CHALLENGES OF PUBLISHING IOT DATA

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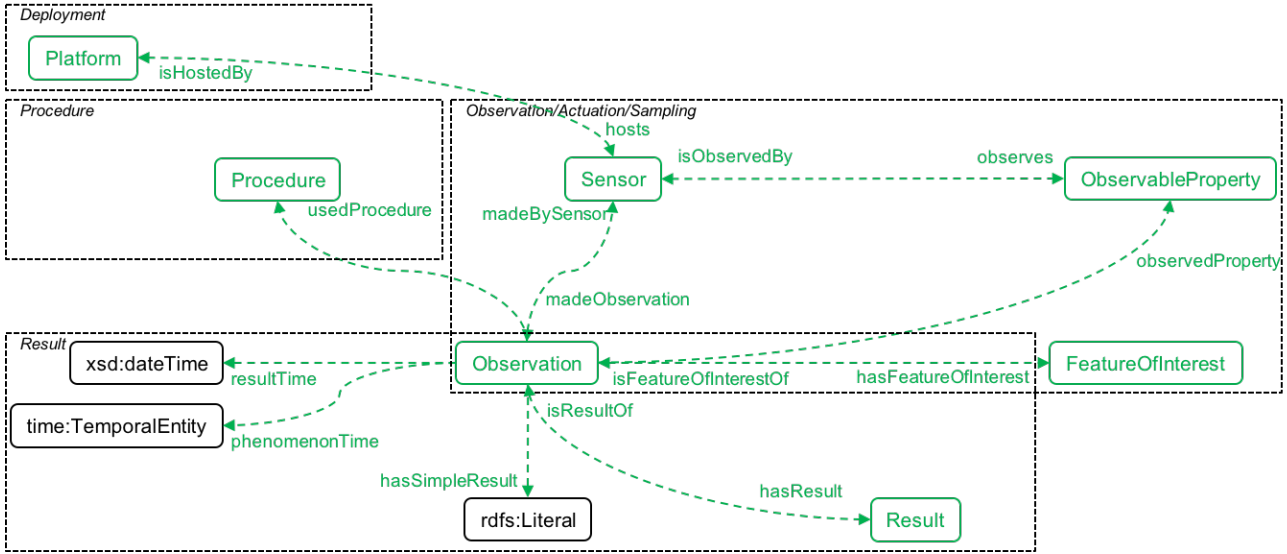
SAVING MEASUREMENTS
SSN AND SOSA

- SOSA: Sensors, Observations, Actuation, Sampling (observation perspective)

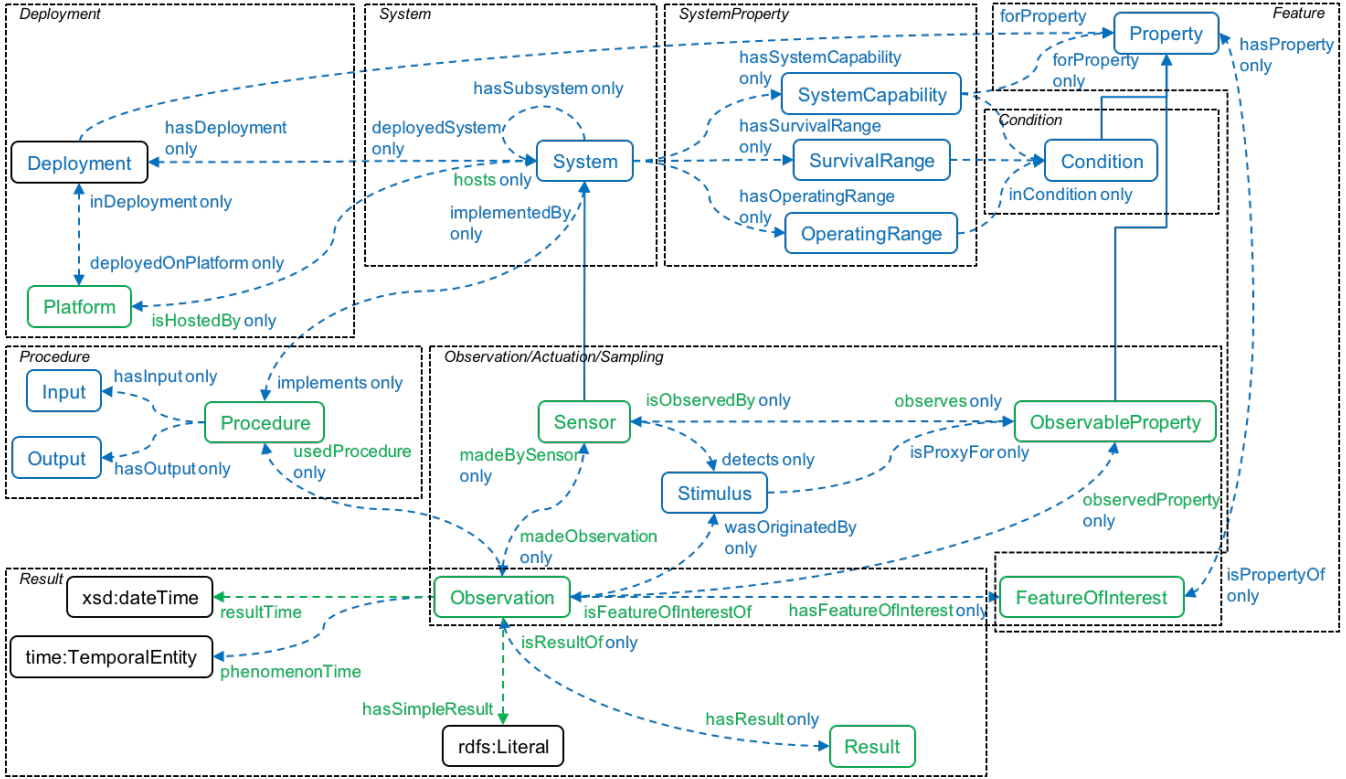


Semantic Sensor Network Ontology (w3.org)

SAVING MEASUREMENTS

SSN AND SOSA

- SSN: Semantic Sensor Network (observation perspective)



[Semantic Sensor Network Ontology (w3.org)]

EXAMPLE
IPHONE BAROMETER

```
# The barometric readings from a Bosch Sensortec BMP282 sensor in an Apple IPhone 7
# observed on June 6 2017 using only the SOSA core for modelling.

<earthAtmosphere> rdf:type sosa:FeatureOfInterest ;
  rdfs:label "Atmosphere of Earth"@en .


# An iPhone 7 as the Platform that hosts several sensors,
# among others the Bosch Sensortec BMP282 atmospheric pressure sensor.

<iphone7/35-207306-844818-0> a sosa:Platform ;
  rdfs:label "IPhone 7 - IMEI 35-207306-844818-0"@en ;
  rdfs:comment "IPhone 7 - IMEI 35-207306-844818-0 - John Doe"@en ;
  sosa:hosts <sensor/35-207306-844818-0/BMP282> .

<sensor/35-207306-844818-0/BMP282> rdf:type sosa:Sensor ;
  rdfs:label "Bosch Sensortec BMP282"@en ;
  sosa:observes <sensor/35-207306-844818-0/BMP282/atmosphericPressure> .
```

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EXAMPLES
IPHONE BAROMETER OBSERVATION

```
# An observation made by the BMP282 atmospheric pressure sensor.

<Observation/346344> rdf:type sosa:Observation ;
  sosa:observedProperty <sensor/35-207306-844818-0/BMP282/atmosphericPressure> ;
  sosa:hasFeatureOfInterest  <earthAtmosphere> ;
  sosa:madeBySensor <sensor/35-207306-844818-0/BMP282> ;
  sosa:hasSimpleResult "1021.45 hPa"^^cdt:ucum ;
  sosa:resultTime "2017-06-06T12:36:12Z"^^xsd:dateTime .


# Another observation made a second later by the BMP282 atmospheric pressure sensor
# using the QUDT Ontology for the Units of Measurement
# and the Time Ontology for the instant.

<Observation/346345> rdf:type sosa:Observation ;
  sosa:observedProperty <sensor/35-207306-844818-0/BMP282/atmosphericPressure> ;
  sosa:hasFeatureOfInterest  <earthAtmosphere> ;
  sosa:madeBySensor <sensor/35-207306-844818-0/BMP282> ;
  sosa:hasResult [
    rdf:type qudt-1-1:QuantityValue ;
    qudt-1-1:numericValue "101936"^^xsd:double ;
    qudt-1-1:unit qudt-unit-1-1:Pascal ] ;
  sosa:resultTime [
    rdf:type time:Instant ;
    time:inXSDDateTimeStamp "2017-06-06T12:36:13+00:00"^^xsd:dateTimeStamp ] .
```

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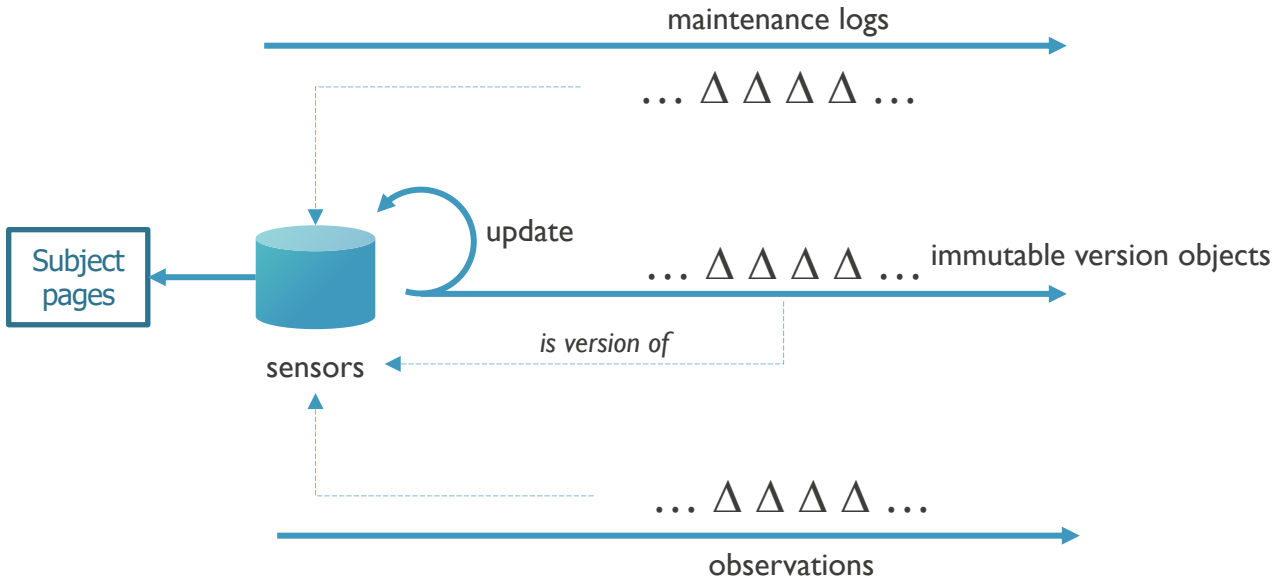
CONTEXT MATTERS

Making measurements useful

- Observations may show sudden changes in atmospheric pressure
- What is going on …
  - Did the weather change?
  - Did the sensor move?
- Keeping track of context is important
  - Sensor properties may change
  - External factors may influence the sensor behavior (maintenance, replacement)
  - …
- But … these are also just timeseries!

CHALLENGES OF IOT

CONTEXT VERSUS MEASUREMENTS

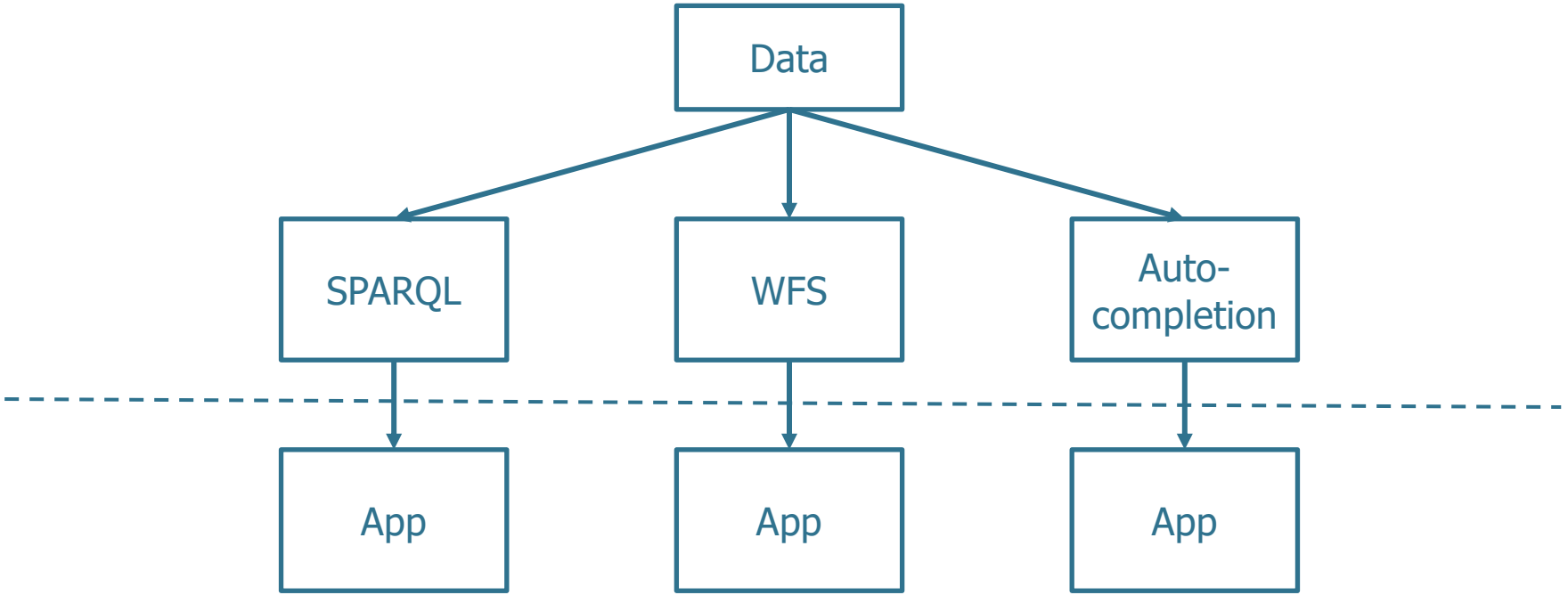


CHALLENGES OF IOT
DATA STORAGE AND PUBLISHING

- Storing IoT timeseries, plenty of options
  - MySQL database
  - Influx DB
  - …
- Publishing IoT timeseries
  - Interface?
  - Scalability?
  - Retention?
  - …

CHALLENGES OF IOT

MAINTENANCE & SCALABILITY HELL



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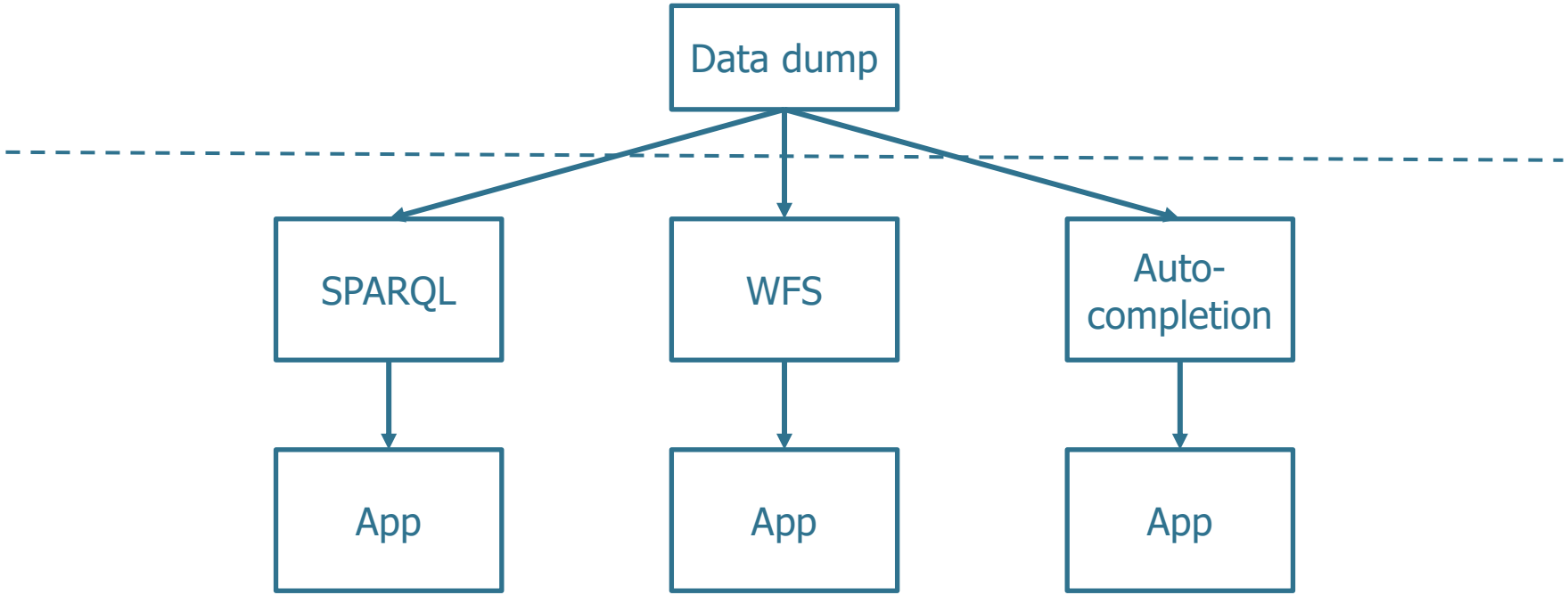
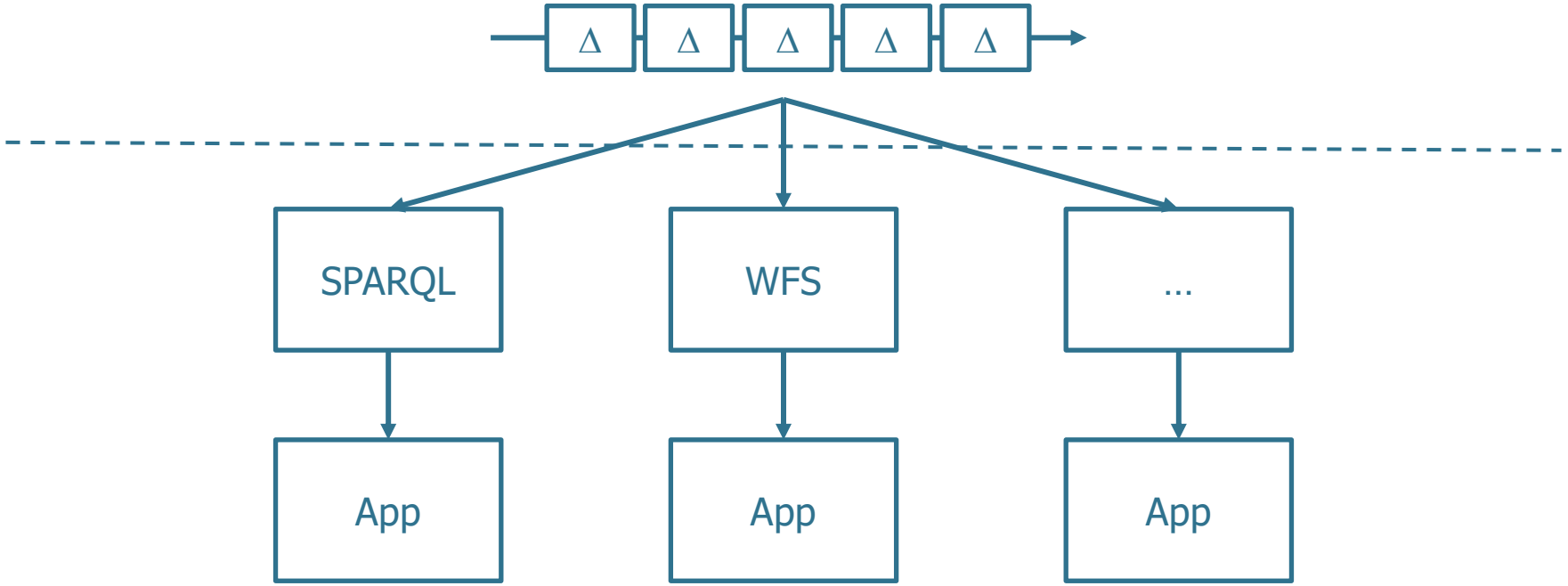
CHALLENGES OF IOT

REPLICATION HELL



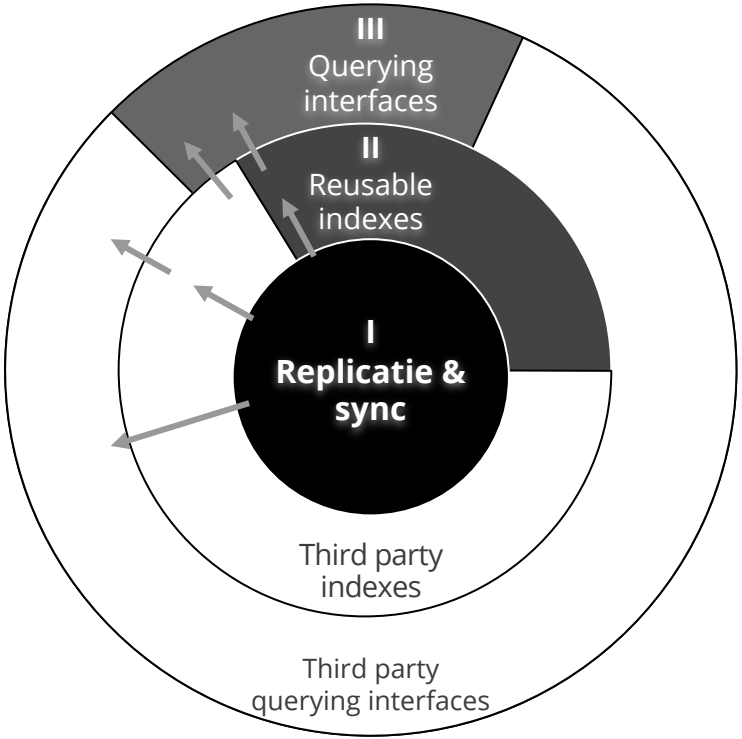
LINKED DATA EVENT STREAMS

STAYING IN SYNC



LINKED DATA EVENT STREAMS
PRIORITIES OF PUBLISHING DATA

- Data publishers focus on efficient scalable publishing, allowing consumers to stay in sync
- Consumers can replicate and stay in sync efficiently via fragment-based syncing
- Alternative fragmenting by publishers or intermediaries supports other use cases (e.g., time-based, geo-based, …)
- Indexes can be combined/queried for use in apps without burdening the publisher
- Retention at publisher side is advertised



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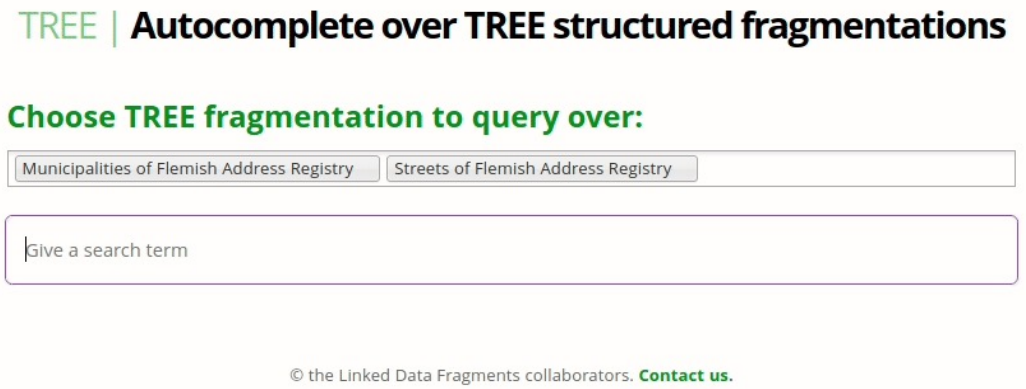
EXAMPLE: ADDRESS REGISTRY

HTTPS://SMARTDATA.DEV-VLAANDEREN.BE/BASE/



- LDES published at the source
  - Communities
  - Street names
- Third party indexes on name (substring fragmentation/index)
- Metadata catalog makes fragmentation discoverable
- Client queries all fragments

Autocomplete demo (treecg.github.io)

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Vlaamse Smart Data Space

Why?

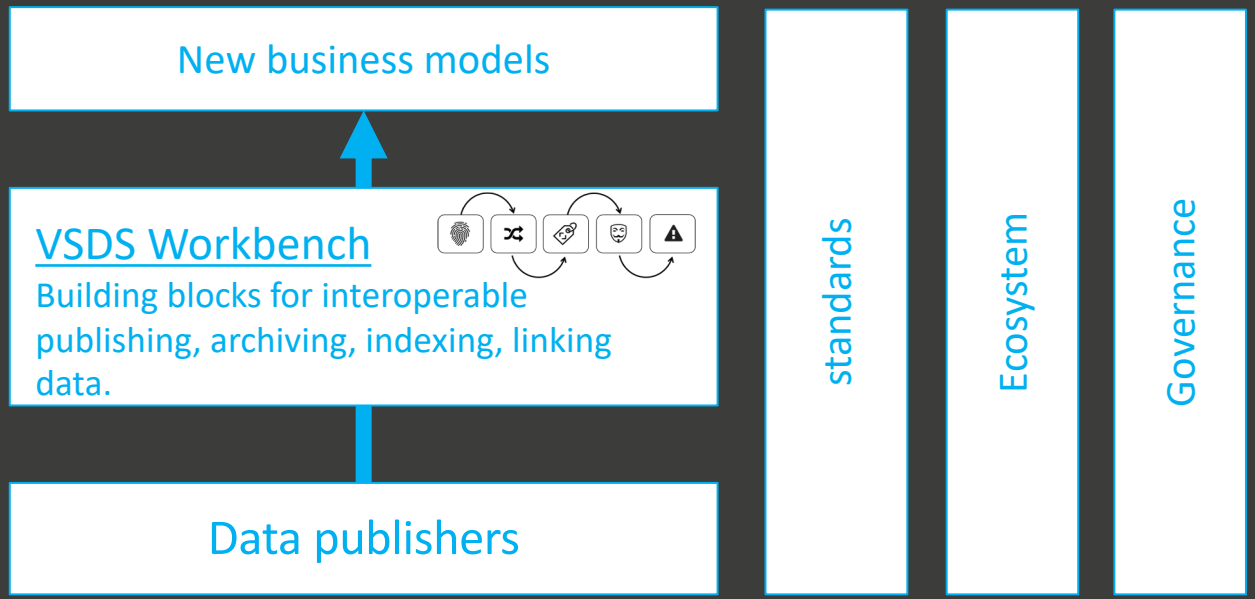
Data gets stuck in silos. Different kinds of lock-ins hamper innovation and business value:

- *Vendor lock-in,*
- *Project lock-in,*
- *Domein lock-in,*
- *Technische lock-in.*

Key: **interoperability**

Leveraging smart data for sustainable growth of the Flemish data economy

4 Pillars



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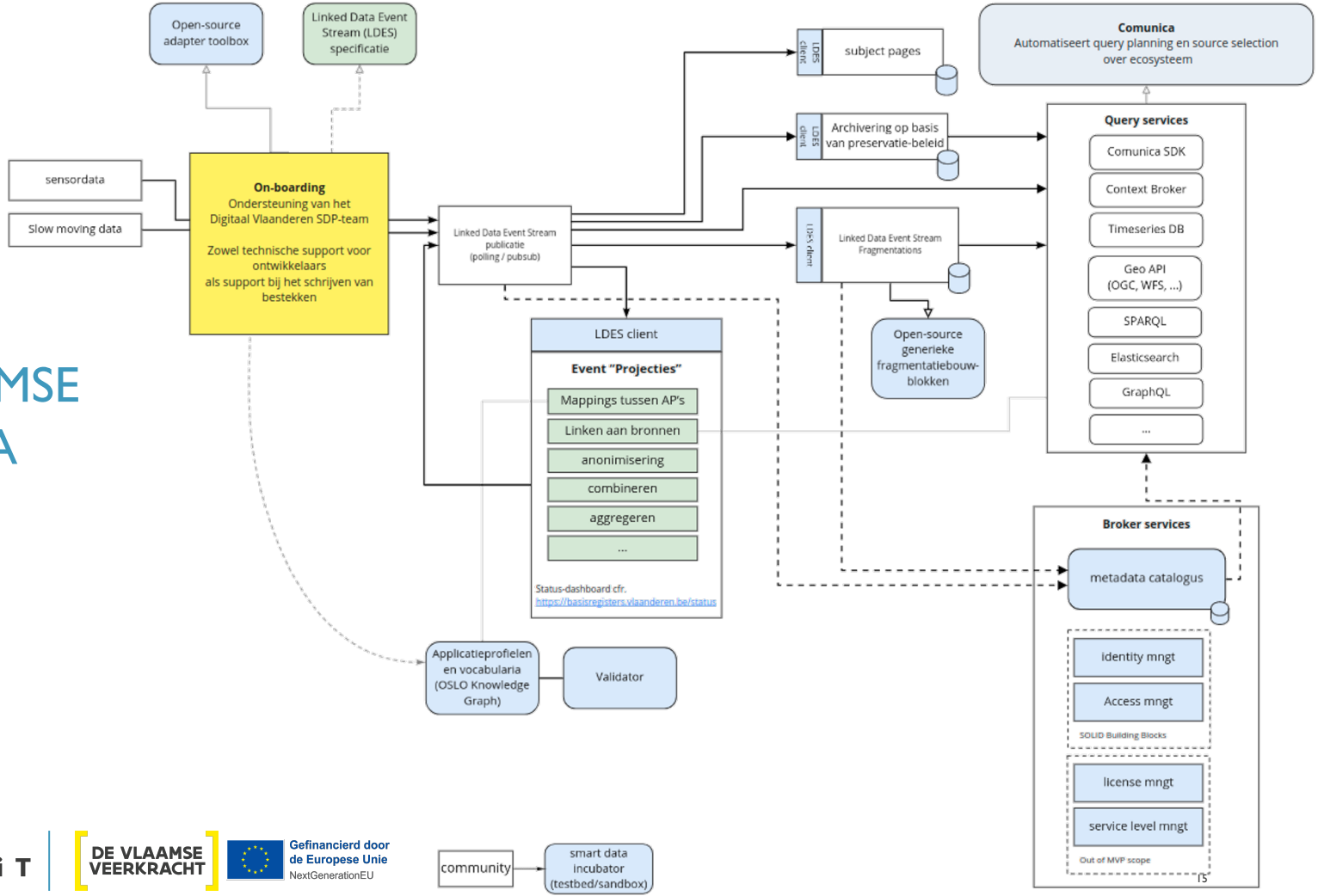
VSDS: VLAAMSE SMART DATA SPACE



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‘BUT WAIT, WHAT’S A DATA SPACE REALLY ABOUT?

BUILDING BLOCKS AND AGREEMENTS

Data spaces are communities that agree on converging to using shared agreements in the form of

- Meta-data publishing
- Data transfer protocols & service standards
- Schemas and semantics
- Data licensing
- Authentication and access control
- Persistent identifier strategy

In addition to agreements, a data space may offer

- Data publishing & processing components
- Run-time environment(s) for running the components
- Community support & tools for data onboarding, software contributions, service development, …

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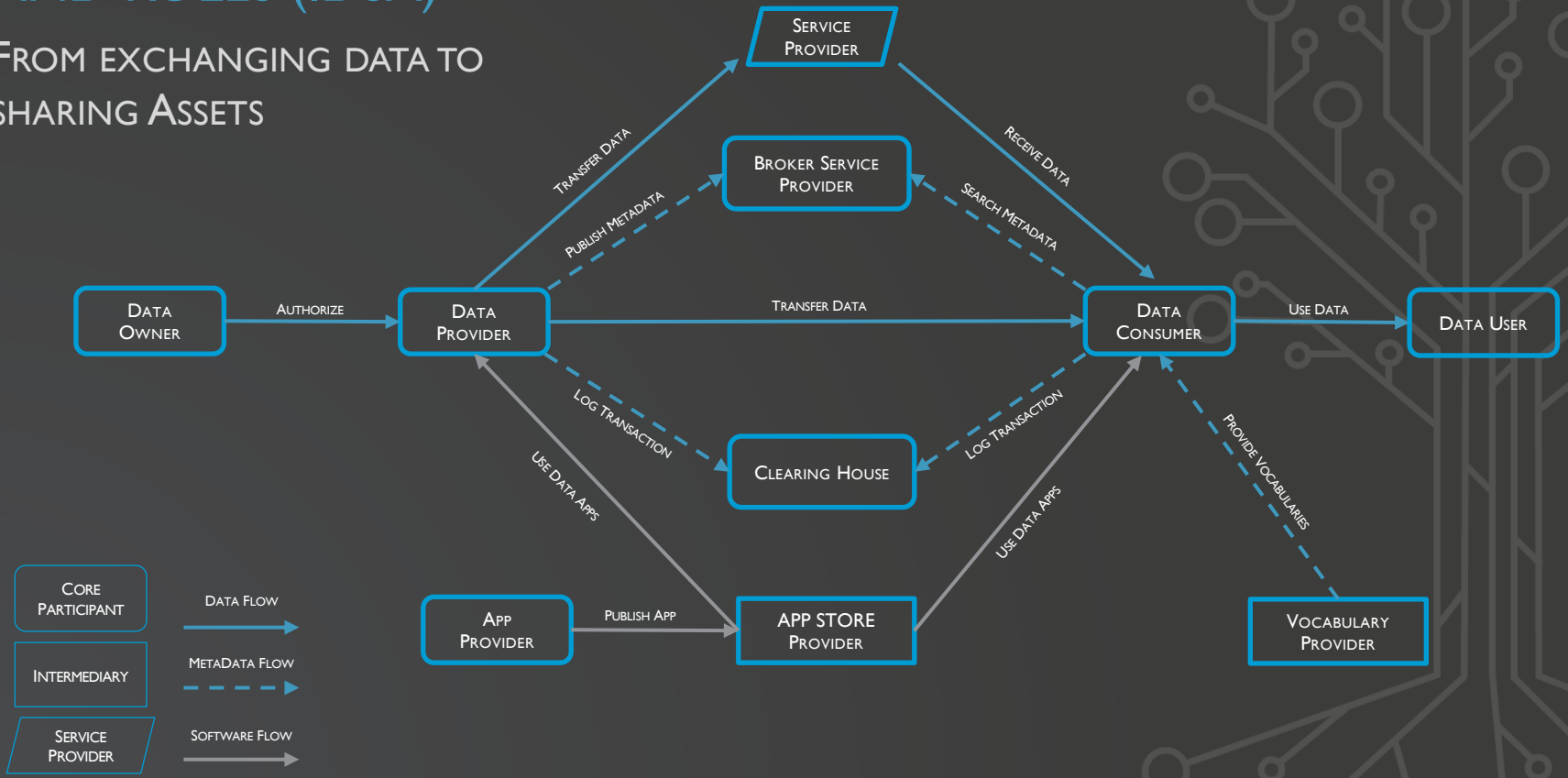
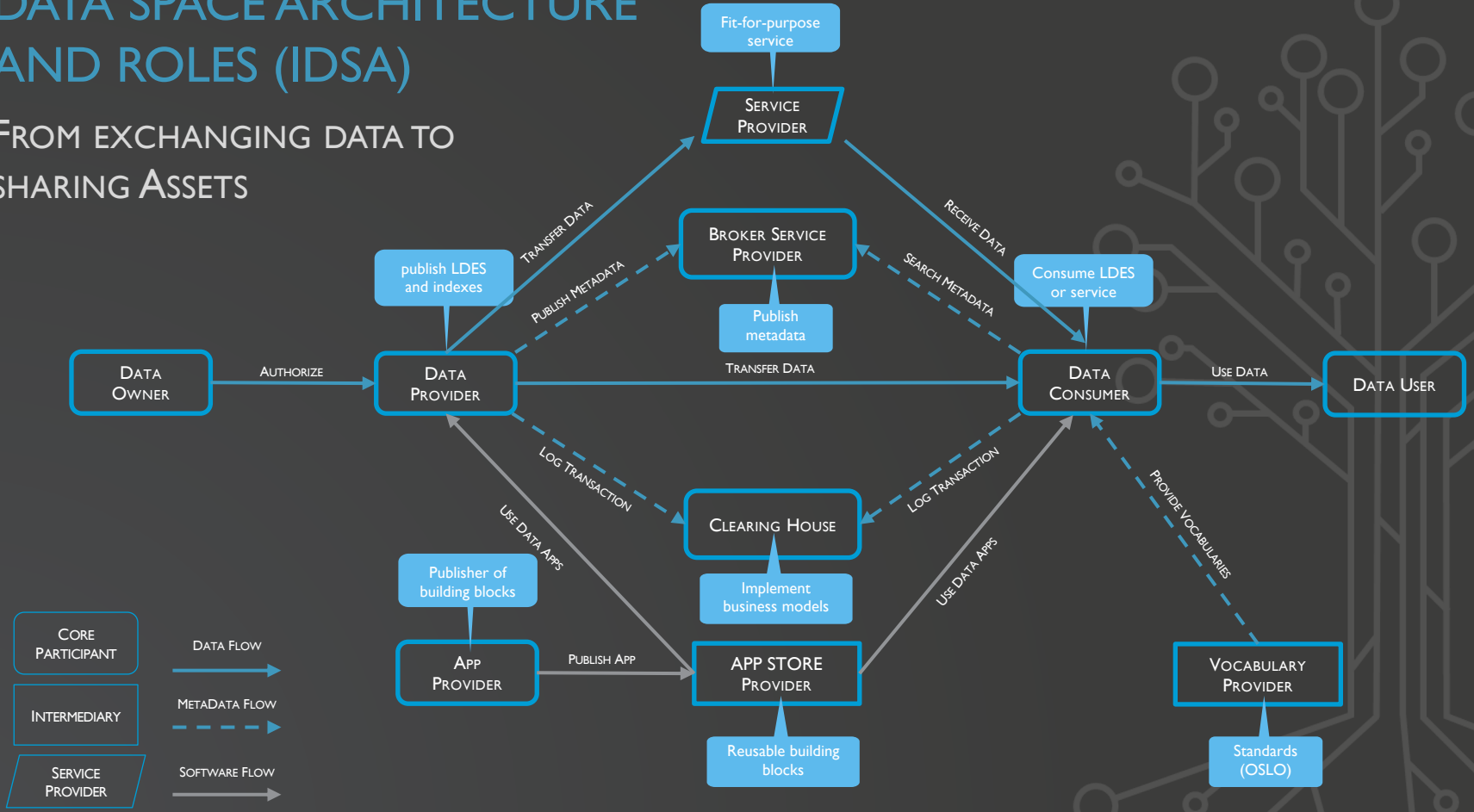
DATA SPACE ARCHITECTURE AND ROLES (IDSA)

FROM EXCHANGING DATA TO SHARING ASSETS



DATA SPACE ARCHITECTURE AND ROLES (IDSA)

FROM EXCHANGING DATA TO SHARING ASSETS



MORE INFORMATION
POINTER AND REFERENCES

- Vlaamse Sensor Data Space: Vlaamse Sensor Data Space | Vlaanderen.be
- Linked Data Event Streams
  - Specification: SEMICeu/LinkedDataEventStreams: The Linked Data Event Streams specification (github.com)
  - Online course: https://academy.europa.eu/courses/publishing-data-with-linked-data-event-streams-why-and-how
  - In-depth article: Publishing Linked Data Event Streams (thepieterdc.github.io)
- Semantic Sensor Ontology: Semantic Sensor Network Ontology (w3.org)
- Imec smart city whitepaper: Download white paper on Smart City and Smart Architecture | imec City of Things

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