



# Why Geospatial Linked Open Data for Smart Mobility ?

*Anuja Dangol, Valerie Dewaelheyne, Thérèse Steenberghen*

Spatial Applications Division Leuven (SADL)  
Department of Earth and Environmental Sciences

# Overview

- **Introduction:**
  - smart mobility and linked open Data
  - why geospatial Linked Open Data (LOD) for smart mobility?
- **Use Case**
  - cycling infrastructure in Flanders as Geospatial LOD
- **Result**
  - standardized workflow for conversion to LOD
- **Discussion and Conclusion :**
  - challenges and Way forward



# Introduction

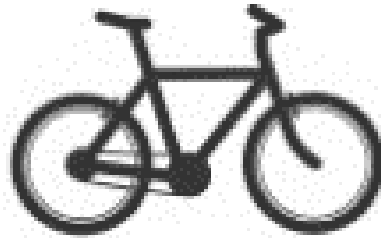
Smart mobility and Linked Open Data



## Belgium: need for evolution towards smart mobility

Congested traffic , road accidents, accidental deaths

# Smart Mobility



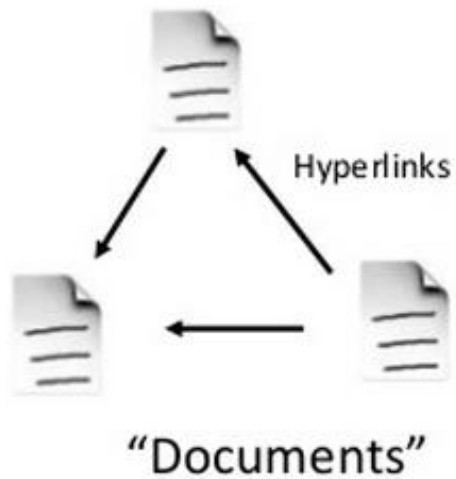
# Why geospatial Linked Open Data for smart mobility?

Open Data and Data interoperability

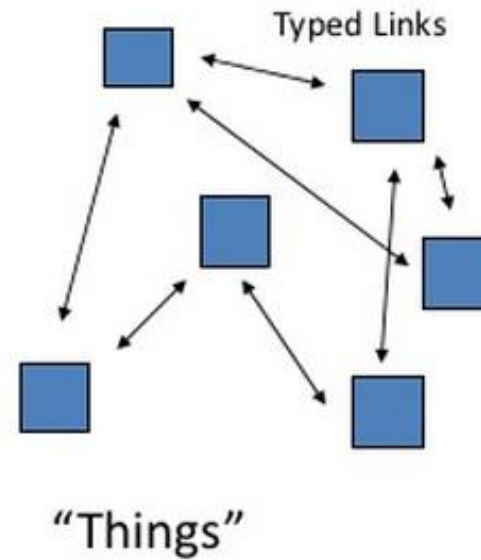
# Semantic Web (Web 3.0)

1998 - Tim Berners Lee

- Web of Documents



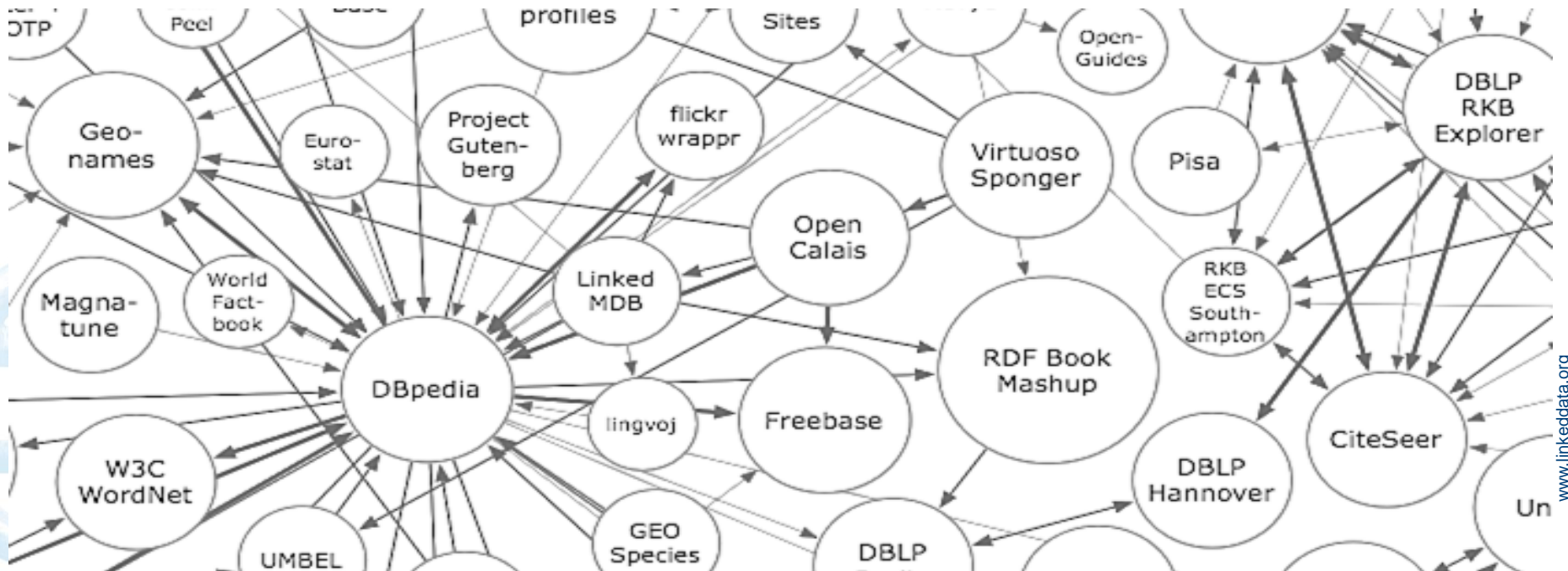
- Web of Data



# Linked Open Data (LOD)

A set of design principles for sharing machine-readable data on the Web for use by public administrations, business and citizens.

(ISA European Commission, 2013)





# LOD Principles

1. Use **Uniform Resource Identifiers (URIs)** as **names of things**

<http://nl.dbpedia.org/resource/Fietspad>



# LOD Principles

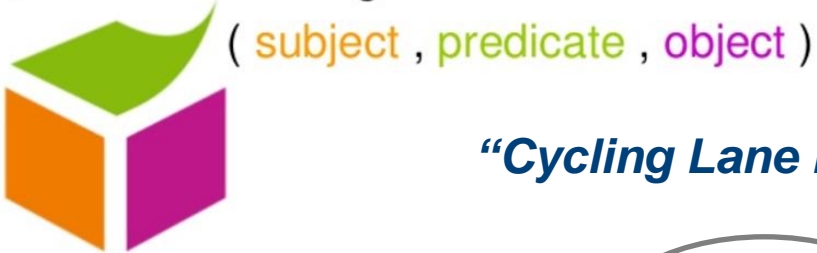
1. Use **Uniform Resource Identifiers (URIs)** as **names** of things
2. Publish it on web using standard protocols ( **HTTP URI** ) :  
people can **look up** those names

HTTP URI : <http://nl.dbpedia.org/resource/Fietspad>

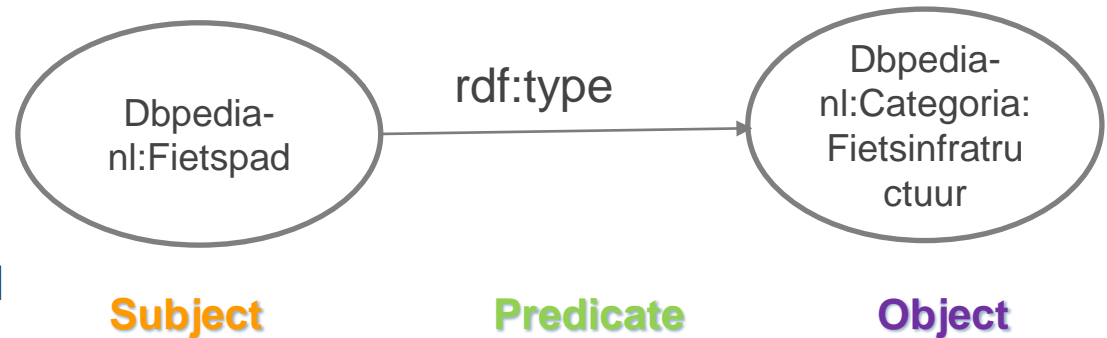
3. When someone looks up a URI,  
**provide useful information**, using the standards  
(**RDF, SPARQL**)

# LOD Principles

**RDF** is a triple model *i.e.* every piece of knowledge is broken down into



**“Cycling Lane is the type of Cycling Infrastructure”**



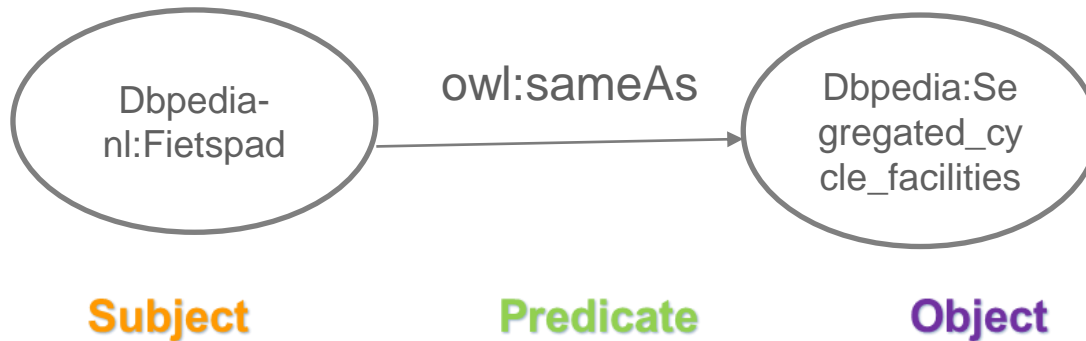
**Subject** (a URI),  
**Predicate** (Relationship) and  
**Object** (a URI/ Literal)

**SPARQL** Protocol and **RDF** Query Language

# LOD Principles

1. Use **Uniform Resource Identifiers (URIs)** as **names** of things
2. Publish it on web using standard protocols ( HTTP URI) : people can **look up** those names
3. When someone looks up a URI, **provide useful information**, using the standards (RDF, SPARQL)
4. Include links to other URIs to allow **discovery** of more things

Links at instance level (rdfs:seeAlso, owl:sameAs)



# Ontologies

- Syntax, Semantics, Taxonomy(classification), Thesauri(Associations), Ontology(Rules).

*“Formal, explicit specifications of a shared conceptualization”*

Studer (1998)

- **Conceptualization:** describe a concept: car, person, love, hate
- **Explicit:** All concepts must be defined
- **Formal:** Machine understandable
- **Shared:** Consensus about the ontology

# Publishing Linked Open Data

## 5-star schema of Linked (Open) Data





# Use case

Cycling infrastructure in Flanders  
Belgium as Geospatial LOD

# Data

- Cycling infrastructure data: Supra-local Functional Cycling Route network

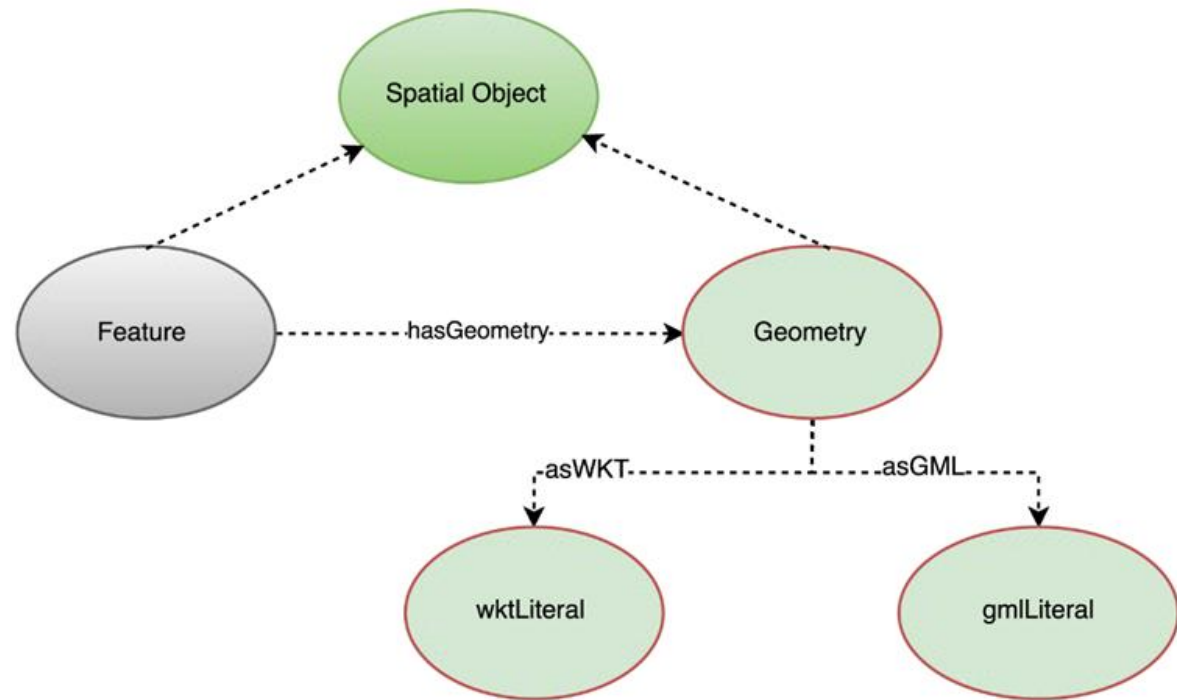




# Geospatial Linked Data

## GEOSPARQL

- An RDF/OWL vocabulary for representing spatial information;
- A set of functions for spatial calculation



Source: GeoSPARQL ontology. Source: Koubarakis and Kyzirakos (2012)

# The process



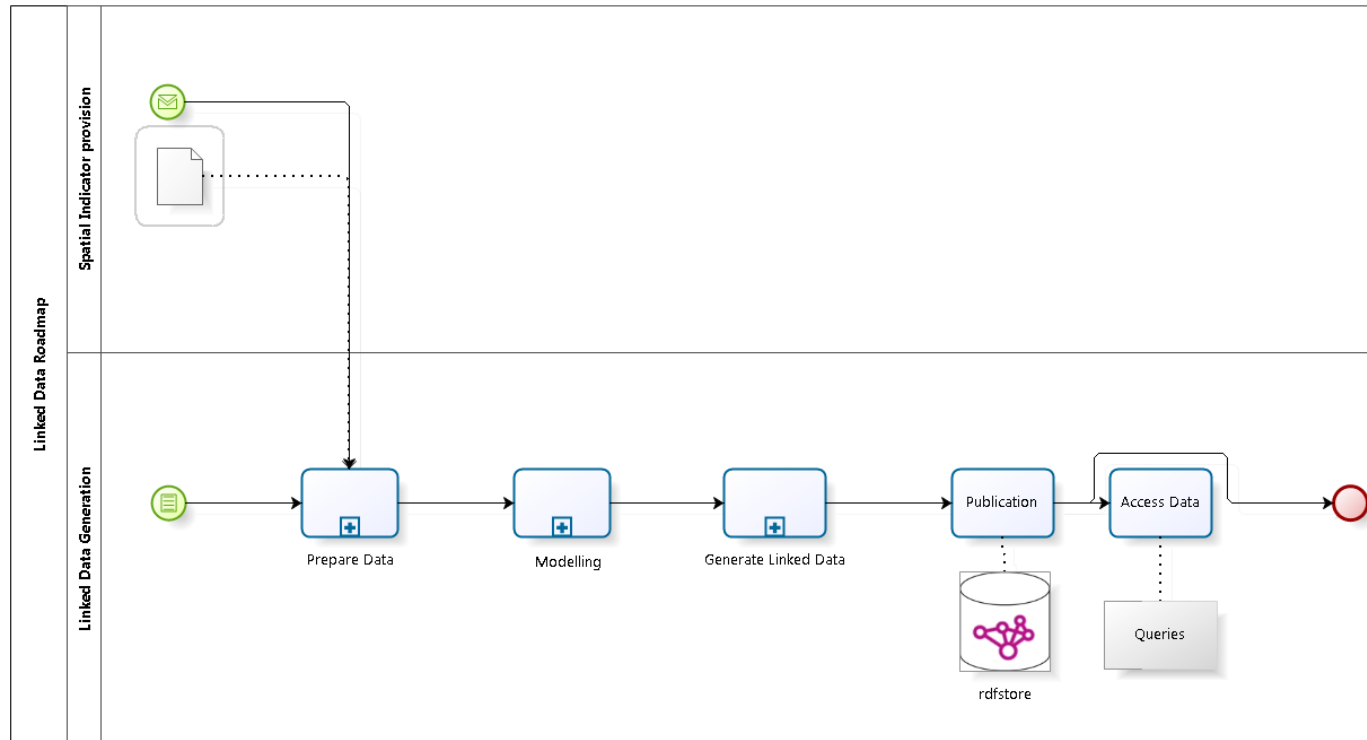


# RESULT

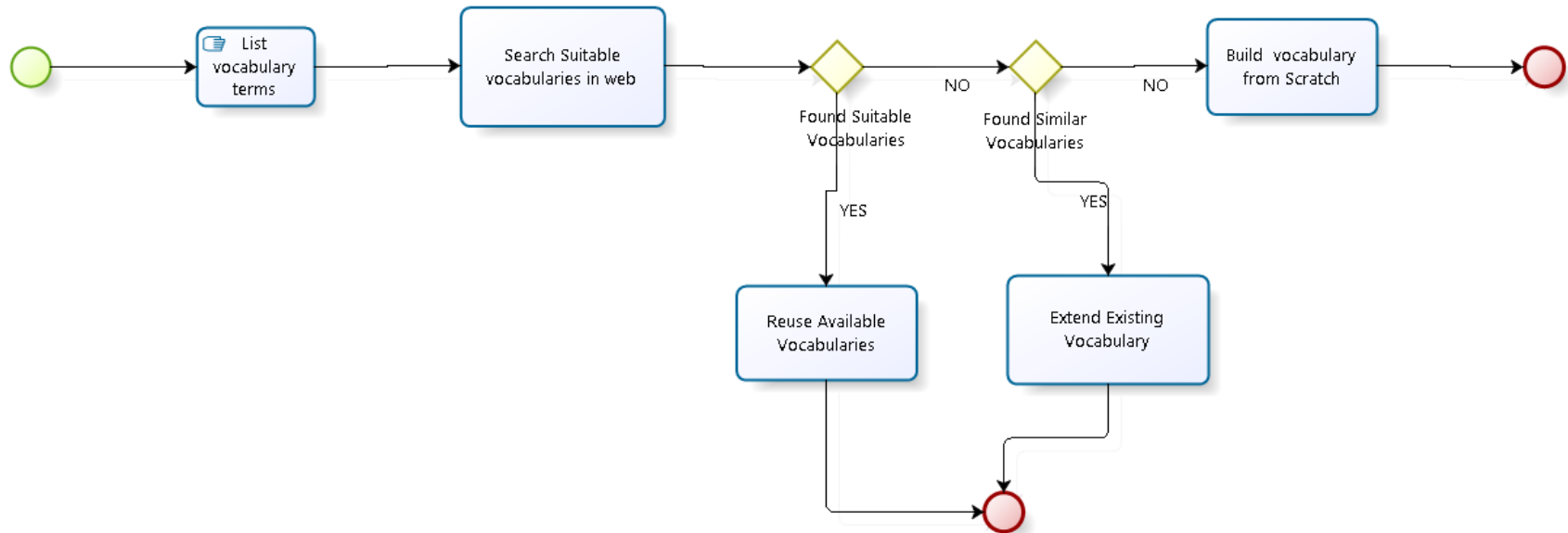
Standardized workflow for conversion to LOD

# Standardized Workflow

- Created in BPMN for publishing of the cycling infrastructure data as Geospatial Linked Open Data

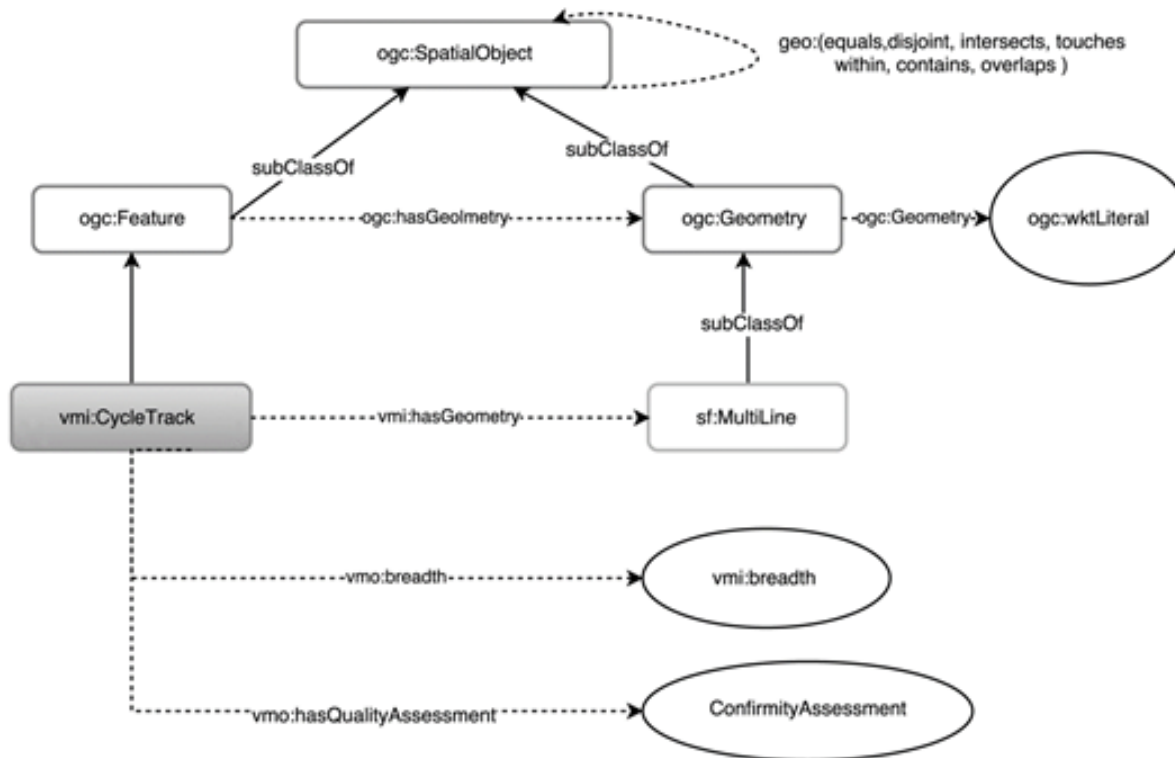


# Ontology design sub-process

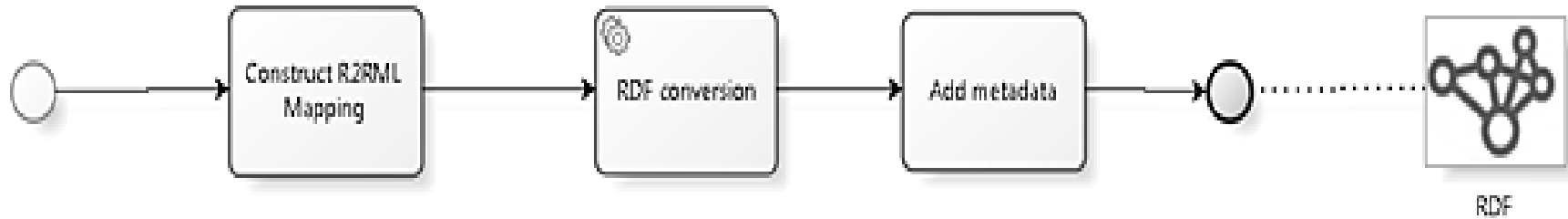


# Ontology design sub-process

<b>Classes</b>	CycleLaneCharacteristics, CycleLaneInventory, QualityAssessment etc
<b>Properties</b>	hasQualityAssessment, hasCyclingDirection, hasServiceType etc
<b>Imported properties</b>	rd <sup>26</sup> :comment, rdf:label, ogc:hasGeometry, ogc <sup>27</sup> :Geometry, ogc_asWKT etc

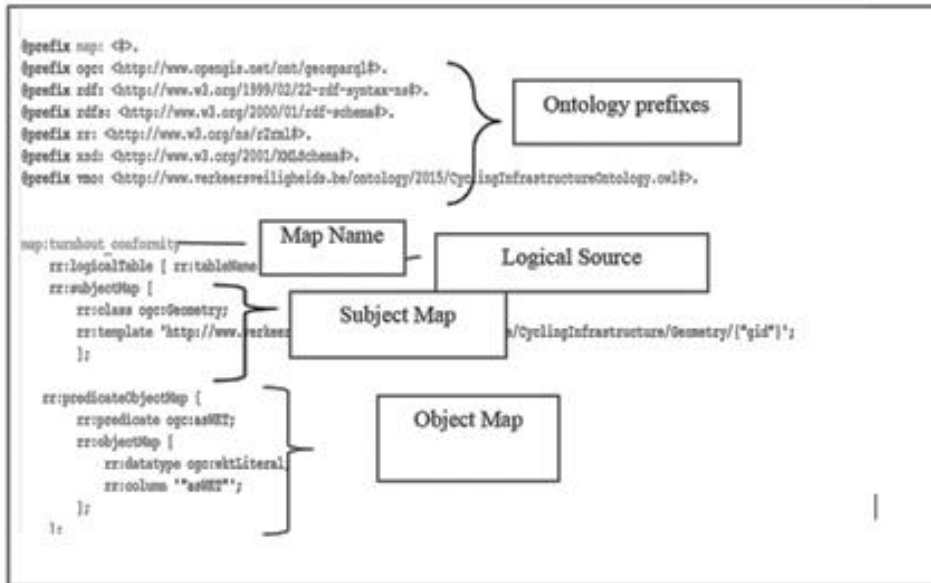


# Linked Data Generation



# Linked Data Generation

## R2RML Mapping



## RDF Conversion

- Geotriples: *n-triples*, *ttr*, *json*

< **Subject** > < **Predicate** > < **Object** >

<<http://www.verkeersveiligheidsmonitor.be/www.verkeersveiligheidsmonitor.be/data/cyclinginfrastructure/Geometry/820>>

<<http://www.opengis.net/ont/geosparql#asWKT>>  
 "<<http://www.opengis.net/def/crs/EPSSG/0/4326>>  
 MULTILINESTRING((4.92600946638259  
 51.3269502191978,4.92618826130224  
 51.3269427799245))"^^<<http://www.opengis.net/ont/geosparql#wktLiteral>> .



# Publication

[www.mobiliteitsmonitor.be](http://www.mobiliteitsmonitor.be)

The screenshot shows the homepage of the Mobiliteitsmonitor website. At the top left is the logo, which consists of a magnifying glass over a circular icon with a location pin and a signal tower, followed by the text "Mobiliteitsmonitor". To the right of the logo are links for "Login" and "Register", and a search bar with a "Search" button. Below this is a dark blue navigation bar with three menu items: "MOBILITEITSMONITOR", "OVER DE MONITOR", and "CONTACT". The main content area starts with the heading "Welkom" and a sub-heading: "De Mobiliteitsmonitor is een centrale toegangspoort voor indicatoren over mobiliteit in Vlaanderen." Below this is a section titled "Thema's" (Themes) containing five icons in a grid. Each icon is a blue circle with a white background, containing a specific symbol. The icons are labeled as follows: "Bereikbaarheid" (Reachability) with a location pin and a signal tower; "Toegankelijkheid" (Accessibility) with a stylized 'G' shape; "Leefbaarheid" (Livability) with a group of people; "Milieu" (Environment) with two leaves; and "Verkeersveiligheid" (Traffic Safety) with a road sign showing a truck and a car.

**Mobiliteitsmonitor**

Login | Register

Search

MOBILITEITSMONITOR | OVER DE MONITOR | CONTACT

## Welkom

*De Mobiliteitsmonitor is een centrale toegangspoort voor indicatoren over mobiliteit in Vlaanderen.*

### Thema's

- Bereikbaarheid
- Toegankelijkheid
- Leefbaarheid
- Milieu
- Verkeersveiligheid

# Geo-Linked data Provider

Conformiteit fietsinfrastruc... x +

mobilitymonitor.be/cms/nl/indicator/conformiteit-fietsinfrastruc

Search

N

10 km  
10 mi

Conformiteit Bovenlokaal Functioneel Fietsnetwerk met de richtlijnen uit het Vademecum Fietsvoorzieningen

- fietsinfrastructuur aanwezig, maar niet conform
- fietsinfrastructuur conform
- geen fietsinfrastructuur aanwezig, wel nodig
- geen inventarisatie
- ontbrekende gegevens over de fietsvoorziening

Download

Open data  
Fietsinfrastructuur\_conformiteit  
(shape-zip)

Download

Linked data  
Fietsinfrastructuur\_conformiteit (.nt)

# Discussion and Conclusion

Challenges and Way forward



# Lesson Learned: Geospatial LOD

- Initial stage of development
- Different software tends to use different vocabularies
- Broken links

# Smart Mobility: Road ahead

- Combining and accessing data from different sources---Best practice LOD
  - Involving citizens: dangerous cycling path (not registered in Road accidents statistics )→ crowd sourcing
  - Suitability for new type: mobility scooters,
  - Real- time traffic information

## @2016 Urban Logistics and Mobility

Funded by IWT-SBO- Research Project Urban Logistics and Mobility. Project partners : Antwerp University, UHasselt, KU Leuven, UGent en VUB.

The Flemish Policy Support Centre on Road Safety (2012-2015) funded this research. The views expressed in this paper are not necessarily those of the Flemish Government.

# Thank you



[anuja.dangol@kuleuven.be](mailto:anuja.dangol@kuleuven.be)  
[therese.steenberghen@kuleuven.be](mailto:therese.steenberghen@kuleuven.be)