

Store legacy EHR content using openEHR and FHIR and let users access it (almost) as before!

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Agenda / content

Context

PoC Task

Background details

Transformation & visualisation in PoC

Extended visualisation (after PoC)

Questions? Discussion!

Extra Material:

Context: Digital Health Platform @ Karolinska / Stockholm

Relation to reinterpretation problems

Context: PoC is just a start

Phase 1: PoC (Proof of Concept)

- real APIs, ordinary test system including forms and configuration
 - (a handful of) fake realistic patient records



Focus of today's presentation

Phase 2:

- Real (frozen) system, real patient records – from “TioHundra” (currently starting up)

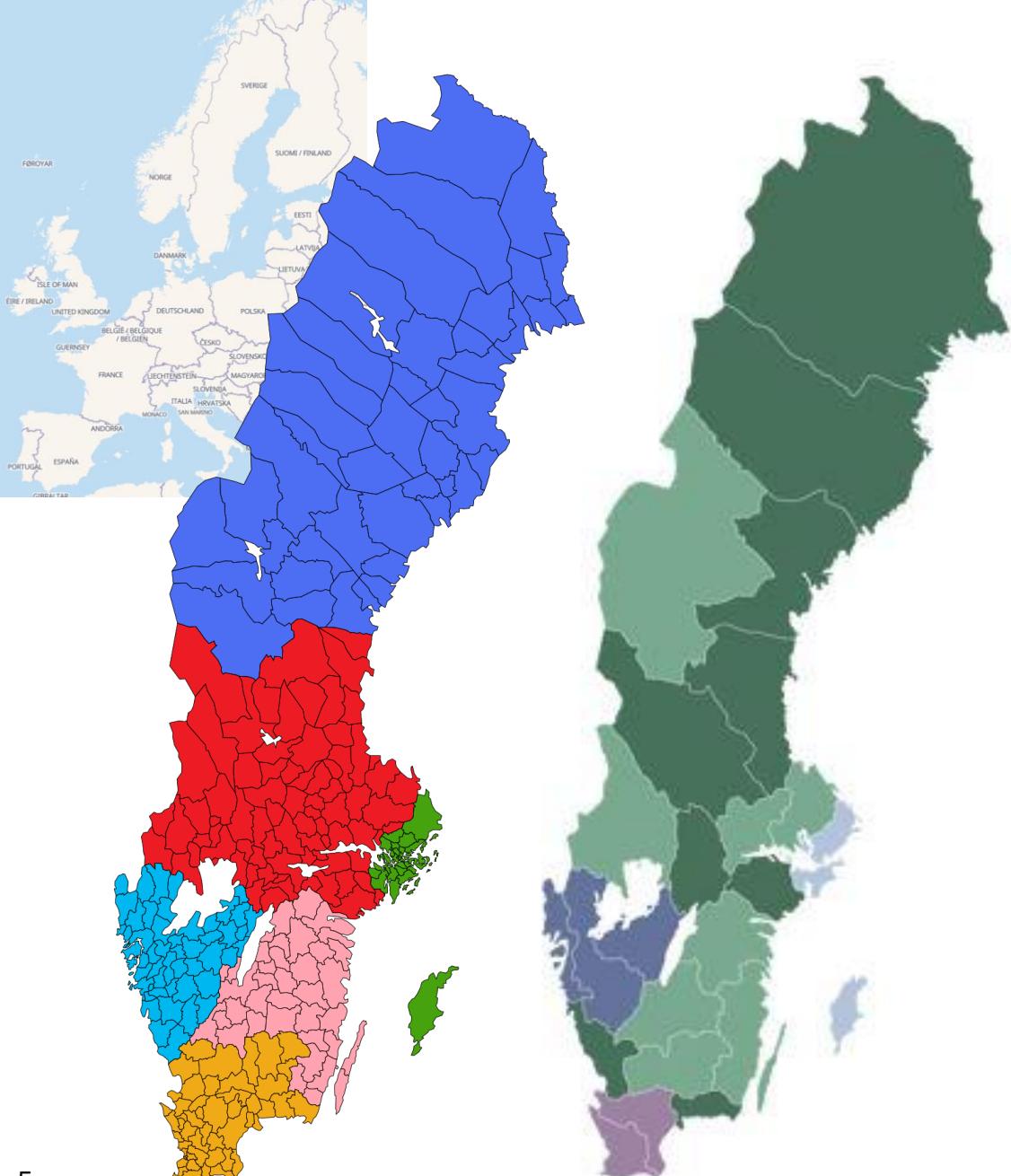


Phase 3:

- Full current TakeCare installation (decision awaiting Phase 2)



Context: Current usage of the TakeCare EHR system



Main EHR systems in Sweden?

█ Sussa samverkan – Cambio

█ Kundgrupp COSMIC (KGC), Cambio

█ Västra Götalandsregionen

█ Region Stockholm och Gotland

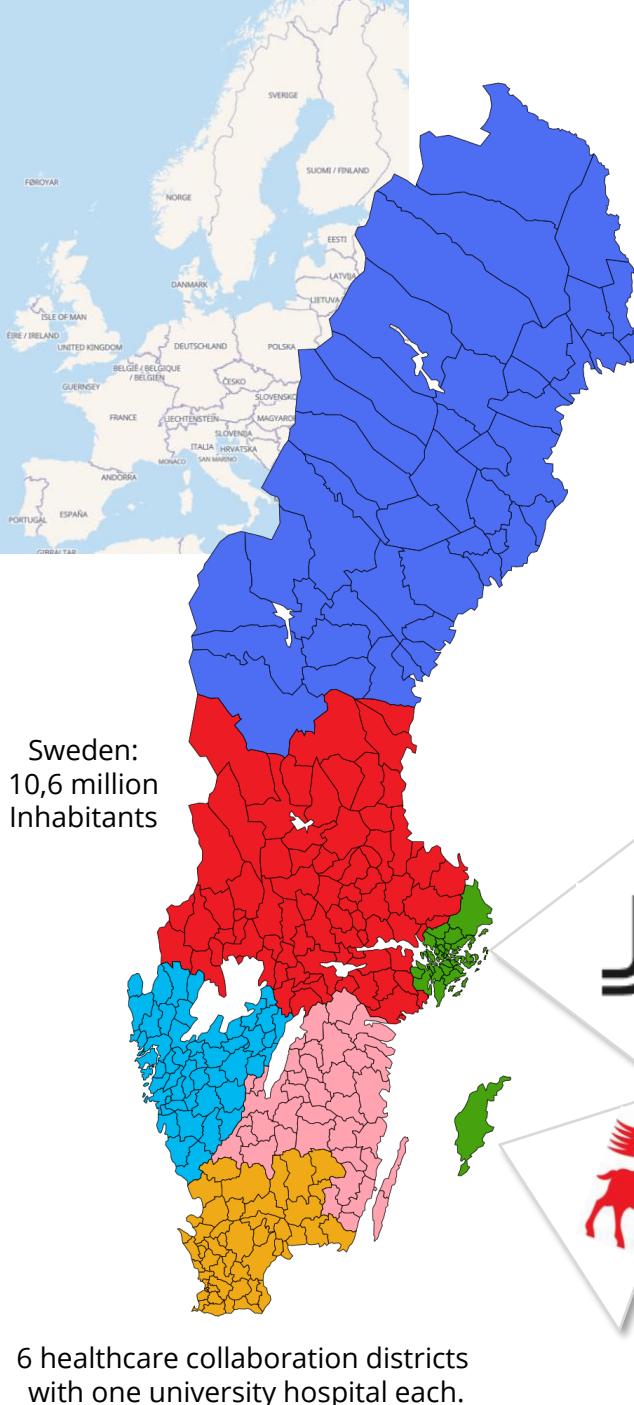
█ Region Skåne

Recent Cambio customers

Cambio customers since long time

Bought Oracle/Cerner Millennium. First rollout a disaster for end user stopped after some days. Now in rethink mode.

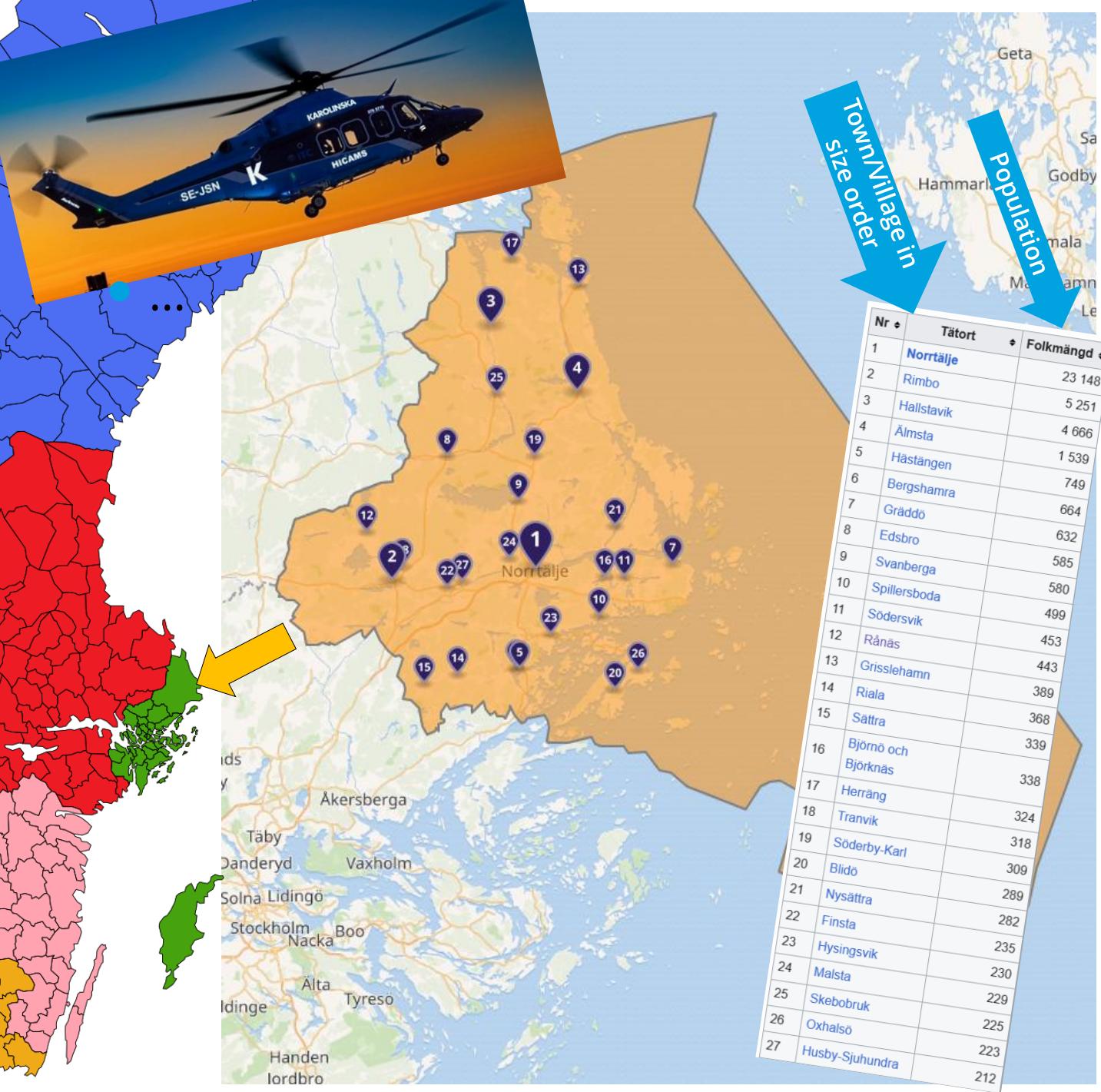
In procurement. Cambio won, but no contract signed yet (last time Erik looked) Competitor legal battle. Bought Oracle/Cerner Millennium. No rollout attempt yet, was planned 2025, revised to fall 2026



- # This installation of the EHR system TakeCare
- Used for both **hospitals and primary care**.
 - **58 000 users**
 - **1.3 million patient cases handled per month**
 - Running since **1994**, currently **6.8 million patient's records** (including visitors to region, deceased etc)

1. Karolinska is the university hospital for the regions Stockholm and Gotland. On behalf of these regions Karolinska's staff is deeply involved in configuring and maintaining TakeCare. Thus involved in shutdown/decommissioning plans.
2. Data from TakeCare is a treasure trove for both research and individual patient care if accessible in efficient ways. XML/PDF-ish archive "church yard" not very attractive (especially not for living patients' data).
3. Karolinska (and thus the region) has a Digital Health Platform with openEHR/FHIR parts from Tietoevry (based on Better's CDR) – it is not used for specific applications, not as the main regional EHR, but can write to main EHR and can be used also for long term (vendor neutral) data storage of main EHR.





- **Norrtälje**, the northernmost municipality.
Small permanent population, several inhabited islands and "long" distances (from a downtown Stockholm perspective)
Avoid unnecessary travel/visits!
 - Organizational solution: "TioHundra" = region+municipality
 - 2300 employees Regional healthcare, Municipal healthcare & Municipal other kinds of care & assistance (food, hygiene etc.)
 - Had their own TakeCare instance **from 2006...**
 - ... but some drawbacks, so **2017 it was frozen** = set to read-only
 - **Patient safety** (want to see everything)
 - **Large summer population** from other parts of the region/country.
- Frozen TioHundra TakeCare content
 - **34 million EHR notes** (68 million if including all versions of them)
 - **200 000 patients**



Context again: This PoC was just a start

Phase 1: PoC (Proof of Concept)

- real APIs, ordinary test system including forms and configuration
 - (a handful of) fake realistic patient records



Phase 2:

- Real (frozen) system, real patient records – from “TioHundra” (currently starting up)

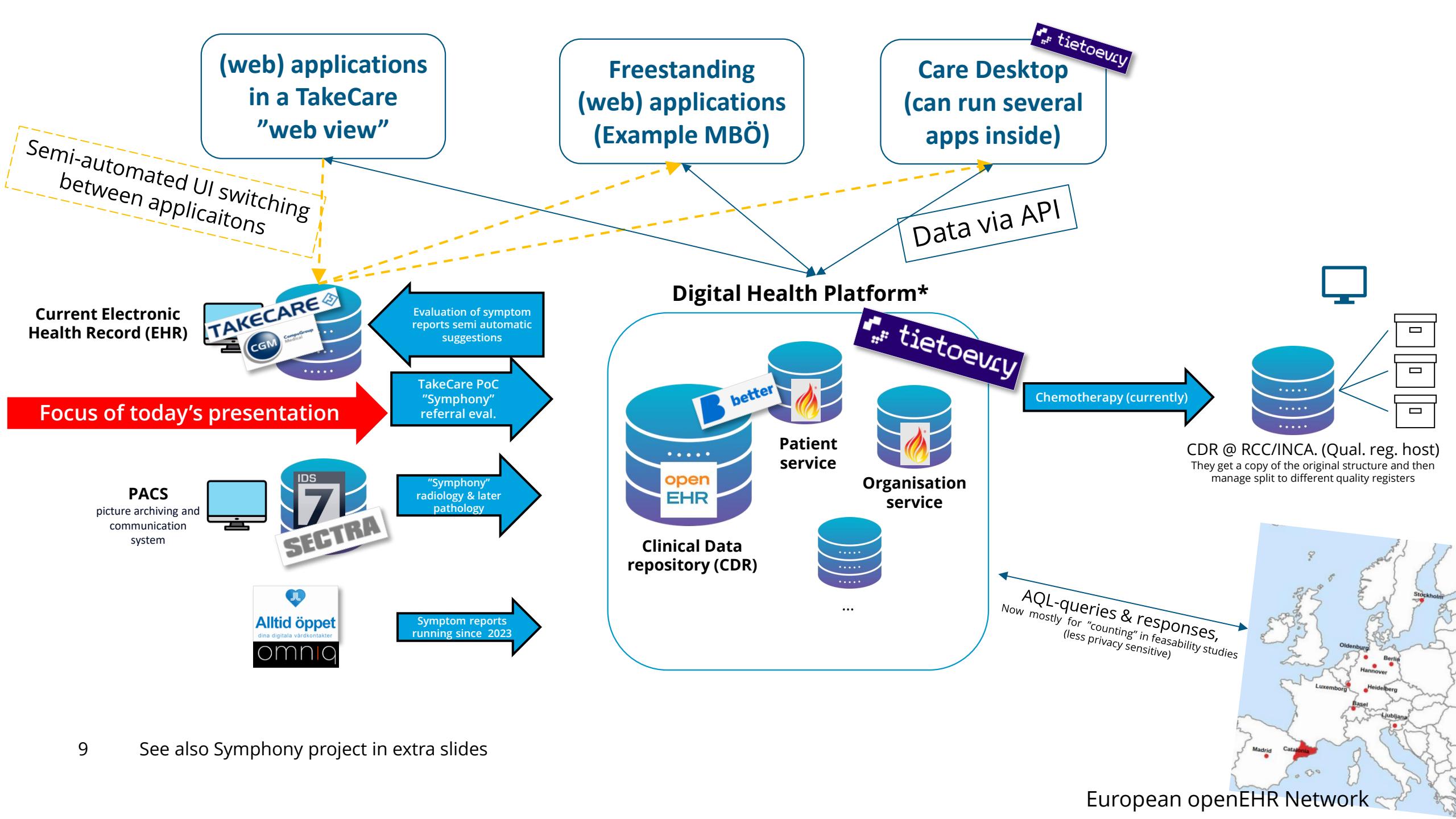


Phase 3:

- Full current TakeCare installation (decision awaiting Phase 2)



Focus of today's presentation



PoC Task

Including exploring practical use of openEHR's
built in integration utilities

Feel free to reuse our material in a procurement of your own PoC etc. 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) <ul style="list-style-type: none"> - P-glukos CGM - P-Kreatinin - P-Alaninaminotransferas (ALAT) 	Juno (JSON) API: <ul style="list-style-type: none"> • .../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: <ul style="list-style-type: none"> - 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: <ul style="list-style-type: none"> • .../measurements • .../measurements-index • .../measurements/ {measurementDocumentId} • etc.
Aktiviteter (cat. #1)	Activities. Variation is mainly in the terminology used, not in structure	Juno (JSON) API <ul style="list-style-type: none"> • .../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:

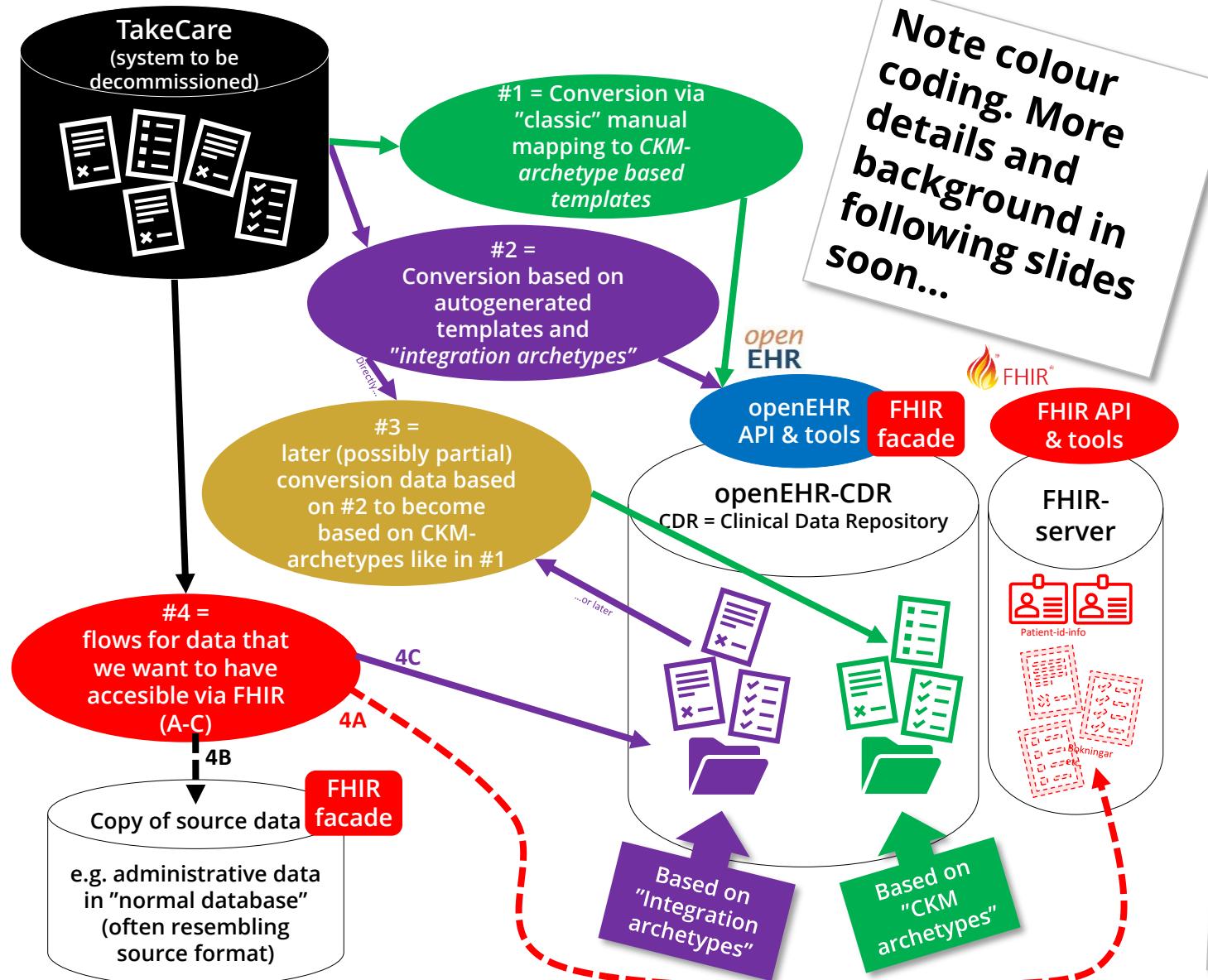
- A. Informatics focus**
[freshEHR won]
- B. Integration & visualisation focus**
[Tietoevry won]

← 6 types of data

~4 methods →

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/) <ul style="list-style-type: none"> • 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 . (See https://specifications.openehr.org/releases/RM/latest/integration.html) <ul style="list-style-type: none"> • 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. <ul style="list-style-type: none"> ○ 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 <ul style="list-style-type: none"> ○ 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 COMPOSITIONs based on #1 (manually designed) templates. <ul style="list-style-type: none"> • 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 COMPOSITIONs 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 type #1 (manually designed) and stored again in the CDR. For some subcategories this will then be followed by a step based on further conversions of 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. <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> ○ 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)

Variants of conversion/mapping that were anticipated in the PoC



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Background details

openEHR's GENERIC_ENTRY is handy for integrations,
but direct conversion with sensible use of FEEDER_AUDIT
can also fit some use cases

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Integration Information Model

Amendment Record

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2.4. Class Descriptions

2.4.1. GENERIC_ENTRY Class

One of
openEHR's
technical
specifications

2.3. Data Conversion Architecture

The integration archetype-based strategy for importing data into an openEHR system, shown in the following figure, consists of two steps.

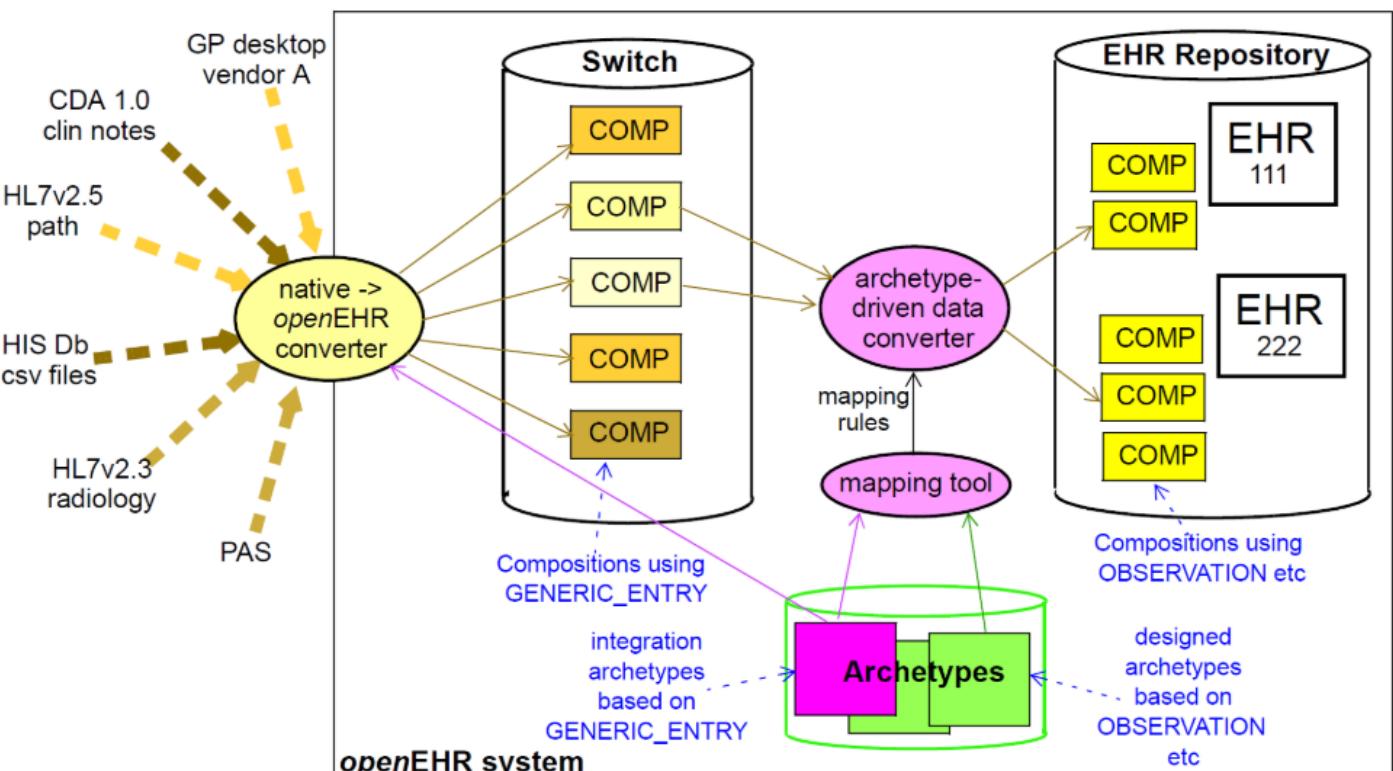
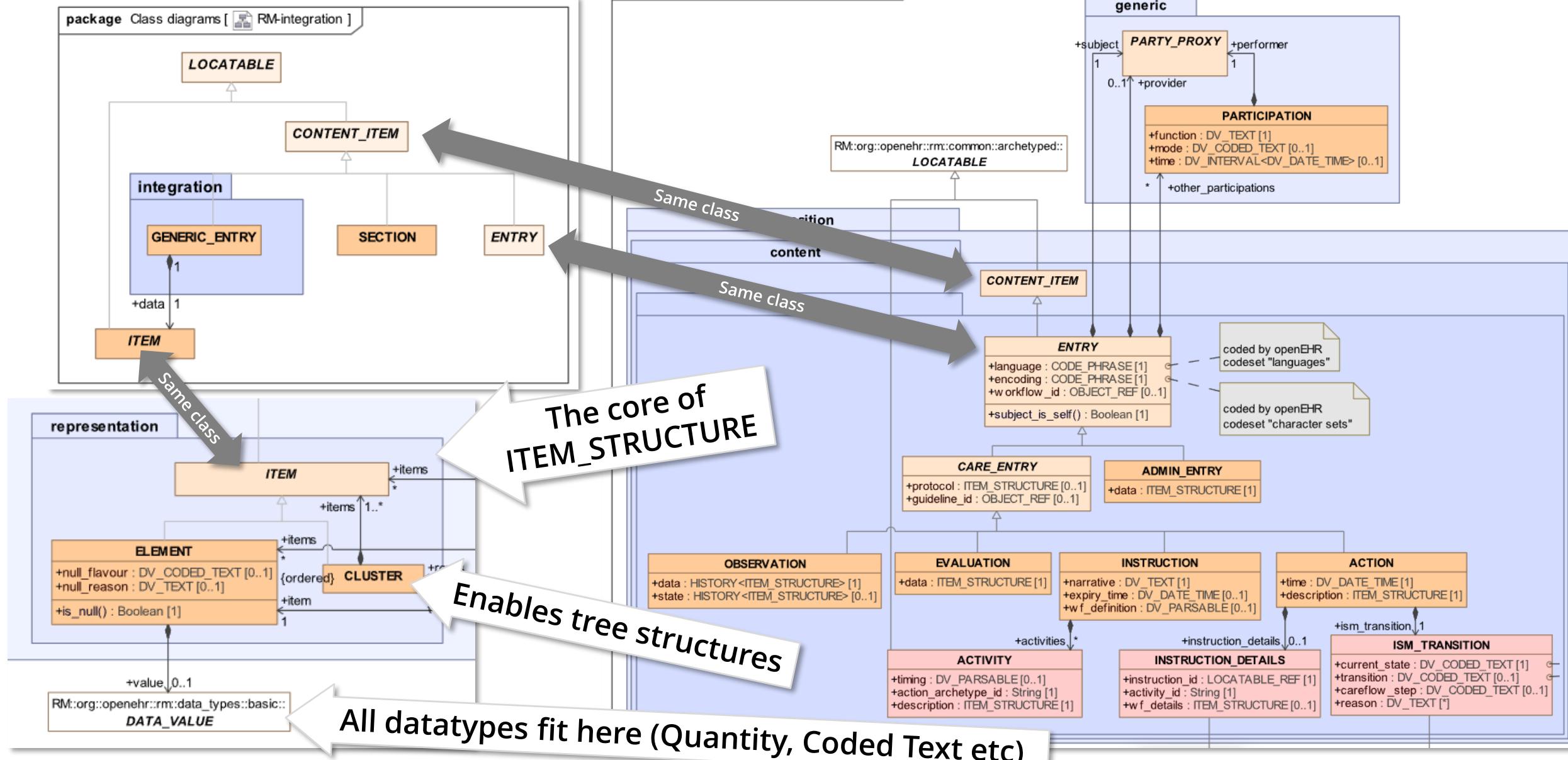


Figure 2. Data Integration using openEHR

Firstly, data are converted from their original syntactic format into openEHR COMPOSITION / SECTION / GENERIC_ENTRY structures, shown in the openEHR integration switch. Most of the data will appear in the GENERIC_ENTRY part, controlled by an integration archetype designed to mimic the incoming structure (such as an HL7v2 lab message) as closely as possible; FEEDER_AUDIT structures are used to contain integration meta-data. The result of this step is data that are expressed in the openEHR type system (i.e. as instances of the openEHR reference model), and are immediately amenable to processing with normal openEHR software.

GENERIC_ENTRY

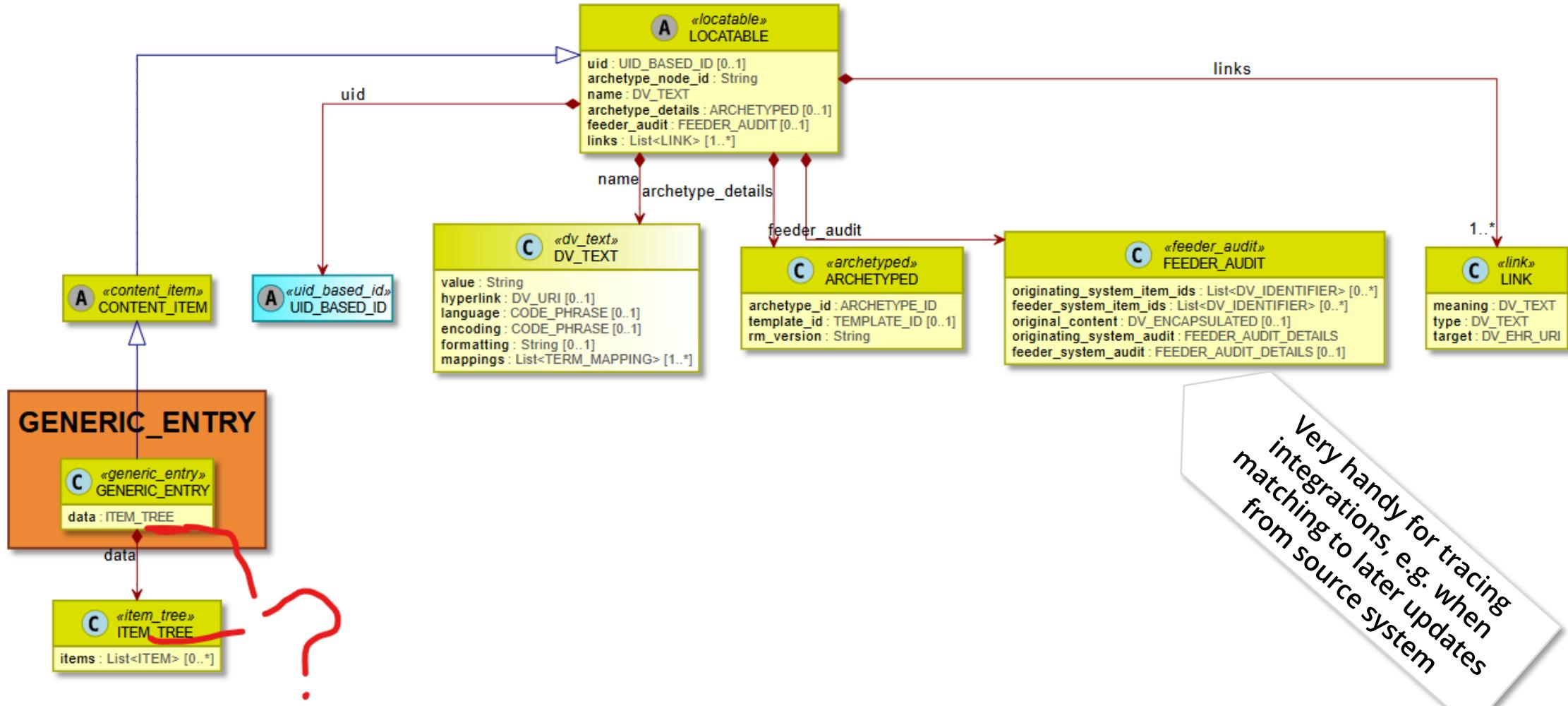
(used for “integration archetypes”)



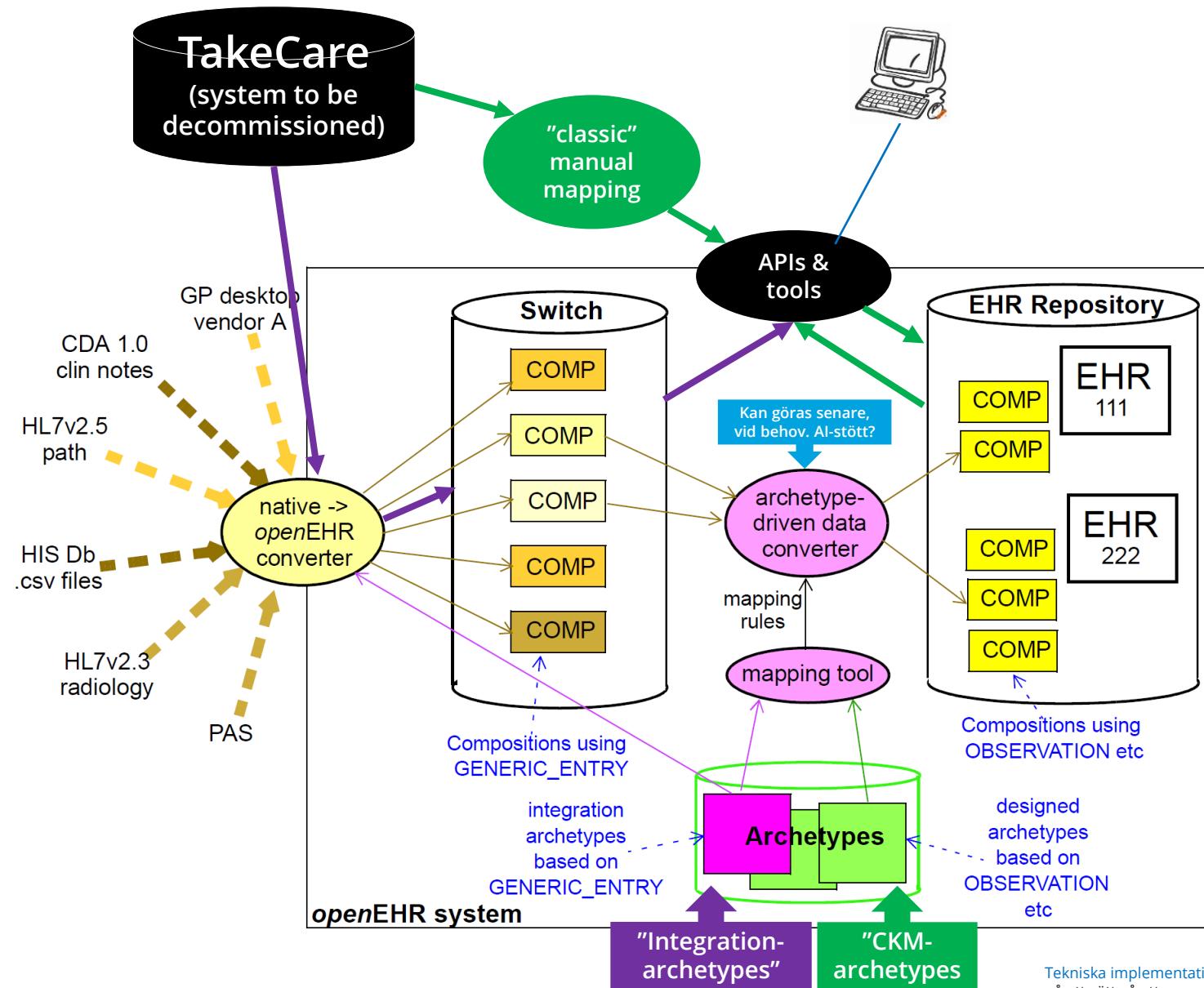
RM 1.1.0

Classes

GENERIC_ENTRY



Modified figure...

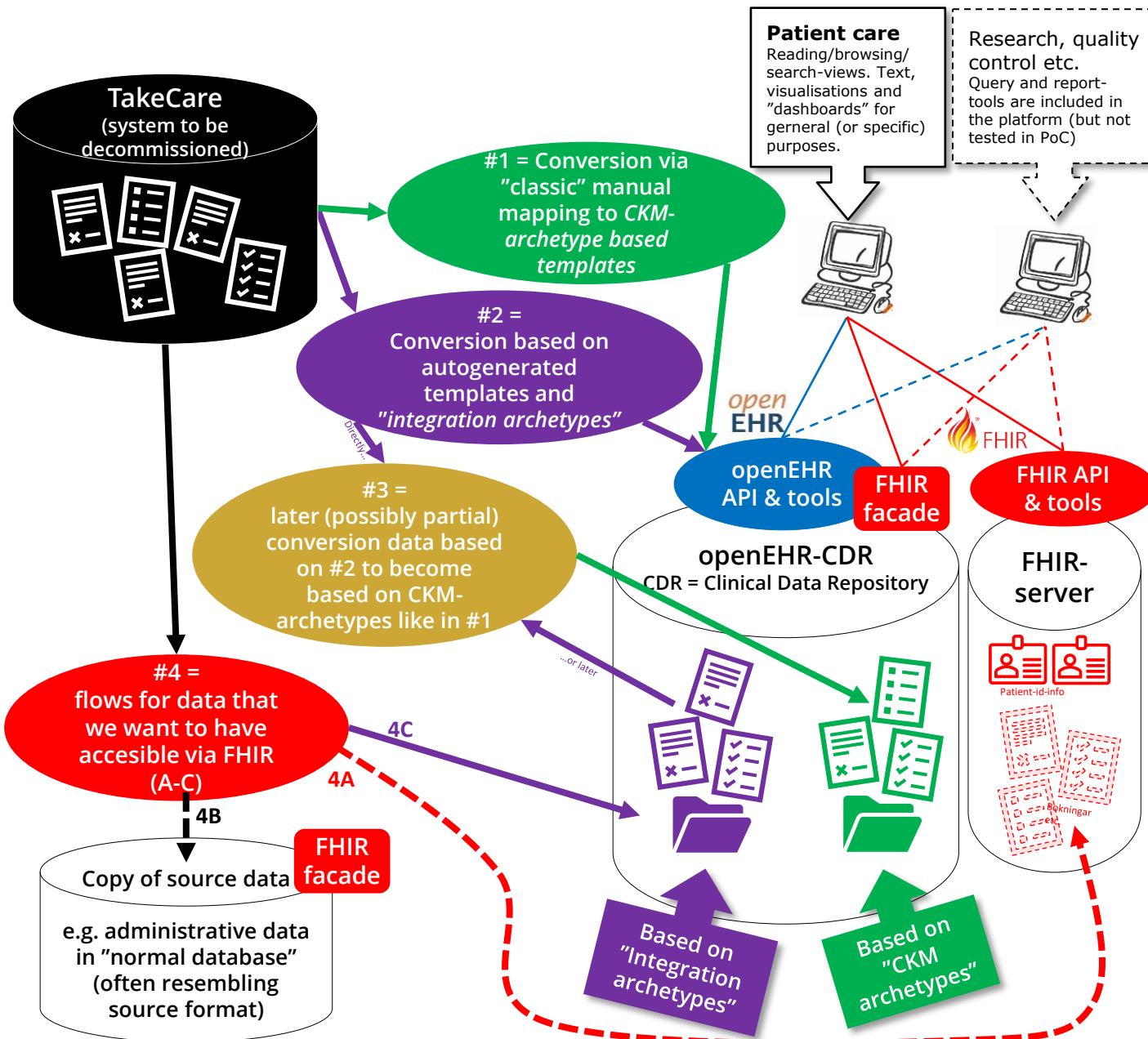


Tekniska implementationsdetaljer: delarna märkta "Switch" och "EHR Repository" kan, om så på ett sätt så att man enkelt vid anrop (exempelvis AQL-sökfrågor) kan välja om man vill ha s



Transformation & visualisation

Variants of conversion/mapping used in PoC



Conversion strategies

- CKM-archetypes** = international or national standardised openEHR structures
- Integration archetypes/templates** = locally/custom developed structures that copy the structure of the source system
- 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**
- 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:
 - FHIR-resources in a FHIR-server (direct conversion, before storage)
 - Store in a database copied from source system, expose via "FHIR-facade"
 - 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.



Clinical notes (forms)

TakeCare

Sök/välj patient | Testenhet 17 **CSTC Int

OpenEHR Man72
19 520729-1591

Nytt | Ålder: 72 år | Gatuadress: Testvägen 14 | Husläkare: <empty>

Kön: Man | Postadress: 132 43 Ehrstad | Vårdcentral: <empty>

Journaltext - 19 520729-1591 OpenEHR Man72

Journalmall: <Samtliga> | Yrke: <Samtliga> | Sökord: <Samtliga>

Sida 1 av 1

Tid	Läkare	Ämne	Förslag
24-11-03 14:29	Läk	Operationsberättelse	Testenhet 5** CSTC SLV
24-08-29 12:06	Läk	Nybesöksanteckning	Testenhet 17 **CSTC Int
24-08-29 10:57	Läk	Remissbedömning	Testenhet 17 **CSTC Int
24-05-14 10:49	Läk	Nybesöksanteckning	Öppenvårdsmott. Urologi
24-01-20 16:09	Läk	Besöksanteckning	Visby-VC Slite
23-09-14 16:01	Läk	Nybesöksanteckning	Visby-VC Slite
23-01-05 15:42	Läk	Daganteckning	Testenhet 5** CSTC SLV
22-11-08 10:57	Läk	Nybesök Vårdcentral	Testenhet 4** SLSO Prim
22-07-06 15:38	Läk	Telefonkontakt utan besök	Testenhet 4** SLSO Prim
20-03-11 08:24	Läk	Läkemedelsgenomgång	Testenhet 17 **CSTC Int

Vissa journaler har redigerats.

19520729-1591 OpenEHR, Man72
72år man

TakeCare journal

Fr.o.m datum och tid
yyyy.MM.dd HH : MM

T.o.m datum och tid
yyyy.MM.dd HH : MM

Välj yrkesroll | Välj journalmall | Välj sökord

Välj vådenhet | Stäng | Filtra

Datum, tid	Yrkesroll	Journalmall	Vådenhet
2024-11-03 14:29	Läkare	Operationsberättelse	Karolinska SV
2024-08-29 12:06	Läkare	Nybesöksanteckning	Karolinska ÖV
2024-08-29 10:57	Läkare	Remissbedömning	Karolinska ÖV
2024-05-14 10:49	Läkare	Nybesöksanteckning	Öppenvårdsmott. Urologi
2024-01-20 16:09	Läkare	Besöksanteckning	Visby ÖV
2023-09-14 16:01	Läkare	Nybesöksanteckning	Visby ÖV
2023-01-05 15:42	Läkare	Daganteckning	Visby ÖV

2024-08-30 14:09:38 Claudia Ehrentraut Läkare Karolinska ÖV (Signerad)

Nybesöksanteckning

Remittent: Jenny Jensen Urolog
Kontaktsak: Prostatacancer, behandlingsdiskussion
Anamnes
Socialt: Gift och 3 utflyttade barn. Pensionär efter ett liv i byggbranschen.
Ärlighet: Ingen känd

Tidigare sjukdomar: Opererad för diskbråck 2015
Nuvarande sjukdomar: Ulcerös kolit, omedicinerad, i inaktiv fas för närvarande.

Tobak: Icke rökare

Aktuellt: Diagnosticerad med prostatacancer 2018, nu uppgraderad efter stigande PSA med hög PSA-densitet. MR och fusionsbiopsi mot två lesioner i 34Cd respektive 2Av där man funnit 70% Gleason 4-mönster. Cancer i totalt 4 av 7 fusionsbiopsier. Systematiska biopsier med Gleason 3+4 med oklar lokalisering. Tidigare palperad u.a. Patienten har LUTS med primärt urgency och nedsatt erektil funktion.

Status
Allmäntillstånd: Gott och opåverkat

Rektalundersökning
T (DRE): 2
Sida: vänster

Bedömnin: En 72-årig man med uppgraderad prostatacancer enligt ovan. Har diskuterat strålning och kirurgi hos inremitterande. Patienten bedöms operabel på MR med vänstersidig ventral EPE 4 samt tydlig konsistensförändring på vänster sida.

Ger skriftlig information och går igenom riskerna för inkontinens och impotens som följer av robotassisterad prostatektomi. Patienten önskar ytterligare betänketid. Vi planerar höras per telefon inom två veckor för ett beslut om behandling.

Poc

Take
Care

#2
integr.
ark.

Dynamic keyword-based forms in TakeCare can contain ant keyword user chooses to add!

RSK - Journal Encounter (openEHR-EHR-COMPOSITION.encounter:v1)

git History

Definition Form Description Analytics

Encounter > context

- Encounter
 - context
 - other_context
 - Extension
 - Metadata $\Delta [0..*]$ to $[0..1]$
 - Care unit v2 $\Delta [0..*]$ to $[0..1]$ NAME (from: 'Extension')
 - Attestation $\Delta [0..*]$ to $[0..1]$
- content
 - Generic entry $\Delta [0..1]$ to $[0..*$
- iCKM NAME (from: 'Ad hoc heading')

iCKM examples
on next slide

content

- Generic entry $\Delta [0..1]$ to $[0..*$
- data
 - Keyword
 - Keyword $\Delta [0..*]$ to $[0..1]$
 - Name
 - Value
 - ScaleText
 - isAccredited
 - Datatype
 - Properties $\Delta [0..*]$ to $[0..0]$
 - Original Unit
 - Comment
 - Level
 - Child node
 - Entry UID
 - PairAnalysis
 - pairAnalysisSamplingDateTime
 - PairAnalysis

History

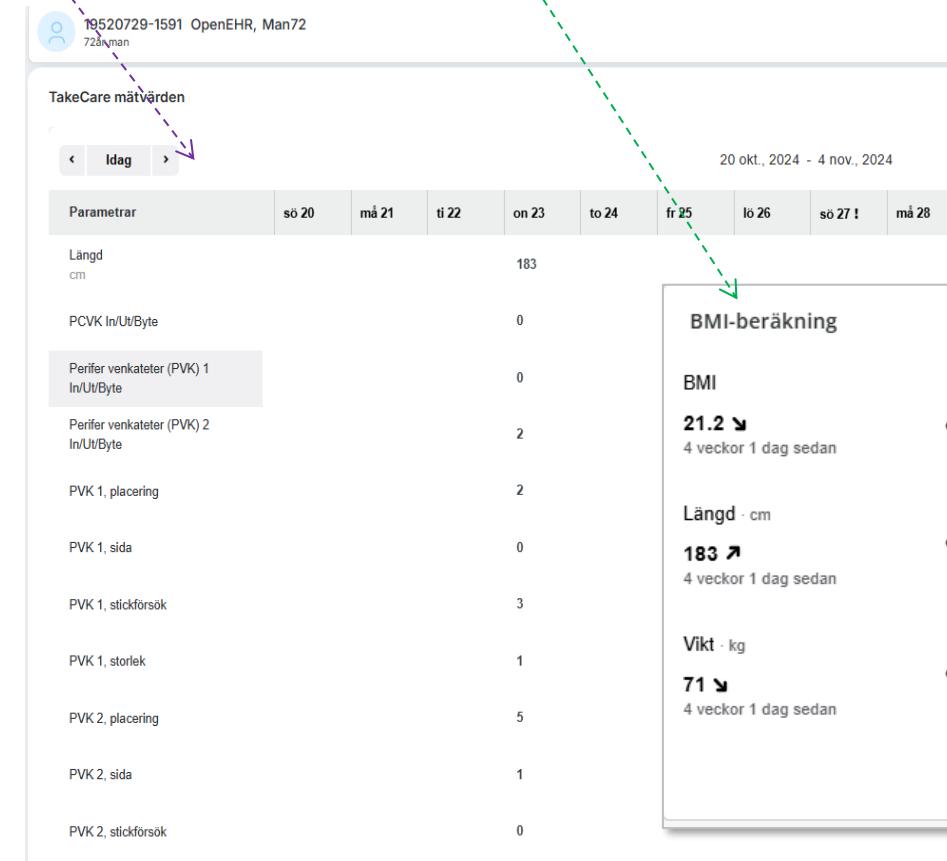
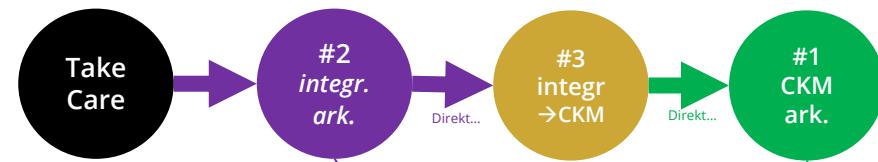
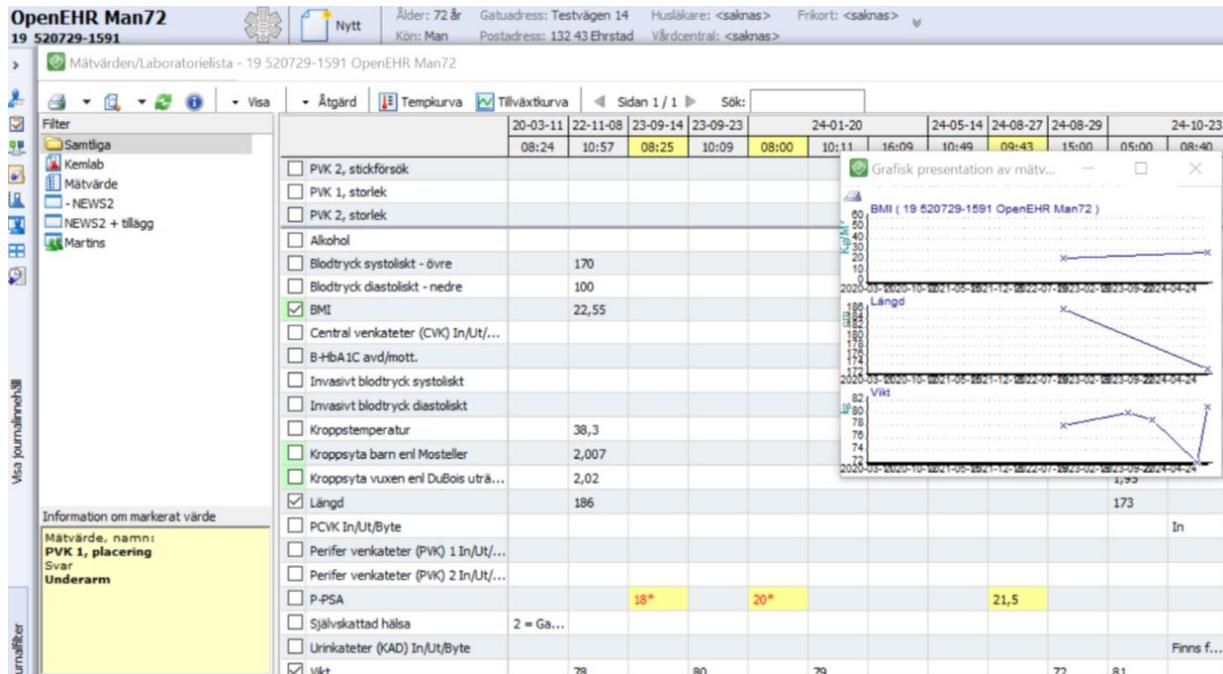
Definition Form Description Analytics

Encounter > context

- context
 - other_context
 - Extension
 - Metadata $\Delta [0..*]$ to $[0..1]$
 - Document ID
 - Parent document ID
 - Approved for patient
 - Template name
 - Template URL
 - Document code
 - Document title
 - Doc created timestamp
 - Document creator professional ID Δ
 - Document creator user ID
 - Document creator full name
 - Document creator Care unit ID
 - Document creator Care unit name
 - Document saved by professional ID
 - Document saved by user ID
 - Document saved by full name
 - Document saved timestamp
 - Document saved Care Unit Id
 - Document saved Care unit name
 - Signed timestamp
 - Signer ID
 - Signed full name
 - Signed Care unit ID
 - Signed Care unit Name
 - Signed by ID
 - Countersigner ID
 - Link Code
 - Version ID
 - IsCopy
 - IsCancelled
 - Header text
 - Provenance
 - Care unit v2 $\Delta [0..*]$ to $[0..1]$ NAME (from: 'Extension')
 - Attestation $\Delta [0..*]$ to $[0..1]$
 - Attested
 - has Deviating analysis
 - Attestation created dateTime
 - Responsible Attester name
 - Latest Version attested
 - Responsible Attester

Measurements

TakeCare



PoC

Normalisation/standardisation examples, certain measurements from TakeCare "keywords"

iCKM NAME (from: 'Ad hoc heading')

- items
 - Blood pressure Δ [0..1] to [0..*]
 - Blood pressure systolic - upper Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
 - Blood pressure diastolic - lower Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
 - MAP Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
 - Invasive blood pressure systolic Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
 - Invasive blood pressure diastolic Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
 - Blood pressure right arm, systolic Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
 - Blood pressure right arm, diastolic Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
 - Blood pressure left arm, systolic Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
 - Blood pressure weak, diastolic Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
 - 24-hour blood pressure curve Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
 - Weight Δ [0..1] to [0..*] NAME (from: 'Body weight')
 - Birth weight Δ [0..1] to [0..*] NAME (from: 'Body weight')
 - Naked weight Δ [0..1] to [0..*] NAME (from: 'Body weight')
 - Length Δ [0..1] to [0..*] NAME (from: 'Height/Length')
 - Length lying down Δ [0..1] to [0..*] NAME (from: 'Height/Length')
 - Length sitting Δ [0..1] to [0..*] NAME (from: 'Body segment length')
 - BMI Δ [0..1] to [0..*] NAME (from: 'Body mass index')
 - BMI calculated Δ [0..1] to [0..*] NAME (from: 'Body mass index')
 - Body temperature Δ [0..1] to [0..*]
 - Heart rate Δ [0..1] to [0..*] NAME (from: 'Pulse/Heart beat')
 - Pulse rate Δ [0..1] to [0..*] NAME (from: 'Pulse/Heart beat')
 - Respiratory rate Δ [0..1] to [0..*] NAME (from: 'Respiration')
 - Saturation Δ [0..1] to [0..*] NAME (from: 'Pulse oximetry')
 - Oxygen level Δ [0..1] to [0..*] NAME (from: 'Container')
 - Saturation with oxygen Δ [0..1] to [0..*] NAME (from: 'Pulse oximetry')
 - NEWS2 Scale 1 Δ [0..1] to [0..*] NAME (from: 'National Early Warning Score 2 (NEWS2)')
 - NEWS2 Scale 1 Heartrate Δ [0..1] to [0..*] NAME (from: 'National Early Warning Score 2 (NEWS2)')
 - NEWS 2 Scale 2 Δ [0..1] to [0..*] NAME (from: 'National Early Warning Score 2 (NEWS2)')
 - NEWS2 Scale 2 Heartrate Δ [0..1] to [0..*] NAME (from: 'National Early Warning Score 2 (NEWS2)')
 - ICD Diagnosis Δ [0..1] to [0..*] NAME (from: 'Problem/Diagnosis')

Archetype Designer Repositories Save Export Import Updates 100

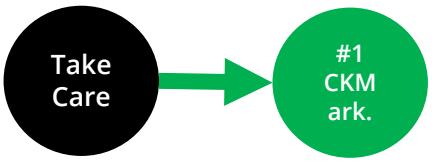
RSK - Journal Encounter (openEHR-EHR-COMPOSITION.encounter.v1)

History

Definition Form Description Analytics

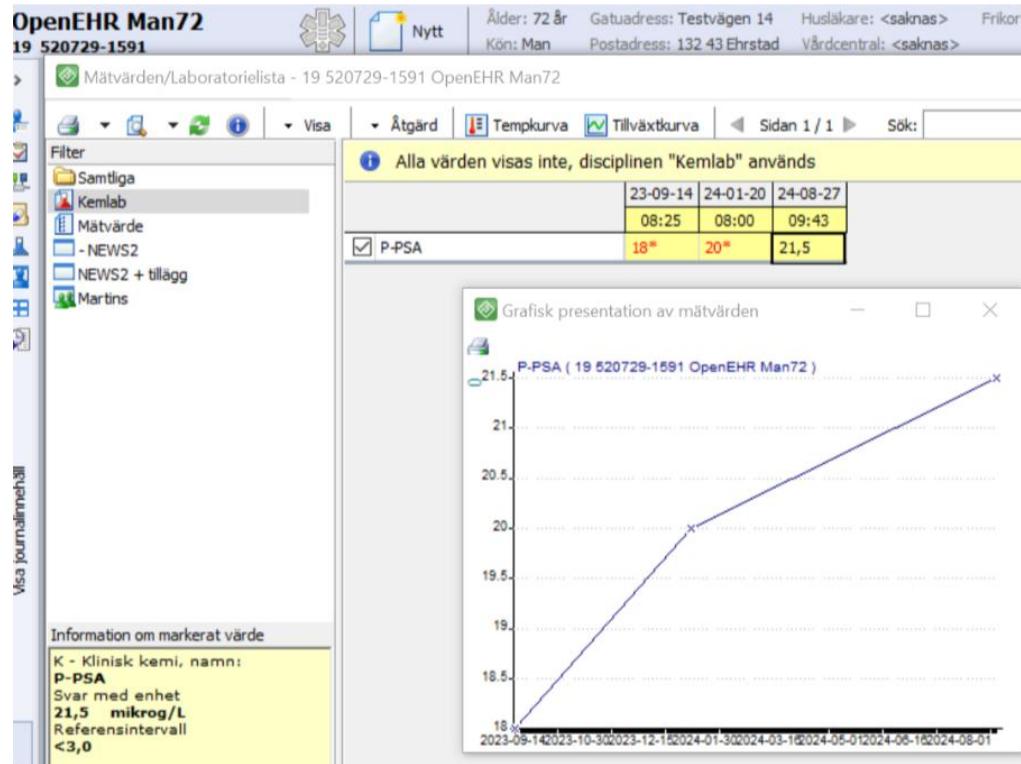
m, systolic>protocol>Location of measurement

- Blood pressure right arm, diastolic Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
- Blood pressure left arm, systolic Δ [0..1] to [0..*] NAME (from: 'Blood pressure')
- Any event Δ [0..*] to [0..1] Δ Values changed
- data
 - Systolic
 - Diastolic Δ [0..1] to [0..0]
 - Mean arterial pressure Δ [0..1] to [0..0]
 - Pulse pressure Δ [0..1] to [0..0]
 - Clinical interpretation Δ [0..1] to [0..0]
 - Comment Δ [0..1] to [0..0]
- state
 - 24 hour average Δ [0..1] to [0..0] Δ Values changed
- protocol
 - Cuff-size Δ [0..1] to [0..0]
 - Location of measurement 0.0
 - Structured measurement location
 - Method Δ [0..1] to [0..0]
 - Mean arterial pressure formula Δ [0..1] to [0..0]
 - Systolic pressure formula Δ [0..1] to [0..0]
 - Diastolic pressure formula Δ [0..1] to [0..0]
 - Diastolic endpoint Δ [0..1] to [0..0]
 - Device
- Extension
 - Keyword Δ [0..*] to [0..1]
 - Name
 - Value
 - ScaleText



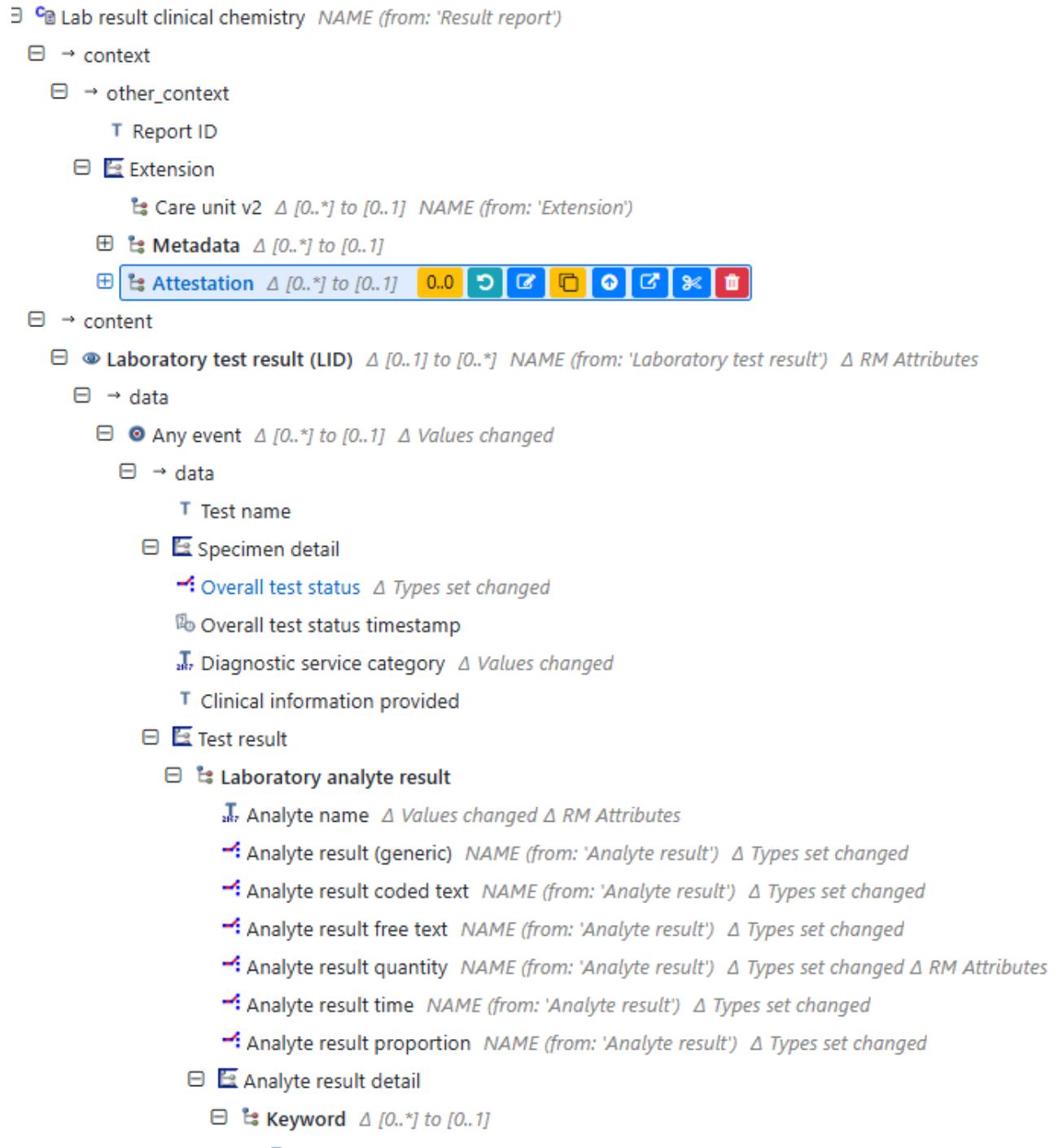
Clinical Chemistry

TakeCare



PoC





Medications

OpenEHR Flicka10 20 140219-2387 Nytt Ålder: 10 år 8 mån Gatuadress: Testvägen 11 Husläkare: <saknas> Frikt: <saknas> Vårcentral: <saknas> Stäng journal

Läkemedelsjournal - 20 140219-2387 OpenEHR Flicka10 Åtgärd Alla enheters lista

Läkemedelslista Tidsöversikt Administrering Infusioner Oxygenbehandling Alla läkemedel Receptförskrivning Vaccinationer

Läkemedelslista Visa NLL

Ord. gäller fr.o.m.	Dos	Rek	Preparatnamn	Styrka	Läkemedelsform	Adm.väg	Adm.metod	Typ	Dostid	Adm tf	Ord. gäller t.o.m.	Signerad	Signerad av	Skapad
2024-09-07		Rek	Insulin Lispro Sanofi	100 enheter/ml	Injektionsvätska, lösning	Intravenöst	Pump	Bhs	se bhs		Tillsvidare	2024-09-06	Anna-Maria Nygren	Testenh
2023-04-02		Rek	Insulin Aspart Sanofi	100 E/ml	Injektionsvätska, lösning i förfylld injektionspenna	Subkutant		Vb	10 E E		Tillsvidare	2024-11-11	Susanne Bergenbrant Glas	Testenh
2024-11-14		Rek	Alvedon	500 mg	Filmdragerad tablett	Oralt		Vb	1 st		Tillsvidare	2024-11-14	Susanne Bergenbrant Glas	Testenh

TakeCare

Take Care

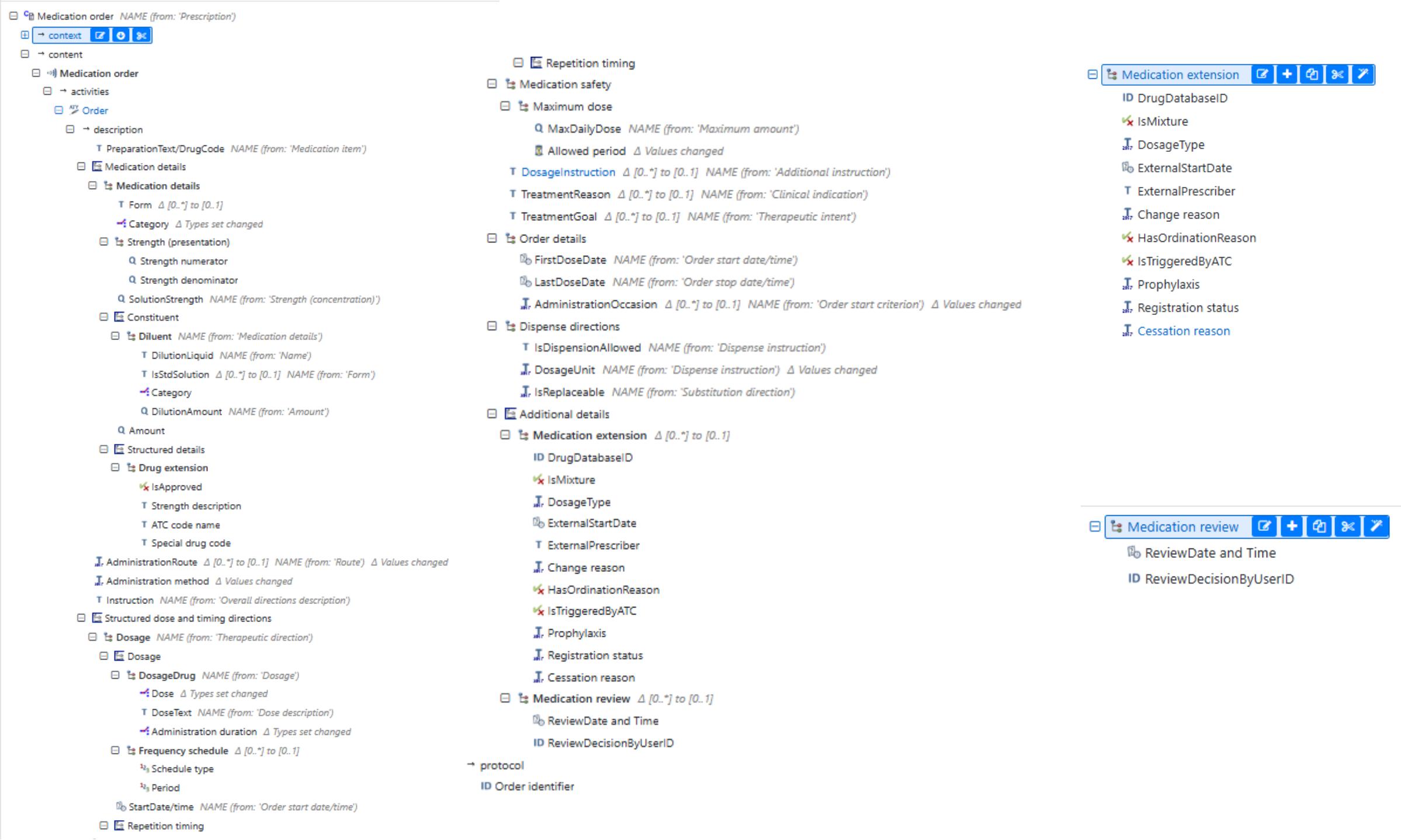
20140219-2387 OpenEHR, Flicka10
10år kvinna

PoC

#1
CKM
ark.

TakeCare läkemedel

Ord. gäller fr.o.m.	Preparatnamn	Styrka	Läkemedelsform	Adm. väg	Doseringstyp	Dosering	Dosanvisning	Ord. gäller t.o.m.	Signeratdatum	Signerad av	Värdenhet
2024-11-14	Alvedon	500 mg	Filmdragerad tablett	Oralt	Vb	1	<1 tablett vid behov mot smärta. Max 6 st per dygn>	2024-11-14	Susanne Bergenbrant Glas	Karolinska ÖV	
2024-11-11	Insulin aspart Sanofi	100 E/ml	Injektionsvätska, lösning i förfylld injektionspenna	Subkutant	Vb	10 E	<10 E E injektionsvätska, lösning i förfylld injektionspenna vid behov diabetes. Max 20 E per dygn>	2024-11-11	Susanne Bergenbrant Glas	Privat ÖV	
2024-09-07	Insulin lispro Sanofi	100 enheter/ml	Injektionsvätska, lösning	Intravenöst	Bhs	se bhs	<enligt separat behandlingsschema>	2024-09-06	Anna-Maria Nygren	SLSO ÖV	



Findings from 3-month Proof of Concept (PoC) – see report

Access to **expertise** crucial

- **Clinicians** available during work to create good conditions for visualisation/viewing/access and medical language review
- International **openEHR** expertise streamlines work
- Deep **TakeCare** expertise to understand certain automatic logic in TC, for example around signing
- Competence in **record keeping** as well as knowledge of procedures and **legislation** is vital

Efficient **project management** with clear documentation and quick decisions

- Short sprints with frequent follow-ups to quickly handle outstanding questions/obstacles
- Document from the start in all parts

Easier than expected, proven to be practically feasible

- Conversion
 - Visualisation
- ... but not all information in TC is suitable for mapping to openEHR/FHIR (e.g. logs, cash register etc.)

Informationsdomain	TakeCare module
Patientinformation	Vårdkontakter Patientuppgifter
Journalinformation	Mätvärden Beställning och remiss Konsultationsärenden Läkemedelsjournal Svar (laboratorie) Aktivitetsplan Akutliggaren Jurnaltext Infektionsverktyget Recept Läkemedel - Administreringstillfällen Läkemedel - Administreringsvägar
Parametrar	Administreringstyp Åtgärdskoder enligt KVÅ Inskrivningskoder Termkatalog Inskrivningplanering akut ICD10-register (diagnoskoden)
Loggar	PDL-loggar Vårdenhetsloggar
Dokument	Blanketter och formulär Brev Skanning Mappar med skannade dokument
Bilder	Picsara Multimedia Teckningar Bilder
Ekonomisk information	Kassa Ekonomiska enheter
Resurser	Bokning Vårdenhet
Händelse	Vårdplanering Inskrivning – Utskrivning Ankomst- och betalningsregistrering Ärende-Besöksrapportering Operationsliggare Inskrivningsplanering

Yellow highlights modules explored in PoC

Extended visualisation (after PoC) Computer Science Student group project

@Linköping University, Sweden

With a challenge from Karolinska University Hospital

Teamet!

Datateknolog-studenter vid Linköpings Universitet, som läser sitt tredje eller högre år.

Kurs: Kandidatprojekt i programvaruutveckling, 15 hp Kurskod: TDDD96

Rapporten, LIU-IDA/LITH-EX-G--2025/001--SE kommer kunna nås via <http://www.ep.liu.se>

Källkod kan nås via https://github.com/Luttu01/TDDD96_2025_PUM14 (Open Source, A



Tabell 2.1: Projektets medlemmar

Namn	Ansvar	E-post
Philip Batan	Teamledare (TL)	phiba500@student.liu.se
Gustav Boberg	Testledare (TES)	gusbo923@student.liu.se
Marcus Hedquist	Analysansvarig (AA)	marhe598@student.liu.se
William Janowsky	Utvecklingsansvarig (DEV)	wilja141@student.liu.se
Lucas Lindahl	Arkitekt (A)	lucli366@student.liu.se
Erik Luttu	Konfigurationsansvarig (C)	erilu272@student.liu.se
Gabriel Matsson	Kvalitetssamordnare (K)	gabma609@student.liu.se
Michael Werner	Dokumentansvarig (DOK)	micwe387@student.liu.se



Journalvy: Canvas Återställ Journalvy | Tidslinje: Tidslinje Gömma yyyy-mm-dd yyyy-mm-dd Sökord Journalmall Värdenhet Yrkesroll Återställ Filter

24-11-06 16:46 Ssk Lev...	2024-05-14 Nybesöksanteckning Remittent: VC Slite Kontaktorsak: Känd prostatacancer, upgraderad? Anamnes Socialt: Gift, inga hemmavarande barn. Pensionär Ärftlighet: Ingen känd Tidigare sjukdomar: Diskbråck, opererad 2015 Nuvarande sjukdomar: Ulcerös kolit, prostatacancer Gleason 3+3 Alkohol: Måttlig Fysisk träning: Sparsamt Aktuellt: Känd prostatacancer, nu med möjligt fynd per rectum hos primärvården och stigande PSA till 20. Diskuterar behandlingsalternativ och möjliga bieffekter. Patienten lutar åt operation om möjligt/lämpligt. Status Allmäntillstånd: Gott, opåverkad Hjärta: Inga blåsljud Blodtryck systoliskt - övre: 110 Blodtryck diastoliskt - nedre: 90 Buk: Mjuk och oöm. Rektalundersökning T (DRE): 1c Bedömning: Känner ingen resistens per rectum men tydlig PSA-stegring föranledder MR-undersökning med påföljande riktade biopsier. Åtgärd/planering: Beställt MR och fusionsbiopsi samt nytt DCA. Ansluter sista och ställer upp till konstellation.	2022-10-11 Nybesöksanteckning Remittent: Johanna Svensson (Läk) /10c2/ Kontaktorsak: Högt blodtryck Anamnes Socialt: Gift bor med make och hund på landet, motionerar mycket. Ärftlighet: Hjärtproblem hos föräldrarna Tidigare sjukdomar: op galla för 15 år sen Tobak: Mindre än 10 cigaretter/dygn Aktuellt: Flåsig vid backar, ökat i vikt. orolig för hjärtssjukdom. Status Allmäntillstånd: gott opåverkad Hjärta: RB inga biljud F 67 Lungor: Normala andningsljud Blodtryck: 160/95 Bedömning: Får lite btsänkande på prov Åtgärd/planering: Åter om 3 månader Diagnos enl ICD-10: I109 Essentiell hypertoni	2019-06-30 Nybesöksanteckning Anamnes Mätvärden P-Glukos avd/mott.: 10 Längd: 140 Vikt: 17 Blodtryck systoliskt - övre: 110 Blodtryck diastoliskt - nedre: 60 Kroppstemperatur: 36.7 Åtgärd Konsultationsremiss: Akut remiss till barnklinik vid misstänkt diabetes	2022-11-08 Nybesöksanteckning Diagnos enl ICD-10: D400 Tumör av osäker eller okänd natur i prostata Socialt: BOr med frun Anamnes Mätvärden Längd: 186 Vikt: 78 Blodtryck systoliskt - övre: 170 Blodtryck diastoliskt - nedre: 100 Kroppstemperatur: 38.3 Åtgärd: Blstatus CRP
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Figur 5.2: Canvas läge med 4 öppnade anteckningar



Journalvy: Canvas Återställ Journalvy

Tidslinje: Tidslinje Gömma

yyyy-mm-dd yyyy-mm-dd

24-11-06 16:46 Ssk Levnadsvanor	2024-05-14	2024-08-29	2024-08-29
24-10-21 17:02 Läk Nybesök Vårdcentral			
24-09-27 13:04 Ssk Utskrivning-omvård...			
24-09-18 10:39 Ssk Inskrivningsanteckni...			
24-09-02 13:35 Läk Intagningsanteckning			
24-08-30 13:42 Läk Mottagningsanteckni...			
24-08-29 14:25 Läk Nybesöksanteckning			
24-08-29 14:11 Läk Remissbedömning			
24-08-29 14:06 Läk Nybesöksanteckning			
24-08-29 12:57 Läk Remissbedömning			
24-07-01 17:12 Läk Nybesöksanteckning			
24-05-14 12:49 Läk Nybesöksanteckning			
23-11-14 09:22 Läk Besöksanteckning			
23-11-13 10:16 Läk Operationsberättelse			
23-10-26 12:57 Läk Läkarbesök			
23-10-19 12:53 Läk Mottagningsanteckni...			
23-01-05 16:42 Läk Daganteckning			
22-11-13 11:13 Läk Daganteckning			
22-11-08 11:57 Läk Nybesök Vårdcentral			
22-10-25 16:17 Läk Mottagningsanteckni...			
22-10-11 10:52 Läk Nybesöksanteckning			
22-07-06 17:38 Läk Telefonkontakt utan ...			
21-10-21 17:41 Läk Mottagningsanteckni...			
20-10-15 13:43 Läk Mottagningsanteckni...			
20-03-11 09:24 Läk Läkemedelsgenom...			

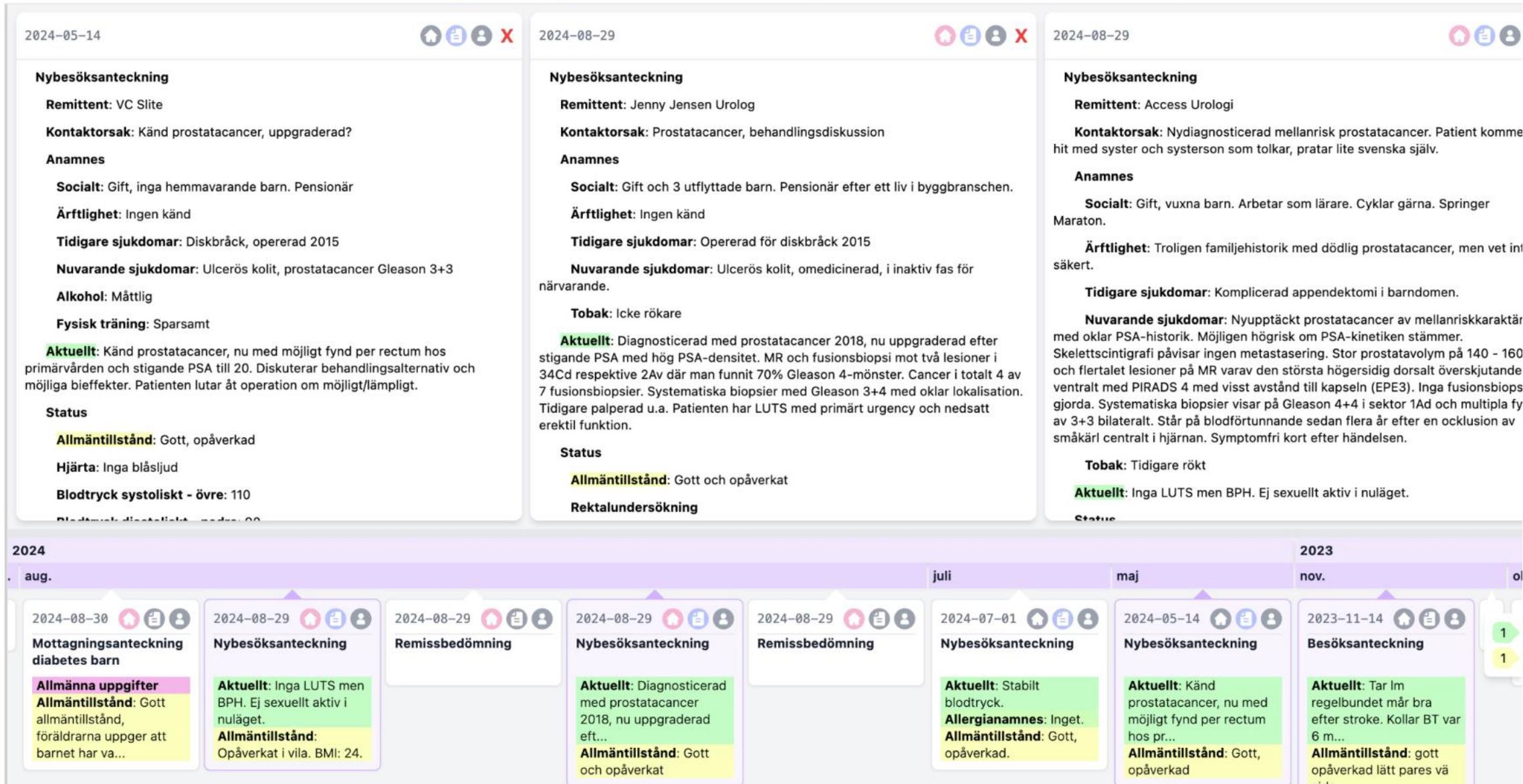
Nybesöksanteckning
Remittent: VC Slite
Kontaktorsak: Känd prostatacancer, upgraderad?
Anamnes
Socialt: Gift, inga hemmavarande barn. Pensionär
Ärftlighet: Ingen känd
Tidigare sjukdomar: Diskbråck, opererad 2015
Nuvarande sjukdomar: Ulcerös kolit, prostatacancer Gleason 3+3
Alkohol: Måttlig
Fysisk träning: Sparsamt
Aktuellt: Känd prostatacancer, nu med möjligt fynd per rectum hos primärvården och stigande PSA till 20. Diskuterar behandlingsalternativ och möjliga bieffekter. Patienten lutar åt operation om möjligt/lämpligt.
Status
Allmäntillstånd: Gott, opåverkad
Hjärta: Inga blåsljud
Blodtryck systoliskt - övre: 110
Blodtryck diastoliskt - nedre: 90
Buk: Mjuk och oöm.
Rektalundersökning
T (DRE): 1c
Bedömning: Känner ingen resistens per rectum men tydlig PSA-stegring föranleder MR-undersökning med påföljande riktade biopsier.
Åtgärd/planering: Beställt MR och fusionsbiopsi samt nytt PSA. Avvaktar svar och skickar remiss till Karolinska om signifikanta fynd görs. Biopsiresultaten meddelas patienten per telefon.
Diagnos enl ICD-10: C619 Malign tumör i prostata

Nybesöksanteckning
Remittent: Jenny Jensen Urolog
Kontaktorsak: Prostatacancer, behandlingsdiskussion
Anamnes
Socialt: Gift och 3 utflyttade barn. Pensionär efter ett liv i byggbranschen.
Ärftlighet: Ingen känd
Tidigare sjukdomar: Opererad för diskbråck 2015
Nuvarande sjukdomar: Ulcerös kolit, omedicinerad, i inaktiv fas för närvanande.
Tobak: Icke rökare
Aktuellt: Diagnosticerad med prostatacancer 2018, nu upgraderad efter stigande PSA med hög PSA-densitet. MR och fusionsbiopsi mot två lesioner i 34Cd respektive 2Av där man funnit 70% Gleason 4-mönster. Cancer i totalt 4 av 7 fusionsbiopsier. Systematiska biopsier med Gleason 3+4 med oklar lokalisering. Tidigare palperad u.a. Patienten har LUTS med primärt urgency och nedsatt erektil funktion.
Status
Allmäntillstånd: Gott och opåverkat
Rektalundersökning
T (DRE): 2
Sida: vänster
Bedömning: En 72-årig man med upgraderad prostatacancer enligt ovan. Har diskuterat strålning och kirurgi hos inremitterande. Patienten bedöms operabel på MR med vänstersidig ventral EPE 4 samt tydlig konsistensförändring på vänster sida. Ger skriftlig information och går igenom riskerna för inkontinens och impotens som följer av robotassisterad prostatektomi. Patienten önskar ytterligare betänketid. Vi planerar höras per telefon inom två veckor för ett beslut om behandling.
Åtgärd/planering: Telefonkontakt till undertecknad inom två veckor.
Diagnos enl ICD-10: C619 Malign tumör i prostata

Nybesöksanteckning
Remittent: Access Urologi
Kontaktorsak: Nydiagnostic hit med syster och systerson so
Anamnes
Socialt: Gift, vuxna barn. / Maraton.
Ärftlighet: Troligen familje säkert.
Tidigare sjukdomar: Komj
Nuvarande sjukdomar: Ny med oklar PSA-historik. Möjliga Skelettscintigrafi påvisar ingen r och flertalet lesioner på MR varav ventralt med PIRADS 4 med viss gjorda. Systematiska biopsier vi av 3+3 bilateralt. Står på blodfö smäkärl centralt i hjärnan. Symp
Tobak: Tidigare rökt
Aktuellt: Inga LUTS men BP
Status
Allmäntillstånd: Opåverka
Hjärta: Regelbunden rytm,
Lungor: Rent andningsljud
Blodtryck: 130/80
Rektalundersökning
Kommentar: Avstår palp palperad som T2 överensstämm
Bedömning: 67-årig man mi resektabel mellan-/högrisk. Patien enligt MR, vilka heller inte skulle MR-prostatarond för bedömnin

Figur 5.3: Basvy med lista där 3 anteckningar har öppnats





Figur 5.4: Tidslinje aktiv med filter- och sökordsmarkering

Related links & poster

- Info + source code used for conversion and visualization in PoC: https://github.com/regionstockholm/poc_tc2openEHR
- This presentation and **Poster at EHRCON25**
Will be made available at the same link as PoC above
(after possible scientific publication).
- **GENERIC_ENTRY** used for “integration archetypes”
<https://specifications.openehr.org/releases/RM/Release-1.1.0/integration.html>
- Erik’s fork of the Student project (might continue later...)
https://github.com/ErikSundvall/TDDD96_2025_PUM14



Using openEHR and FHIR to store and access legacy data from an EHR to be decommissioned

Authors: Erik Sundvall^{1,2,3} & Ian McNicoll^{4,5}
¹Karolinska University Hospital, Stockholm, Sweden. ²Karolinska Institutet, Stockholm, Sweden. ³Linköping University, Sweden.
⁴freshEHR Clinical Informatics Ltd, UK. ⁵University College, London, UK.

Decommissioning of large-scale Electronic Health Record (EHR) systems presents challenges like preserving data while ensuring continued, clinically useful access to it when the originating system is shut down. We present a practical approach for migrating clinical data:

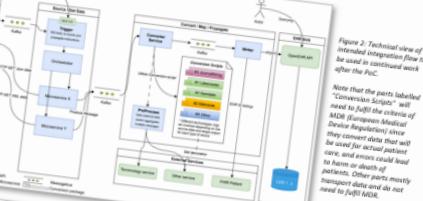
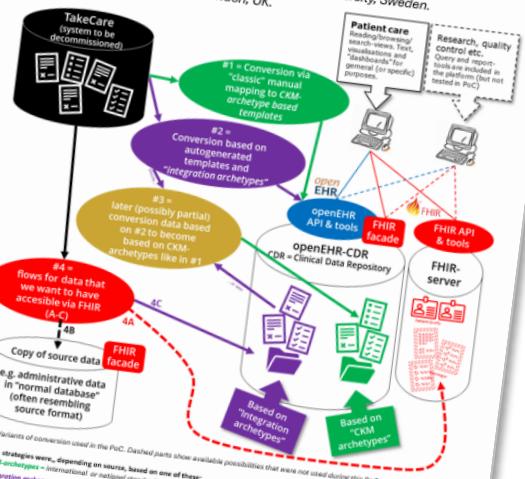
- from Region Stockholm’s current EHR system “TakeCare” [1] that is due to be decommissioned
- to a modern, standards-based EHR platform using openEHR and FHIR.

An important goal is that the end users of the platform should from the start be able to access the records in a familiar manner, but “under the hood” now via standards like openEHR and FHIR in a new platform [2] so that the old system can be shut down without clinical disruption. We believe that the approach is suitable also for other legacy EHR systems.

A Proof of Concept (PoC) in three months using a handful of full-time equivalents of consultants and hospital staff succeeded (via API) in automating the transfer of medical record text, medication prescriptions, clinical chemistry lab results, measurements, activities, etc., from TakeCare, to an EHR platform based on open standards such as openEHR and FHIR. During the same period, user interfaces were built in the EHR platform that mimicked the structure and functions (including the filtering system) of TakeCare so that healthcare professionals would feel familiar and could use the same types of filtering and workflows as before. Having fine-grained, multifaceted filtering available is much more useful to clinicians than just a word-based search in a set of PDF files that other archiving methods often provide. After the initial PoC some additional visualisation possibilities (timelines etc) were explored and implemented.

Conversion methods were chosen [3] depending on sources, targets and what was reasonable, technically, informatically, and resource-wise:

1. Well-defined parts with limited variability and easy to convert to international information models were converted directly.
2. Some parts of TakeCare are not easy to convert, but do not necessarily need to be modelled in a fully internationally standardised way to be clinically useful for human browsing, filtering, and reading. Here we used case specific templates based on “integration archetypes” or similar patterns [4] using the openEHR reference model to automatically “preserve” old medical record notes, etc.
3. Hybrids where you first “preserve” (#2) and later convert (to #1) some or all the content.



Questions? Discussion!

Extra slides follow, the entire slide deck will be available from.

https://github.com/regionstockholm/poc_tc2openEHR



Context: Digital Health Platform @ Karolinska / Stockholm

A part of the data platform – new possibilities...
...but rather boring when almost empty

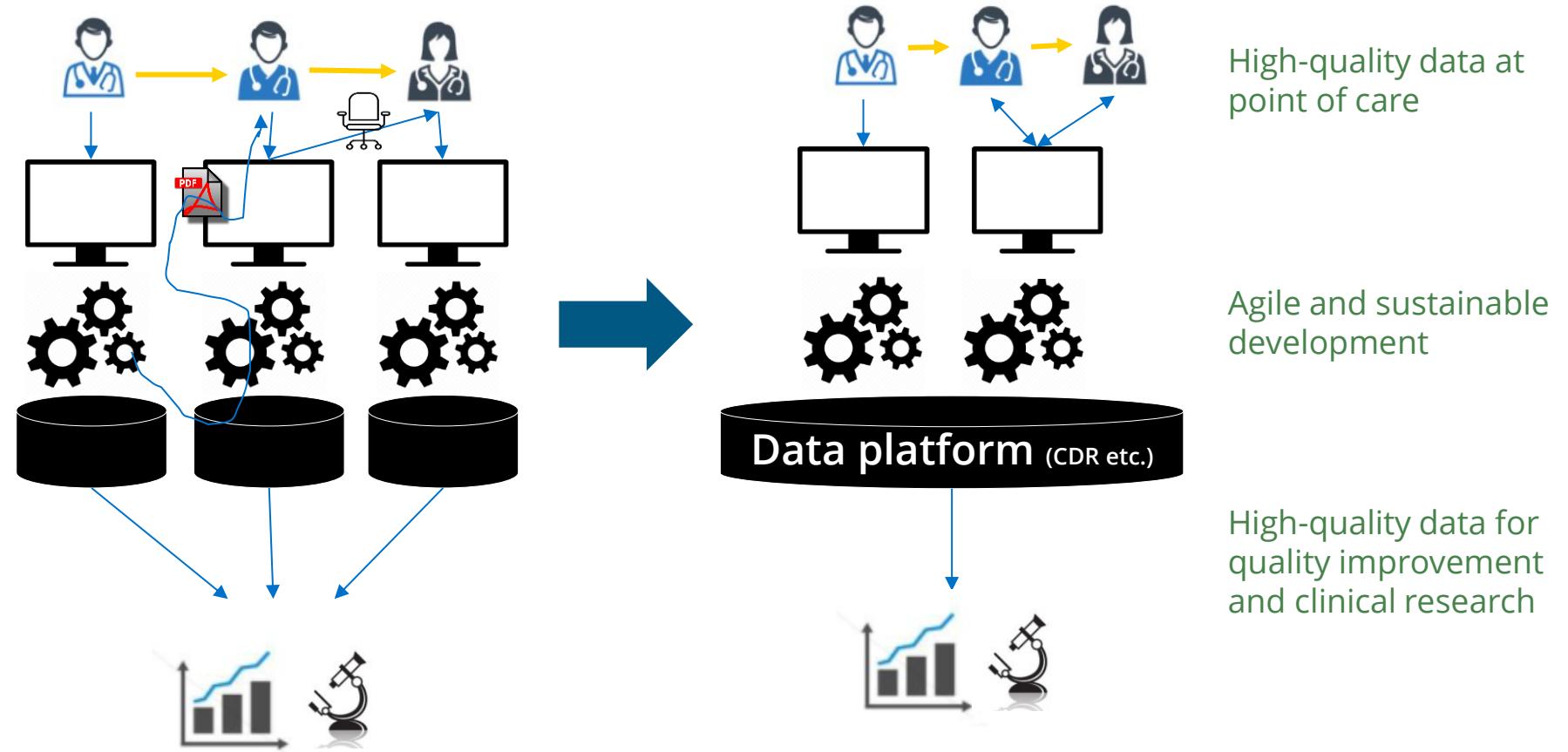
Soon (~2030?) the current EHR "TakeCare" shall be decommissioned (shut down)

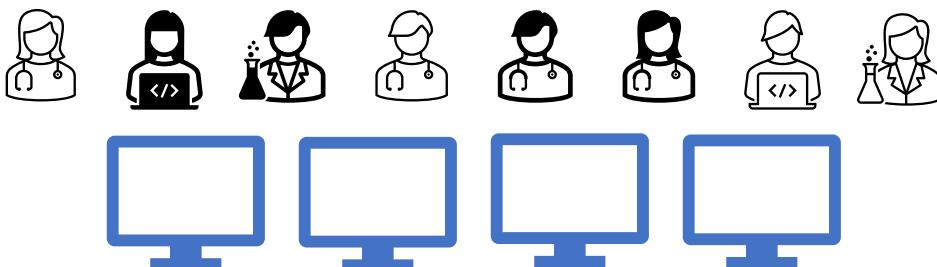
Now vs. a data-centric platform based on openEHR etc.

A fragmented IT-environment complicates collaboration in the clinical process

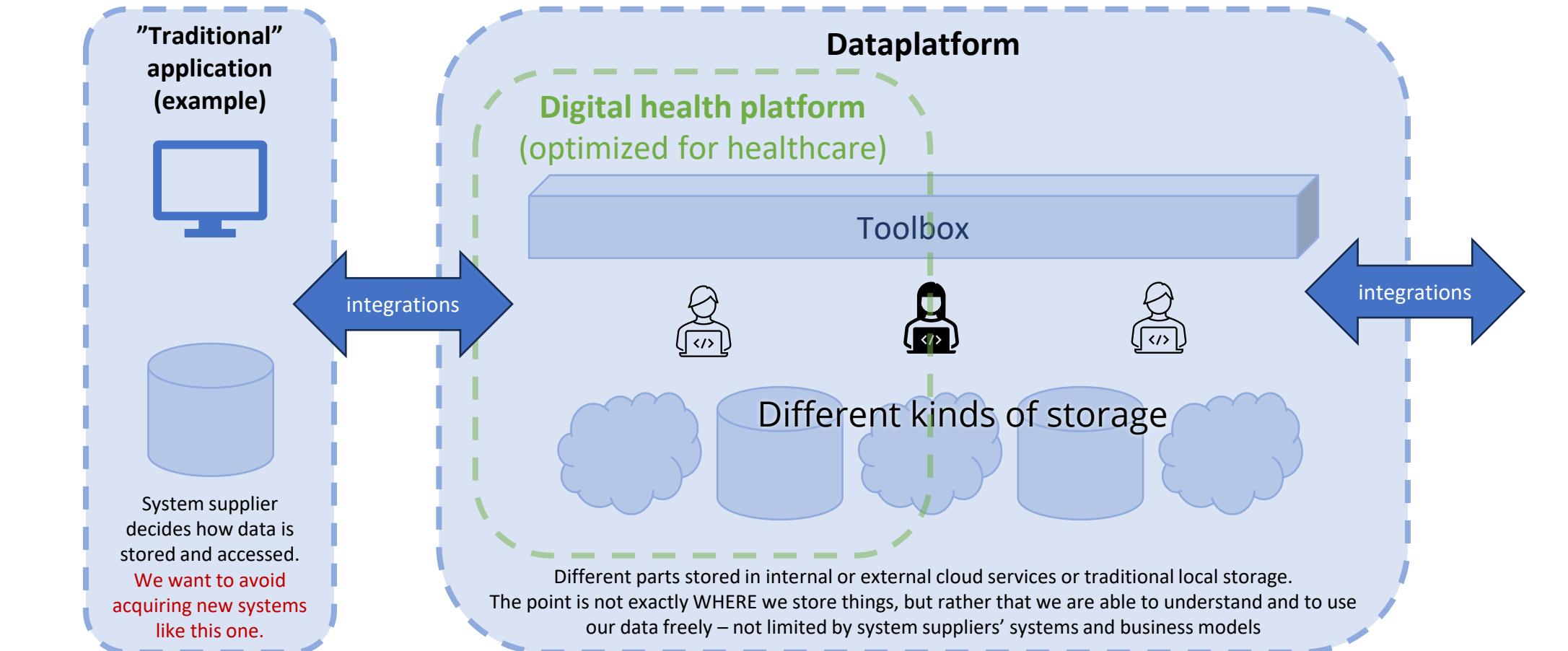
It is difficult to keep up with new and changing requirements

A fragmented IT-environment complicates secondary use of data in quality improvement and research





Various views and applications. Purchased or developed by ourselves.





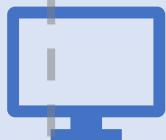
New main EHR

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



Various views and applications. Purchased or developed by ourselves.

"Traditional"
application
(example)



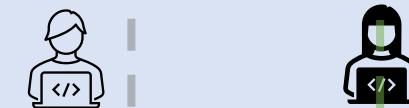
System supplier
decides how data is
stored and accessed.
**We want to avoid
acquiring new systems
like this one.**

integrations

Digital health platform
(optimized for healthcare)

Dataplatform

Toolbox



Different kinds of storage

Data will be copied/converted

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

Specialized
EHRs/EMRs

LIMS

RIS/PACS

Patient
Monitoring

PDMS

**Shutdown
~2030(?)
Current main EHR**

**New main
EHR**
...if legacy monolith

...



Relation to reinterpretation problems

Reinterpretation problems

Reinterpretation problem type	System A	System B
Type I $A \leftrightarrow B$ Can be done with algoritm/program	Birth weight: 3300g Date: 1954-03-13	Body weight: 3,3 kg Timepoint: 13 Mar 1954
Type II $A \rightarrow B$ Semantic loss and distortion due to reinterpretations. Hard, dangerous or impossible with algorithm/program... ...but often done manually by medically skilled staff over and over for each transfer... (Thoroughly tested AI might work? MDR?)	Needs surgery at latest: 2018-01-30 Surgery scheduled: 2018-01-20 15:30 Main diagnose* : 323291000119108 Osteoarthritis of left hip joint Other Diagnosis* : 25343008 Secondary localized osteoarthritis of pelvic region 299308007 Hip joint painful on movement Procedure* : 19954002 Reconstruction of hip with use of methyl methacrylate Surgery type**: Lubinus SP II Preferred anaesthesia* : 18946005 Epidural anaesthesia NEWS2-score at admission: 1 Anaesthesia assessment: - Fitness: can handle light physical exercise - Cardiovascular: OK - Lungs: OK - Throat: OK - Gastrointestinal*: 16331000 Heartburn	Surgery date: 2018-01-20 Diagnosis code: M16.7 Other secondary coxarthrosis Surgery code***: NFB49 Primär total höftledsplastik med cement (Primary total hip arthroplasty with cement) Anaesthesia code***: ZXH50 Epiduralanestesi (epidural anaesthesia) ASA-classification: ASA I = normal healthy patient
B → A Missing information impossible with algorithm/program		*) Codes from Snomed CT **) special kind of hip replacement with cement ***) Codes from the Swedish "KVÅ" terminology
Type III Reinterpretation impossible (even for skilled humans) due to aggregations etc.	Number of cigarettes smoked per week: 6-10 ...specified in a system with the options: 0, 1-5, 6-10, 11-15, 16-30, 31-50, 51-100, 101+	Number of cigarettes per week: ? ...specified in a system with the options: 0, 1-3, 4-7, 8-14, 15-28, 29-69, 70+

Reinterpretation problems

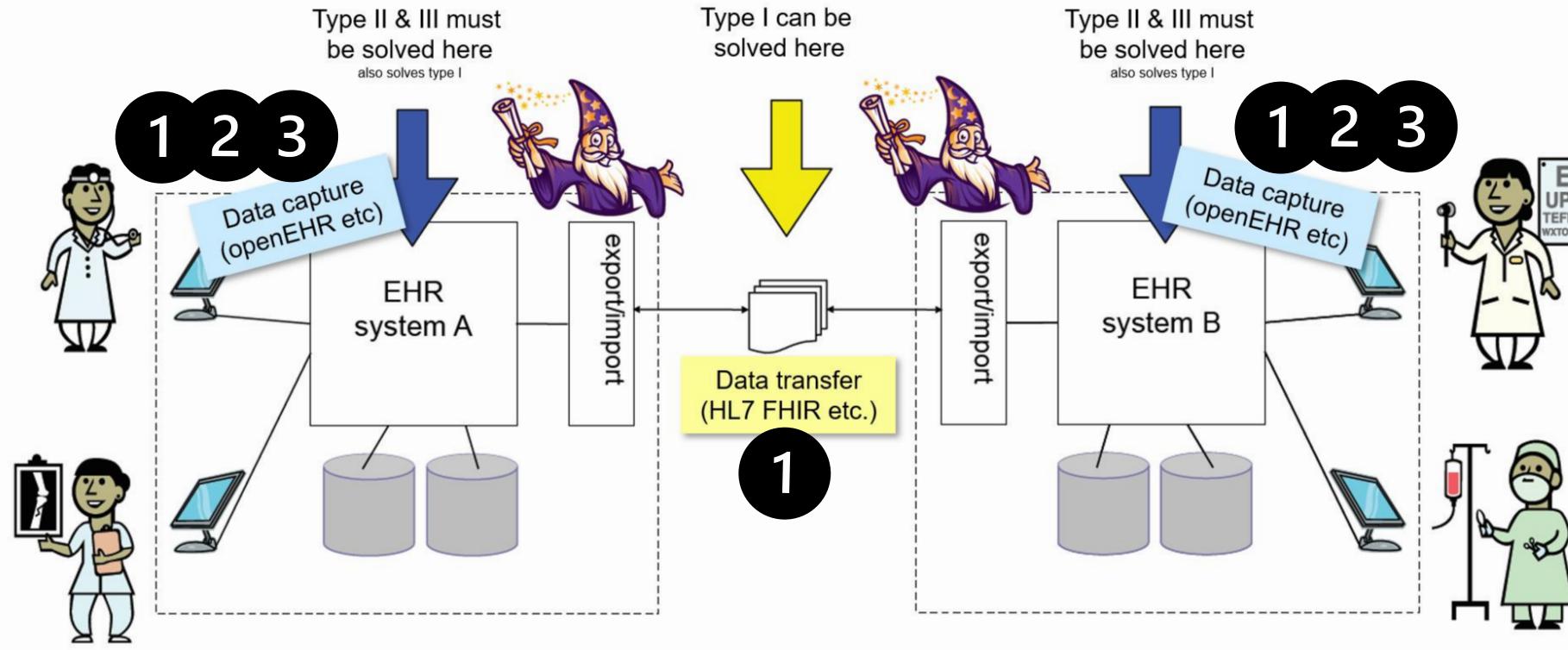
Reinterpretation problem type	System A	System B
Type I $A \leftrightarrow B$ Can be done with algorithm/program	Birth weight: 3300g Date: 1954-03-13	1 Body weight: 3,3 kg Timepoint: 13 Mar 1954
Type II $A \rightarrow B$ Semantic loss and distortion due to reinterpretations. Hard, dangerous or impossible with algorithm/program... ...but often done manually by medically skilled staff over and over for each transfer... (Thoroughly tested AI might work? MDR?) B → A Missing information impossible with algorithm/program	Needs surgery at latest: 2018-01-30 Surgery scheduled: 2018-01-20 15:30 Main diagnose* : 323291000119108 Osteoarthritis of left hip joint Other Diagnosis* : 25343008 Secondary localized osteoarthritis of pelvic region 299308007 Hip joint painful on movement Procedure* : 19954002 Reconstruction of hip with use of methyl methacrylate Surgery type**: Lubinus SP II Preferred anaesthesia* : 18946005 Epidural anaesthesia NEWS2-score at admission: 1 Anaesthesia assessment: - Fitness: can handle light physical exercise - Cardiovascular: OK - Lungs: OK - Throat: OK - Gastrointestinal*: 16331000 Heartburn	2 Surgery date: 2018-01-20 Diagnosis code: M16.7 Other secondary coxarthrosis Surgery code***: NFB49 Primär total höftledsplastik med cement (Primary total hip arthroplasty with cement) Anaesthesia code***: ZXH50 Epiduralanestesi (epidural anaesthesia) ASA-classification: ASA I = normal healthy patient
Type III Reinterpretation impossible (even for skilled humans) due to aggregations etc.	Number of cigarettes smoked per week: 6-10 ...specified in a system with the options: 0, 1-5, 6-10, 11-15, 16-30, 31-50, 51-100, 101+	3 Number of cigarettes per week: ? ...specified in a system with the options: 0, 1-3, 4-7, 8-14, 15-28, 29-69, 70+

Reinterpretation problem type	System A	System B
Type I A <- -> B Can be done with algorithm/program	Birth weight: 3300g Date: 1954-03-13 1	Body weight: 3,3 kg Timepoint: 13 Mar 1954 1
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B -> A Missing information impossible with algorithm/program	Number of cigarettes smoked per week: 6-10 ...specified in a system with the options: 0, 1-5, 6-10, 11-15, 16-30, 31-50, 51-100, 101+ 3	Number of cigarettes per week: ? ...specified in a system with the options: 0, 1-3, 4-7, 8-14, 15-28, 29-69, 70+ 3
Type III Reinterpretation impossible (even for skilled humans) due to aggregations etc.		

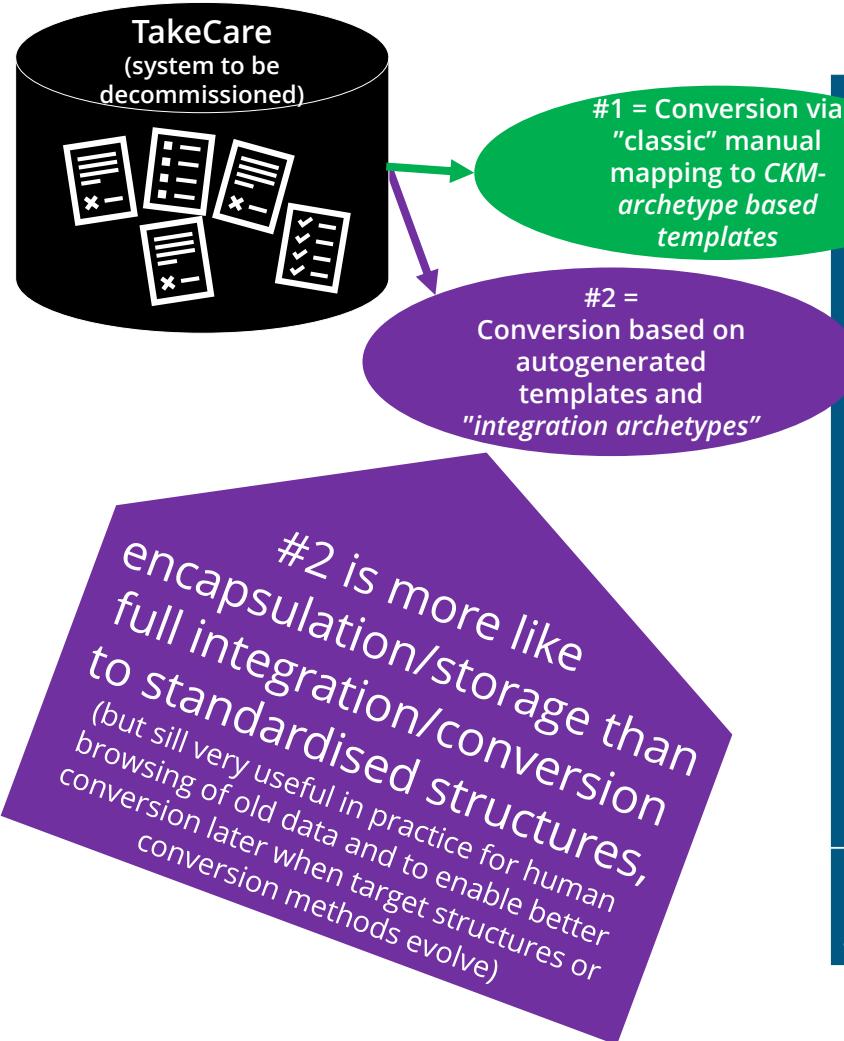
More detailed in "**Introduction to openEHR, part 1: What & Why**".
Silje & Erik @ Vitalis/MIE2023
https://youtu.be/KgXVsIsr_Ts?feature=shared&t=774



Agree on what, where?



Method choice depends on HOW different source and target are, and how varying, and available staff resources



Reinterpretation problem type	System A	System B
Type I A <--> B done with algorithm/program	Birth weight: 3300g Date: 1954-03-13 1	Body weight: 3,3 kg Timepoint: 13 Mar 1954 2
Type II A --> B Semantic loss and distortion due to reinterpretations. Hard, dangerous or impossible with algorithm/program... ...but often done manually by medically skilled staff over and over for each transfer... (Thoroughly tested AI might work? MDR?)	Needs surgery at latest: 2018-01-30 Surgery scheduled: 2018-01-20 15:30 Main diagnose*: 323291000119108 Osteoarthritis of left hip joint Other Diagnosis*: 25343008 Secondary localized osteoarthritis of pelvic region 299308007 Hip joint painful on movement Procedure*: 19954002 Reconstruction of hip with use of methyl methacrylate Surgery type**: Lubinus SP II Preferred anaesthesia*: 18946005 Epidural anaesthesia NEWS2-score at admission: 1 Anaesthesia assessment: <ul style="list-style-type: none"> - Fitness: can handle light physical exercise - Cardiovascular: OK - Lungs: OK - Throat: OK - Gastrointestinal*: 16331000 Heartburn 	Surgery date: 2018-01-20 Diagnosis code: M16.7 Other secondary coxarthrosis Surgery code***: NFB49 Primär total höftledsplastik med cement (Primary total hip arthroplasty with cement) Anaesthesia code***: ZXH50 Epiduralanestesi (epidural anaesthesia) ASA-classification: ASA I = normal healthy patient *) Codes from Snomed CT **) special kind of hip replacement with cement ***) Codes from the Swedish "KVÅ" terminology
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