14TH ITU ACADEMIC CONFERENCE

ITU KALEIDOSCOPE
ACCRA 2022

The knowledge graph as interoperability foundation for Augmented Reality

7-9 December 2022
Accra, Ghana

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Session 2 – Augmented reality systems: design and implementation

Paper S2.3

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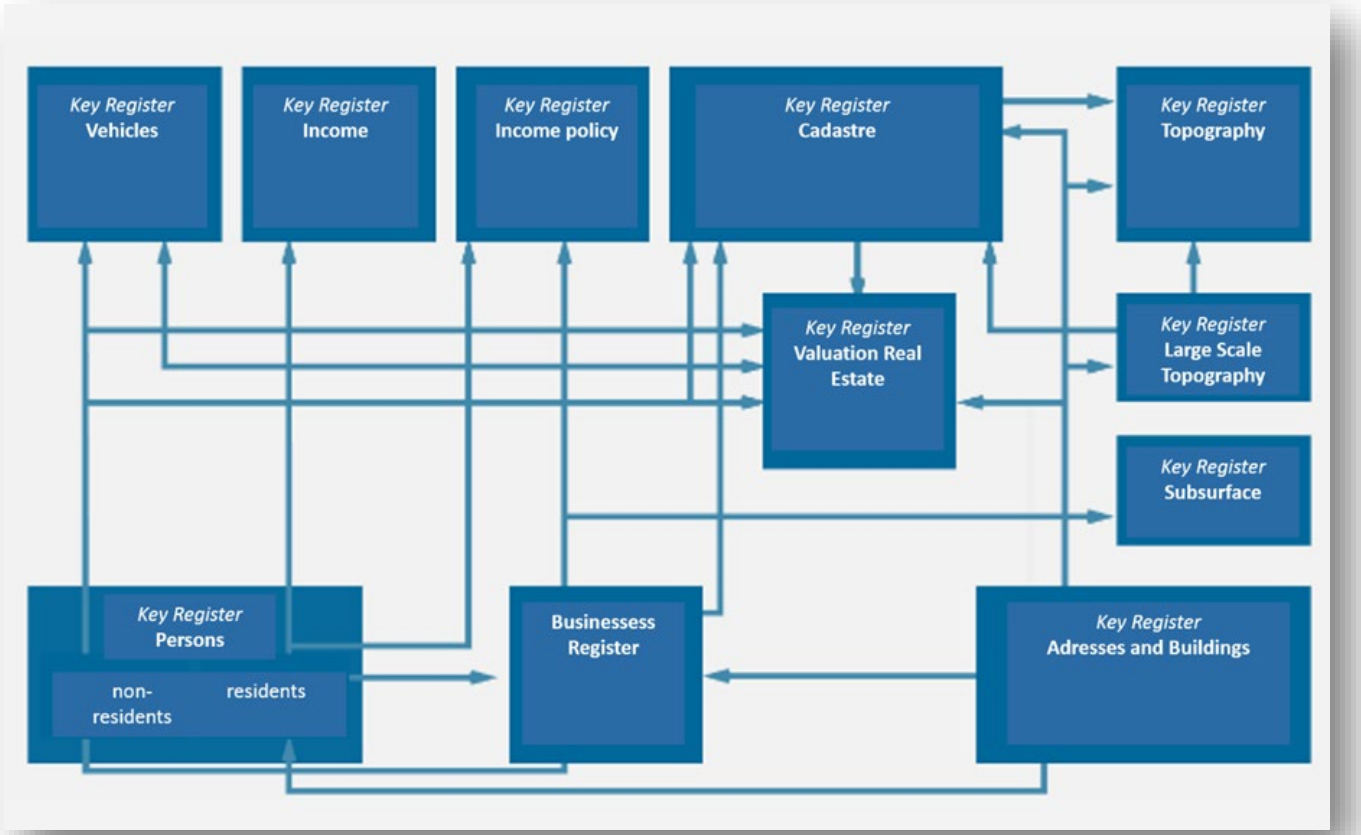
Kadaster
Dutch Land Registry and Mapping Agency

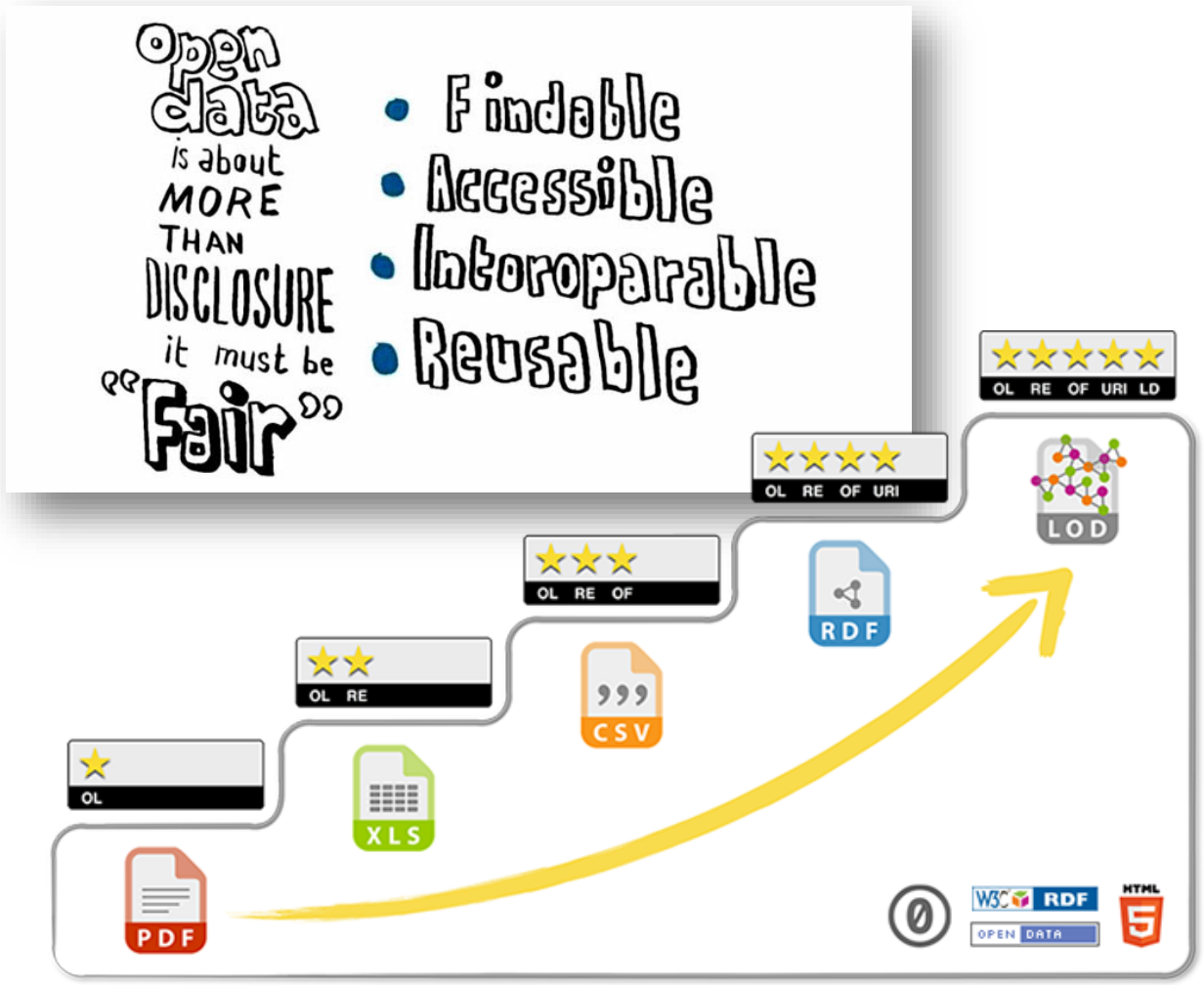
- **Role:** National agency tasked with the maintenance and publication of several key registers.
- Spatial Data Infrastructure (SDI) developments in the Netherlands are strongly related to the key registers using in e-government policy
- Organisation is based on the an interrelated (although not automatically connected) system.



Data per Key Register

From Data Siloes to Linked Data

- Data siloes are a consequence of needing to organize information.
- A need for more certainty and more reuse of data calls for integration and ease of use.
- An integration of data needs to be explicitly modelled (with **semantics**), include **provenance**, published (using **open standards**) and easy to use (provide **metadata**).
- Our data should, therefore, be:
  - Findable, accessible, interoperable and reusable (FAIR)
  - 5-star data



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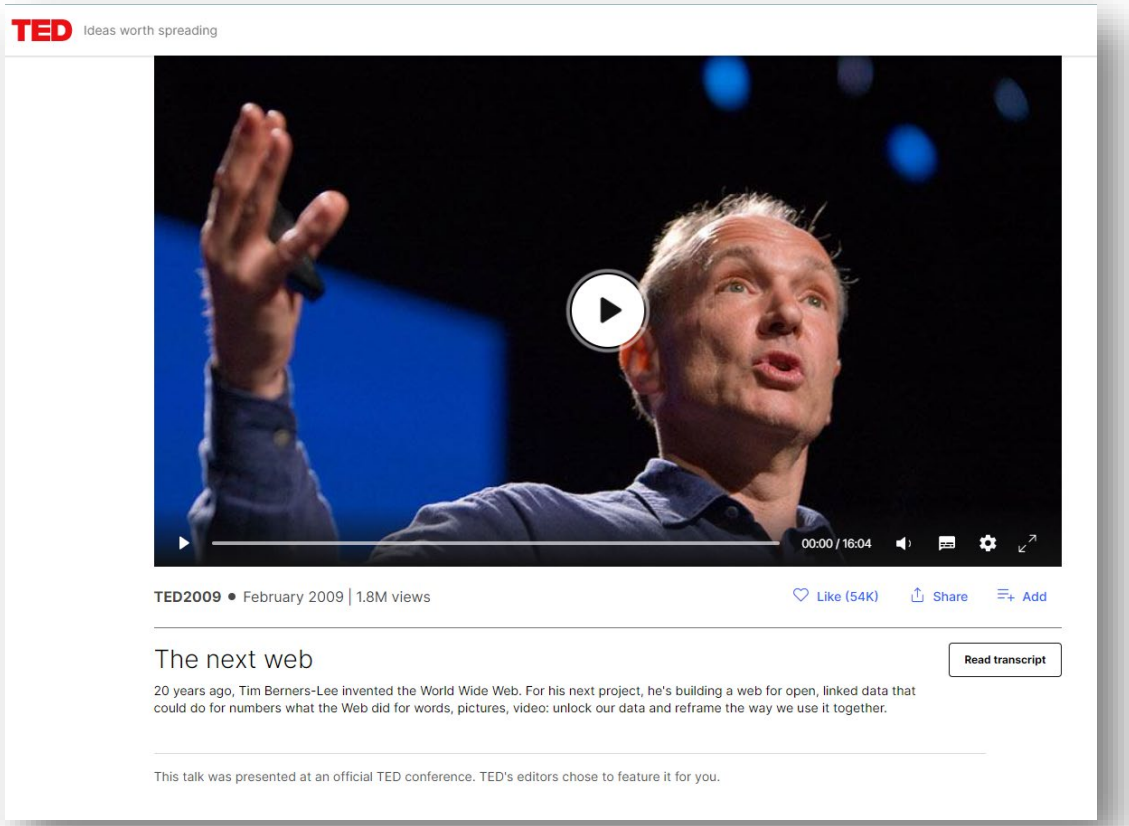

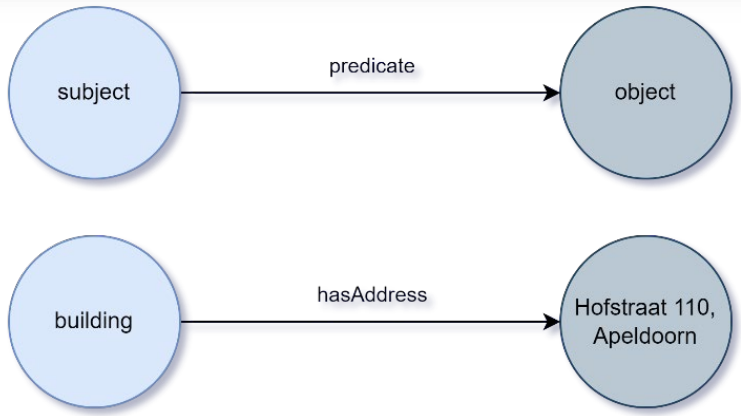

Linked Data?

- A way of publishing data (reusable, web standards, semantics, related to open and big data) on the web which is stored as triples (RDF standard) and can be (in a federated manner) queried with SPARQL.

  - Semantics = shared understanding
  - **Open standards = increase reuse**
  - **Web standards = increase findability**
  - Interoperability = increased connectivity between distributed data sources

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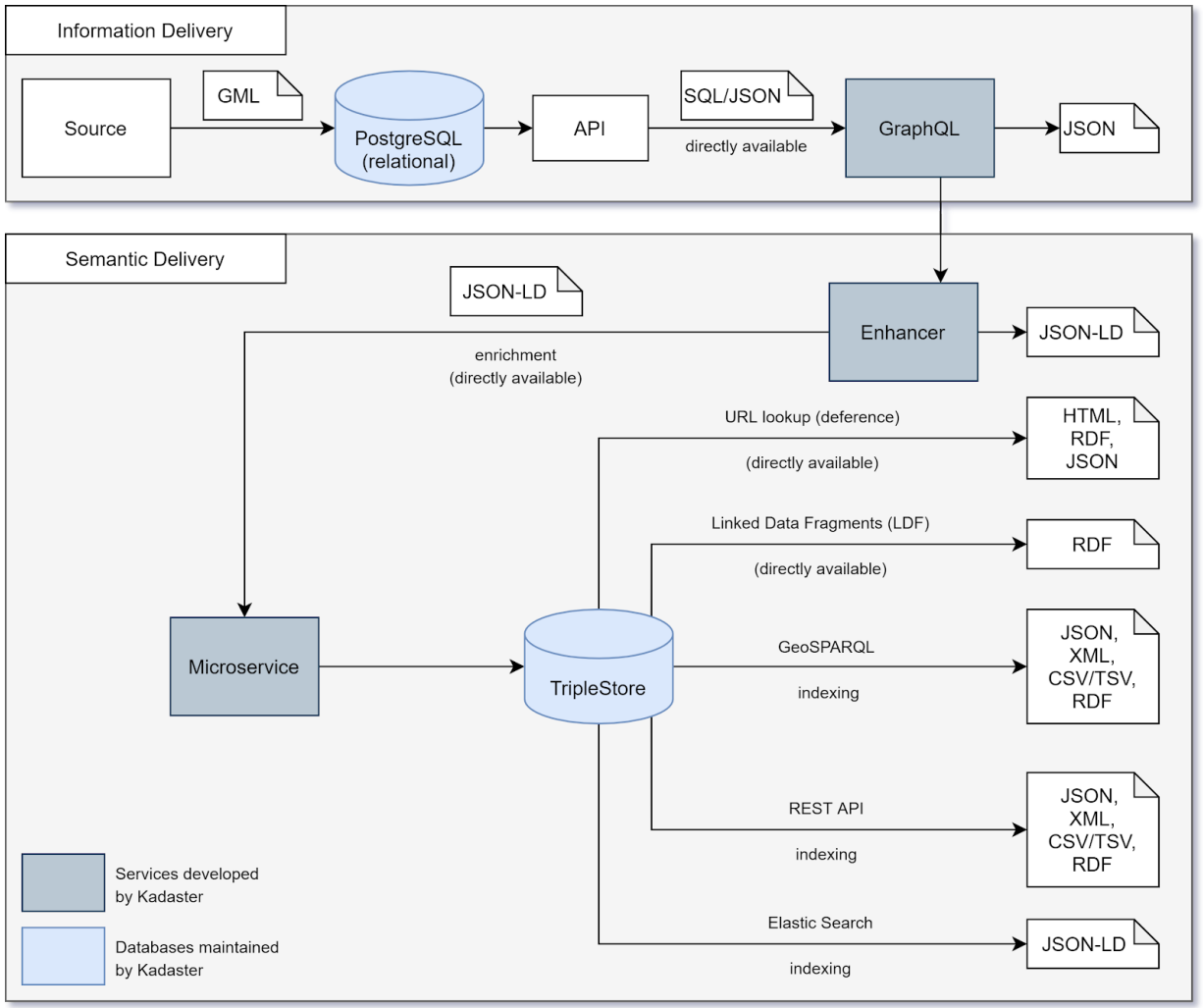

Building the Kadaster Knowledge Graph (KKG)

- The KKG contains several key registers, each first made available as a siloed linked data source through an ETL process.
- Extract, Transform, Load (ETL) process:
  - GML indexing step
  - GraphQL endpoint
  - Enhancer microservice to return JSON-LD format
  - SHACL validation step
  - Publication in TriplyDB
  - SPARQL service

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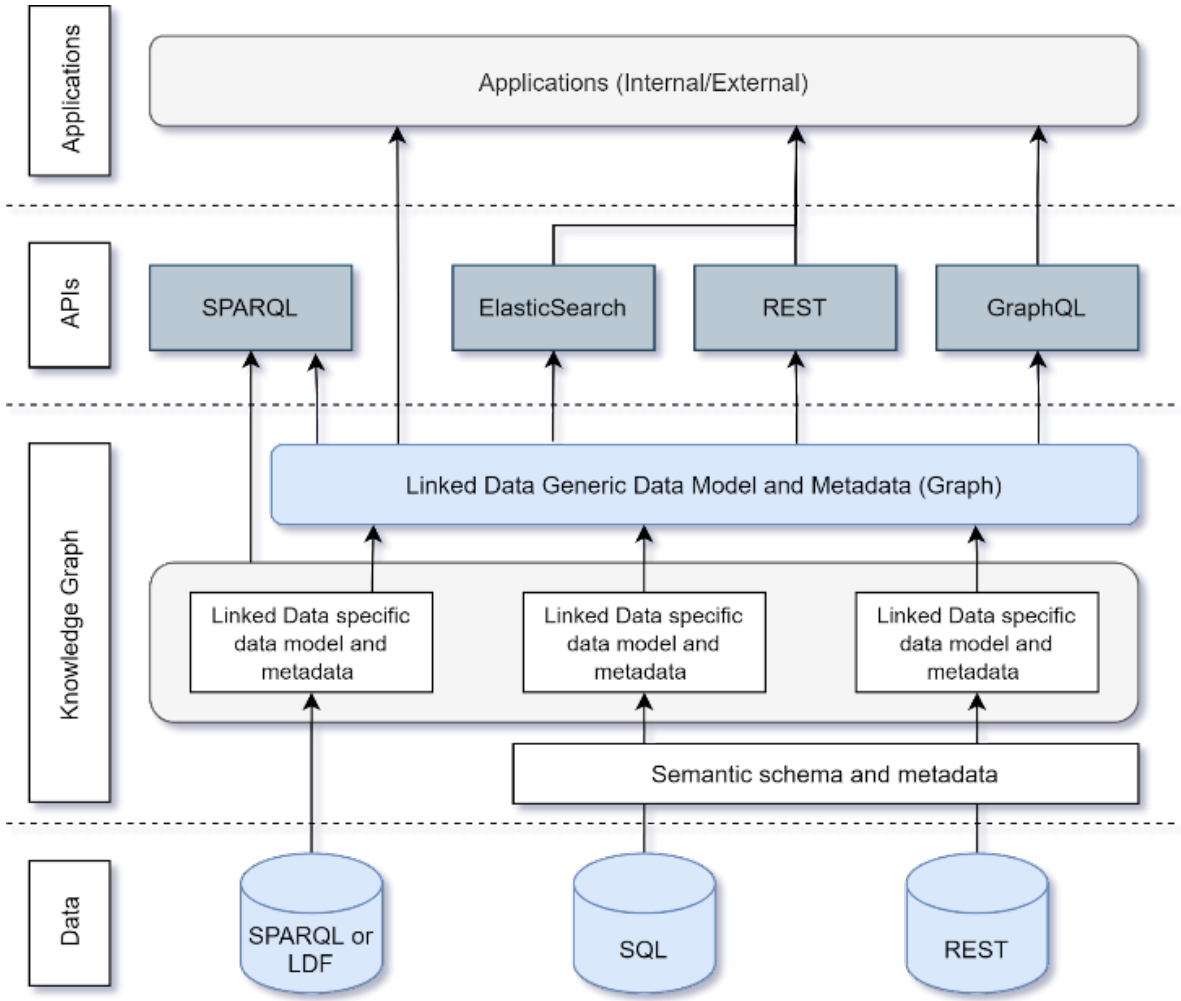
Building the Kadaster Knowledge Graph (KKG)

- Combine key registers with a central data model:
  - Samenhangende Object Registratie (SOR)
- Siloes to Knowledge Graph is achieved by implementing SPARQL Construct queries
- Layered approach:
  - Preservation of provenance
  - Traceability
- KKG contains contains approximately 680 million triples
- Updated on a quarterly basis



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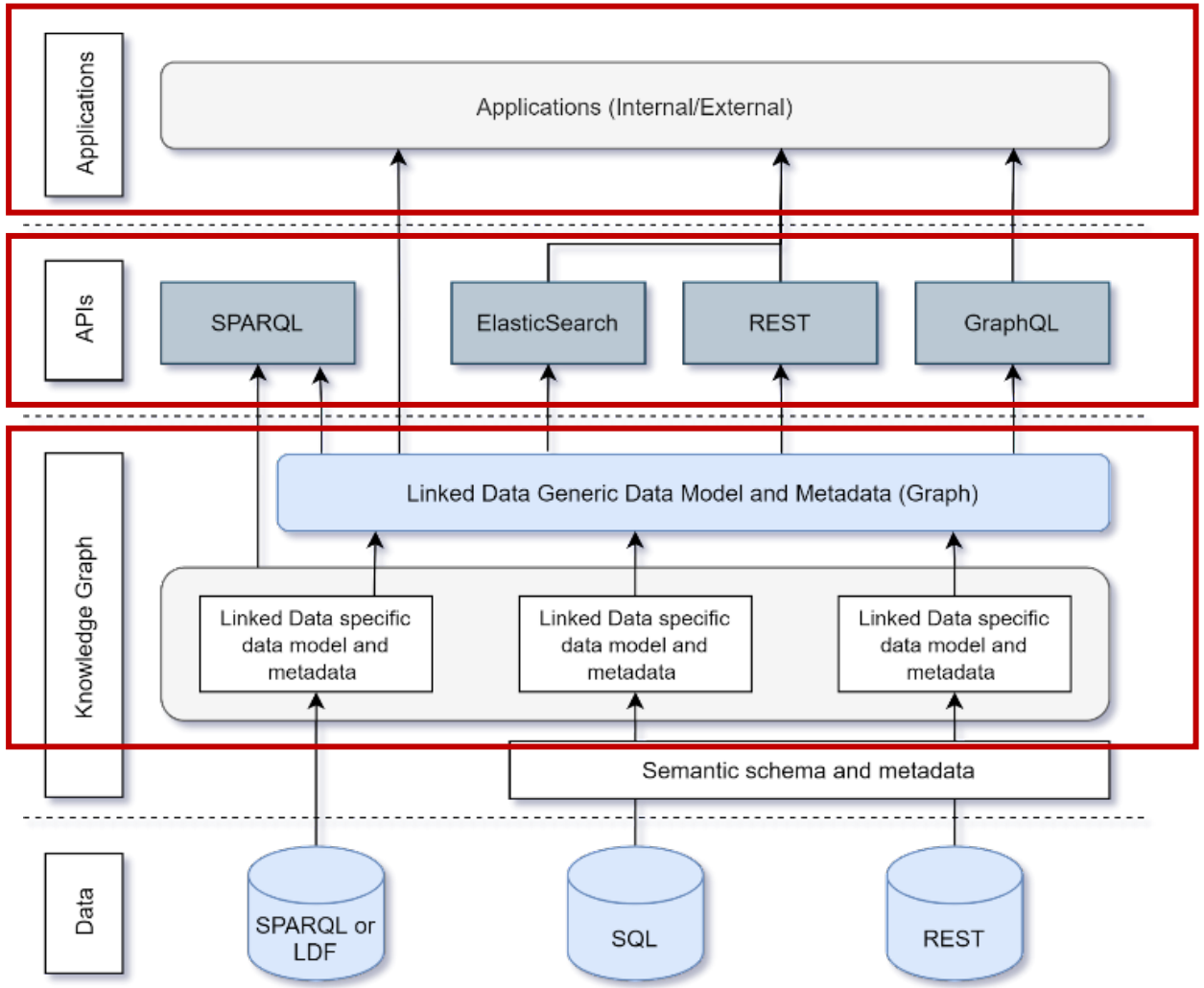
Proposed Architectural Approach

- Data remains ‘at the source’
- Application-independent data management
- **Open standards-based** interfacing between applications and data sources



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The Augmented Reality Application

- **Goal:** Support the interoperability between distributed data sources and end-user applications, allowing users to interact (in a low-threshold manner) with authoritative data published by the organization.
- **Architectural approach:** Separation of application and data source
- **Techniques:** Linked Data, Standardized Interfaces, Augmented Reality (AR)

- **Spatial coverage:** The Netherlands
- **Initial prototype:** Built in 2021/2022 and updated in the summer of 2022
- **Main functionality:** Allow the user to 'scan' a building and see information about that building on their phone screen.

Standardised Interfaces
SPARQL APIs

- SPARQL queries used as interfaces between the KKG and the AR application
- 3 SPARQL queries
- The results of each query are made available through a standardized API which can be used directly in the application.
- Available serialisations:
  - JSON-LD
  - Turtle
  - N-Quads

API GET: https://api.labs.kadaster.nl/queries/dst/AR-punt-distance/run?

Variables

punt

POINT(4.7892923355103 51.669044494629)

View populated query

```
PREFIX sor: <https://data.kkg.kadaster.nl/sor/model/def/>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
prefix geof: <http://www.opengis.net/def/function/geosparql/>
prefix uom: <http://www.opengis.net/def/uom/OGC/1.0/>
prefix xsd: <http://www.w3.org/2001/XMLSchema#>
prefix nen3610: <https://data.kkg.kadaster.nl/nen3610/model/def/>
prefix geo: <http://www.opengis.net/ont/geosparql#>

SELECT ?gebouwId ?polygon where {
  ?gebouwzone
    a sor:Gebouwzone;
    sor:geregistreerdMet/nen3610:identificatie ?gebouwId;
    geo:hasGeometry/geo:asWKT ?polygon.
    filter (geof:distance (?punt, ?polygon, uom:meter ) < 100 )
}
```

Feature 1: Geolocation

- Application returns latitude and longitude of GPS location and transforms to a point.
- Point is used as a parameter for the query
- The query returns all building identifiers and polygons of buildings within a 100m radius.
- UI allows user to select which object based on a house icon.

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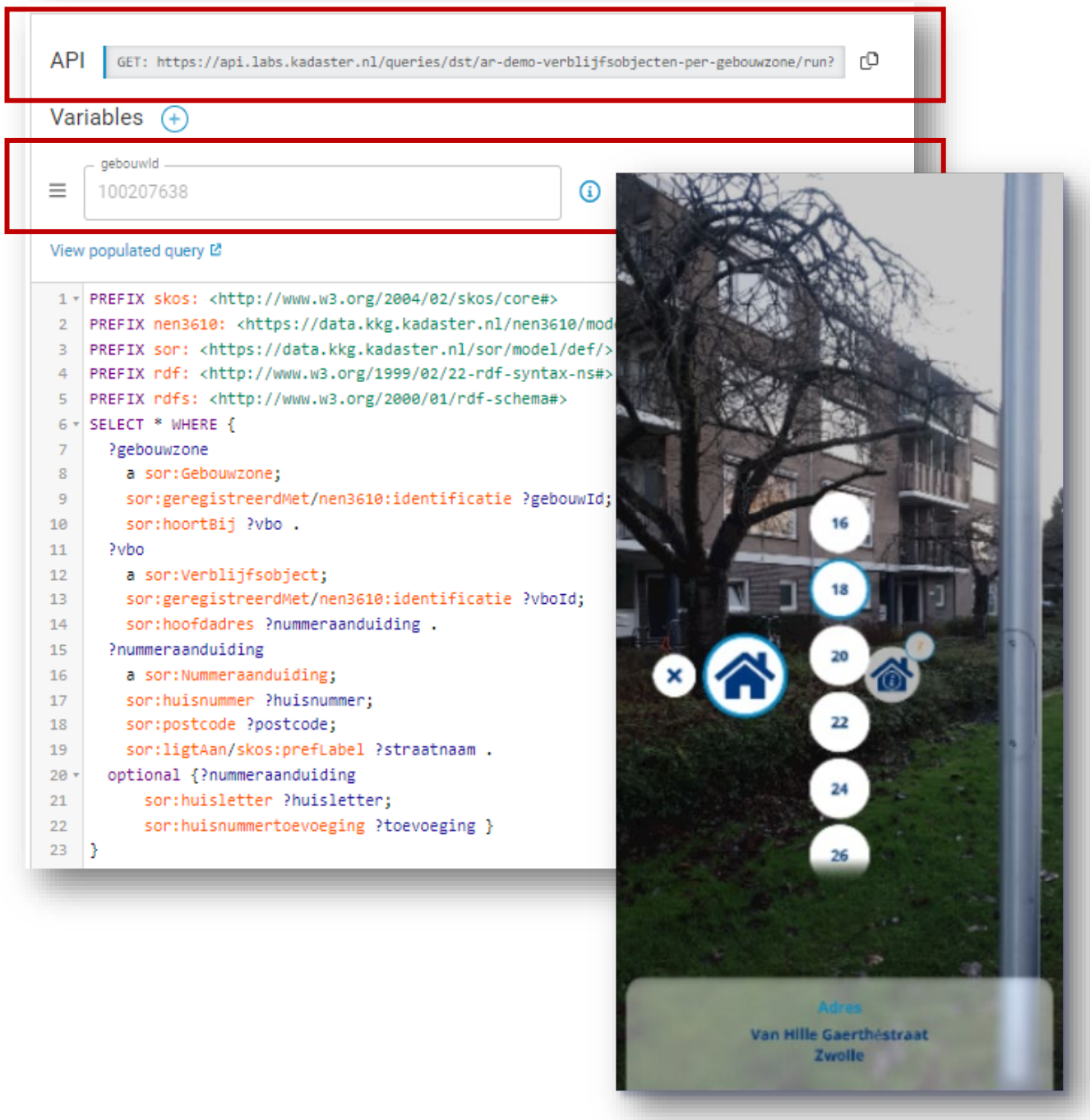

Feature 2:
House Number Selection

- Key registers have a distinction between a whole building and parts of the building (e.g. apartments)
- Some attributes are associated with the building object, some with the building part.
- UI displays all building parts based on identifier and allows user to select building part of interest based on a number icon.

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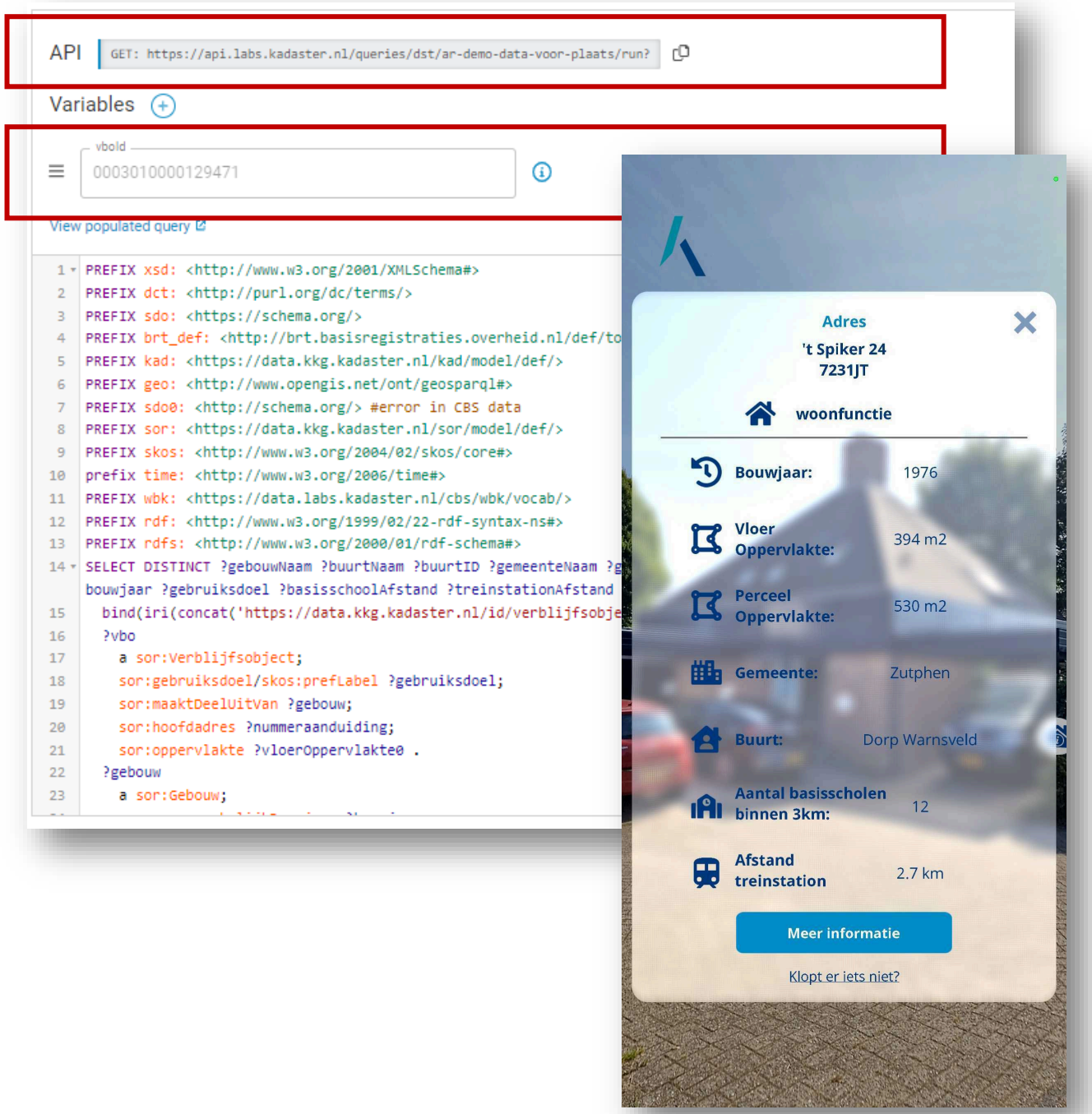

Feature 3:
Building Information

- Selected building identifier and building part identifier is used as input, all attribute information for both objects are returned in the UI
- Includes:
  - Building year
  - Floorsize
  - Parcel size
  - Municipality name
  - Neighbourhood name
  - Number of schools within a 3km radius
  - Distance to the nearest trainstation

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Added Value of Architectural Approach

- Open standards-based approach:
  - ✓ SPARQL relatively easy to understand
  - ✓ Open standards-based API is recognisable for all developers
  - ✓ Only requirement is results visualisation, no integration or transformation
  - ✓ Updates are immediately reflected in the application
  - ✓ Copying and self-storage of data is no longer required
  - Small learning curve involved in learning to write performant queries
  - Underlying schema changes require maintenance to the query.

- Application-Independent Data Publication:
  - ✓ Data source is easily updated and expanded
  - ✓ Data is immediately digestible by the application
  - ✓ Organization dependent: only a single KG is required, and various applications can consume the data
  - ✓ Supports cross-organization interoperability, federated SPARQL queries.
  - Only appropriate where data (content and structure) is not context-specific

Geoinformation for everyone?

Thank you!