VA HEALTH CARE Defining EXCELLENCE in the 21st Century

Linked Vitals

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A Linked Data Approach to Semantic Interoperability

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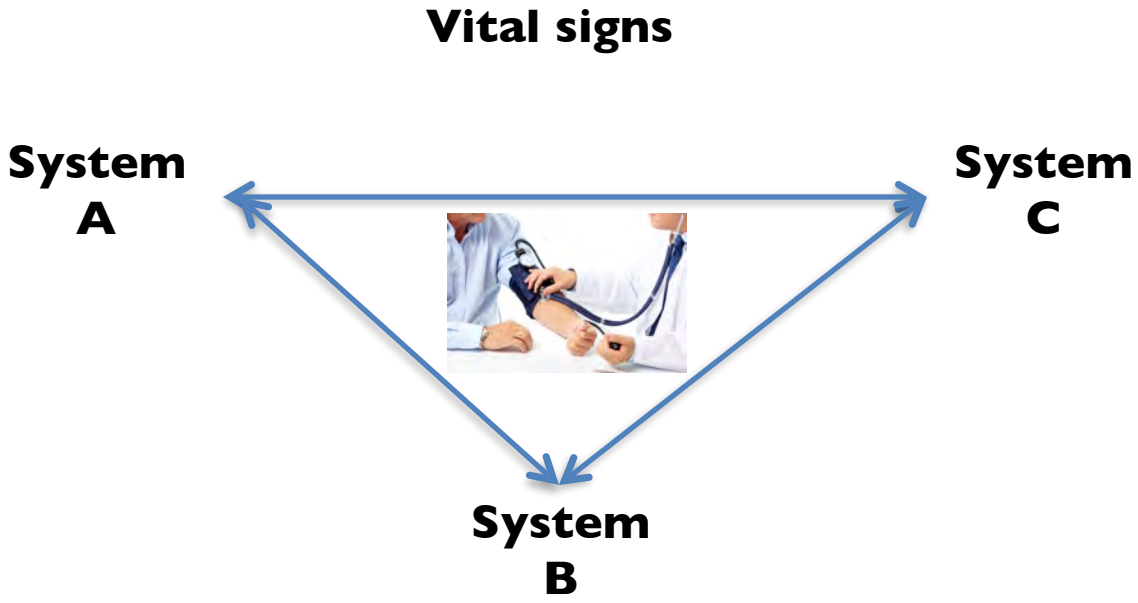
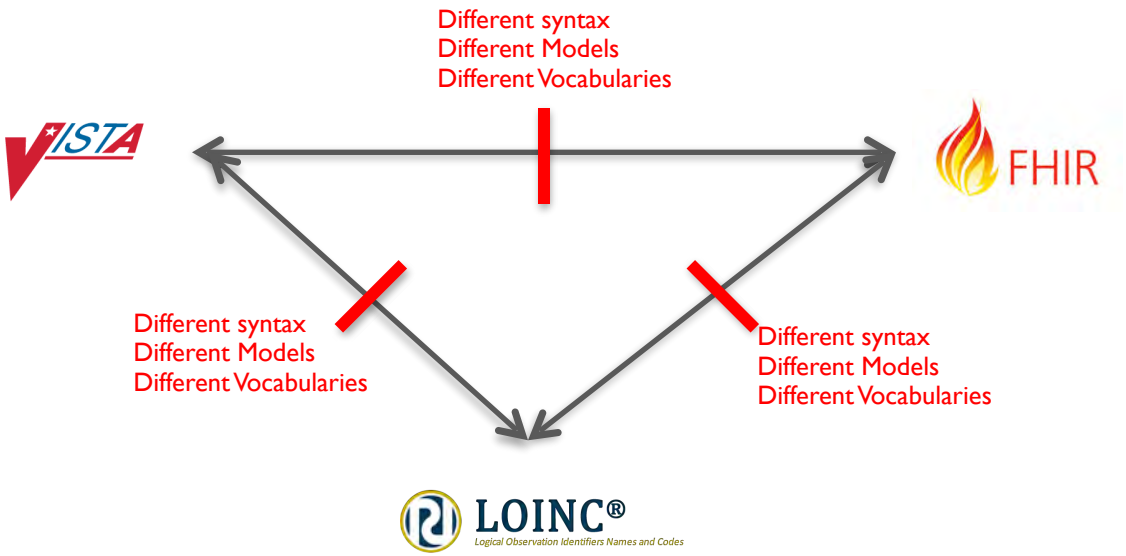
Problem Statement: General

How do we integrate data such as vital signs *meaningfully* from different information systems?



Problem Statement: Specific

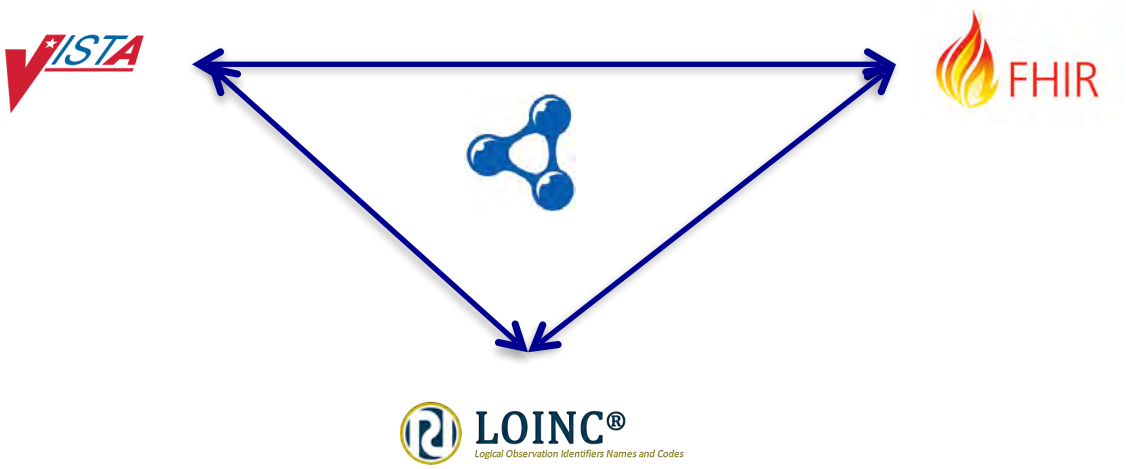
How do we integrate vital signs between VistA and FHIR each with different syntax, different models, and different vocabularies ?



Language barriers to exchange

Solution Statement

How do we integrate vital signs between VistA and FHIR each with different syntax, different models, and different vocabularies ?



A common exchange language

Overview of Translation Process

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Source Data	Syntatic alignment	SMART	Semantic alignment	Integrated Data

Syntax A
Model A
Vocabulary A

VISTA

FM Schema

Vocabulary B

LOINC®
Logical Observation Identifiers Names and C

CSV

Syntax C
Model C
Vocabulary C

FHIR

XML

SPIN
SPARQL Inferencing Notation

Shared Syntax
Shared Model
Shared Vocabulary
Shared Meaning

Different Syntax
Different Models
Different Vocabularies

Common syntax within model-flexible medium (Linked Data)

Rule-based mapping
Model alignment
Vocabulary alignment

What is VISTA?

- Veterans Information Systems and Technology Architecture
- Information system of all VA care sites
- Foundation of other public health information systems
  - VA (VISTA): 1200+ care sites
  - DoD(CHCS): 900+ care sites
  - IHS(RPMS): 500+ care sites
  - NY State: 24 hospitals
- Most physicians in U.S. have used VISTA
- Open source
  - Deployed in many other settings in U.S. and internationally
  - Many developments by open source community

VISTA in the U.S.

VistA Architecture: Overview

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All 150+ VistA applications are integrated within one shared multidimensional data engine.

FMQL is the Fileman Query Language

Fileman is VistA's database management system

M is VistA's application-data integration engine.

VistA's Data Manager: Fileman

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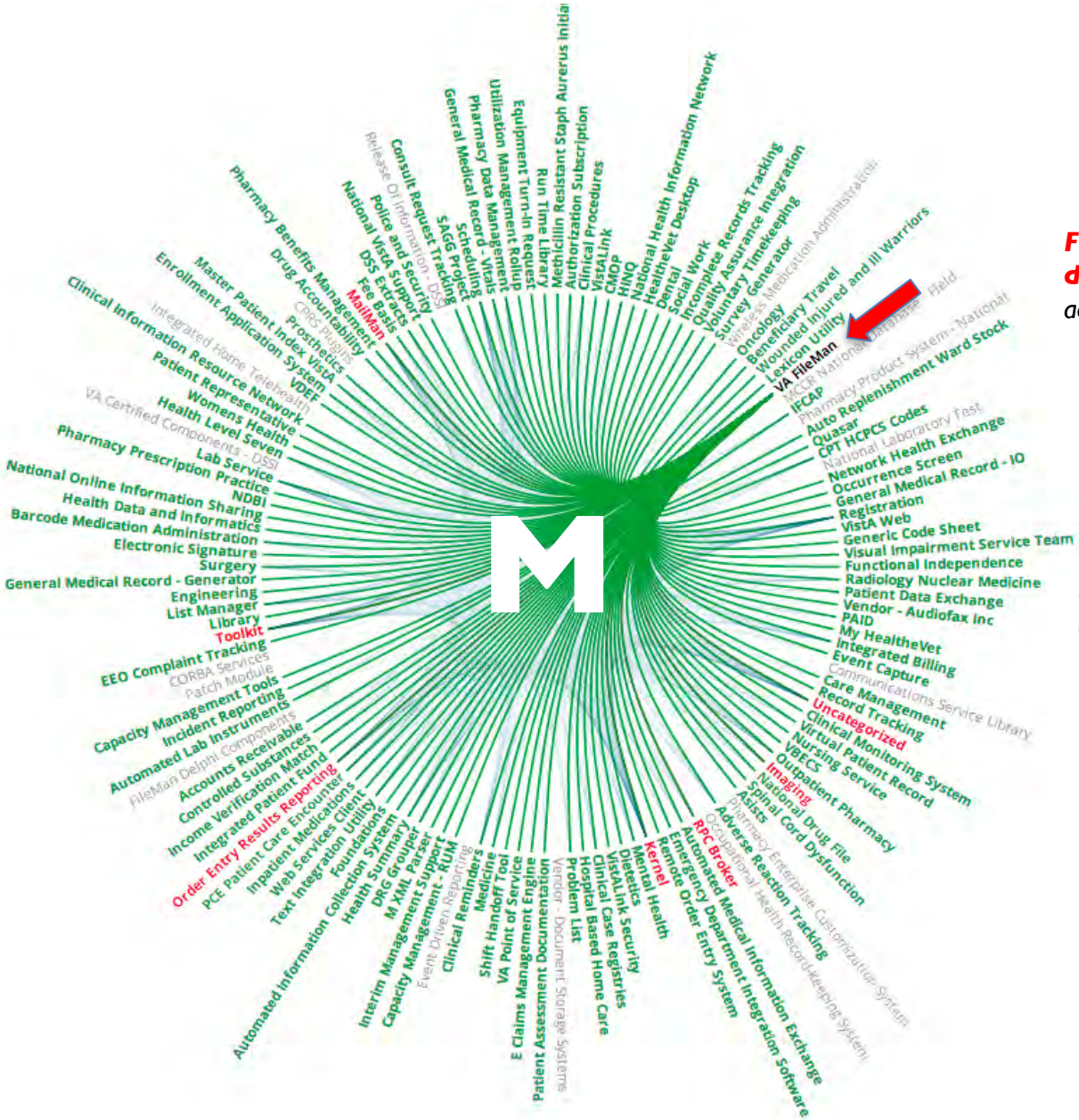

Fileman is the gateway to all VistA data. *All VistA applications use Fileman to access, structure, and query all data in VistA.*

VistA's integrated data engine. All 150+ applications are integrated to their data inside the multidimensional data engine, represented by the inner circle.

Reference:
code.osehra.org/vivian

Exposing VistA's native data model

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Objective: Make machine-processable schemas, vocabularies, and datasets from VISTA

http://vista.caregraf.info/analytics

Challenge: Poor RDF/OWL model

Solution: Refine RDF/OWL model (example here)

Exposing VistA's native data model

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FileMan Schema Browser

Populated Files

In this system 1245 out of 2356 have entries.

#	Name	Global	Count
.11	INDEX	^DD("IX",	644
.31	KEY	^DD("KEY",	64
.4	PRINT TEMPLATE	^DIPT(	1234
.401	SORT TEMPLATE	^DIBT(	773
.402	INPUT TEMPLATE	^DIE(	1519
.403	FORM	^DIST(.403,	144
.404	BLOCK	^DIST(.404,	519
.44	FOREIGN FORMAT	^DIST(.44,	11
.5	FUNCTION	^DD("FUNC",	169
.7	MUMPS OPERATING SYSTEM	^DD("OS",	7
.81	DATA TYPE	^DI(.81,	11
.84	DIALOG	^DI(.84,	2574
.85	LANGUAGE	^DI(.85,	11
1	FILE	^DIC(	2356
1.2	ALTERNATE EDITOR	^DIST(1.2,	4
2	PATIENT	^DPT(	40
3.07	PROGRAMMER MODE LOG	^%ZUA(3.07,	930

VistA's native data model is comprised of hierarchical files and subfiles, each which addresses a specific M Global storage.

Fileman Query Language (FMQL)

FMQL is the Fileman Query Language. This provides real-time web-based query access to the entirety of VistA's data.

It exposes the native hierarchical data model of Fileman in web standard forms including HTML, JSON, and RDF.

HTML:	hypertext markup language (visual document markup)
JSON:	javascript object notation (data serialization / packaging)
RDF:	resource description framework (linked data / semantics)
JSON-LD:	JSON with linked data capability

VistA Vitals: HTML output

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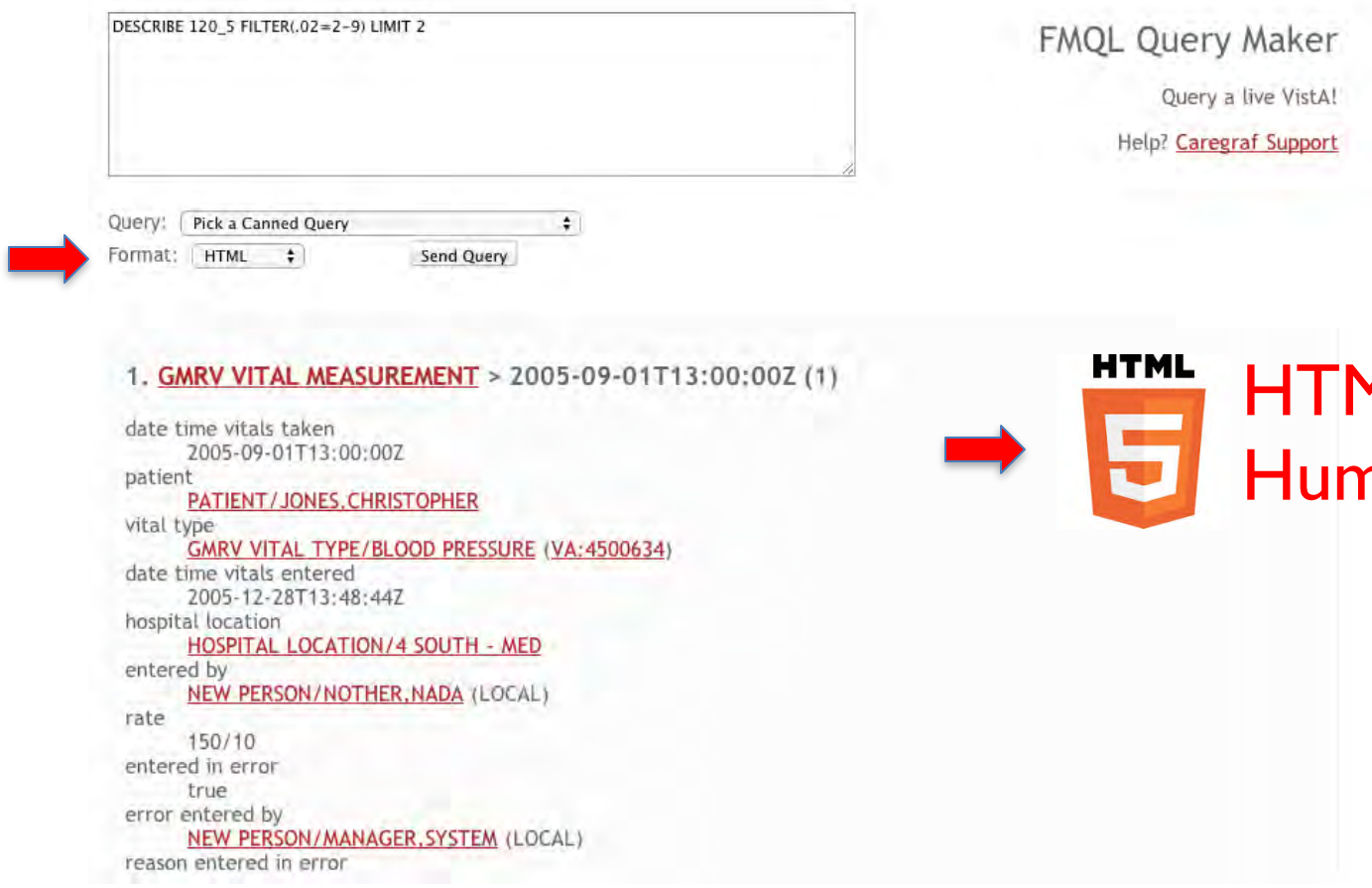
FMQL query of VistA for vital signs with output in HTML.



VistA Vitals: RDF output

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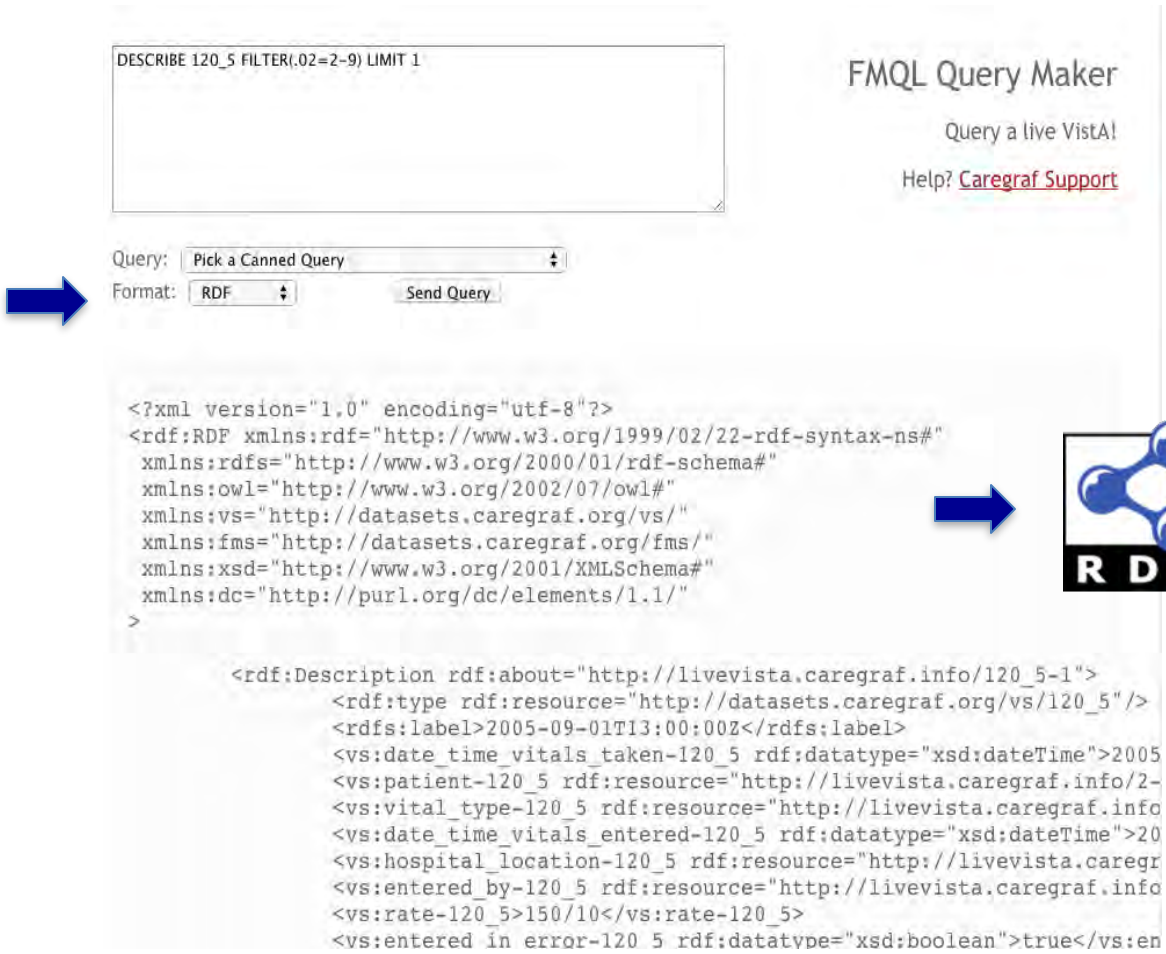
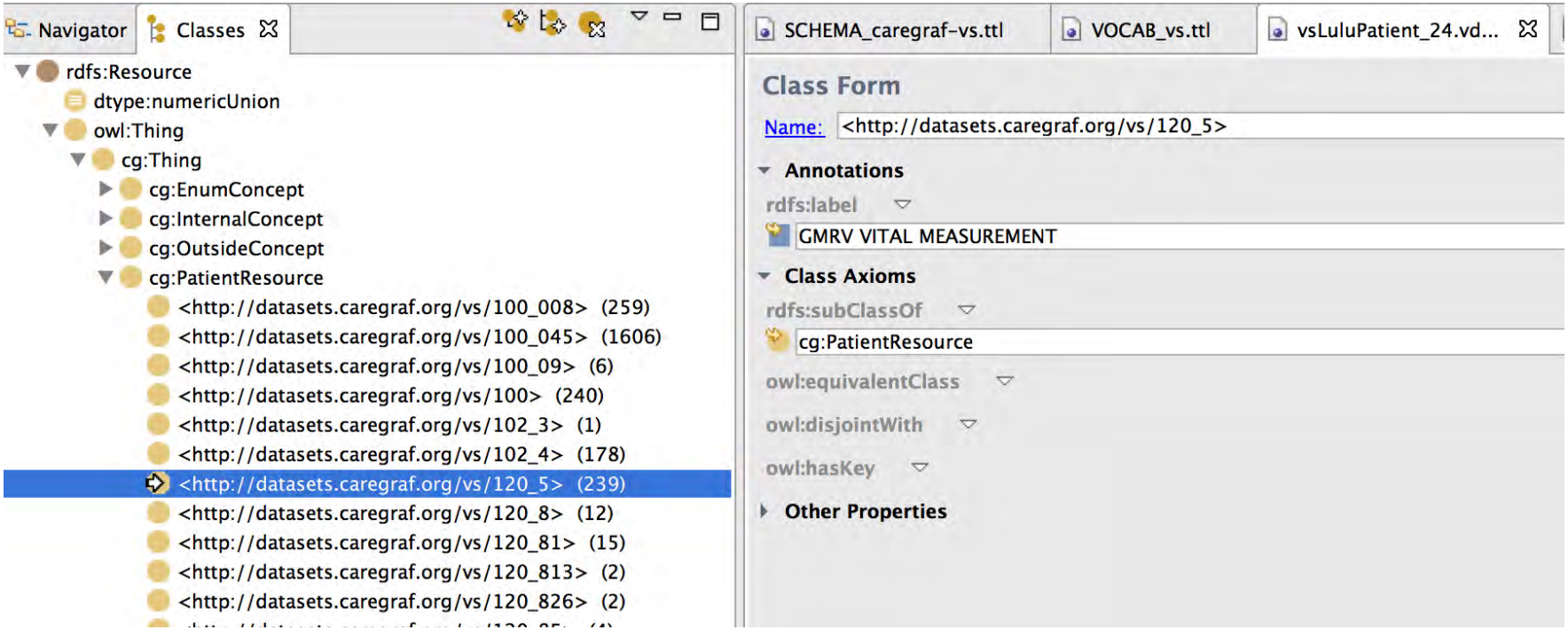
FMQL query of VistA for vital signs with output in RDF.



RDF

RDF output: Machine readable

VistA Vitals in RDF



239 instances in the sample dataset

VistA Vitals in RDF

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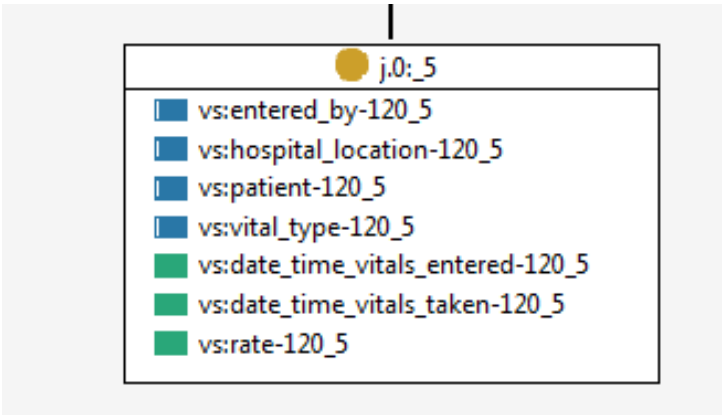
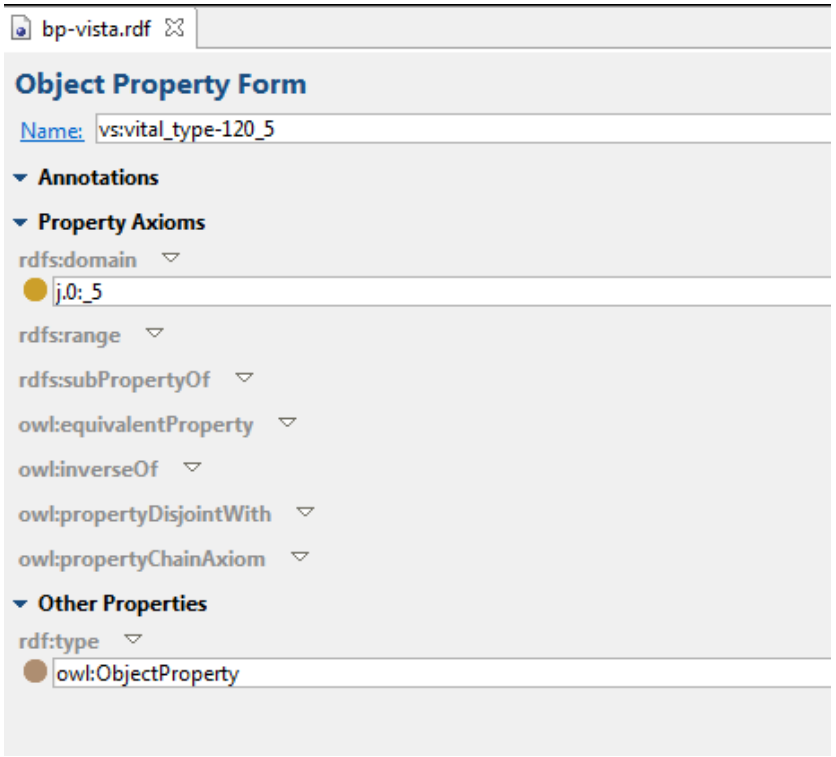
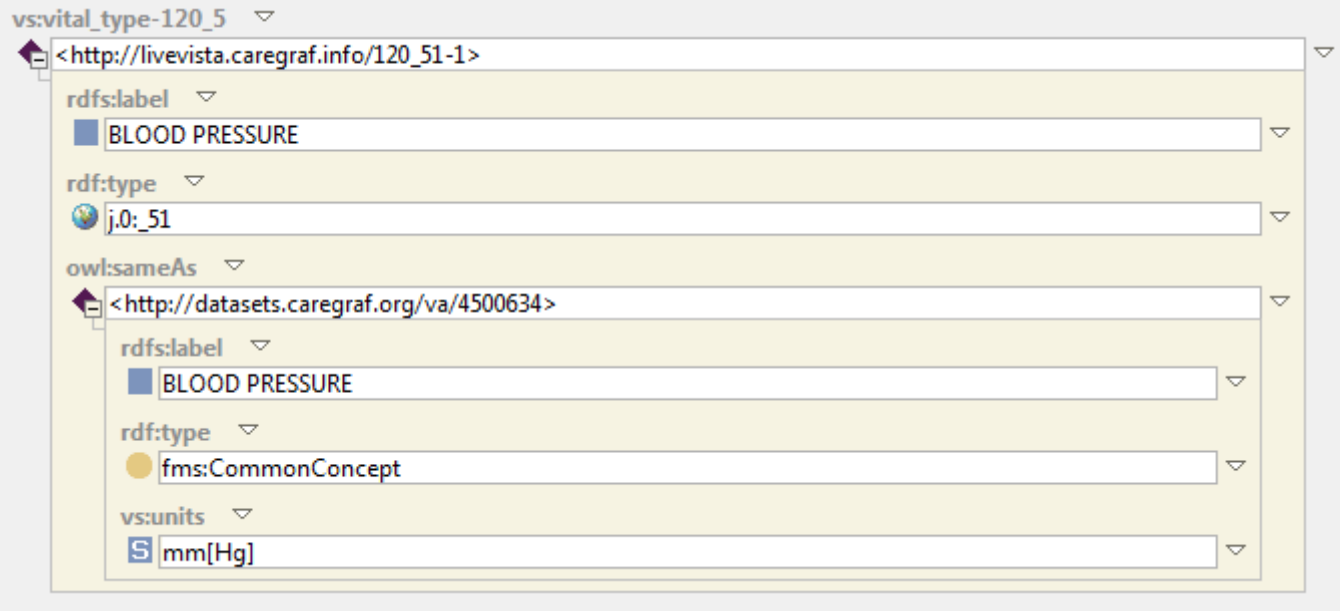
Exposing VistA's intrinsic data model for vitals





VistA Vitals in RDF

- Native VistA in RDF did not contain "common concepts" (so we created some).
- URIs are "messed up" (so we fixed them)



VistA Vitals in RDF

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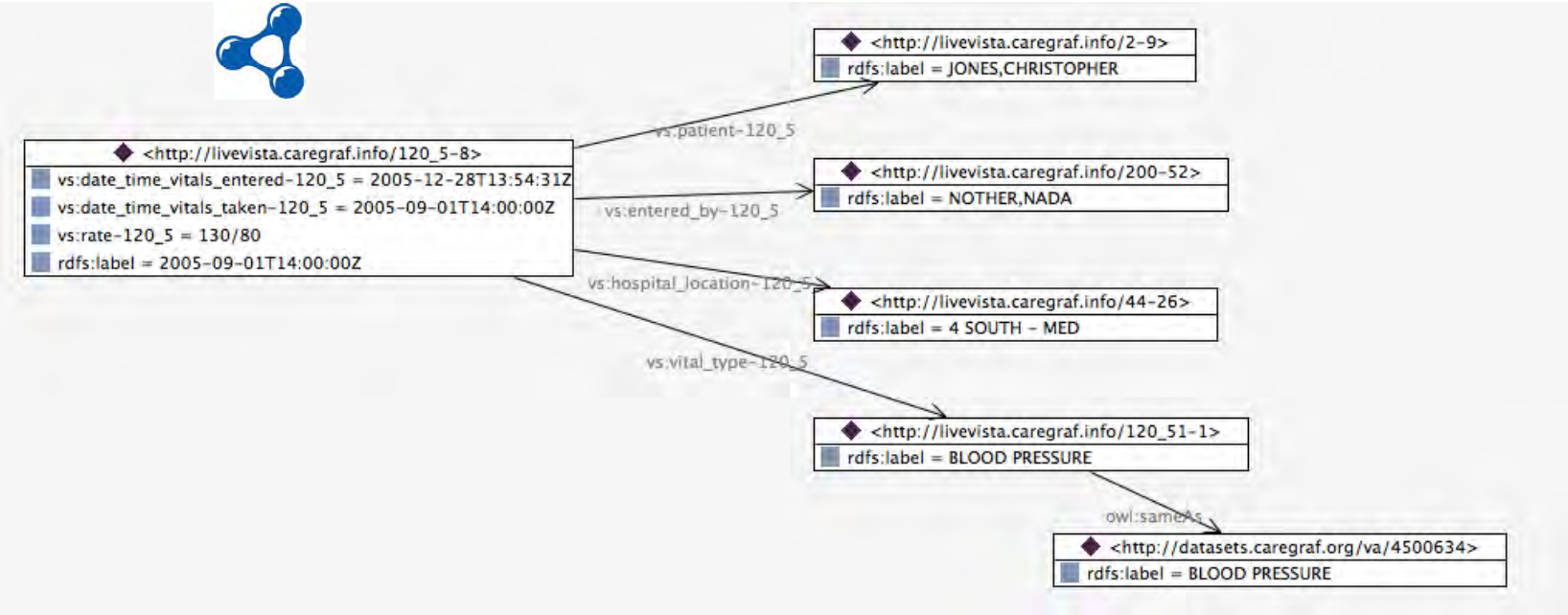
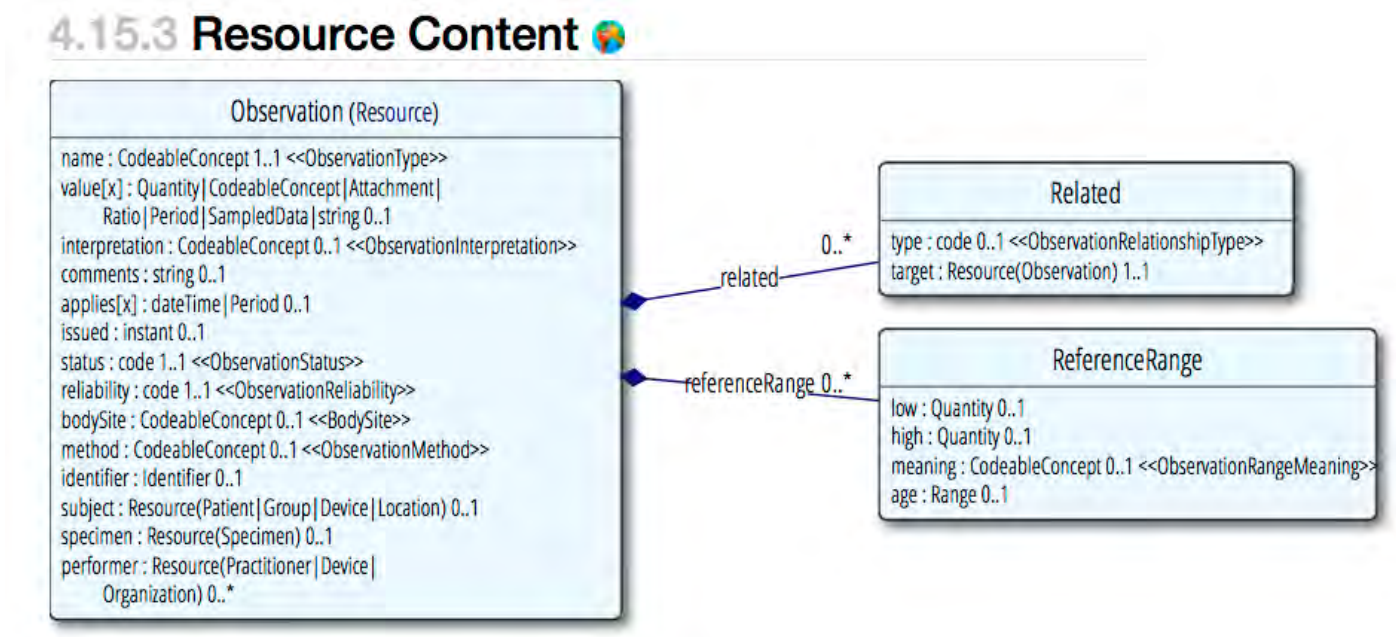
Exposing VistA's native data model for vitals



FHIR: Native model

- FHIR - Observation
- XML model in XML Schema



FHIR Vitals in RDF

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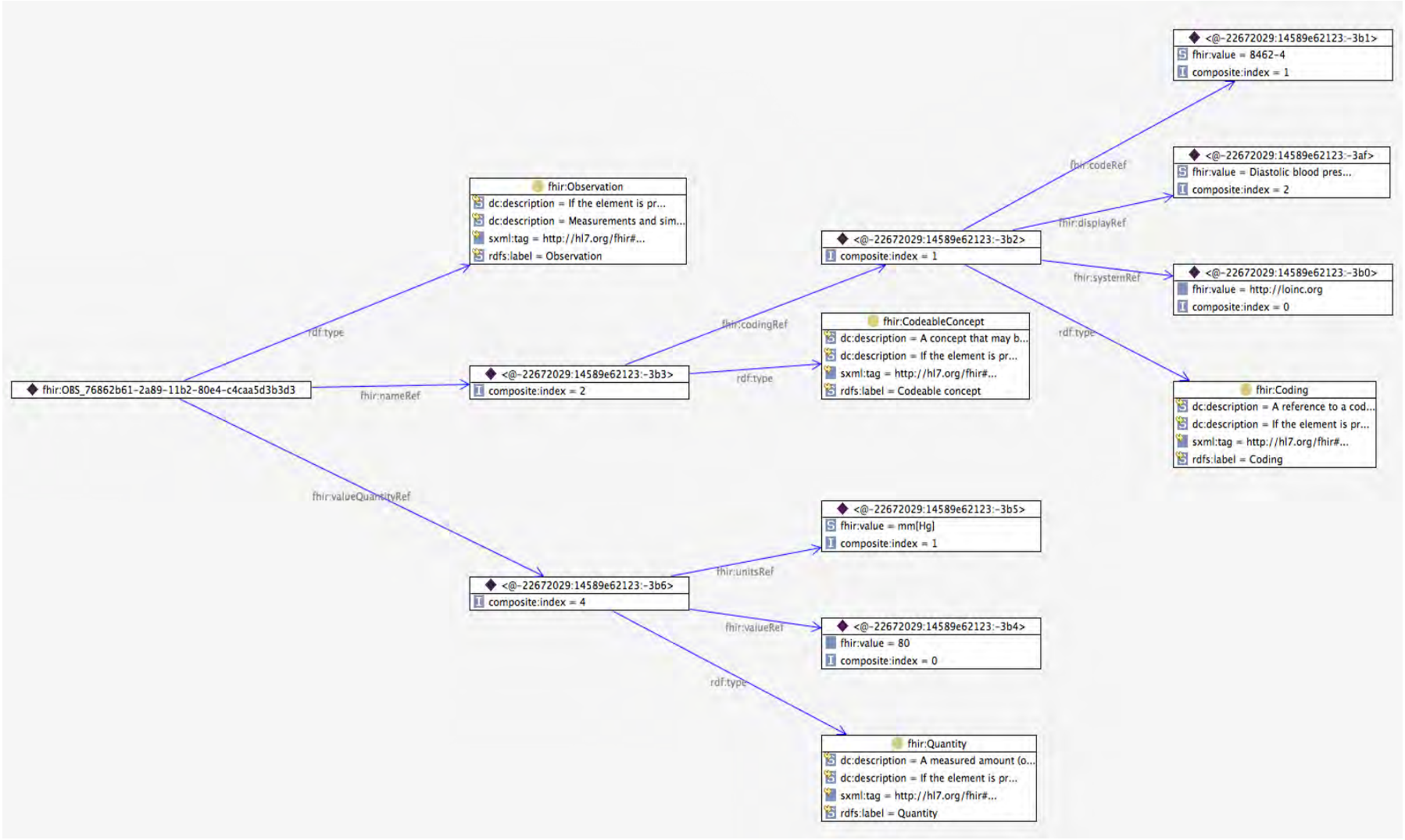
Automated transformation from FHIR XML Schema -> RDF



FHIR Vitals in RDF Enhanced

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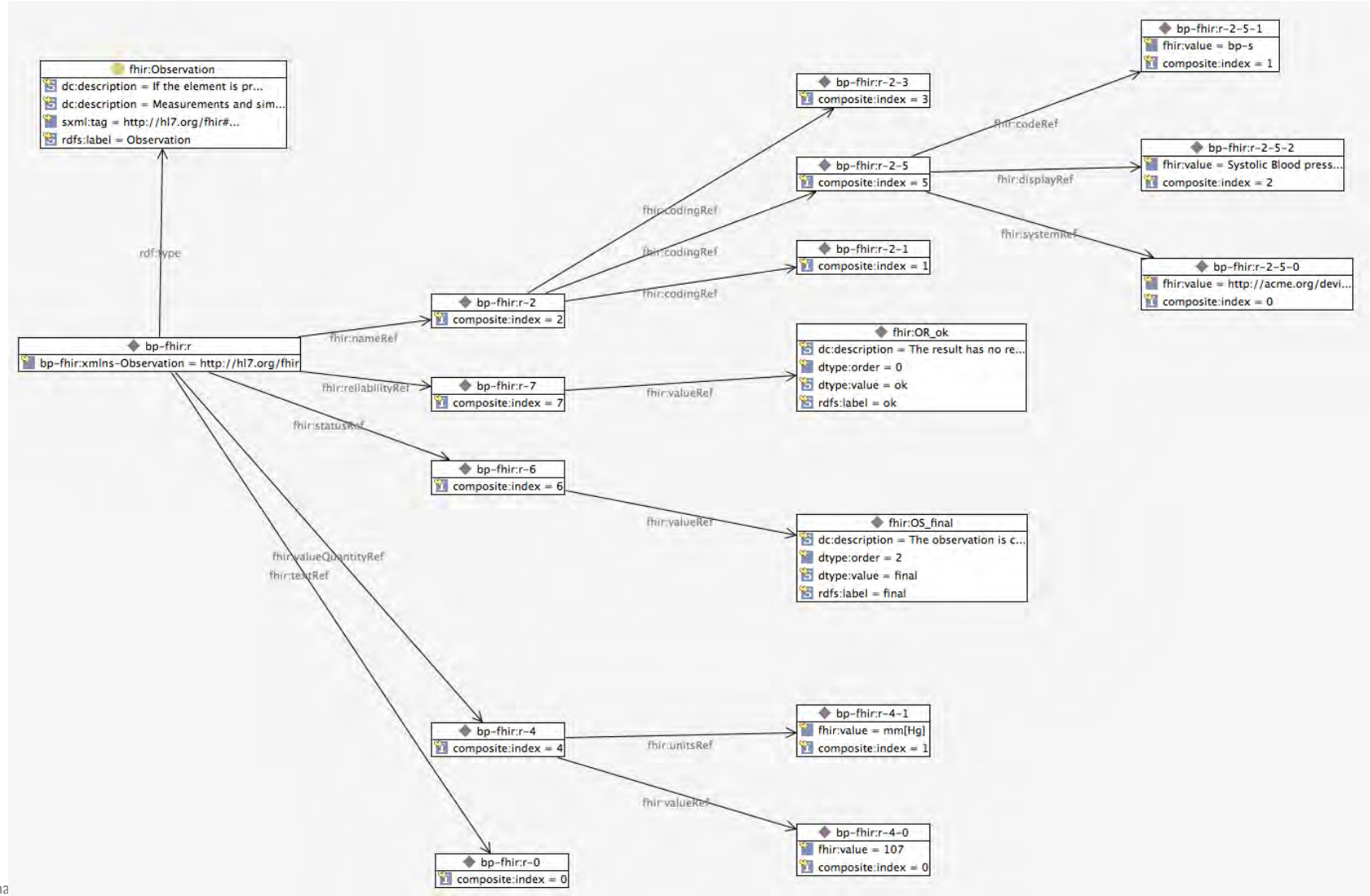
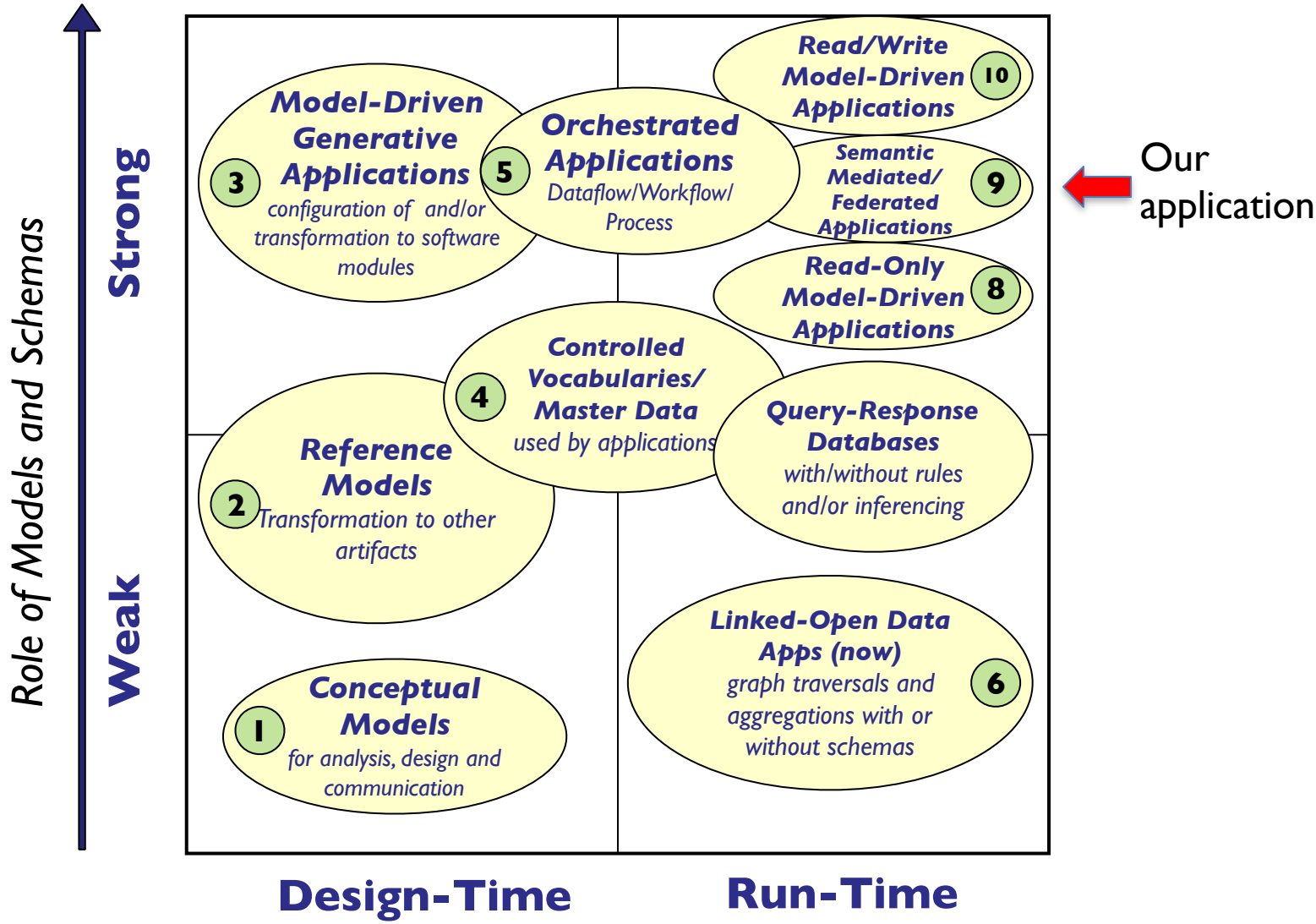
Enhanced bridge model for FHIR in RDF



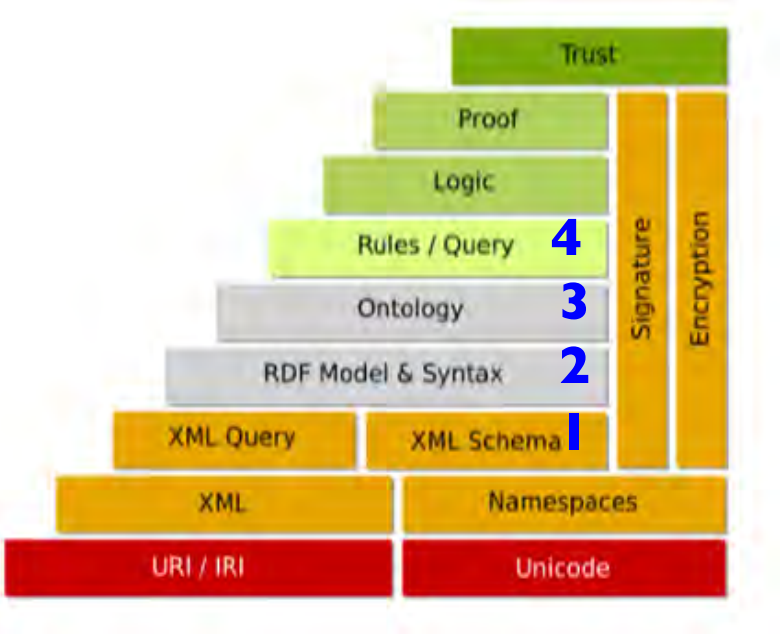
Many ways of using "Ontologies"



Our application

Context of Translation: RDF Technology Stack

- FHIR: XML Schema -> RDF **(1->2)**
- VISTA: Fileman model -> RDF **(2)**
- LOINC: CSV -> RDF **(2)**
- Create bridge model **(3)**
- Merge models and terminology: SPIN Map **(4)**



1. FHIR native model (XML Schema)
2. Translation (RDF Schema)
3. Bridge schema (OWL)
4. SPARQL rules (SPINMap)

SPIN: SPARQL Inferencing Notation

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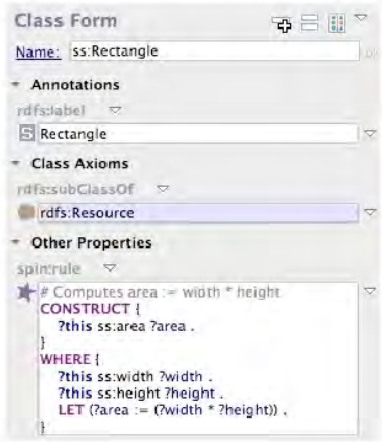
SPIN
SPARQL Inferencing Notation

- A W3C candidate standard
- A SPARQL Rules Language
- Builds on top of the SPARQL query language
- Enables exchangeable rules and transformations

SPIN is a SPARQL Rules Language

The property spin:rule can be used to link a class with SPARQL CONSTRUCT queries that define inference rules for the members of the class



Benefits

- Natural object-oriented way of modeling
- SPARQL is very expressive
- Rules can be natively executed by SPARQL engines of the database
- Easy to combine with other SPARQL rule bases like OWL RL

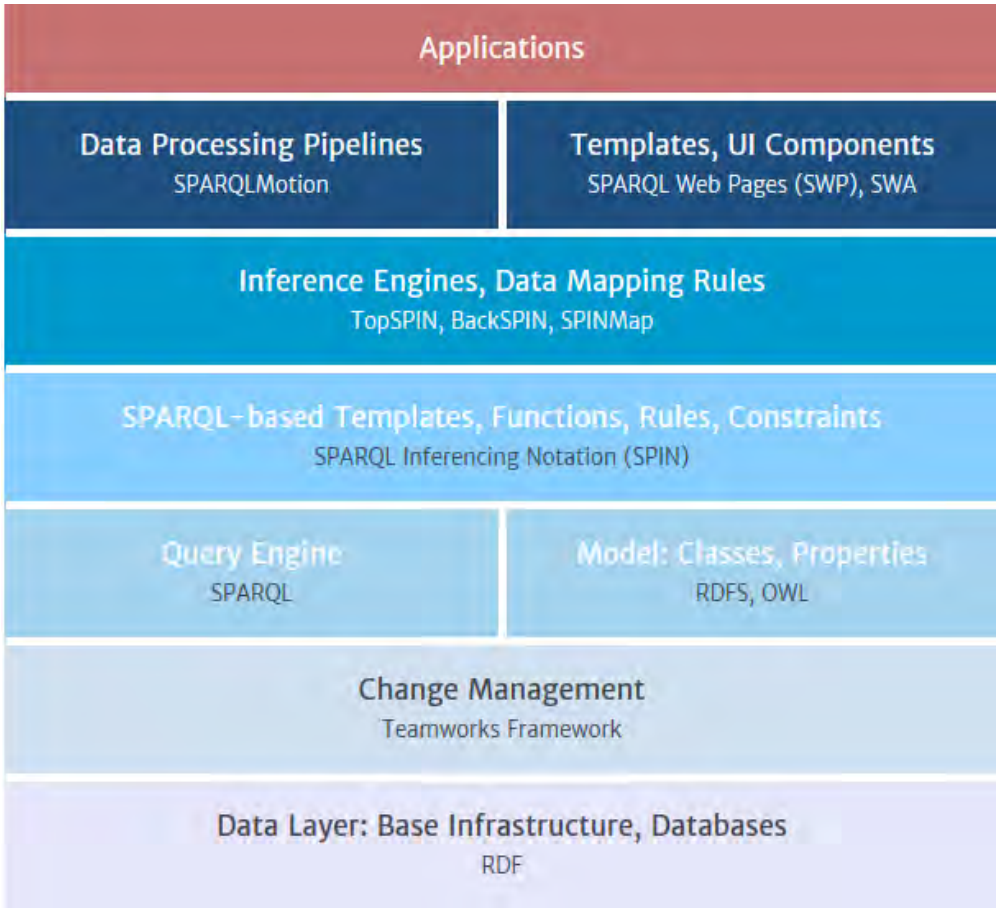
SPIN Standard Modules Library
http://spinrdf.org/spl
Reusable modeling constructs like cardinality, instanceOf

SPIN Modeling Vocabulary
http://spinrdf.org/spin

Rules and Constraints	Functions and Templates
Define the semantics of classes and their relationships	Encapsulate reusable queries with template arguments

SPIN SPARQL Syntax
http://spinrdf.org/sp
An RDF vocabulary for representing queries, variables, filter clauses etc.

SPINMap: Data transformation stack



SPINMap: Data mapping rules engine

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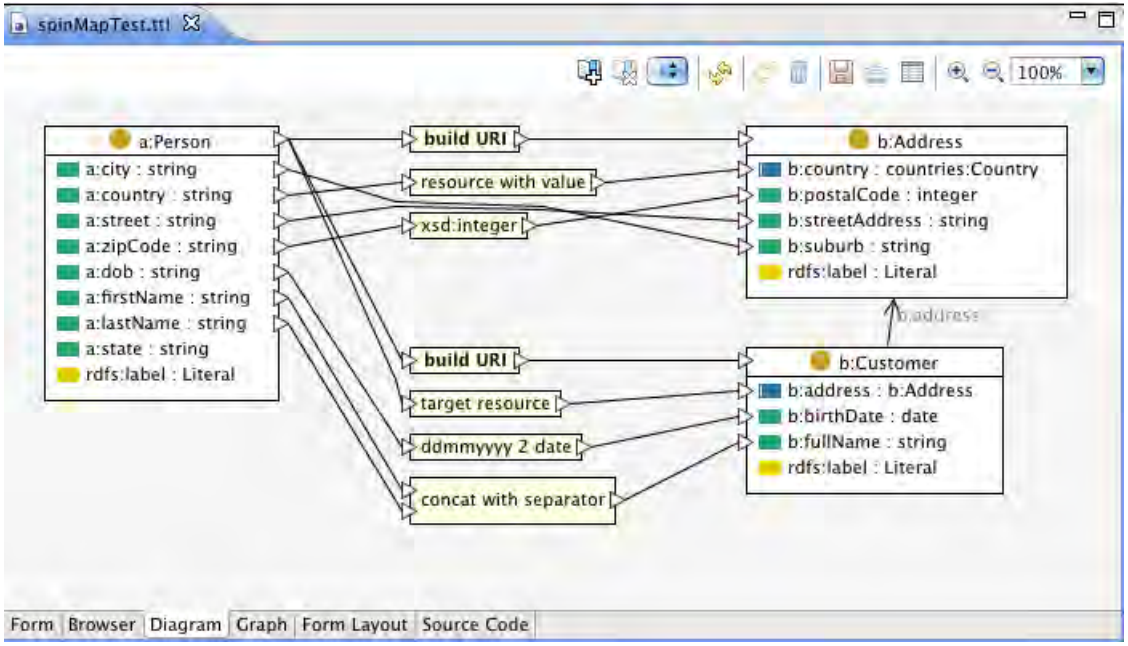
Motivation: Simplifies mappings between different models

Key Features: Creates executable transformations



SPINMap: Field mapping with rules

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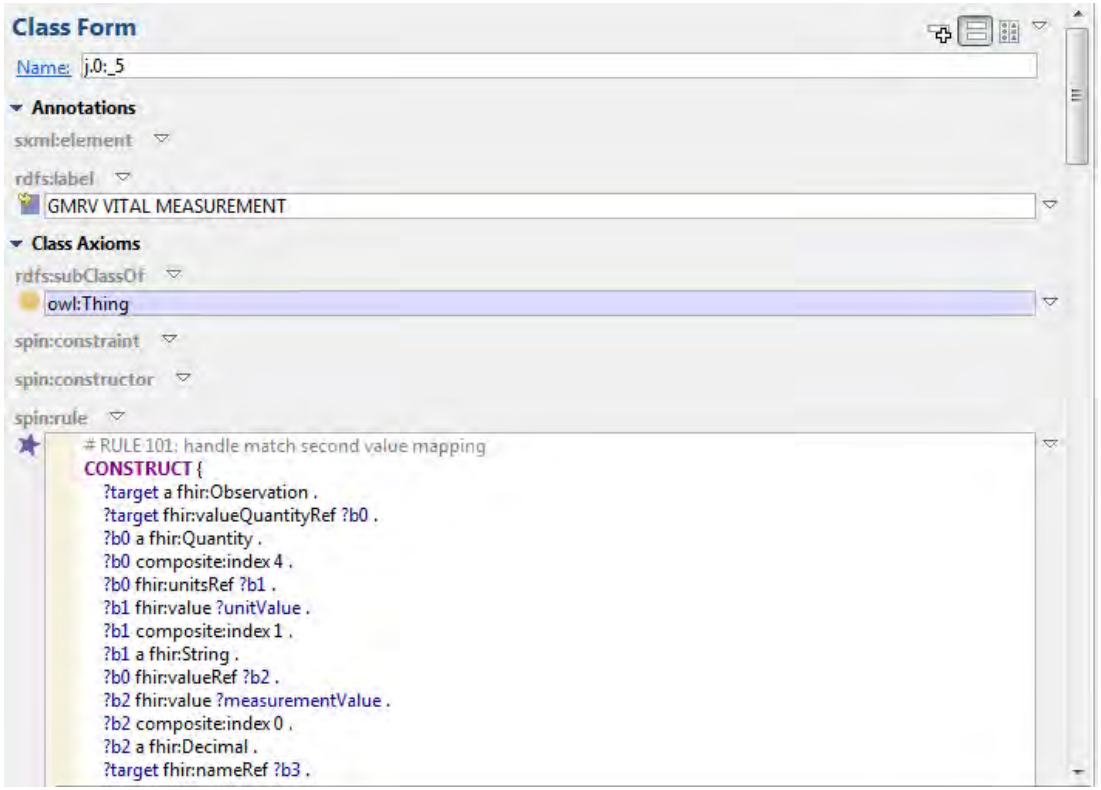
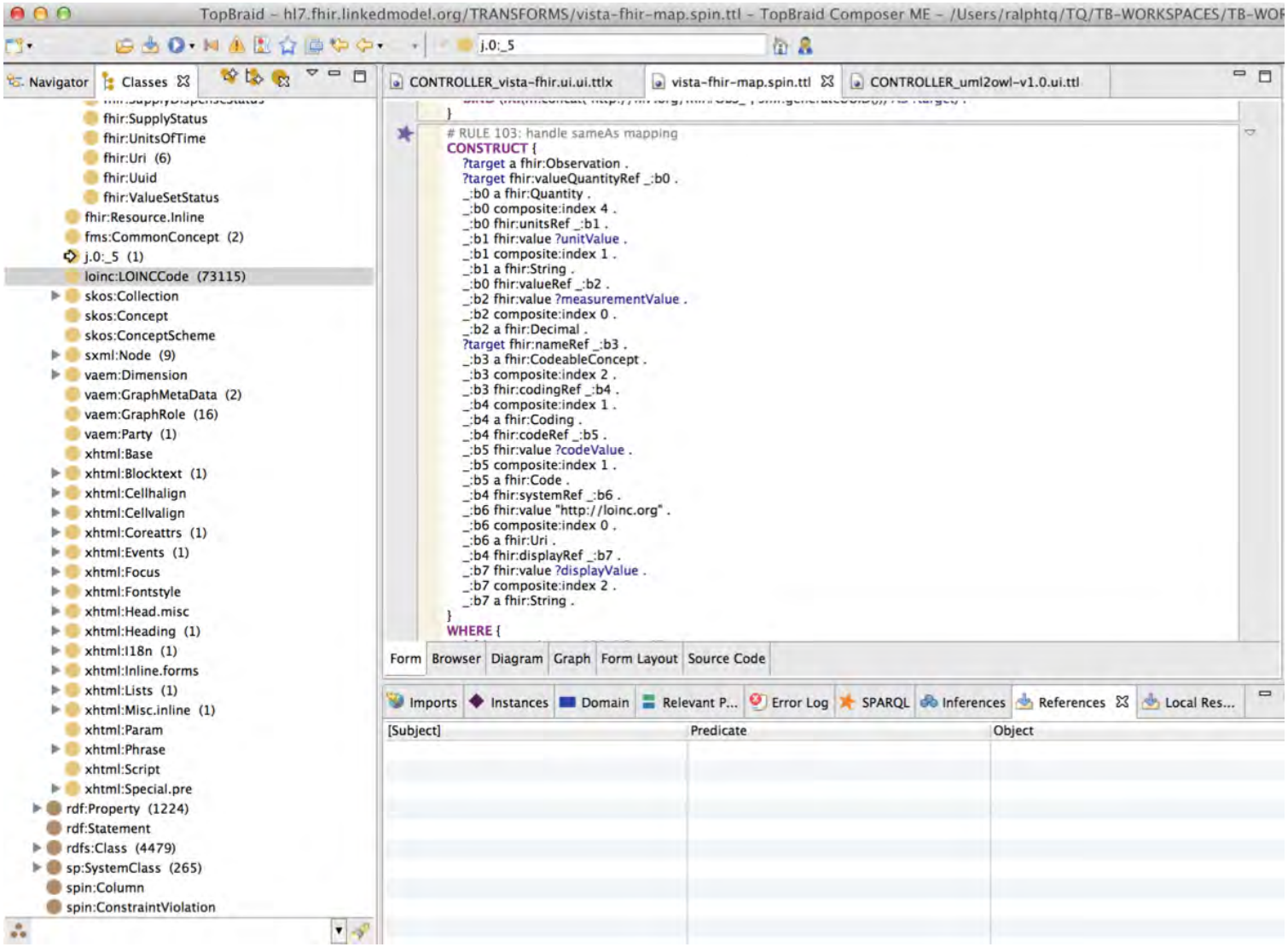
Easier to create deep nested structures in the target



SPINMap: Rules for LOINC terminology



SPINMap Output: Linked Vitals

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VistA Patient Records of Interest

VistA Patient Record	Blood Pressure
http://livevista.caregraf.info/120_5-8	130/80

SPIN SPARQL Inferencing Notation

Same As

FHIR Patient Records

FHIR Patient Record	Blood Pressure	Value
http://hl7.org/fhir#OBS_cf8c9913-2aa1-11b2-80b1-f6177b67abba	Diastolic blood pressure	130/80
http://hl7.org/fhir#OBS_cf8c9912-2aa1-11b2-80b1-f6177b67abba	Systolic blood pressure	130
http://hl7.org/fhir#OBS_cf8c9909-2aa1-11b2-80b1-f6177b67abba	Diastolic blood pressure	80

Linked Vitals: A step towards Linked Health