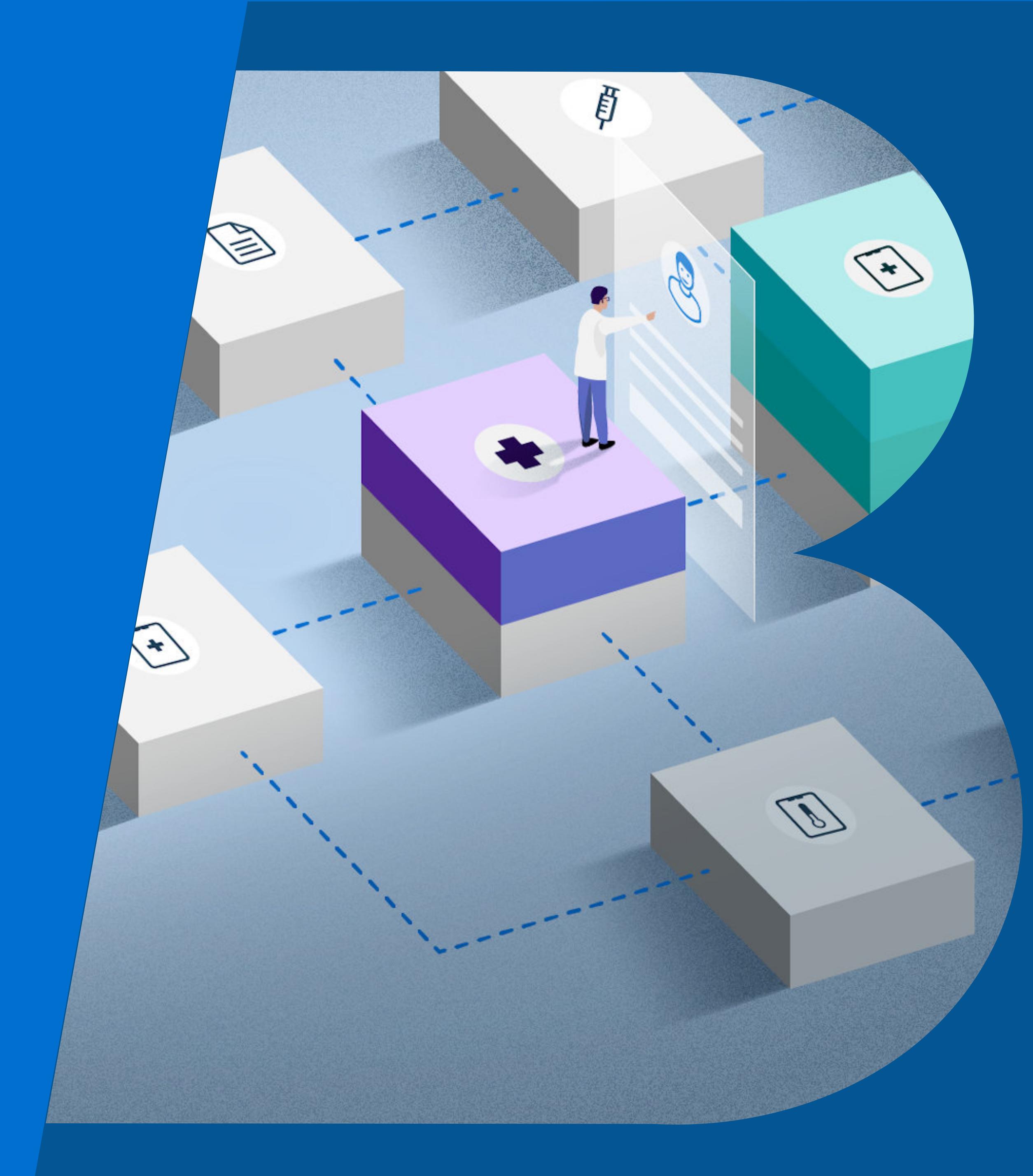


B better

openEHR clinical modelling

Vanessa Pereira

Pathfinder health informatics engineer
@VanessapPT



About me

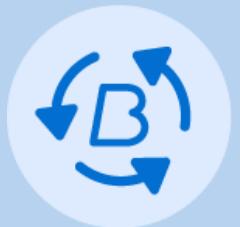
**Background:**

- B.Sc. in Medical instrumentation and computer engineering
- M.Sc. in Medical informatics

Currently:

- Pathfinder clinical modelling lead
- openEHR Portugal associate
- E-MAIS associate - representative of Portugal in the European Federation for Medical Informatics (EFMI)

Better data, better care.



Healthcare data is highly complex and usually changing within biological, cultural and political aspects.



A model is only as good as the data used to test and tune it. In order to have better data, a good model is mandatory.



What we will do

Summary

*open*EHR

Introduction to openEHR



CIM repositories - openEHR CKM

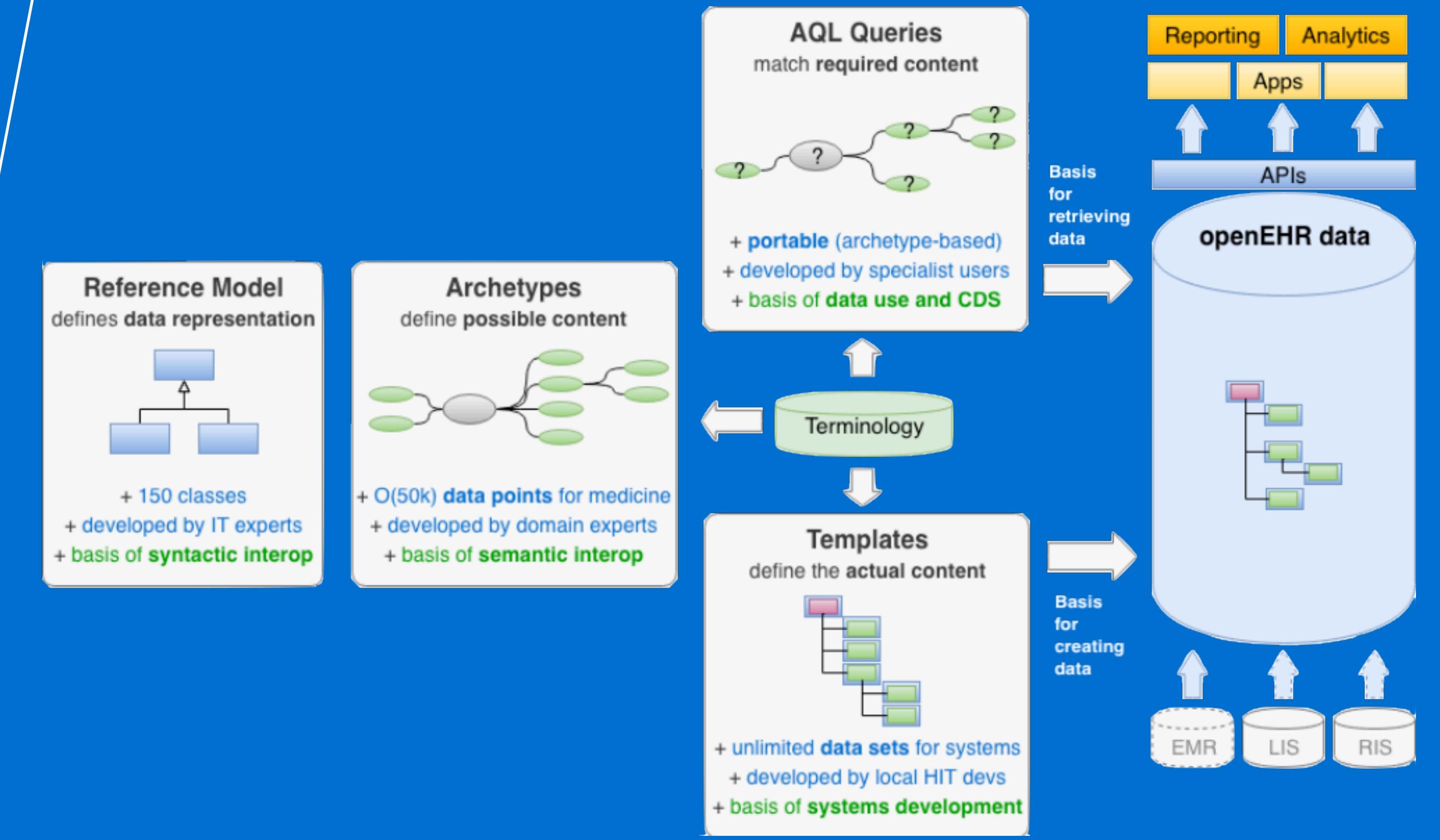


Archetypes and templates
AQL's



Modelling tools - ADL designer

OpenEHR introduction



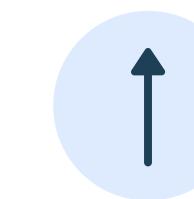
source: openEHR

What is openEHR ?



An open specification/architecture

Provides rules of how to work, share and store health data with the principal idea of separating this data from applications as an agnostic approach. Based on ISO/TR 20514, ISO/TS 18308, etc.



Non-profit foundation

Focused on standards for managing clinical data.



Information quality changer

To improve outcomes In healthcare, public health and the value of secondary data use.



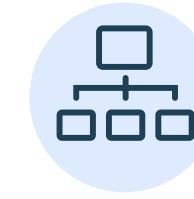
Research friendly

Clinical data is separated from demographics data. Great for secondary use of data.



Vendor lock-in and technology avoider

Data belongs to hospital institutions and not to IT companies.



Guideline on how to model HI

Same datatypes will be used across different systems based on openEHR

Based on standards

- ISO/TR 20514. Health informatics - Electronic health record - Definition, scope, and context. ISO TC 215/WG 1.
- ISO/TS 18308. Technical Specification for Requirements for an EHR Architecture. ISO TC 215/WG1.
- OMG HDTF Standards - general design
- CEN EN 13606:2006: Electronic Health Record Communication
- CEN HISA 12967-3: Health Informatics Service Architecture - Computational viewpoint
- CEN HISA 12967-2: Health Informatics Service Architecture - Information viewpoint
- CEN ENV 13940: Continuity of Care.
- ISO 8601: Syntax for expressing dates and times (used in openEHR Quantity package)
- ISO 11404: General Purpose Data types (mapped to in openEHR assumed_types package in Support Information Model)
- HL7 UCUM: Unified Coding for Units of Measure (used by openEHR Quantity data type)
- HL7v3 GTS: General Timing Specification syntax (used by openEHR Time specification data types).
- some HL7v3 domain vocabularies are mapped to the openEHR terminology.
- IETF RFC 2440 - openPGP.
- ISO RM/ODP
- OMG UML 2.0
- W3C XML schema 1.0
- W3C Xpath 1.0

The following standards are in use and require data conversion for use with openEHR:

- CEN EN 13606:2005: Electronic Health Record Communication - near-direct conversion possible, as openEHR and CEN EN 13606 are actively maintained to be compatible.
- HL7v3 CDA: Clinical Document Architecture (CDA) release 2.0 - fairly close conversion may be possible.
- HL7v3 messages. Quality of conversion currently unknown due to flux in HL7v3 messaging specifications and diversity of message schemas.
- HL7v2 messages. Importing of HL7v2 message data is technically not difficult, and is already used in some openEHR systems. Export from openEHR may also be possible.

What is openEHR is not



A platform

Platforms are made by vendors following openEHR specification rules.



EHR Server

openEHR gives specifications on how a EHR Server should be done (same as platform).



FHIR competitor

The aim of FHIR and openEHR is different. FHIR is best at exchange of HI information. openEHR is best at representation and saving of fine-grained structured clinical content.



openEHR archetypes and templates

 **Modelling**





**“All models are approximations.
However, the proximate nature of the model must
always be borne in mind.”**

George Box

“Data is for life, not just for one clinical system.”

Rachel Dunscombe,
EY Healthcare Summit

openEHR artefacts



Archetypes and templates are software

They are susceptible to change overtime depending on gather clinical evidence evolution.



Archetypes (concept definition)

Open source structured computable models of clinical concepts. Can define clinical interface structures and data storage schema for openEHR systems.



Maximal dataset, structured data - the holy grail!

Tries to capture as much as possible clinical perspectives, structured.



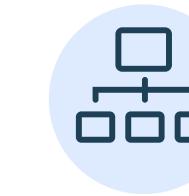
Clinically driven content definition

Medical practitioners and clinical analysts (domain experts) do the content.



Vendor and technological neutral

No lock-in to a single vendor and proprietary language.



Templates (document definition)

Deliver the contextualised datasets by aggregating archetypes together.

openEHR artefacts



Fig. 1 - Lego analogy for openEHR resources

What is the benefit?

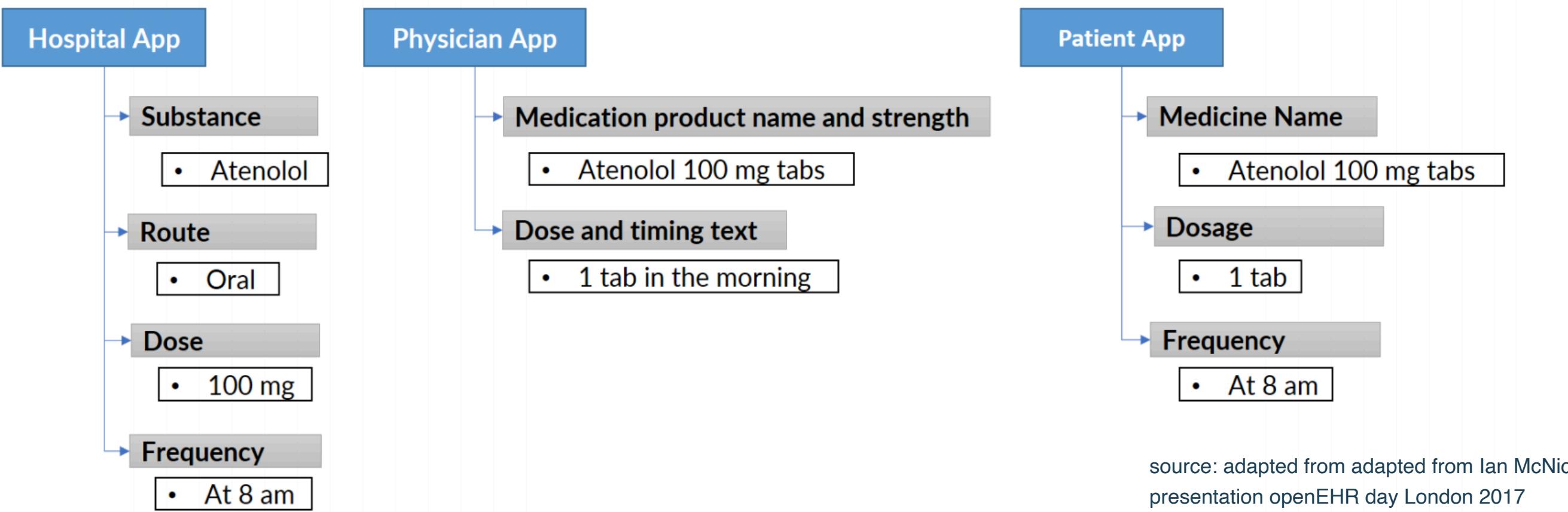
- Models are clinician centered and led, not programmer centered - domain experts (medical practitioners, clinical analysts, MI engineers) agree on the modelling side and create the database schema.
- Agile development - small chunks of information can be quickly added per iteration if necessary.
- Scalable - archetypes are ready for future use of shadow actions and task planning (if the modelling was well planned).
- Interoperable (if using archetypes internationally agreed on the openEHR CKM)
- Semantically based.
- Easy to bind to international terminologies (SNOMED, ICD, LOINC).
- Works very well with other standards (e.g FHIR)

But why?

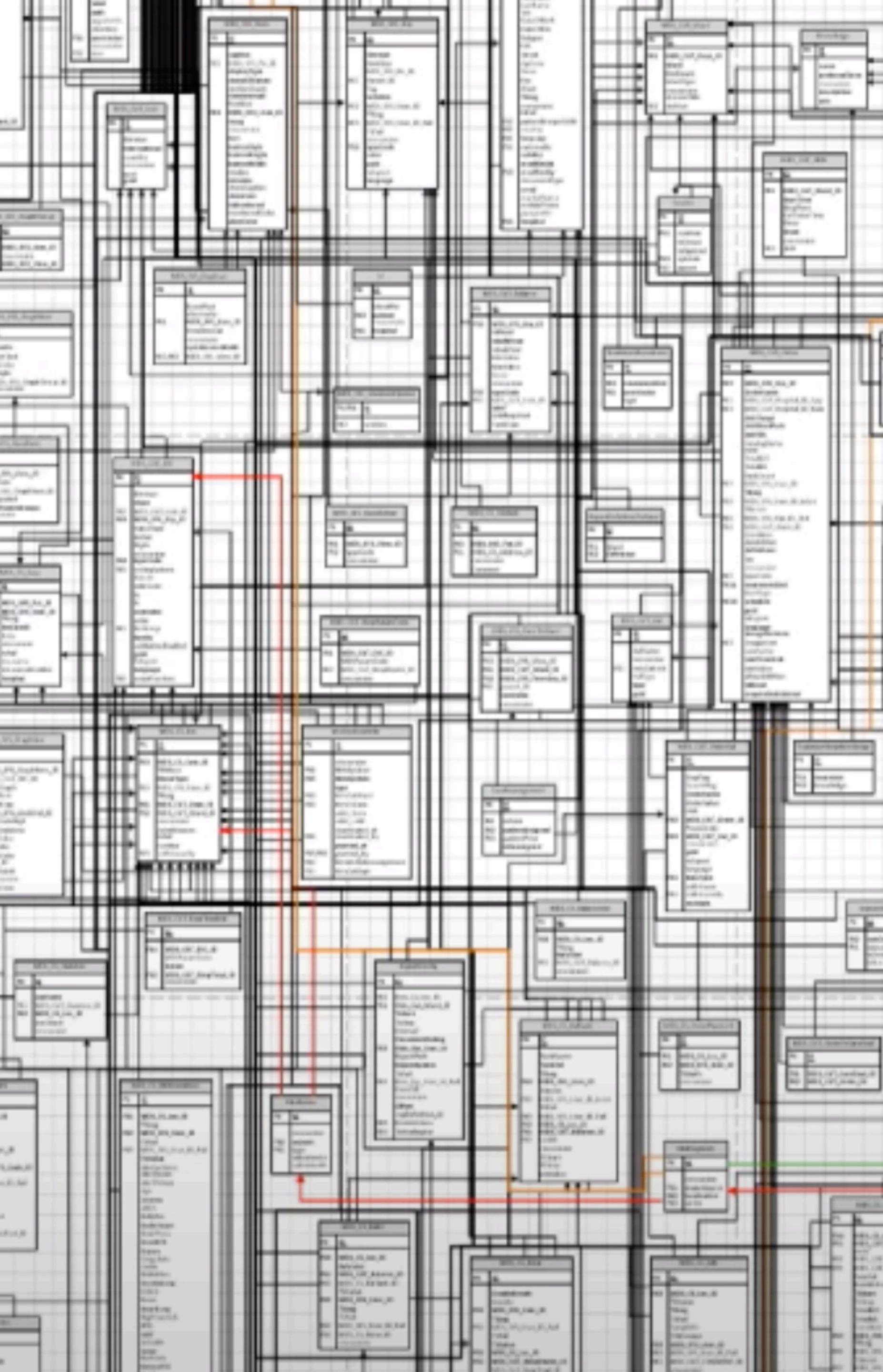
- In a traditional development, models are usually locked-in to an application, made by programmers (no domain knowledge), written in a programme language that fits best the programmer who made it and not sharable.
- One archetype per clinical concept - avoid duplications and different structures for the same concept.
- Elements have concrete data types that always have the same structure.

But why? (2)

Mismatched information models



- Prescribing medication defined in $O(n)$ different ways by different implementers.
- Replicated concepts, weird structure.



What is required to do modelling?

- Clinical modellers need **solid competence and skills** in:
 - Health informatics knowledge
 - Information architecture
 - Clinical modelling
 - Basic knowledge about existing systems (e.g. Pathfinder, Better Portal)
 - Clinical knowledge and clinical/medical advisors
 - Test management
 - openEHR reference model



Same applies to build forms using FormBuilder on EHR Studio.

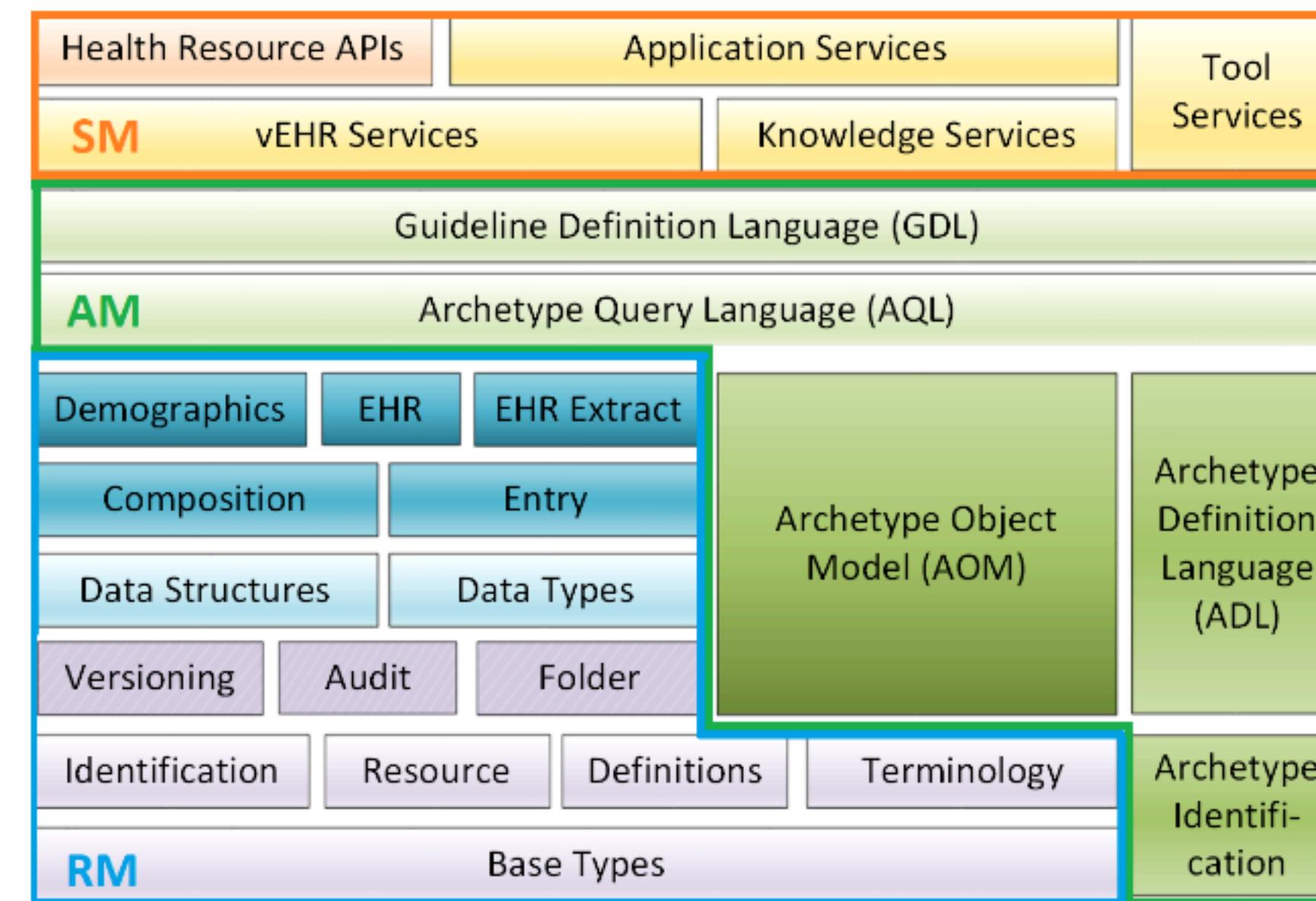
The two level modelling approach

Level 1 (UML)

Reference model - how health data is represented in a patient record.

Level 2 (ADL)

Archetypes (with terminology binding) and templates - clinical content definitions are represented separately from the reference model but automatically inherits parts of it (e.g. data-types). **Archetypes and templates are datasets external to any system!**



source: openEHR

Note: Each level has versioning!

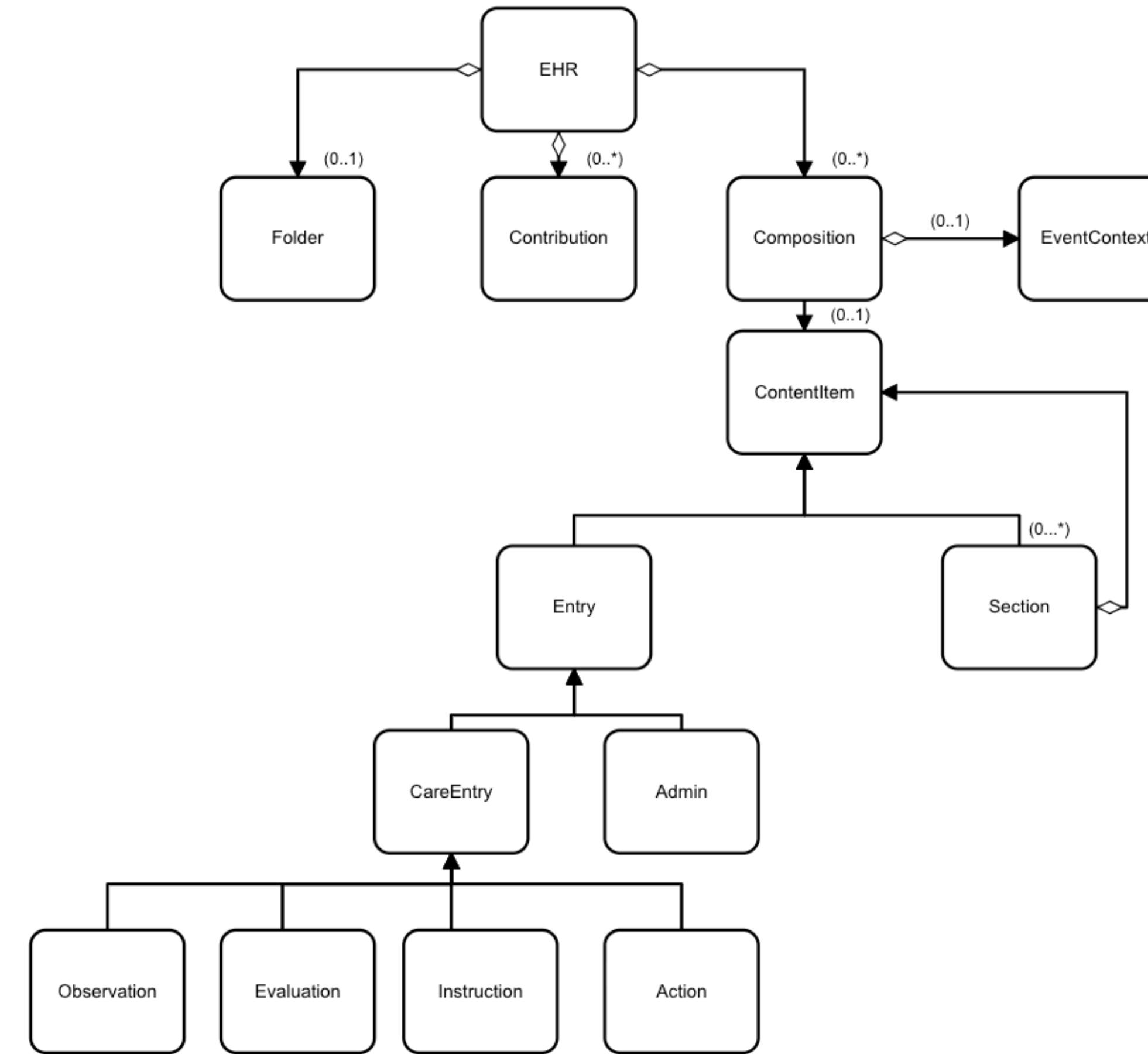
Currently the following versions are supported by Better tools and platform:

Reference model (RM): <https://specifications.openehr.org/releases/RM/Release-1.0.4>
Archetype model (AM): <https://specifications.openehr.org/releases/AM/Release-1.4>



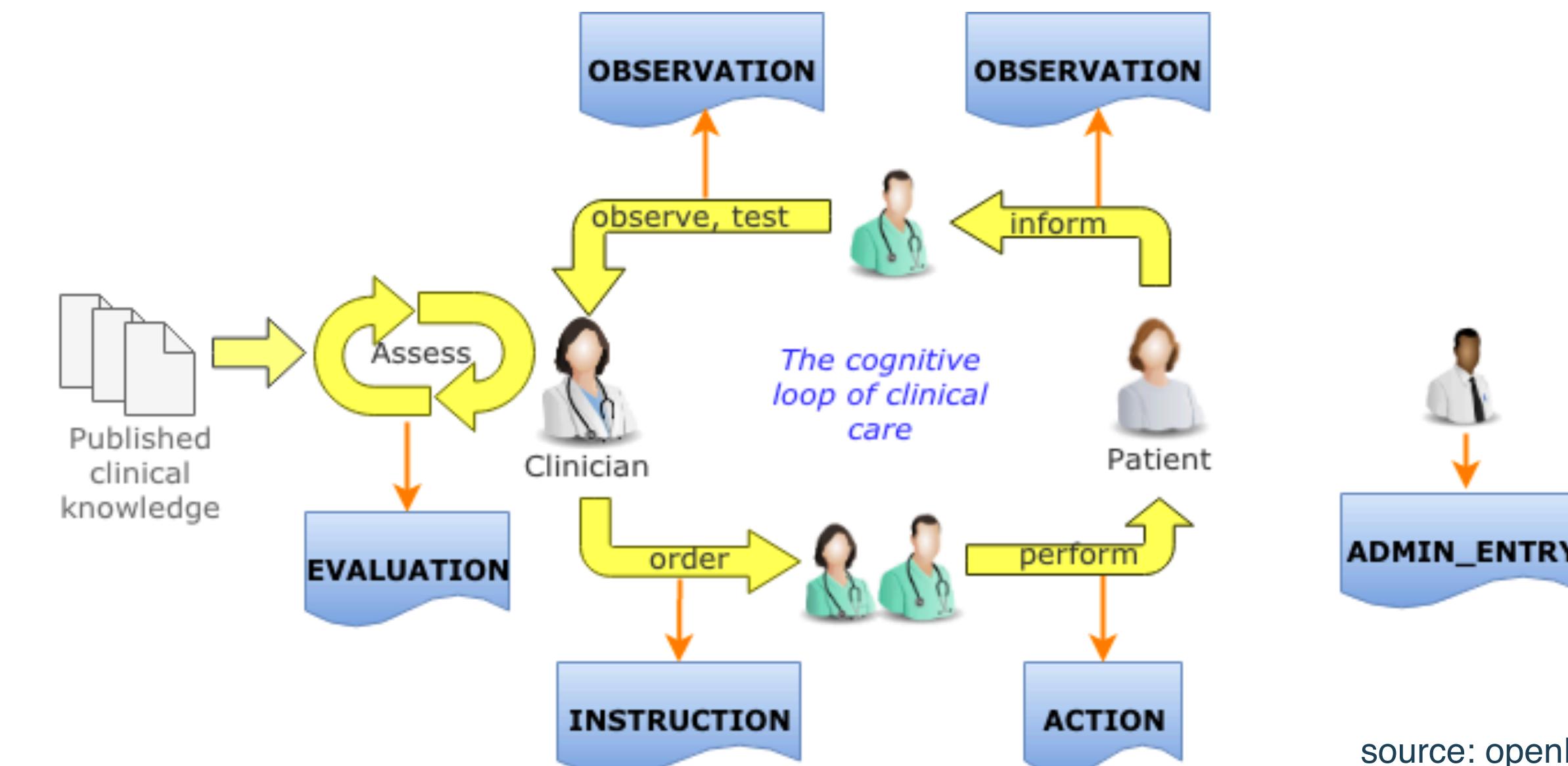
The reference model (RM)

- Tools used for modelling (e.g. ADL designer) have the RM functions hidden by default.
- **Archetypes are built on top of RM classes and inherited their attributes**
- Usually medical experts or 3rd party developers don't need to know details about it.
- **But it's important to know the existing information and functions to not rebuild the wheel** (creating elements that already exist) - the responsible modeller / final review should have knowledge about the reference model before the structure going into production.



The reference model (RM) -EHR

- **Observation:** Makes the record of a direct observation or measurement, such as body weight, blood pressure, or having the patient record in a historical retrospective.
- **Evaluation:** Can be a clinical opinion like a goal or a diagnosis, that have been measured or gathered and show clinical evidence.
- **Instruction:** It is used to record a clinical activity, providing a set of rules and instructions, and includes cancellation or postponement. It will have an action as a reply. Can be a medication order, a service request, laboratory test, etc.
- **Action:** Record a step in carrying out a clinical activity, including cancellation or postponement. Can be a reply to an instruction.
- **Admin_entry:** Record administrative information.



source: openEHR

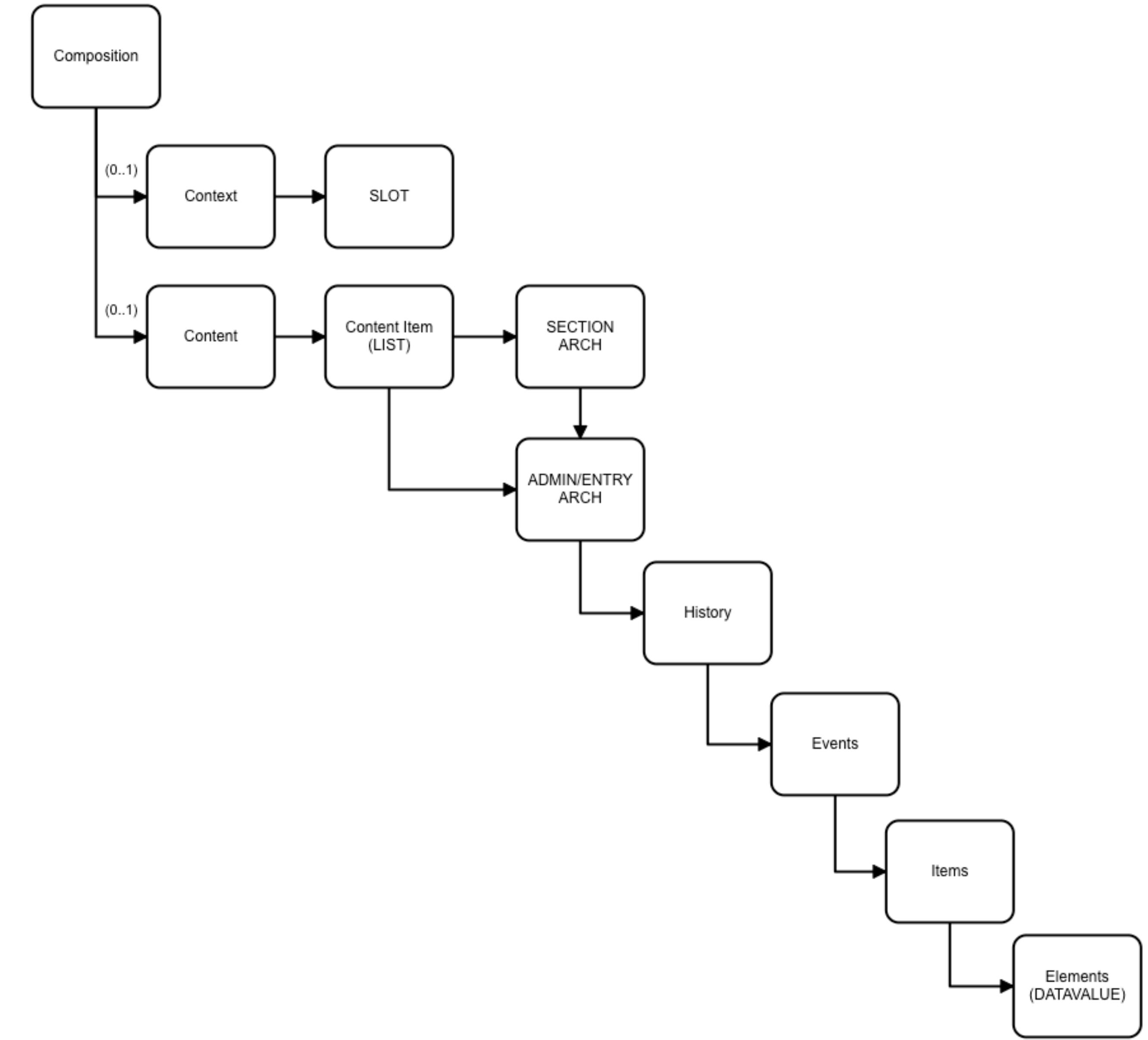
The reference model (RM)

- Data structures

- **Cluster** - organising nested multi-part data structures such as time series, and to represent the columns of a table.
- **Slot** - allows inclusion of any archetype named “openEHR-EHR-CLUSTER”.
- **Section** - data within a COMPOSITION that belongs under one clinical heading.
- **Element** - leaf node of the EHR hierarchy, containing a single data value.
- **History** - root object of a linear history, i.e. time series structure.
- **Event** - abstract notion of a single event in a series. Englobes point event and interval event.
- **Composition** - set of information committed to one EHR by one agent, as a result of a single clinical encounter or record documentation session.

The reference model (RM)

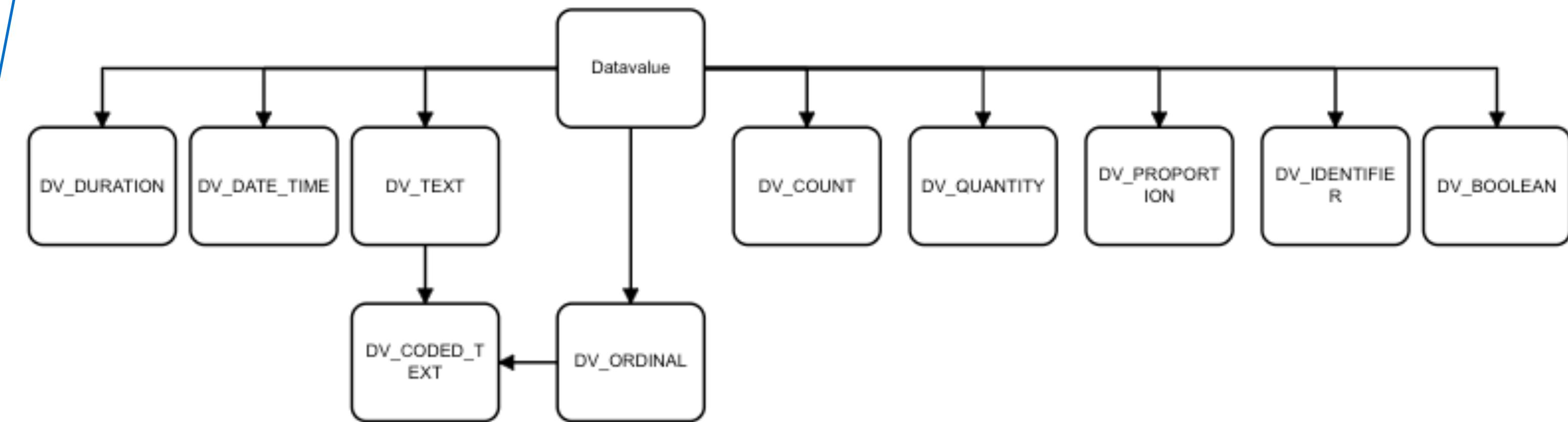
- Data structures



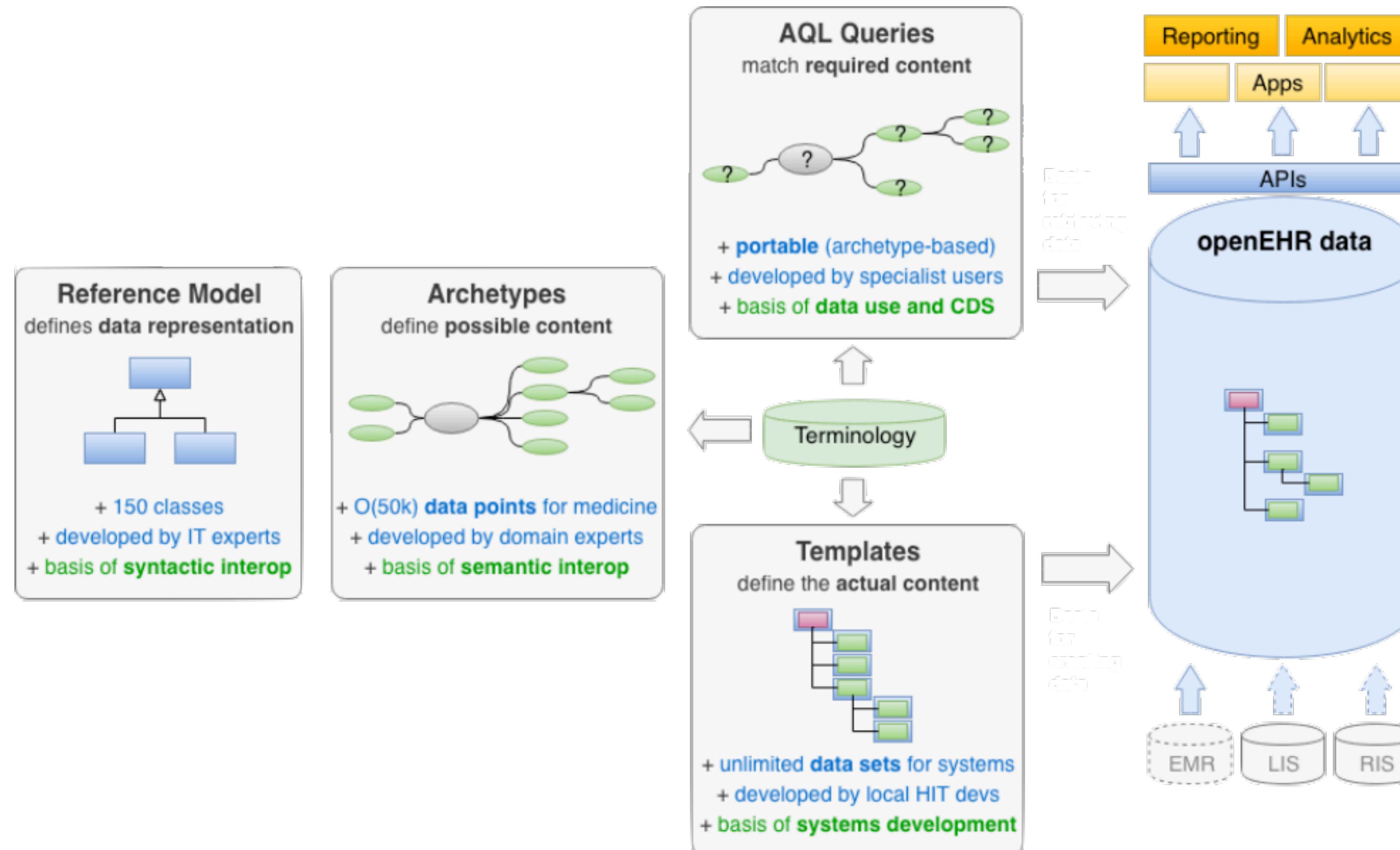
The reference model (RM)

- Data types

- DV_BOOLEAN
- DV_TEXT
- DV_CODED_TEXT
- DV_ORDINAL
- DV_QUANTITY
- DV_PROPORTION
- DV_COUNT
- DV_DATE
- DV_DATE_TIME
- DV_DURATION
- DV_INTERVAL
- DV_IDENTIFIER
- DV_MULTIMEDIA
- DV_URI
- DV_PROPORTION

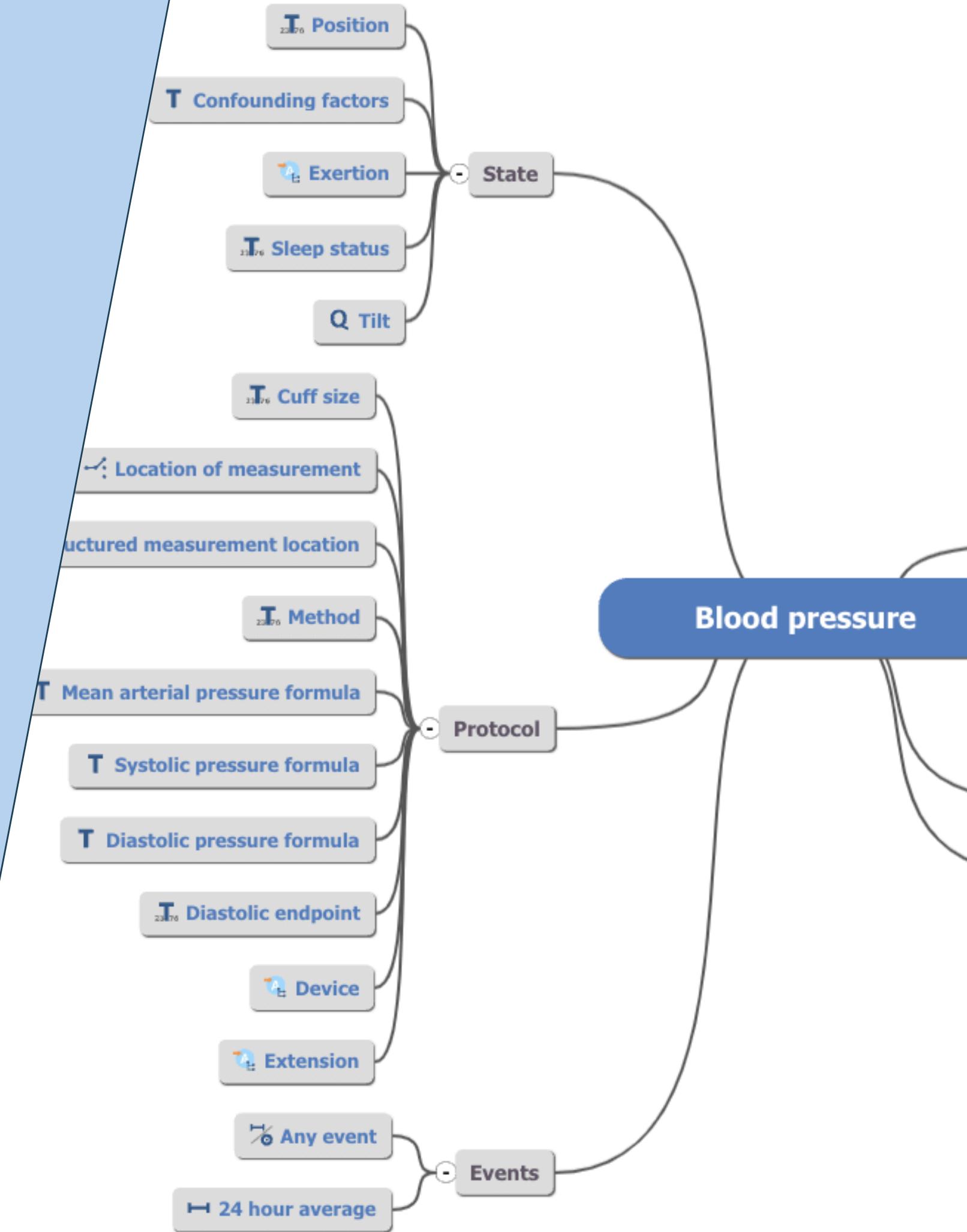


openEHR semantic workflow





openEHR Clinical Knowledge Manager (CKM)



About CKM (International)

- Main web tool that makes the management of clinical models' resources (archetypes and templates)
- Created in April 2009, product from Ocean Health System (ex-Ocean Informatics).
- Currently under management of the openEHR community.
- Free registration for individuals from all around the world, focused on giving added value to the repository on a voluntary basis.
- All non-technical healthcare area professions are also encouraged to contribute, it is not a requirement to be a physician to redound.



openEHR CKM instances

Main:

- openEHR CKM (International): <https://ckm.openehr.org/ckm/>

National:

- Apperta (United Kingdom): <https://ckm.apperta.org/ckm/>
- Nasjonal IKT (Norway): <https://arketyper.no/ckm/>
- Highmed (Germany): <https://ckm.highmed.org/ckm/>
- Ezdrav (Slovenia): <http://ukz.ezdrav.si/ckm/>

Why is so important to get archetypes from openEHR CKM?

- openEHR artefacts are software: **changes to archetypes and templates have potentially direct effects on systems.**
- **openEHR CKM should be the initial source of truth:** It assures interoperability if everyone is using the same based archetype (same structure of the clinical model in different databases or systems).
- **Archetypes on CKM are keep updated with new versions as the clinical evidence evolves.** All the artefacts have their own life-cycle.

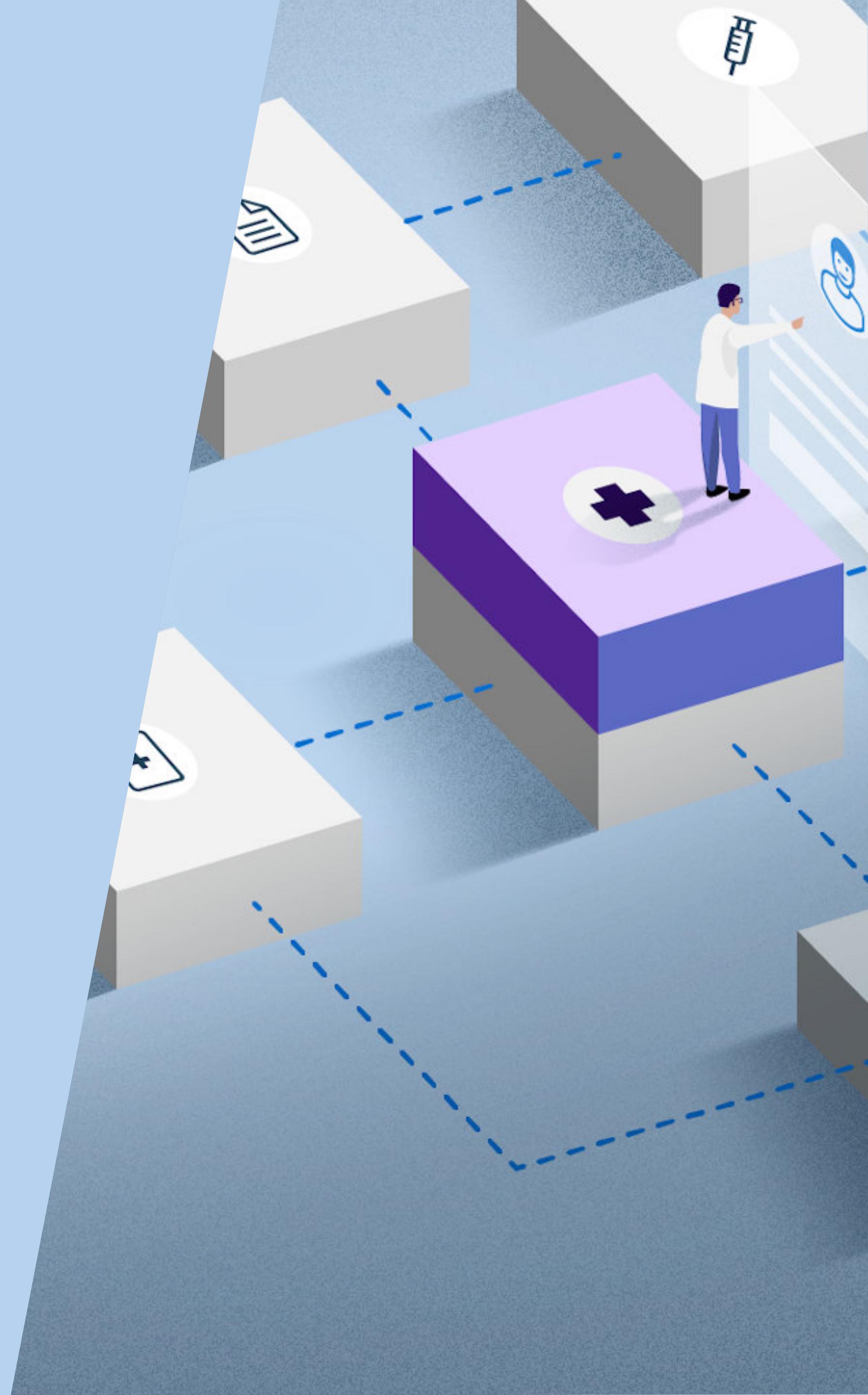


Demo



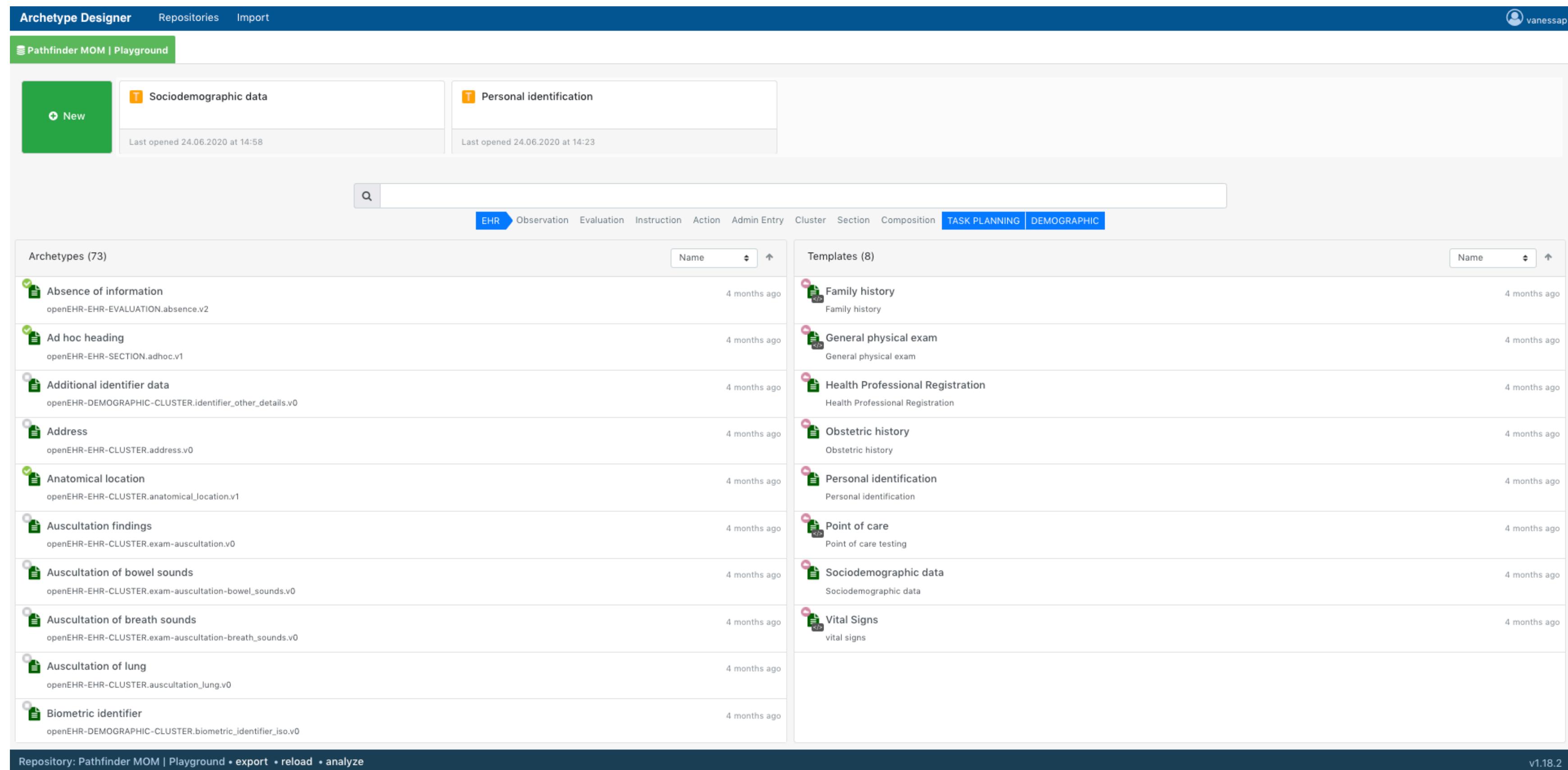
Archetype Designer

(Also known as ADL Designer)



What is Archetype designer?

- Web based tool to model openEHR artefacts.
- Has archetype editor and template editor embedded in the same application (on Ocean tools these editor are separated applications)
- Developed and maintained by Better - new features are quickly added over time.

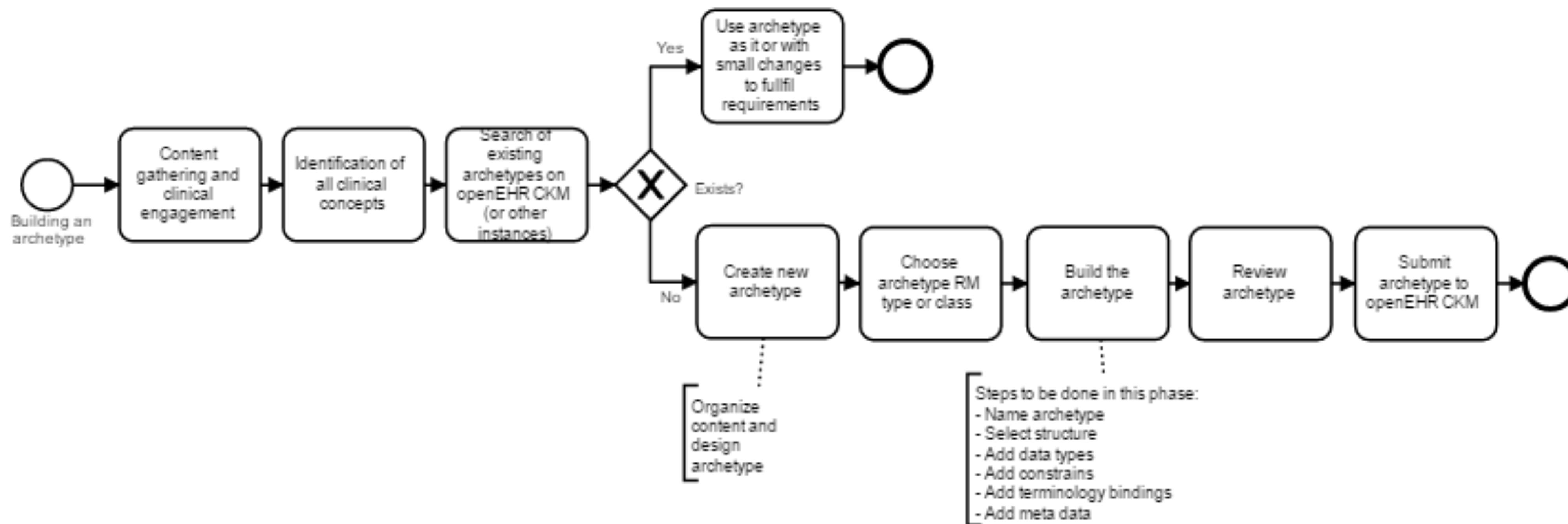


The screenshot shows the Archetype Designer application interface. At the top, there is a navigation bar with tabs for "Archetype Designer", "Repositories", and "Import". On the right side of the top bar, there is a user profile icon labeled "vanessap". Below the navigation bar, there is a header with a "Pathfinder MOM | Playground" button, a "New" button, and two cards: "Sociodemographic data" and "Personal identification". A search bar is located below the header. The main content area is divided into two sections: "Archetypes (73)" on the left and "Templates (8)" on the right. Both sections have a "Name" dropdown and a sorting arrow. The "Archetypes" section lists items like "Absence of information", "Ad hoc heading", "Additional identifier data", "Address", "Anatomical location", "Auscultation findings", "Auscultation of bowel sounds", "Auscultation of breath sounds", "Auscultation of lung", and "Biometric identifier". The "Templates" section lists items like "Family history", "General physical exam", "Health Professional Registration", "Obstetric history", "Personal identification", "Point of care", "Sociodemographic data", and "Vital Signs". At the bottom of the page, there is a footer with the text "Repository: Pathfinder MOM | Playground • export • reload • analyze" and "v1.18.2".

Functionalities

- **ADL designer allows to:**
 - **Create** archetypes and templates
 - **Translate** archetypes and templates
 - **Export** .OPT and .OET files
 - Filesets (.zip folder with all the archetypes used to make a template and the template)
 - Web template (.json)
 - The whole repository (.zip)
- When the template is finalised -> Download it as .OPT (Operational template) to further upload it to the Better Platform.

Archetype development process



Versioning

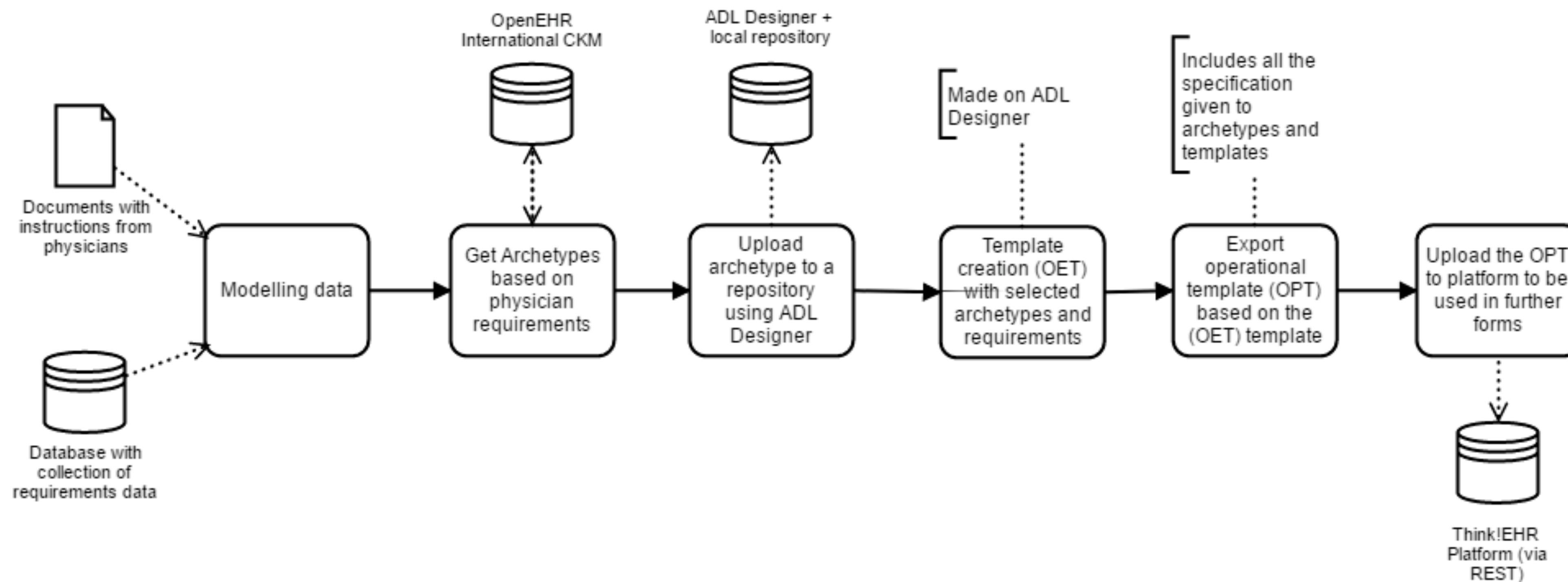
- **Archetypes** are managed on the openEHR CKM (including other national instances). A solid research needs to be done and check if they match the user requirements. If the use case is not found, we can create our local/internal archetype on ADL designer.
- **Templates** are (currently) build and managed on ADL Designer.
 - It allows to create local archetypes or specialize international archetypes.
 - Can be connected to a GIT (Github, Gitlab, local GIT) or other versioning based system.

Note: Some templates can also be found at the openEHR CKM, but due to tool limitations, they are not usually updated.

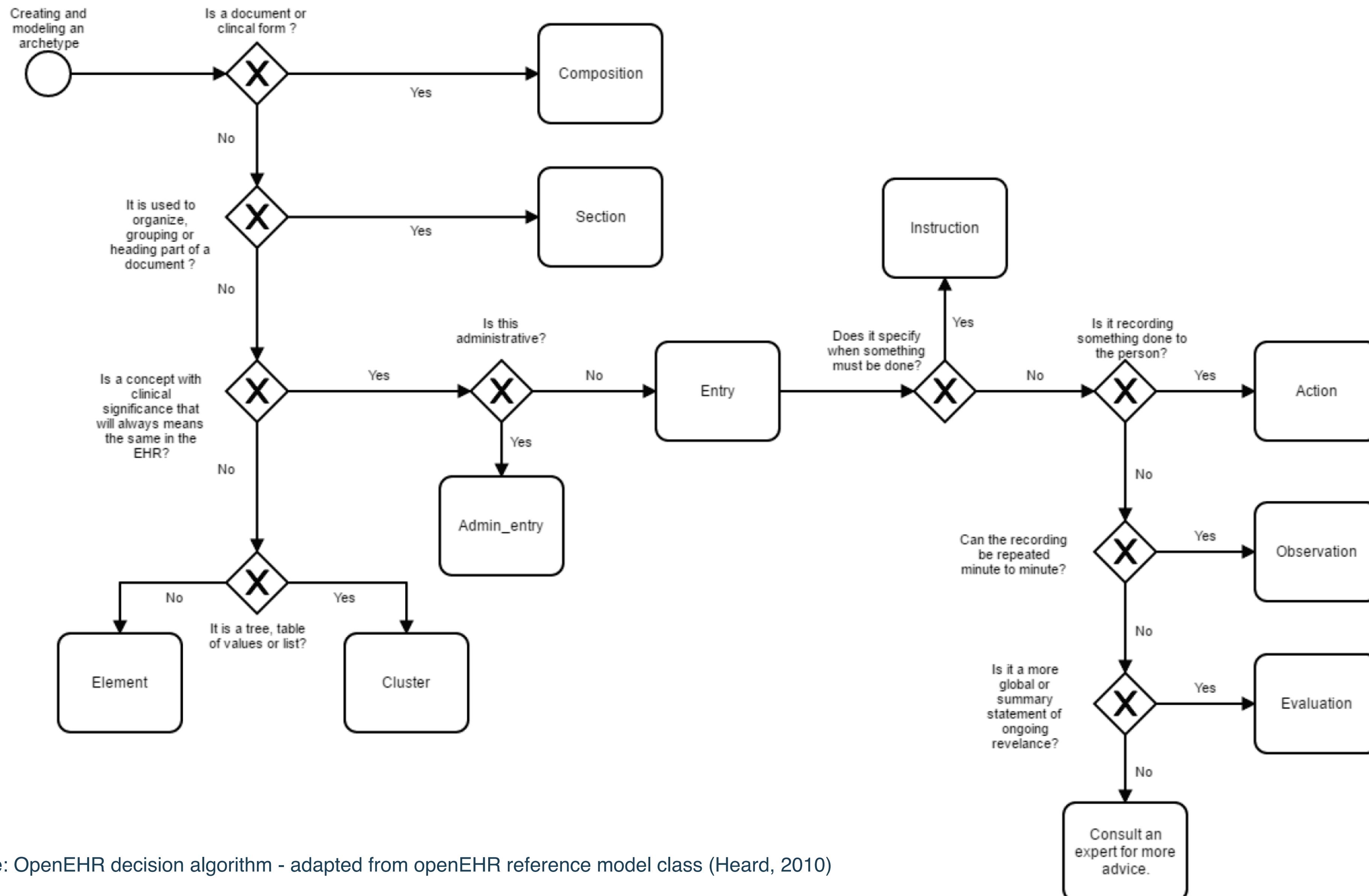


Tip! Always connect your repository to a GIT based system. It is *almost* a life saviour.

Workflow - from archetype and template to platform



Choosing RM classes

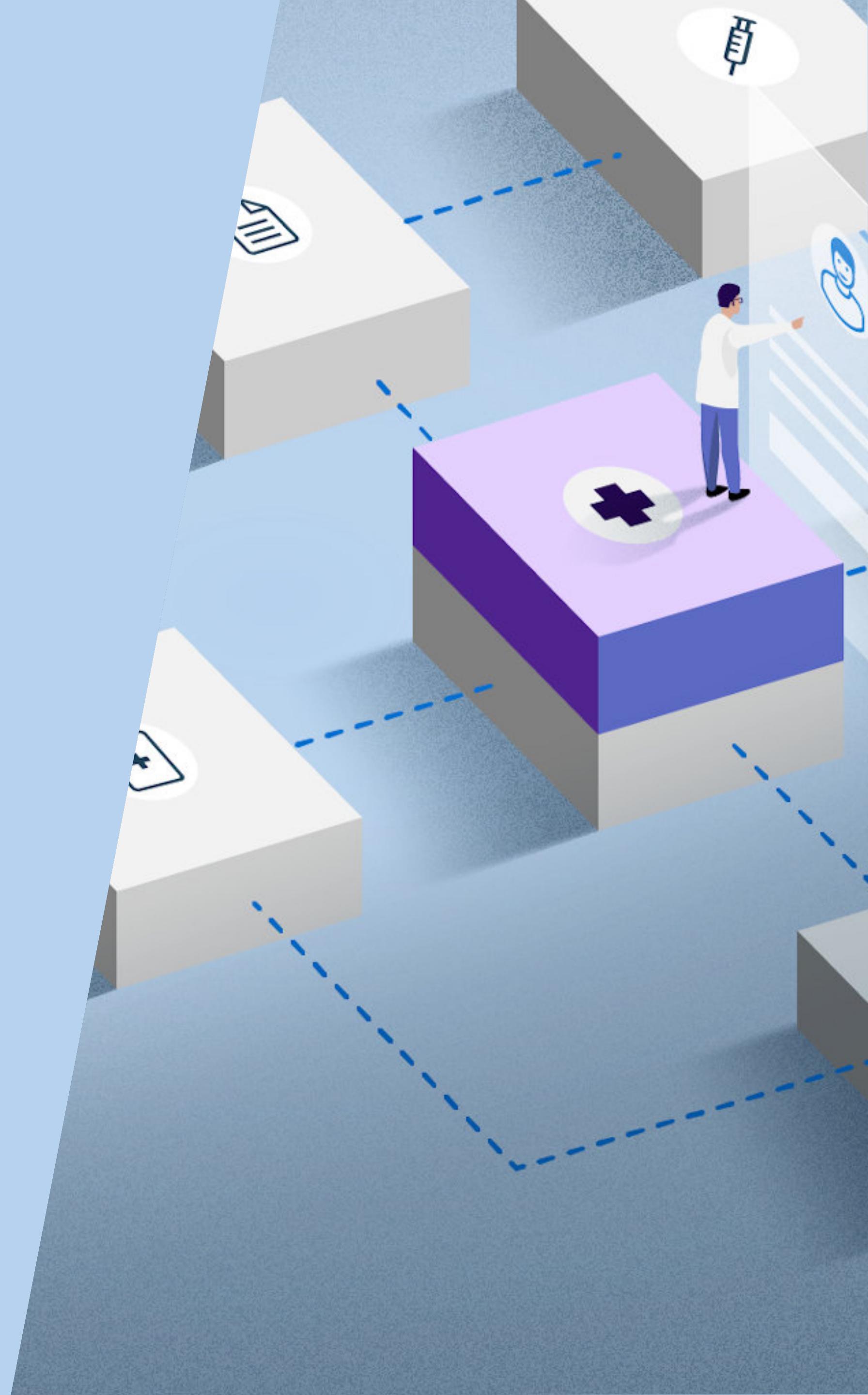




Demo



Language translations of openEHR artefacts



Translation process

- Archetypes

- **If your archetype comes from openEHR CKM:**
 - Translation should be done on openEHR CKM.
 - An account on this tool is necessary (**and it's free!**).
 - A translator role needs to be required.
 - Fields are translated directly on the tool.
- **If your archetype was made internally (e.g. on Archetype designer):**
 - Translation should be done on Archetype designer.
 - An account on this tool is necessary (**and it's free!**).
 - Fields can be translated directly on the tool or by downloading an excel file, translating it and upload again.
 - **(New!)** Two roles can be used for translation - 'DESIGNER' or 'TRANSLATOR'.

Translation process

- Templates

- **Templates are translated on Archetype designer:**
 - An account on this tool is necessary **(and it's free!).**
 - Two roles can be used for translation - 'DESIGNER' or 'TRANSLATOR'.

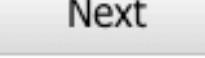
Archetypes ▾ Templates ▾ Termsets ▾ Release Sets ▾ Reviews ▾ Projects ▾ Discussion ▾ Reports ▾ Tools ▾ Help ▾

 Dashboard  Find Resources  Blood pressure  Translate: Blood pressure

Translate Archetype: Blood pressure

Translating Blood pressure (openEHR-EHR-OBSERVATION.blood_pressure.v2, branch: vanessa.pereira) from English to Portuguese (Portugal).

Archetype	TEXT (AT0004)
Purpose	Original node text: Systolic Translated node text: Sistólica
Use	
Misuse	
Keywords	
Blood pressure	
History	
Any event	Original description: Peak systemic arterial blood pressure - measured in systolic or contraction phase of the heart cycle. Translated description: Pico da pressão arterial sistêmica - medida na fase sistólica ou de contração do ciclo cardíaco.
Systolic	
Diastolic	
Mean arterial pressure	
Pulse pressure	
Clinical interpretation	
Comment	
Position	
Standing	
Sitting	
Reclining	
Lying	
Lying with tilt to left	
Confounding factors	
Exertion	
Sleep status	
Awake	
Sleeping	



 Save Translation and Continue  Save Translation and Continue Later  Submit Final Translation and Notify Editor

Archetype Designer Repositories Save Export Import

 testing  openEHR-EHR-OBSERVATION.blood_pressure.v2 x

[openEHR-EHR-OBSERVATION.blood_pressure.v2](#)

[Specialize](#) pt-pt ↗

Tree Mindmap Tabbed ADL Terminology Analytics

Terms Bindings Constraints Languages and terminologies

Reference language English (en) ↗

Code	Text	Description	Comment
at0000	*Blood pressure (en)	*The local measurement of arterial blood pressure which is a surrogate for arterial pressure in the systemic circulation. (en)	*Most commonly, use of the term 'blood pressure' refers to measurement of brachial artery pressure in the upper arm. (en)
at0001	*History (en)	*History Structural node. (en)	Click to add comment...
at0003	blood pressure	@ internal @	Click to add comment...
at0004	Sistólica	Pico da pressão arterial sistêmica - medida na fase sistólica ou de contração do ciclo cardíaco.	Click to add comment...
at0005	*Diastolic (en)	*Minimum systemic arterial blood pressure - measured in the diastolic or relaxation phase of the heart cycle. (en)	Click to add comment...
at0006	*Any event (en)	*Default, unspecified point in time or interval event which may be explicitly defined in a template or at run-time. (en)	Click to add comment...
at0007	state structure	@ internal @	Click to add comment...
at0008	*Position (en)	*The position of the individual at the time of measurement. (en)	Click to add comment...
at0011	*Tree (en)	*List structure. (en)	Click to add comment...
at0013	*Cuff size (en)	*The size of the cuff used for blood pressure measurement. (en)	*Perloff D, Grim C, Flack J, Frohlich ED, Hill M, McDonald M, Morgenstern BZ. Human blood pressure determination by sphygmomanometry. Circulation 1993;88:2460-2470. (en)
at0014	*Location of measurement (en)	*Simple body site where blood pressure was measured. (en)	Click to add comment...
at0015	*Adult_Thigh (en)	*A cuff used for an adult thigh. (en)	Click to add comment...

[Export translations](#) [Import translations](#)



Demo



AQL

Archetype Query

Language



Development - retrieve data

```
        .0001]/ ... /items[at0004]/value AS systolic,
        .0001]/ ... /items[at0005]/value AS diastolic,
        _id=$ehrId]
AINS
VERSIONED_OBJECT vo
TAINS
VERSION[all_versions]
NTAINS
COMPOSITION c
    [openEHR-EHR-COMPOSITION.encounter.v1]
ONTAINS
OBSERVATION o [openEHR-EHR-OBSERVATION.blood_p
data[at0001]/ ... /items[at0004]/value/value >= 140
data[at0001]/ ... /items[at0005]/value/value >= 90 o

-----
SELECT
e/ehr_id/value
M
EHR e
    CONTAINS COMPOSITION c [openEHR-EHR-COMPOSITION.re
ERE
c/archetype_details/template_id/value = $foo

-----
SELECT
o/data[at0001]/events[at0006]/data[at0003]/items[at0004]/value AS systolic,
o/data[at0001]/events[at0006]/data[at0003]/items[at0005]/value AS diastolic,
o/ehr_id/value="1234"]
CONTAINS COMPOSITION [openEHR-EHR-COMPOSITION.encounter.v1]
    CONTAINS OBSERVATION o [openEHR-EHR-OBSERVATION.blood_pressure.v1]
        .0001]/ ... /items[at0004]/value/value >= 140
        .0001]/ ... /items[at0005]/value/value >= 90 o

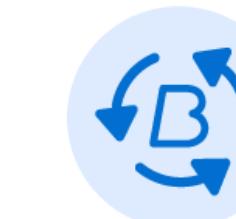
-----
```

Queries

- Queries follow archetypes structures
 - If something is changed on the archetype structure (archetype_id, atcodes, template_id), change on query is mandatory!
 - AQL structure is quite similar with SQL.

Query example:

```
SELECT
n/data[at001]/events[at006]/data[at003]/items[at004]/value as systolic,
n/data[at001]/events[at006]/data[at003]/items[at005]/value as diastolic,
c/context/start_time as dateCompositionSubmitted
FROM EHR e
CONTAINS COMPOSITION c[openEHR-EHR-COMPOSITION.encounter.v1]
CONTAINS OBSERVATION n[openEHR-EHR-OBSERVATION.blood_pressure.v2]
WHERE systolic > '120' AND diastolic > '180'
ORDER BY dateCompositionSubmitted DESCENDING
OFFSET 0 LIMIT 10
```



EHR Studio AQL builder will greatly help to build your own queries



Better data,
better care.



vanessa.pereira@better.care
@VanessapPT

B better

EHR Studio

Vanessa Pereira

Pathfinder health informatics engineer
@VanessapPT



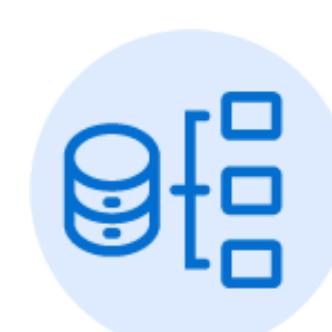
What we will do

Summary

Introduction to EHR Studio



Form Builder



AQL Builder

Connection to external APIs

Functionalities

- Form builder

- **Create a form** directly from the openEHR template
- **Language translation** (forms follow the translation provided from the openEHR template)
- **Connection to 3rd party applications** APIs (most used on Pathfinder - terminology adapter and demographics)



To create a form, you need a openEHR template - be sure that is already uploaded to the Better Platform before start doing the form.

Functionalities

- AQL builder

- **Assess saved data** into the EHR Server
- A great help to design **AQL queries** - click on desired fields, query will write itself.
- **Different possible views:**
 - Template
 - EHR objects (e.g. ehr_id)
 - Composition (e.g. composition_uid)
 - openEHR reference model (e.g. start_time, participations)



Demo



Better data,
better care.



vanessa.pereira@better.care
@VanessapPT

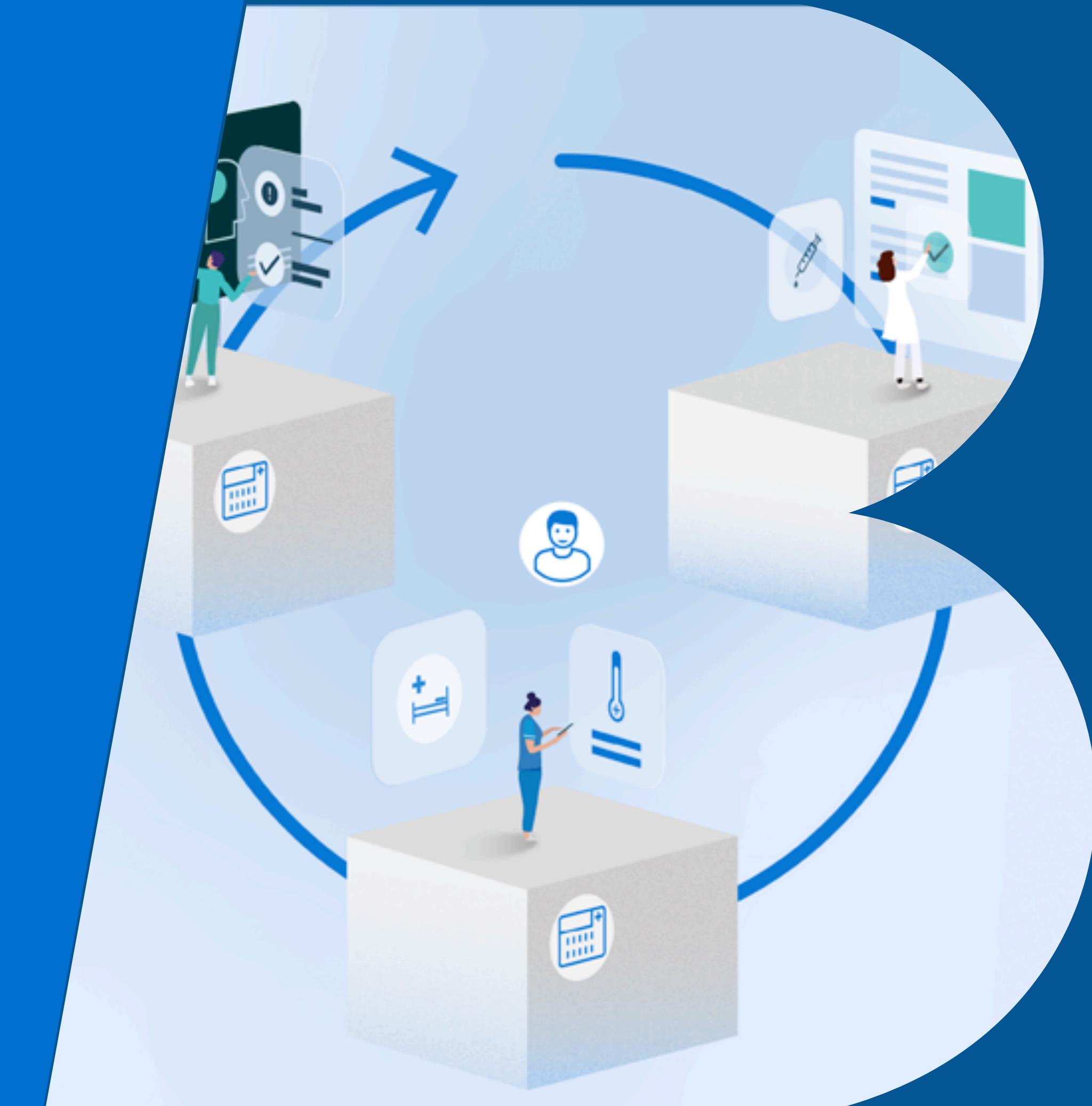
B better

Pathfinder

Deploying and testing forms

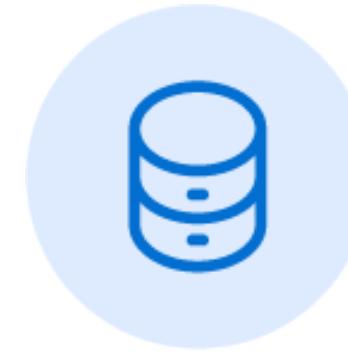
Vanessa Pereira

Pathfinder health informatics engineer
@VanessapPT



What we will do

Summary



How modelling should be done
within Pathfinder



Tagging forms for different use-
cases (e.g. care plans, PROMS)



Deploying forms on Pathfinder



Saving compositions on
Pathfinder and testing

Templates - required archetypes

- Under composition **context**:
 - **Encounter context** (if required (optional), registers encounter id)
 - **XDS metadata** (for IHE compliant profiles) (e.g. for medtronic IHU- it's optional.)
 - **Research information** (useful to query composition per cohort)
- Under composition **content**:
 - **Care plan** (mandatory on all templates that will be part of a care plan)
 - **Informed consent** (mandatory on all templates that will be part of a care plan)

Name	NodeId	Metadata	Occurrences
🕒 FILE TEMPLATE ROOT NAME (from: 'Encounter')	at0000.1	COMPOSITION	1..1
🕒 → context		EVENT_CONTEXT	0..1
🕒 → other_context		ITEM_STRUCTURE	0..1
🕒 Extension	at0002	CLUSTER	0..*
🕒 Encounter Context Δ [0..*] to [0..1]	at0000.1	CLUSTER	0..1
🕒 XDS Metadata Δ [0..*] to [0..1]	at0000.1	CLUSTER	0..1
🕒 Research information Δ [0..*] to [0..1]	at0000.1	CLUSTER	0..1
🕒 → content		CONTENT_ITEM	0..1
🕒 Care Plan	at0000.1	ACTION	0..1
🕒 Informed consent	at0000.1	ACTION	0..1

Forms - tags

- **Available tags:**
- **Under desired form container:**
 - **hideButtons** (hide pathfinder buttons ‘close, save progress, submit’)
- **Under ‘Global annotations’:**
 - **UserForm:UserForm** (show form on ‘Start assessment’)
 - **CarePlanForm** (form that can be added to a care plan)
 - **formClosePin:4321** (id defined by form owner - useful for PROM forms)
 - **Group:'GroupName'** (put a form into a group defined by group name - visible on ‘Start assessment’). Note that by default forms are in “Inpatient care and risk document” group if no group is defined.



Note: These tags only works with Pathfinder/Better Portal!

Forms

- connection to external API's

- Terminology adapter:
 - Add variable 'terminologyUrl' (Externally provided)
 - Add a test value
- Demographics:
 - Add variable 'demographyPatientUrl' (Externally provided)
 - Add a test value

Both need to be also configured on API connector!



When form is deployed on Pathfinder, these variables are automatically filled
- but they need to be included in the form!

- Forms always follow languages that are available on openEHR templates.
- Connection to terminology adapter (TA) works on what language is available on template and what version is available on the code system uploaded to TA

Forms

- Language translation

Terminology adapter

- API that provides function to upload and retrieve .csv and .json files
- It's not a terminology server! (e.g. SNOMED)

Requires a code system name: e.g. 'VitalStatus'

Accepts files with following structure:

```
"code","description_en","description_fr"  
"L","Alive","Vivant"  
"D","Dead","Décedé"  
"UNK","Unknown","Inconnu"
```

On Pathfinder (if this code system is used) this means that English and French version are available, but on FORM, it will only appear both if the template supports English and French. If the template only has English language, French will be ignored.





Demo



Better data,
better care.



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