Nordic openEHR Collaboration Meeting March 4th, 2025

Ongoing work at Karolinska University Hospital

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Agenda

- Focus for openEHR work
- Radiology (MRI) prostate
- Patient reported data
- PoC TakeCare to openEHR
- Primary documentation of Multidisciplinary conference notes
- Pathology
- Medical Oncology Treatment

Focus for openEHR work

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Focus in all projects

- openEHR modelling for primary documentation
- Data used for care and treatment
- Build forms in various source systems based on openEHR-templates rather than mappings

Radiology (MRI) prostate

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Symphony project

Project details

- Innovation project in EU + Turkey
- 3 years with start October 2022
- 4 use cases
- Sweden: Prostate cancer use case

Problem

- Rising healthcare demand and staff shortages
- Clinical data are heterogeneous, complex, and siloed
- Lack of **interoperability** hinders primary and secondary use of source data

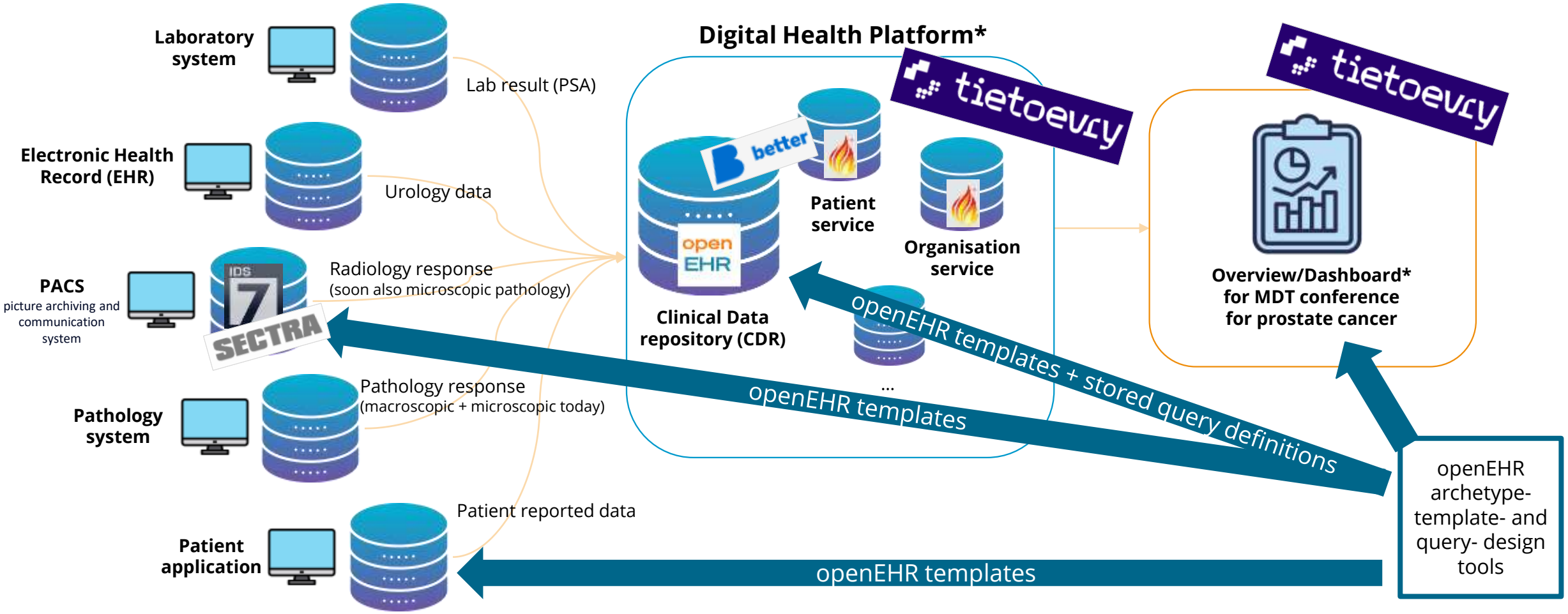
Solution

- Develop an open, interoperable healthcare IT ecosystem
- Integrate clinical workflows and data from heterogeneous sources
- Ensure the system aligns with key principles of healthcare technology integration with **structured** and **standardized** data

Effect

- Data-driven decision-making, including **predictive modelling**
- **Visualization** of complex data following the patients' disease pathway as well as guidelines
- Enhanced patient safety with reduced information loss, including **patient-reported data**
- Real-time quality reporting and feedback

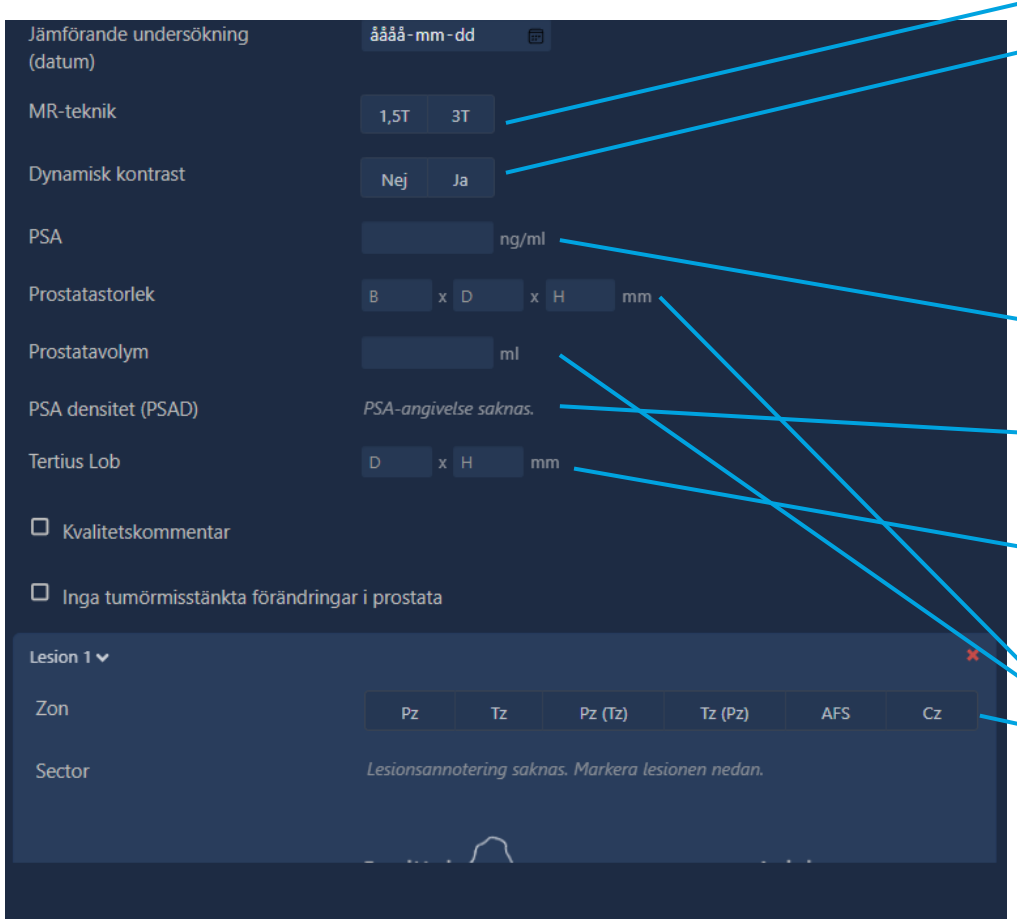
Symphony architecture

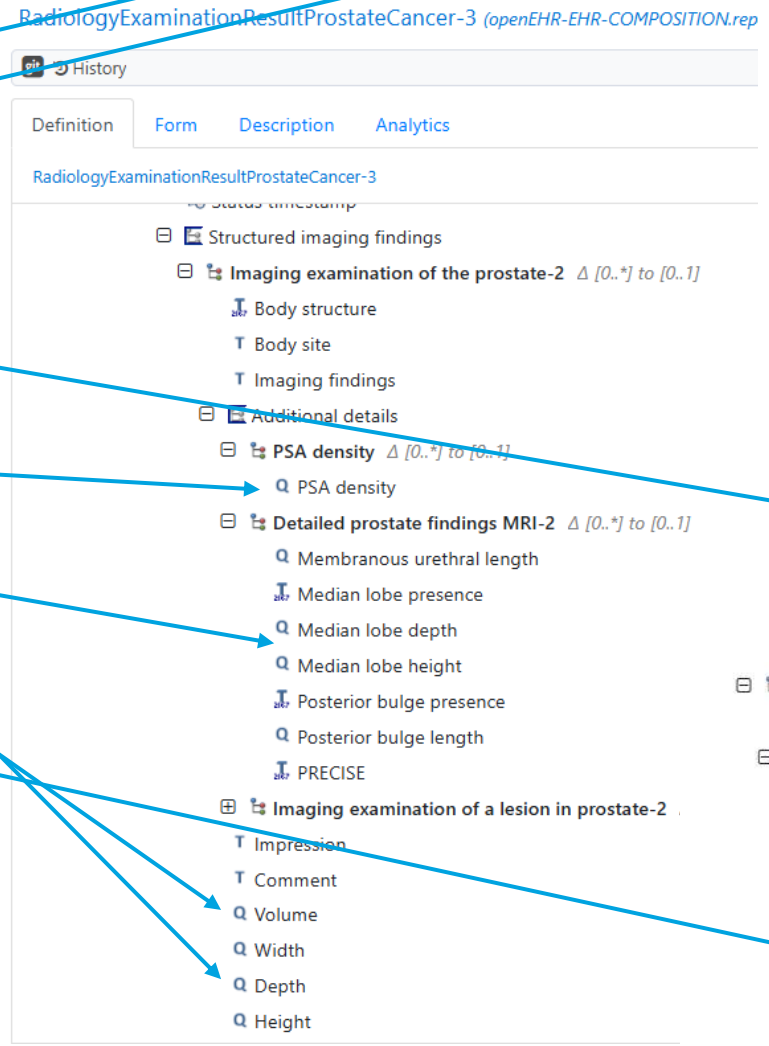


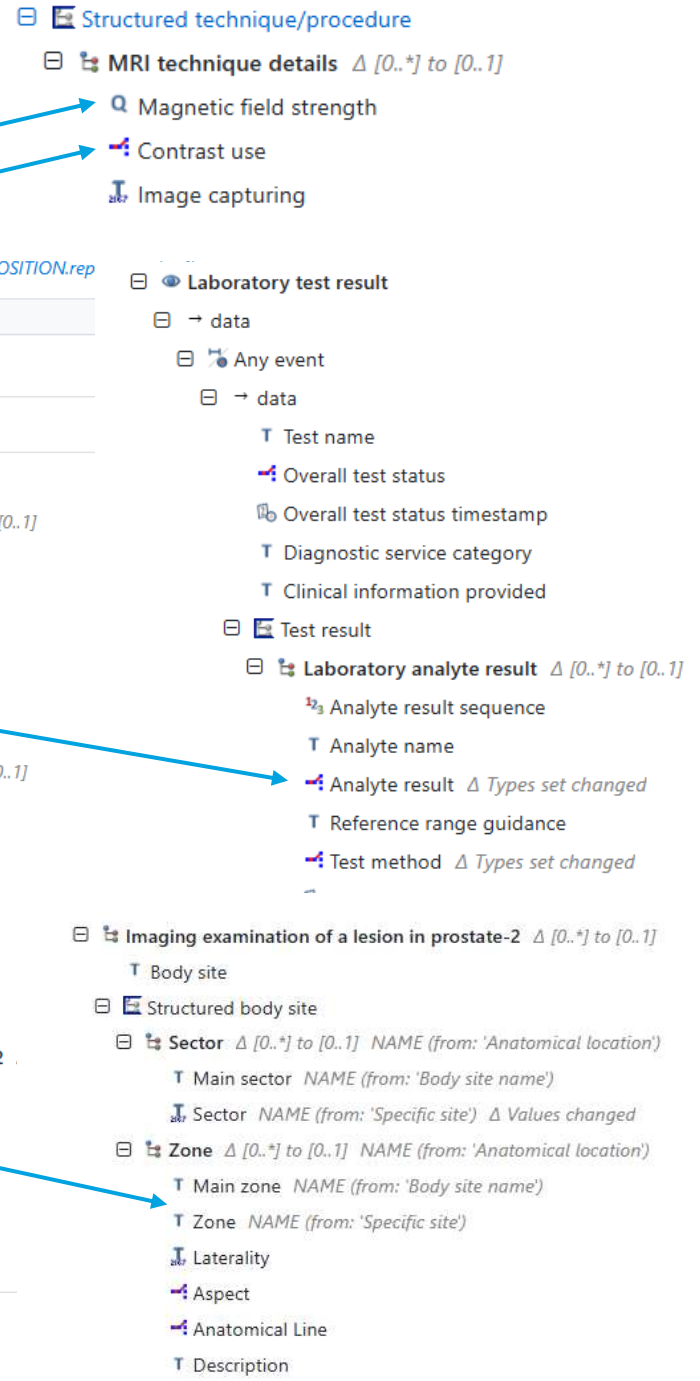
Symphony project

*) Cambio also provides similar services within the Symphony project

Radiology (MRI) prostate







[GitHub - regionstockholm/CKM-mirror-via-modellbibliotek at prostate-cancer-radiology]
[Radiology response prostate - openEHR Clinical - Confluence]

Archetypes

- Existing archetypes
  - COMPOSITION Result Report (v1)
    - OBSERVATION Imaging examination result (v1)
      - CLUSTER Imaging examination of a body structure (v1) (specialization for prostate?)
      - CLUSTER Imaging examination of an anomaly (v0) (specialization for lesion?)
      - CLUSTER Anatomical location (v1)
      - CLUSTER PI-RADS v2.1 (V1)
    - OBSERVATION Laboratory test result (v1)
      - CLUSTER Laboratory analyte result (v1)
- Create new Cluster-archetypes for
  - PSA density
  - Detailed prostate findings MRI
  - Detailed lesion findings prostate MRI
  - MRI technique details

Patient reported data

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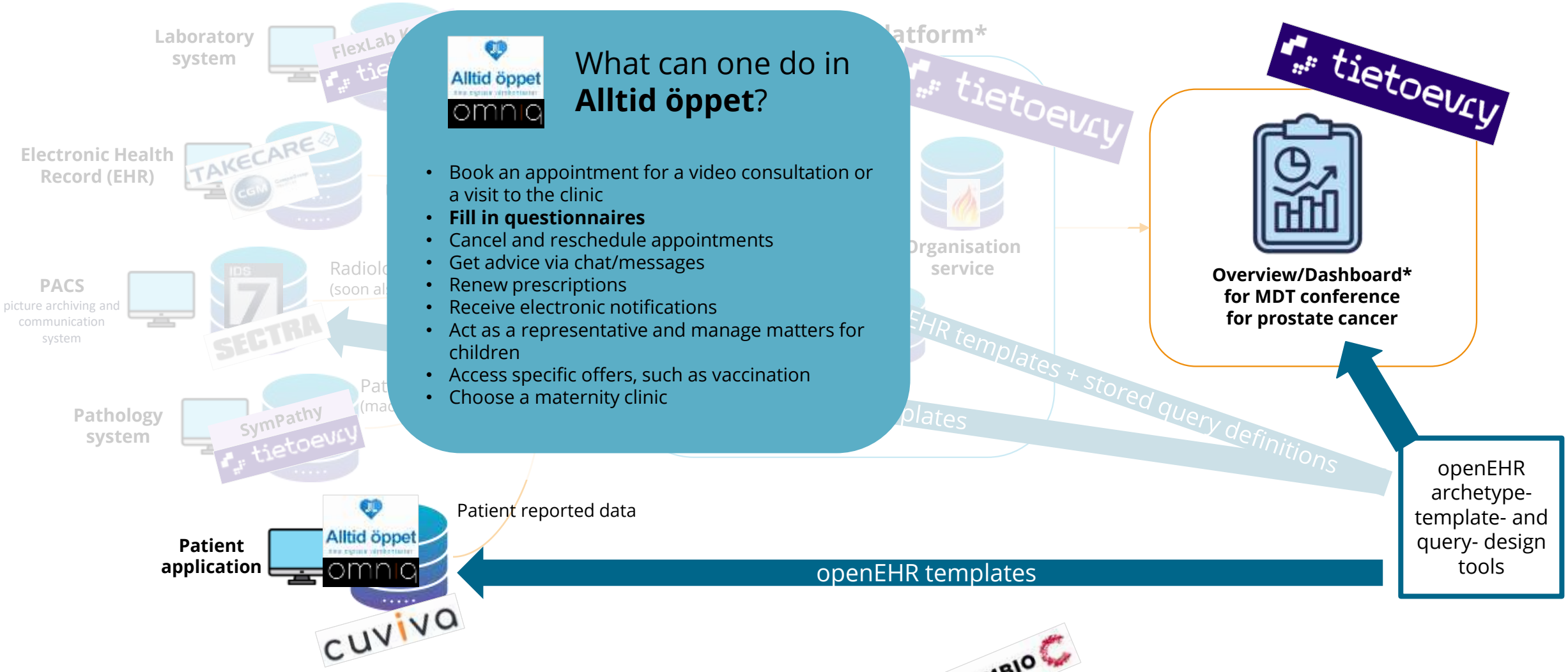
Symphony architecture – Patient reported data



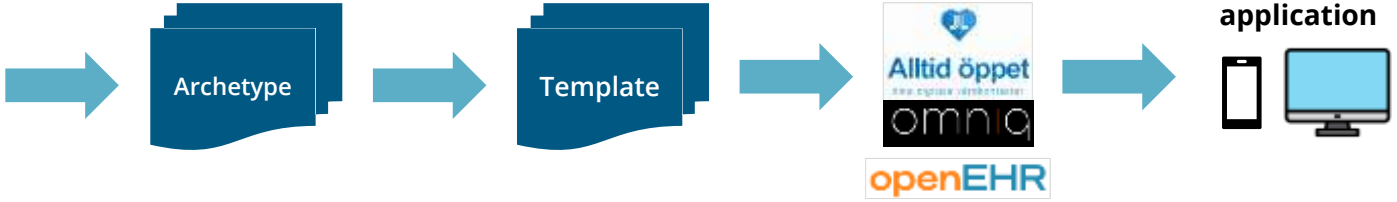
Symphony project

*) Cambio also provides similar services within the Symphony project

Patient reported data in the Symphony project

INTERNATIONAL PROSTATE SYMPTOM SCORE (I-PSS)

1. Incomplete Emptying Over the past month, how often have you had a sensation of not emptying your bladder completely after you finish urinating?	0	1	2	3	4	5	
2. Frequency Over the past month, how often have you had to urinate again less than two hours after you have finished urinating?	0	1	2	3	4	5	
3. Intermittency Over the past month, how often have you found you stopped and started again several times when you urinated?	0	1	2	3	4	5	
4. Urgency Over the past month, how often have you found it difficult to postpone urination?	0	1	2	3	4	5	
5. Weak Stream Over the last month, how often have you had a weak urinary stream?	0	1	2	3	4	5	
6. Straining Over the past month, how often have you had to push or strain to begin urination?	0	1	2	3	4	5	
	None	One	Two	3 times	4 times	5 or more	YOUR SCORE
7. Nocturia Over the past month how many times did you most typically get up each night to urinate from the time you went to bed until the time you got up in the morning?	0	1	2	3	4	5	
Total I-PSS Score							



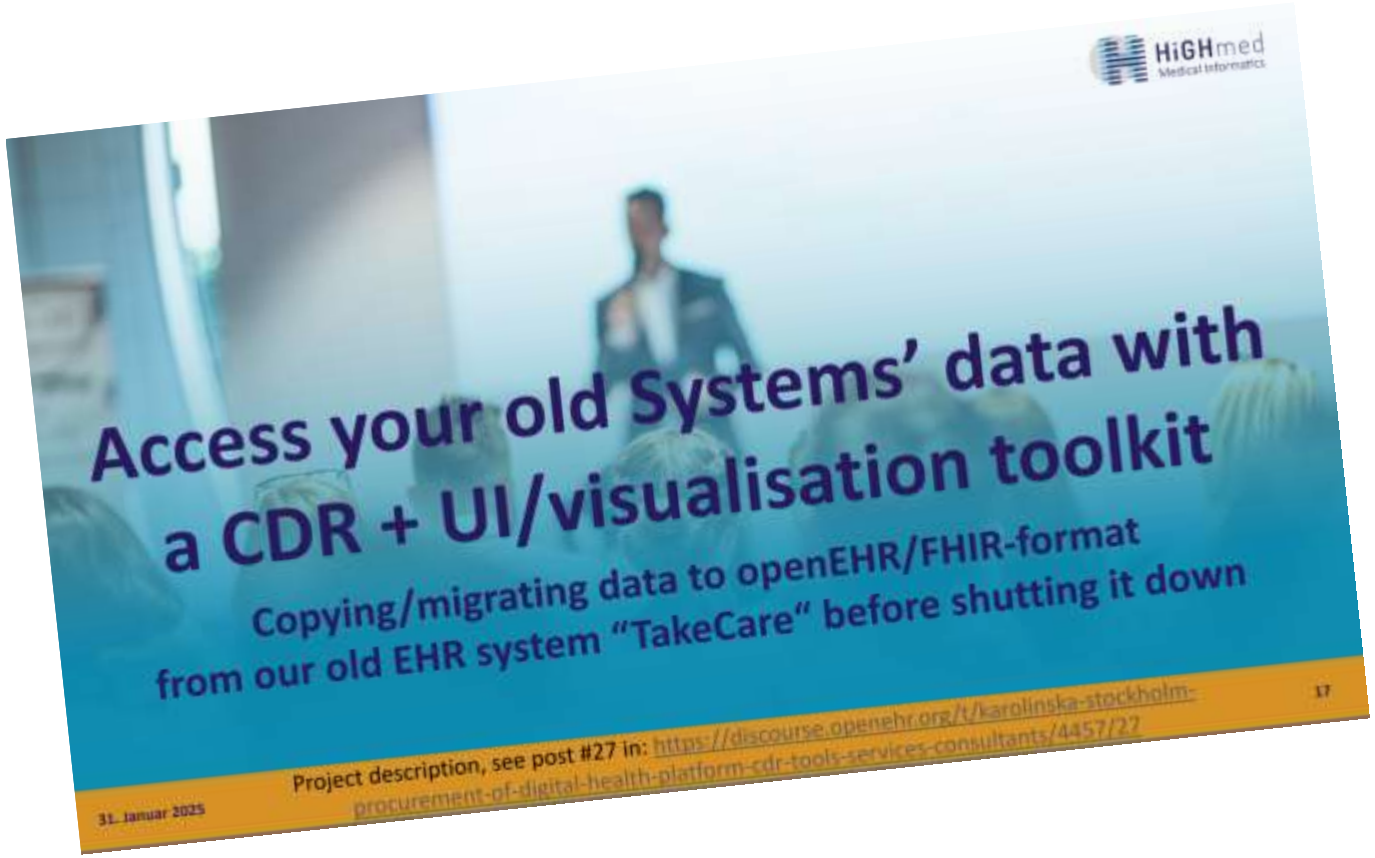
Health Declaration
General & Prostate Cancer Specific

Webbformulär
(add-on to TakeCare)

GISYS

Challenges

- Alltid Öppet currently does not support the import of all openEHR data types
- Webbformulär is not openEHR compatible



PoC TakeCare to openEHR

1h, in Swedish, May 20 @ Vitalis https://invitepeople.com/events/bd0a6002b4/seminars/82887 (+ previously ~10m @HiGHmed)

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Various views and applications. Purchased or developed by ourselves.

”Traditional” application (example)

System supplier decides how data is stored and accessed.
We want to avoid acquiring new systems like this one.

integrations

Dataplatform

Digital health platform
(optimized for healthcare)

Toolbox

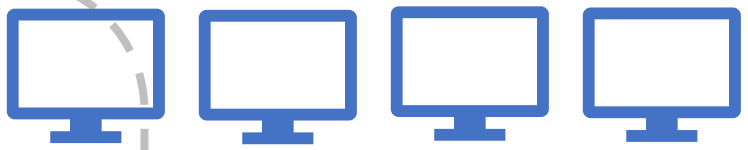
Different kinds of storage

integrations

Different parts stored in internal or external cloud services or traditional local storage.
The point is not exactly WHERE we store things, but rather that we are able to understand and to use our data freely – not limited by system suppliers’ systems and business models

New main EHR

...if partially or fully open/standardised, then it will fit somewhere here



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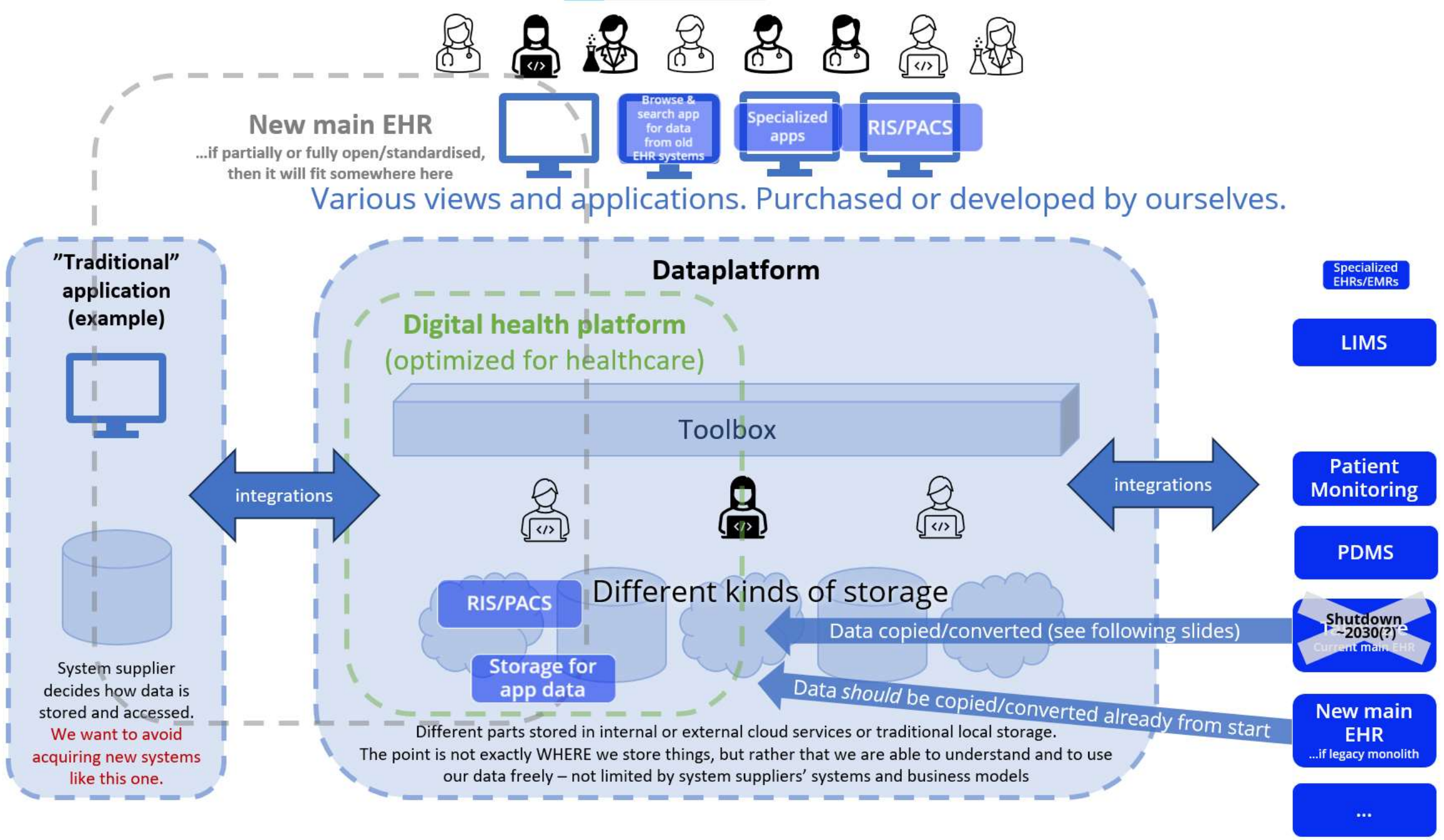
Data copied/converted (see following slides)

Data *should* be copied/converted already from start

Different parts stored in internal or external cloud services or traditional local storage.
The point is not exactly WHERE we store things, but rather that we are able to understand and to use our data freely – not limited by system suppliers’ systems and business models

- Patient reported data openEHR CDR
- Clinical data openEHR CDR
- Images MMA
- Omics data GDR
- Waveform data TSDB
- Operational data Demographics/FHIR
- Production data EDW

- Specialized EHRs/EMRs
- LIMS
- RIS/PACS
- Patient Monitoring
- PDMS
- ~~Future~~ Shutdown ~2030(?) Current main EHR
- New main EHR ...if legacy monolith
- ...


New main EHR
...if partially or fully open/standardised, then it will fit somewhere here
Browse & search app for data from old EHR systems
Specialized apps
RIS/PACS
Various views and applications. Purchased or developed by ourselves.
"Traditional" application (example)
System supplier decides how data is stored and accessed.
We want to avoid acquiring new systems like this one.
integrations
Dataplatform
Digital health platform
(optimized for healthcare)
Toolbox
RIS/PACS
Storage for app data
Different kinds of storage
integrations
Data copied/converted (see following slides)
Data should be copied/converted already from start
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The point is not exactly WHERE we store things, but rather that we are able to understand and to use our data freely – not limited by system suppliers' systems and business models
Specialized EHRs/EMRs
LIMS
Patient Monitoring
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Shutdown ~2030(?)
Current main EHR
New main EHR
...if legacy monolith
...

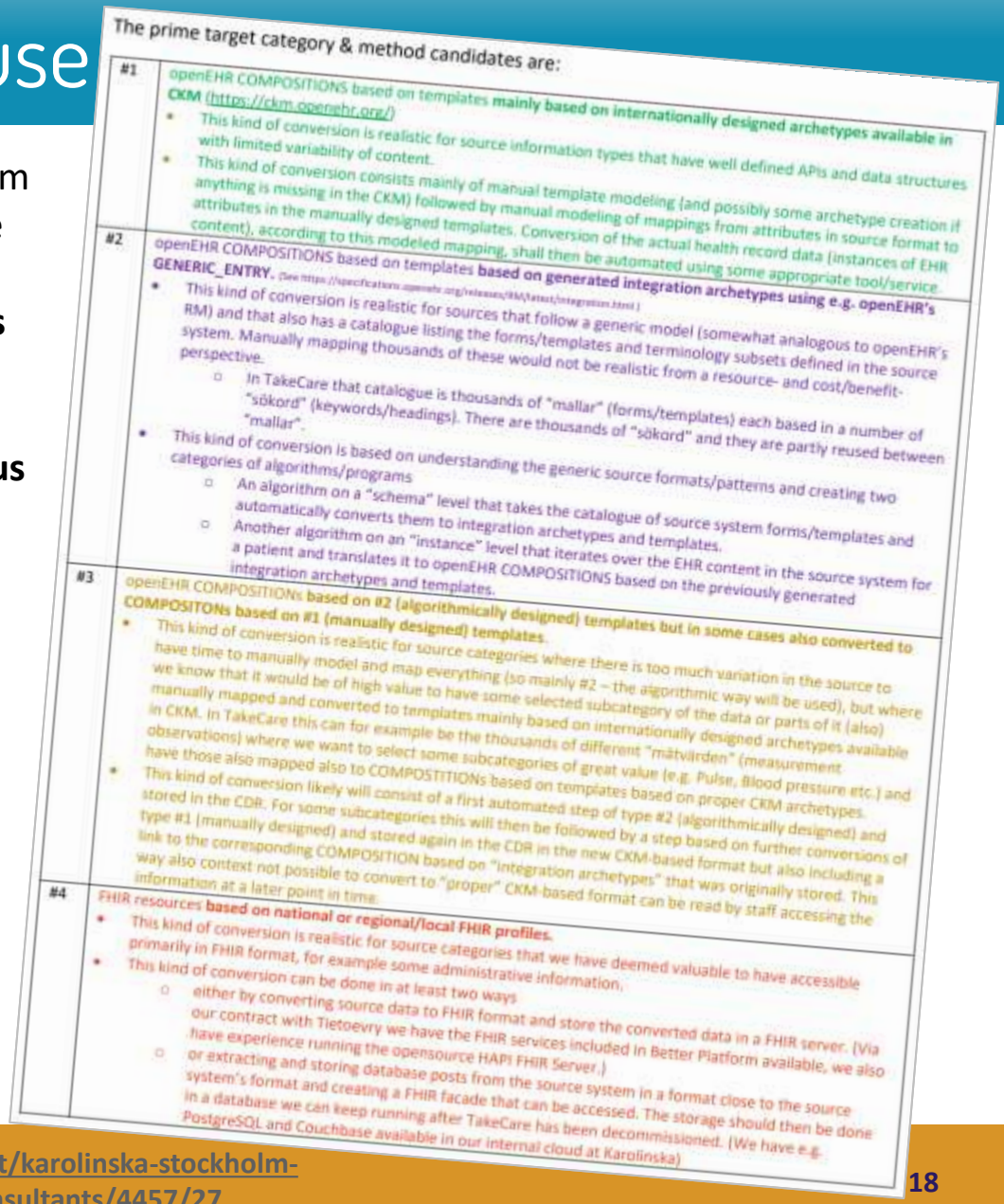
Reuse our material in a procurement of your own…
…also our PoC results are open for reuse

Swedish name & Category # above	English name + comments	Main API in TakeCare
Läkemedel (cat. #1)	**Medications**. The source API is fairly well documented and has limited variability.	Xchange (XML) API: Medications. MedicationHistoryGet
Journaltext (cat. #2)	**Clinical notes** (forms). Huge variability in size, structure, and content.	Xchange (XML) API: CaseNote. CareDocumentationGet
Kemlabb (cat. #1)	**Clinical Chemistry** (a lot of analysis and mapping is already done). The mapping/conversion should be general and cover any value from the source, but for the visualization at least the following are of special demo-interest (Swedish terms) - P-glukos CGM - P-Kreatinin - P-Alaninaminotransferas (ALAT)	Juno (JSON) API: • …/lab/replies/chemistry • …/lab/replies/chemistry/{documentId} • etc.
Mätvärden (cat. #3)	**Measurements**. Uses a kind of forms/templates (there are more than 1000). Map at least these also to CKM-based form: - NEWS2 Score and several vital parameters it is depending on - Blood Pressure (there might be more than one "mätvärde" as source) - Height, Weight, BMI - If time allows, also some other values we have shortlisted as useful for a patient overview/dashboard	Juno (JSON) API: • …/measurements • …/measurements-index • …/measurements/{measurementDocumentId} • etc.
Aktiviteter (cat. #1)	**Activities**. Variation is mainly in the terminology used, not in structure	Juno (JSON) API • …/activities • etc.
Bokningar (cat. #4)	**Appointment bookings**.	Juno? (JSON) might be in a data dump rather than via API

1 FTE consultancy from each of two expertise areas:

A. **Informatics focus** [freshEHR won]
B. **Integration & visualisation focus** [Tietoevry won]

Project length:
3 months



The prime target category & method candidates are:

#1 openEHR COMPOSITIONS based on templates **mainly based on internationally designed archetypes available in CKM** (https://ckm.openehr.org/)
- This kind of conversion is realistic for source information types that have well defined APIs and data structures with limited variability of content.
- This kind of conversion consists mainly of manual template modeling (and possibly some archetype creation if anything is missing in the CKM) followed by manual modeling of mappings from attributes in source format to attributes in the manually designed templates. Conversion of the actual health record data (instances of EHR content), according to this modeled mapping, shall then be automated using some appropriate tool/service.

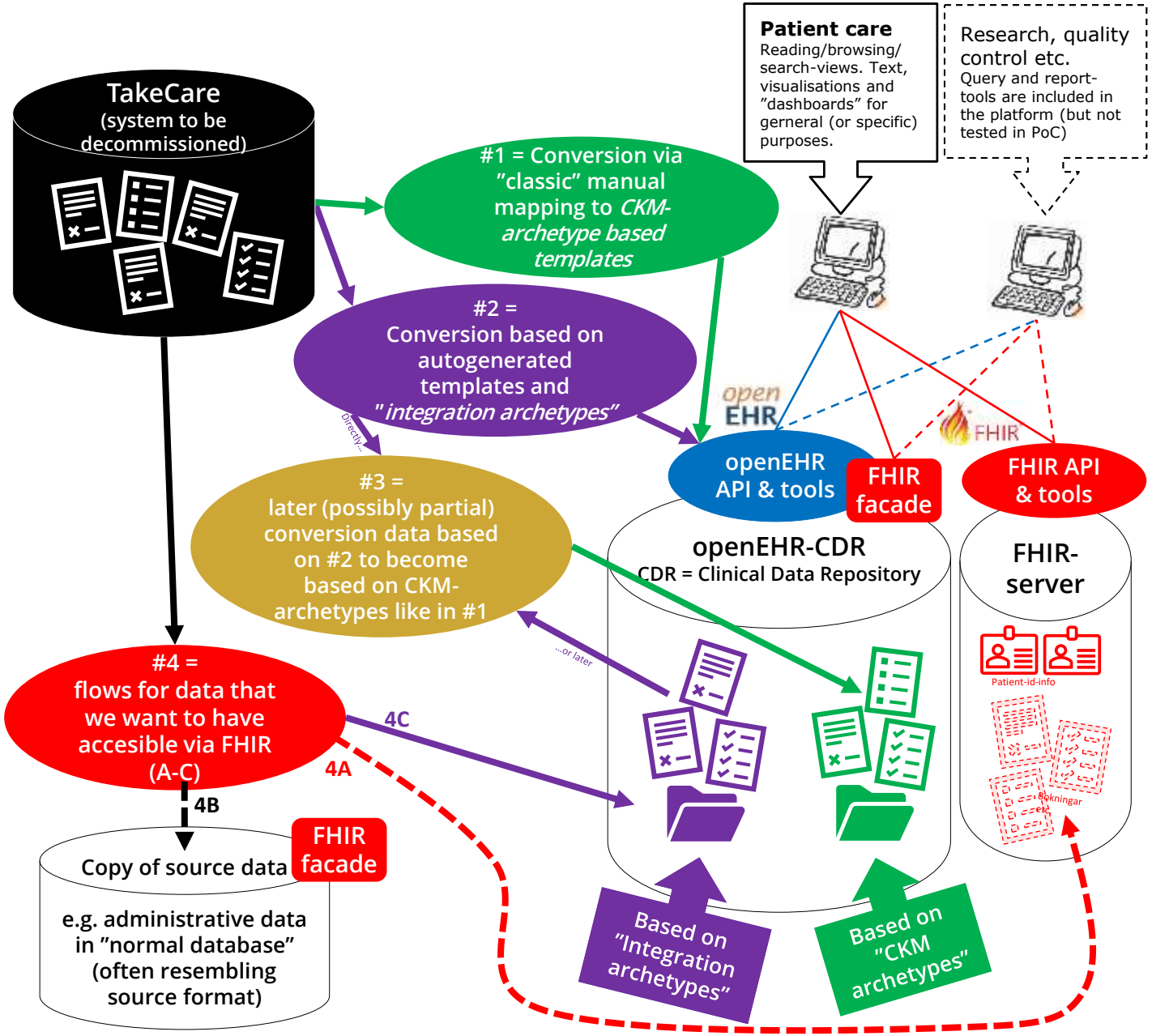
#2 openEHR COMPOSITIONS based on templates **based on generated integration archetypes using e.g. openEHR's GENERIC_ENTRY.**
- This kind of conversion is realistic for sources that follow a generic model (somewhat analogous to openEHR's RM) and that also has a catalogue listing the forms/templates and terminology subsets defined in the source system. Manually mapping thousands of these would not be realistic from a resource- and cost/benefit-perspective.
  - In TakeCare that catalogue is thousands of "mallar" (forms/templates) each based in a number of "sökord" (keywords/headings). There are thousands of "sökord" and they are partly reused between "mallar".
- This kind of conversion is based on understanding the generic source formats/patterns and creating two categories of algorithms/programs
  - An algorithm on a "schema" level that takes the catalogue of source system forms/templates and automatically converts them to integration archetypes and templates.
  - Another algorithm on an "instance" level that iterates over the EHR content in the source system for a patient and translates it to openEHR COMPOSITIONS based on the previously generated integration archetypes and templates.

#3 openEHR COMPOSITIONs **based on #2 (algorithmically designed) templates but in some cases also converted to COMPOSITONs based on #1 (manually designed) templates**
- This kind of conversion is realistic for source categories where there is too much variation in the source to have time to manually model and map everything (so mainly #2 – the algorithmic way will be used), but where we know that it would be of high value to have some selected subcategory of the data or parts of it (also) manually mapped and converted to templates mainly based on internationally designed archetypes available in CKM. In TakeCare this can for example be the thousands of different "mätvärden" (measurement observations) where we want to select some subcategories of great value (e.g. Pulse, Blood pressure etc.) and have those also mapped also to COMPOSTITIONs based on templates based on proper CKM archetypes.
- This kind of conversion likely will consist of a first automated step of type #2 (algorithmically designed) and stored in the CDR. For some subcategories this will then be followed by a step based on further conversions of type #1 (manually designed) and stored again in the CDR in the new CKM-based format but also including a link to the corresponding COMPOSITION based on "integration archetypes" that was originally stored. This way also context not possible to convert to "proper" CKM-based format can be read by staff accessing the information at a later point in time.

#4 FHIR resources **based on national or regional/local FHIR profiles.**
- This kind of conversion is realistic for source categories that we have deemed valuable to have accessible primarily in FHIR format, for example some administrative information.
- This kind of conversion can be done in at least two ways
  - either by converting source data to FHIR format and store the converted data in a FHIR server. (Via our contract with Tietoevry we have the FHIR services included in Better Platform available, we also have experience running the opensource HAPI FHIR Server.)
  - or extracting and storing database posts from the source system in a format close to the source system's format and creating a FHIR facade that can be accessed. The storage should then be done in a database we can keep running after TakeCare has been decommissioned. (We have e.g. PostgreSQL and Couchbase available in our internal cloud at Karolinska)

Project description, see post #27 in: https://discourse.openehr.org/t/karolinska-stockholm-procurement-of-digital-health-platform-cdr-tools-services-consultants/4457/27

Variants of conversion/mapping used in PoC



Conversion strategies

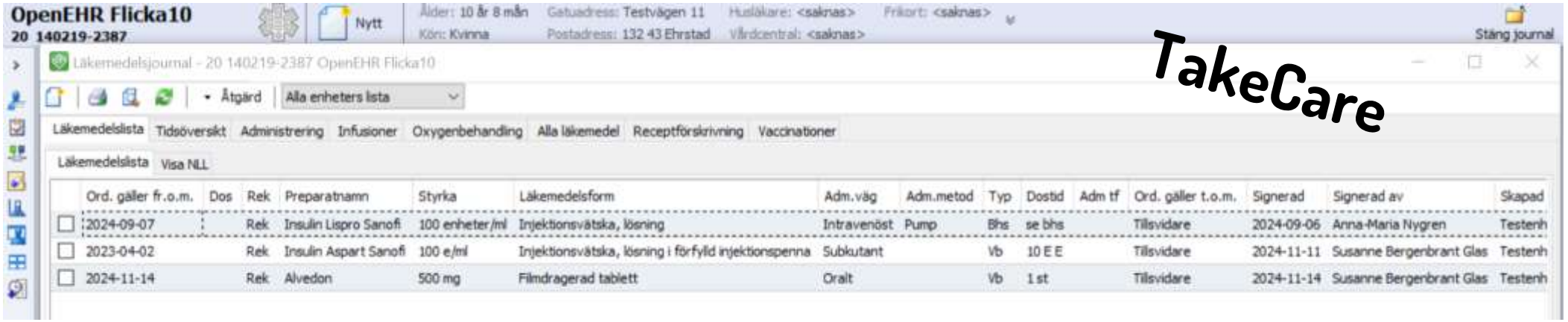
1. **CKM-archetypes =** international or national standardised openEHR structures
2. **Integration archetypes/templates =** locally/custom developed structures that copy the structure of the source system
3. **Combination (of 1+2) =** first converted using integration archetypes and in a later step, either immediately or (even years) later, some (or all) values are converted also based on CKM-archetypes
4. **FHIR =** international standard for integrations, used e.g. for some administrative data in Karolinska's Digital Health Platform. There are (at least) three solution patterns:
   4A. FHIR-resources in a FHIR-server (direct conversion, before storage)
   4B. Store in a database copied form source system, expose via "FHIR-facade"
   4C. Store openEHR-integration-archetype-based in CDR expose via "FHIR-facade"

Priority ordered* data from TakeCare, colour coded as planned at start of project:

- **Medications, #1** – TC Exchange (XML), well defined API
- **Clinical notes (forms), #2** – TC Exchange (XML), thousands of forms/templates and headings. Huge variations in structure/modelling.
- **Clinical Chemistry, #1** – TC Juno (JSON), some modelling and partial mappings were available. Well defined API.
- **Measurements, #3** – TC Juno (JSON), thousands of different legacy source templates. Some were converted to CKM-archetype-based
- **Activities, #1** - TC Juno (JSON), variation in terms, fixed structure in TakeCare
- **Appointment Bookings, #4** – TC Juno (JSON) raw data-dump, interesting to expose via FHIR

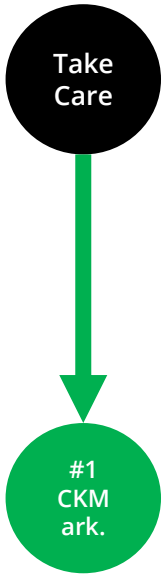
*) We listed some more than we expected that the consultants would have time for, but it went surprisingly well! All types were mapped and converted. All were visualized in GUI except the last one (Appointment Bookings) before time ran out.

Medications

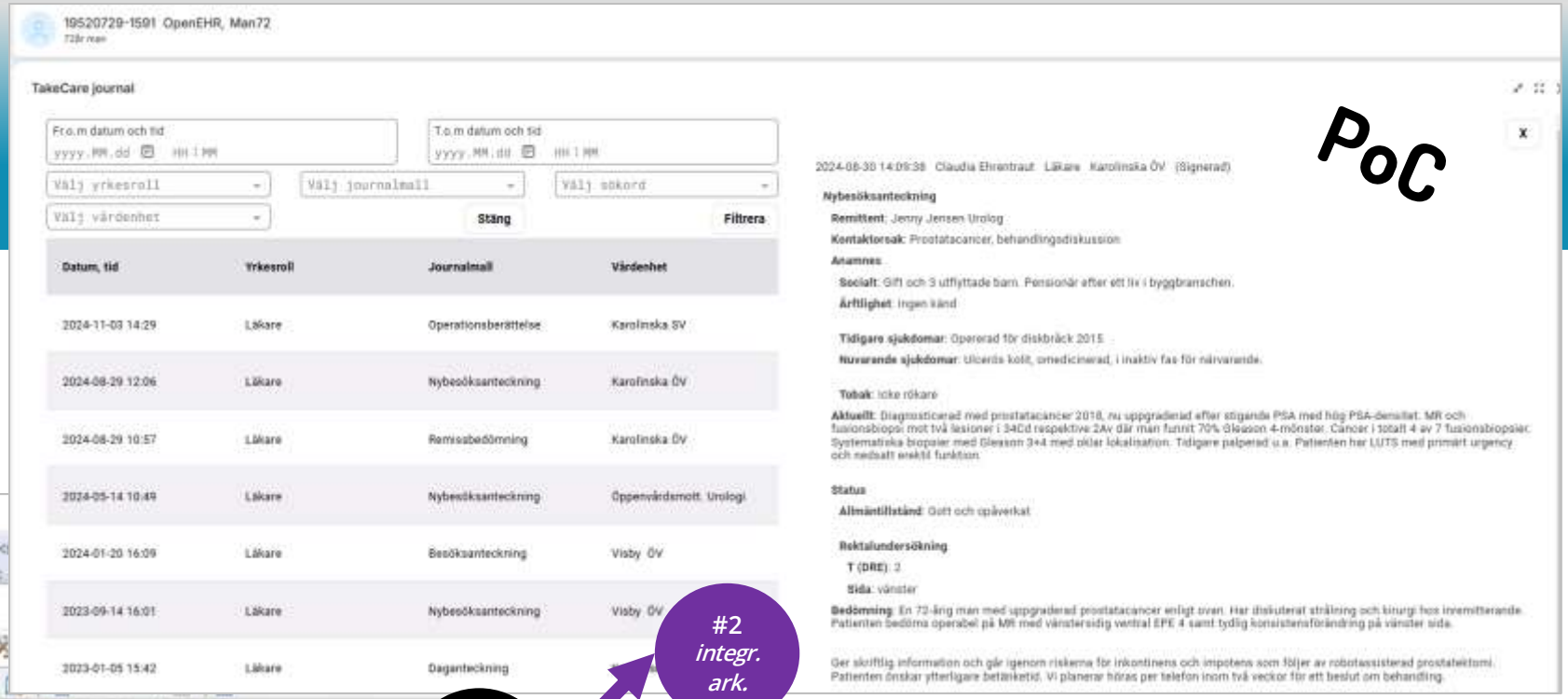


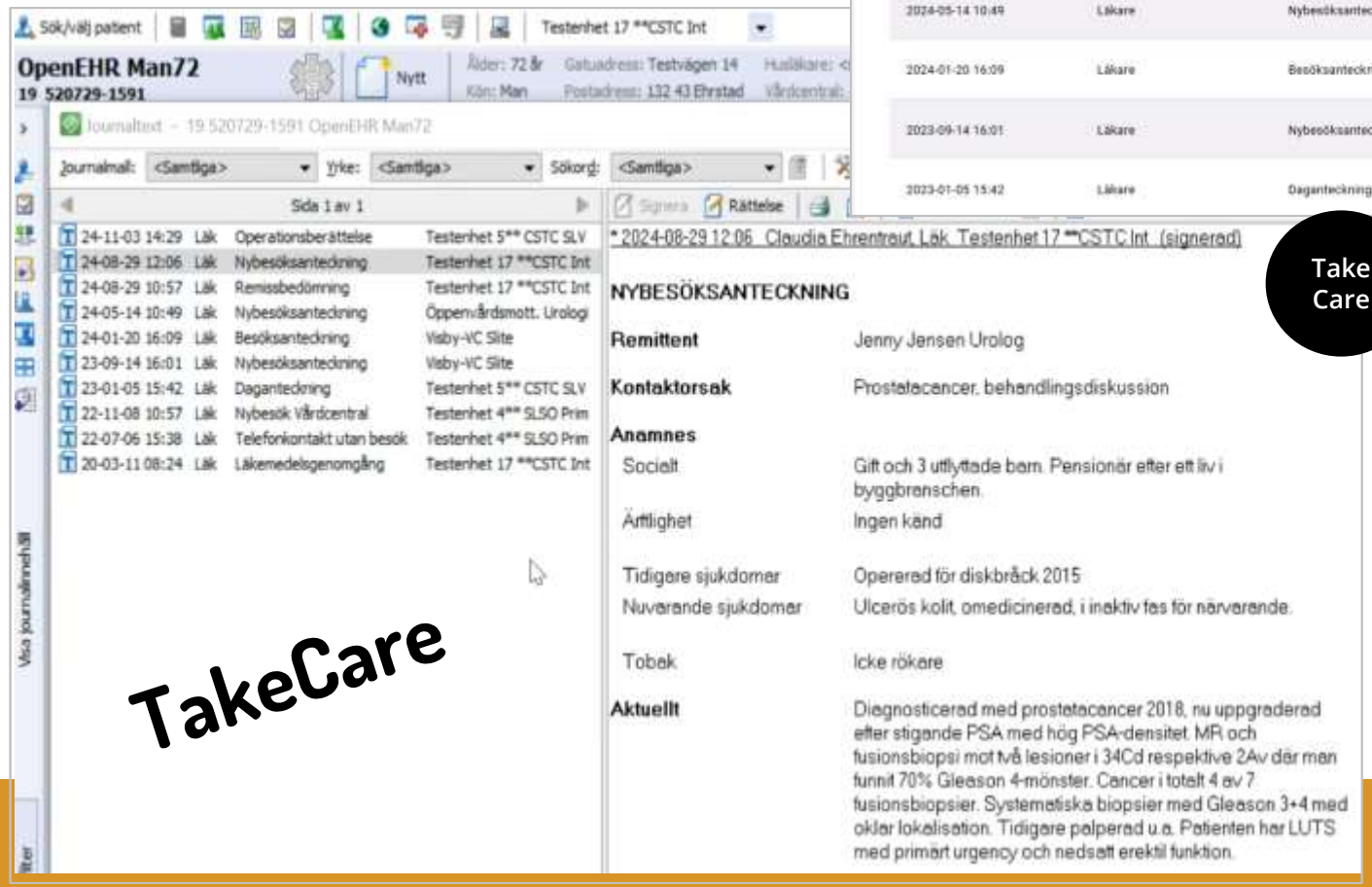
TakeCare

PoC



Clinical notes (forms)

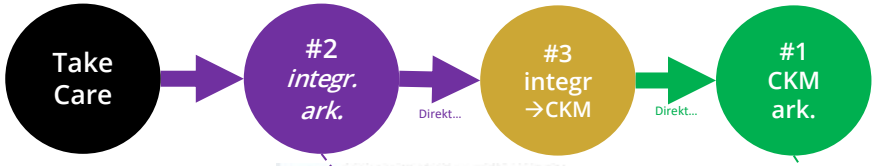


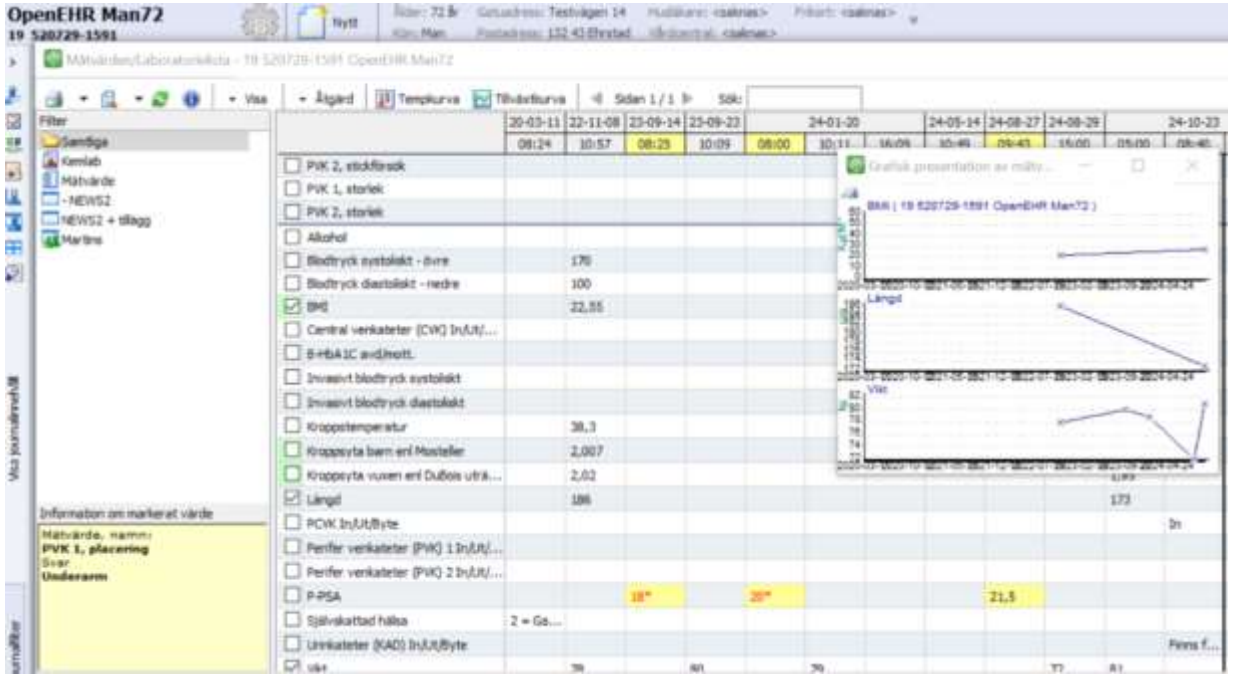


Take Care → #2 *integr. ark.*

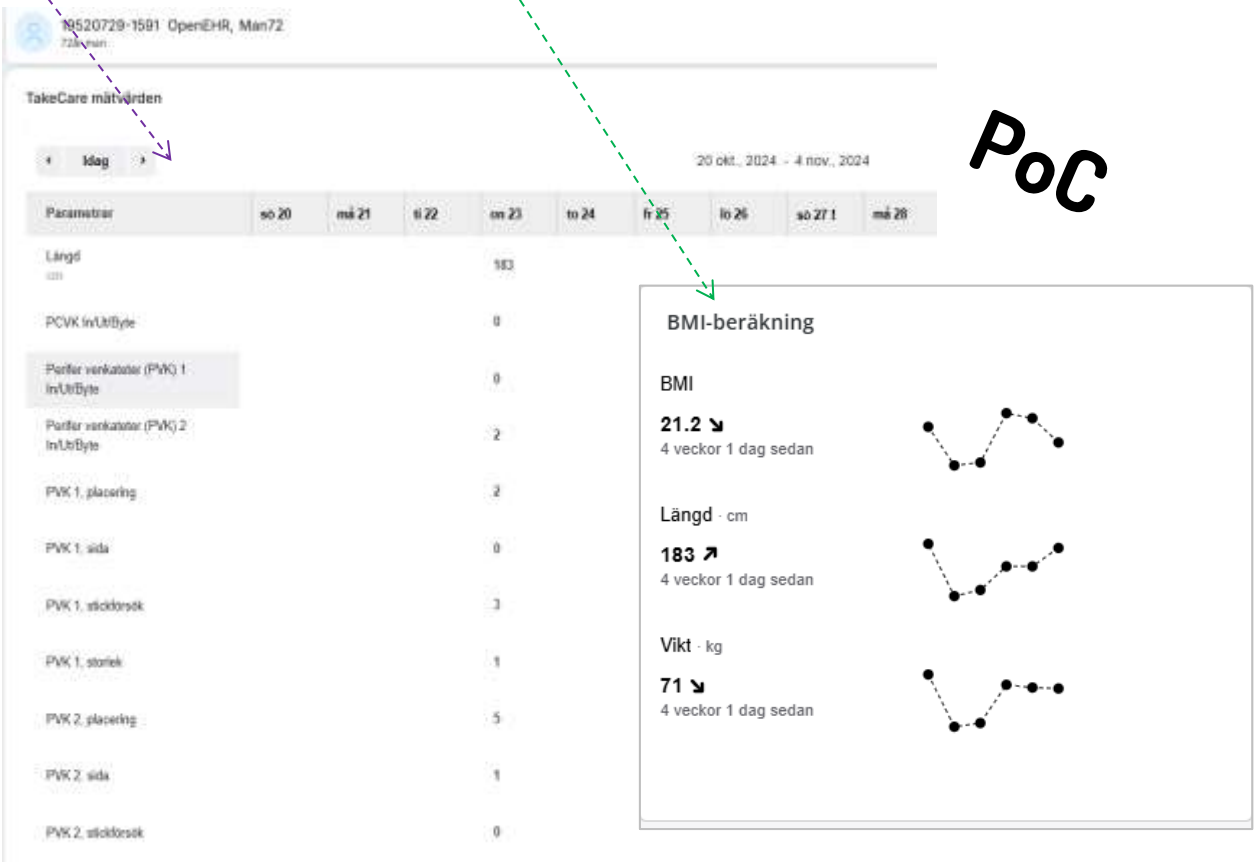
Measurements

TakeCare





PoC



Primary documentation of Multidisciplinary conference notes

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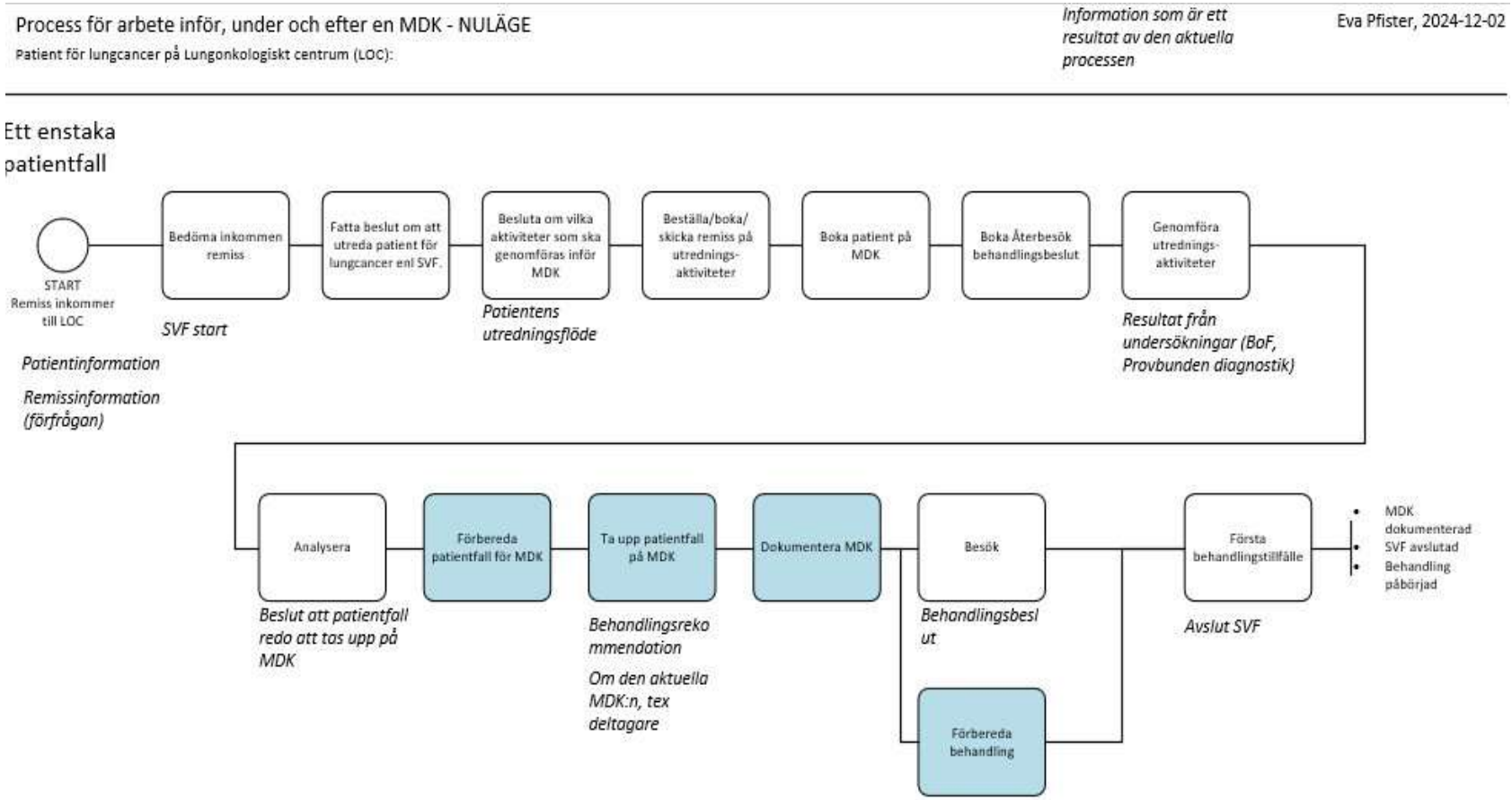
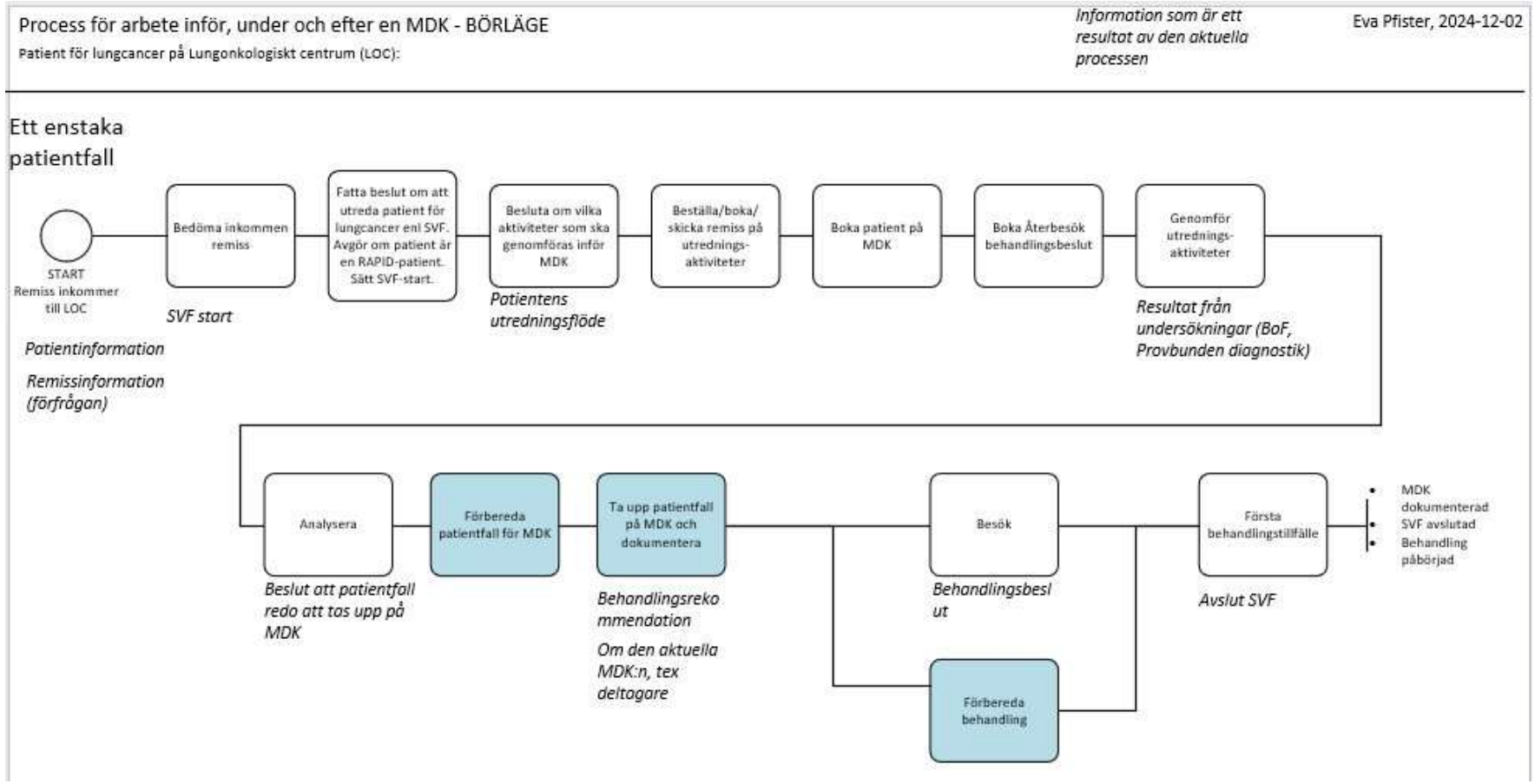
Primary documentation of Multidisciplinary conference notes

Current work process



Primary documentation of Multidisciplinary conference notes

New work routine



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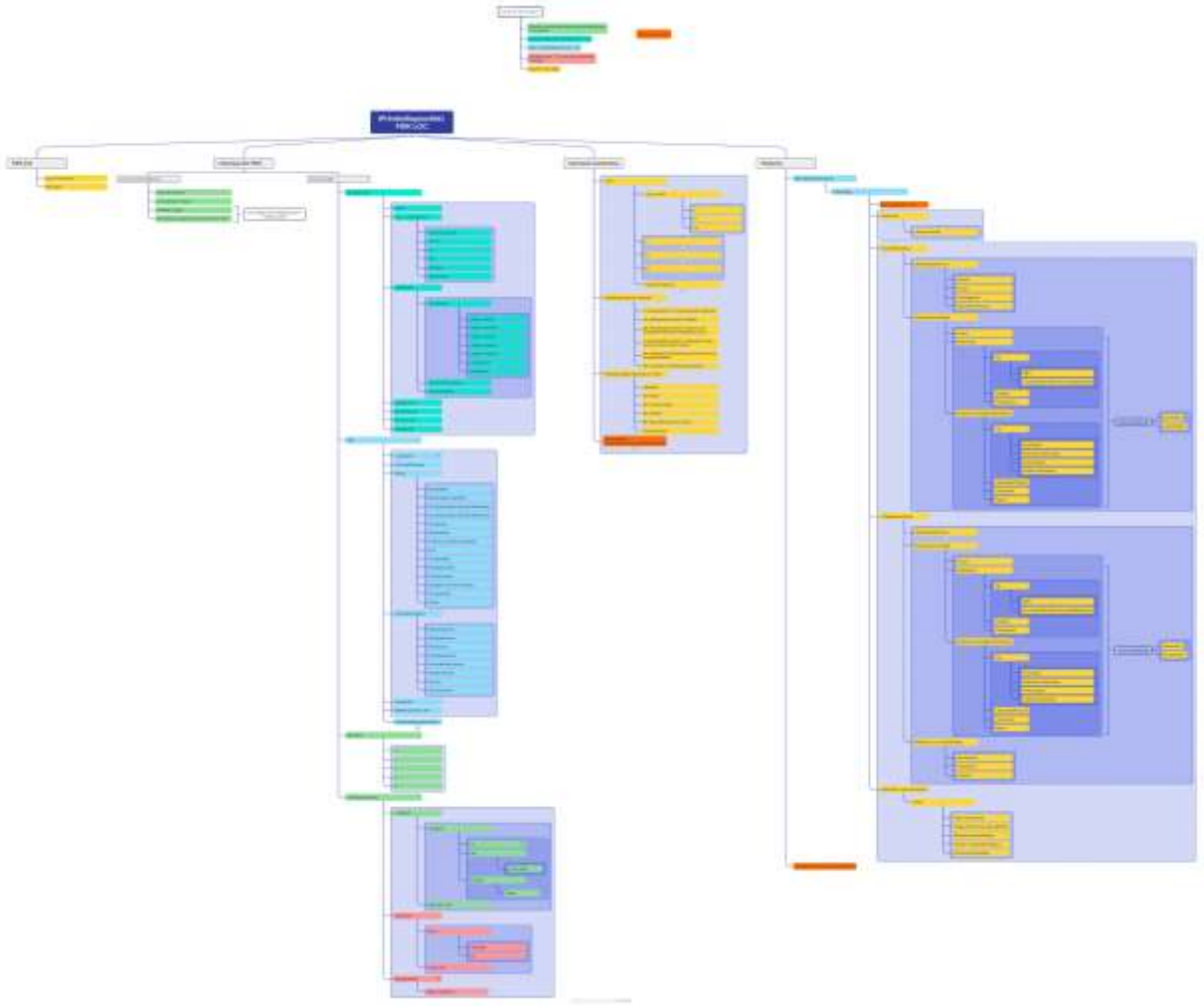

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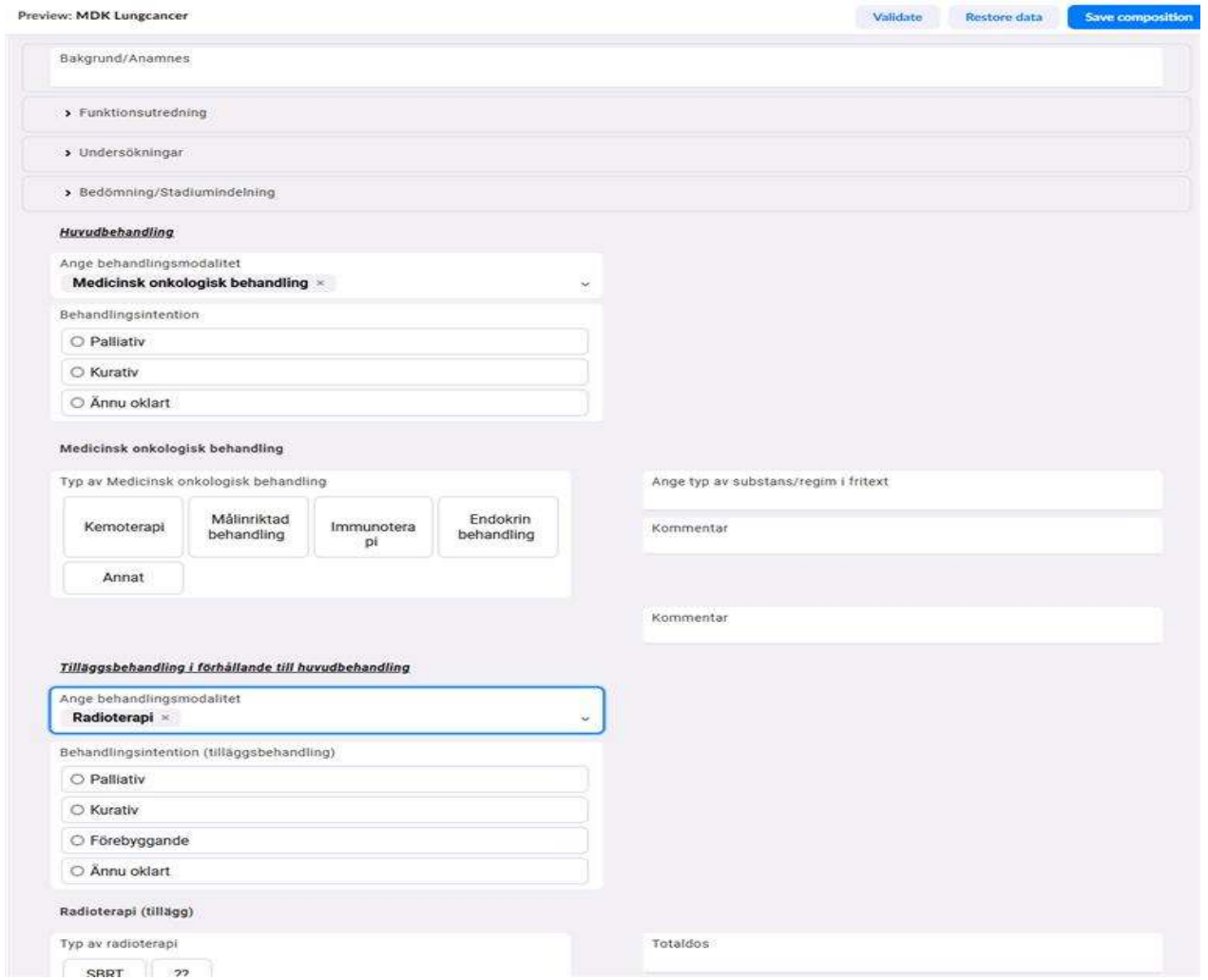

Pathology

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Pathology

- National quality and standardization committees (pathologists) per organ
- National working group: structured pathology information
  - Domain expertise (pathologists, BMAs, surgeons and oncologists)
  - Information architects
  - Snomed CT expertis

<u>In sync with:</u>

- International Collaboration on Cancer Reporting (ICCR)
- International openEHR-modelling of pathology information

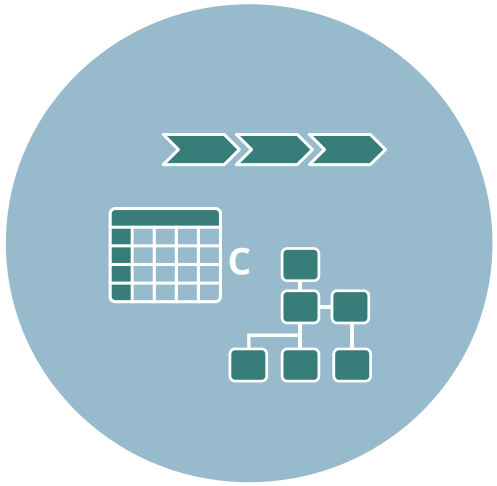
Pathology: Goal - forms with built-in knowledge support

Domain expertise

Information content decided by domain expertise

National group structured patholoy information

Structuring of information content, logic & business rules



Standardization of information (Snomed CT, openEHR)

Histopathology laboratory

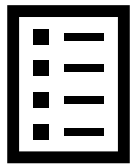
Implemented forms in relevant healthcare information systems

National working group structured pathology information

Konfiguration material:

- Patient flow models
- Concept models
- Information models (UML) + terminology binding to Snomed CT
- openEHR-templates + terminology binding to Snomed CT
- Documented triggers, business rules, calculations, logic etc.
- Form prototypes

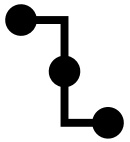
Pathology Result Report – documentation on different occasions and by different individuals



Information in service request (a.k.a. clincial information provided)

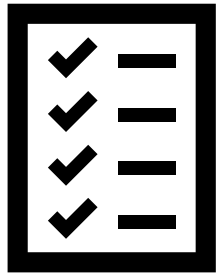
Macroscopic analysis

Microscopic analysis & assessment



Pathology Anatomical Diagnosis - PAD

Result report



Pathology Breast – Surgically Removed Specimen

openEHR Templates

- Service request to Clinical Pathology
- Documentation of macroscopy analysis and assessment – breast
- Documentation of macroscopy analysis and assessment – lymph nodes
- **Documentation of microscopy analysis and assessment – breast** (in progress)
- **Documentation of microscopy analysis and assessment – lymph nodes** (in progress)

Mindmap openEHR-modelling of microscopic analysis and assessment of breast tissue and lymph nodes:

Mikroanalys operationspreparat bröst.xmind - Xmind AI

Pathology Breast – Surgically Removed Specimen

openEHR Archetypes

Existing archetypes

- Composition: Result report (v.1)
- Observation: Laboratory test result (v.1)
- Cluster:
  - Specimen (v.1)
  - Anatomical location (v1)
  - Circular anatomical location (v1)
  - Relative anatomical location (v.1)
  - Specimen measurements (v.1)
  - Anatomical pathology exam (v.0)
  - Surgical resection margins (v.0)

New archetypes

Cluster:

- Microscopy findings (v.0)
- Tumor resection margin (v.0)
- Molecular analysis (v.0)
- Invasive breast carcinoma microscopy (v.0)
- Breast carcinoma in situ (v.0)
- Breast tumor panel (v.0)

Pathology Prostate - Core Needle Biopsy

In progress:

- Patient flow model
- Service request

Planned:

- Macroscopic analysis
- Microscopic analysis

Medical Oncology Treatment

KAROLINSKA UNIVERSITY HOSPITAL

WE ARE PART OF REGION STOCKHOLM

Medical Oncology Treatment – openEHR Archetypes

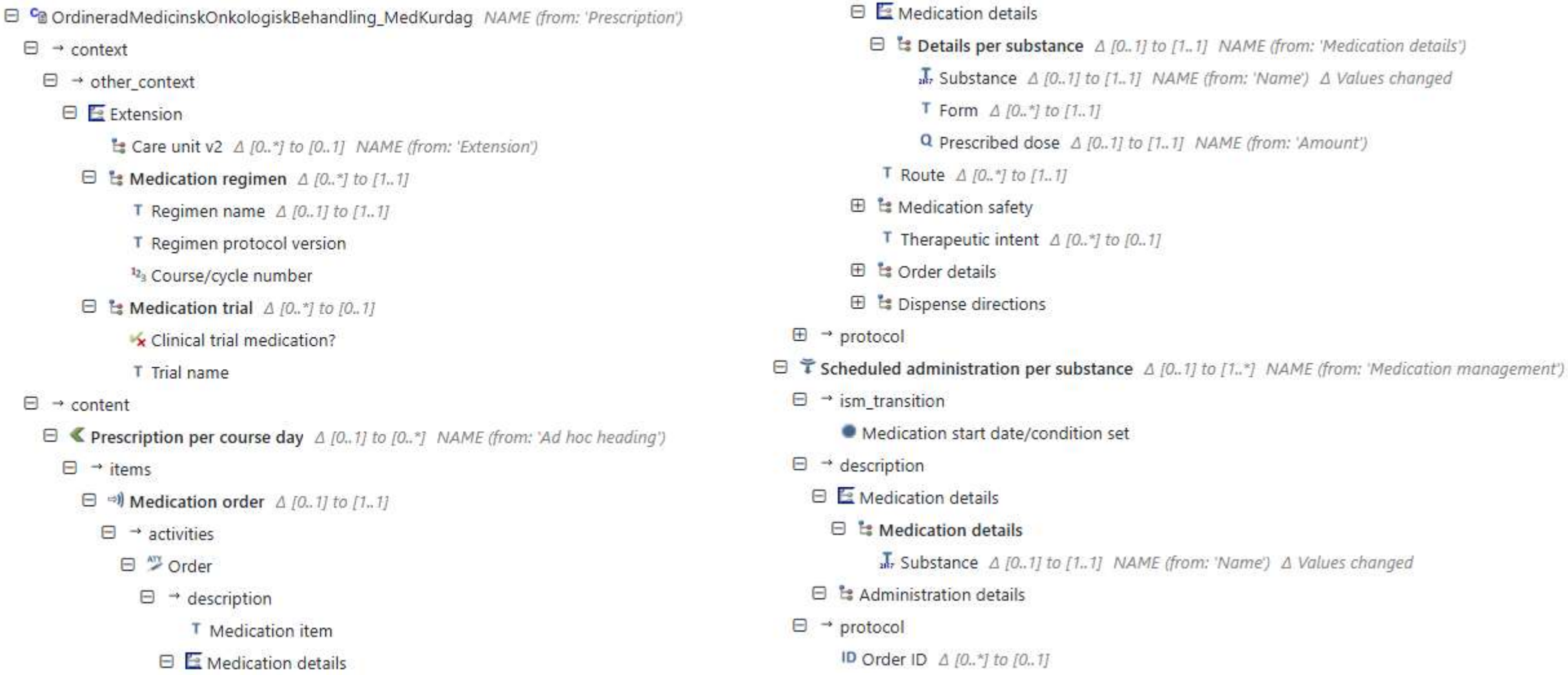
Existing archetypes

- Composition: Prescription (v.0) & Encounter (v.1)
- Instruction: Medication Order (v.3)
- Action: Medication Management (v.1)
- Section: Ad hoc heading (v.1)
- Cluster:
  - Medication details (v.2)

New archetypes

- Cluster:
  - Medication regimen (v.0)
  - Medication trial (v.0)

Medical Oncology Treatment - Prescription



Medical Oncology Treatment - Administration