From semantics to services – the *open*EHR experience

OMG SOA in HEALTHCARE CONFERENCE 13-15 JULY 2011

Thomas Beale, Washington, 13 July 2011

What are we trying to do today?

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Ultimate ICT goals

- To **Compute** with health information
  - Cross-enterprise
  - Patient-centric
  - Over time & technology changes

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Ultimate ICT goals

- In particular:
  - X-enterprise patient care pathway tracking
  - Decision support for doctors
  - Business process analysis for provider orgs
  - Business intelligence for payers & public health
  - Medical research 'study' analysis
  - Person-centred data analysis, ethically targetted marketing etc
  - Integrate health data with social & educational media streams in patient-centred portals

Ultimate ICT goals

- While dealing with relentless change in
  - Medicine, esp. drugs, interactions, procedures…
  - Information
  - Care processes
  - Patient needs
  - Legislation

Getting there requires...

- A ~change-immune **semantic architecture**, allowing
  - **meaning** of information and healthcare process steps etc to be safely and reliably defined
  - **convertability** of information from proprietary / legacy sources to common formats

Getting there requires...

- A systems and **services** **architecture** defining groupings and access protocols enabling:
  - **Aggregation** of information from source systems
  - Varying **levels of conformance**, esp. for existing systems
  - **Incremental deployment**
  - Satisfying **changing business** needs

Assumptions

- A services architecture with no semantic underpinning can deliver:
  - Human – human information transmission
  - Very basic search facilities
  - Limited computability, where information is already widely standardised, e.g. HL7v2 lab, ADT
  - Some security / privacy support
- But not generalised patient-centric computability – can't access the main economic potential

The clock is ticking...

- Today we are still creating peta-bytes of non-interoperable, non-computable health data
- Post-hoc 're-engineering' of the data to make it computable is too expensive to be realistic
- We know this because medical research projects regularly burn their entire budget on data re-engineering

The semantic part

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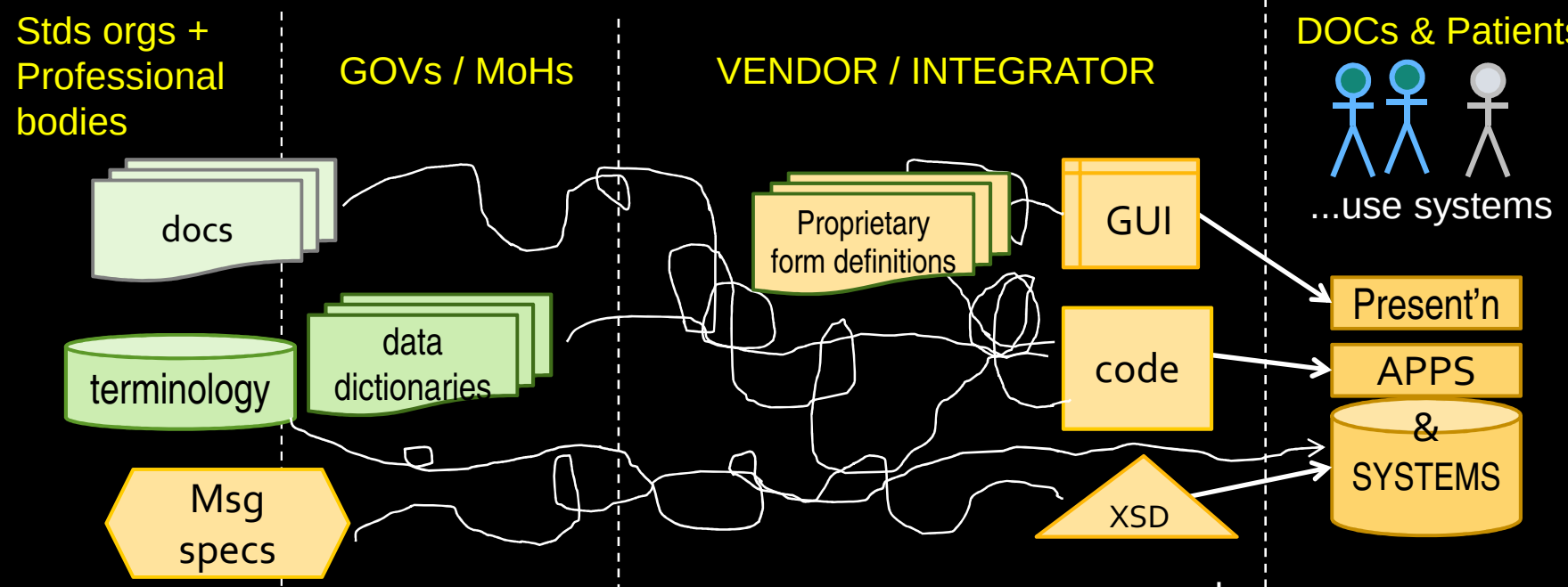
Historical Industry Structure



Write docs, create message specs

... Write data specs, minimum data sets, schemas for DS, referral etc

...consume documents and msg specs

developers ... make up what they don't understand

PROVIDERS Buy (poor) Solutions

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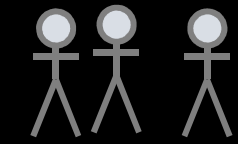
Historical Industry Structure

Stds orgs + Professional bodies

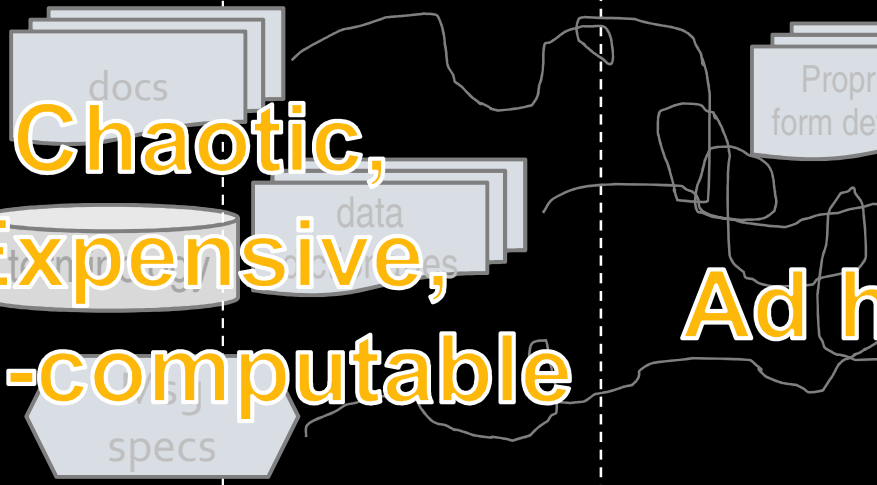
GOVs / MoHs

VENDOR / INTEGRATOR

DOCs & Patients



...use systems



Chaotic, Expensive, non-computable

Lock-in

Ad hoc

Poor interop-erability

...manual

Expensive, low reuse

Write docs, create message specs

... Write data specs, minimum data sets, schemas for DS, referral etc

...consume documents and msg specs

... make up what they don't understand

PROVIDERS Buy (poor) Solutions

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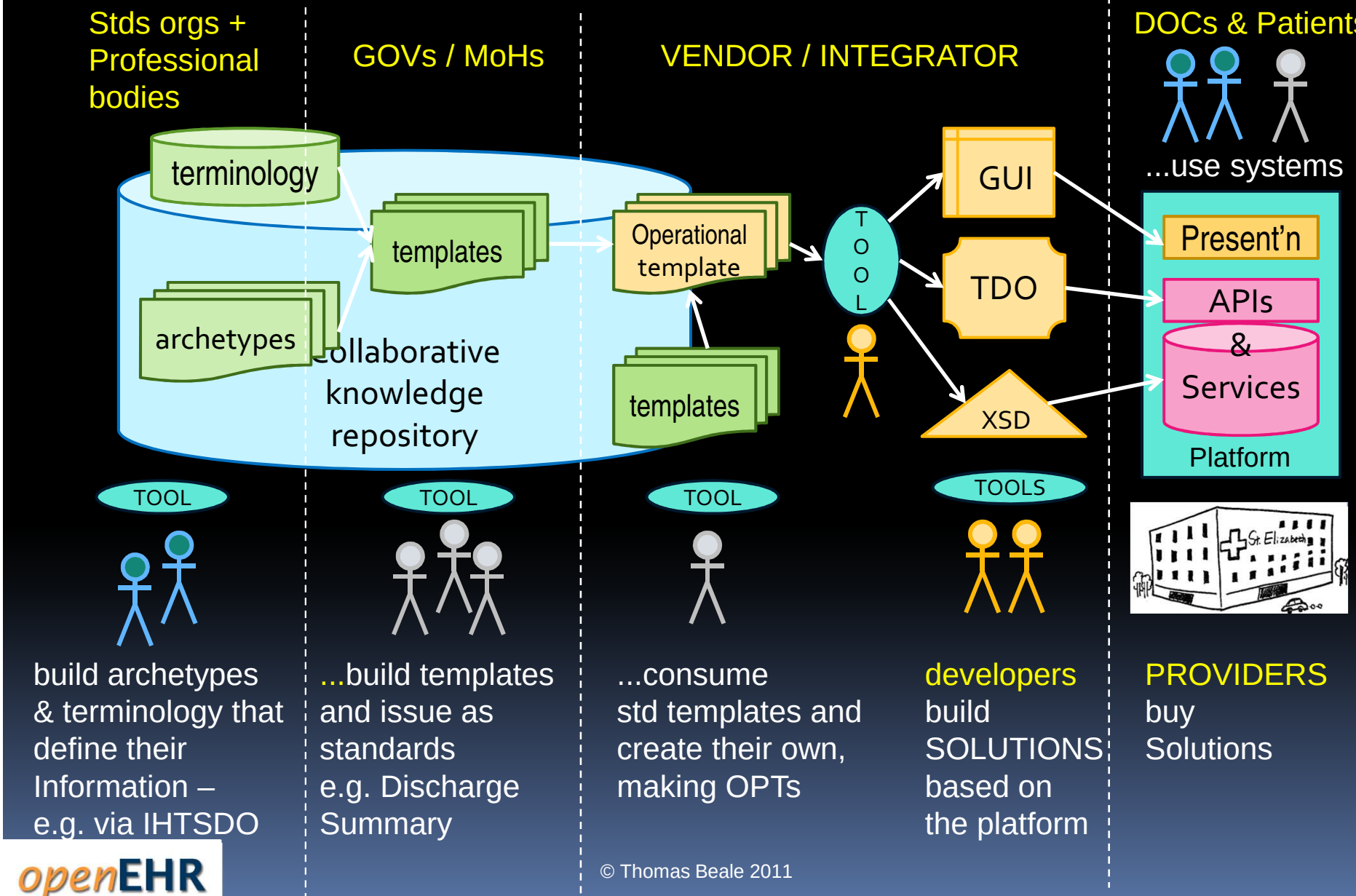
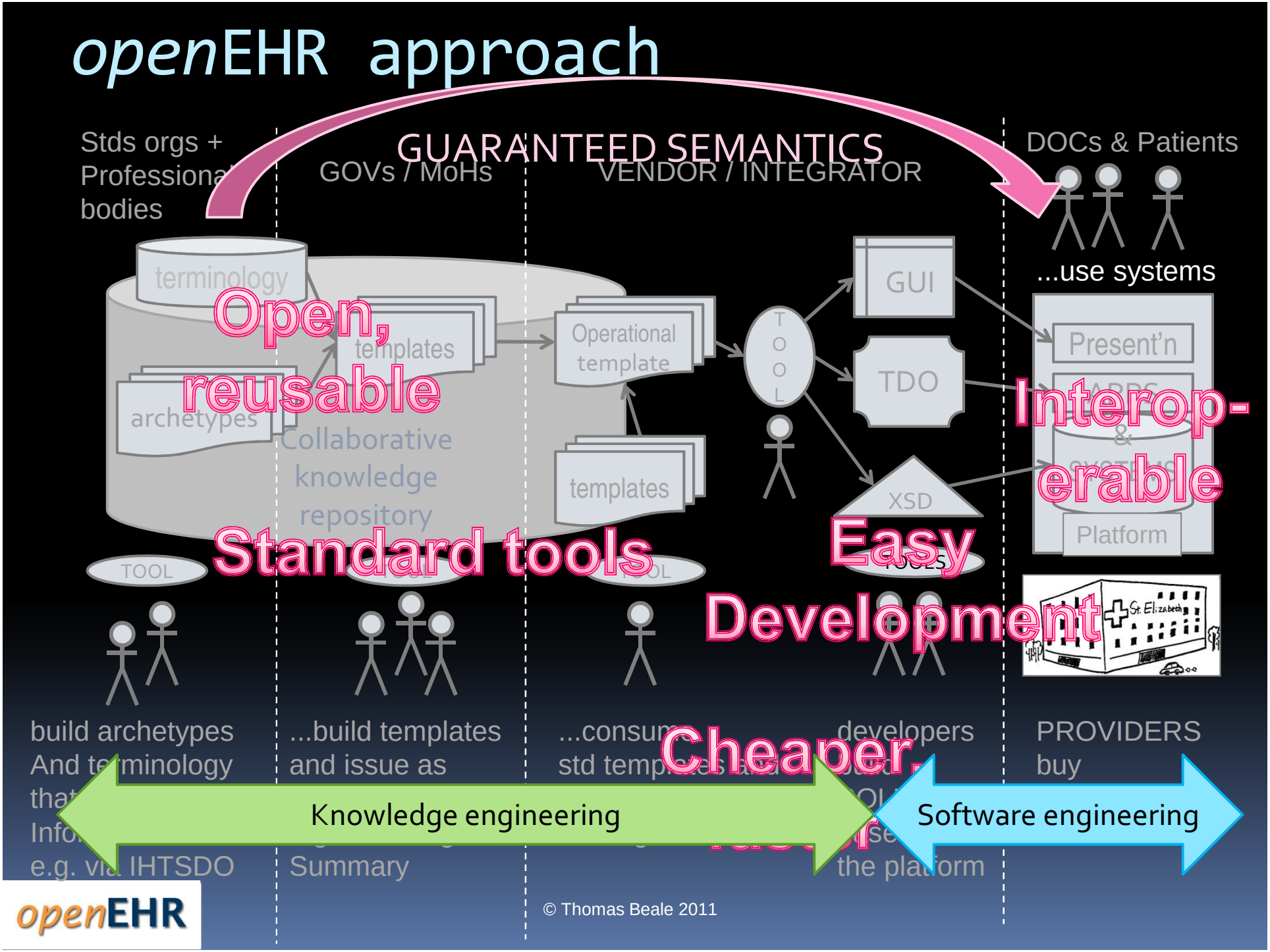
*open*EHR approach



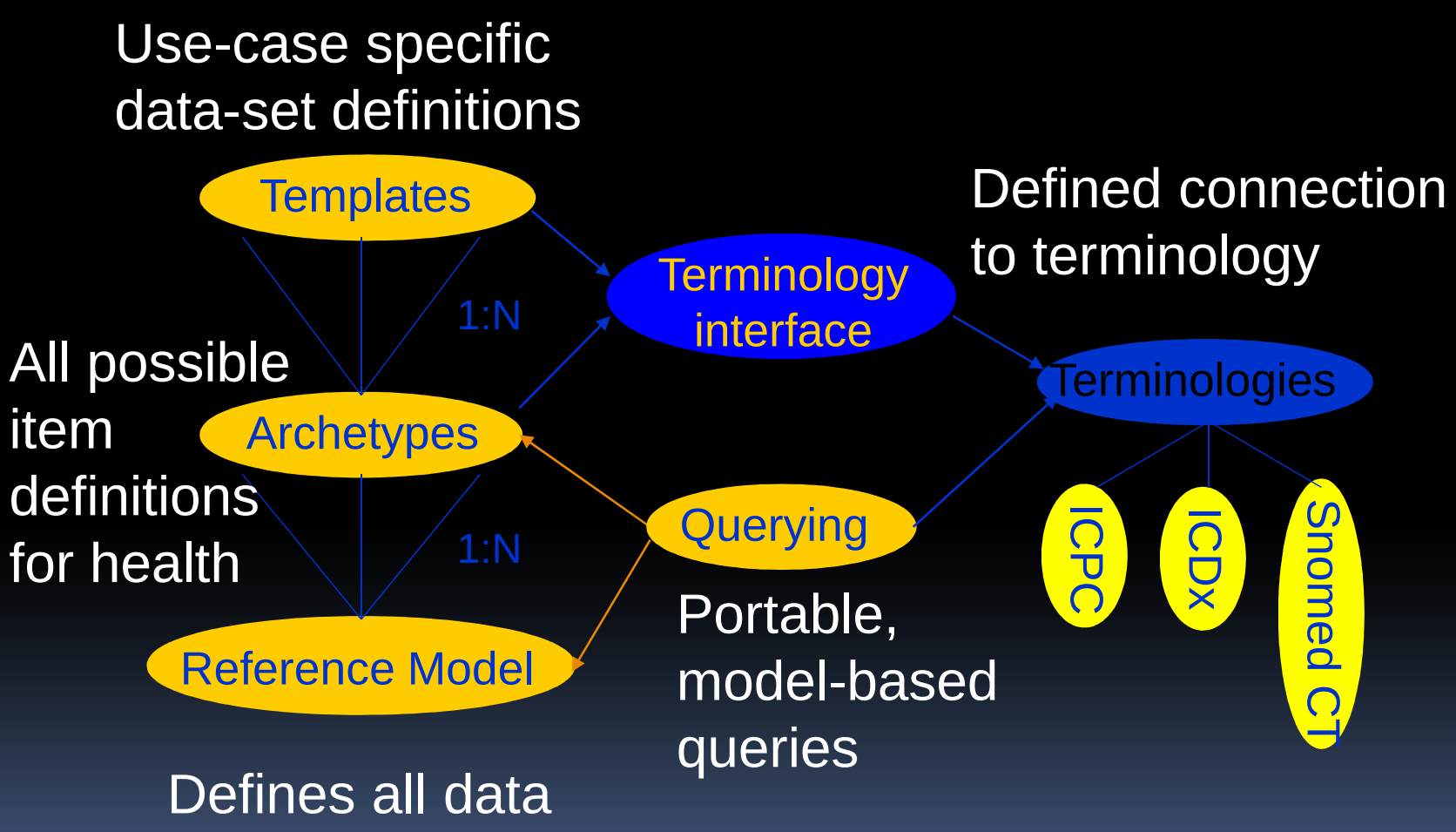
*open*EHR approach



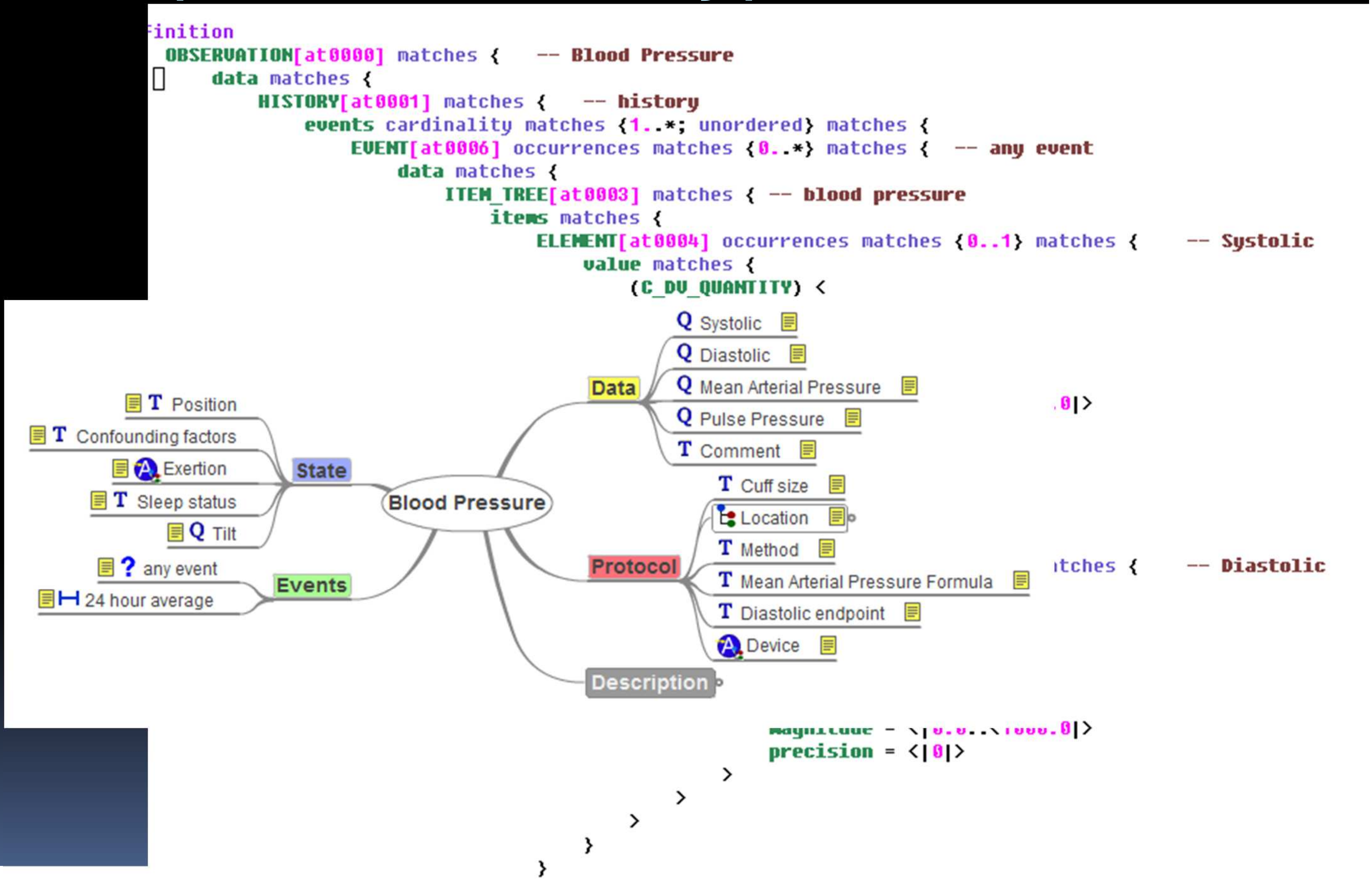
The basic plan

- A general theoretical paradigm or **framework**
- An **architecture** specific to the domain, including
  - Actual specifications for formalisms, models etc
- Actual **models**

The *open*EHR framework



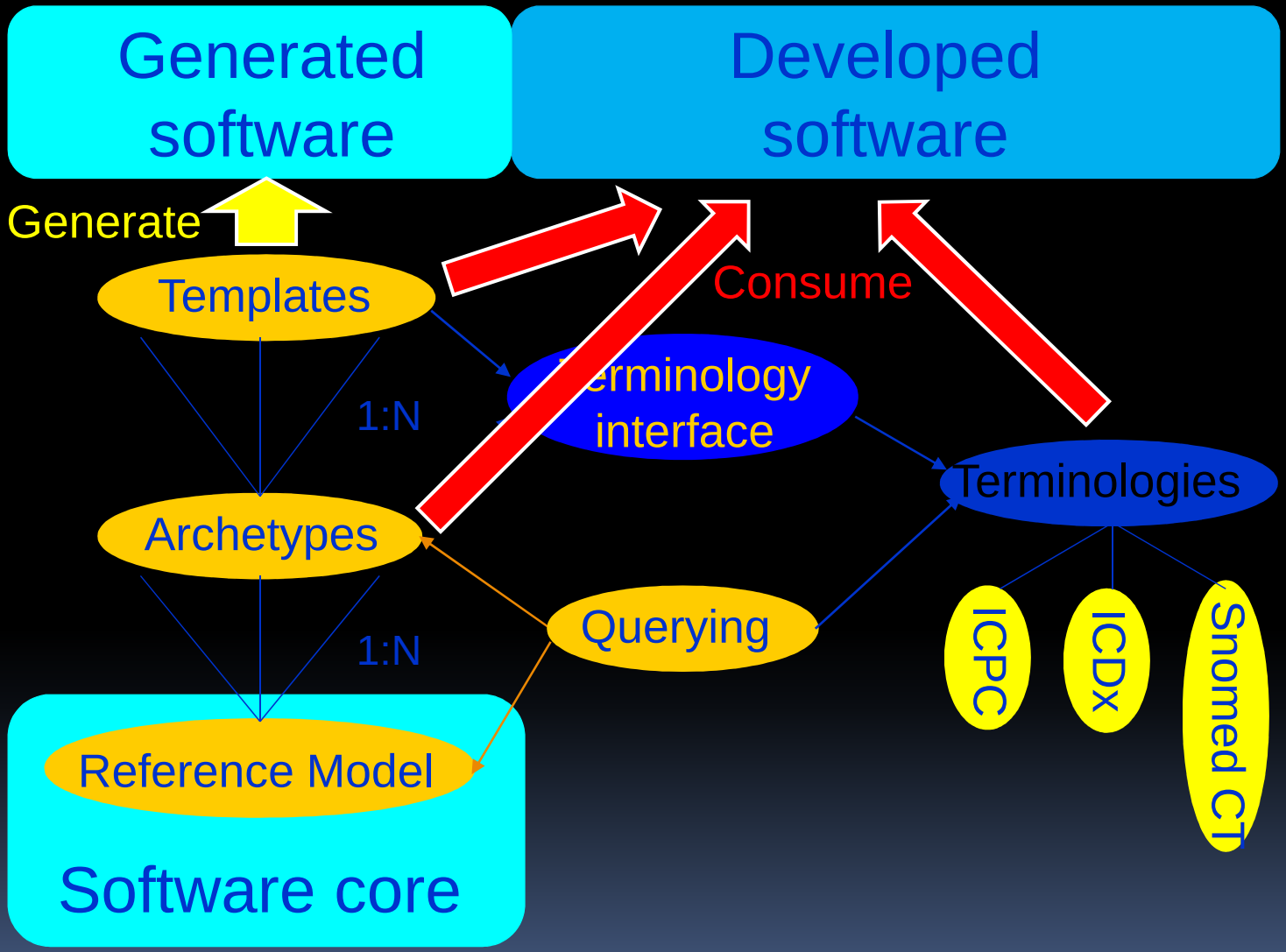
openEHR Archetype



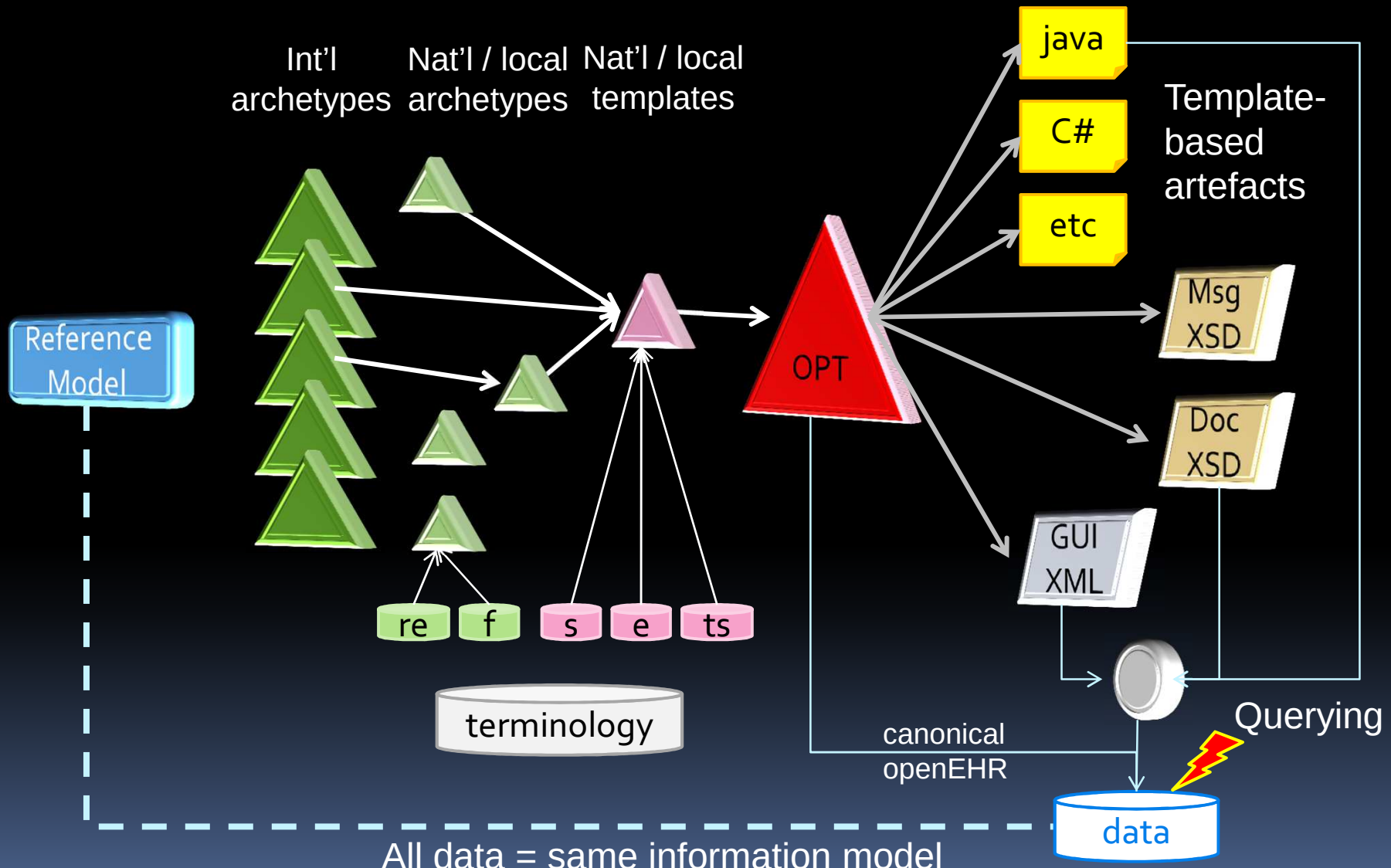
AQL query

- SELECT com2/context/start_time/value as START_DATE,
  obs1/data[at0001]/events[at0006]/data[at0003]/items[at0004]/value/magnitude as SYSTOLIC,
  obs1/data[at0001]/events[at0006]/data[at0003]/items[at0005]/value/magnitude as DIASTOLIC,
  obs3/data[at0002]/events[at0003]/data[at0001]/items[at0004]/value/magnitude as PULSE_RATE,
  obs4/data[at0001]/events[at0002]/data[at0003]/items[at0004]/value/magnitude as RESPIRATORY_RATE....
- FROM EHR e[ehr_id/value='f271cd26-23fc-43a1-b411-34cdadaea067'] CONTAINS COMPOSITION com2 [openEHR-EHR-COMPOSITION.encounter.v1]
- CONTAINS (OBSERVATION obs3 [openEHR-EHR-OBSERVATION.heart_rate-pulse-zn.v1] OR OBSERVATION obs1 [openEHR-EHR-OBSERVATION.blood_pressure-zn.v1] OR OBSERVATION obs4 [openEHR-EHR-OBSERVATION.respiration.v1] ....
- WHERE com2/name/value matches {'Vital functions', 'Respiratory assessment', 'Assessment scales'} AND obs9/name/value = 'PEF before' AND obs10/name/value = 'PEF after' AND com2/context/start_time >= '20110406T000000.000+0200' AND com2/context/start_time < '30000101T000000.000+0100'

Properties - software



The architecture



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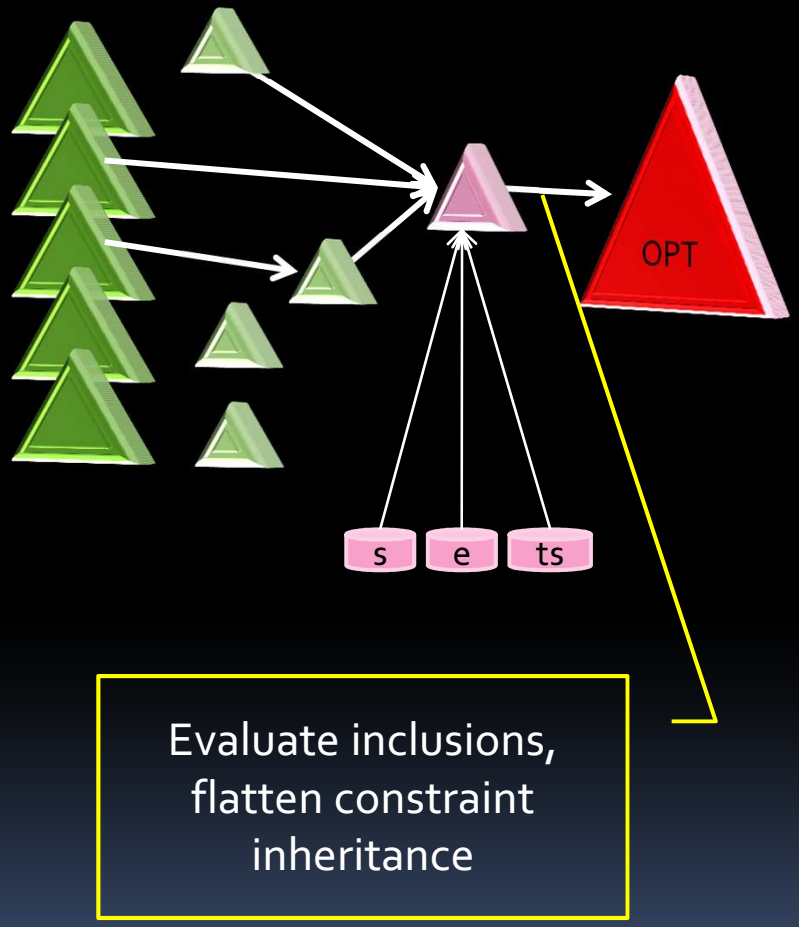
The key...



- Is the operational template (OPT) – this is the joining point between the semantic specifications and deployable software artefacts that can be used by normal developers

Key Outcomes

- Normal developers can engage – *open*EHR + Snomed become economic and ~quick
- Semantic connection exists between definitions and implementations
  - → now we know what the meaning of data are, and DS and BI can work…

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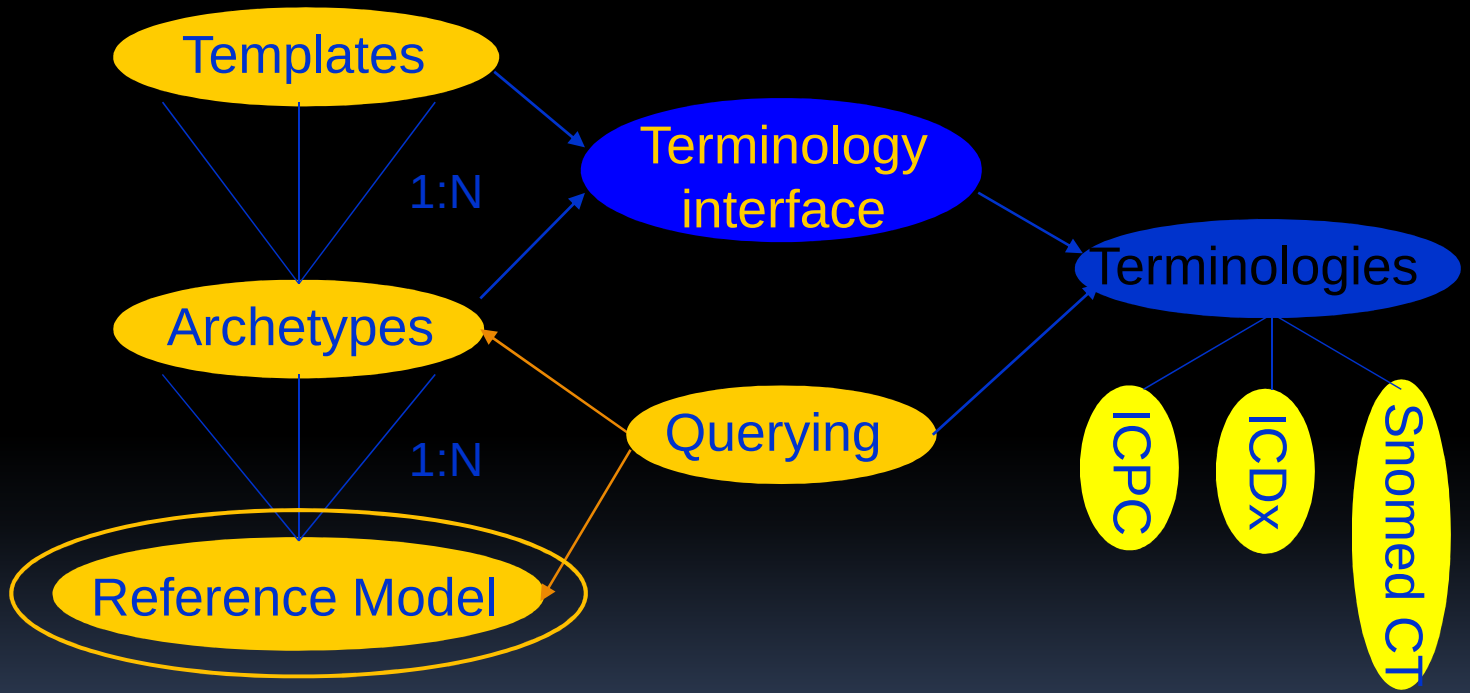
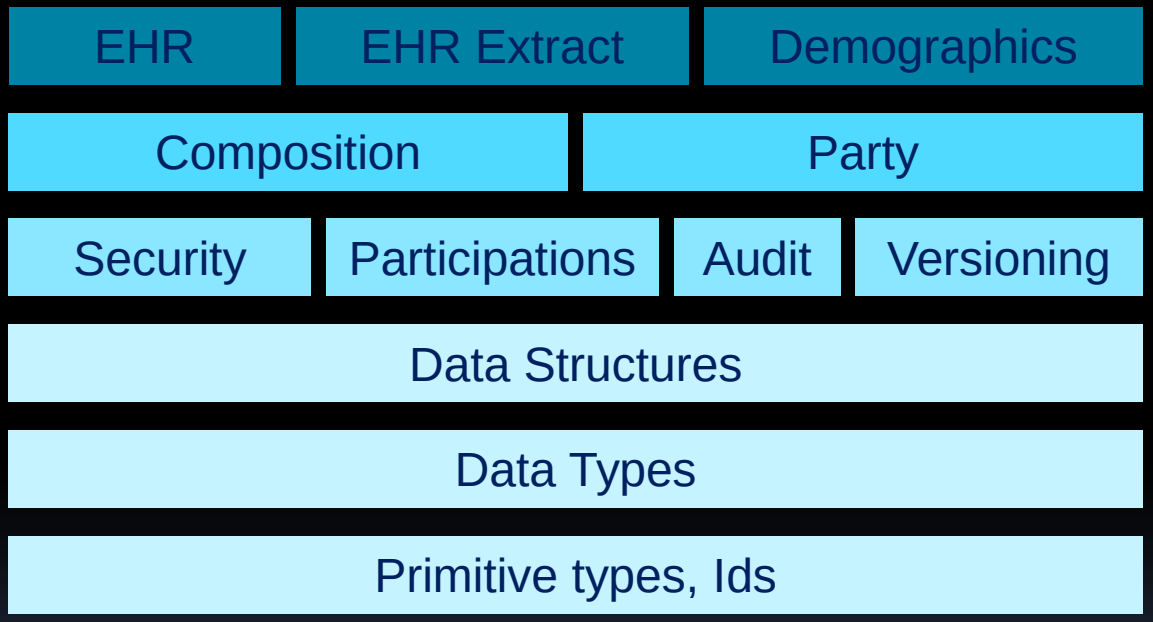
The *open*EHR framework



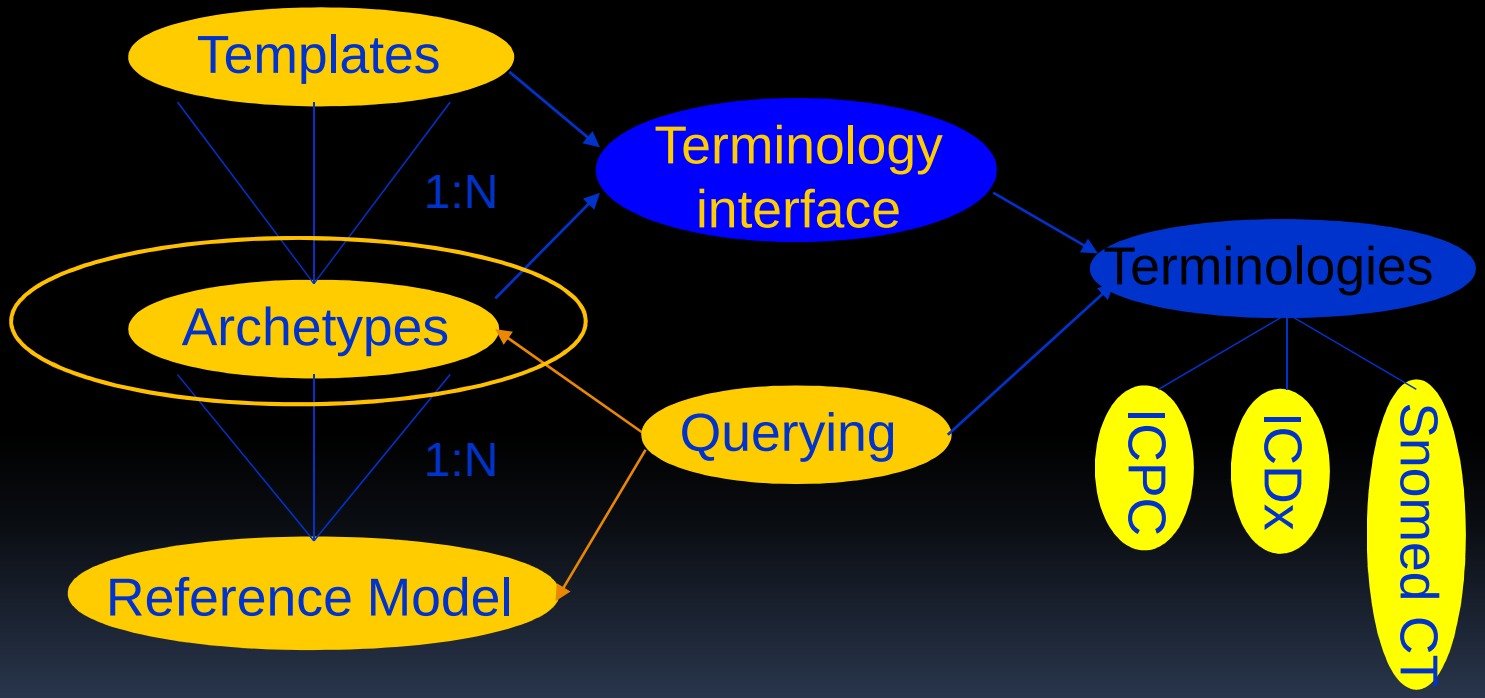
The reference model

Will continue to grow, to accommodate process, workflow etc

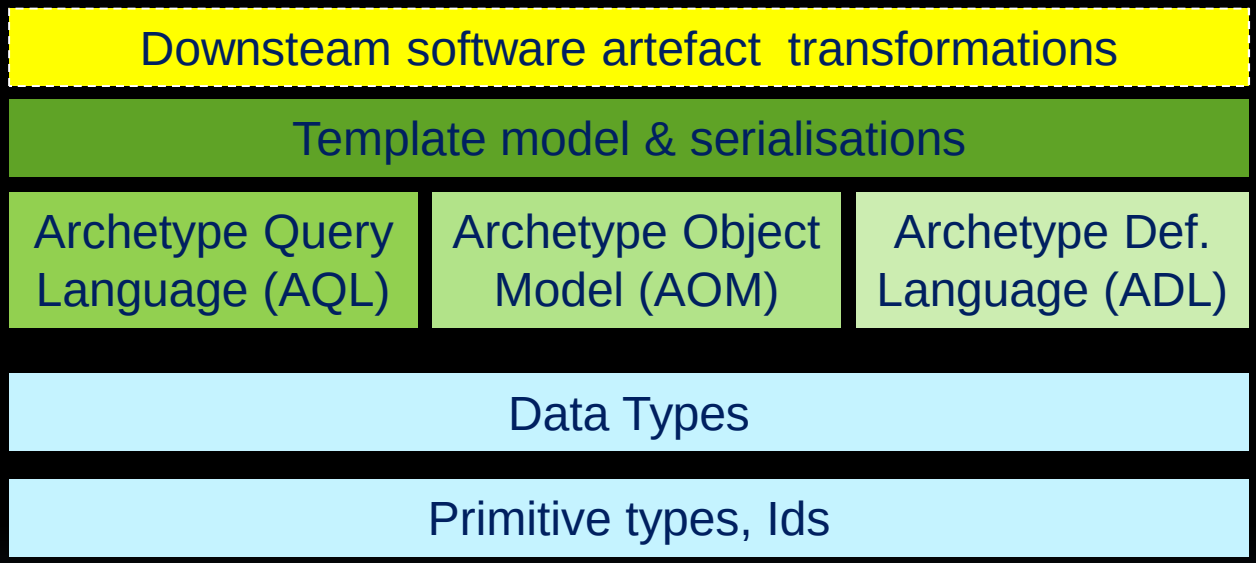


http://www.openehr.org/releases/1.0.2/roadmap.html

The *open*EHR framework



The archetype architecture



http://www.openehr.org/releases/1.0.2/roadmap.html

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Managing knowledge artefacts

- Content models & terminology ref sets managed outside of software process & people
- Needs:
  - Governance
  - Methodology
  - Identification
  - Sharing and release rules
  - etc

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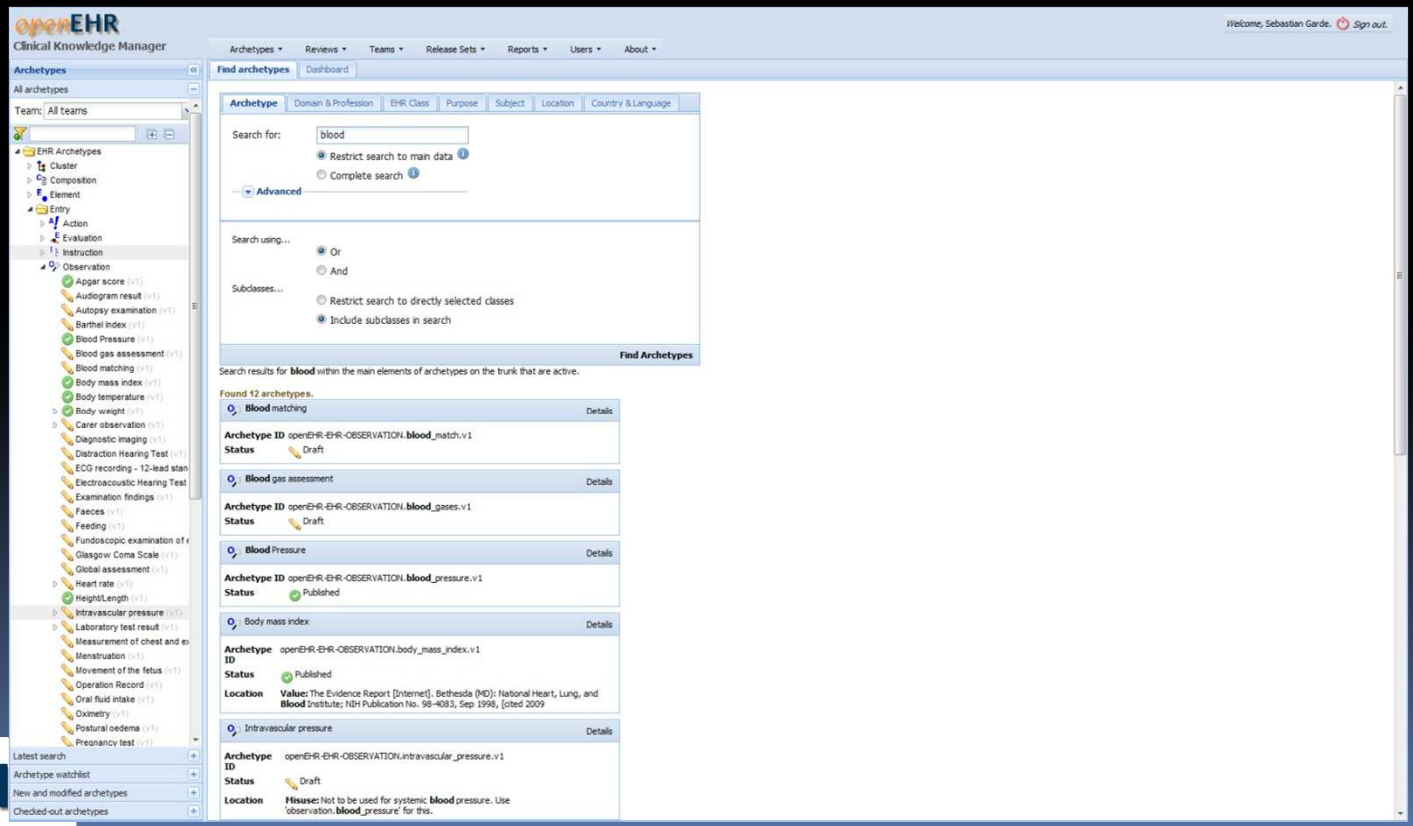
Clinical Knowledge Manager

- A tool for involving clinicians in defining clinical content based on archetypes, templates, and termsets



CKM Core Principles

Separation of technical and clinical aspects to successfully involve clinicians in

- Informal Discussions
- Formal Reviewing (content, terminology binding, translations)
- Sharing
- Publishing
- Revision/Version Management
- Release and Dependency Management

CKM Approach

- Web 2.0 design
  - Easier to engage clinicians: Can now use 5 mins or 1 hour of an expensive specialised clinician's time; before, they lost hours on physical meetings
- Implementation is growing as we learn
  - Can respond quickly to changing needs, evolving methodology
- More than a tool
  - Engage and manage the community

CKM Users

- International *open*EHR CKM instance
  - > 630 users
  - From 64 countries
- National programs with an instance of CKM
  - Australia: Nehta
  - Sweden: SKL

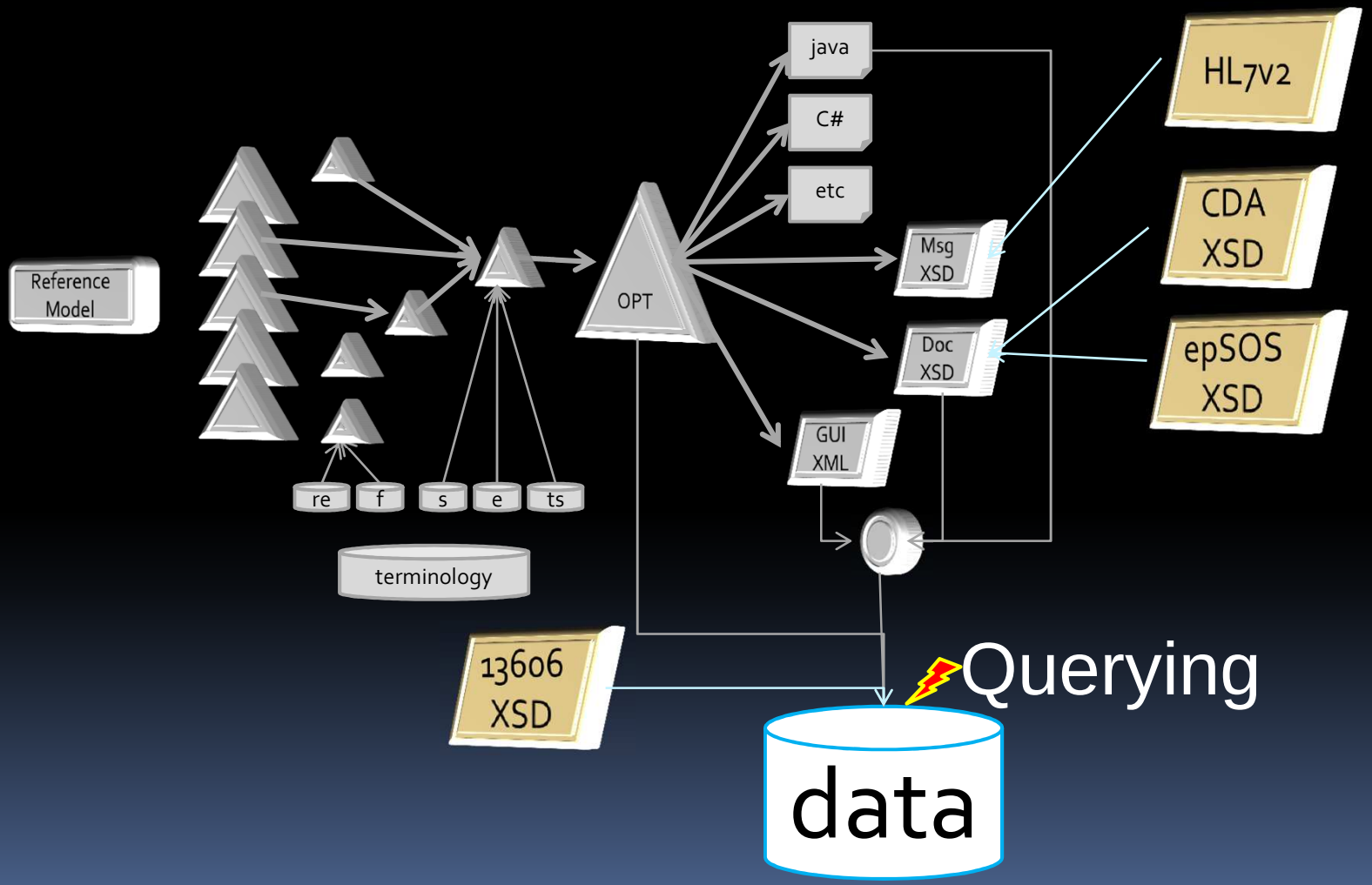
Key Messages

- Knowledge Management is crucial
  - High-quality archetypes with high-quality clinical content
  - Semantically interchangeable between clinical systems; also the basis for decision support
  - Key to success: how to engage with clinicians and capture their knowledge
- CKM - http://www.openehr.org/knowledge

Key Outcomes

- We can now start to situate existing standards in the framework
  - Concrete content-specific standards like HL7 message definitions, CDAs, CCRs etc are DOWNSTREAM generations and/or mappings of operational templates
  - Meaning we can connect them into a semantic framework and potentially guarantee their semantics
  - Rather than manually building them in a standalone fashion

Tool-based standards



The Services Part

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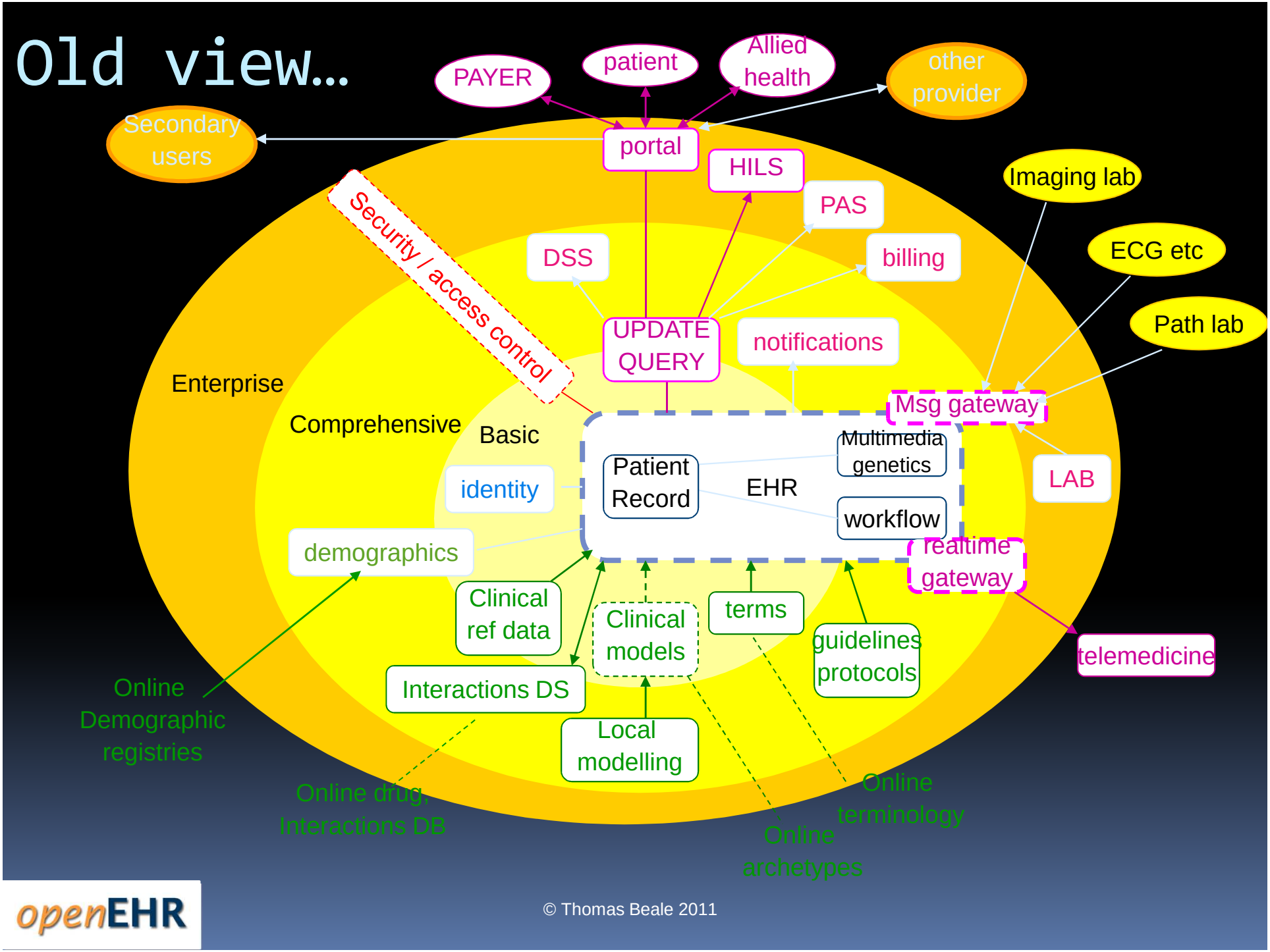
Old view…



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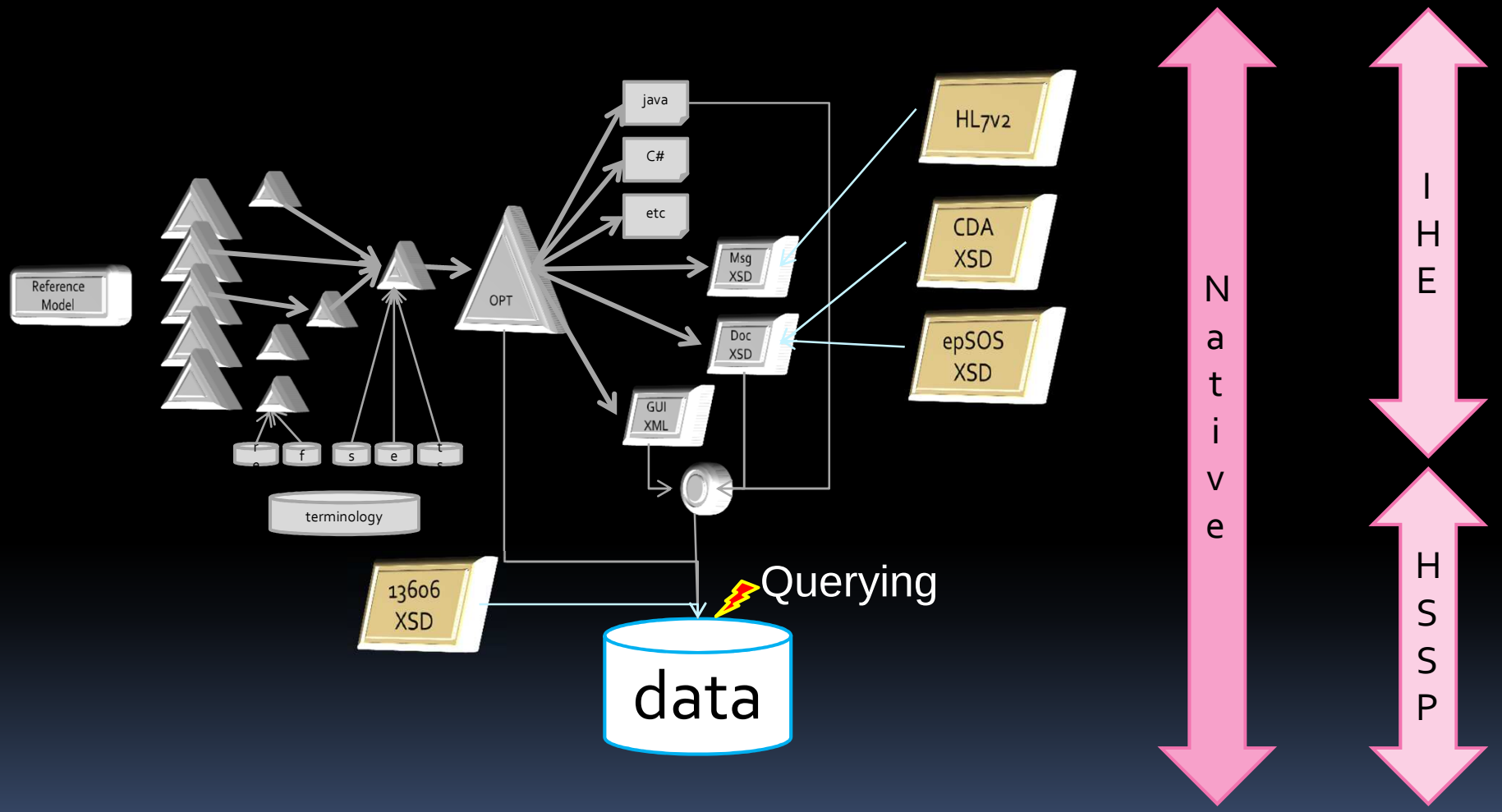
General approach

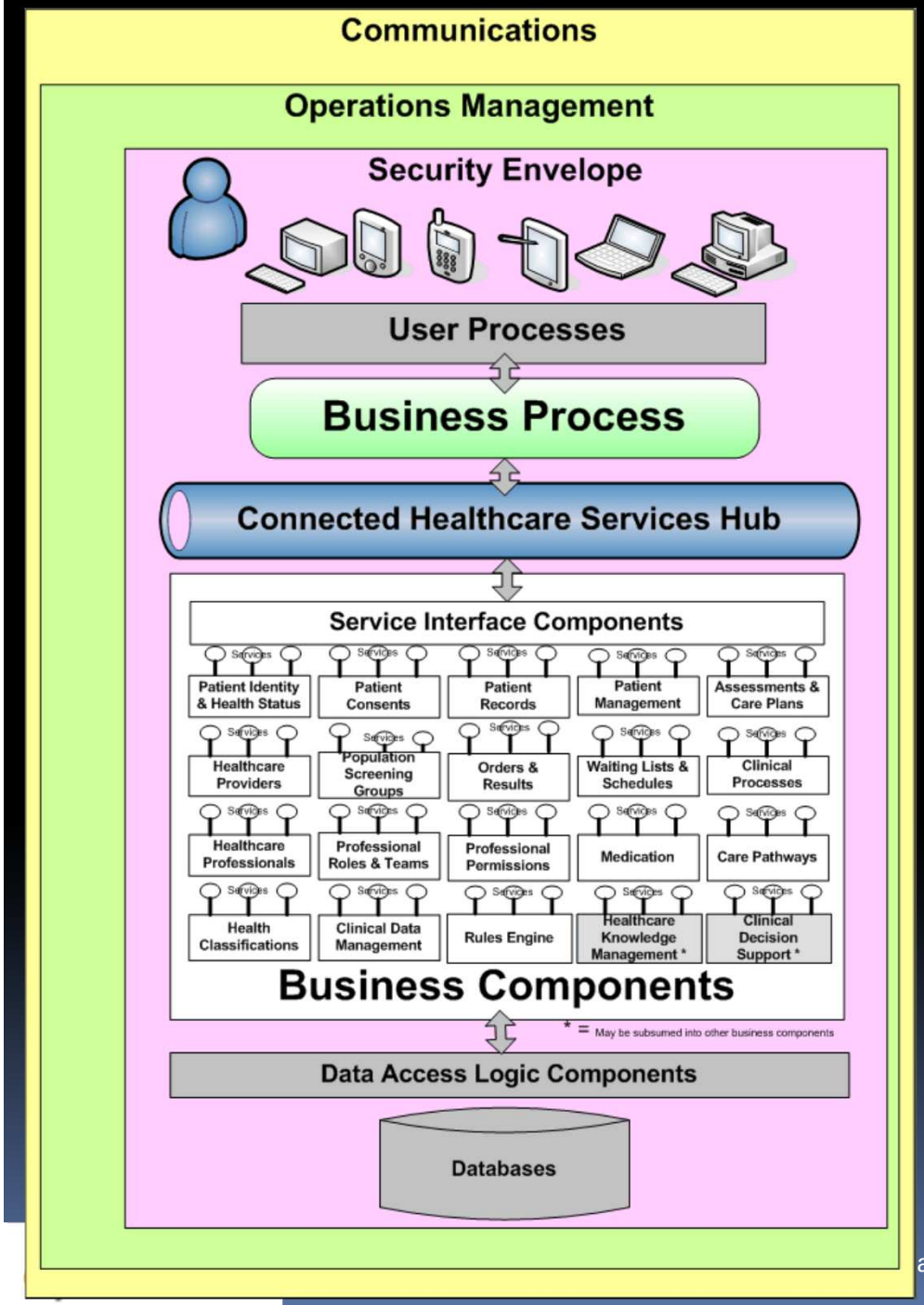
- Build from bottom up – 'Native' services
  - Needed services, consistent with information and model artefacts
- And from top-down – 'Standard' services
  - Connect IHE, HSSP etc to native services

Services



On Services...

- Some architectural inspiration from Microsoft Connected Health Framework (CHF)
- Native layer
  - Take as much of IHE, HSSP etc interfaces & adapt for native compatibility, making **archetype-aware**
- Standards layer
  - Service – service connection

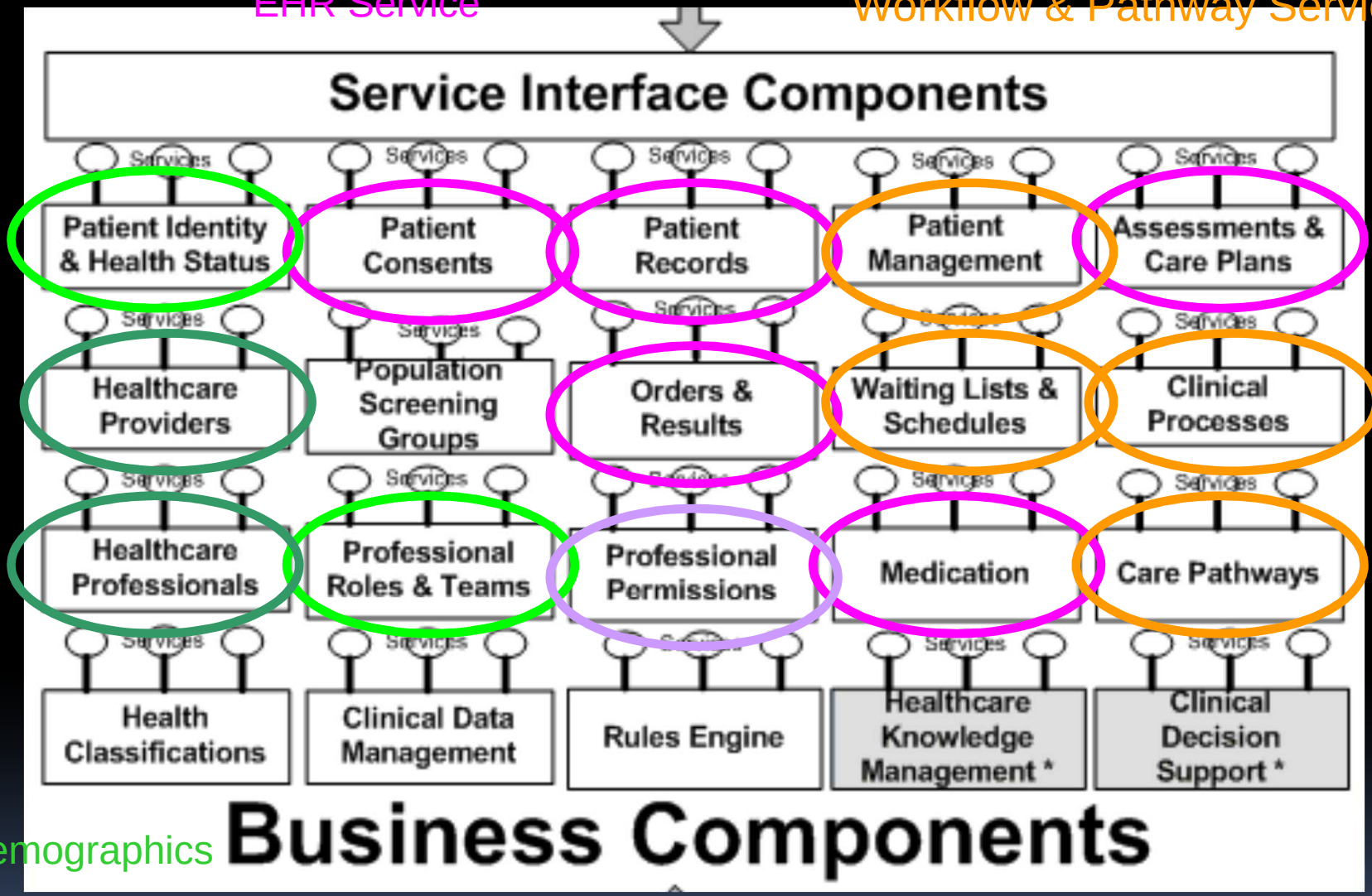


Microsoft CHF

- ProcessModels
- Service Models
- Information Models

EHR Service

Workflow & Pathway Services



demographics

Security & privacy

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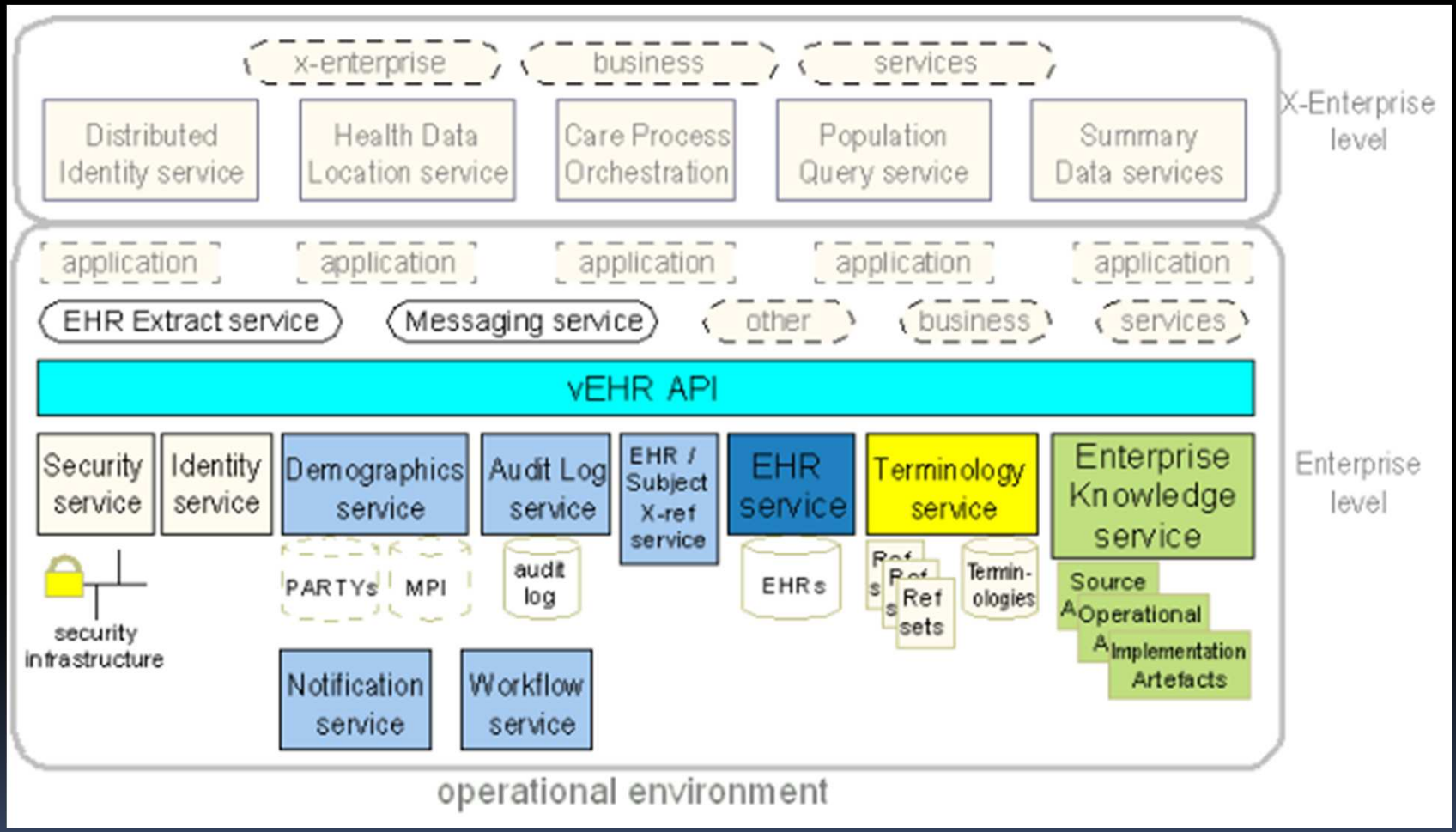
The openEHR services architecture



http://www.openehr.org/wiki/display/spec/openEHR+Service+Model

Native services

- All services archetype/template aware
- Query service based on AQL / a-path
  - No SQL queries against physical database!!!

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Key data services - EHR

- ARCHETYPE-AWARE
- Virtual EHR – fine-grained creation, modification, retrieval, querying
- EHR back-end – coarse-grained DVCS-like interface – 'change-set' based
- EHR audit log

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Key data services - patient

- Demographics – ARCHETYPE-AWARE
  - Authentication info
  - Patient relationships
  - HCP relationships – teams etc
- EHR subject X-ref service
  - openEHR EHRs are identified by EHR id only
  - Deals with merged & split EHRs, i.e. 2 subject ids → 1 EHR, 2 EHR ids → 1 subject
  - Enables dynamic distribution of EHRs
  - Becoming the EHR meta-data service

Key knowledge services

- Archetypes & templates
- Terminology ref-sets
- Terminology service
  - access
  - Inferencing
  - Terminology administration
- Medications, devices
- Allergies & interactions database

Key process services

- Event-based notifications
- Care pathway
  - Based on archetyped *open*EHR structures
- Booking / appointments
  - Requires access to patient requests & doctor's diary & other resource availability data
- Doctor's diary
  - Forces syncing of appointments to filler
- Patient diary
  - Allows multi-function visits

Key elements that MUST WORK

- Standardised **querying** of data, based on knowledge artefacts, not physical DB
  - → standardised knowledge artefact identification, including versions
  - → standardised ability to designate finest grain items in the data
- Enabling URI to any data item

Key elements that MUST WORK

- Everything in openEHR relies on **archetype paths**, which are X-path compatible
- The two tests are being able to:
  - Write portable queries
  - Create URIs to finest grain of data

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AQL query

- SELECT com2/context/start_time/value as START_DATE,
  obs1/data[at0001]/events[at0006]/data[at0003]/items[at0004]/value/magnitude as SYSTOLIC,
  obs1/data[at0001]/events[at0006]/data[at0003]/items[at0005]/value/magnitude as DIASTOLIC,
  obs3/data[at0002]/events[at0003]/data[at0001]/items[at0004]/value/magnitude as PULSE_RATE,
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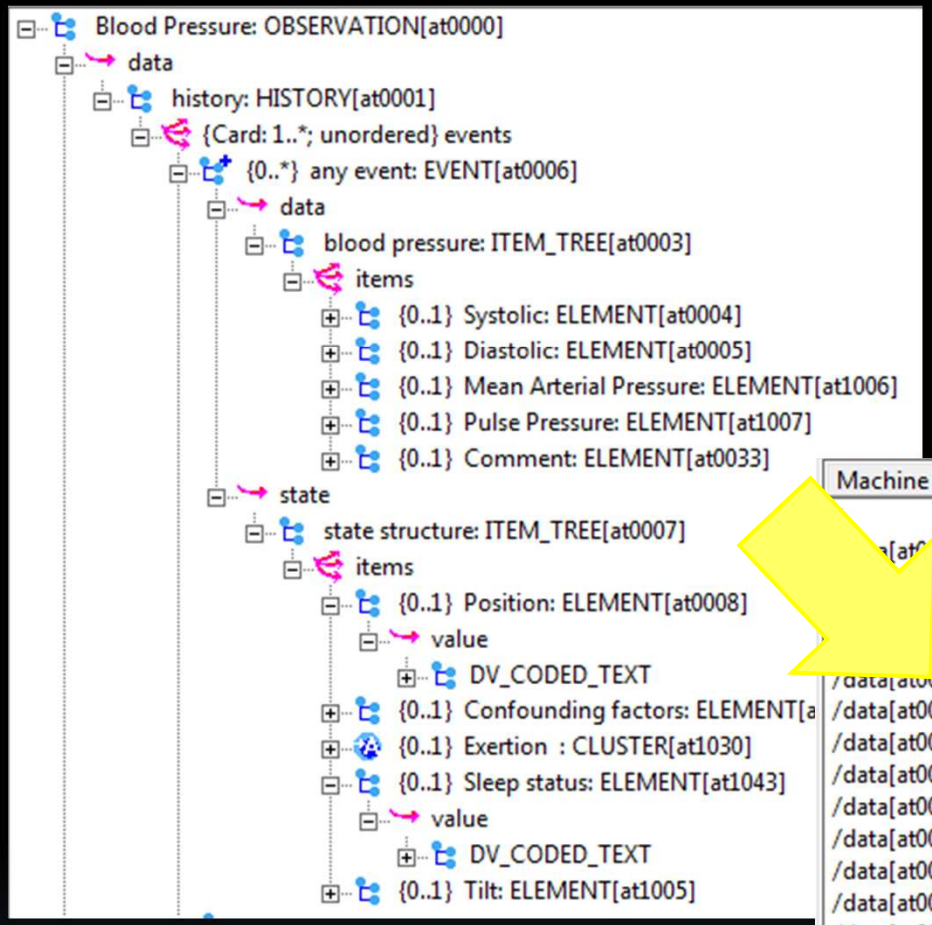
openEHR URI

- ehr:1234567/87284370-2D4B-4e3d-A3F3-F303D2F4F34B@latest_trunk_version/content[openEHR-EHR-SECTION.vital_signs.v1]/items[openEHR-EHR-OBSERVATION.heart_rate-pulse.v1]/data/events[at0006, 'any event']/data/items[at0004]

Where paths come from



Machine	RM Type
	OBSERVATION
[at0001]	HISTORY
001]/events[at0006]	EVENT
001]/events[at0006]/data[at0003]	ITEM_TREE
001]/events[at0006]/data[at0003]/items[at0004]	ELEMENT
/data[at0001]/events[at0006]/data[at0003]/items[at0004]/value	DV_QUANTITY
/data[at0001]/events[at0006]/data[at0003]/items[at0005]	ELEMENT
/data[at0001]/events[at0006]/data[at0003]/items[at0005]/value	DV_QUANTITY
/data[at0001]/events[at0006]/data[at0003]/items[at0033]	ELEMENT
/data[at0001]/events[at0006]/data[at0003]/items[at0033]/value	DV_TEXT
/data[at0001]/events[at0006]/data[at0003]/items[at1006]	ELEMENT
/data[at0001]/events[at0006]/data[at0003]/items[at1006]/value	DV_QUANTITY
/data[at0001]/events[at0006]/data[at0003]/items[at1007]	ELEMENT
/data[at0001]/events[at0006]/data[at0003]/items[at1007]/value	DV_QUANTITY
/data[at0001]/events[at0006]/state[at0007]	ITEM_TREE
/data[at0001]/events[at0006]/state[at0007]/items[at0008]	ELEMENT
/data[at0001]/events[at0006]/state[at0007]/items[at0008]/value	DV_CODED_TEXT
/data[at0001]/events[at0006]/state[at0007]/items[at0008]/value/defining_code	CODE_PHRASE
/data[at0001]/events[at0006]/state[at0007]/items[at1005]	ELEMENT
/data[at0001]/events[at0006]/state[at0007]/items[at1005]/value	DV_QUANTITY
/data[at0001]/events[at0006]/state[at0007]/items[at1030]	CLUSTER
/data[at0001]/events[at0006]/state[at0007]/items[at1043]	ELEMENT
/data[at0001]/events[at0006]/state[at0007]/items[at1043]/value	DV_CODED_TEXT
/data[at0001]/events[at0006]/state[at0007]/items[at1043]/value/defining_code	CODE_PHRASE
/data[at0001]/events[at0006]/state[at0007]/items[at1052]	ELEMENT
/data[at0001]/events[at0006]/state[at0007]/items[at1052]/value	DV_TEXT
/data[at0001]/events[at1042]	INTERVAL_EVENT

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Conclusions

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Basic premise

- If we want to share and compute with health data at any level of detail, we need a knowledge-based architecture

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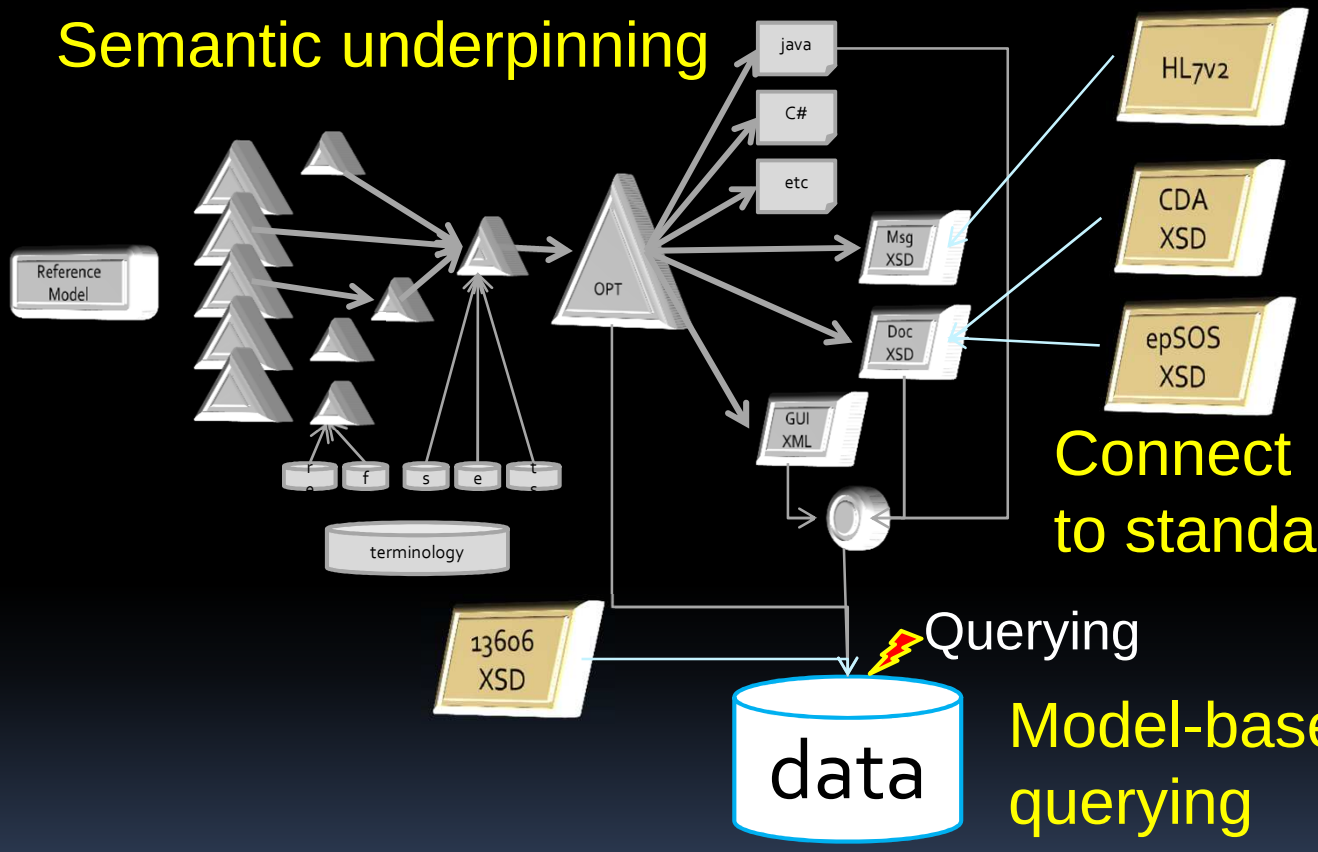
Architecture

Knowledge-enabled services

Semantic underpinning



Connect to standards

Querying

Model-based querying

Native

IHE

HSSP

Services lessons

- Need native and standard layers, i.e.
  - Inside-out, outside-in
- Knowledge-based architecture brings new needs:
  - New knowledge services – archetypes, ref-sets
  - Other services must be knowledge-aware
- Business services need to be small, with changeable interfaces

Knowledge awareness means...

- Service layer understands:
  - knowledge artefact identification system
  - Fine-grained data item identification
- Which means we need standardised knowledge models
- Aka DCMs

The ultimate test

- If you can create a URI to 'my instantaneous resting, lying down systolic BP, recorded 7/jan/2011' then you can communicate at any level of detail about health information