Decentralised Interoperable Architecture



`http://ipin2022.solidweb.org/`



`orientation.ttl`

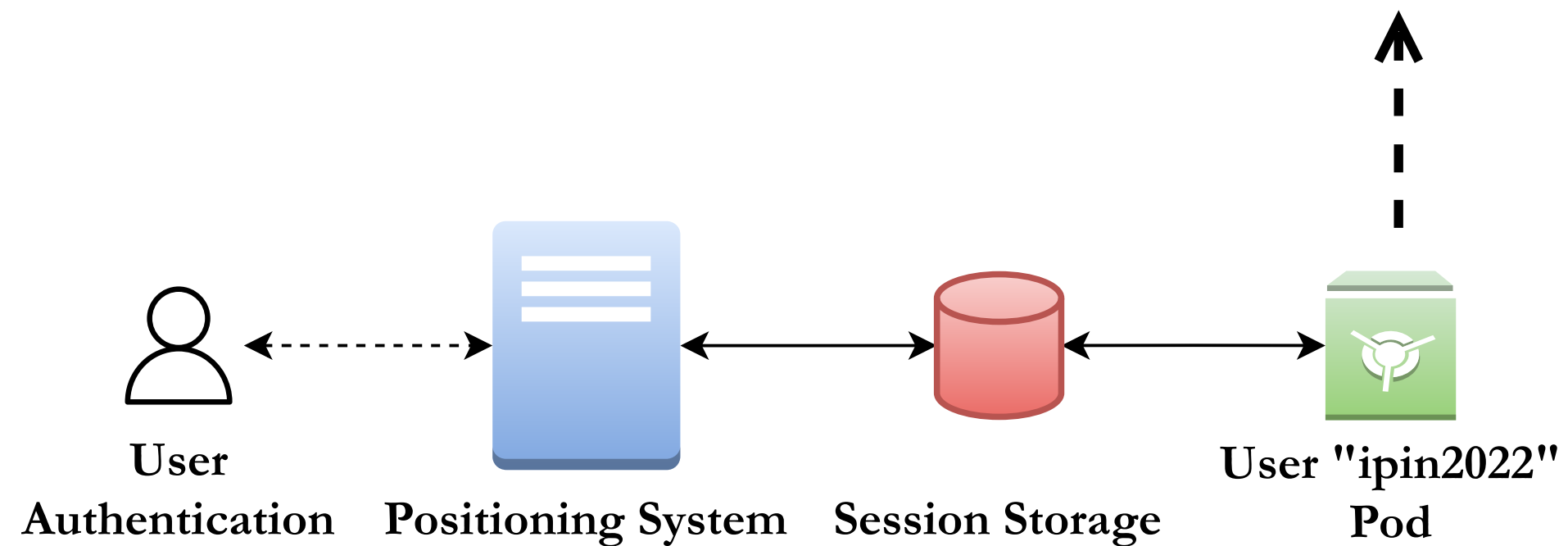
```
<> a sosa:ObservableProperty ;
    rdfs:label "My Orientation"@en .
```

`position.ttl`

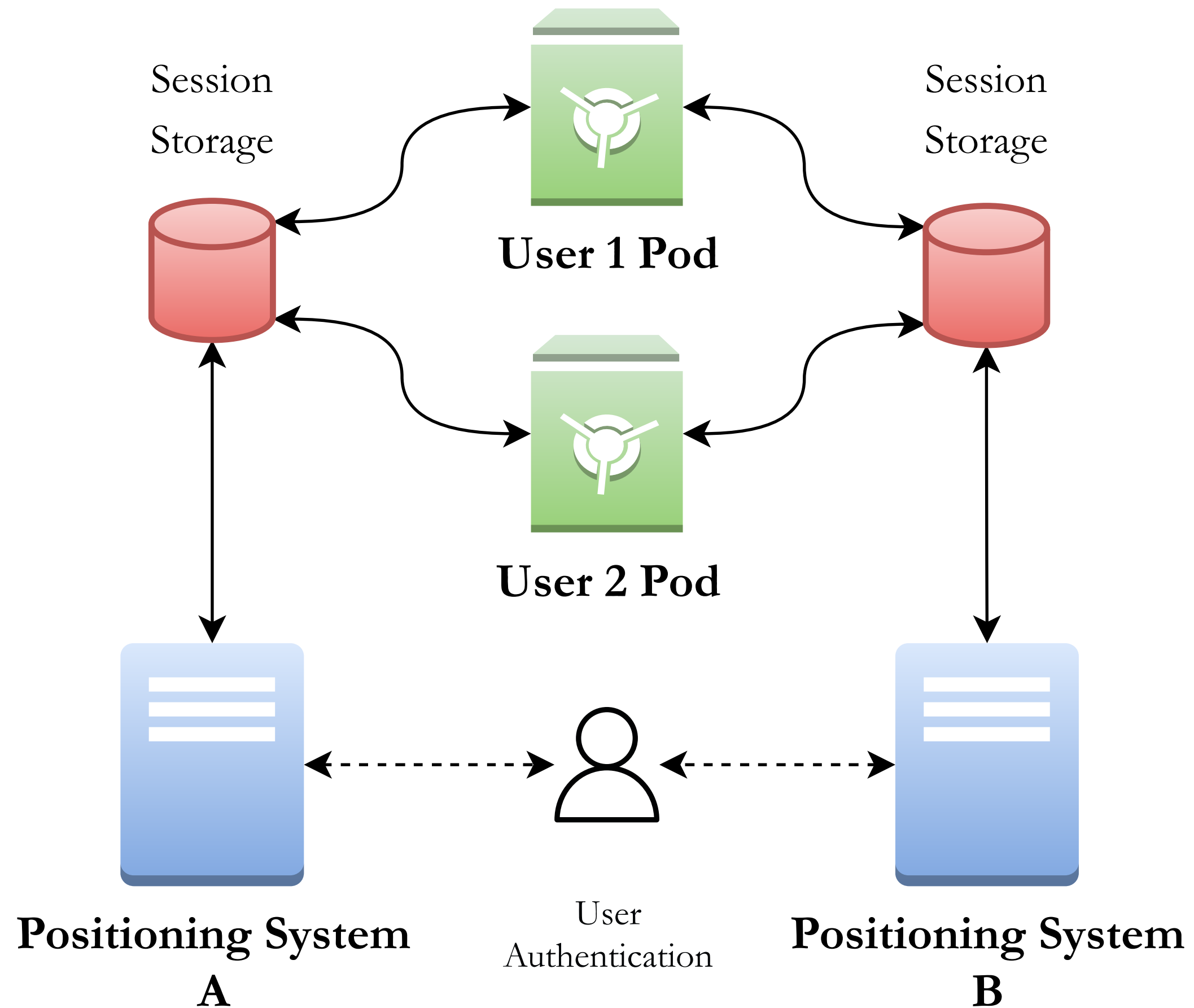
```
<> a sosa:ObservableProperty ;
    rdfs:label "My Position"@en .
```

```
:1648831850 a sosa:Observation ;
    sosa:observedProperty <> ;
    sosa:resultTime "...";
    sosa:hasResult: [ ... ] .
```

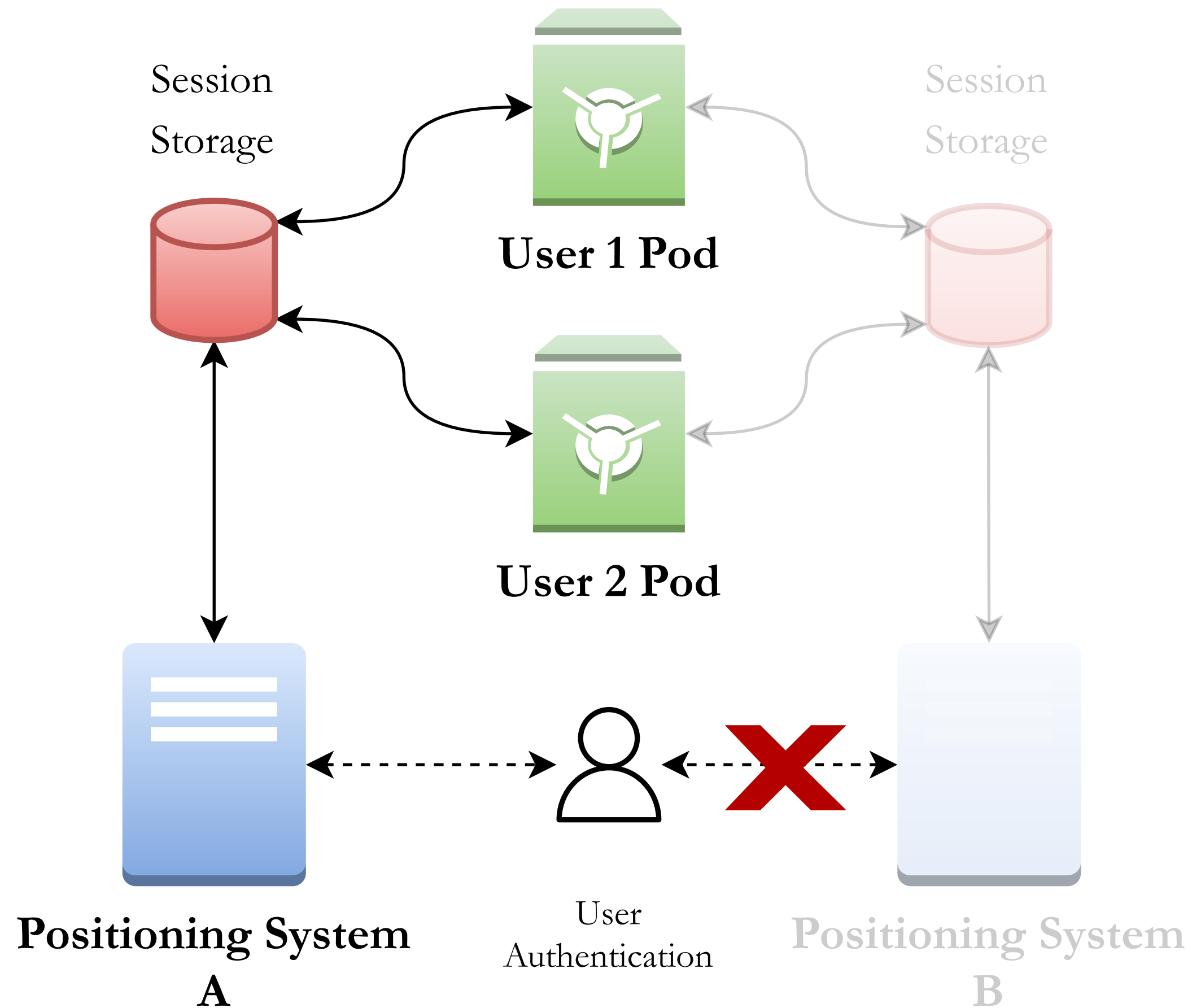
```
:1648831900 a sosa:Observation ;
    sosa:observedProperty <> ;
```



Decentralised Interoperable Architecture



Decentralised Interoperable Architecture



Vocabularies

Core vocabularies:

- ▶ SOSA
- ▶ SSN

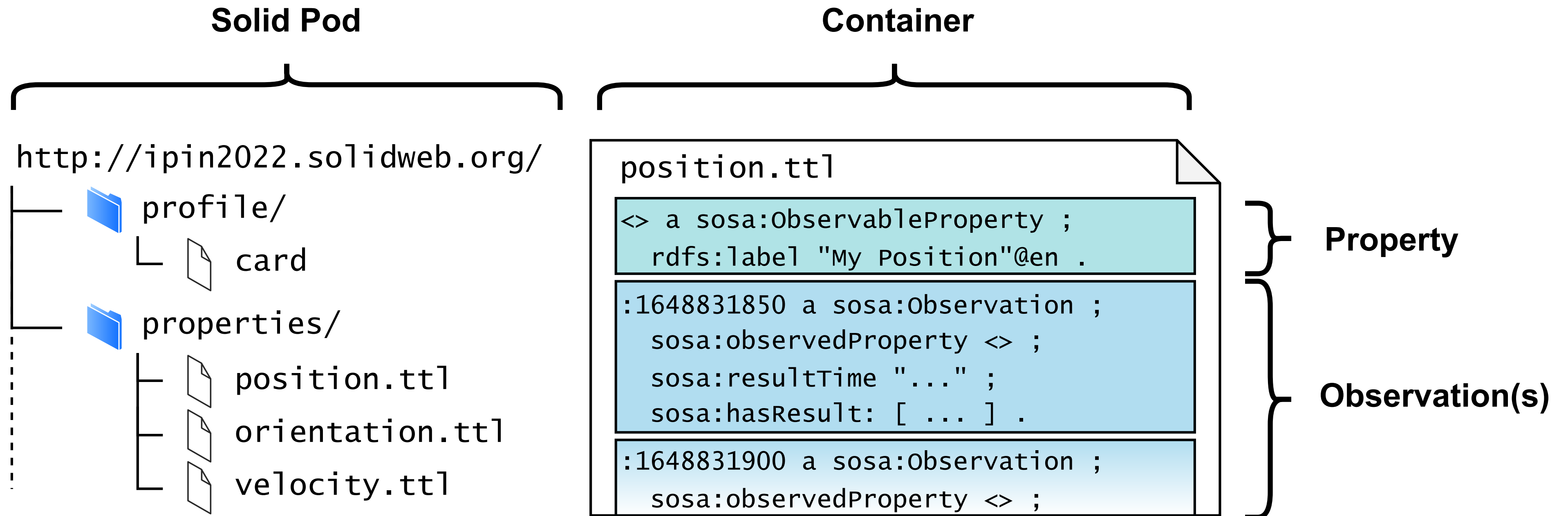
Alignment vocabularies:

- ▶ GeoSPARQL
- ▶ QUDT
- ▶ SSN-Systems

See paper for more details ...



Properties and Observations



Properties and Observations

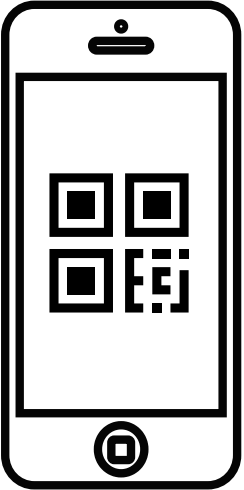
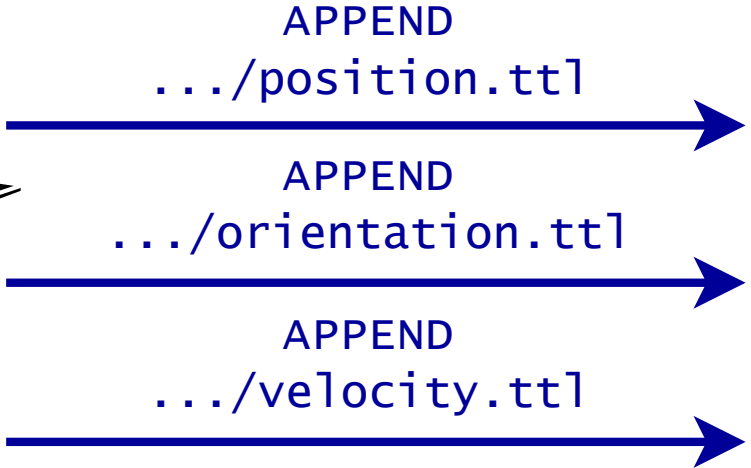
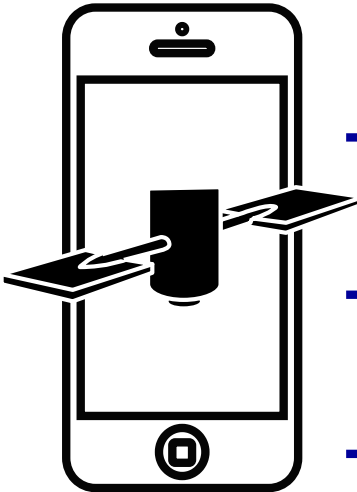
<http://ipin2022.solidweb.org/properties/orientation.ttl>

```
<>
  a sosa:ObservableProperty;
  rdfs:comment "Orientation of John Doe"@en;
  rdfs:label "Orientation"@en;
  ssn:isPropertyOf profile:me.
:1651065740981
  a sosa:Observation;
  sosa:hasFeatureOfInterest profile:me;
  sosa:hasResult [
    a qudt:QuantityValue;
    qudt:numericValue 108.11512756347656;
    qudt:unit unit:DEG;
  ];
  ssns:qualityOfObservation [
    a qudt:QuantityValue;
    qudt:numericValue 12;
    qudt:unit unit:DEG;
  ];
  sosa:observedProperty <>;
  sosa:resultTime "2022-04-27T13:22:20.981Z"^^xsd:dateTime;
  sosa:usedProcedure ipin:geolocationapi.
```

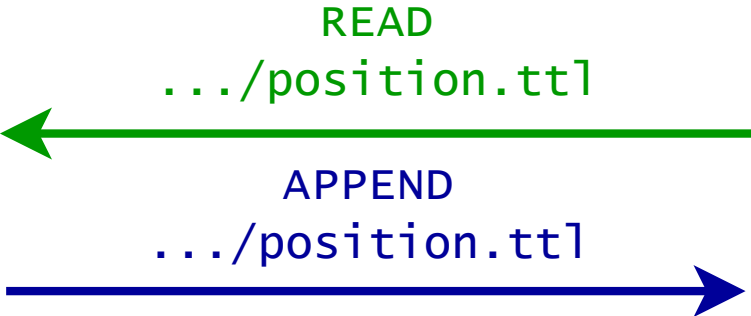
PoC Demonstrator



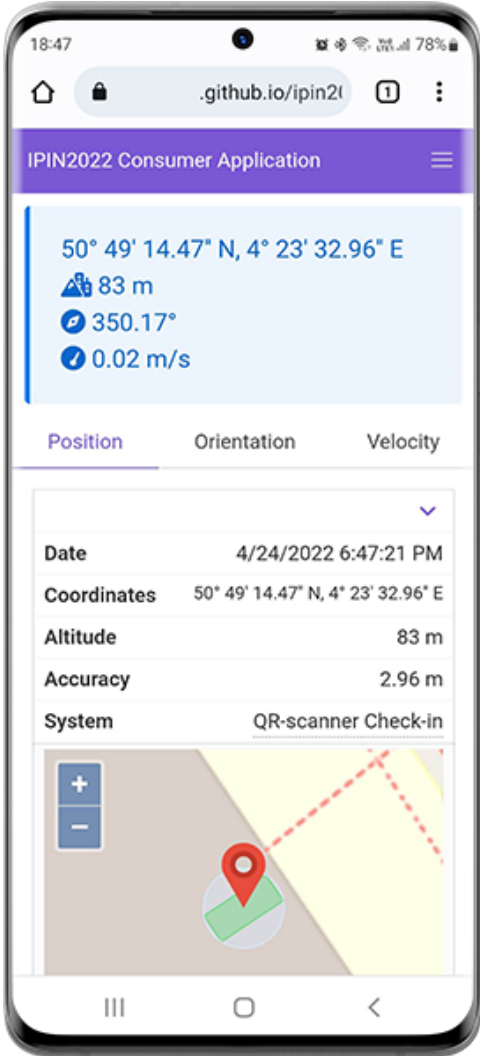
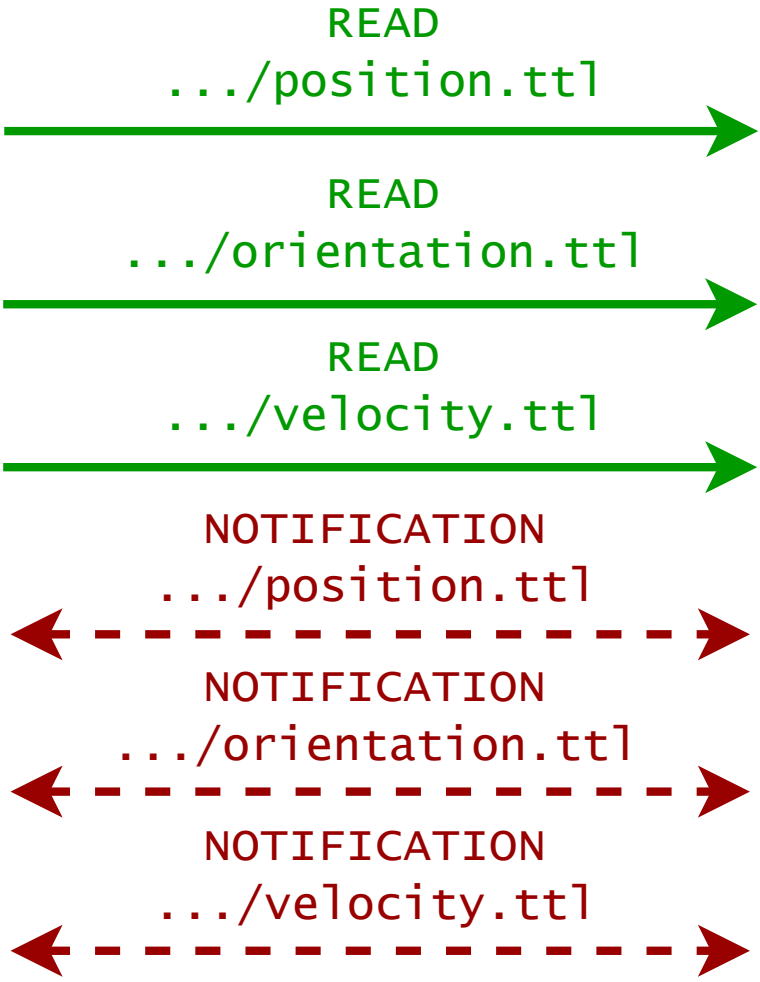
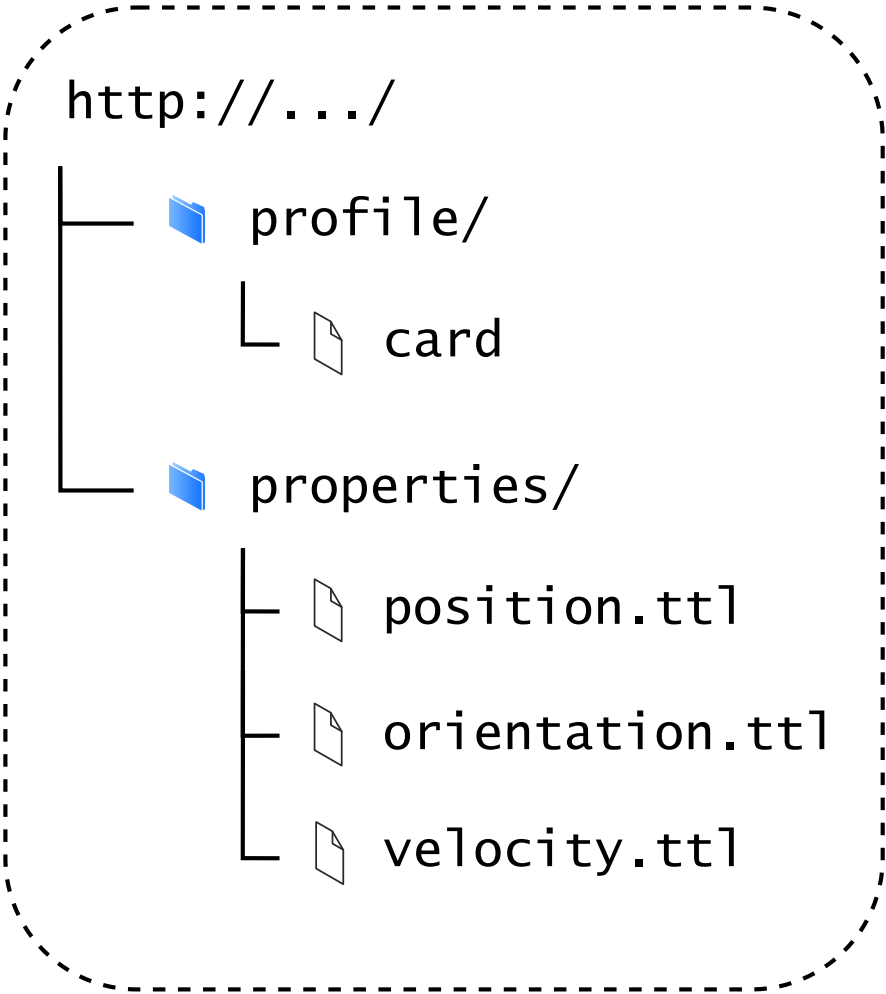
Geolocation API



QR-scanner IPS



User Pod

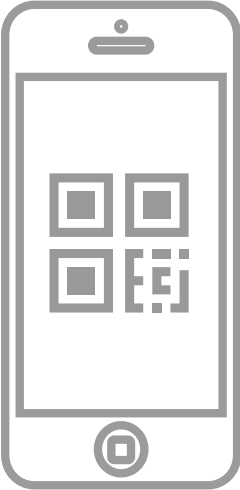
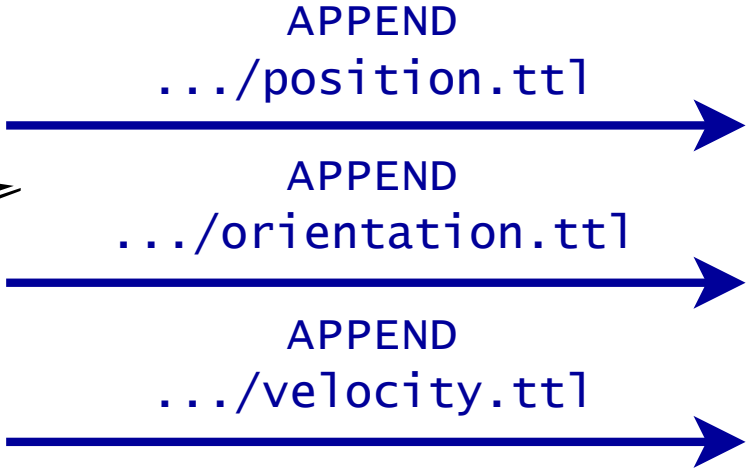
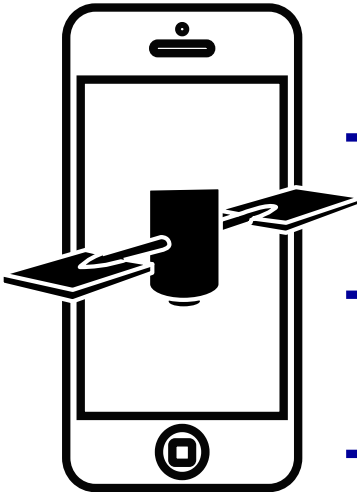


Consumer Application

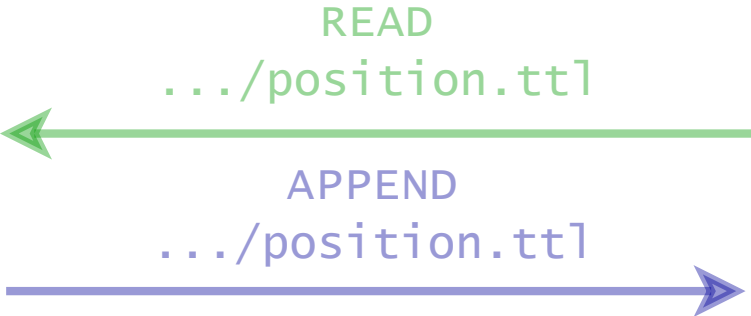
PoC Demonstrator



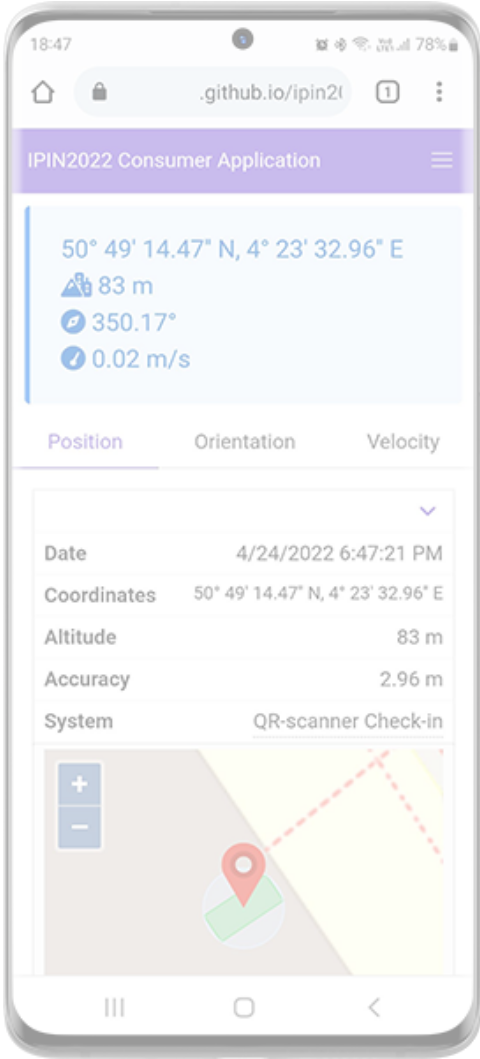
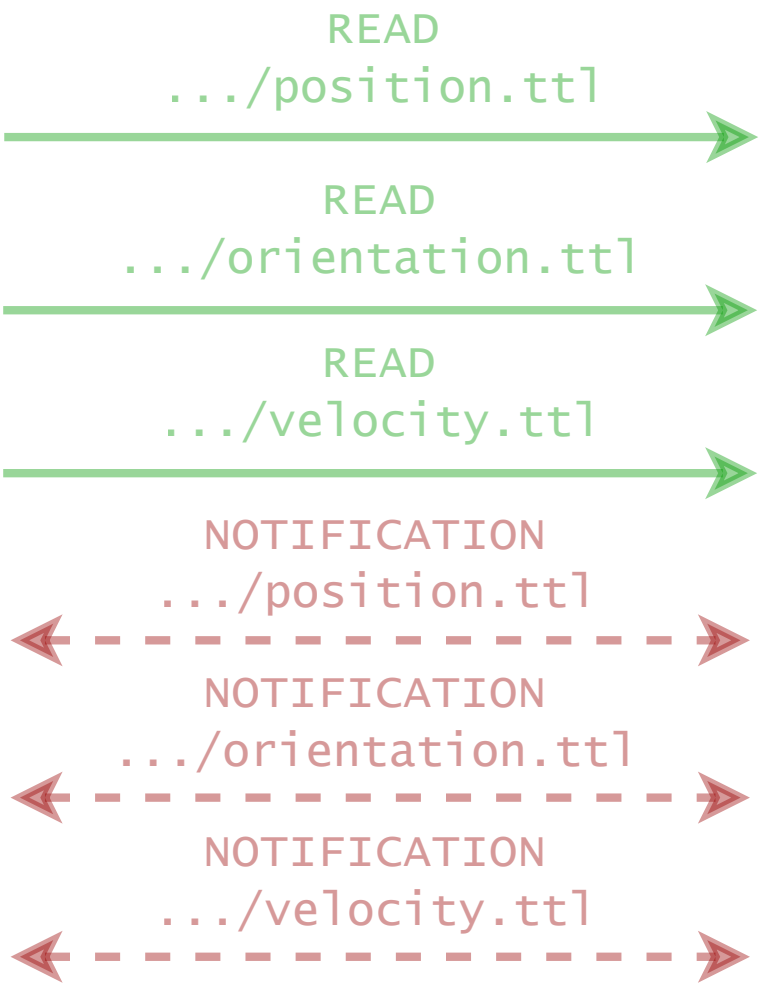
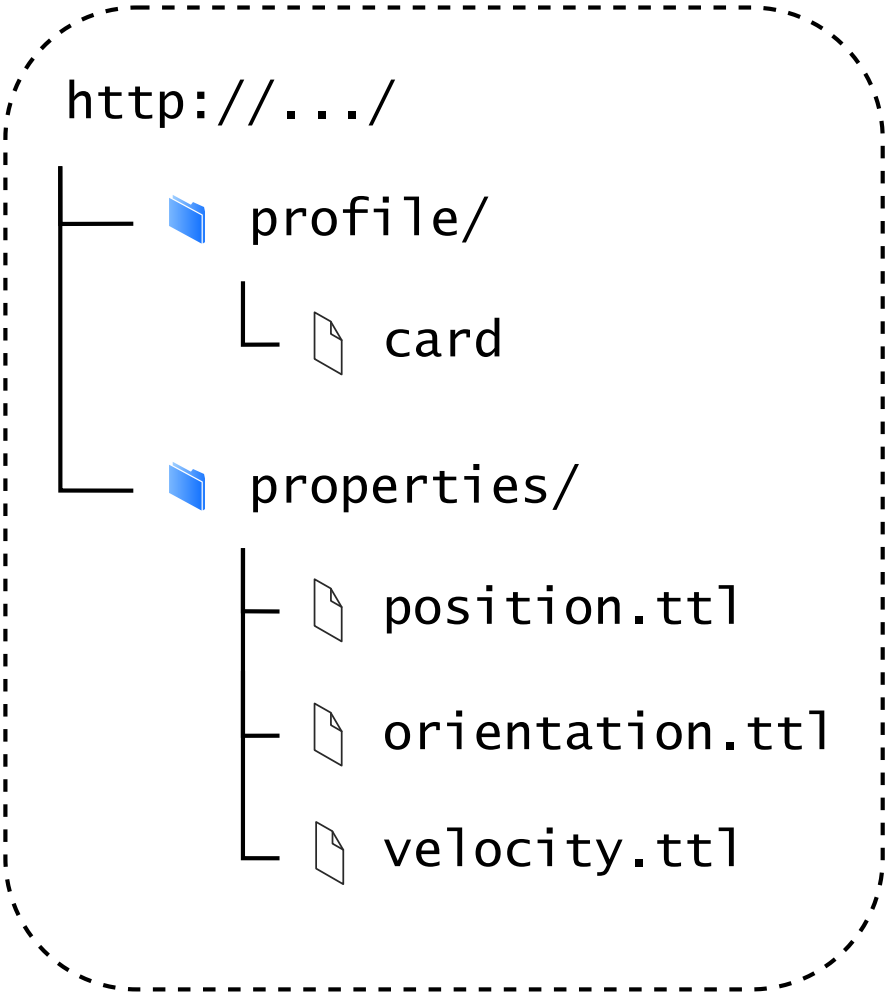
Geolocation API



QR-scanner IPS



User Pod

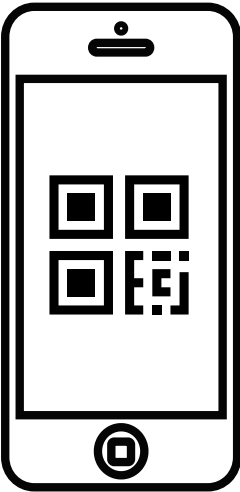
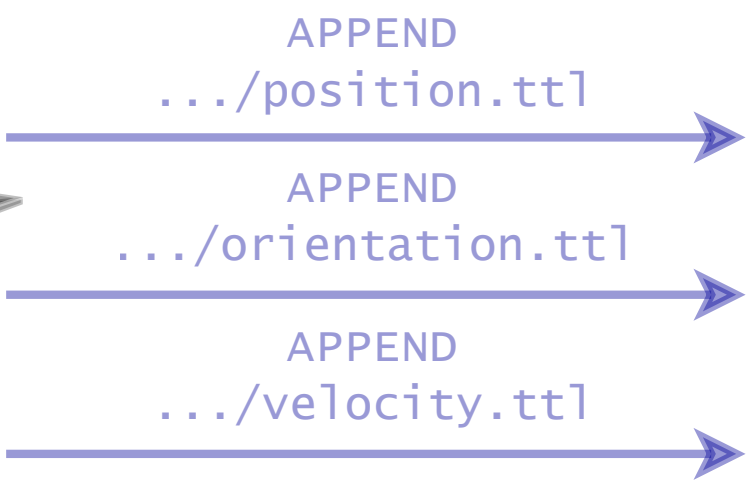
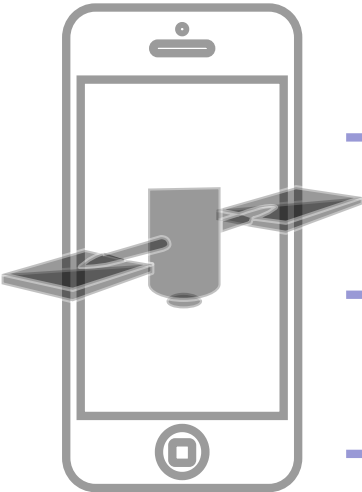


Consumer Application

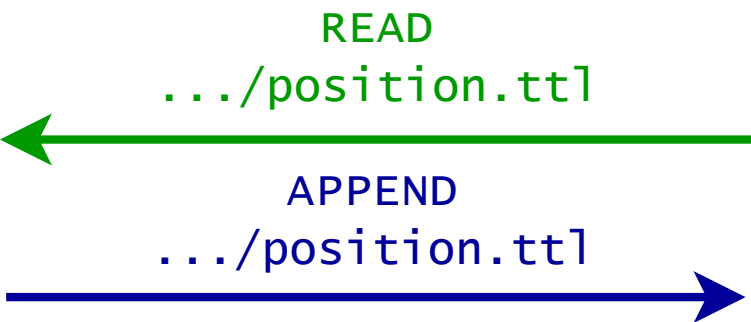
PoC Demonstrator



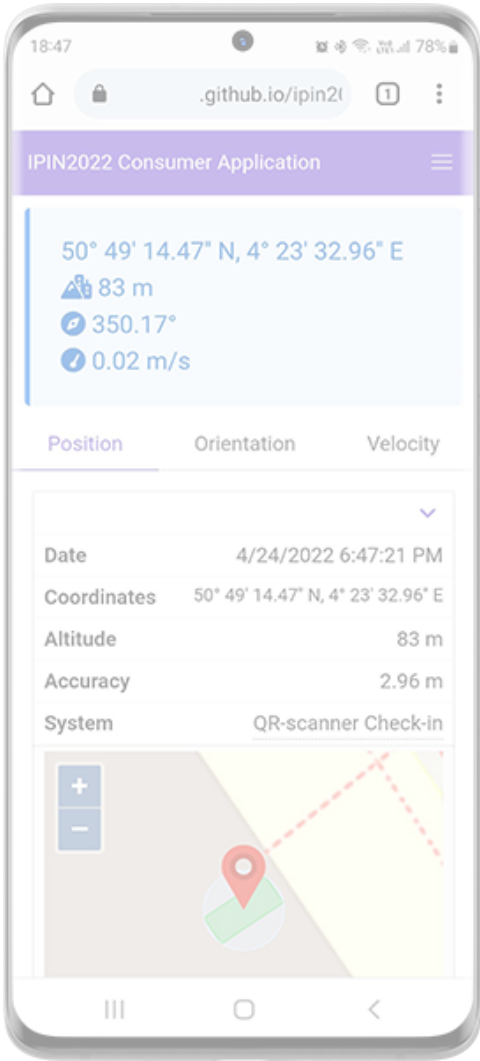
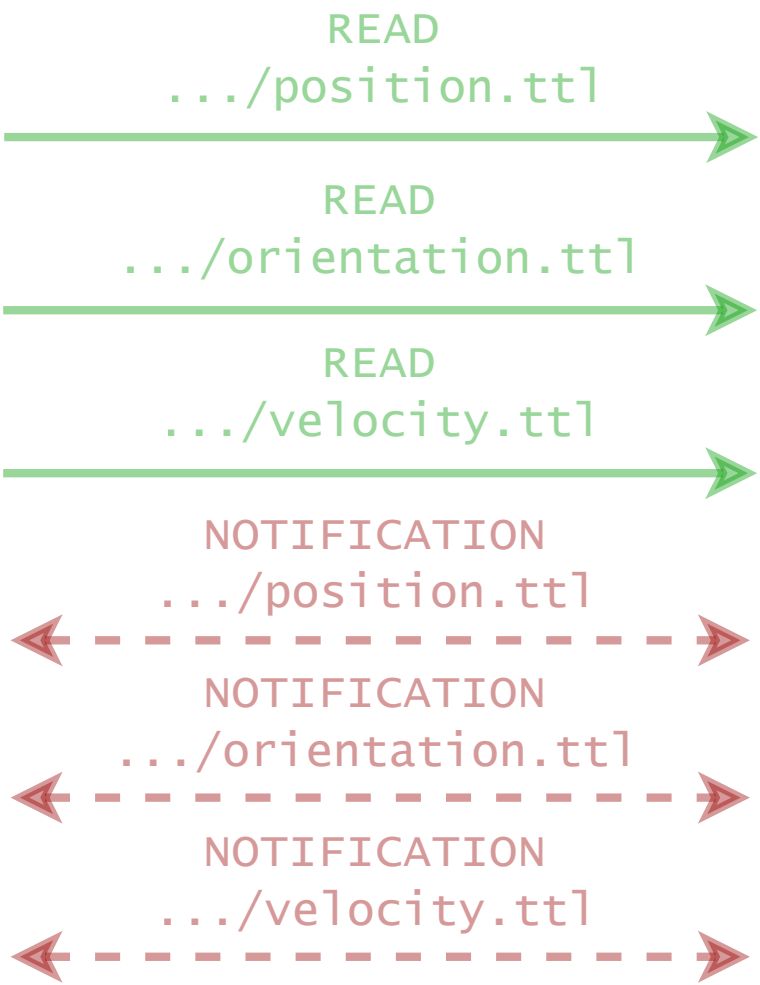
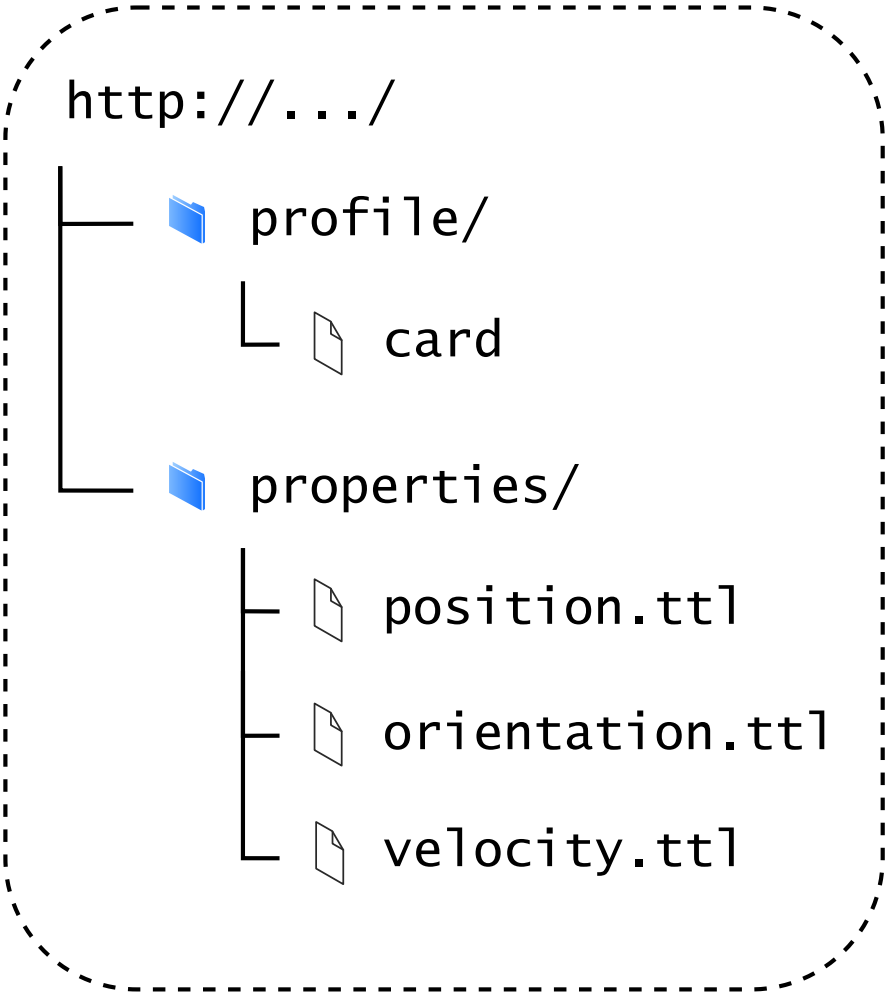
Geolocation API



QR-scanner IPS



User Pod

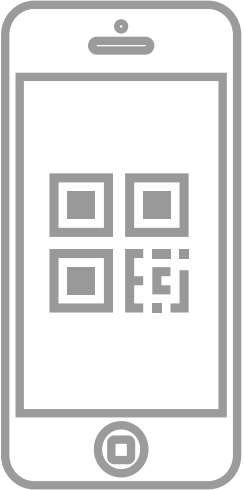
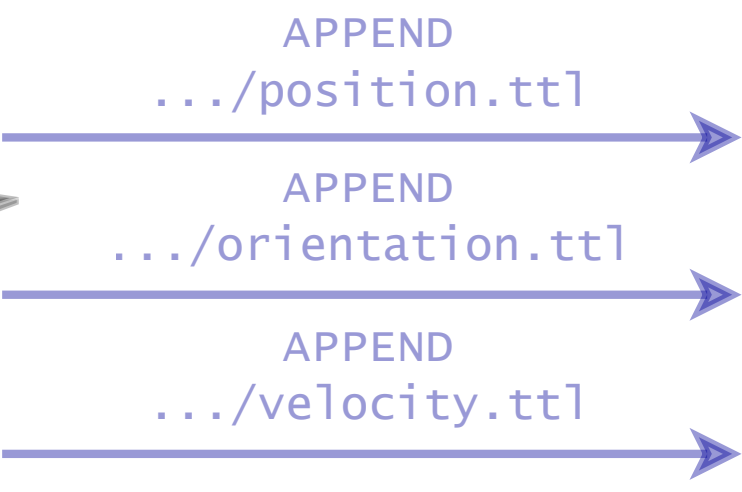
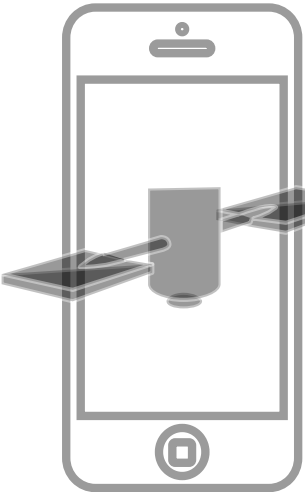


Consumer Application

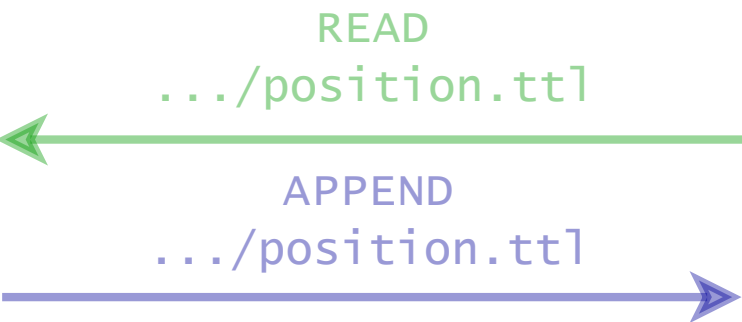
PoC Demonstrator



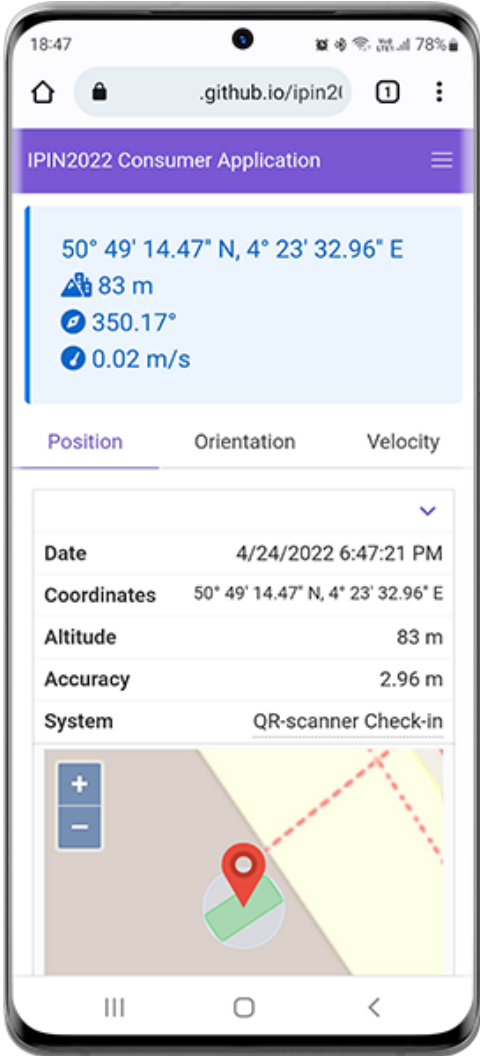
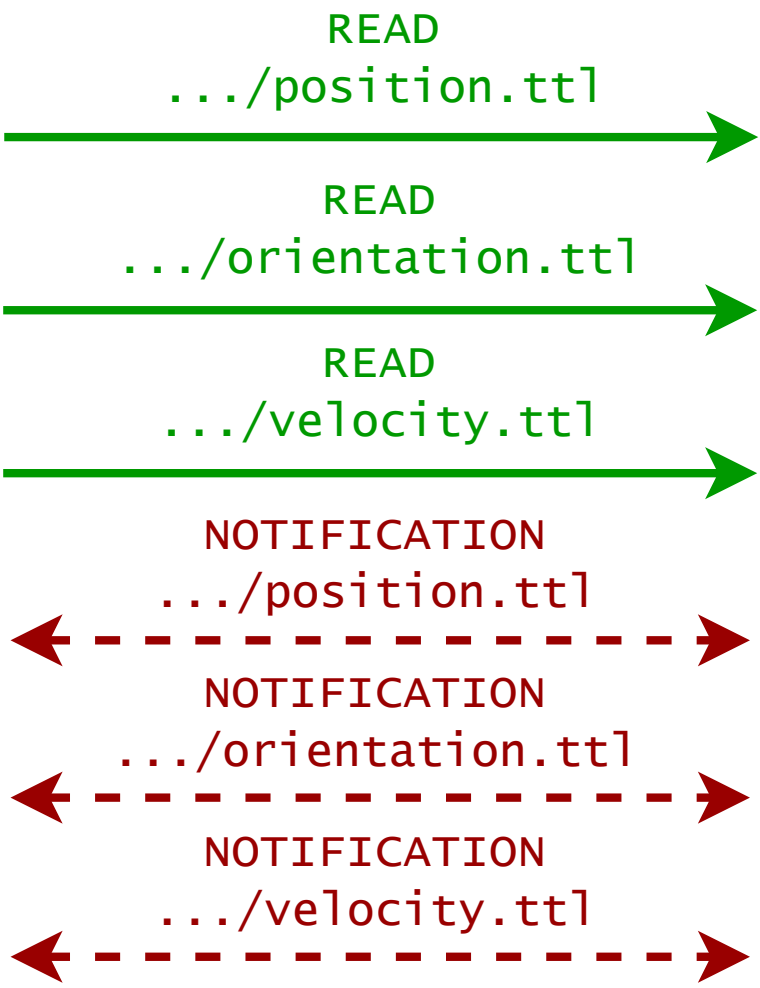
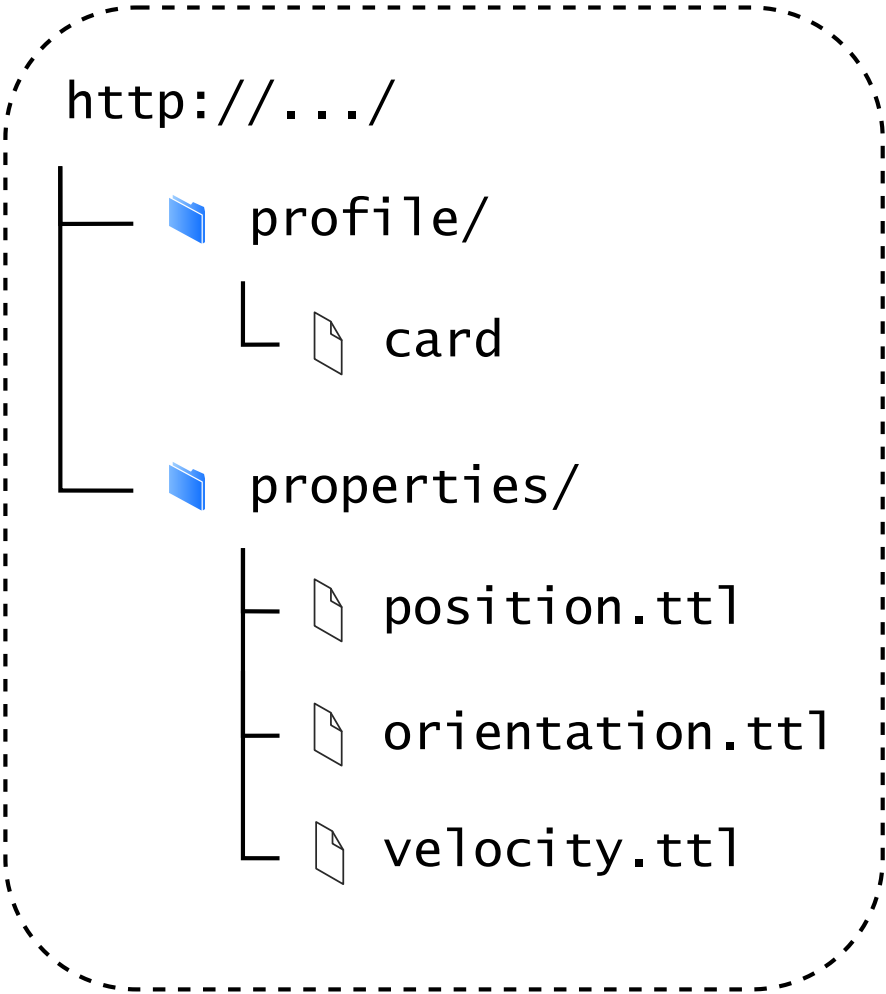
Geolocation API



QR-scanner IPS



User Pod

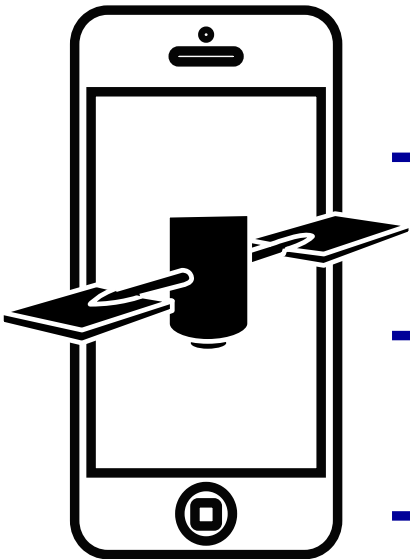


Consumer Application

PoC Demonstrator



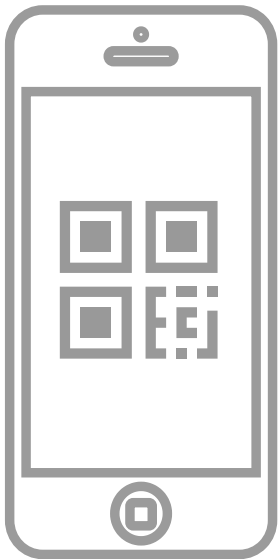
Geolocation API



APPEND
.../position.ttl

APPEND
.../orientation.ttl

APPEND
.../velocity.ttl

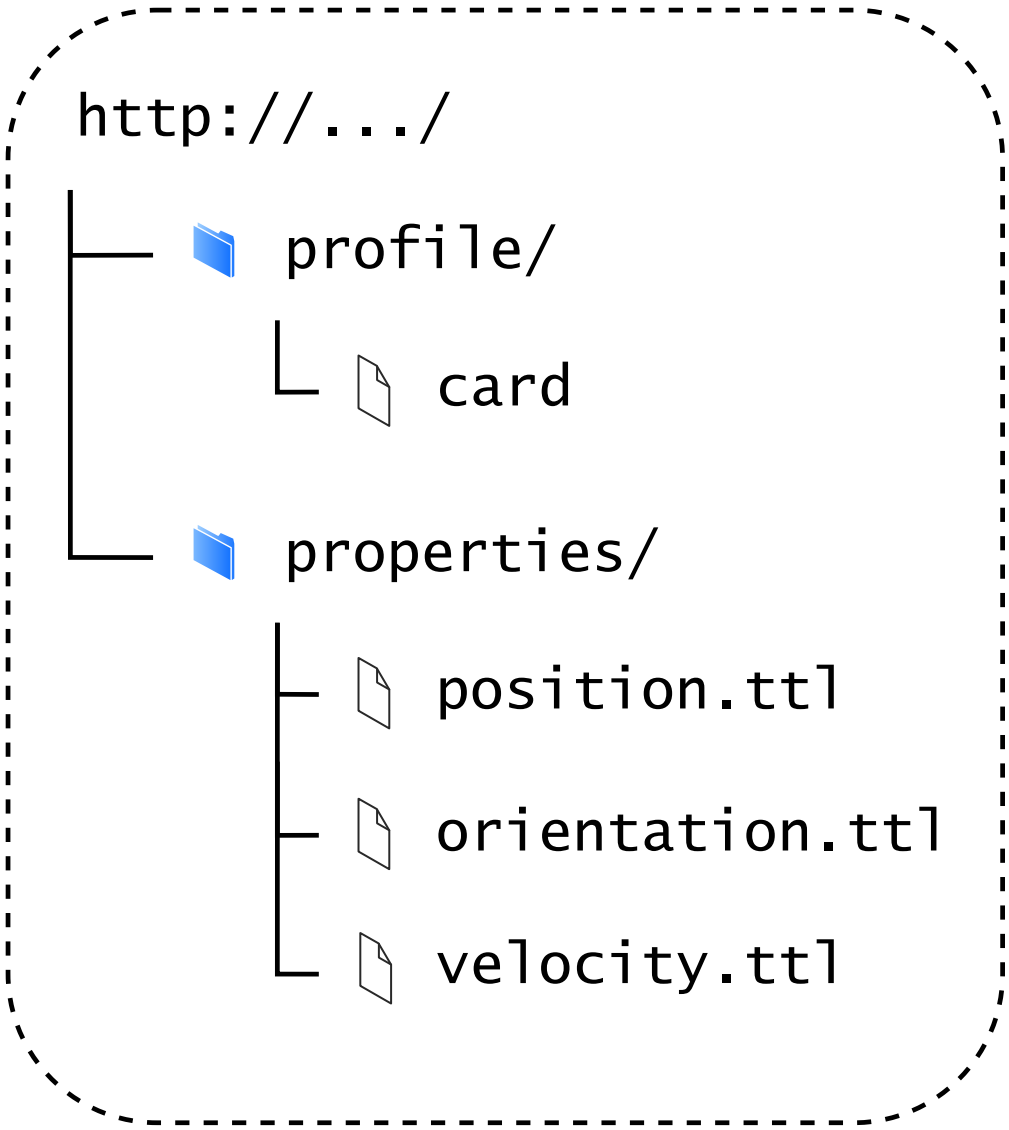


READ
.../position.ttl

APPEND
.../position.ttl

QR-scanner IPS

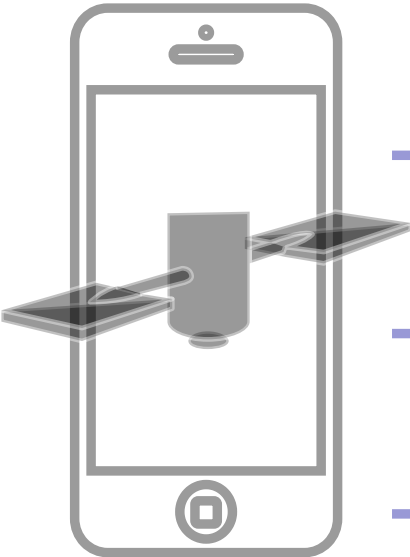
User Pod



PoC Demonstrator



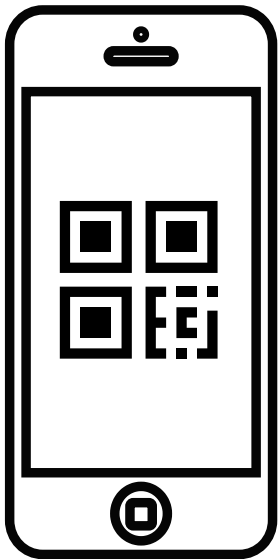
Geolocation API



APPEND
.../position.ttl

APPEND
.../orientation.ttl

APPEND
.../velocity.ttl



READ
.../position.ttl

APPEND
.../position.ttl

QR-scanner IPS

User Pod

http://.../

profile/

card

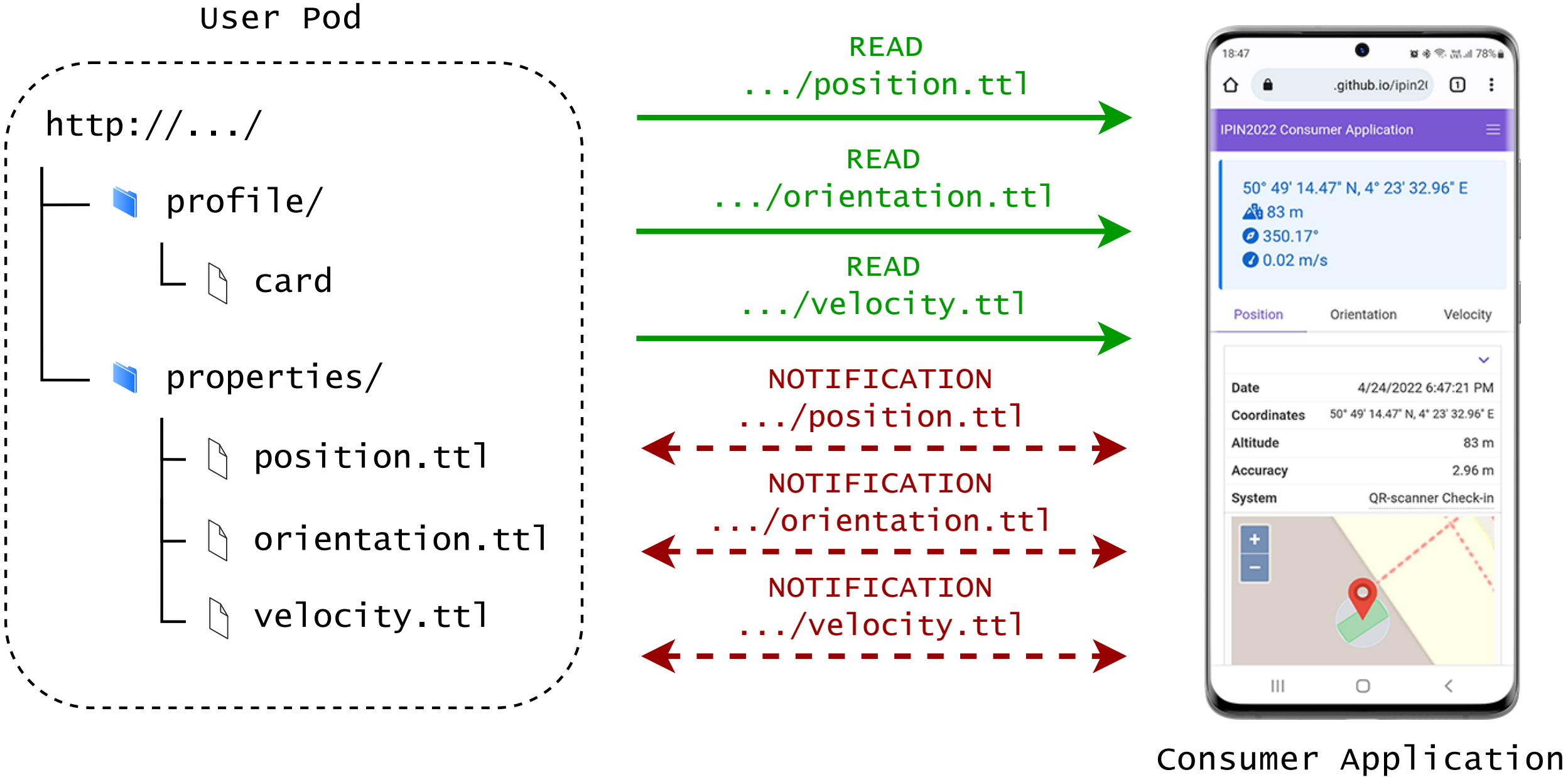
properties/

position.ttl

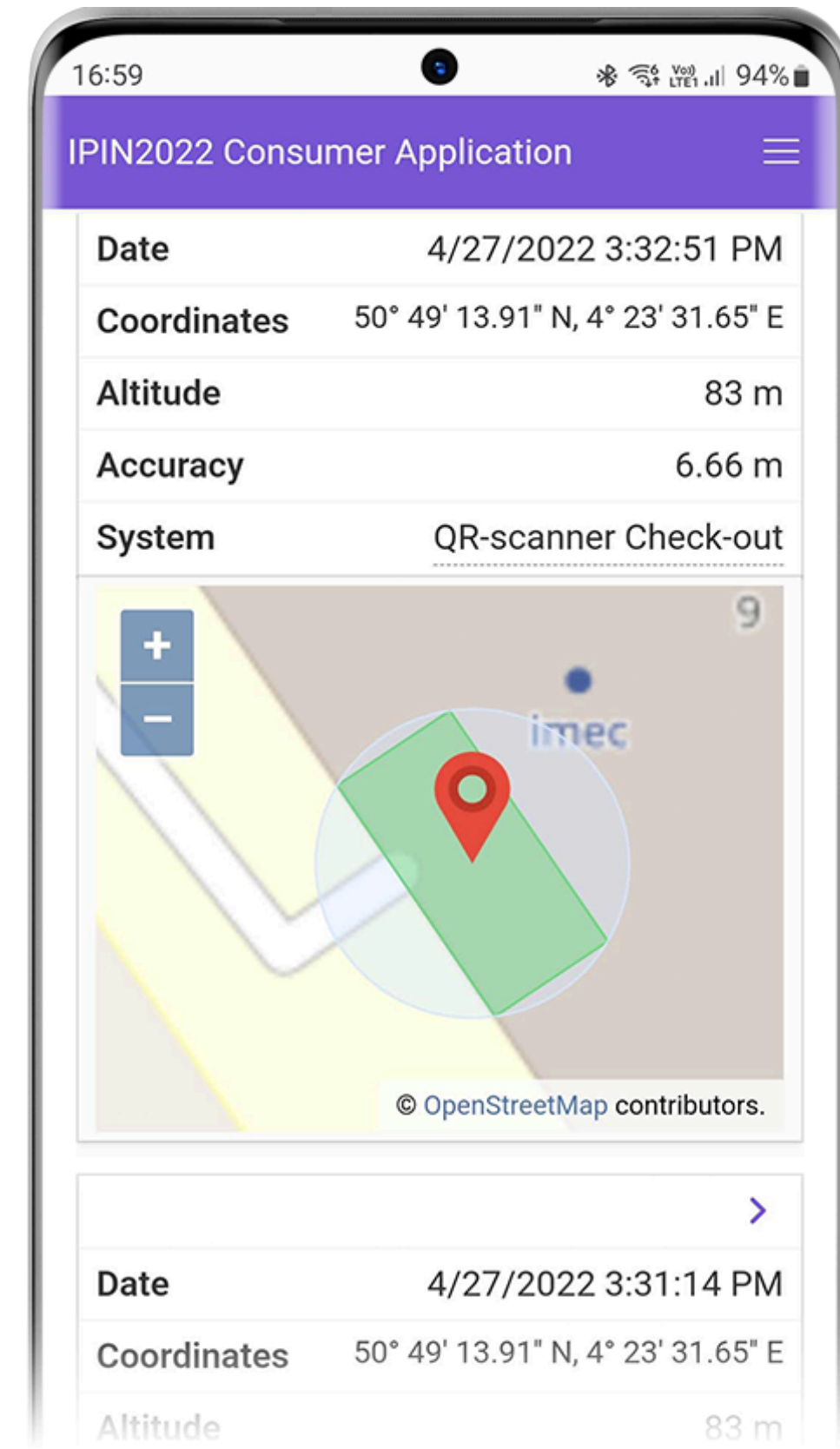
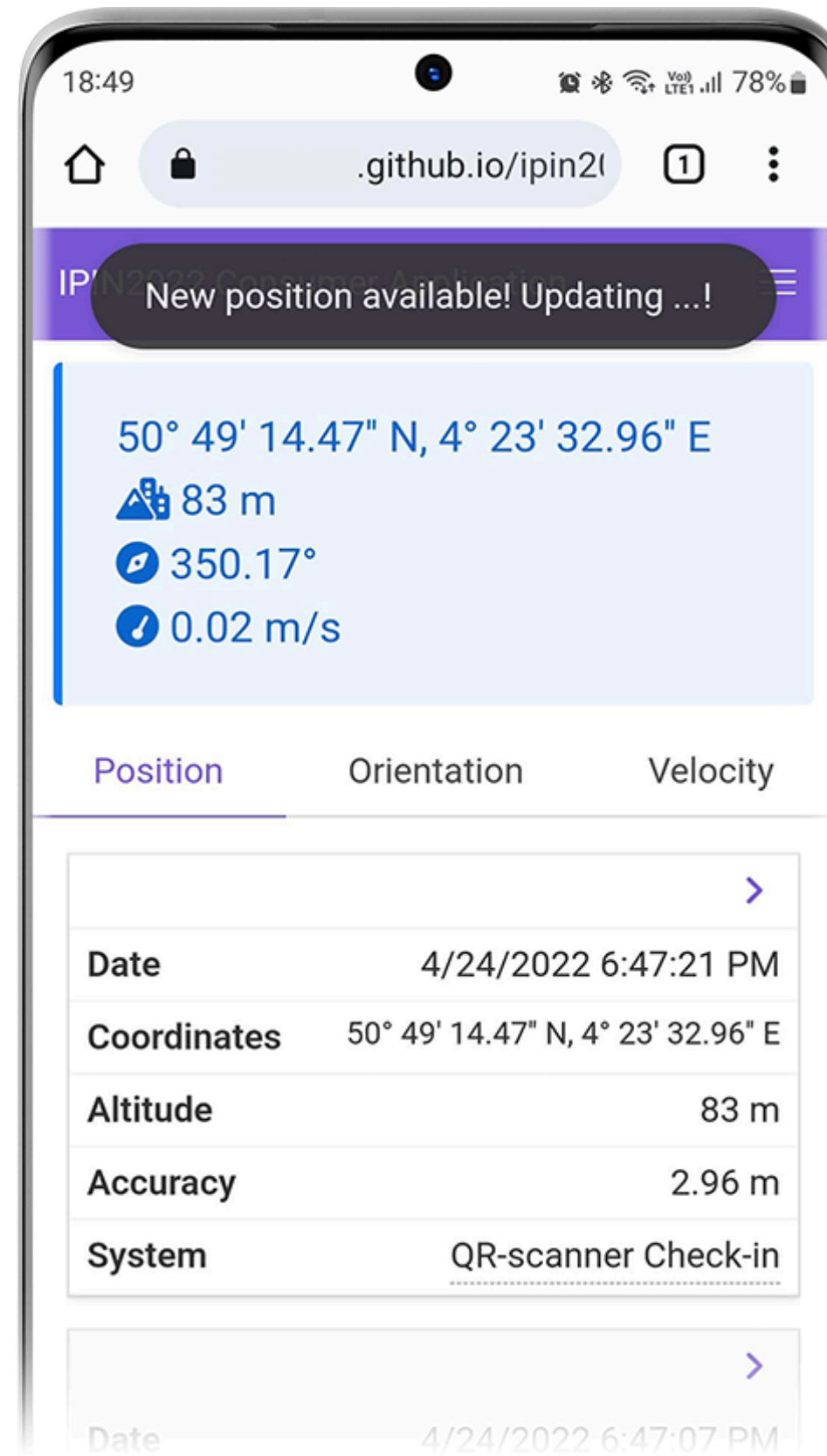
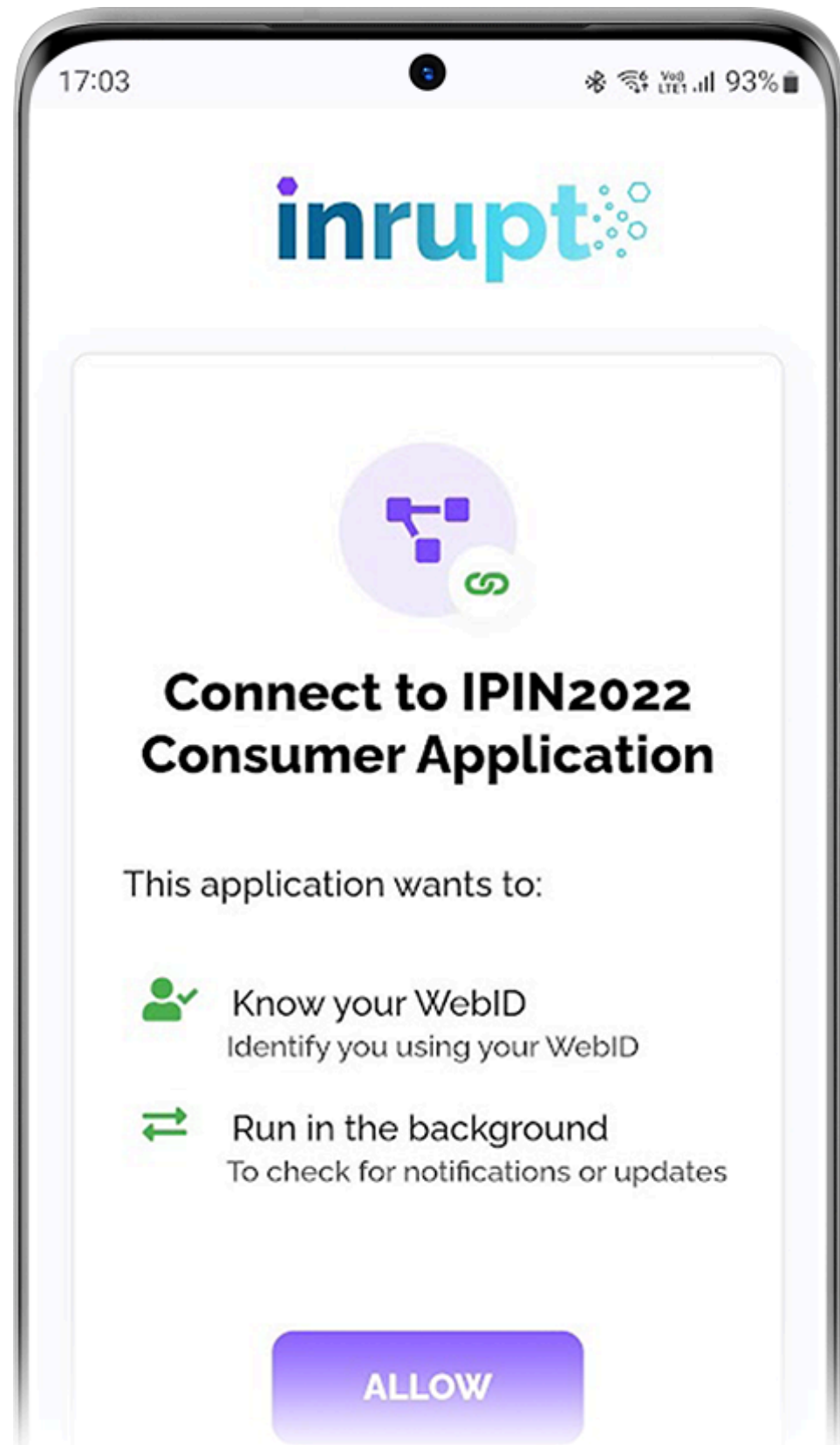
orientation.ttl

velocity.ttl

PoC Demonstrator



PoC Demonstrator



PoC Demonstrator

http://.../properties/position.ttl

```
:1660049553011
  a sosa:Observation;
  sosa:hasFeatureOfInterest profile:me;
  sosa:hasResult
    [
      a geosparql:Geometry;
      geosparql:asWKT
        "POINT Z(4.3922073 50.8206522 143.29)"^^geosparql:wktLiteral;
      geosparql:coordinateDimension 3;
      geosparql:dimension 3;
      geosparql:hasSpatialAccuracy
        [
          a qudt:QuantityValue;
          qudt:numericValue 29.363000869750977;
          qudt:unit unit:M
        ];
      geosparql:spatialDimension 3
    ];
  sosa:observedProperty <>;
  sosa:resultTime "2022-08-09T12:52:33.011Z"^^xsd:dateTime;
  sosa:usedProcedure ipin:geolocationapi.
```

PoC Demonstrator

http://.../properties/position.ttl

```
:1660049449839
  a sosa:Observation;
  sosa:hasFeatureOfInterest profile:me;
  sosa:hasResult
    [
      a geosparql:Geometry;
      ipin:inDeployment ipin:deployment_pl9_3_58;
      geosparql:asWKT
        "POINT Z(4.3922260 50.8204372 84.49)"^^geosparql:wktLiteral;
      geosparql:coordinateDimension 3;
      geosparql:dimension 3;
      geosparql:hasSpatialAccuracy
        [
          a qudt:QuantityValue;
          qudt:numericValue 3.716614723104883;
          qudt:unit unit:M
        ];
      geosparql:spatialDimension 3
    ];
  sosa:observedProperty <>;
  sosa:resultTime "2022-08-09T12:50:49.839Z"^^xsd:dateTime;
  sosa:usedProcedure ipin:qrscanner_checkin.
```

PoC Demonstrator

<http://.../properties/position.ttl>

```
:1660049553011
  a sosa:Observation;
  sosa:hasFeatureOfInterest profile:me;
  sosa:hasResult
    [
      a geosparql:Geometry;
      geosparql:asWKT
        "POINT Z(4.3922073 50.8206522 143.29)"^^geosparql:wktLiteral;
      geosparql:coordinateDimension 3;
      geosparql:dimension 3;
      geosparql:hasSpatialAccuracy
        [
          a qudt:QuantityValue;
          qudt:numericValue 29.363000869750977;
          qudt:unit unit:M
        ];
      geosparql:spatialDimension 3
    ];
  sosa:observedProperty <>;
  sosa:resultTime "2022-08-09T12:52:33.011Z"^^xsd:dateTime;
  sosa:usedProcedure ipin:geolocationapi.
```

PoC Demonstrator

```
SELECT ?posGeoJSON ?datetime ?accuracy {  
  ?profile a sosa:FeatureOfInterest ;  
    ssn:hasProperty ?property .  
  ?observation sosa:hasResult ?result ;  
    sosa:observedProperty ?property ;  
    sosa:resultTime ?datetime .  
  ?result geosparql:hasSpatialAccuracy ?spatialAccuracy ;  
    geosparql:asWKT ?posWKT .  
  BIND(geof:asGeoJSON(?posWKT) AS ?posGeoJSON)  
  ?spatialAccuracy qudt:numericValue ?value ;  
    qudt:unit ?unit .  
  OPTIONAL { ?unit qudt:conversionMultiplier ?multiplier }  
  OPTIONAL { ?unit qudt:conversionOffset ?offset }  
  BIND(COALESCE(?multiplier, 1) as ?multiplier) # Default 1  
  BIND(COALESCE(?offset, 0) as ?offset) # Default 0  
  BIND(((?value * ?multiplier) + ?offset) AS ?accuracy)  
} ORDER BY DESC(?datetime) LIMIT 20
```

Conclusion and Future Work

- ▶ Novel architecture for **decentralising** location **data**
 - **User** remains **in control** of their data
- ▶ **Interoperability** between systems and applications
 - **Handover** of tracking between systems
 - Single **navigation** application
 - High-level decision fusion
- ▶ **Vocabulary extensible** with additional semantics

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