

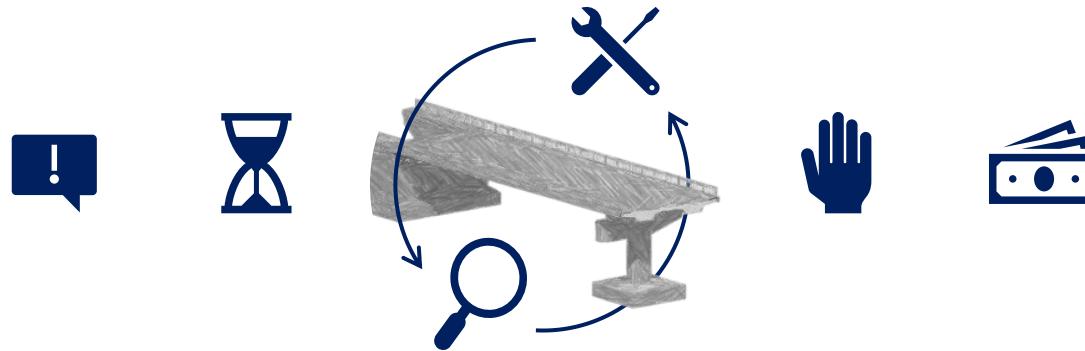
Conversion of legacy domain models into ontologies for infrastructure maintenance

Anne Göbels | Jakob Beetz
CIB W78 - LDAC 2021



Introduction

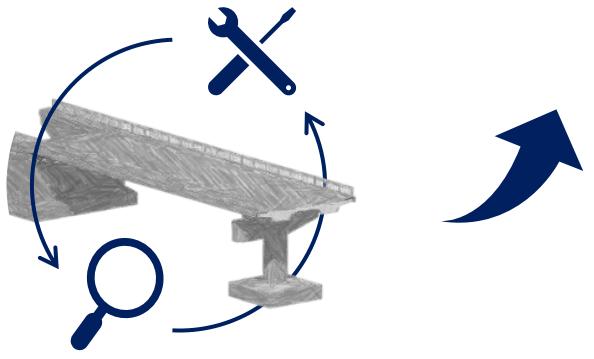
Infrastructure Maintenance



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Conversion of legacy domain models into ontologies for infrastructure maintenance

Funded by:





IFC Infra initiative



CEDR-Interlink
Project, Bridge
Ontology, etc.



Sensors,
Drones etc.



Funded by:



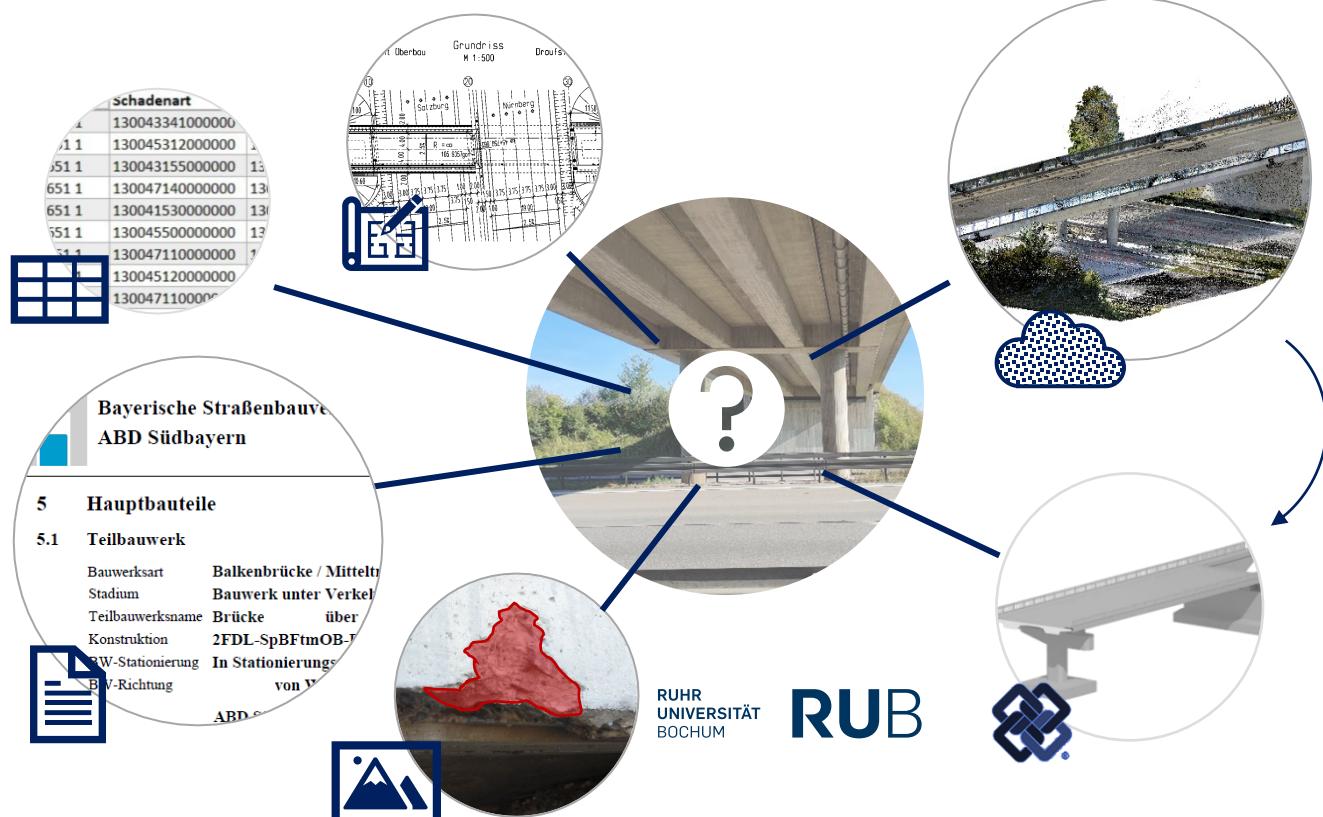
Federal Ministry
of Transport and
Digital Infrastructure



RWTH AACHEN
UNIVERSITY

TwinGen Project

Use Case Data | Partners



gia Geodätisches Institut und Lehrstuhl für Bauinformatik & Geoinformationssysteme | **RWTHAACHEN UNIVERSITY**

Technical University of Munich | **TUM**

Source: Autobahn GmbH des Bundes - Niederlassung Südbayern

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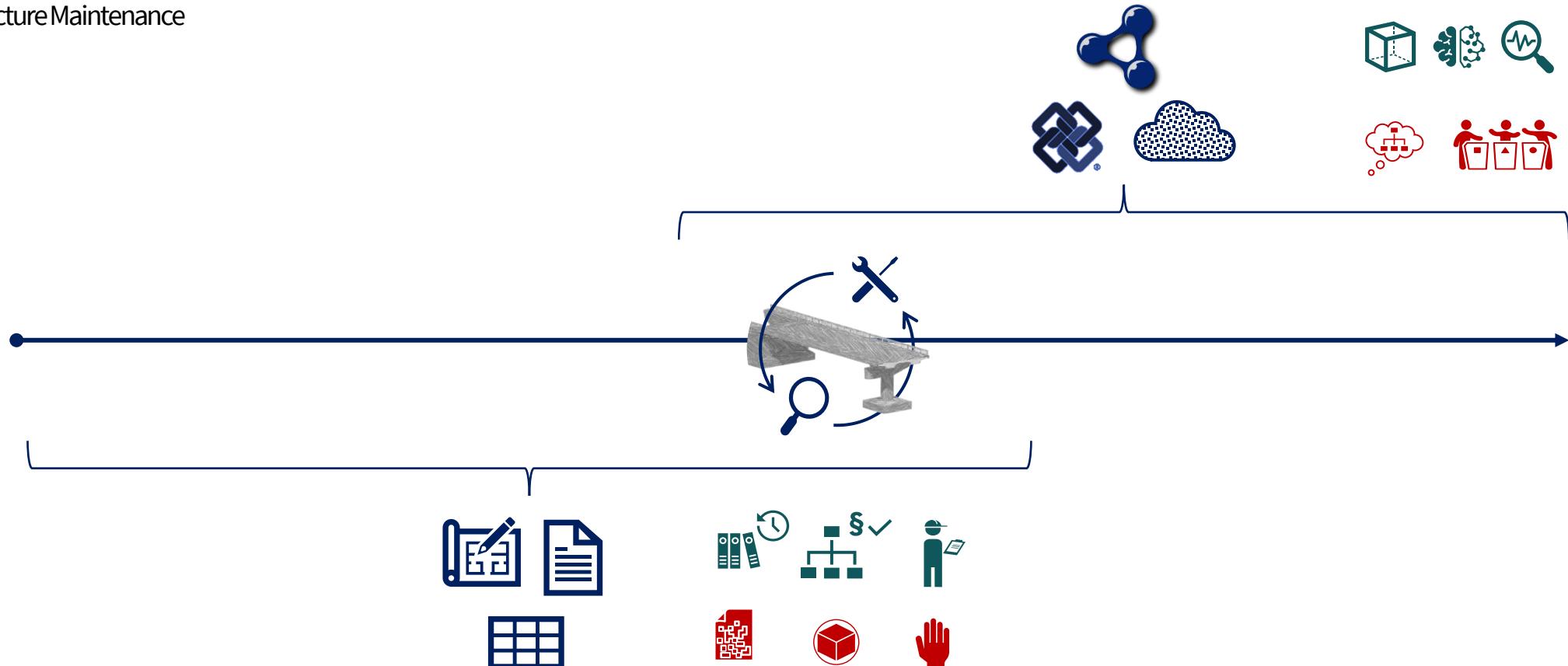
Conversion of legacy domain models into ontologies for infrastructure maintenance

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Problem Statement

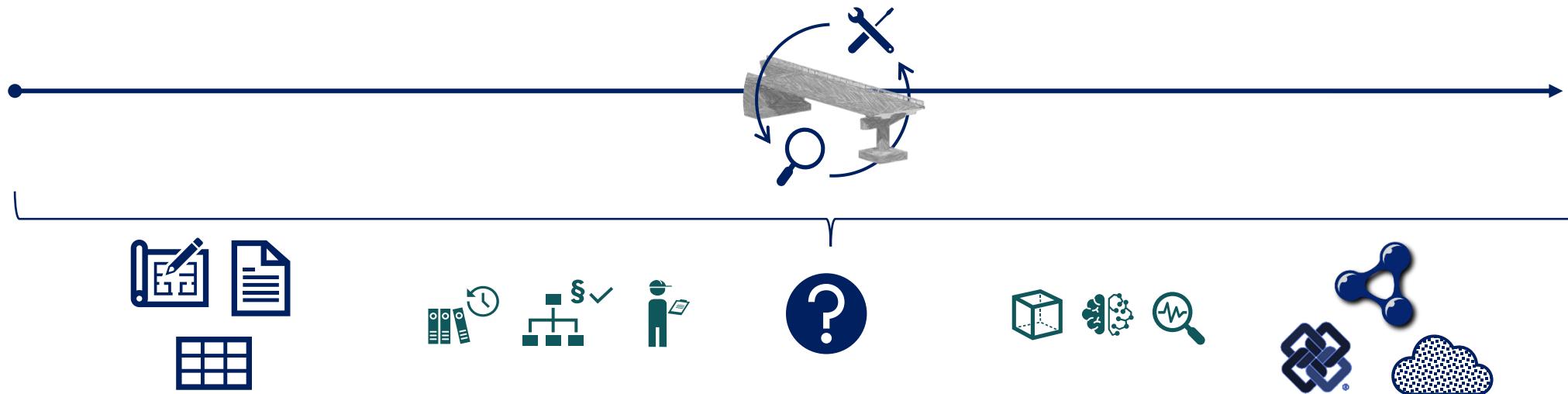
Infrastructure Maintenance

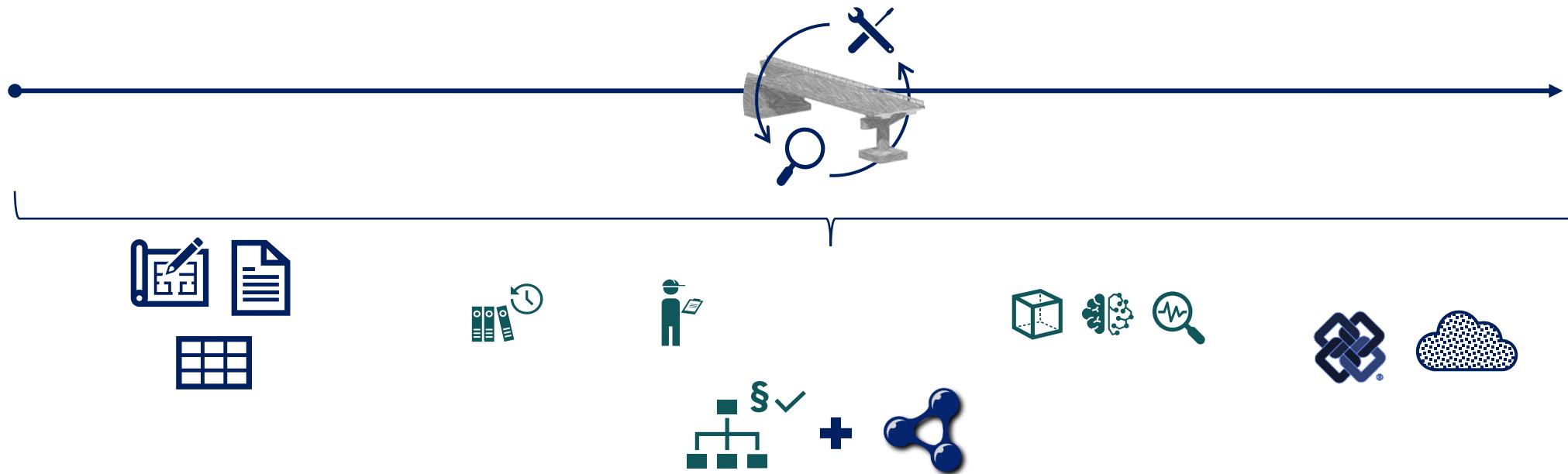


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Conversion of legacy domain models into ontologies for infrastructure maintenance

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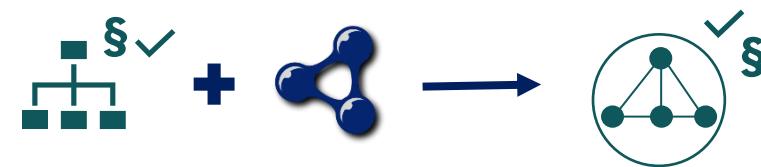


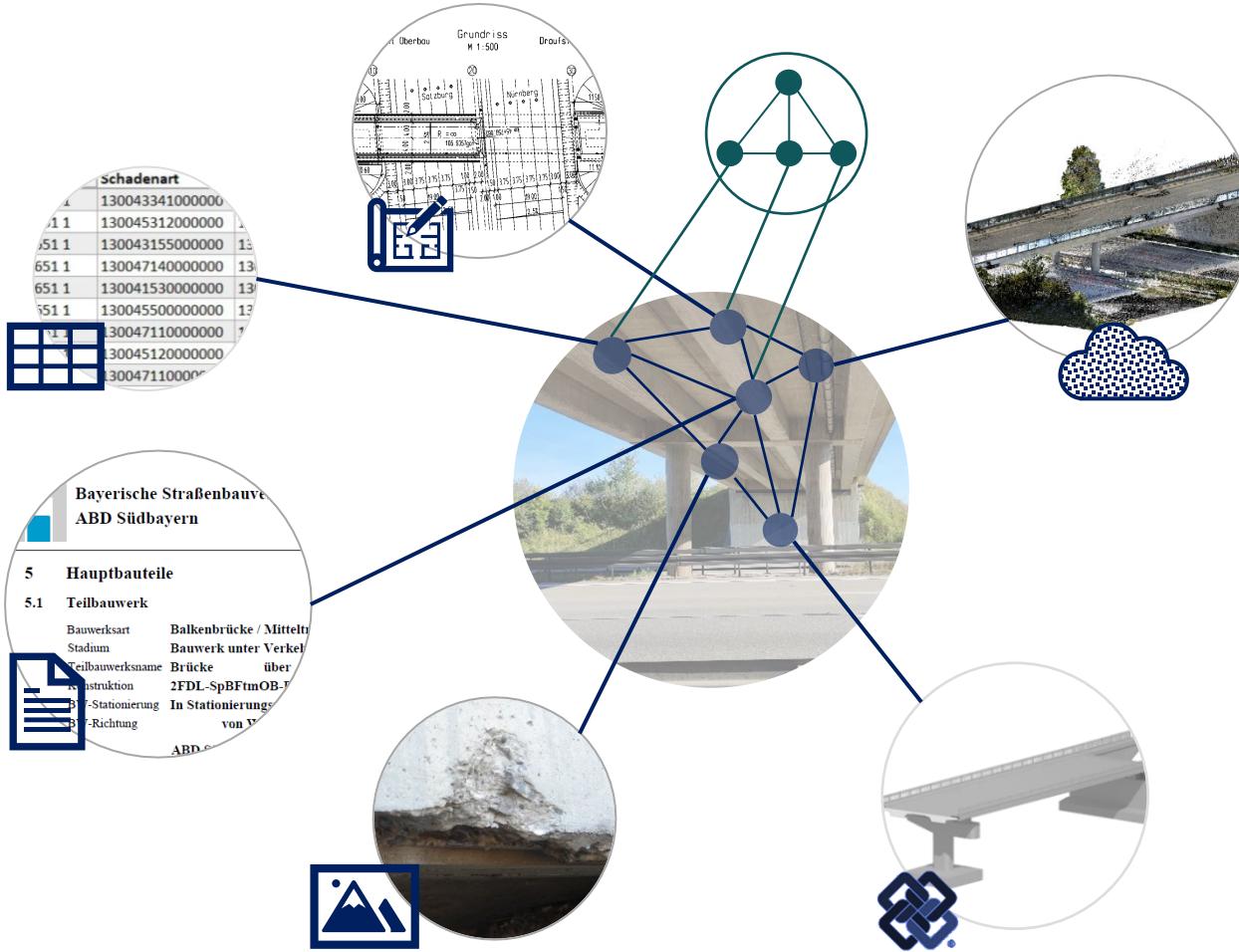
ASB-ING Ontology

Conversion of Infrastructure domain model

Legacy domain model as basis for Ontology

- Representation of existing data in Linked Data format
- Still compatible with legacy guidelines, field-tested
- Reuse of existing definitions/ rules/ constraints, no new developments





Source: Autobahn GmbH des Bundes -
Niederlassung Südbayern

ASB-ING data model

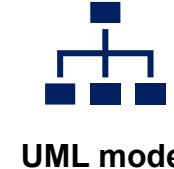
Legacy domain model for infrastructure in Germany

ASB-ING

Anweisung Straßeninformationsbank,
Teilsystem Bauwerksdaten

*[Instruction for the Road Information Database,
subsystem structural data]*

- Documentation data model for bridges and tunnels in Germany
- Only text, pictures & 2D documents
- used for ~ 40.000 bridges
- currently new version under development: **UML model**



UML model



120 classes



80 datatype classes



500 attributes



3000 predefined values



Relations & dependencies

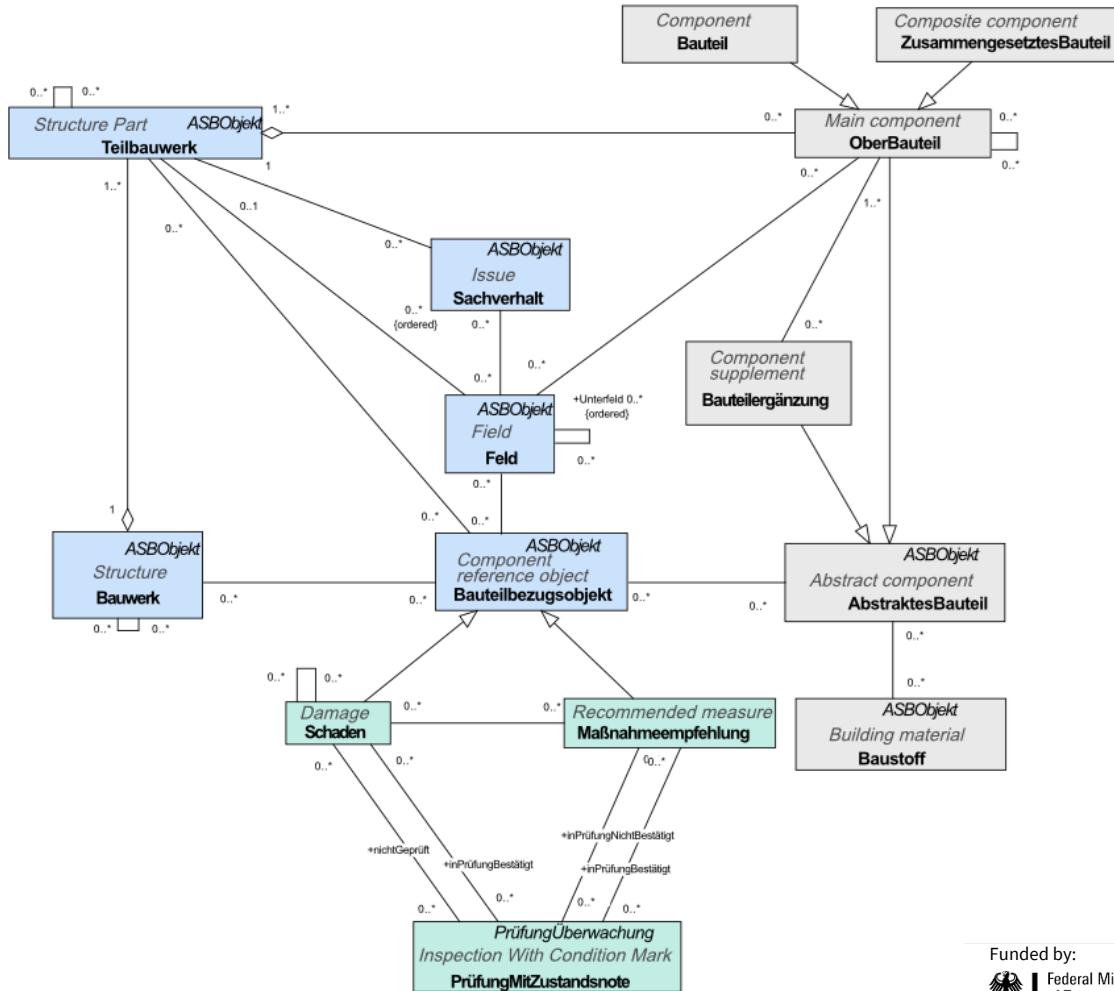
Source : ASB-ING 2013 , BASt



Metadata/ Administrative data

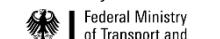
Inspection related data

Building element data



Source : Landesamt für Straßenbau und Verkehr Mecklenburg-Vorpommern

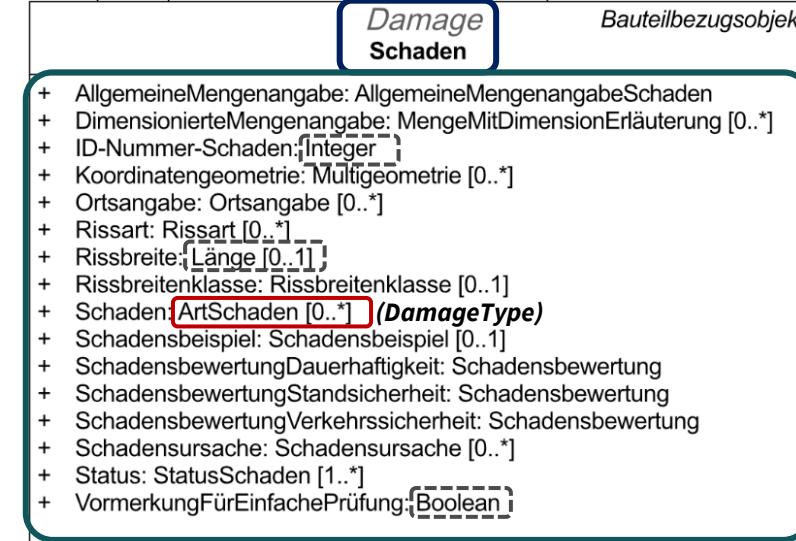
Funded by:



Federal Ministry
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Class (subjects)

Attributes (with cardinality)

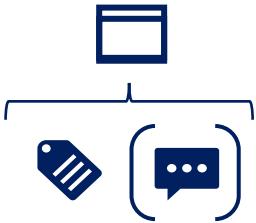
Datatype definitions:

- textual/ numerical values
- values from “Schlüsseltabellen”
(key tables)

Source : Landesamt für Straßenbau und
Verkehr Mecklenburg-Vorpommern

Funded by:





key table class

- Attributes : key & text
- Constraints: predefined value options

Class : ArtSchaden (DamageType)

Constraint: Werteliste

B I U A | |

'3.3', 'Material', 'b'
'3.3.1', 'abgearbeitet'
'3.3.2', 'abgefahren'
'3.3.3', 'abgelöst'
'3.3.4', 'abgeplattet'
'3.3.5', 'abgerissen'
'3.3.6', 'abgerutscht'
'3.3.7', 'abgesichert'
'3.3.8', 'Absatz'
'3.3.9', 'absturzgefährdet'
'3.3.10', 'Alkalischäden'
'3.3.11', 'allgemein'
'3.3.12', 'angesault'
'3.3.13', 'ausgeschlagen'
'3.3.14', 'Beton ohne ausreichenden Zuschlag'
'3.3.15', 'brüchig'
'3.3.16', 'chloridbelastet'
'3.3.17', 'einsacken'

Constraints

Key table: DamageType

**ID / key
Text**

«Schlüsseltabelle»	
Schlüsseltabellen: ArtSchaden	
+ Kennung: CharacterString	
+ Langtext: CharacterString	

Source : Landesamt für Straßenbau und Verkehr Mecklenburg-Vorpommern

Funded by:

ASB-ING Ontology

Conversion process



ASB-ING Ontology

asb: <https://w3id.org/asbingowl/core#>



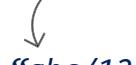
owl:Class



owl:ObjectProperty



owl:DatatypeProperty



rdfs:subClassOf



asb:isPartOf



asb:associatedWith

ASB-ING Ontology

prefix asb:<https://w3id.org/asbingowl/core>

Ontology Specification Draft

ASB-ING Ontology

This version:
<https://w3id.org/asbingowl/core>

Authors:
Anne Göbels, RWTH Aachen, Design Computation

Imported Ontologies:
[Web Ontology Language](#)
[RDF-Schema](#)
[XML-Schema](#)

Download serialization:
[Format JSON LD](#) [Format RDF/XML](#) [Format N Triples](#) [Format TTL](#)

License:
[License Creative Commons](#)

Visualization:
[Visualize with WebVowl](#)

Ontology Specification Draft

Bruecke_ArtQuerschnitt^{op}

[back to ToC or Object Property ToC](#)

IRI: https://w3id.org/asbingowl/core#Bruecke_ArtQuerschnitt

Angabe der Tragwerksquerschnitte des Ueberbaus. Alt: Der Tragwerksquerschnitt des Ueberbaus ist zu erfassen. Bei Bruecken kommt manchmal ein Wechsel des Querschnitts vor. In solchen Faellen ist im Allgemeinen der Querschnitt anzugeben, der ueberwiegt auftritt. Haben mehrere aufeinander folgende Felder einen gleichen Querschnitt und mehrere daran anschliessende Felder einen anderen Querschnitt, kann es sinnvoll sein, das Brueckenbauwerk auch dann in mehrere Teilbauwerke aufzuteilen, wenn durchgehende Fugen fehlen.

has super-properties
[hat_schlüssel_kennung](#) ^{op}
has domain
[Bruecke](#) ^c
has range
[ArtQuerschnittBruecke](#) ^c

Bauwerk^c

IRI: <https://w3id.org/asbingowl/core#Bauwerk>

is equivalent to
[Bauwerk_Bauwerksnummer](#) ^{dp} min 1
[Bauwerk_NaechstgelegenerOrt](#) ^{dp} max 1

has super-classes

[ASBObjekt](#) ^c

is in domain of

[Bauwerk_Bauwerksnummer](#) ^{dp}, [Bauwerk_NaechstgelegenerOrt](#) ^{dp}, [associatedWith](#) ^{op}

is in range of

[isPartOf](#) ^{op}

is also defined as
[named individual](#)

ASB-ING Ontology

Key table classes into sub-ontology



ASB-ING Ontology

asb: <https://w3id.org/asbingowl/core#>

asbkey: <https://w3id.org/asbingowl/keys#>



asbkey:Class



ASB-ING Ontology

asb: <https://w3id.org/asbingowl/core#>

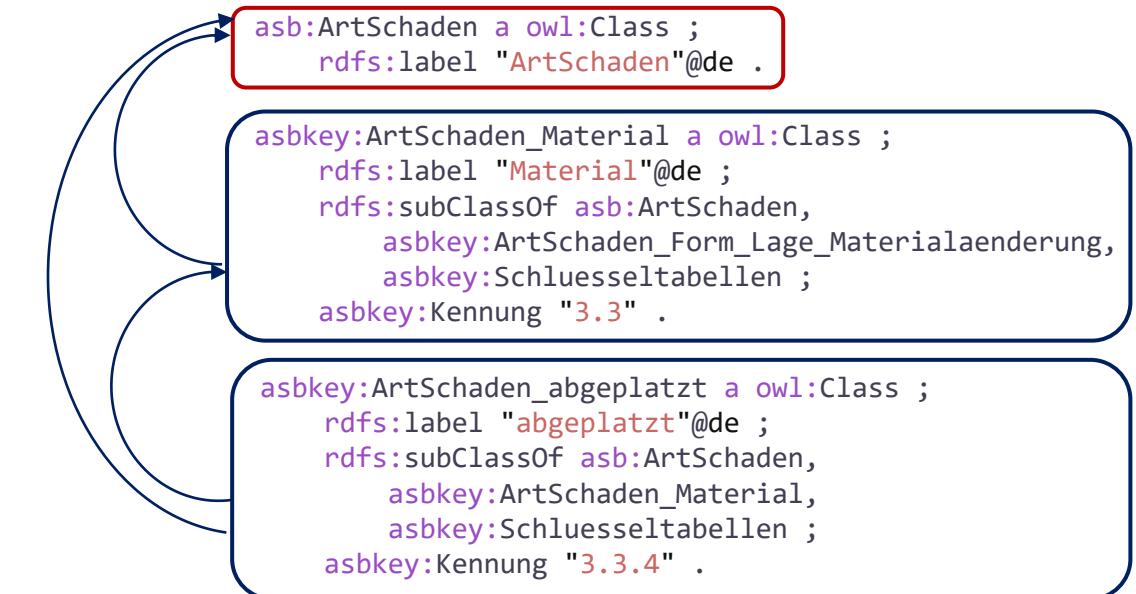
asbkey: <https://w3id.org/asbingowl/keys#>

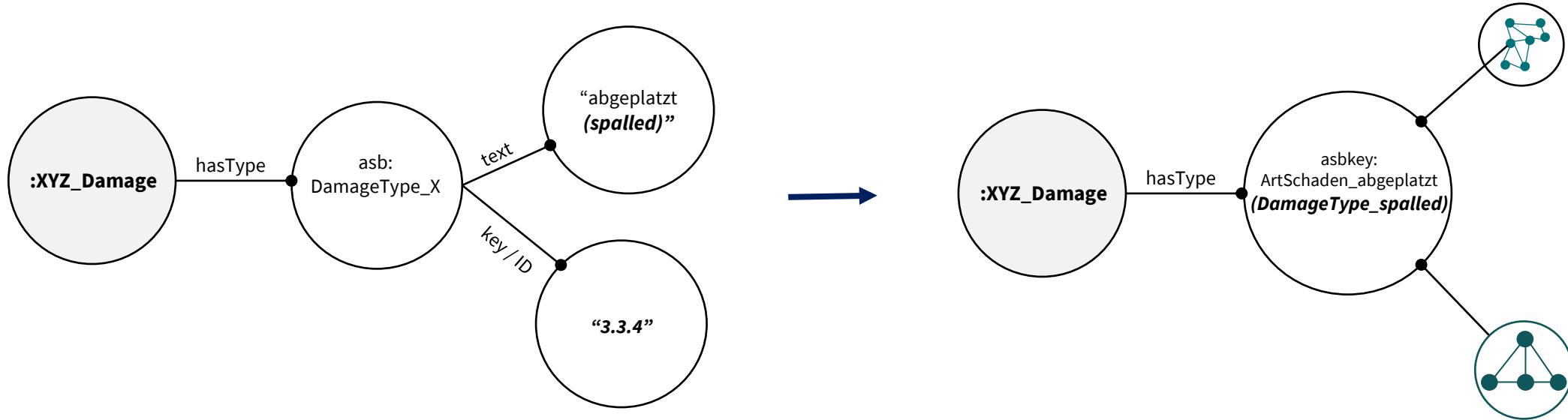
Class : ArtSchaden (DamageType)

Properties
General
Responsibilities
Requirements
Constraints
Scenarios
Files
Related
Links

Constraint:
Werteliste

B I U A [3.3], 'Material', 'b'
'3.3.1', 'abgearbeitet'
'3.3.2', 'abgefahren'
'3.3.3', 'abgelöst'
'3.3.4', 'abgeplatzt' ('spalled')
'3.3.5', 'abgerissen'
'3.3.6', 'abgerutscht'





ASB-ING Ontology

Overview



Core Ontology

asb: <https://w3id.org/asbingowl/core#>

Classes: 462

Object prop.: 548

Datatype prop.: 347



Sub-Ontology (vocabulary) : New Keys

asbkey: <https://w3id.org/asbingowl/keys#>

Classes: 3.463

Object prop.: 0

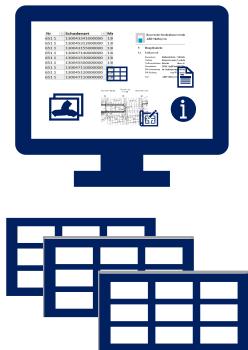
Datatype prop.: 1

Conversion Script on GitHub:
<https://github.com/AnneGoebels/ASB-ING Ontology>

ASB-ING Ontology

Application

Current Bridge/Inspection Data Documentation



~ 40.000 bridges,
for 20 years

SIB-BAUWERKE

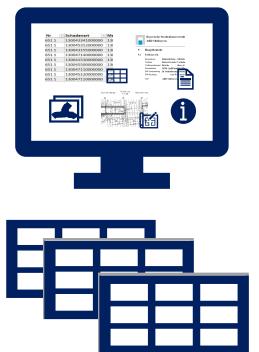
Bauwerksnummer: 4807506	1 Interne BWnr. Km.: 001,823	Nr. 1 Anz. 3
Hauptdaten Zusatzangaben		
Teilbauwerk		
Bauwerksname: AS Düsseldorf-Benrath		
Bauversatz: Plattenbalken		
Konstruktion: Durchlaufplatte über 3 Felder		
Stadium: Bauwerk unter Verkehr		
BW-Richtung: Düsseldorf Süd - Leverkusen West		
BW-Stationierung: Gegen Stationierungsrichtung		
Amt: RNL Rhein-Berg		
Meisterer: AM Leverkusen		
Baulastkonstrukt: Bund		
Anderes Bauwerk nach DIN 1076: Nein		
Uf/Ua-pflichtiger Partner:		
Baujahr: --		
Int. Sortierschl.: --		
Datenfer. abgesch.: Ja		
Letzte Bearbeitung: 20.01.2009 11:02:36 Bearbeiter: [redacted]		
Bauamnahrmen Prüfanweisungen Durchgeführte Prüfungen Prüfung / Zustand		
Entwürfe, Berechnungen	Prüffahrzeuge, -geräte	Sachverhalte
Verwaltungsmassnahmen	Anlagen BW-Buch	Datenaktion
Brücke Bilder Zeichn. Dokumente		



Schadenart	MengeAllgemein	ID Schaden	Pruefjahr	SchadenID
130043341000000	130053500000000	WR0RNE35	2017	14
130045312000000	130053200000000	WR0RL2RV	2017	31
130043155000000	130053500000000	WSOEF SKL	2017	32
130047140000000	130053500000000	WS0EP2TP	2017	21
130041530000000	130051800000000	WS0FCB98	2017	43
130045500000000	130053200000000	W30EL9GG	2017	5
130047110000000	130053200000000	WS0E4TRD	2017	41
130045120000000	130051900000000	WS0F1XZP	2017	17
130047110000000	130052100000000	WS0F7KCL	2017	33

Source : ZPP Ingenieure

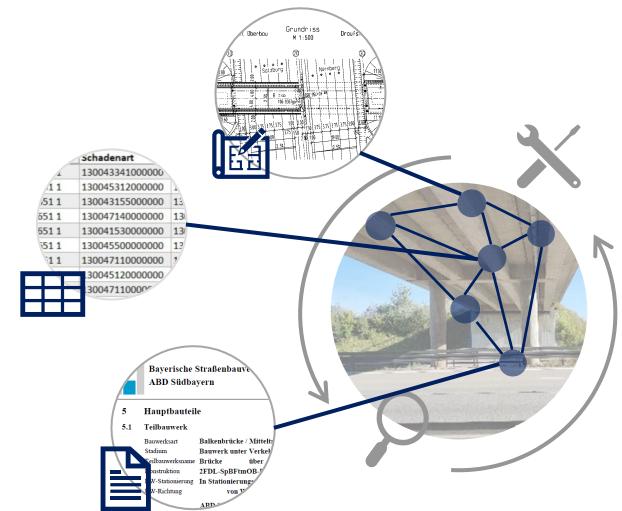
Current Bridge/Inspection Data Documentation

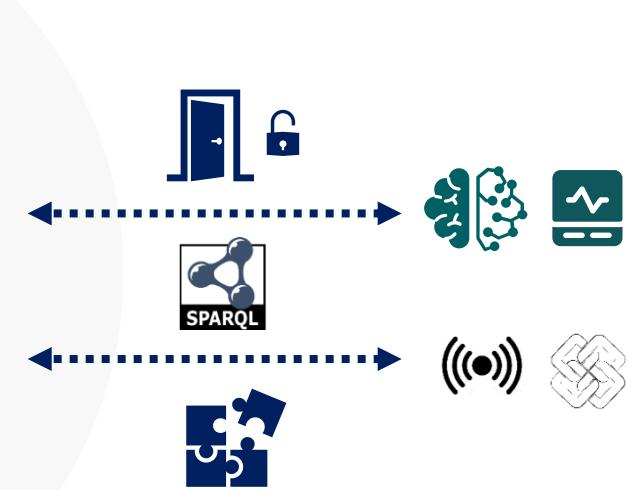
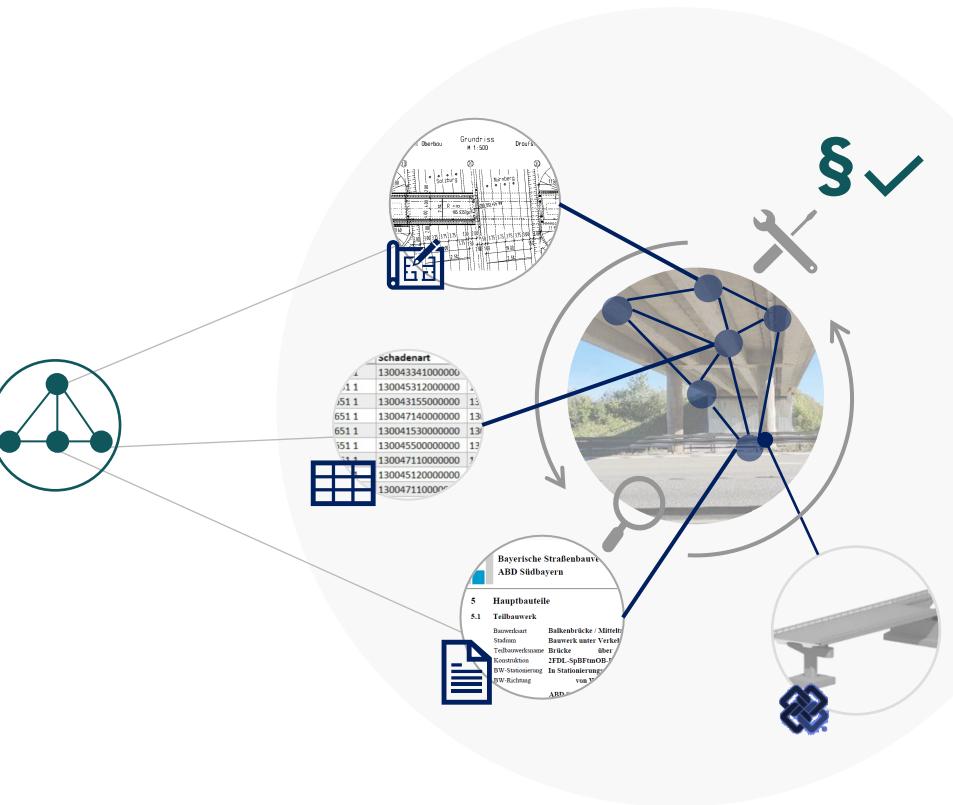
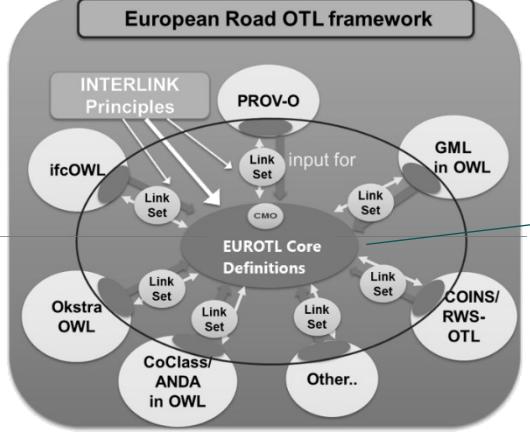


~ 40.000 bridges,
for 20 years



Linked Data Model of Bridge/Inspection Data





Conclusion



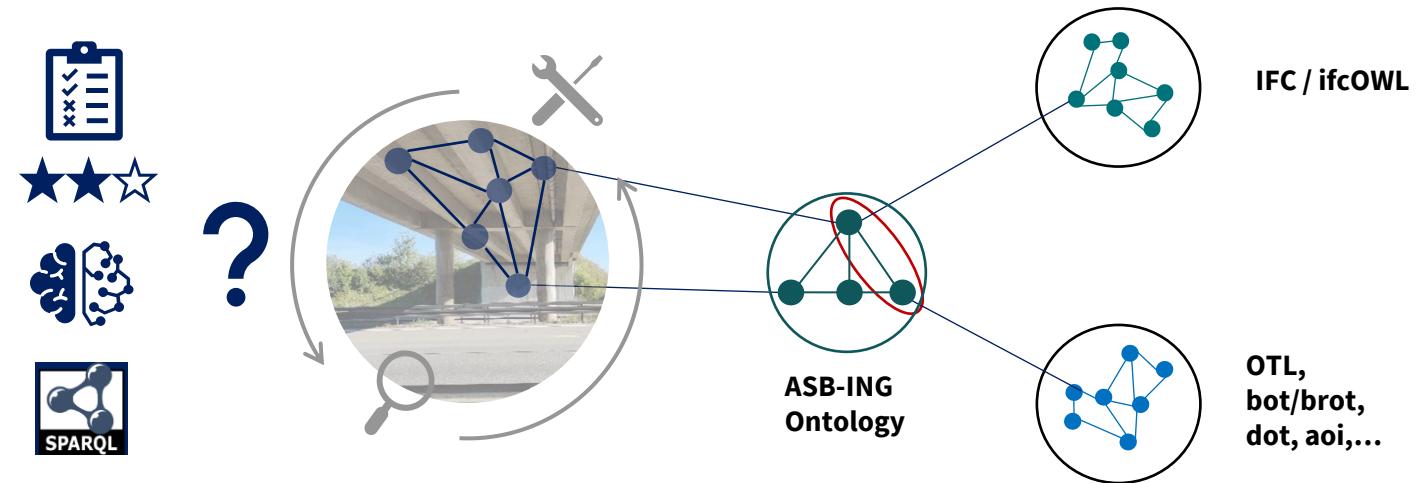
- compliant with national standard
- No new development/ definitions of classes and relations etc.
- effortless Linked Data representation of existing bridge/inspection data
- access to extensive data resource (for AI, ML technologies)
- support the Interlink approach for infrastructure information exchange



Weakness of original ASB-ING data model

- too extensive / complex
- Sometimes inconsistent and no straightforward solutions
- External links only for a subset of classes feasible
- not comply with ontology development method: creating as few new classes and properties as possible

Future Work



Acknowledgements

This research is part of the **TwinGen** project funded by the Federal Ministry of Transport and Digital Infrastructure (BMVI). We would like to thank the **Autobahn GmbH des Bundes - Niederlassung Südbayern** for their support.

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Thank you for your attention!

