A street scene in a European city, likely Bruges, Belgium. The street is paved with cobblestones and lined with historic buildings. In the background, a large Gothic church with multiple spires is visible. The sky is overcast, and the lighting suggests it might be late afternoon or early morning. A person is riding a bicycle in the foreground on the right side of the street.

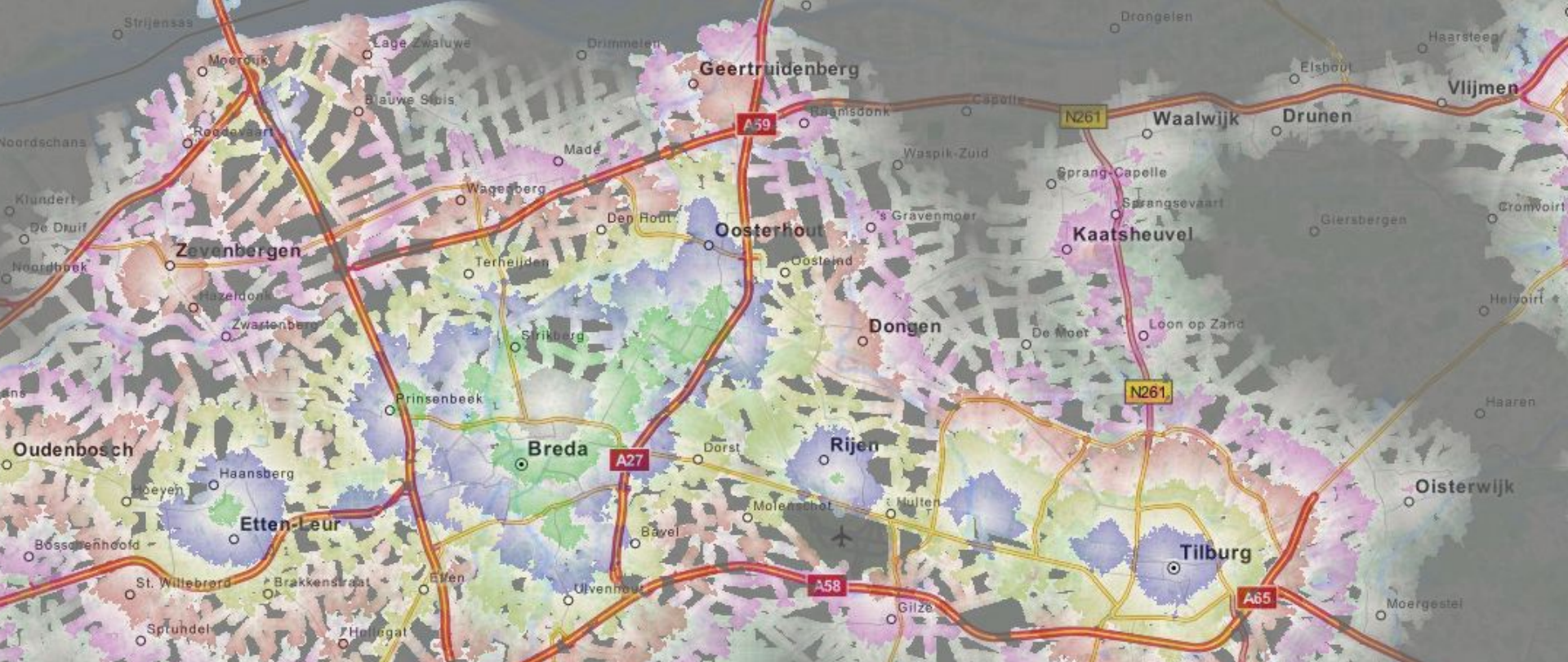
Knowledge Science in action: transport and mobility

Pieter Colpaert

<https://pietercolpaert.be>

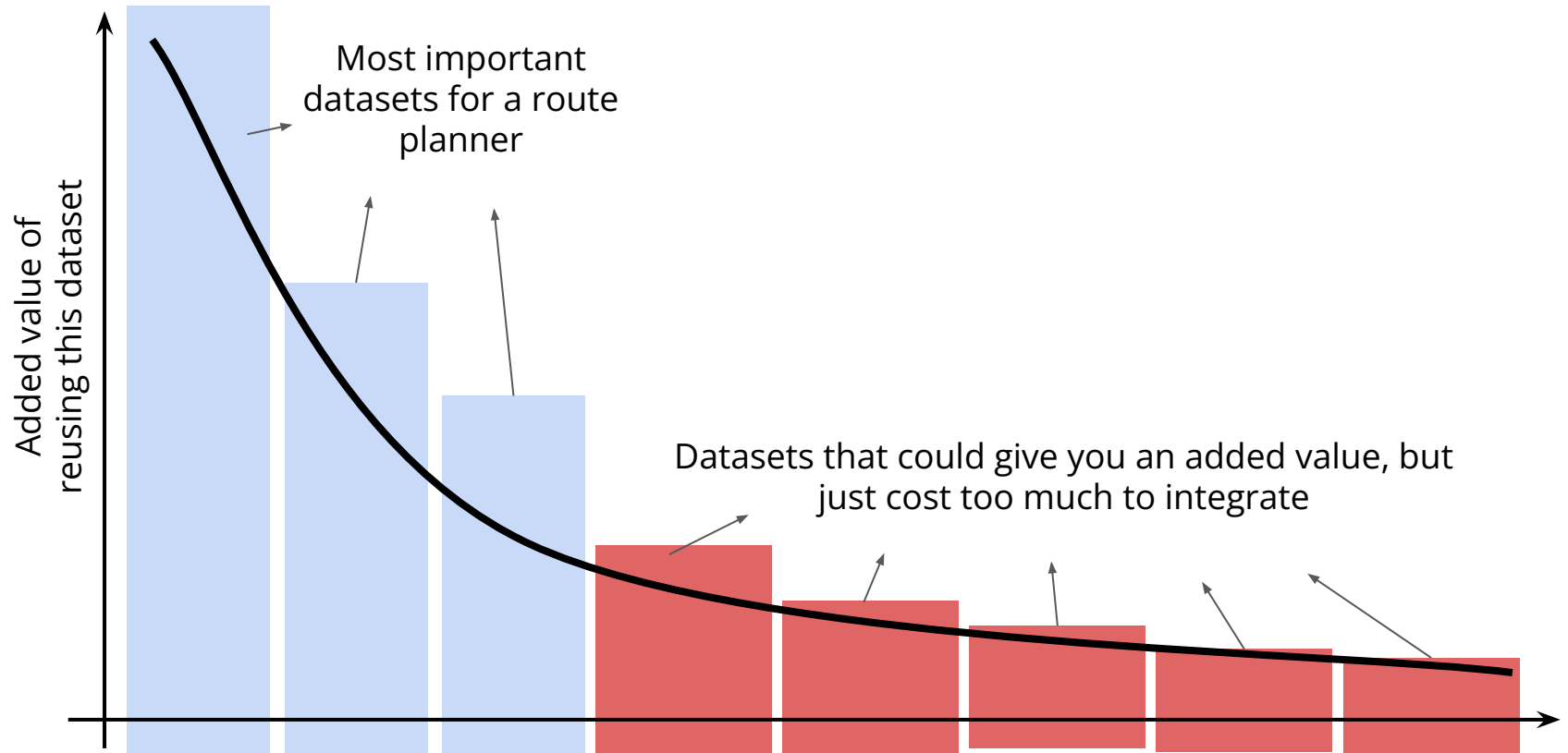
How far do you live from work?

Who answered
a distance in time using one or more
modes of transport?



Transport use cases can always use more data

The long tail of data adoption in route planners



How do we lower integration costs then?

Steps to publishing your data for automated reuse

A very surprising slide
for this audience
probably

1. **Vocabulary**

Choose and document your domain model (rdfs is fine, really)

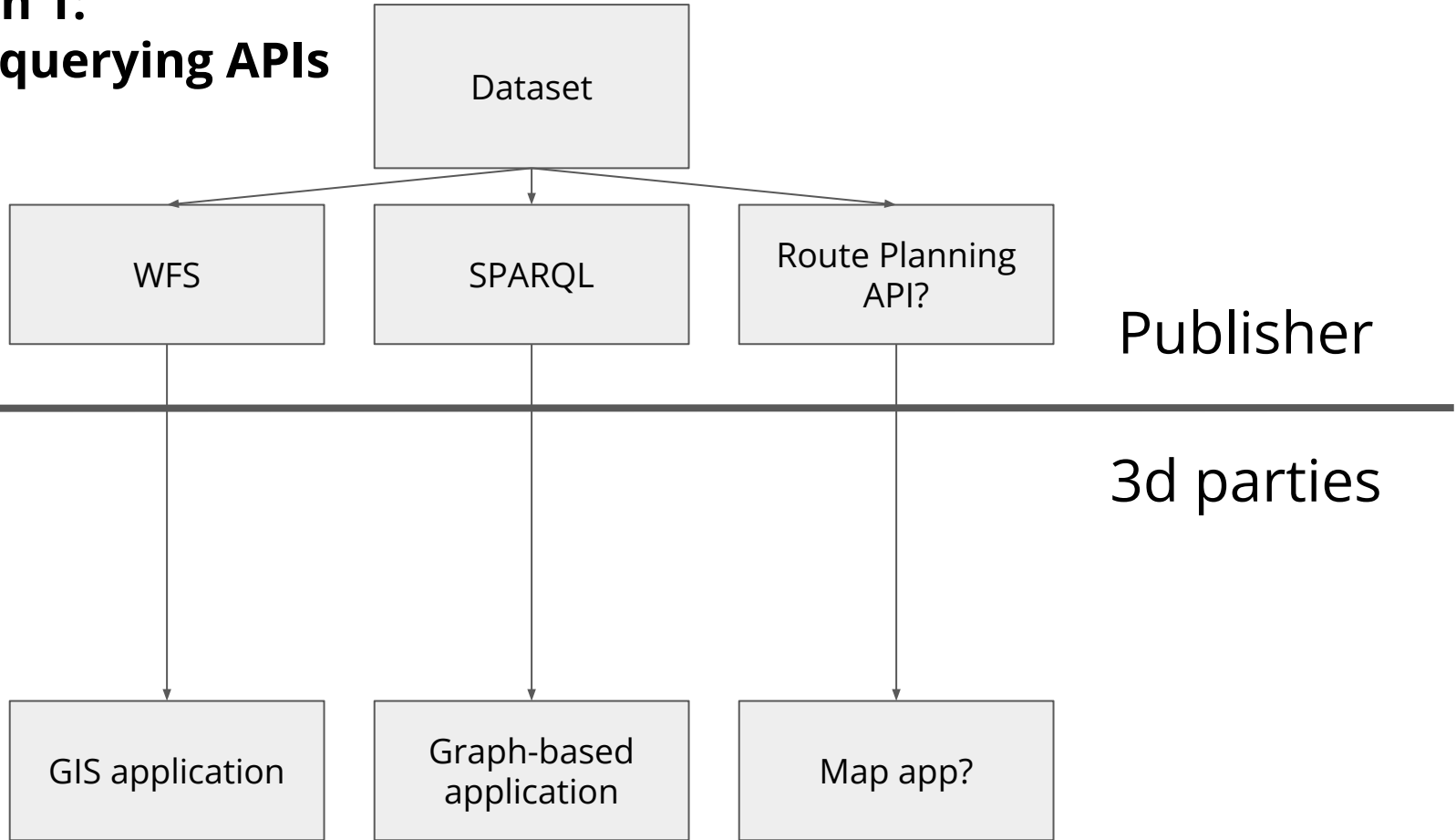
2. **Application Profile**

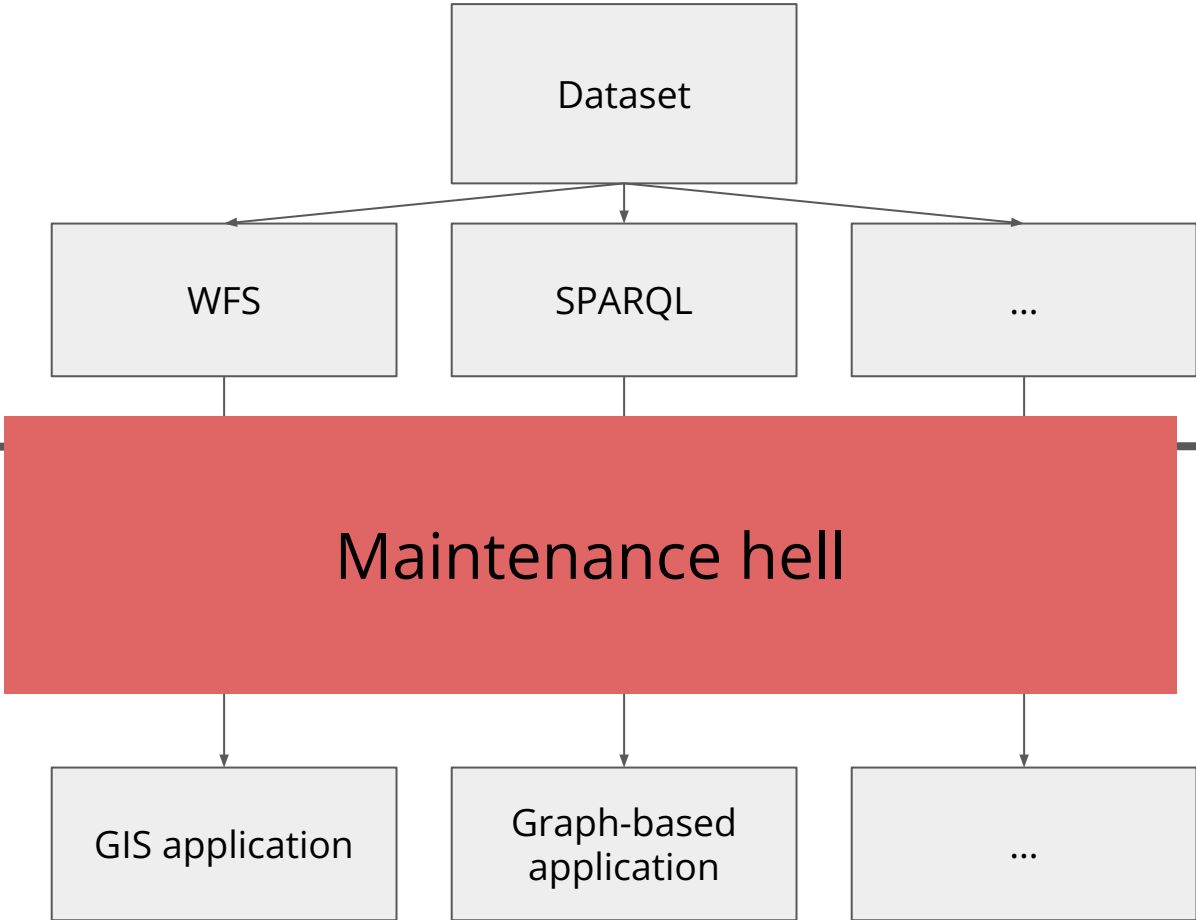
Describe your things by documenting what fields you keep in your dataset using SHACL or ShEx, and where you refer to other databases

3. **Self-describing Linked Data API**

Now publish the actual data... But what API should you use?

Approach 1: Hosting querying APIs





Publisher

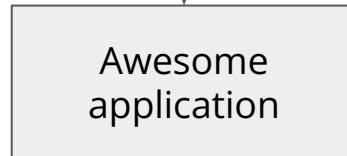
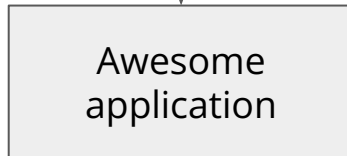
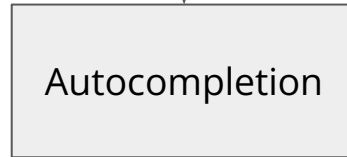
3d parties

Approach 2: Sharing dumps



Publisher

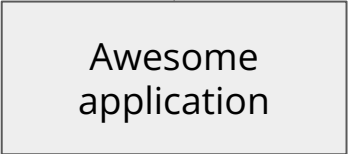
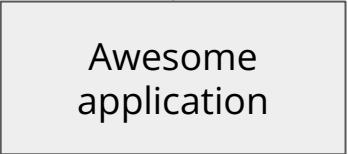
3d parties



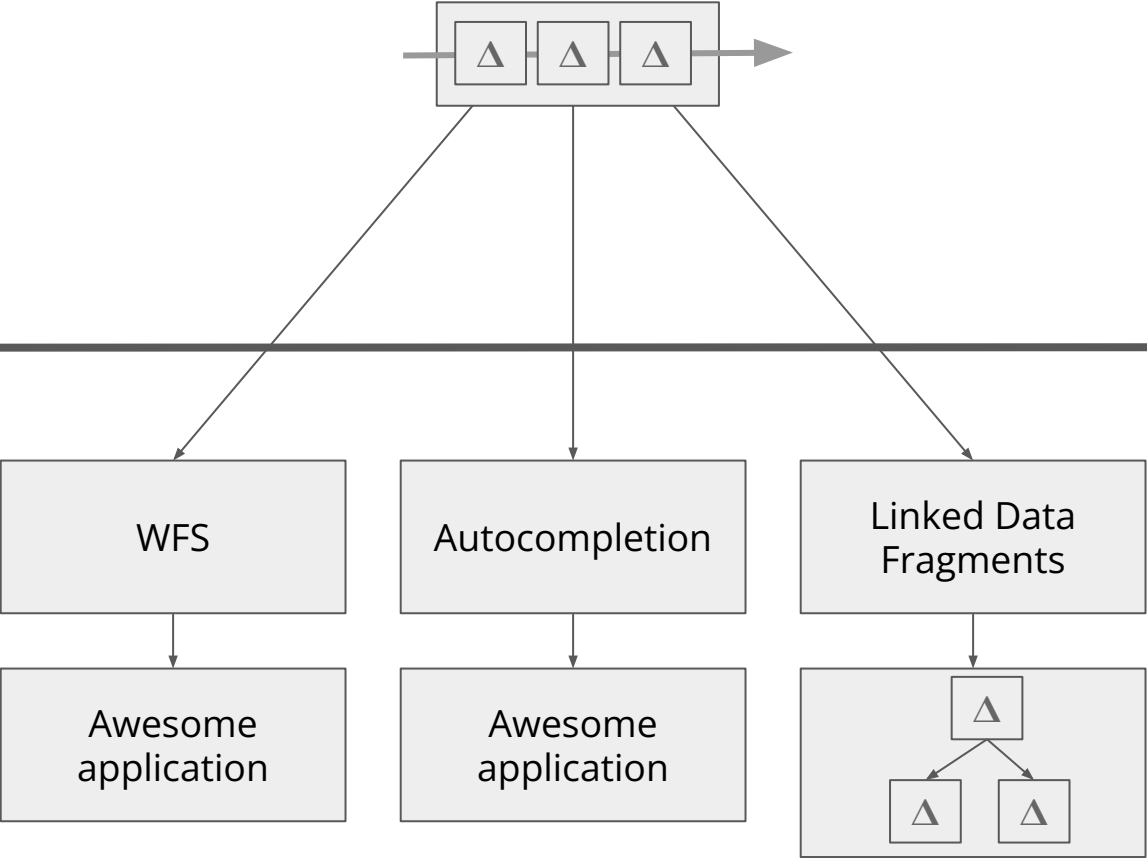


Publisher

3d parties



Event streams focus on live replication



Publisher

3d parties

The SEMIC EU specification on Linked Data Event Streams (LDES) – <https://w3id.org/ldes/specification>

TABLE OF CONTENTS

- 1 Introduction
- 2 Fragmenting and pagination
- 3 Retention policies
 - 3.1 Time-based retention policies
 - 3.2 Version-based retention policies
- Conformance
- References
 - Normative References

Linked Data Event Streams

Living Standard, 15 March 2021

This version:


<https://w3id.org/ldes/specification>

Issue Tracking:

[GitHub](#)

Editor:

[Pieter Colpaert](#)

 To the extent possible under law, the editors have waived all copyright and related or neighboring rights to this work. In addition, as of 15 March 2021, the editors have made this specification available under the [Open Web Foundation Agreement Version 1.0](#), which is available at <http://www.openwebfoundation.org/legal/the-owf-1-0-agreements/owfa-1-0>. Parts of this work may be from another specification document. If so, those parts are instead covered by the license of that specification document.

Abstract

A Linked Data Event Stream is a collection of immutable objects (such as version objects, sensor observations or archived representations). Each object is described in RDF.

§ 1. Introduction

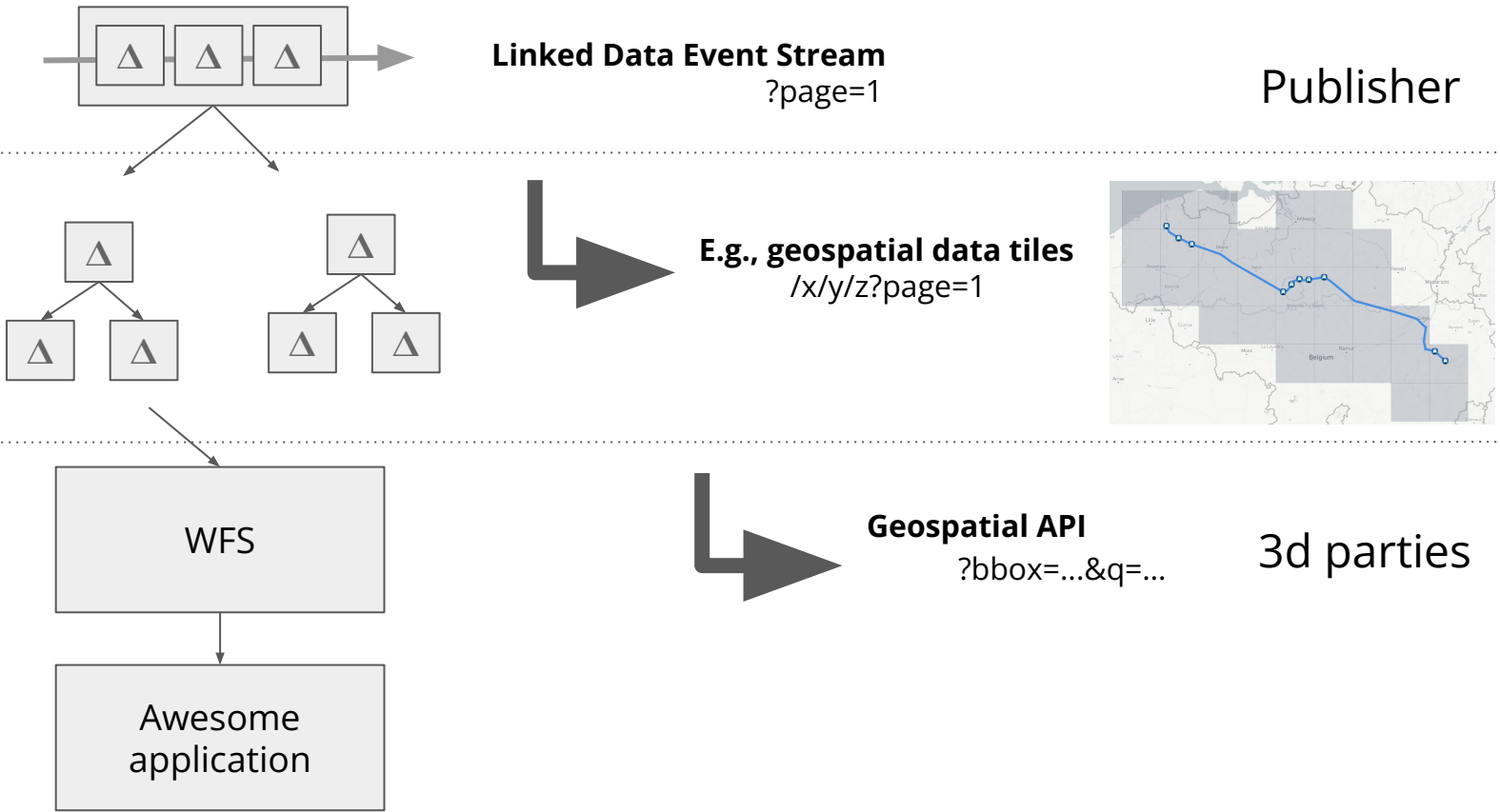
A Linked Data Event Stream (LDES) (`ldes:EventStream`) is a collection of immutable objects, each object being described using a set of RDF triples ([rdf-primer](#)).

This specification uses the [TREE specification](#) for its collection and fragmentation (or pagination) features, which in its turn is compatible to other specifications such as [activitystreams-core](#), [VOCAB-DCAT-2](#), [LDP](#) or [Shape Trees](#). For the specific compatibility rules, read the [TREE specification](#).

An `ldes:EventStream` is an `rdfs:subClassOf` the `tree:Collection` class. It extends the `tree:Collection` class by saying all of its members are immutable, and you can thus only add members to the collection.

Note: When a client once processed a member, it should never have to process it again. A Linked Data Event Stream client can thus keep a list (or cache) of already processed member IRIs. A reference implementation of a client is available as part of the [Comunica](#) framework on [NPM](#) and [Github](#).

LDES published through multiple Linked Data Fragments interfaces



5 minutes,
5 demos,
here we go

1. Parking availabilities
2. Public Transit time schedules
3. Route Planning on OSM
4. Railway Infrastructure (RINF)
5. Autocompletion of street names

Decentralized parking availabilities

Smart Flanders demo

This demo automatically discovers live and historic off-street parking site availabilities in cities across Flanders. — [read more \(Dutch\)](#)

Pick a city:

And pick a parking site

This parking site has ... vacant parking spaces.

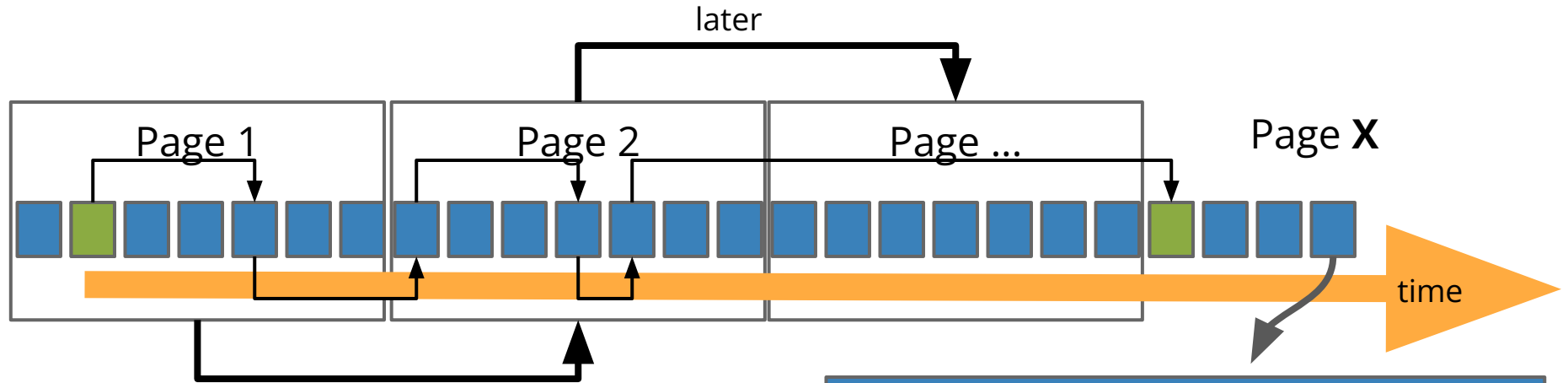


This demo is part of [Smart Flanders](#): a support program for publishing real-time Open Data in Flanders.

1. Retrieve DCAT **catalog**
2. Javascript **filters** parking dataset and **populates** dropdown
3. **Fetch LDES view** for a parking site
4. Show **real-time** and **historic info in sparkline**

Old but still functional code example at <https://smart.flanders.be/kennis-en-instrumenten/data-piloten/parkeren/>

Time-based fragmentation of public transit time schedules with Linked Connections



```
<> a lc:Connection ;  
    lc:departureTime "2022-03-30T17:00";  
    lc:arrivalTime "2022-03-30T17:10";  
    lc:arrivalStop <S1> ;  
    lc:departureStop <S2> .
```

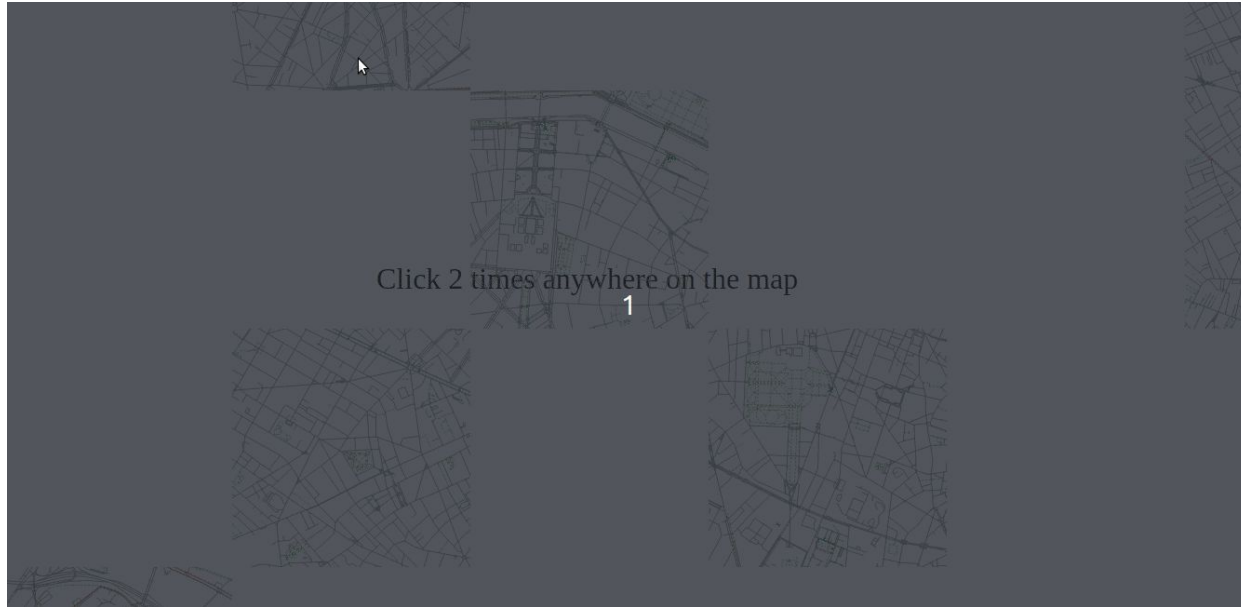
Plan routes from your browser



<https://linkedconnections.org>

Pieter Colpaert, Ruben Verborgh, and Erik Mannens. “[Public Transit Route Planning Through Lightweight Linked Data Interfaces](#)”. International Conference on Web Engineering. 2017.

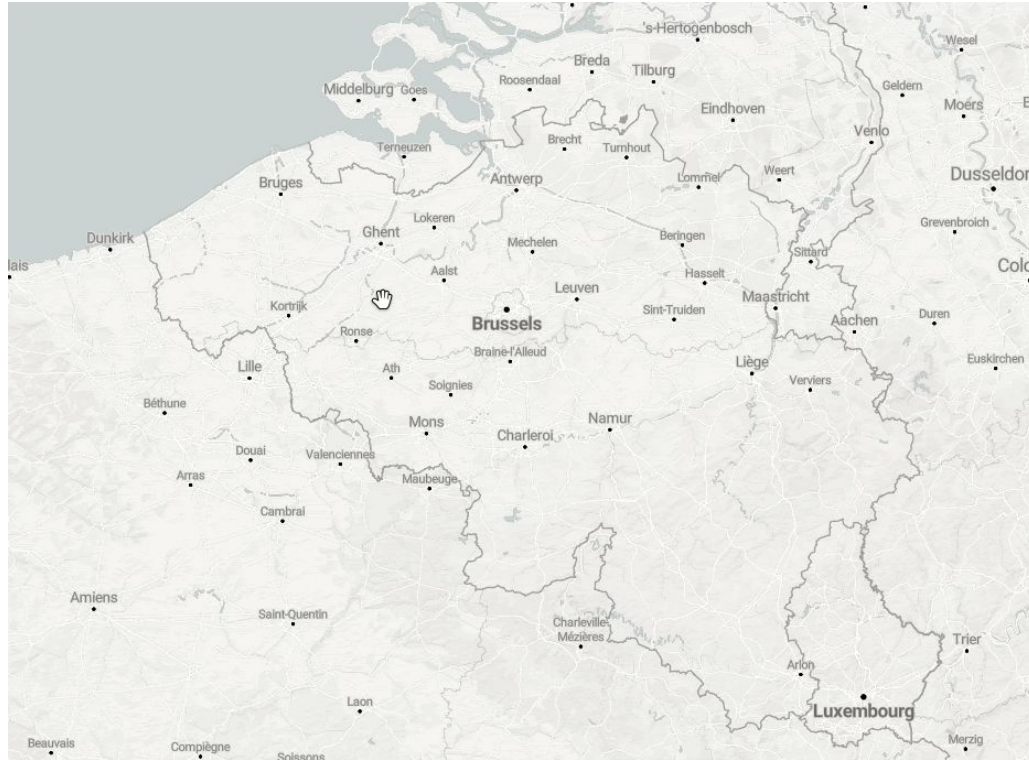
Same idea, but geospatial tiling of roads



Routable Tiles: fragmenting OSM in LD tiles

P. Colpaert, B. Abelshausen, J. Rojas, H. Delva, and R. Verborgh, “**Republishing Open Street Map’s roads as Linked Routable Tiles**”, in *Proceedings of the 16th ESWC: Posters and Demos*, 2019.

Extra summary index speeds it up



[Client-side route planning: preprocessing the OpenStreetMap road network for Routable Tiles](#)

Harm Delva, Julián Rojas, Ben Abelshausen, Pieter Colpaert, Ruben Verborgh *Academic Track, State of the Map 2019*

Railway compatibility in Europe

EUROPEAN AGENCY FOR RAILWAYS Route Compatibility Check ⓘ

FROM: Roissy-Aéroport-Charles-de-Gaulle 1 ⊙

TO: Schiphol Airport ⊙

Max number of routes: 1

51-041-0002-8-001 - Tagnpps 95 m3 Grain Hopperwag... ×

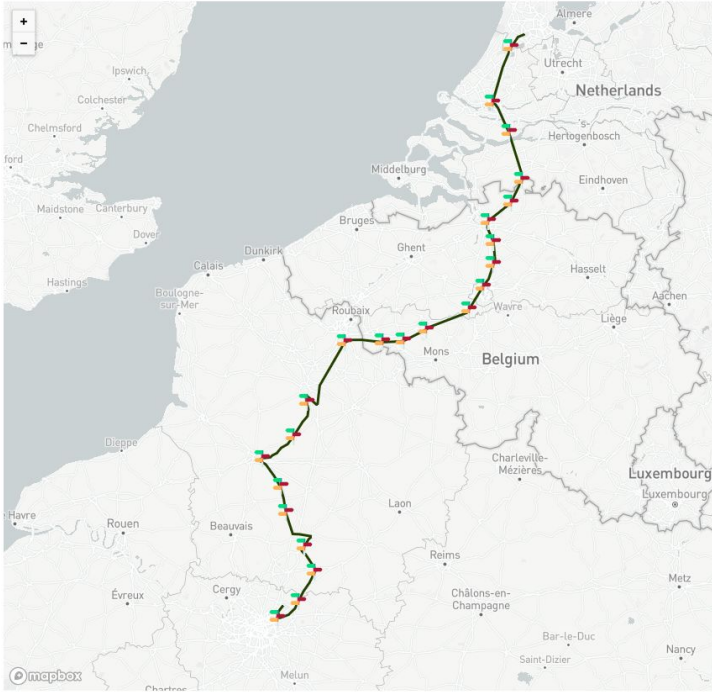
338407640006 - Grain Hopper WagonTagnpps 95m3 w... ×

Route 1:

1 Roissy-Aéroport-Charles-de-Gaulle 1 (station)

Track: http://era.europa.eu/implementation#T_2534622_382_2534878
Vehicle Type: 51-041-0002-8-001
Vehicle: 338407640006

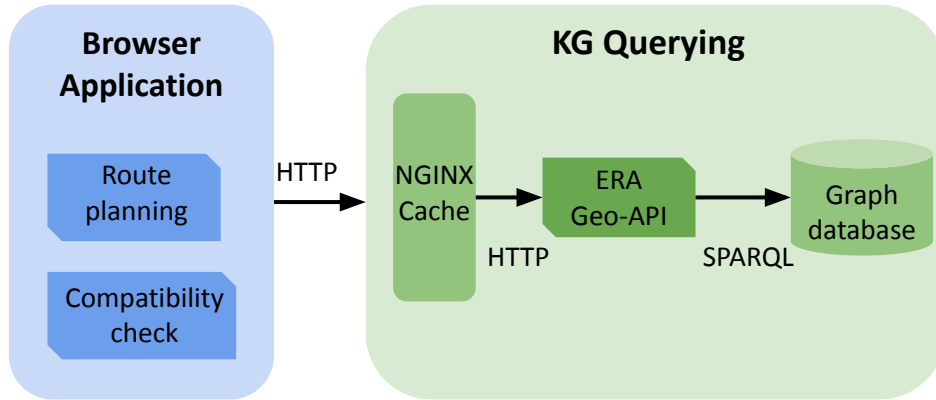
Properties	Compatible	Track	Vehicle
- gauging profile	UNKNOWN	no data	G1
- train detection system	YES	- wheel detector loop - track circuit	- wheel detector loop - track circuit
- has axle box detector - axle bearing condition monitoring	YES	false	Detectable by line side
- rail inclination	UNKNOWN	1/20	no data
- wheel set gauge	YES	1435	1435



The map displays a route from Paris, France, to Amsterdam, Netherlands, passing through Belgium. The route is marked with various colored icons (red, green, blue) indicating compatibility issues or specific track/vehicle characteristics. Major cities like Paris, Brussels, and Amsterdam are labeled. The map also shows the borders of France, Belgium, the Netherlands, and Luxembourg.

Online app at <http://data-interop.era.europa.eu/>

Railway compatibility in Europa



In-use architecture shields a SPARQL endpoint with a geospatial fragmentation

Vocabulary at <https://data-interop.era.europa.eu/era-vocabulary/>

API at <https://data-interop.era.europa.eu/ldf/sparql-tiles/implementation/10/522/343>

In-use paper at ISWC: "[Leveraging semantic technologies for digital interoperability in the European Railway domain](#)" by J. Rojas, M. Aguado, P. Vasilopoulou, I. Velitchkov, D. Van Assche, P. Colpaert & R. Verborgh

Substring fragmentations for autocompletion

TREE | Autocomplete over TREE structured fragmentations

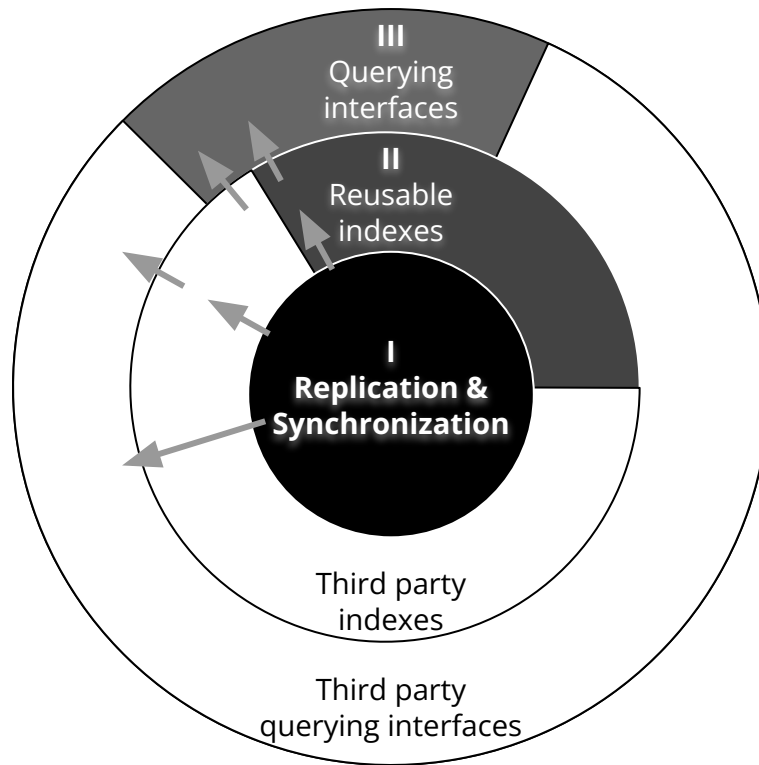
Choose TREE fragmentation to query over:

© the Linked Data Fragments collaborators. [Contact us](#).

[Live demo at tree.linkeddatafragments.org](https://tree.linkeddatafragments.org)

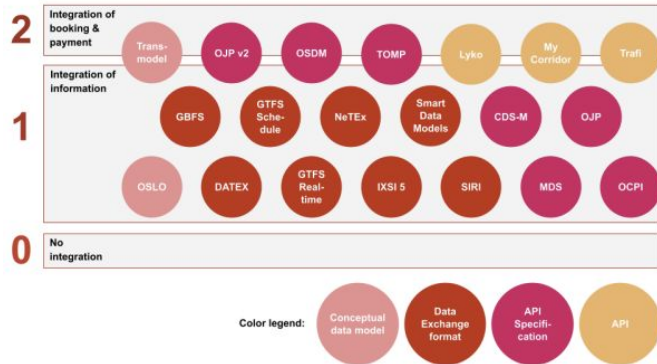
Ruben, D., Delva, H., Colpaert, P., & Verborgh, R. (2021, May). "[A File-Based Linked Data Fragments Approach to Prefix Search](#)". Proceedings of the 21th International Conference on Web Engineering.

But everything API starts from the Linked Data Event Stream



Current status of Linked Data in mobility

1. Interesting prototypes, vocabularies and architectures are sprouting
2. The MaaS alliance doesn't list Linked Data as a useful exchange model, but only sees it as a way to create conceptual data models



https://maas-alliance.eu/wp-content/uploads/2021/11/20211120-Def-Version-Interoperability-for-Mobility.-Data-Models-and-API-_-FINAL.pdf

3. I believe the idea of Linked Data Event Streams and the ecosystem around it will bridge that gap

Want to help? Next up: the Sem4Tra Workshop

In September at SEMANTiCS! Prepare your submissions!



Sem4Tra Workshop

@sem4tra



We're happy to announce that the 4th edition of Sem4tra is officially going to happen at [@SemanticsConf](#) Europe! CfP and deadlines will be soon available at sem4tra.linkeddata.es [#Sem4Tra22](#)



[Tweet vertalen](#)

9:34 a.m. · 28 mrt. 2022 · TweetDeck

Join our Slack:

https://join.slack.com/t/sem4tra/shared_invite/zt-16c579hlg-sXwAgIPK mreRyd2Dje08oQ

A street scene in a European city, likely Bruges, Belgium. The street is paved with cobblestones and lined with historic buildings. In the background, a large Gothic church with multiple spires is visible. The sky is overcast, and the lighting suggests it might be late afternoon or early morning. A person is riding a bicycle in the foreground on the right side of the street.

Knowledge Science in action: transport and mobility

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