



## TOWARDS USABLE ICDD CONTAINERS FOR ONTOLOGY-DRIVEN DATA LINKING AND LINK VALIDATION

Philipp Hagedorn (RUB), Madhumitha Senthilvel (RWTH), Hans Schevers (BuildingBits),  
Lucas B. Verhelst (BIM-Connected)

# Towards usable ICDD containers



Hans  
Works together with Lucas

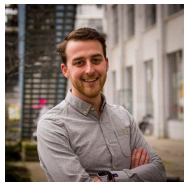
We all worked with ICDD and were connected by **Pieter Pauwels** after a Master Thesis Defense at TU/e.

RUHR  
UNIVERSITÄT  
BOCHUM

RUB



Philipp  
PhD Exchange



Lucas  
Works in Eindhoven



TU/e



Madhumitha  
PhD Exchange

- Discussed ICDD in research and practice
- Recognized issues when ICDD is implemented
- Proceeded to write this (discussion) paper

# Towards usable ICDD containers

- **Aim of ICDD:**

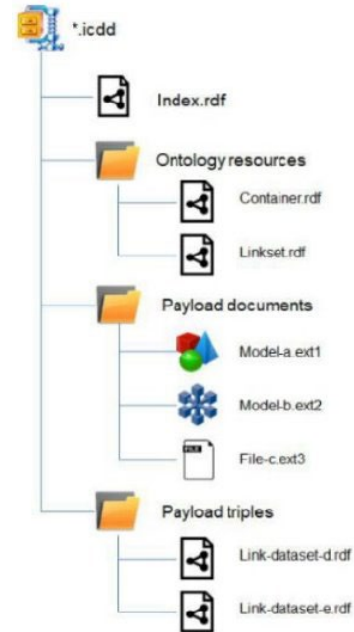
Provide a vendor-neutral structure for exchanging heterogeneous distributed building data

- Part 1

- specifies a container with a structure that holds the payload
- Index.rdf: metadata of contained files
- Linkset files: (deep) links between these files

- Part 2: extended linkset

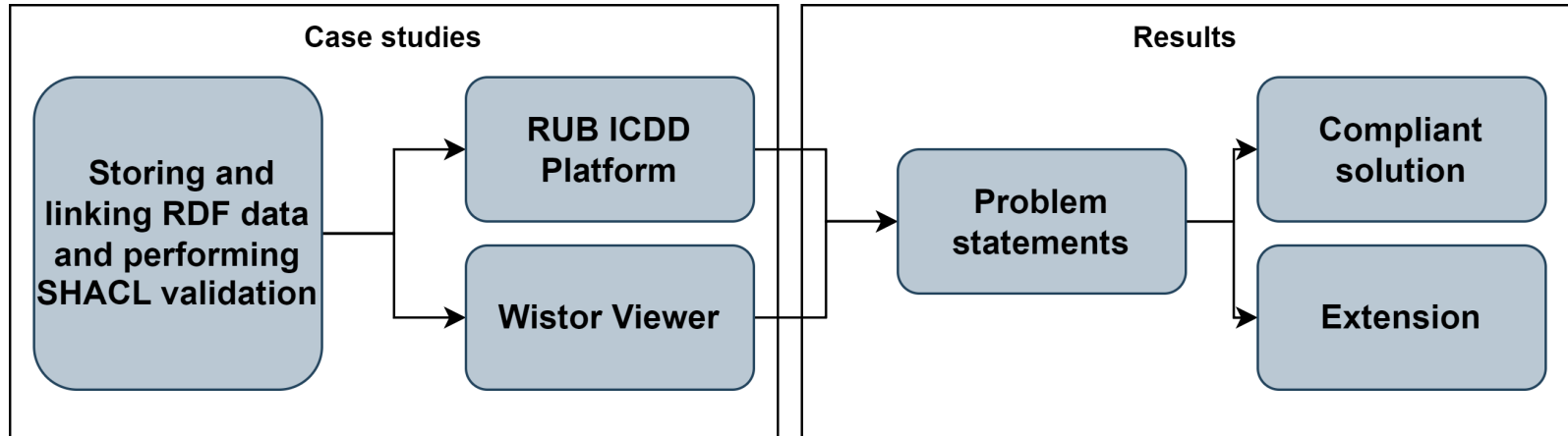
- Encoded in Semantic Web formats, i.e., RDF and OWL



Source: ISO 21597-1

# Towards usable ICDD containers

*How can we make linking and validation of heterogeneous data in ICDD containers more usable?*



# RUB ICDD Platform

- Collaboration platform based on ICDD containers
- Option to store **RDF files** either in payload documents or in payload triples
- Registers **RDF files** from payload triples additionally using an extension of the external document class
- Enables **SHACL exchange requirements** as payload triples or remotely as external documents

The screenshot displays the RUB ICDD Platform interface. At the top, there is a navigation bar with the logo of the Chair of Computing in Engineering, the text 'RUB ICDD PLATFORM [DEV]', and links for HOME, PROJECTS, SHAPES, DOCUMENTATION, API, CONTACT, and ADMIN AREA. On the right, there is a user profile for 'philippagedorn' with a LOGOUT button and the RUB logo.

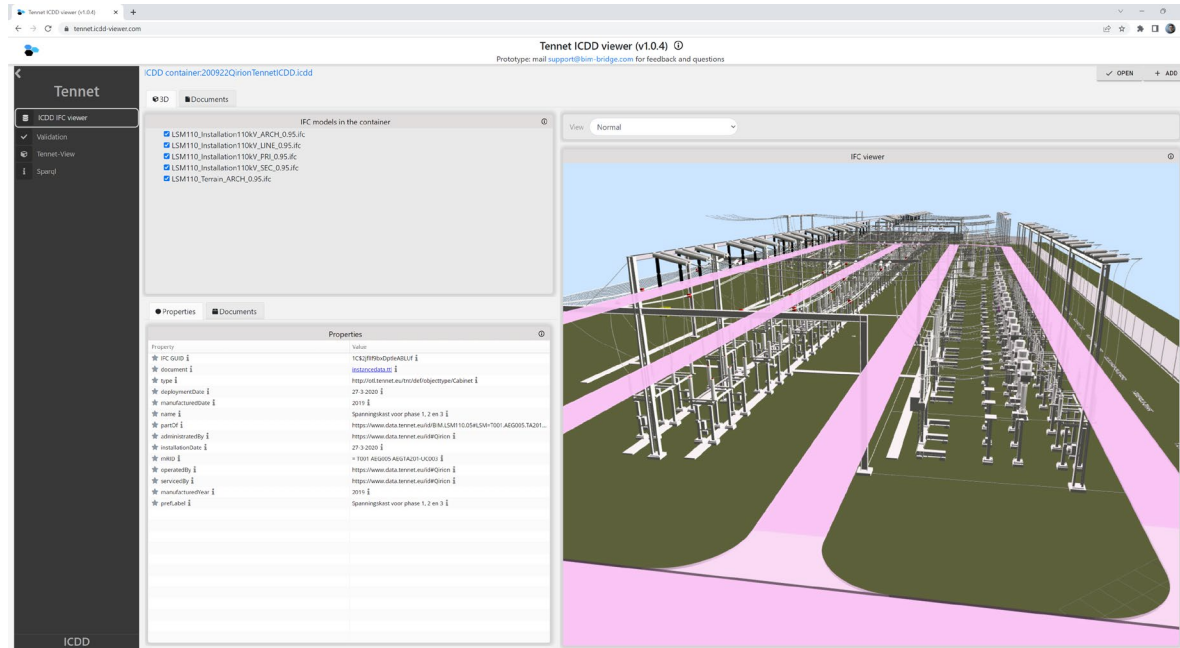
The main interface is divided into three panels:

- EXPLORER:** Shows a tree view of the 'LinkageDemo' container. The tree includes 'RdfAsPayloadTriples.icdd', 'index.rdf', 'Ontology Resources' (with sub-items 'Container.rdf', 'Linkset.rdf', 'ExtendedLinkset.rdf', 'ExtendedDocument.rdf'), 'Payload documents' (with 'model.ifc'), and 'Payload triples' (with 'UriBasedLinks.rdf', 'StringBasedLinks.rdf', 'GeneratedGraph.ttl', and 'RdfAsPayloadDocument.icdd (change container)').
- CONTENT:** Displays the 'UriBasedLinks.rdf' document. It features a 'LINKS' section with a search bar and a table showing one link. The table has columns for 'Type', 'From / Left', 'To / Right', and 'Info'. The link shown is between 'model.ifc' (GUID: 802f95c472f810e0a3f8e1) and 'GeneratedGraph.ttl' (URL: https://icdd.vw.rub.de/ontology/sb188Activity\_20).
- PROPERTIES:** Shows a 3D model of a building structure. Below the model are controls for 'Transparency mode' and 'Orbit', along with a 'Reset viewer' button. The 'Model' section shows 'model.ifc' with a 'Visibility' toggle set to 'on'. The 'Selected elements' section lists '802f95c472f810e0a3f8e1'.

At the bottom of the interface, there are buttons for 'Remove', 'Export as ttl', and 'Export as icdd'. A footer at the very bottom reads 'Disclaimer & Licenses - Version - Copyright 2022 by Chair of Computing in Engineering, Ruhr University Bochum'.

# Wistor ICDD Viewer

- Based on **low code platform**
- **Opening, validating and viewing** ICDD containers
- **Validation** of ICDD container, SHACL restrictions and IFC files
- **Viewing validation results** in an integrated way from different perspectives
- **Dashboards** with validation results and statistics about ICDD container

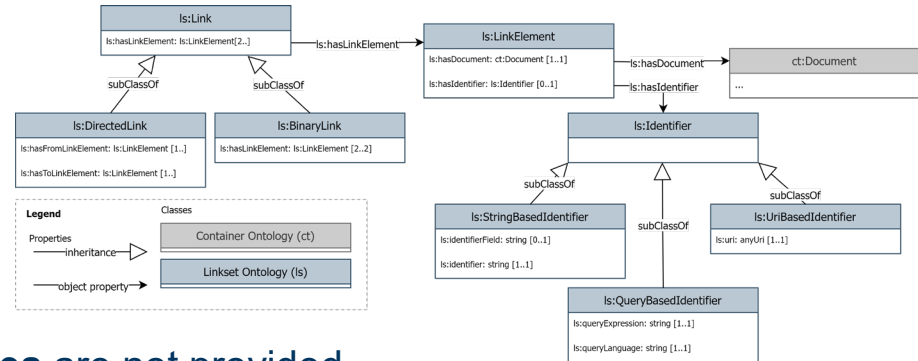




# Towards usable ICDD containers

## ■ Problem statements

1. Linking mechanism of ICDD is unnecessarily **cumbersome** for linking RDF data
2. **Overhead** of the linking structure in ICDD may lead to redundancy
3. **Storing and/or registering RDF data in ICDD** is not fully resolved in the standard<sup>1</sup>
4. **SHACL exchange requirements for ICDD containers** only provided for conformance not for content validation
5. **Extensions** of the ontologies are **not allowed** by the standard
6. **Standard formats for deep link references** are not provided



<sup>1</sup> According to the conformance criteria in 6.2 f) of ISO 21597-2, RDF data must be placed in the Payload triples folder and is thus not registered in the index file of the container.

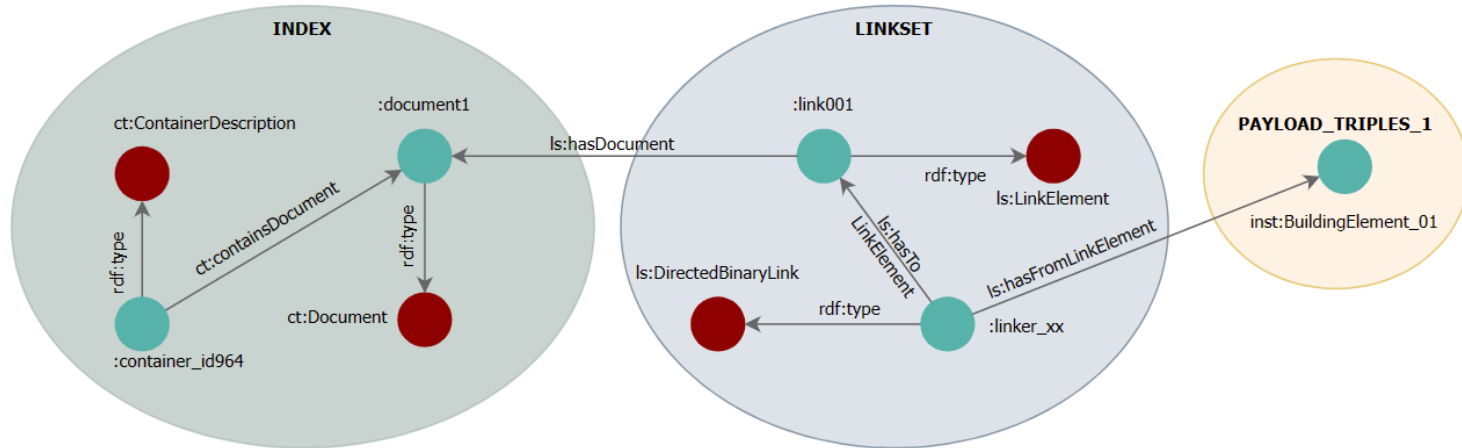




# Solution 1 for extending the standard

## Referring to an RDF entity in the payload triples directly

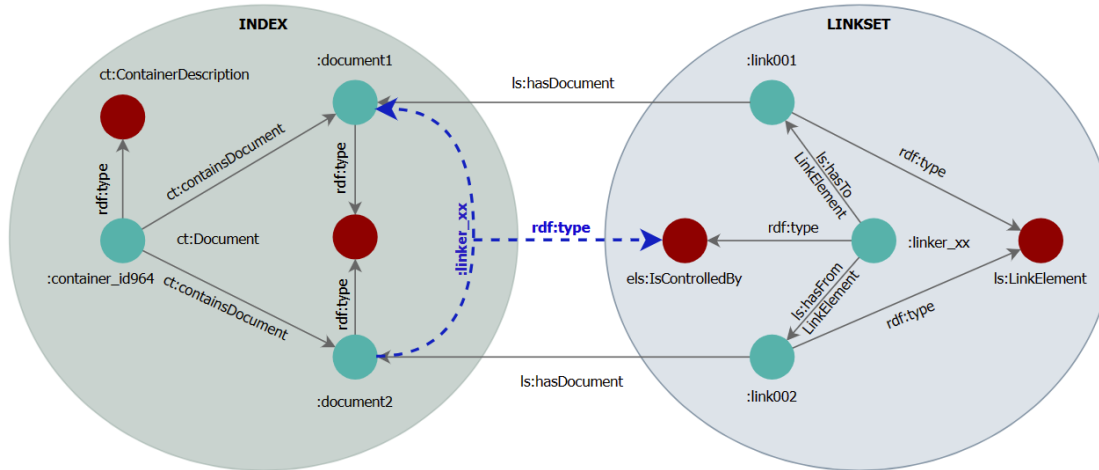
- Referencing the RDF node directly from any `Is:Link` instance
- Possible with weaker restrictions on `Is:hasFromLinkElement`, `Is:hasToLinkElement` and `Is:hasLinkElement` (introduce as a super-property)



# Solution 2 for extending the standard

## Direct linking mechanism between documents using the extended linkset vocabulary

- Retain original folder-based structure of ICDD and omit mandatory declaration of both `ls:Link` and `ls:LinkElement`
- Unrestricted usage of linktypes – assign a link class as a property value directly – inspired by Noy et al.<sup>2</sup>



2) N. Noy, M. Uschold, C. Welty, Representing Classes As Property Values on the Semantic Web, 2005. URL: <https://www.w3.org/TR/2005/NOTE-swbp-classes-as-values-20050405/>.

# Conclusions and Recommendations

1. **The benefits of LD are not realized** by treating the datasets as normal documents.
2. To realize the benefits of LD in containers, the **extensions of classes and properties of the ICDD ontologies should be allowed.**
3. The storage of internal and external **RDF files should be registered in the index file.**
4. Encoding data requirements as SHACL shapes in the container  
→ **registered inside the index file with (e.g.) hasRequirements property**
5. Supplemental agreements:
  - **Structuring link elements**
  - **Identifiers for specific file types**, e.g., IFC, GIS, or spreadsheets  
→ help interpret the links inside ICDD in different systems uniquely



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# Compliant solution (stay within the standard)

For unique identification of entities in other file types (IFC models, GIS data, or calculation spreadsheets)

- Establish common understanding on the use of `Is:StringBasedIdentifier`

**Known Issues – two prototypical implementations show:**

- For IFC documents, different key-value pairs for referring to the IFC GUID can be used for linking, e.g., when utilizing different keys: "GUID", "globalID", "IFC GUID".

**Hard for software systems to implement ICDD in an interoperable way.**