



**MEDINFO'21**

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# **TermiCron: Bridging the Gap between FHIR Terminology Servers and Metadata Repositories**

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# Why is Metadata Needed?



- More and more medical data captured every year
- Secondary Use: Re-use of clinical data in research studies

Hospital A	Hospital B	Hospital C
<b>Condition</b> Problem/Dx Cancer Body site Lung Status <input checked="" type="radio"/> Suspected <input type="radio"/> Confirmed <input type="radio"/> Not found OK Cancel	<b>Problem</b> Problem/Dx Name Lung cancer Status Suspected OK Cancel	<b>Diagnosis</b> Name Suspected lung cancer OK Cancel

## Why is Metadata Needed?



- More and more medical data captured every year
- Secondary Use: Re-use of clinical data in research studies
- Field of healthcare is broad and comprehensive
  - Different areas of study
  - Own naming systems and requirements
  - Dependency on context
- Large diversity of data models for capturing similar pieces of information

Hospital A	Hospital B	Hospital C
<b>Condition</b>	<b>Problem</b>	<b>Diagnosis</b>
Problem/Dx Cancer	Problem/Dx Name Lung cancer	Name Suspected lung cancer
Body site Lung	Status Suspected	
Status <input checked="" type="radio"/> Suspected <input type="radio"/> Confirmed <input type="radio"/> Not found		
OK Cancel	OK Cancel	OK Cancel

# Metadata and Metadata Repositories



- „Data About Data“
- Structured, atomic, units of information that describe data

The screenshot displays a web interface for a metadata repository. At the top, a header bar shows 'Administrative Movement Data' with a URL 'urn:miracum1:dataelementgroup:68:3' and a star icon. Below this, a sub-header also reads 'Administrative Movement Data'. The main content area features a red vertical bar on the left and a star icon on the right. The central text describes the 'Date of admission to the department' with the URL 'urn:miracum1:dataelement:814:1'. It states: 'In the case of prehospital treatment, the first day of full inpatient treatment (admission date) must be indicated. The change from preadmission to full admission within the same department does not have to be documented by a separate repetition of the department information.' Below this text is a configuration panel with the following fields: 'Validationtype' set to 'Datetime', 'Date representation' set to 'YYYY-MM-DD, YYYY-MM (ISO 8601)', 'Time representation' set to 'The 24 hours time format (22:34:54, 22:34)', and a 'With seconds' checkbox that is currently unchecked.



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  - Annotation of data elements with standard terminology, such as SNOMED CT

The screenshot displays a web interface for a metadata repository. At the top, there is a header for 'Administrative Movement Data' with a URL 'urn:miracum1:dataelementgroup:68:3'. Below this, a specific data element is shown: 'Date of admission to the department' with a URL 'urn:miracum1:dataelement:814:1'. A descriptive text explains that this date must be indicated for prehospital treatment and that changes in admission status within the same department do not require a new entry. Below the text, there are several configuration options: 'Validationtype' set to 'Datetime', 'Date representation' set to 'YYYY-MM-DD, YYYY-MM (ISO 8601)', 'Time representation' set to 'The 24 hours time format (22:34:54, 22:34)', and a 'With seconds' checkbox which is currently unchecked.



- „Data About Data“
- Structured, atomic, units of information that describe data
- Semantic associations and relationships between shared entities
  - Annotation of data elements with standard terminology, such as SNOMED CT
- Metadata Repositories store metadata at the schema level (e.g. attributes, data types, relations, annotations, ...) for data elements
- ISO/IEC 21526, ISO/IEC 11179, et al., for Medical Metadata Repositories (MDRs)

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MDRs are a lot of work.

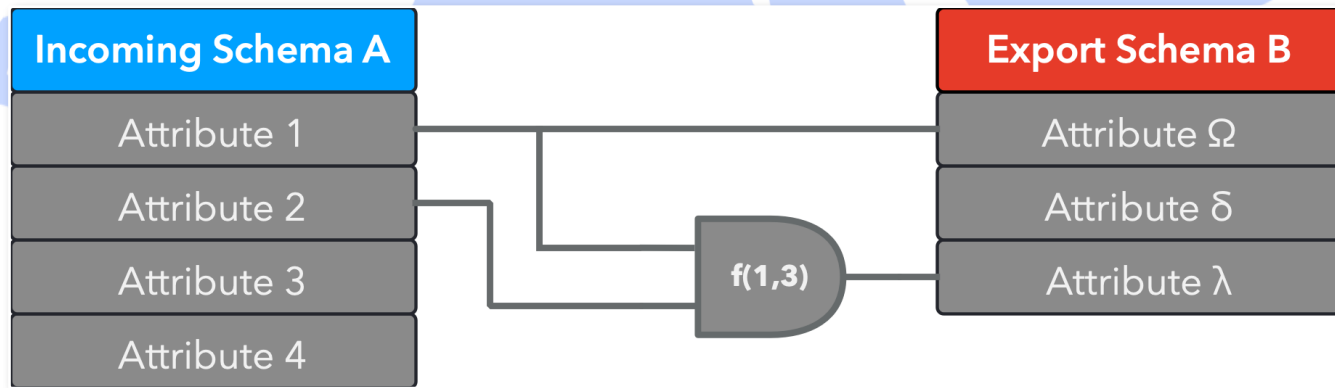


Image: Going from Schema A to Schema B takes a lot of work.

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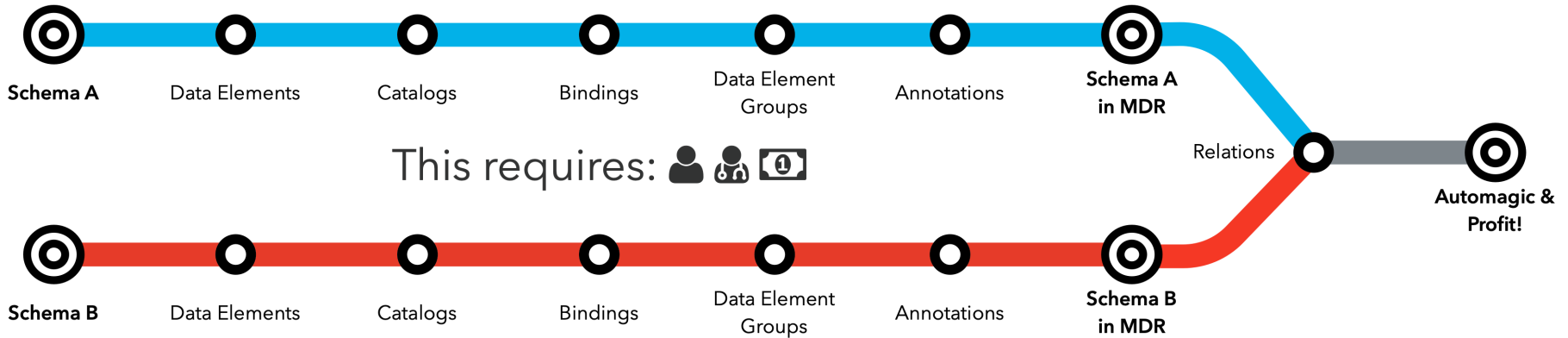
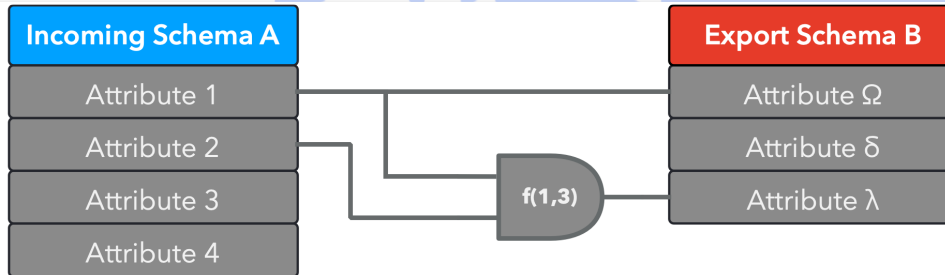
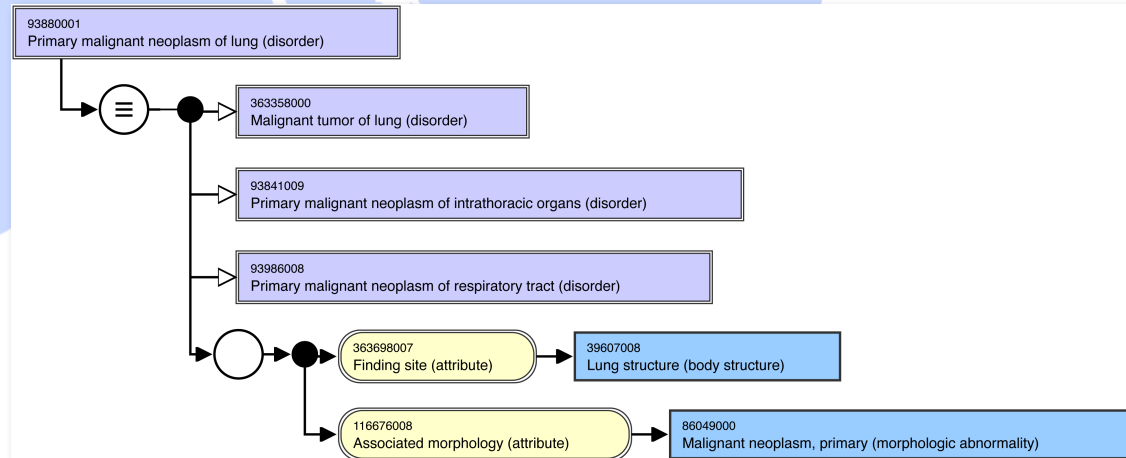


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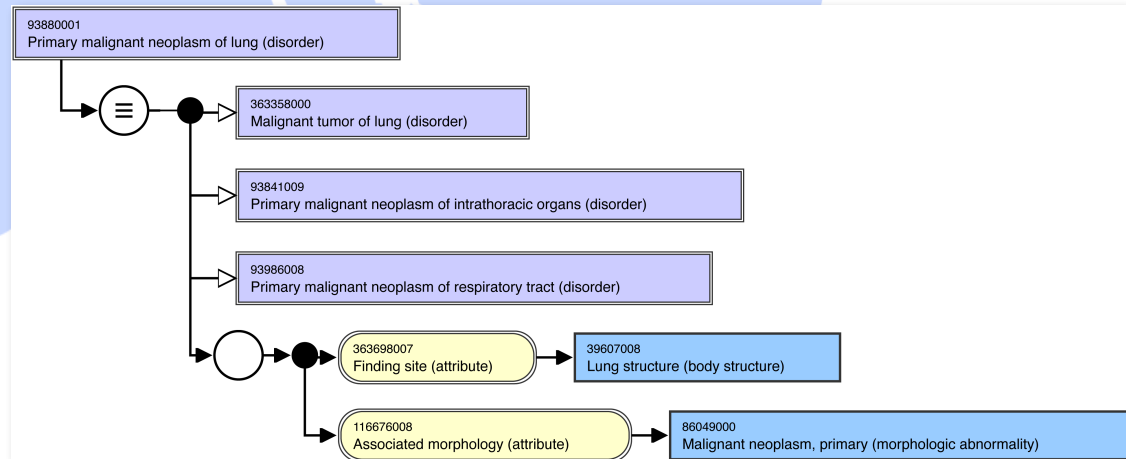


- Common identification of relevant concepts required for cross-institutional exchange and integration of data (“semantic interoperability”)
- Use of adequate, expressive, terminologies throughout the entire data model ideal



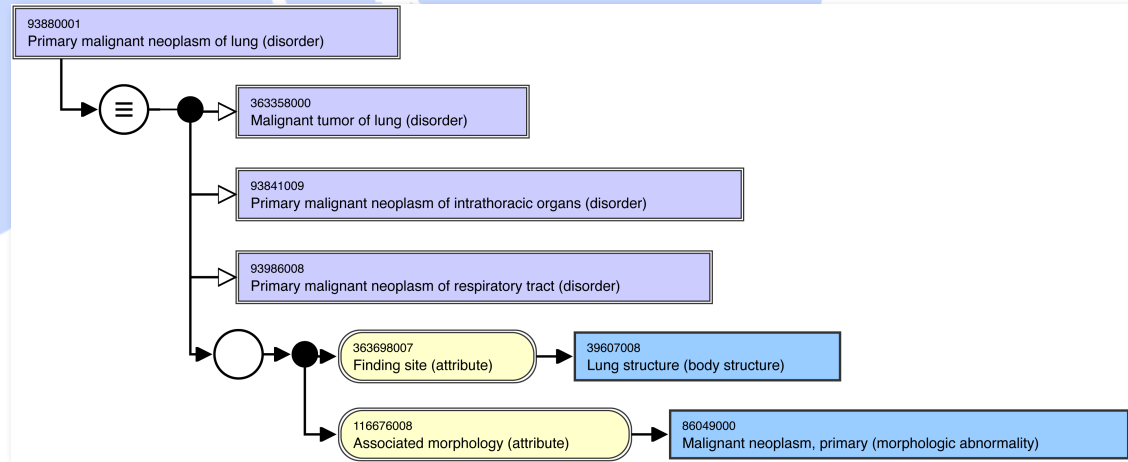


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- Need for use-case specific lists of concepts that are bound to data elements
  - all neoplastic diseases versus
  - all fractures from SNOMED CT





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  - all neoplastic diseases versus
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- Distribution of terminological artefacts?



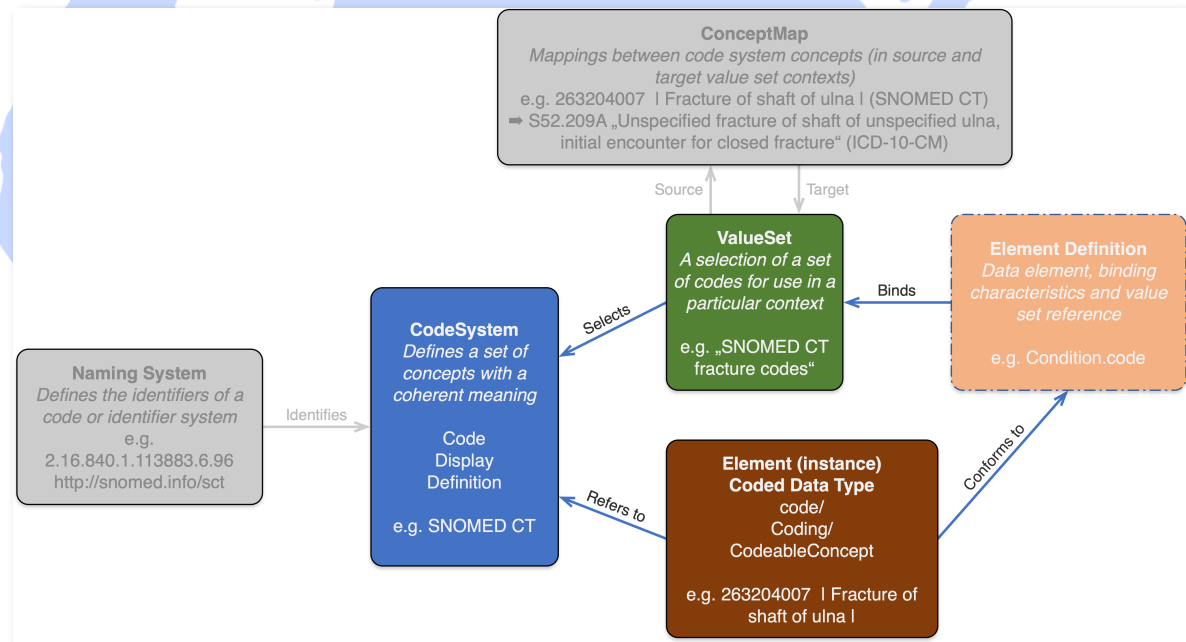
## Terminology Servers (TS)



- Provision of Code Systems, Value Sets, and Mappings
  - Creation, Maintenance and Query



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  - Creation, Maintenance and Query
- Standards for TS design: HL7 FHIR 🔥
  - specifies *resources*: mature data model for terminological artefacts
  - specifies *operations*: REST-API surface of an compliant FHIR TS
- current initiatives for national (FHIR) TS





- Binding of metadata elements to terminology a fundamental feature of MDR implementations
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- Binding of metadata elements to terminology a fundamental feature of MDR implementations
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  - What about complex terminologies like SNOMED CT or large ValueSets with multiple terminologies?
- **Terminology does not belong in MDRs**
- *Responsibility split* between MDR and TS



- Referencing and query of TS resources within the MDR during creation and validation of data elements using FHIR APIs
- Not realised in practice!
  - Constant redefinition of value lists for the same atom of information

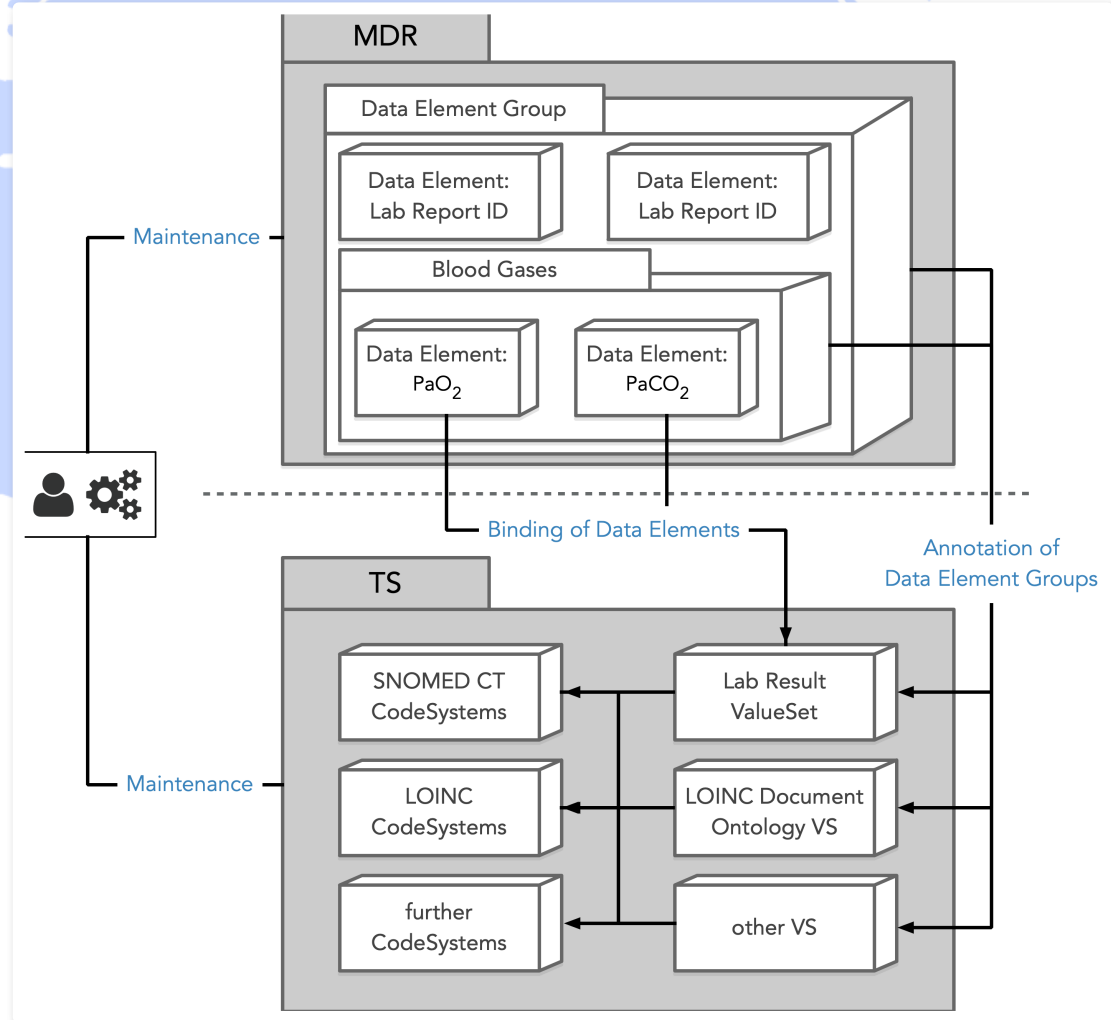


Image: Example of proposed responsibility split between MDR and TS



- “Stopgap Solution”
  - Bridge between TS and MDR until responsibility split is adopted
- TS resources (ValueSet) drive MDR

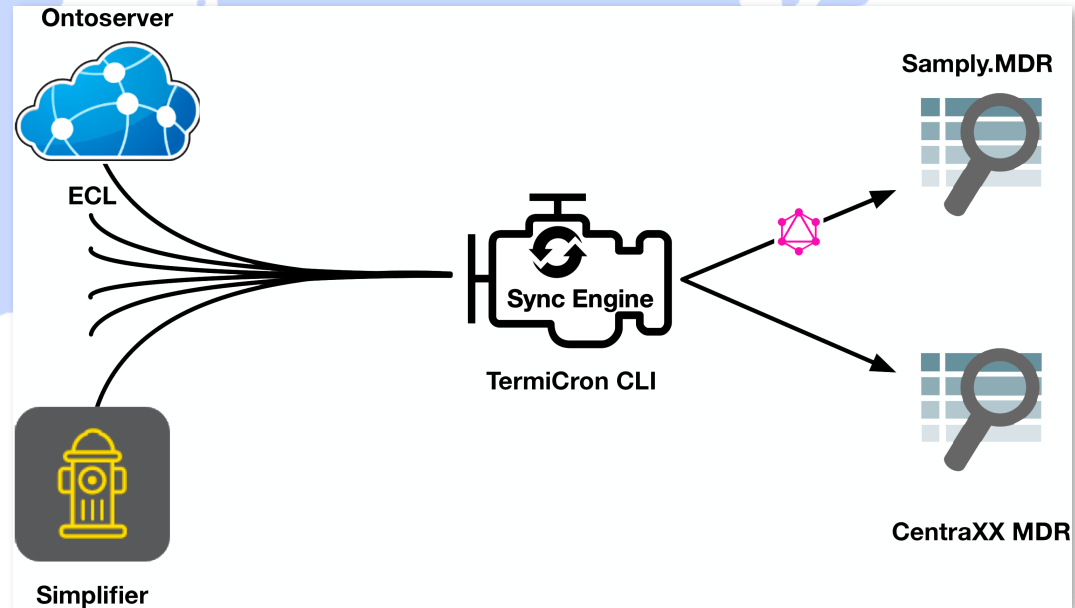


- “Stopgap Solution”
  - Bridge between TS and MDR until responsibility split is adopted
- TS resources (ValueSet) drive MDR
- Consume FHIR terminology resources from authoritative sources
- Convert them to a suitable representation for MDRs
- Handle MDR specific requirements (authentication, format, updates etc.) transparently

# TermiCron: Bridging the Gap between TS and MDRs



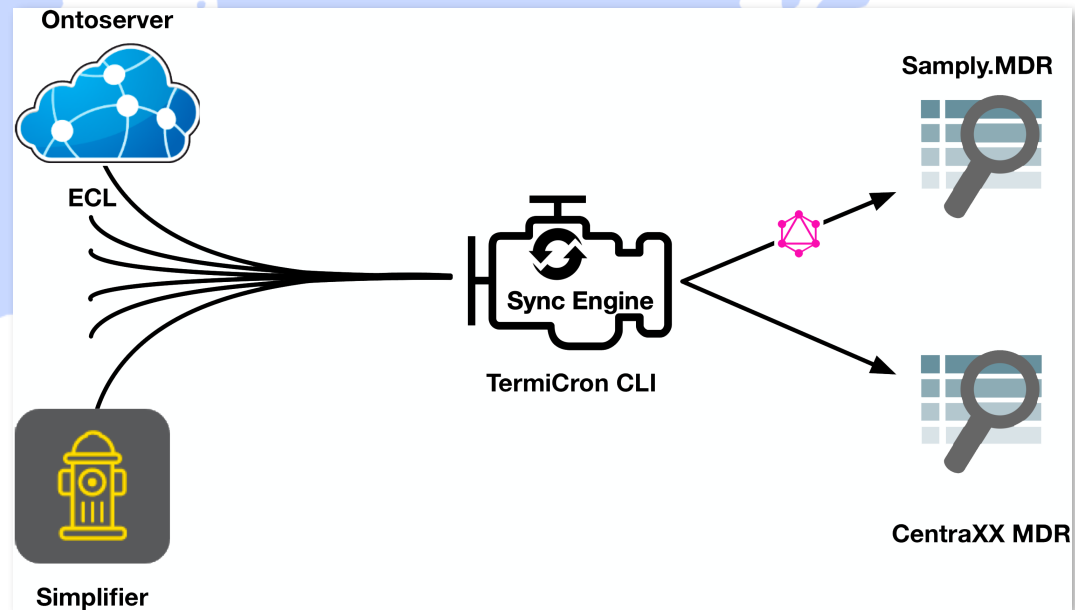
- Adaptable pipeline to provision terminological resources in MDR implementations



# TermiCron: Bridging the Gap between TS and MDRs

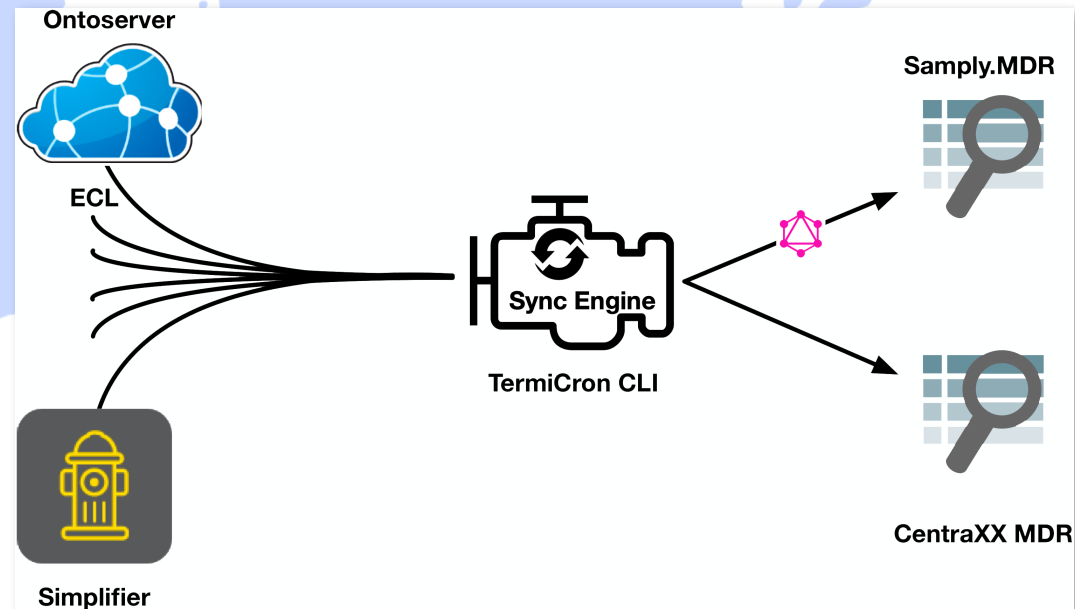


- Adaptable pipeline to provision terminological resources in MDR implementations
- Input from
  - FHIR Terminology Servers
  - Flat Directories
  - FHIR NPM Registries (such as Simplifier)
  - SNOMED CT Expression Constraint Language queries



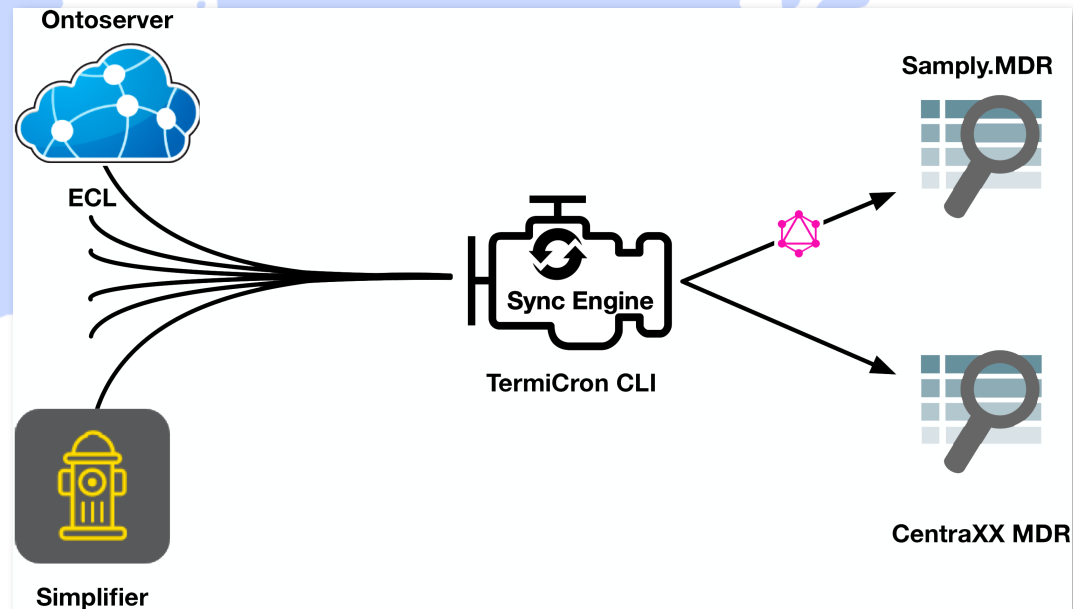


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  - QL4MDR (GraphQL-based query language for federated MDRs)
  - CentraXX MDR (proprietary)
  - Samply.MDR (open-source)





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  - QL4MDR (GraphQL-based query language for federated MDRs)
  - CentraXX MDR (proprietary)
  - Samply.MDR (open-source)
- Powerful Command Line Interface
- Free/Libre Open Source Software



<https://github.com/itcr-uni-luebeck/TermiCron>





### TermiCron Bundle Builder

Step 1: Enter the endpoints to query.

Endpoint 1  Remove

Add Endpoint Continue...



**TermiCron Bundle Builder**

**TermiCron Bundle Builder**

**Step 2: Select the resources to add to your bundle.**

Remove

Bundle ID (required)  Build Bundle A [valid](#) bundle ID and at least one resource is required.

<https://enter-an-endpoint-here.com/fhir> resources

**68 CodeSystems (with valueSet URL)**

- <https://www.netzwerk-universitaetsmedizin.de/fhir/CodeSystem/frailty-score> (Frailty Score) version 1.0
- <http://dicom.nema.org/resources/ontology/DCM> (DICOM Controlled Terminology Definitions) version 01
- <http://fhir.de/CodeSystem/dimdi/atc> (Anatomisch-therapeutisch chemische Klassifikation (ATC) Amtliche deutsche Fassung 2020) version 2020
- <http://fhir.de/CodeSystem/dimdi/atc> (Anatomisch-therapeutisch chemische Klassifikation (ATC) Amtliche deutsche Fassung 2021) version atcgm2021
- <http://fhir.de/CodeSystem/dimdi/icd-10-gm> (ICD-10) version 2014
- <https://uni-luebeck.de/CodeSystems/kderm-psoriasis-topische-therapie> (KDERM Psoriasis topische Therapie) version 20210528
- <https://www.medizininformatik-initiative.de/fhir/core/modul-fall/CodeSystem/Fachabteilungsschluesel> (Fachabteilungsschluesel) version 1.0

**100 ValueSets**

- <http://highmed.org/ValueSet/antiinfektiva-resistenzbestimmung-loinc> (HiGHmed Antiinfektiva-Resistenzbestimmung [LOINC]) version 1.0
- <http://highmed.org/ValueSet/antiinfektiva-substanzen-snomedct> (HiGHmed Antiinfektiva-Substanzen [SNOMED CT]) version 1.0
- <http://highmed.org/ValueSet/haeufigkeiten-befund-snomedct> (HiGHmed Häufigkeiten (Befund) [SNOMED CT]) version null
- <http://highmed.org/ValueSet/mikrobiologische-erreger-bakterien-pilze-snomedct-explizit> (HiGHmed Mikrobiologische Erreger (Bakterien, Pilze) [SNOMED CT explizit]) version 2.0
- <http://highmed.org/ValueSet/mikrobiologische-erreger-bakterien-pilze-snomedct-implizit> (HiGHmed Mikrobiologische Erreger (Bakterien, Pilze) [SNOMED CT implizit]) version null
- <urn:oid:1.2.840.10008.6.1.2> (AnatomicRegion) version 20200704



TermiCron

**TermiCron Bundle Builder**

**Step 2: Select the resources to add to your bundle**

Bundle ID (required)

<https://enter-an-endpoint-here.com/fhir> resources

68 CodeSystems

- <https://www.netzwerk-universitaetsmedizin.de/fhir/CodeSystem/>
- <http://dicom.nema.org/resources/ontology/DCM> (DICOM Control
- <http://fhir.de/CodeSystem/dimdi/atc> (Anatomisch-therapeutisch
- <http://fhir.de/CodeSystem/dimdi/atc> (Anatomisch-therapeutisch atcgm2021
- <http://fhir.de/CodeSystem/dimdi/icd-10-gm> (ICD-10) version 201
- <https://uni-luebeck.de/CodeSystems/kderm-psoriasis-topische-t>
- <https://www.medizinformatik-initiative.de/fhir/core/modul-fallC>
- <http://highmed.org/ValueSet/antiinfektiva-resistenzbestimmung->
- <http://highmed.org/ValueSet/antiinfektiva-substanzen-snomedct>
- <http://highmed.org/ValueSet/haeufigkeiten-befund-snomedct> (H
- <http://highmed.org/ValueSet/mikrobiologische-erreger-bakterien> [SNOMED CT explizit] version 2.0
- <http://highmed.org/ValueSet/mikrobiologische-erreger-bakterien> [SNOMED CT implizit] version null
- urn:oid:1.2.840.10008.6.1.2 (AnatomicRegion) version 20200704

**TermiCron Bundle Builder**

**Step 3: Bundle Result**



```
{
  "resourceType": "Bundle",
  "id": "demo-bundle",
  "meta": {
    "profile": [ "http://fhir.imi.uni-luebeck.de/StructureDefinition/TermiCron%20Bundle" ]
  },
  "type": "collection",
  "total": 2,
  "entry": [ {
    "link": [ {
      "relation": "canonical",
      "url": "http://fhir.de/ValueSet/dimdi/icd-10-gm"
    }, {
      "relation": "CodeSystem",
      "url": "https://enter-an-endpoint-here.com/fhir/CodeSystem/icd10gm2014"
    } ],
    "fullUrl": "https://enter-an-endpoint-here.com/fhir/CodeSystem/icd10gm2014"
  }, {
    "link": [ {
      "relation": "canonical",
      "url": "https://www.netzwerk-universitaetsmedizin.de/fhir/ValueSet/rheumatological-immunological-diseases-icd"
    }, {
      "relation": "ValueSet",
      "url": "https://enter-an-endpoint-here.com/fhir/ValueSet/1.2.276.0.76.11.512--20200504223024"
    } ],
    "fullUrl": "https://enter-an-endpoint-here.com/fhir/ValueSet/1.2.276.0.76.11.512--20200504223024"
  } ]
}
```

**Create bundle on endpoint**

<https://enter-an-endpoint-here.com/fhir>

Start Over





**edit Catalog**

Code: SARS-CoV-2-Symptoms  
 Version: 1.0  
 Modification time: 04/21/2021 04:12:54  
 Catalog type: FHIR-TermCron  
 Valid from:   
 Valid until:   
 URI: tag:kairos.de,2017:mdr/catalog:SARS  
 System URL: https://www.netzwerk-universitaetsm  
 System OID:   
 Publisher:   
 Attributes:

Name	Code
Feeling feverish (finding)	103001002
Dry cough (finding)	11833005
Bleeding (finding)	131148009
Asthenia (finding)	13791008
Pain in throat (finding)	162397003
Abdominal pain (finding)	21522001
Pain (finding)	22253000
Indrawing of ribs during respiration (finding)	248567008
Headache (finding)	25064002
Dyspnea (finding)	267036007
Eruption of skin (disorder)	271807003
Unable to walk (finding)	282145008
Productive cough (finding)	28743005
Chest pain (finding)	29857009

Number of entries: 40

German English + Add Language

Name: SARS-CoV-2-Symptoms  
 Description:

Save Cancel

```
mutation {
  createConceptSystem (
    name: "SARSCoV2Symptoms"
    uri: "https://www.example.de/fhir/ValueSet/sars-cov-2-symptoms"
    version: "1.0"
    concepts: [
      {
        uri: "http://snomed.info/sct#21522001"
        prefLabel: "21522001"
        altLabel: ""
        definition: "Abdominal pain (finding)"
      }
    ]
  ) {
    name
  }
}
```

Images: [left] A FHIR CodeSystem within the CentraXX MDR; [right] The same FHIR CodeSystem as a QL4MDR query



- Free and open-source software can be adapted to other MDRs by the community
- Support for QL<sup>4</sup>MDR allows ISO 21526-compliant representation of FHIR VS for systems that don't internally comply to the standard
- Support for responsibility within MDRs split is sorely needed, and anticipated by ISO/IEC 21526
- “Stopgap” solution, but it works!

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