openEHR.org

What it is and Why it matters

v0.9

Thomas Beale

CTO Ocean Informatics,

Researcher, CHIME, UCL

The Speaker

- Engineering background
- In Health Informatics since GEHR (1994)
- Active in CEN since 2001
- Active in HL7 since 2000
- Co-founder of *open*EHR

* * * Programme * * *

- What is *open*EHR?
- The community and getting involved
- *open*EHR deliverables, products, systems
- *open*EHR in use
- Technical basis
- Archetypes, templates and 2-level modelling
- EHR communication
- *open*EHR, CEN, HL7

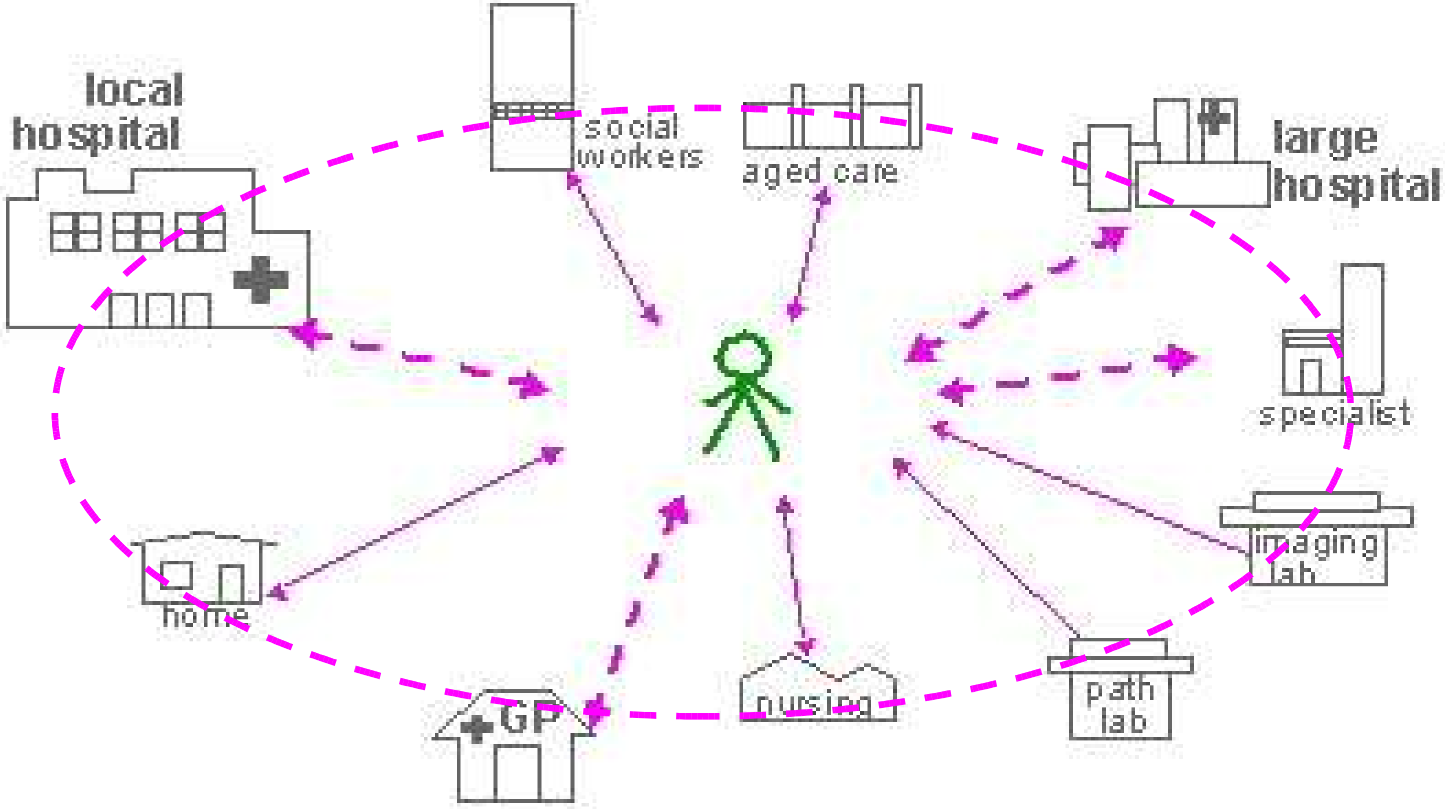
The *open*EHR Foundation

- *open*EHR: a non-profit organisation founded by UCL & Ocean Informatics (legally in the UK)
- Mission: to improve clinical health care via 1) better EHR architectures 2) interoperability between systems and applications 3) clinician empowerment
- Funding: currently subsidised by University College London and Ocean Informatics; future: donations + business model based on conformance testing and archetype development
- Jurisdiction: no official jurisdiction; aims to be appropriate for all types of health care, all localities, all languages

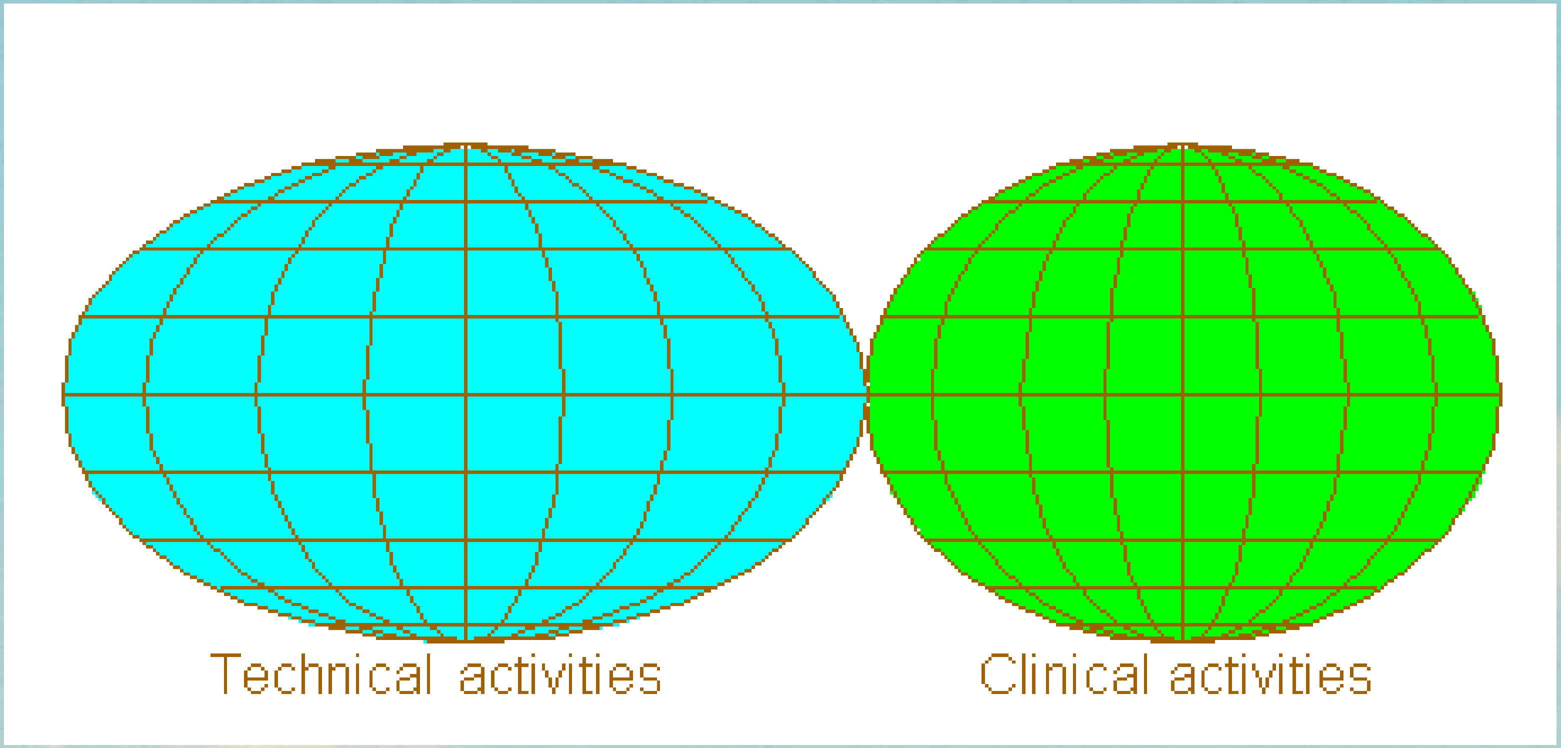
The *open*EHR Foundation - aims

- Requirements: research, develop and publish EHR requirements
- Architecture: research, develop and publish open, modular architecture for EHR
- Implementation: via the community, create open source implementations to validate approach, providing library of interoperable components
- Clinical knowledge: to promote and develop clinical modelling approach, tools and models which empower users

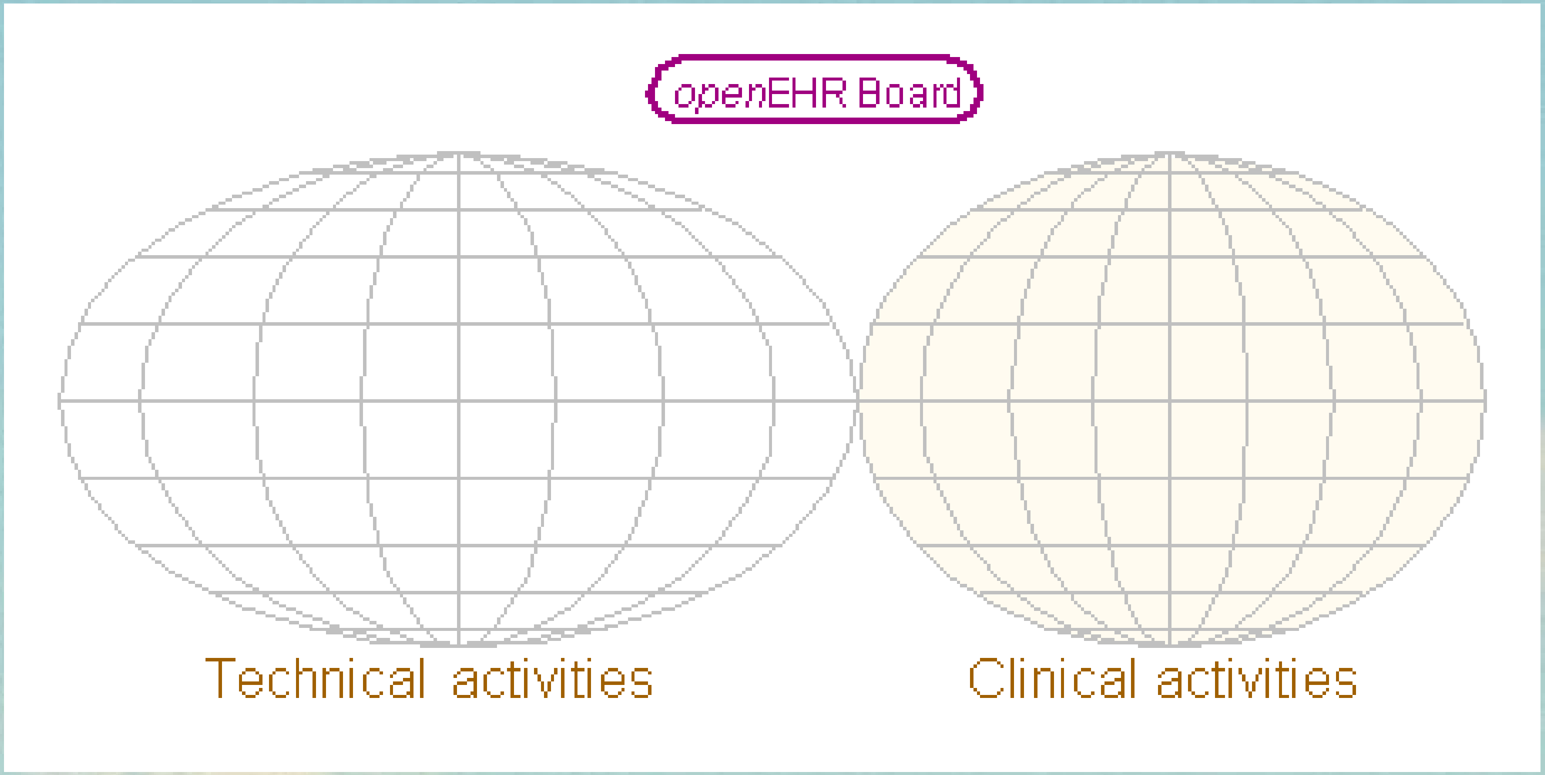
Patient-centred shared care



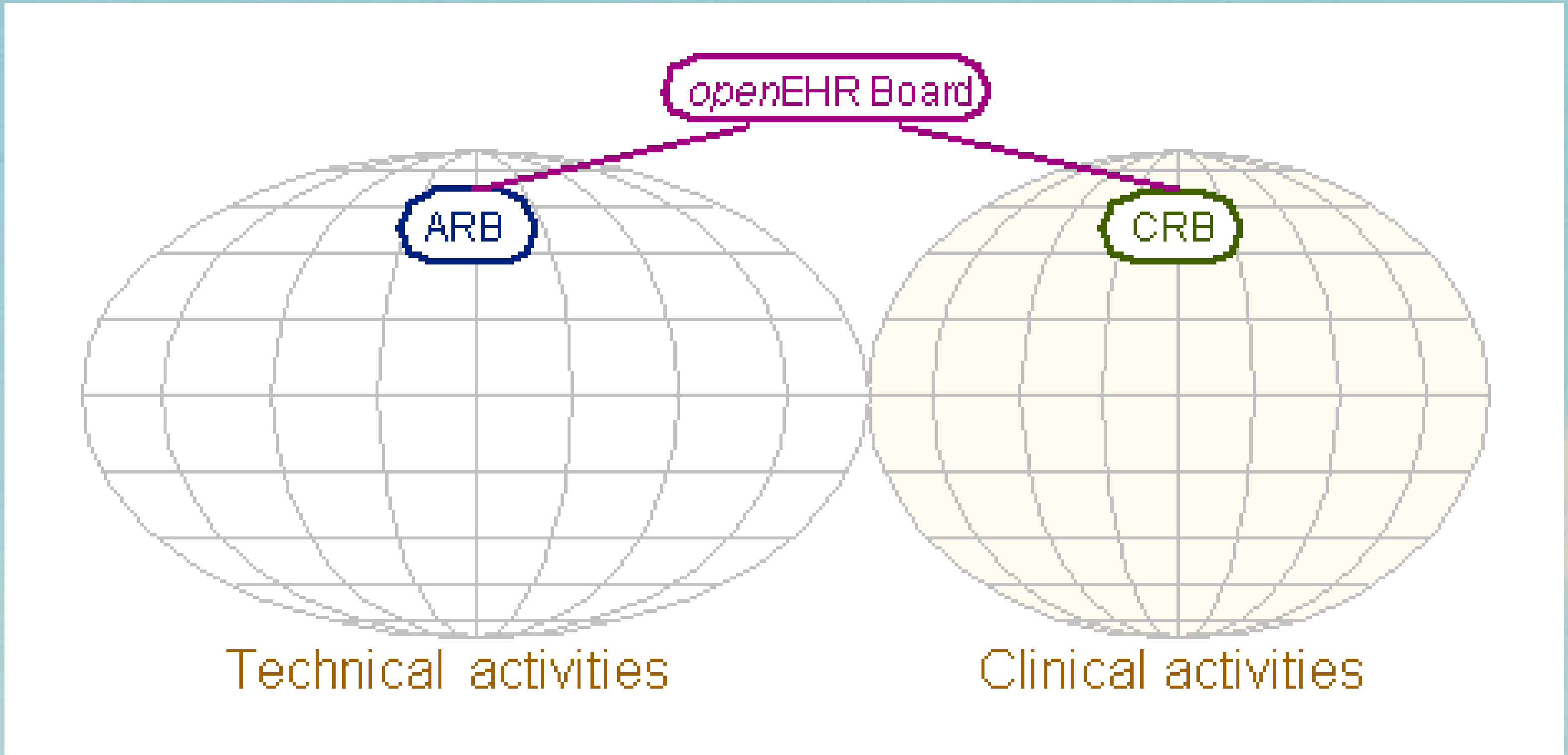
*open*EHR - two types of activities



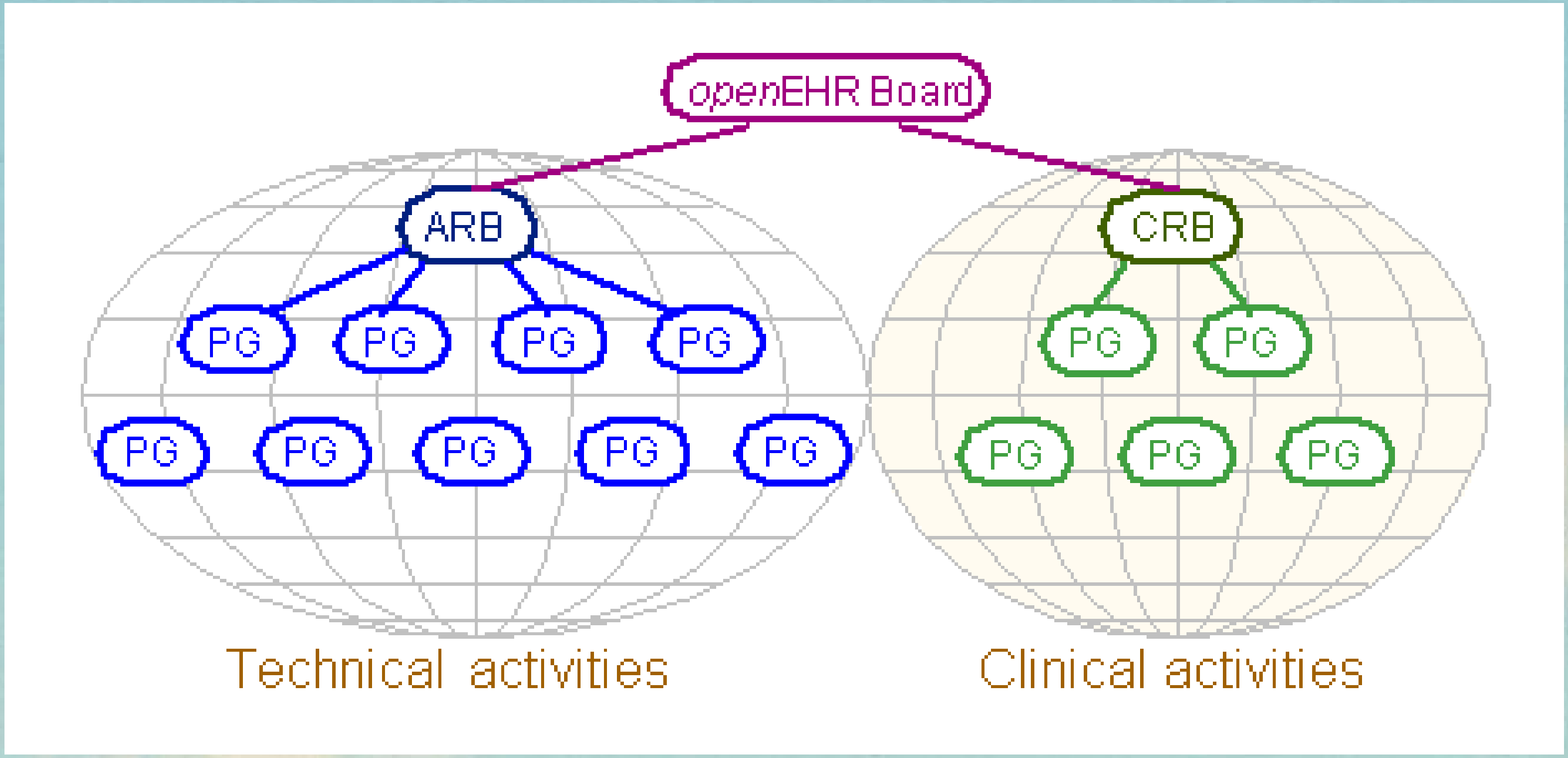
*open*EHR – Governing Board



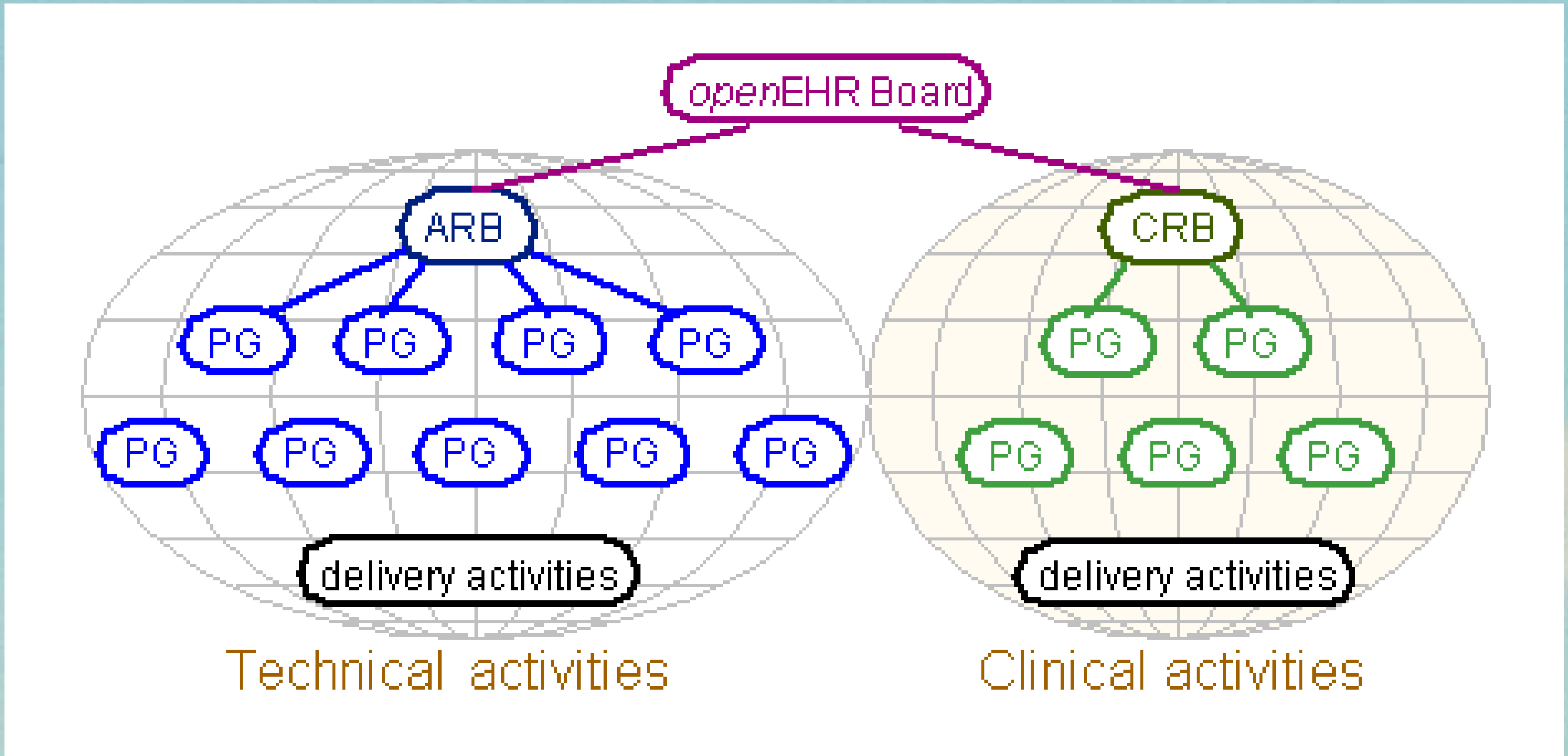
*open*EHR – Architecture and Clinical Review Boards



*open*EHR – development projects



*open*EHR – publication, dessemination, education



* * * Programme * * *

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The *open*EHR Community

- Who are its members?
  - 576 members, 60 countries (5/May/2005)
- What levels of involvement are there?
  - Initial: become a member on the website
  - Discussion: subscribe to discussion lists – announce, technical, clinical
- Technical stream
  - Experiment: subscribe to implementors’ discussion list
  - Use software or specs and submit Problem Reports (PRs) (plone server)
  - Join a project: become a developer (see project pages), work with Change Requests (CRs) & submit changes

The *open*EHR Community

- Clinical stream
  - Discuss: subscribe to openehr-clinical list
  - Use archetype tools and share archetypes
  - Join a project: clinical projects are starting…

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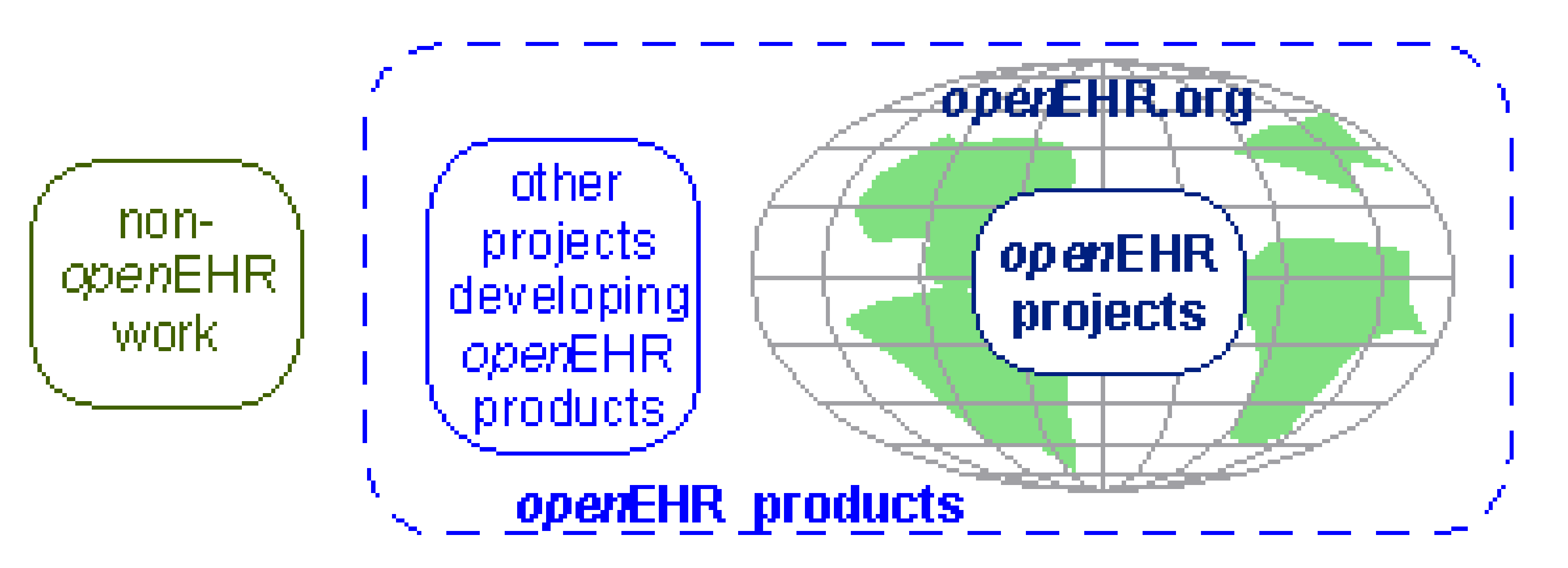
*open*EHR Projects and Products



non-*open*EHR work

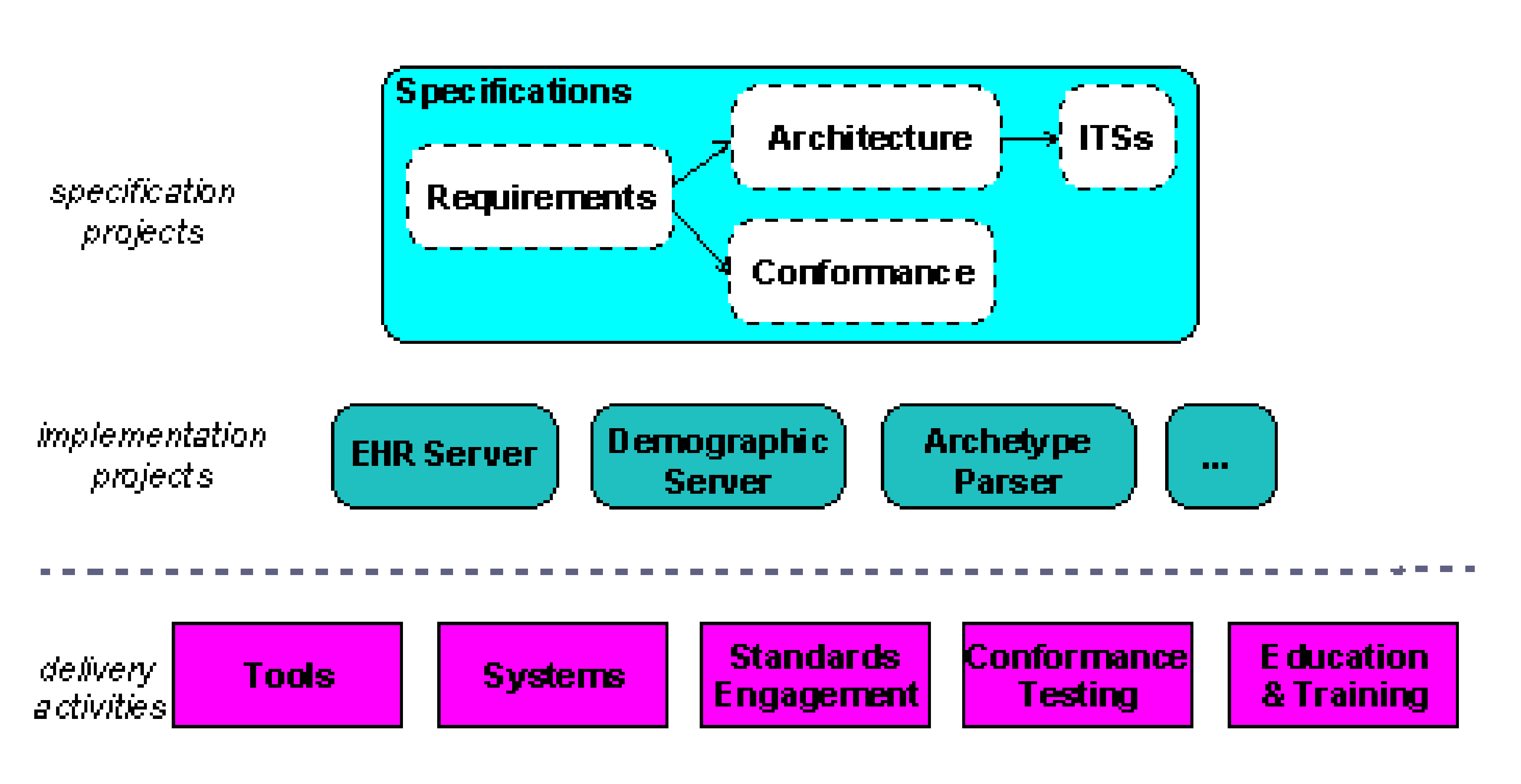
other projects developing *open*EHR products

*open*EHR.org

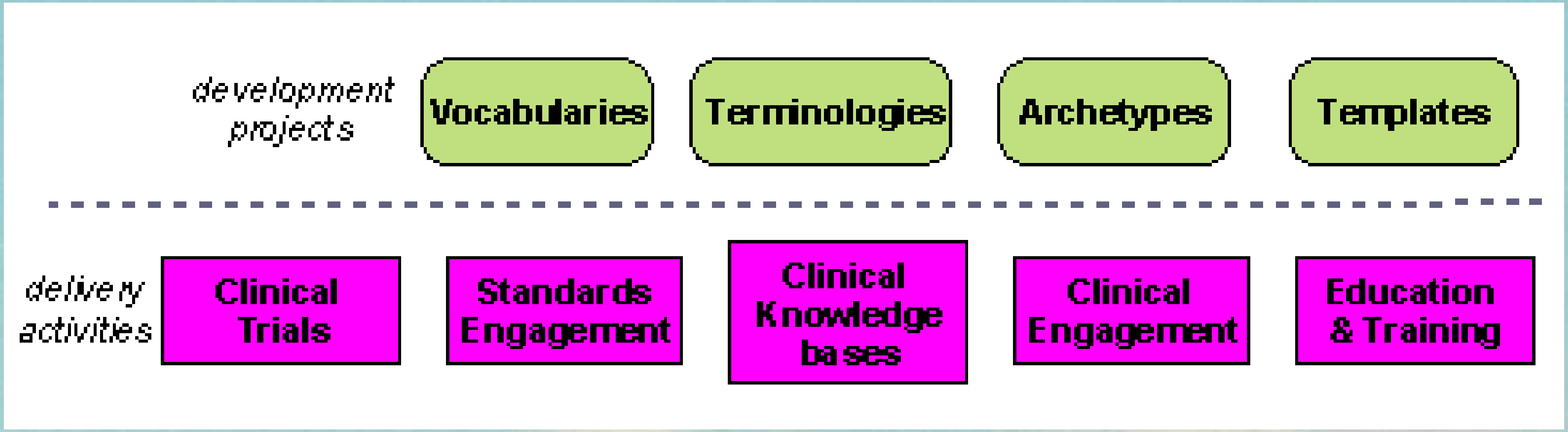
*open*EHR projects

*open*EHR products

*open*EHR Technical projects



*open*EHR Clinical projects



Development Process

- Software engineering process:
  - Requirements
  - Analysis & design
  - Implementation, V&V, deployment
- Change process:
  - Identified project teams
  - Change Management plan (see website)
  - All changes documented with Change Requests
  - All problems reported with Problem Reports
  - Reference projects use ARB

*open*EHR Products: free, open source

- Archetypes
  - ADL reference parser (.net, java)
  - Workbench
  - Ocean archetype editor
  - Browsing and repository environment (coming)
- Java EHR system (hibernate, MySQL, Spring…)
  - EHR service
  - Demographics service
  - Archetype service
  - Terminology access service
  - Application component
  - Test data & archetypes
  - Basic GUI

The *open*EHR website

- Main server
  - MacOS server
  - Apache
- Software Configuration Management
  - Currently BitKeeper
  - May migrate to Subversion
- Zope/Plone server
  - Problem Reports
  - Change requests
- 5 Discussion lists

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Who is using it?

- Australia
  - National clinical modelling project
  - National e-Health programme – Health*Connect*
  - Existing $3m diabetic system in Brisbane (1000 patients, 60 physicians)
  - Ocean Informatics
- UK/UCL
  - Clef (MRC project) cancer research database system
  - UCL open source development with a-code.se
- Europe
  - CEN standard EN13606-part 2 (archetype model)
  - Various companies (nl, se, es, …)
  - 5 EU Framework 6 proposals specified *open*EHR
- Americas: various US, Uruguay, Brazil etc

Who is researching it?

- University College London
- University of South Australia
- University of Central Queensland
- University of Manchester, UK
- University of Seville, Spain
- University of Moratuwa, Sri Lanka
- Mayo Clinic, Rochester, US

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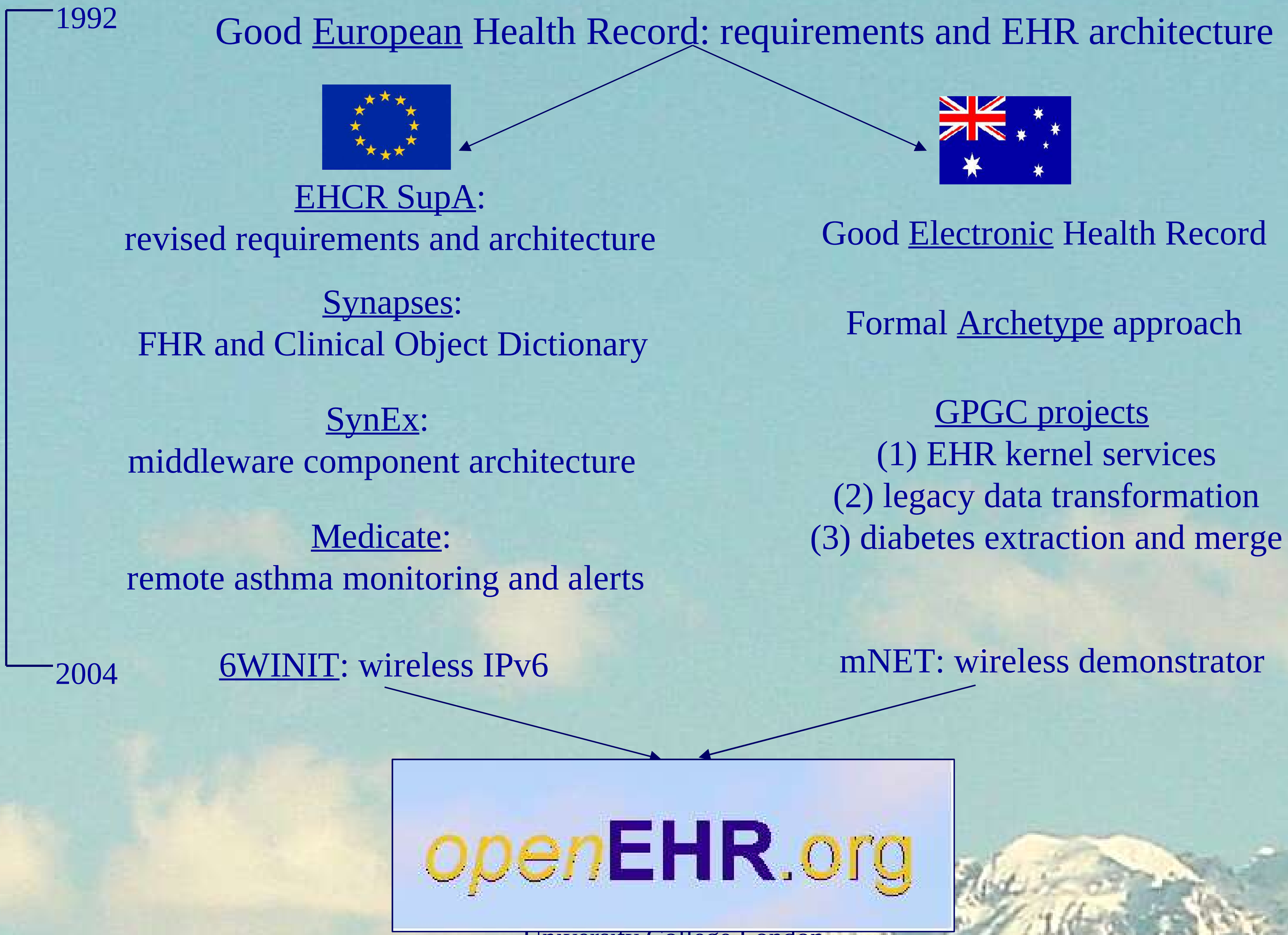
Technical Methodology

- 15 years of research into the EHR
- Using lessons from at least 10 EU projects
- Requirements-based
- Engineering design approach (small, focussed team, reviews, prototypes)
- Ongoing implementation
- Software configuration and release management

*open*EHR research pedigree



1992

Good European Health Record: requirements and EHR architecture

EHCR SupA:
revised requirements and architecture

Synapses:
FHR and Clinical Object Dictionary

SynEx:
middleware component architecture

Medicate:
remote asthma monitoring and alerts

Good Electronic Health Record

Formal Archetype approach

GPGC projects
(1) EHR kernel services
(2) legacy data transformation
(3) diabetes extraction and merge

2004

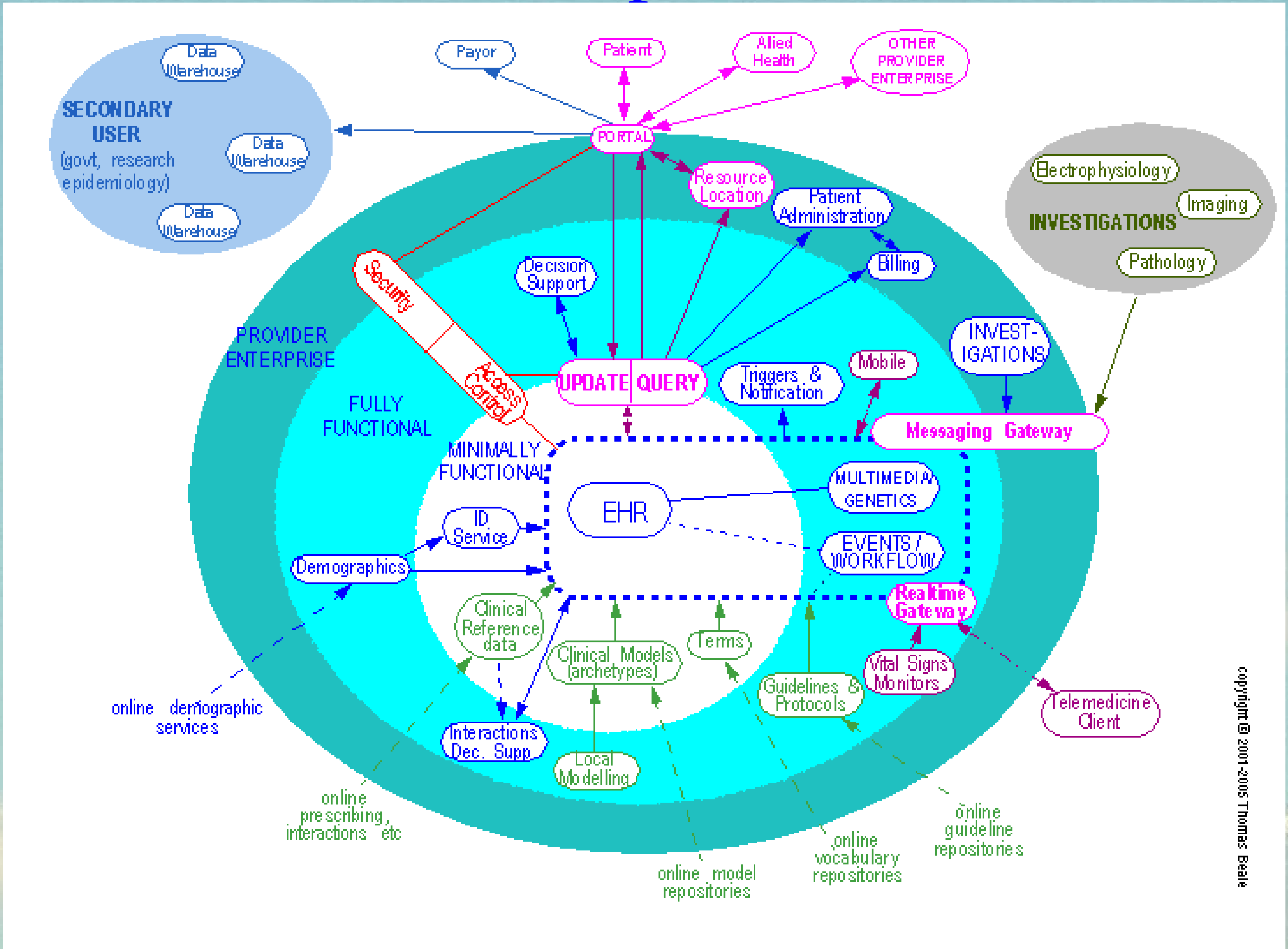
6WINIT: wireless IPv6

mNET: wireless demonstrator

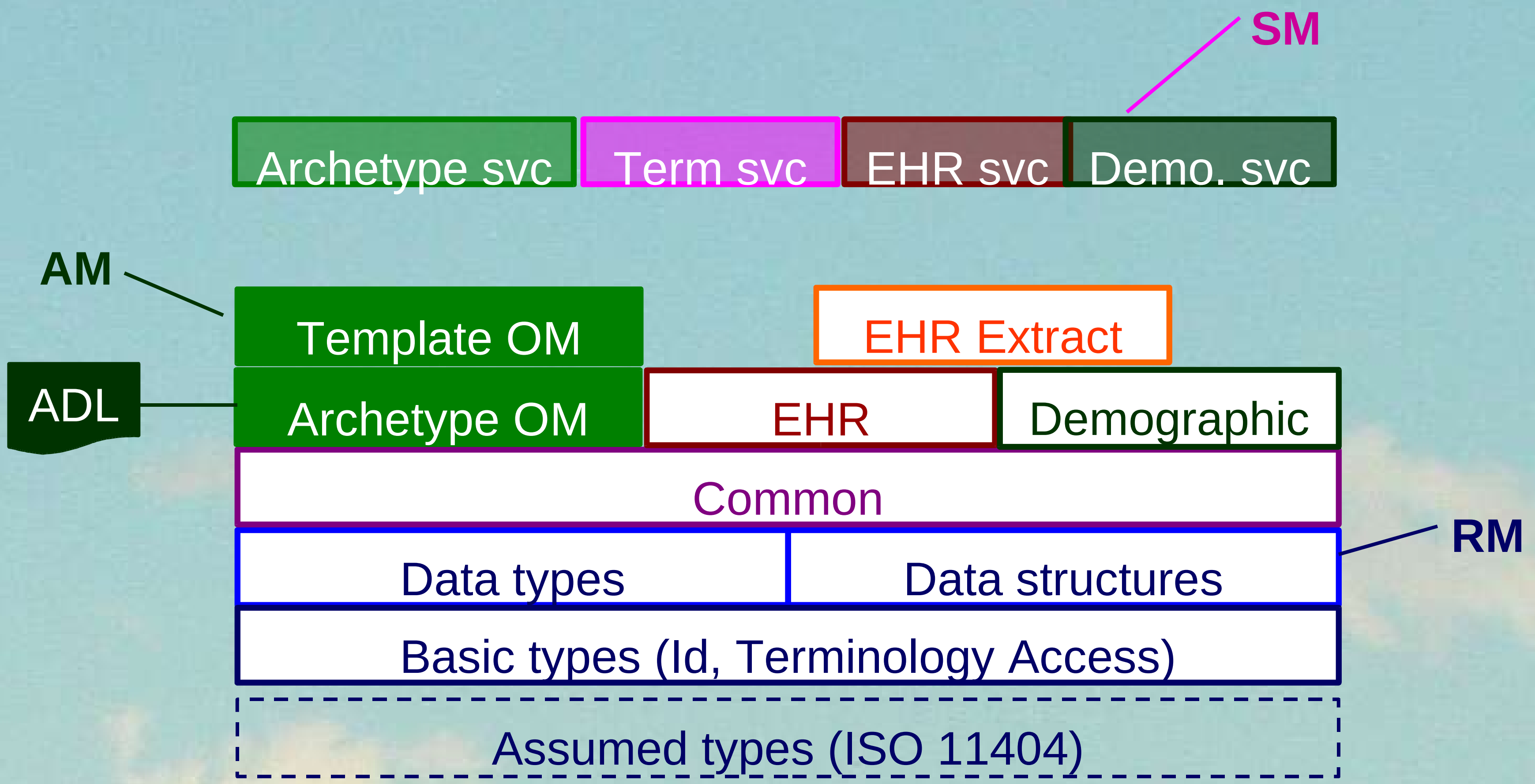
Technical Principles

1. Componentised – into areas such as demographics, workflow, ehr
   - Why? Same principle as low-coupled software
2. Separation of viewpoints - RM/ODP EV, IV, CV
   - Why? Separates information (fine-grained) and service (coarse-grained) semantics
   - Don’t hardwire policies & bus process into the software
3. Ontologically layered
   - Why? Separates progressively more specific & changeable concepts into modular layers
   - Allows division of what is hard-wired into software and what is knowledge available at runtime

1. components



2. Separation of Viewpoints



SM

Archetype svc

Term svc

EHR svc

Demo. svc

AM

Template OM

EHR Extract

ADL

Archetype OM

EHR

Demographic

Common

RM

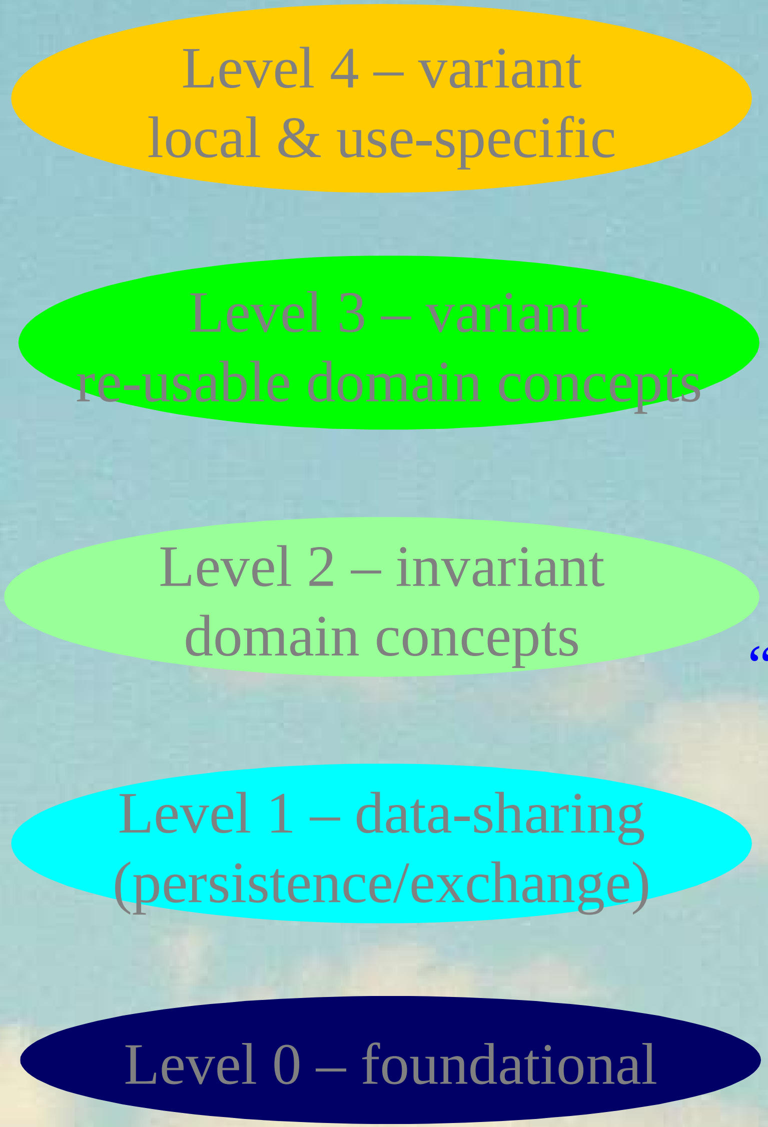
Data types

Data structures

Basic types (Id, Terminology Access)

Assumed types (ISO 11404)

3. Ontological Layering



Level 4 – variant
local & use-specific

use context-specific concepts, e.g.
“asthma note”, “ante-natal exam”

Level 3 – variant
re-usable domain concepts

atomic domain concepts, e.g.
“lab result”, “patient”,
“apgar score”, “BP measurement”, …

Level 2 – invariant
domain concepts

base ontological
commitments of domain, e.g.
“observation”, “subject-of-care”, “protocol”…

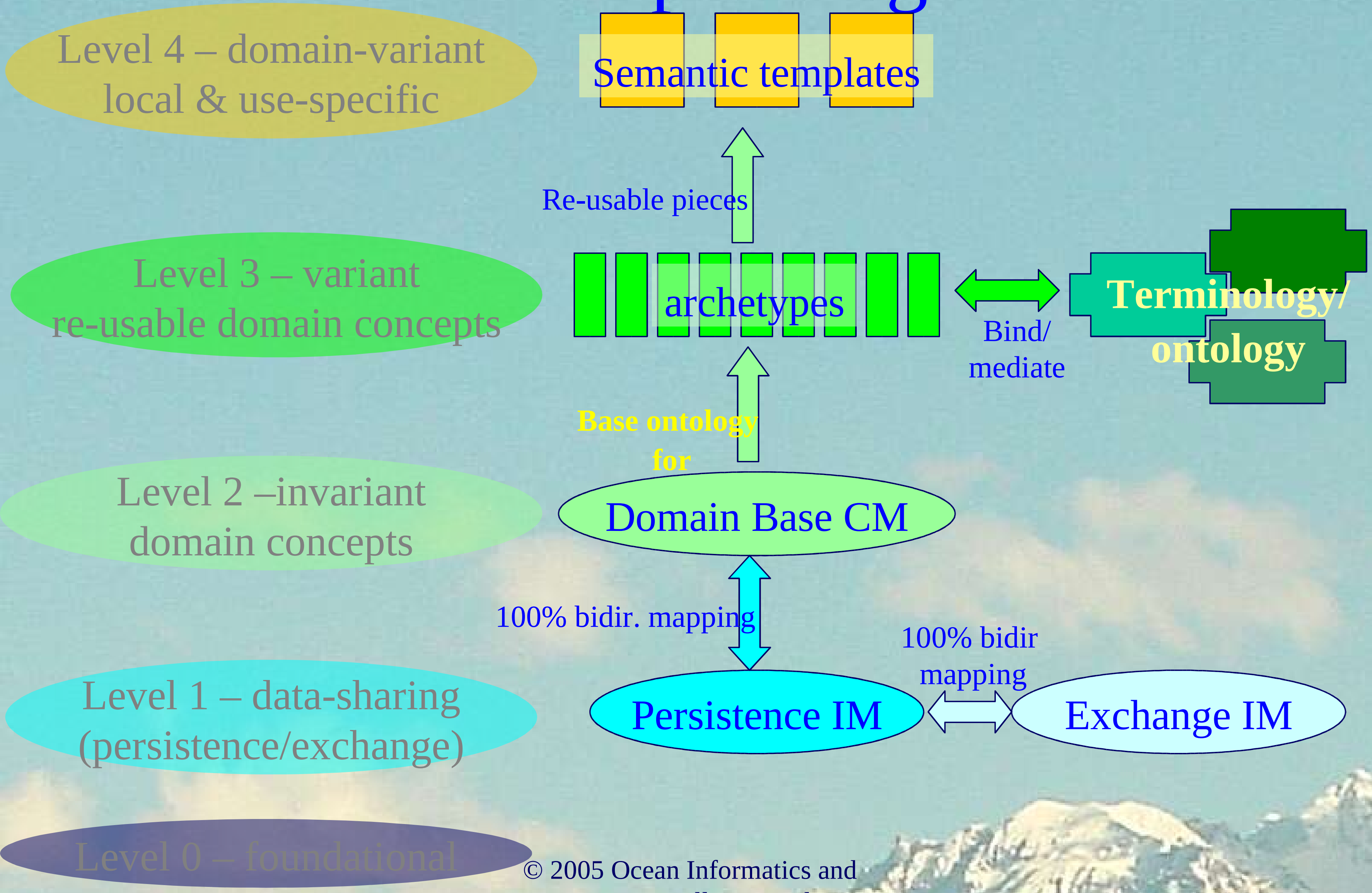
Level 1 – data-sharing
(persistence/exchange)

minimal ontological commitments –
sufficient for “recording” and “sharing”, e.g.
“composition”, “committer”, “attestation”…

Level 0 – foundational

Object meta-model (objects, attributes etc)
built-in data types,

…and corresponding models



Level 4 – domain-variant local & use-specific

Level 3 – variant re-usable domain concepts

Level 2 –invariant domain concepts

Level 1 – data-sharing (persistence/exchange)

Level 0 – foundational

Semantic templates

Re-usable pieces

archetypes

Bind/ mediate

Terminology/ ontology

Base ontology for

Domain Base CM

100% bidir. mapping

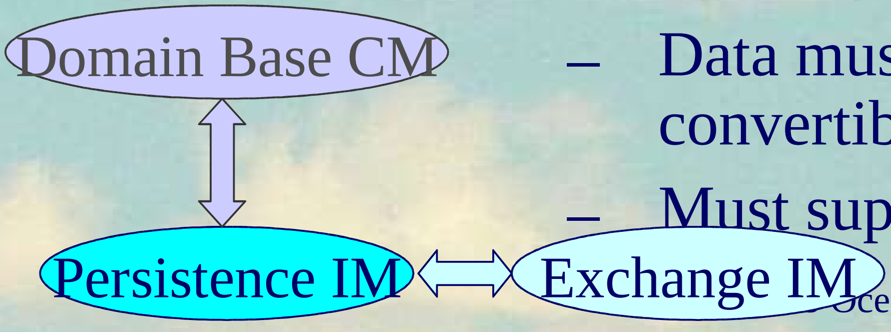
100% bidir mapping

Persistence IM

Exchange IM

Level 1 – Persistence & Exchange IM

- The job of the Persistence IM is to:
  - be a faithful in-situ representation of data for sharing by applications
- The job of the Exchange IM is to:
  - be an LCD standard for sharing data by systems
  - provide semantics which are invariant across all IMs: i.e. audit, identity, attestation, basic containment
- Relationship to Domain Base CM:
  - Data must be 100% bidirectionally convertible (maybe via persistence IM)
  - Must support archetype meta-data

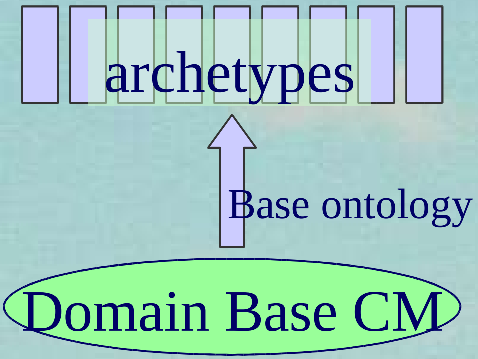


Level 1 – data types

- Only data types needed are those required for structural attributes:
  - Date_time (i.e. concept of a timestamp)
  - Strings
  - Information item identifiers
  - Boolean
  - Uri
  - Coded text
- I.e. basic ISO 11404 set + coded text
- No other data types needed at this level

Level 2 - Domain Base Concept Model

- The job of this model is to:
  - define base ontological commitments for archetypes – else archetypes not definable
  - interface to persistence/exchange IMs
  - therefore define as OO model (in UML)
- Example ontological content:
  - Observation (from *open*EHR):
    - Data/state/protocol split
    - Data: History<Structure>
    - Structures: List, Table, Tree, Single



Domain Base CM - characteristics

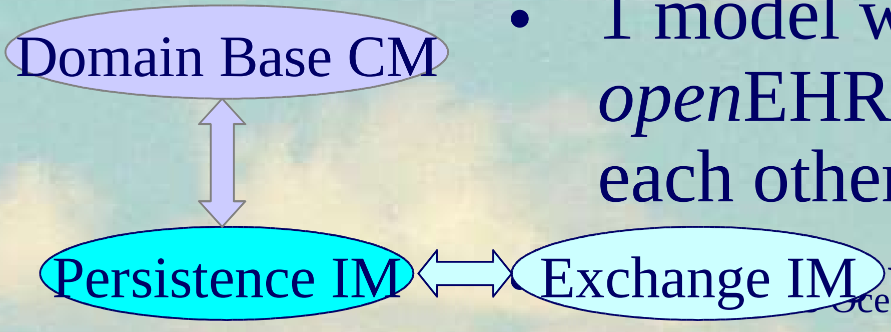
- This is the model whose class and attribute names you can use in an archetype
- It also defines the base ontology for archetypes
- Concepts must be invariant for the entire domain
- Hence things like Observation, Evaluation etc but not “substance administration”, “invoice”…
- This level must be standardised and agreed for archetypes to be sharable
- It can be sourced from existing IMs, and can grow (slightly) in time…

Level 2 – data types

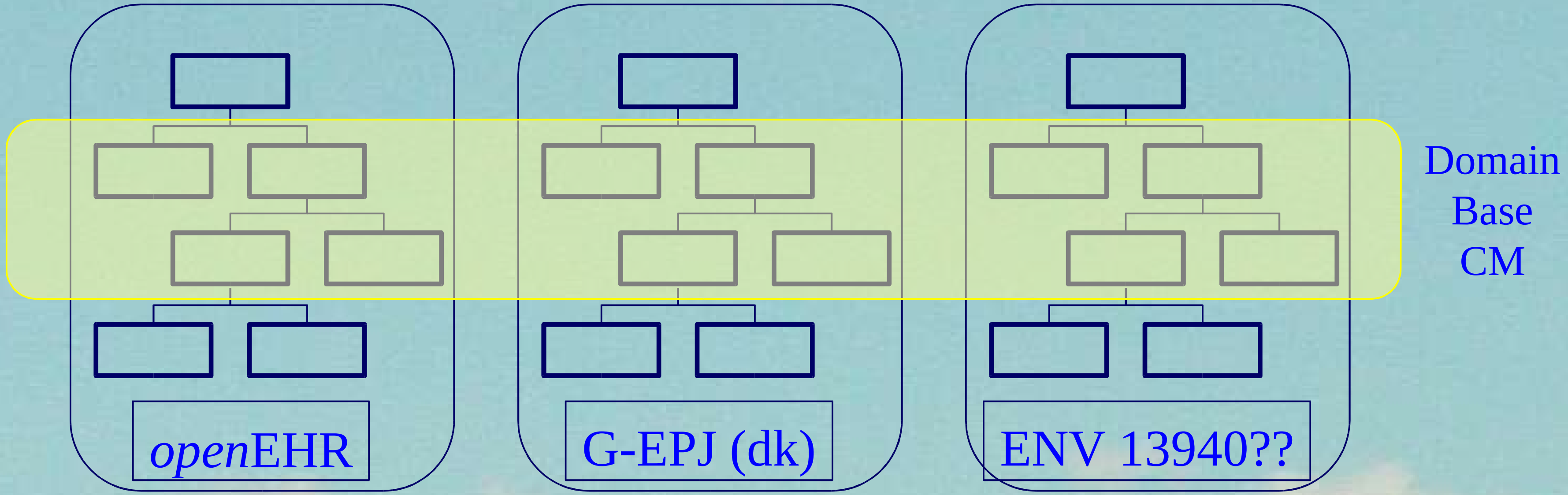
- This level needs data types which are subtypes of Data_value, and which satisfy clinical needs:
  - Date_time, Date, Time, Duration
  - Text (w. language)
  - Coded text
  - Quantity, ratio, range, count
  - Real world identifiers
  - Bistate (yes/no, true/false, …)
  - State
  - Ordinal
  - Time specification
  - Uri
  - Multimedia

Level 1/2 – 3 models really needed?

- These 3 “models” stand for 3 distinct functions which are needed in the computational framework
- They could be separate models, but the functions could also be satisfied by one or two information models only
- 3 models will occur with archetypes based on *open*EHR-like IM; persistence in private form; exchange in 13606
- 1 model will occur with e.g. native *open*EHR or G-EPJ systems talking to each other
- with *open*EHR + 13606



Domain Base CM - candidates

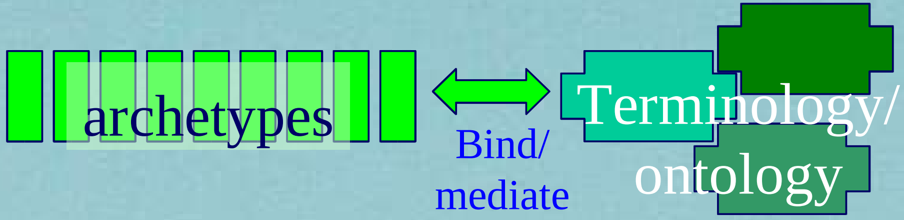


- Pieces of particular cleanly defined information models
- Concepts must be *completely invariant* for the entire domain
- What makes sense in this model is what makes sense in an archetype editor

Defining the Domain Base CM

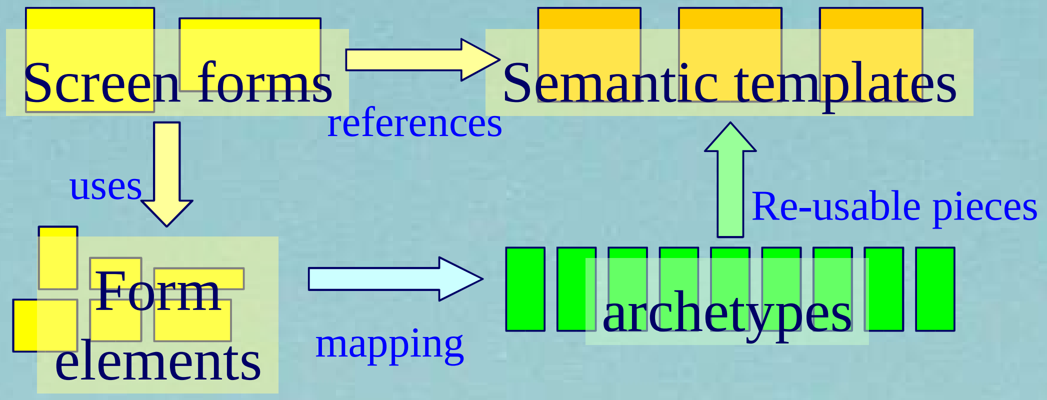
- A base concept model for archetypes needs concepts like those in *open*EHR; potentially some in G-EPJ and ENV13940; some ontological content retrievable from HL7 RIM and CDA
- Initial candidate = core of *open*EHR with simplified names; maybe some of G-EPJ – both these models have been designed for archetyping
- Further minor *open*EHR/EN13606-1 alignment required to guarantee safe 100% mapping
- Data types should be consistent throughout all models!!!!

Level 3 - Archetypes



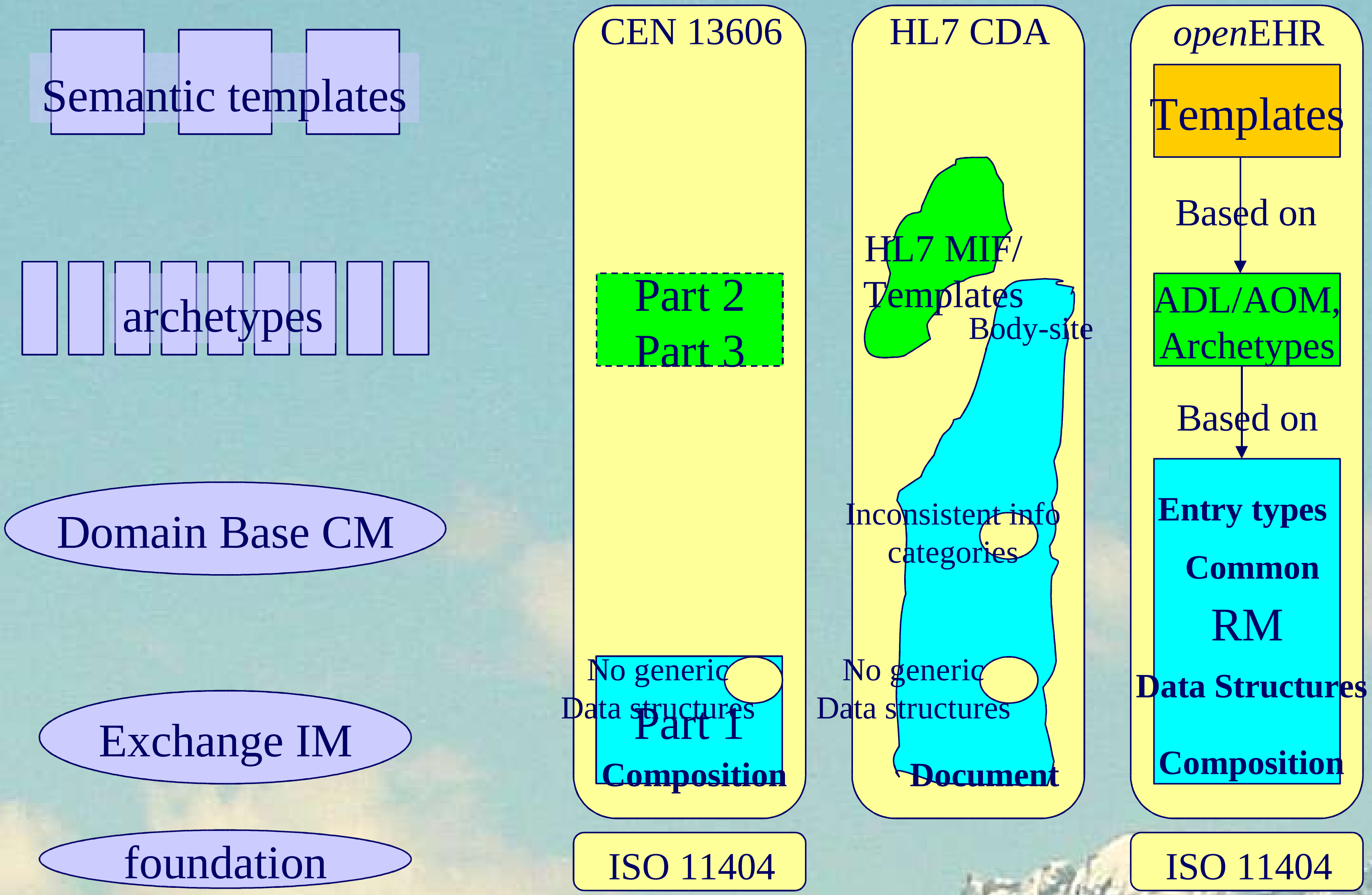
- The functions of this level are to:
  - connect to data by defining clinical models, in terms of Domain Base Concept Model concepts
  - connect to knowledge by binding to terminology
  - form the basis for querying and other semantically meaningful data-processing
- Must be separate from level 2 to enable maintainable software and self-adapting systems to be constructed

Level 4 – Templates and the GUI



- Archetypes act as re-usable components in locally defined semantic templates…
- They are also a basis for defining re-usable screen elements…
- which eventually appear in semi-automatically engineered screen forms

EHR Model Comparison



Semantic templates

archetypes

Domain Base CM

Exchange IM

foundation

CEN 13606

Part 2
Part 3

No generic
Data structures

Part 1

Composition

ISO 11404

HL7 CDA

HL7 MIF/
Templates

Body-site

Inconsistent info
categories

No generic
Data structures

Document

*open*EHR

Templates

Based on

ADL/AOM,
Archetypes

Based on

Entry types

Common

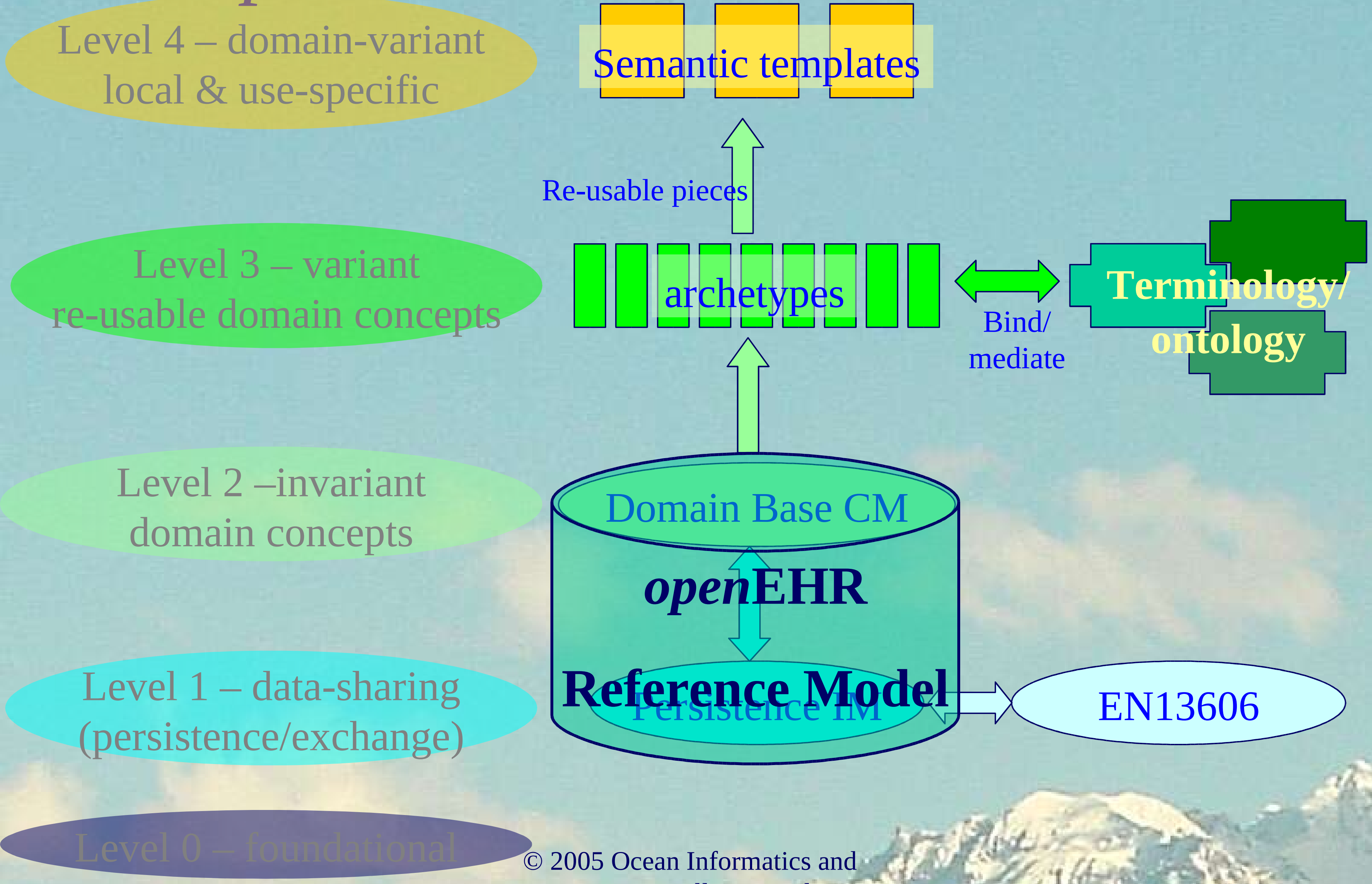
RM

Data Structures

Composition

ISO 11404

*open*EHR combines 2 models

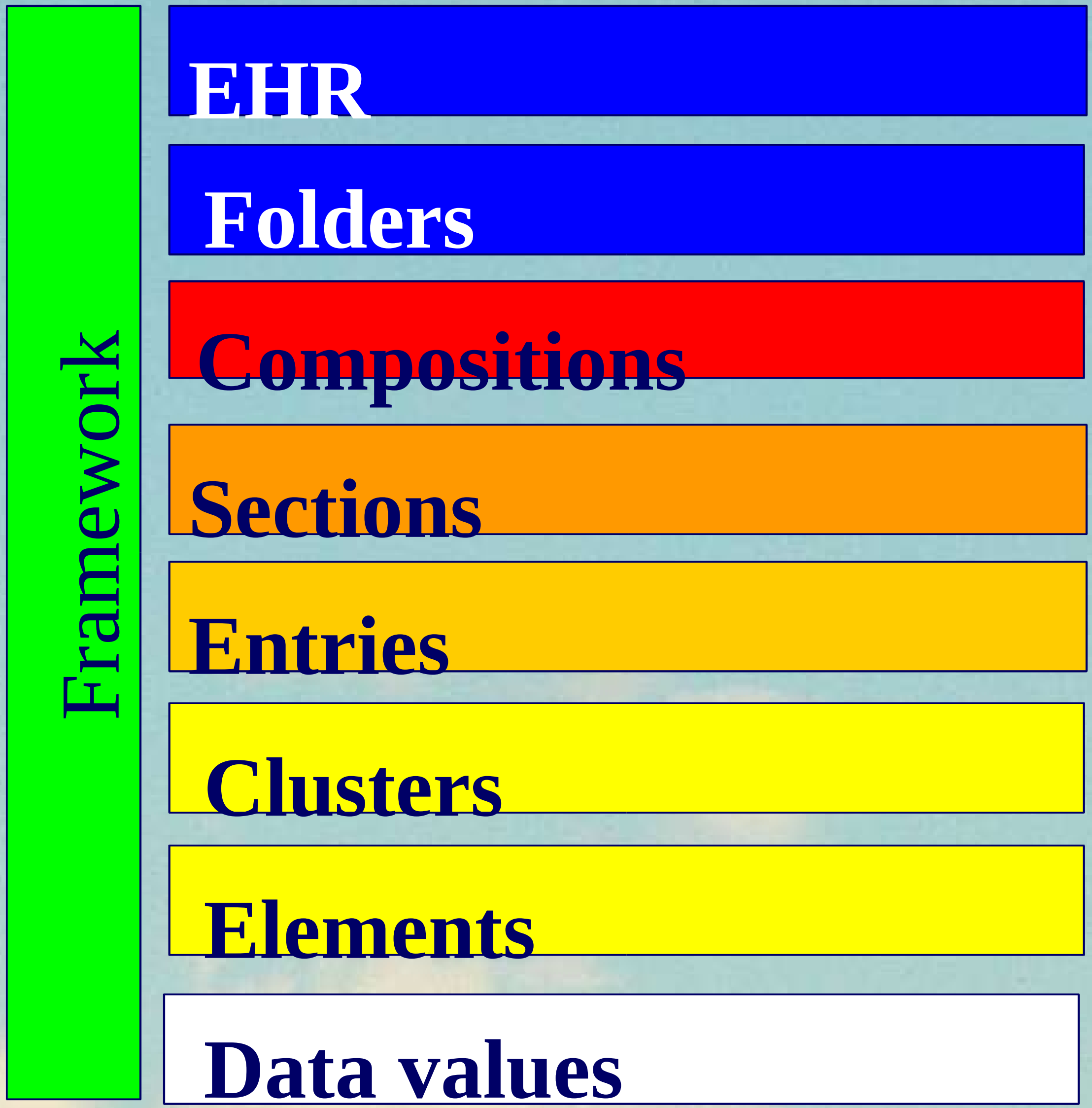


Level 4 – domain-variant local & use-specific
Semantic templates
Re-usable pieces
Level 3 – variant re-usable domain concepts
archetypes
Bind/ mediate
Terminology/ ontology
Level 2 –invariant domain concepts
Domain Base CM
*open*EHR
Reference Model
Persistence IM
EN13606
Level 1 – data-sharing (persistence/exchange)
Level 0 – foundational

*open*EHR Modelling

- Layered
- Data types and data structures provide building blocks
- Uses basic scientific information types for Entries
- Includes model of versions and change-sets to handle input errors, multiple simultaneous modifying users, medico-legal needs, historical process analysis
- Archetype-enabled

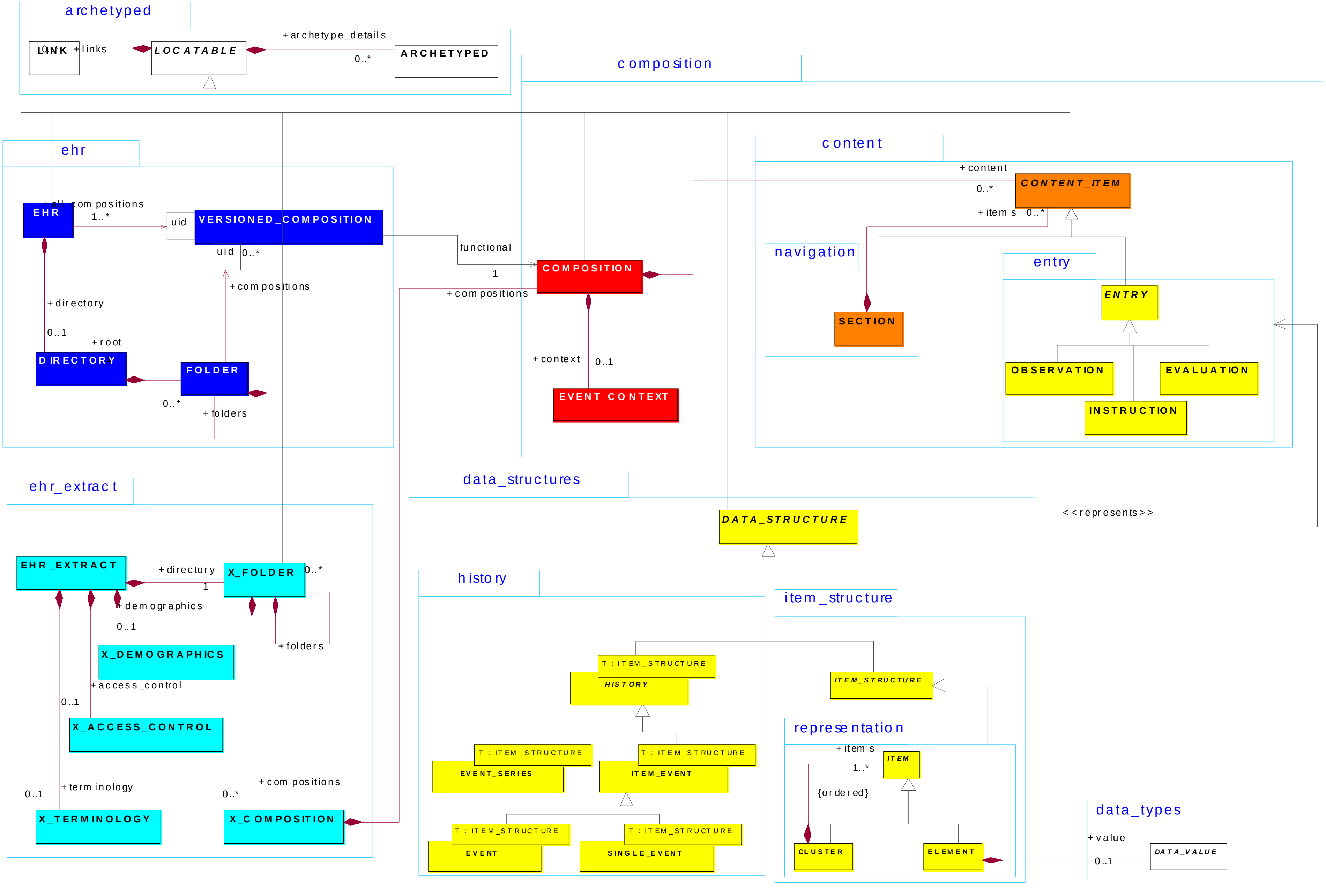
What is in the Reference Model?



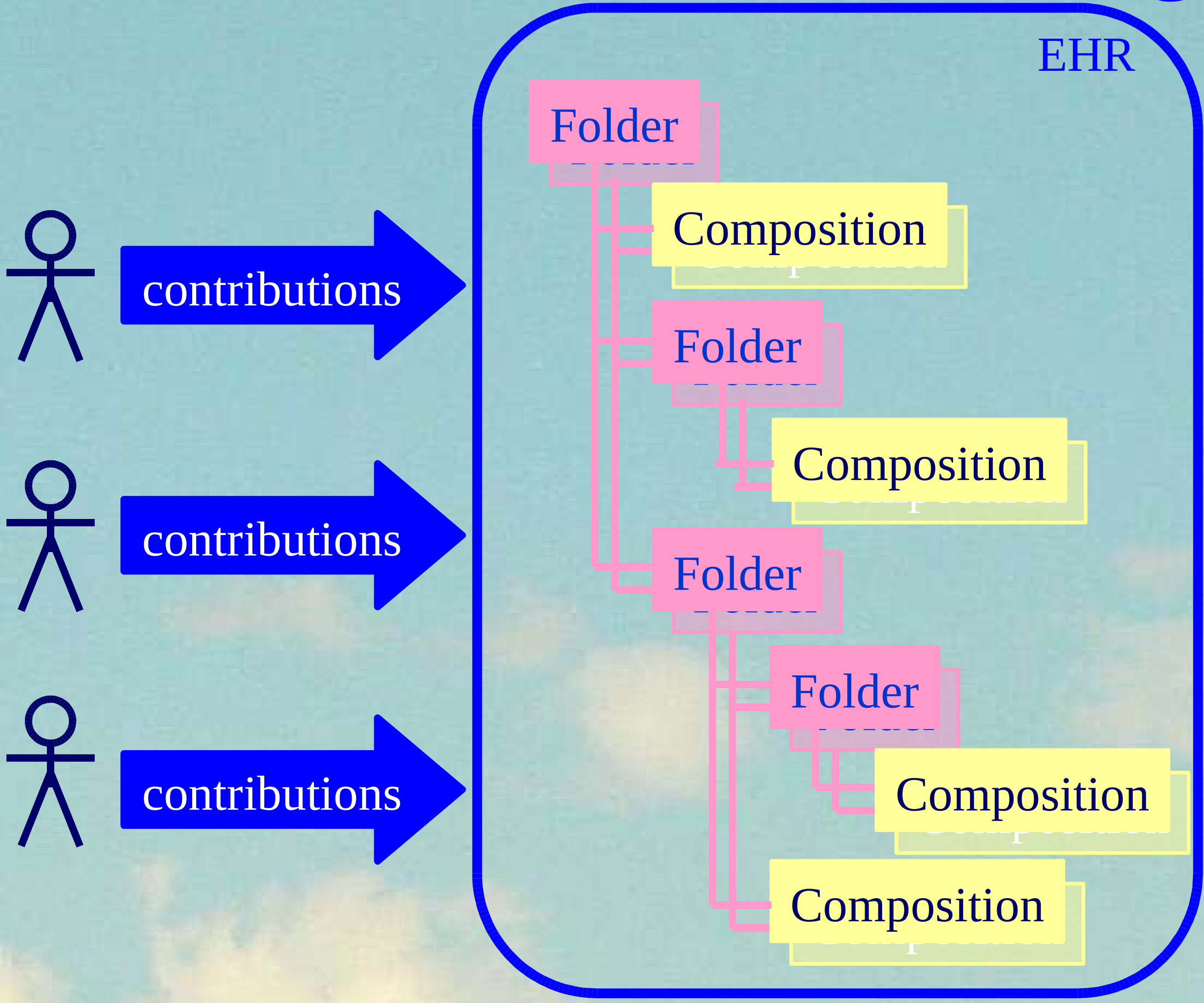
Framework

EHR	The electronic health record for one person
Folders	High-level organisation of the EHR e.g. per episode, per clinical speciality
Compositions	Set of entries committed at one date/time e.g. progress note, report, letter, test result
Sections	Clinical headings reflecting the workflow and consultation/reasoning process
Entries	Clinical “statements” about Observations, Evaluations, and Instructions
Clusters	Compound entries e.g. blood pressure, full blood count
Elements	Element entries e.g. reason for encounter, body weight
Data values	e.g. Coded terms from term sets, measurements with units

RM Overview

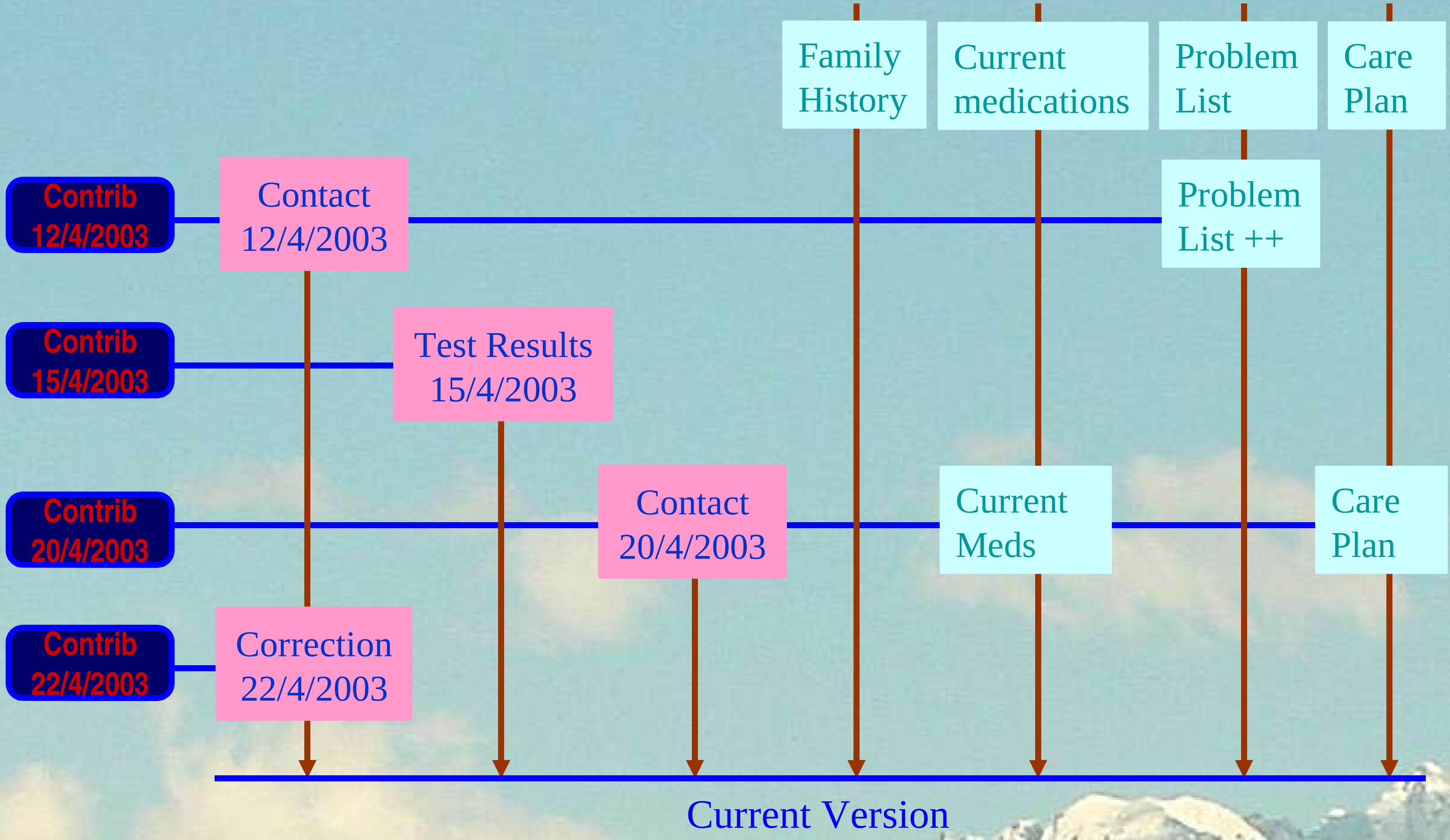

archetyped
LINK
0..*
+links
LOCATABLE
+archetype_details
0..*
ARCHETYPED
composition
ehr
EHR
+all_compositions
1..*
uid
VERSIONED_COMPOSITION
uid
0..*
+compositions
functional
1
+directory
0..1
+root
DIRECTORY
FOLDER
0..*
+folders
COMPOSITION
+compositions
+context
0..1
EVENT_CONTEXT
content
+content
0..*
CONTENT_ITEM
+items
0..*
navigation
SECTION
entry
ENTRY
OBSERVATION
EVALUATION
INSTRUCTION
ehr_extract
EHR_EXTRACT
+directory
1
X_FOLDER
0..*
+demographics
0..1
X_DEMOGRAPHICS
+access_control
0..1
X_ACCESS_CONTROL
+terminology
0..1
X_TERMINOLOGY
+folders
+compositions
0..*
X_COMPOSITION
data_structures
DATA_STRUCTURE
<<represents>>
history
T : ITEM_STRUCTURE
HISTORY
T : ITEM_STRUCTURE
EVENT_SERIES
T : ITEM_STRUCTURE
ITEM_EVENT
T : ITEM_STRUCTURE
EVENT
T : ITEM_STRUCTURE
SINGLE_EVENT
item_structure
ITEM_STRUCTURE
representation
+items
1..*
ITEM
{ordered}
CLUSTER
ELEMENT
data_types
+value
0..1
DATA_VALUE

EHR Versioning

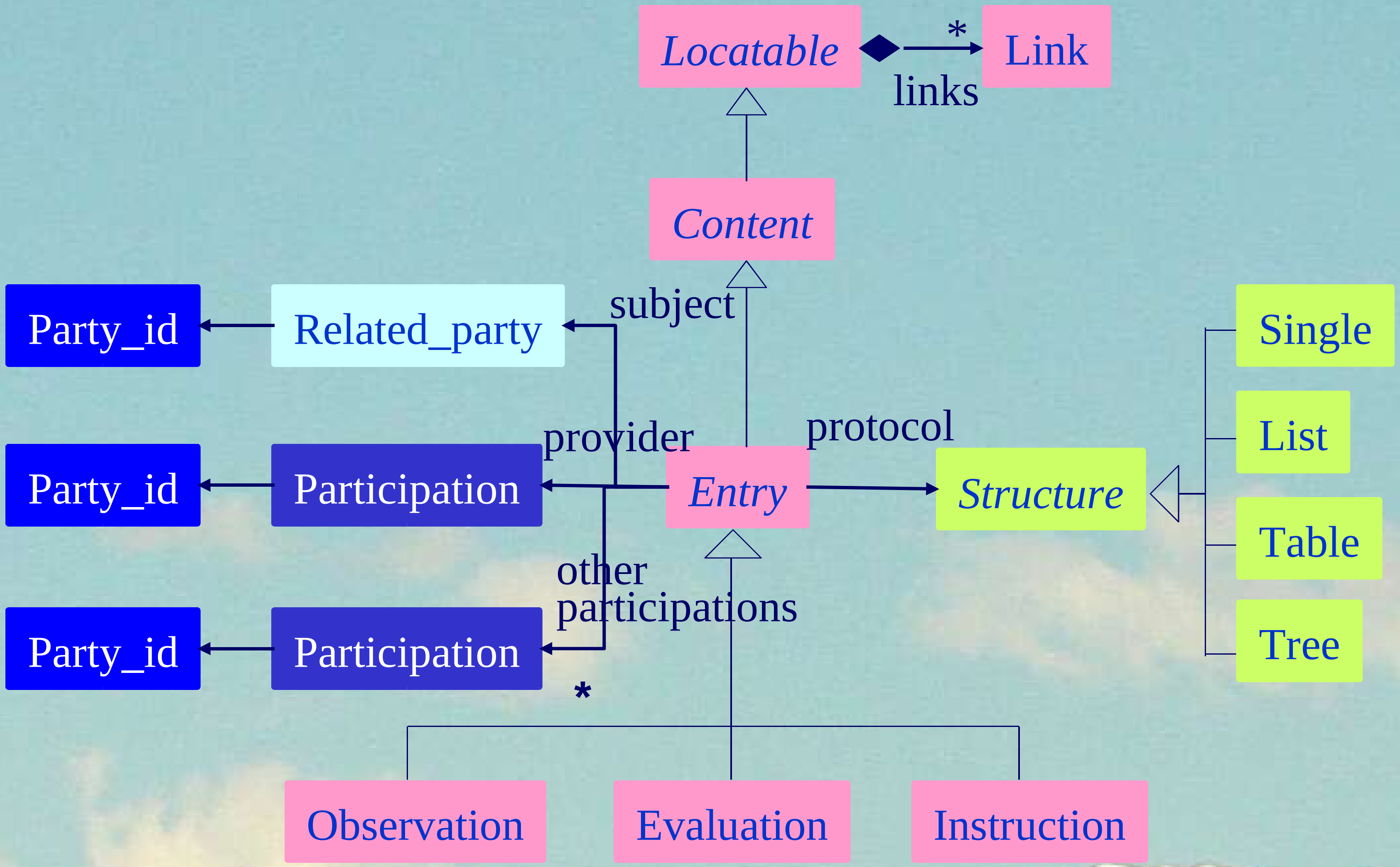


Information
Directory
Repository
Users
Contributions
Versioning

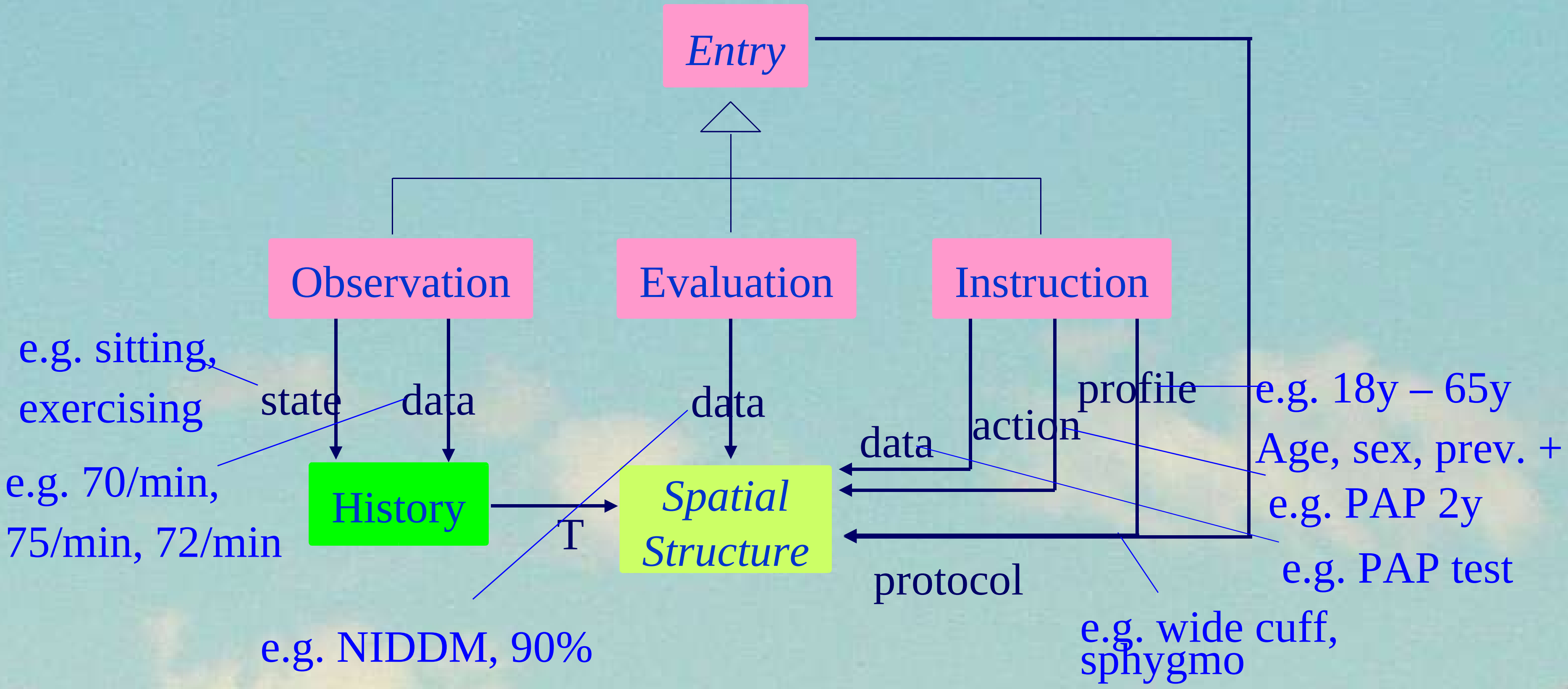
How Contributions Work



The *open*EHR Entry Types

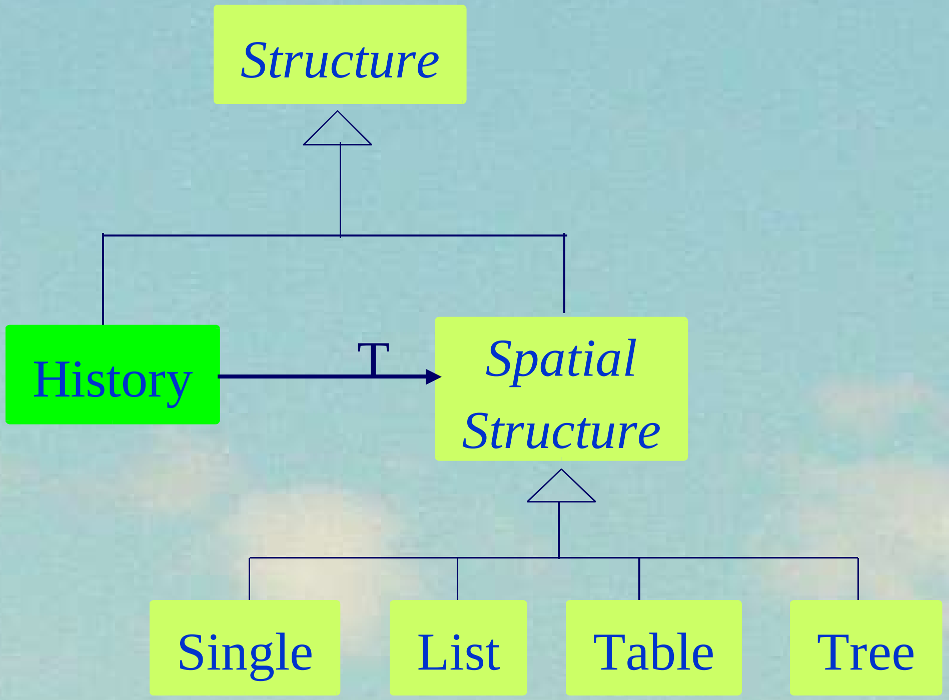


Entry



Entry
Observation
Evaluation
Instruction
e.g. sitting,
exercising
state
data
e.g. 70/min,
75/min, 72/min
History
T
data
Spatial
Structure
e.g. NIDDM, 90%
data
action
profile
e.g. 18y – 65y
Age, sex, prev. +
e.g. PAP 2y
e.g. PAP test
protocol
e.g. wide cuff,
sphygmo

Structures


Structure
History
T
Spatial Structure
Single
List
Table
Tree

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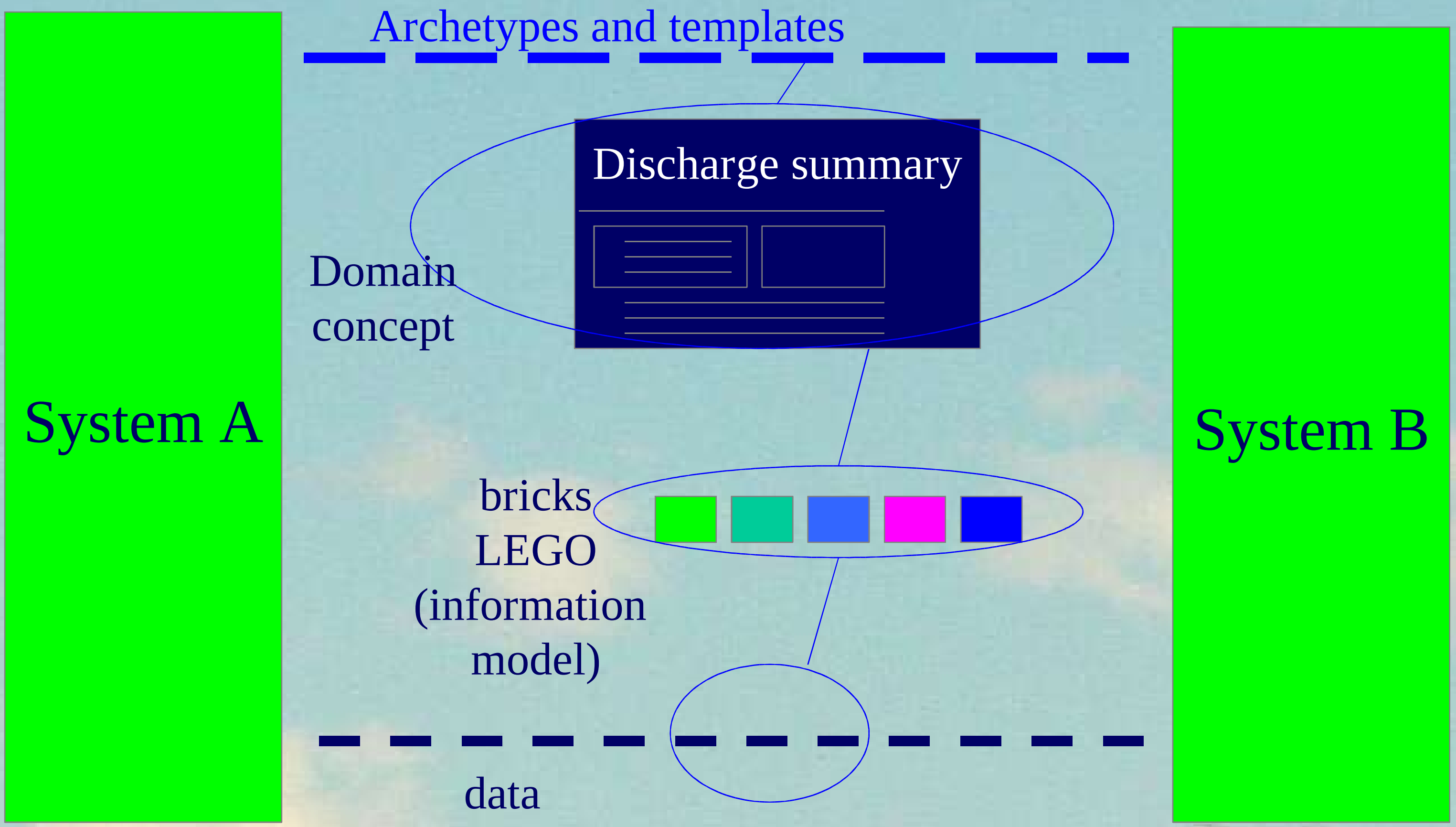
The vision of archetypes

- Single-source models for:
  - Representing clinical concepts
  - Intelligent creation and processing of data
  - Defining behaviour of GUI screens
  - Saying how to use terminology
  - Message definitions, where messages needed

What Archetypes Are Used For

- Implementing 2-level modelling
- Connecting terminology to data
- Formally expressing models of domain concepts – as modelled by clinicians
- Validating user input
- Providing the basis for semantic querying
- Providing a basis for dealing with legacy data and messages, via legacy archetypes
- Providing a basis for data conversion, using archetype to archetype conversion

How they improve interoperability



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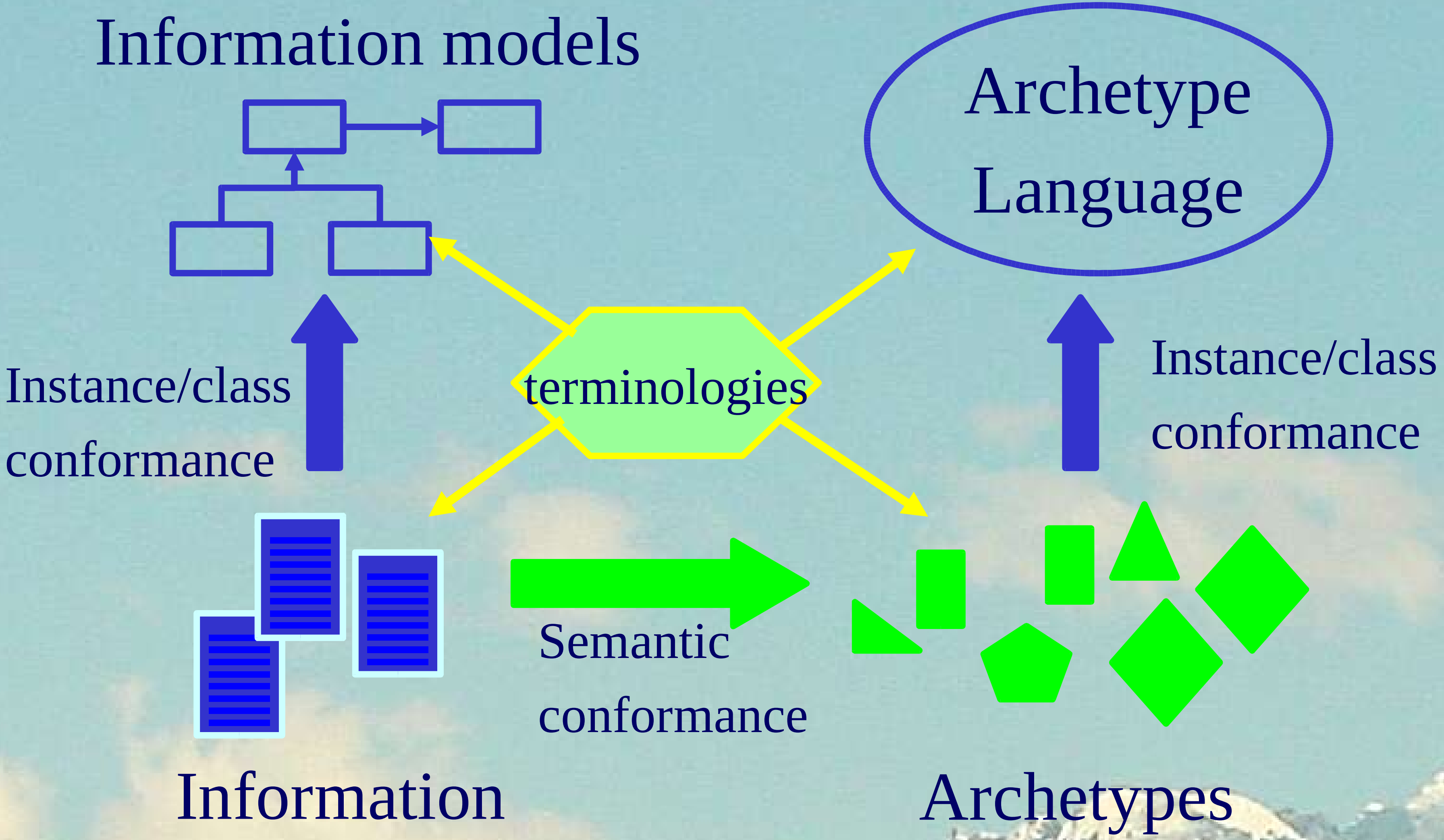
How the software is designed



Information models

Archetype Language

Instance/class conformance

terminologies

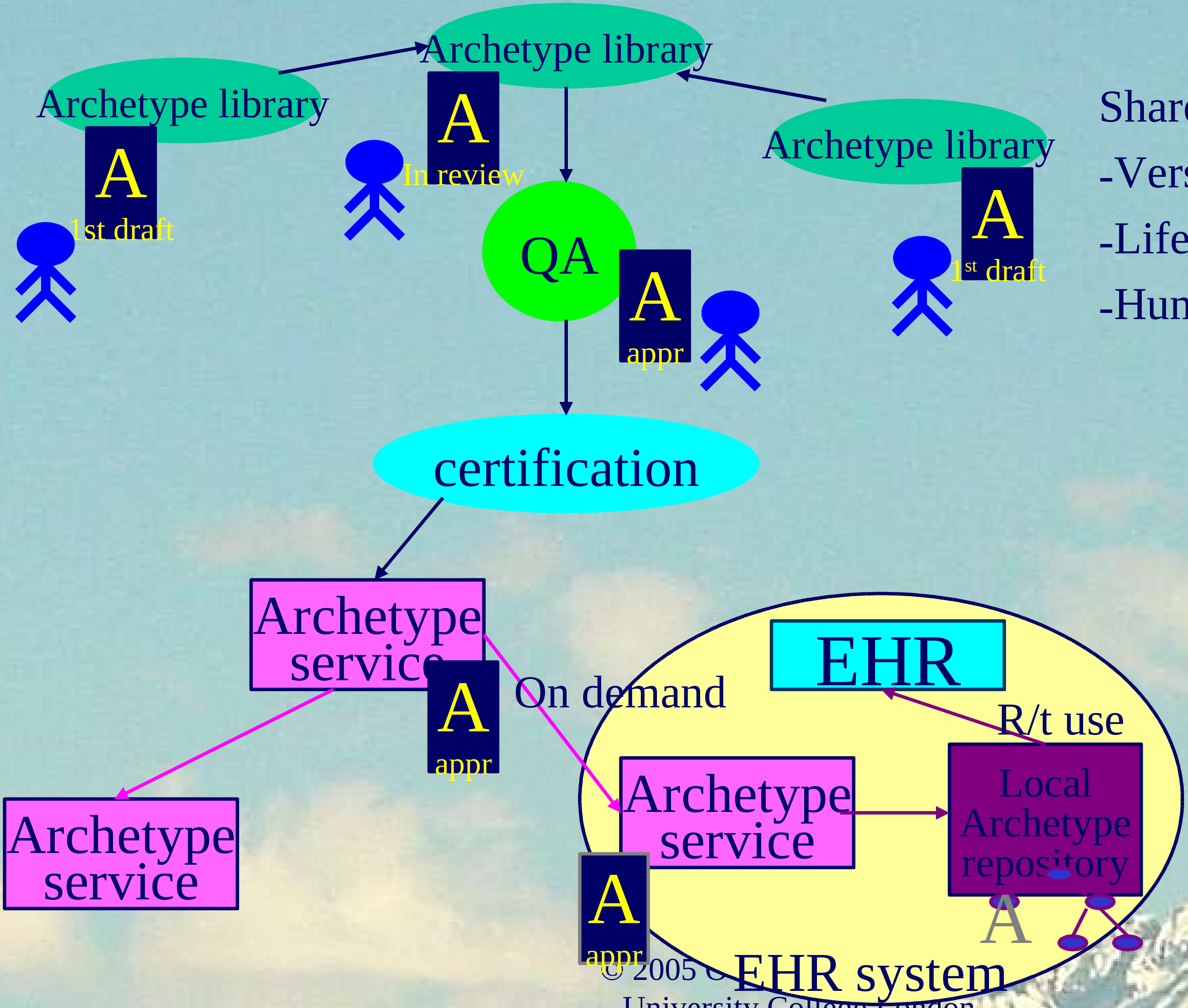
Instance/class conformance

Semantic conformance

Information

Archetypes

How archetypes are made and shared



Shared archetype library(s):

-Versioning

-Lifecycle

-Human – human interop

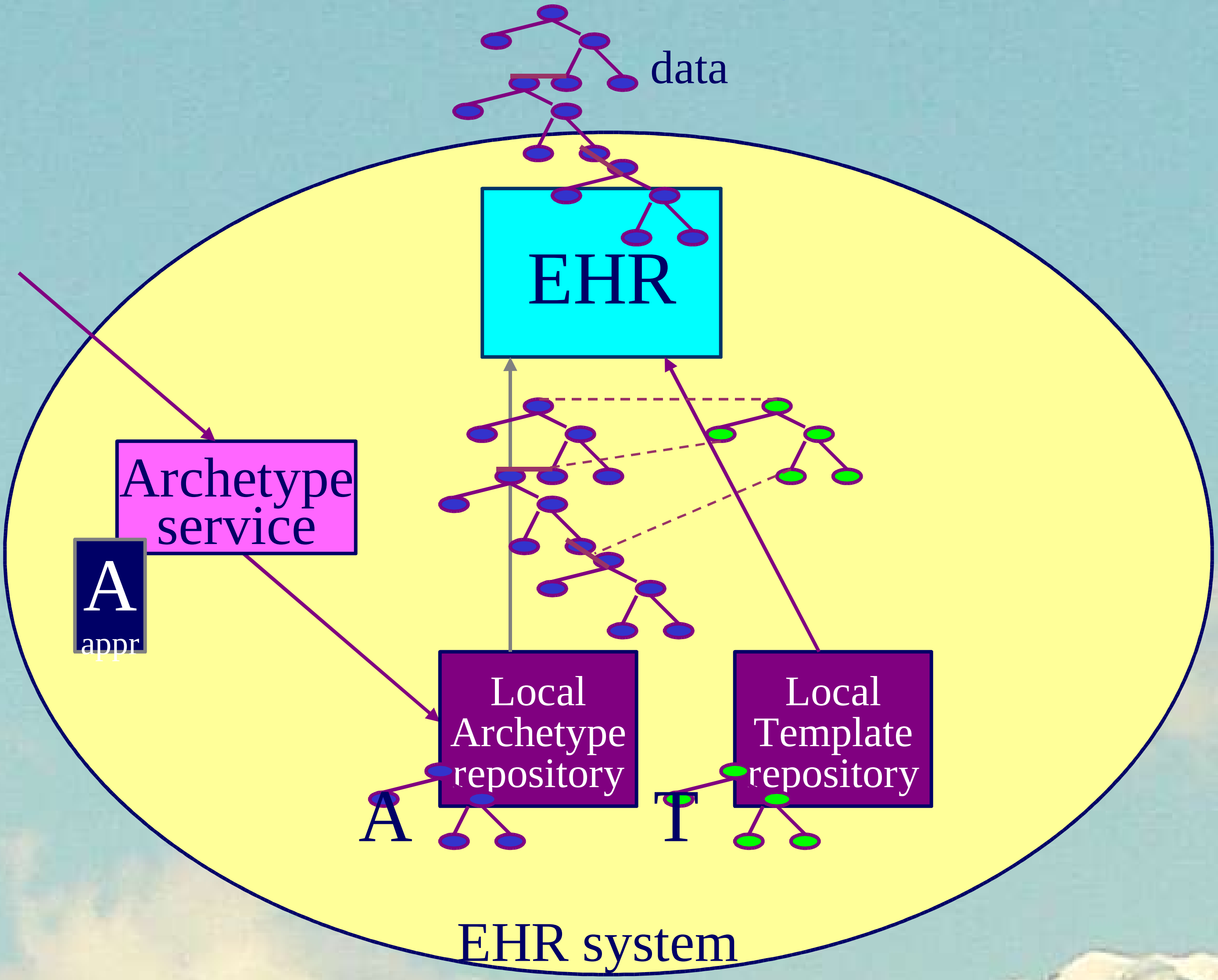
Archetype server

Network

-machine interop

-Approved archs

Templates and archetypes at runtime



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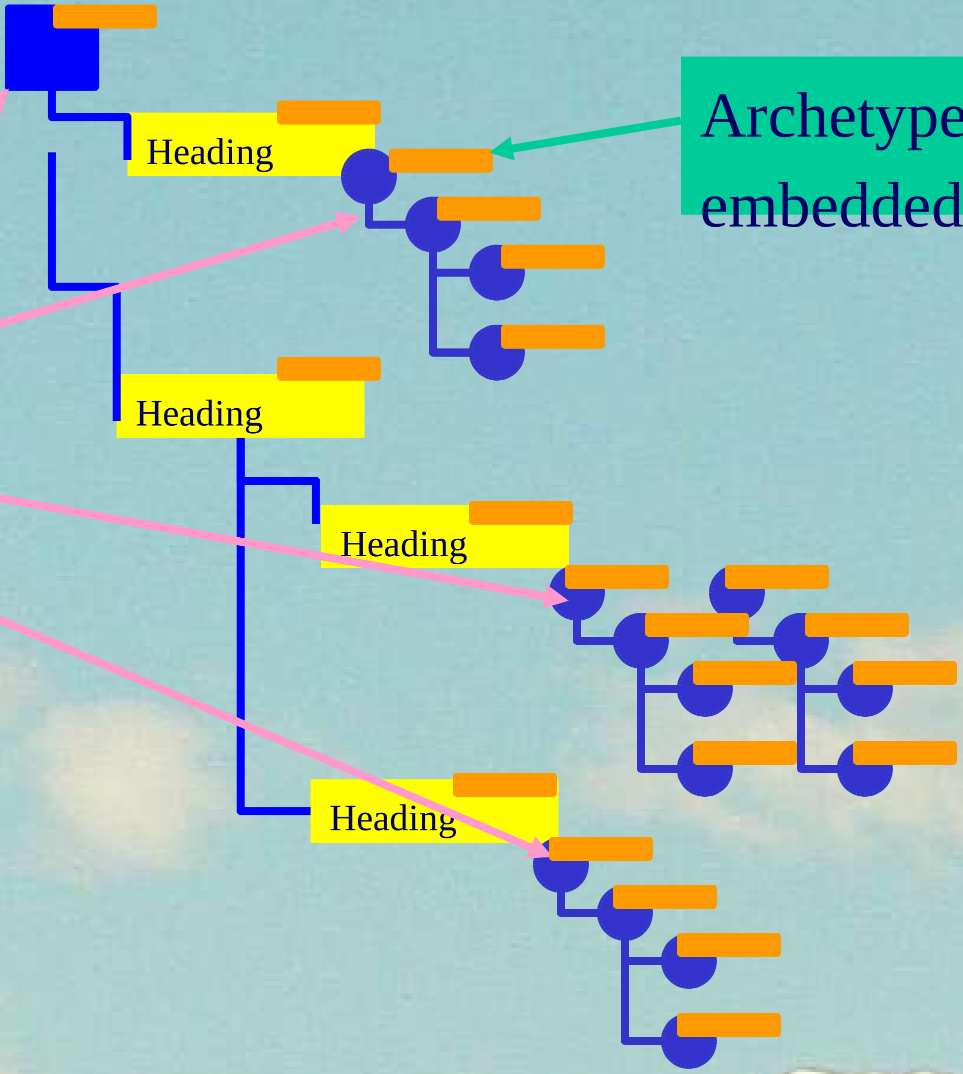
What the data look like



Archetype ids embedded in data

Template

-slots filled

-default values

-constraints narrowed

-terminologie(s) chosen

-language chosen

What an archetype looks like

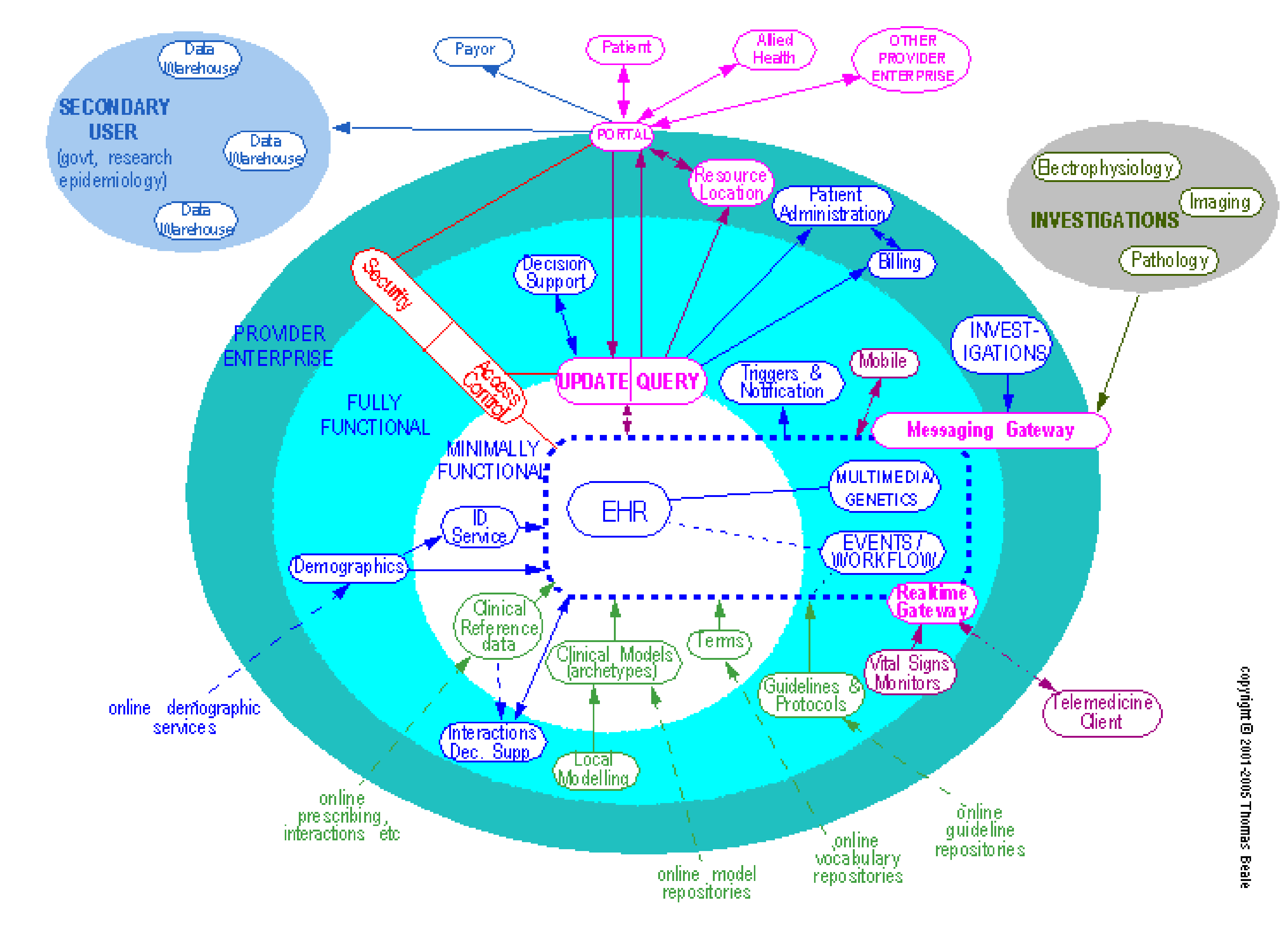
- (editor) ▶
- (HTML) ▶
- (workbench) ▶

- Formal basis:
  - Constraint part corresponds to an F-logic query
  - Ontology part acts as a binding to terminologies

* * * Programme * * *

- What is *open*EHR?
- The community and getting involved
- *open*EHR deliverables, products, systems
- *open*EHR in use
- Technical basis
- Archetypes and 2-level modelling
- EHR communication
- *open*EHR, CEN, HL7

Various types of comm. needed



Communication Methods

- Via EN13606 (will be built-in)
- Via *open*EHR Extracts (fewer transformations)
- Future: via *open*EHR messages for pathology and imaging (based directly on archetypes)
- In XML/SOAP, .Net, Corba…

Distributed Architectures

- Consolidated federation is better than pure virtual federation
  - *open*EHR repository at each node – acts as smart cache
  - Legacy conversion at local points using legacy archetypes, at data capture time
  - Main backbone of system is *open*EHR, with common security and communication between nodes
  - Avoids problems of differing security, query, performance etc of different systems
- Each major node could be e.g. J2EE application server supporting thick client and web client

* * * Programme * * *

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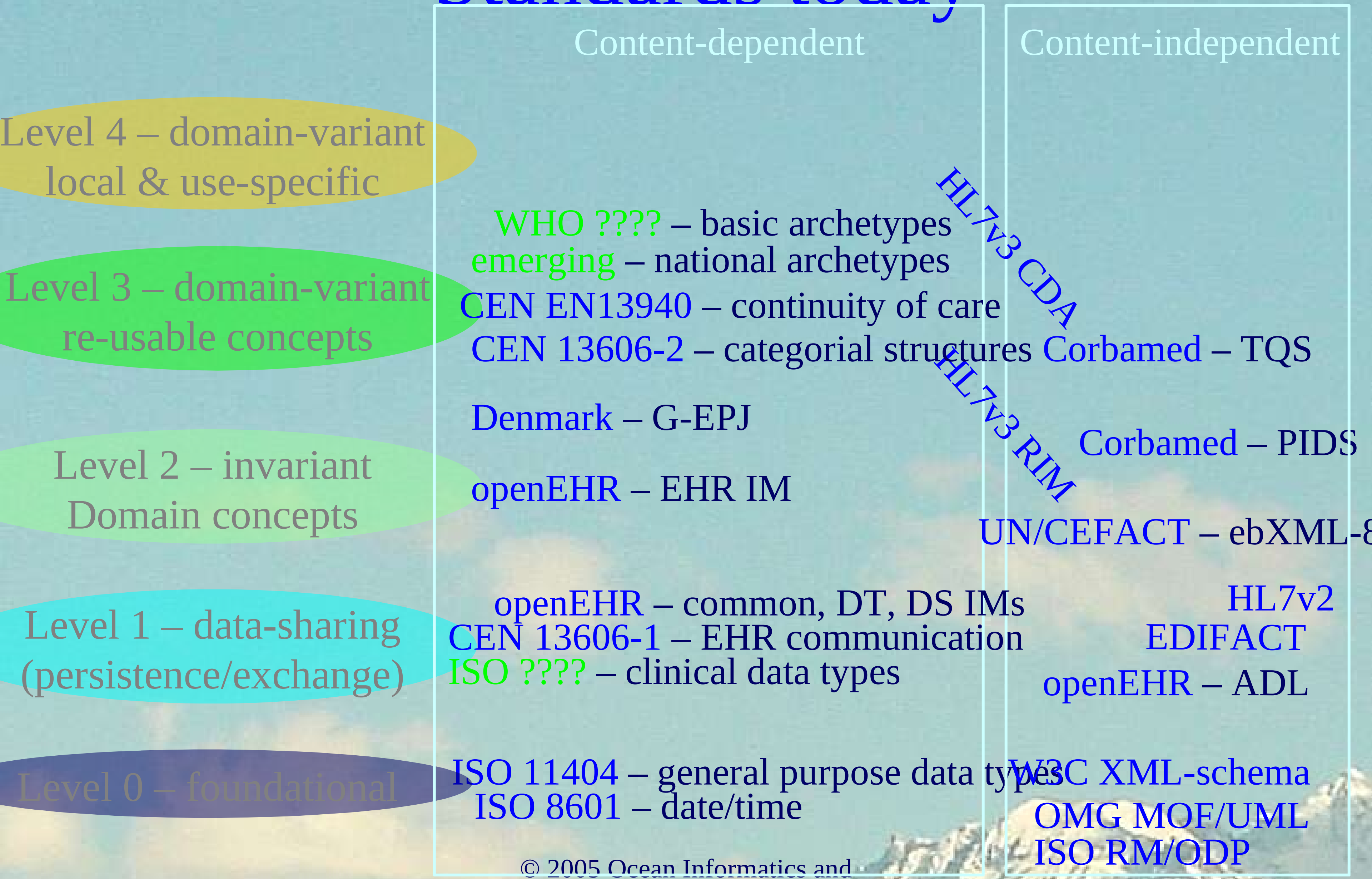
Standards today



Content-dependent

Content-independent

Level 4 – domain-variant local & use-specific

Level 3 – domain-variant re-usable concepts

Level 2 – invariant Domain concepts

Level 1 – data-sharing (persistence/exchange)

Level 0 – foundational

WHO ???? – basic archetypes

emerging – national archetypes

CEN EN13940 – continuity of care

CEN 13606-2 – categorial structures

Corbamed – TQS

HL7v3 CDA

HL7v3 RIM

Denmark – G-EPJ

Corbamed – PIDS

openEHR – EHR IM

UN/CEFACT – ebXML-8

openEHR – common, DT, DS IMs

CEN 13606-1 – EHR communication

ISO ???? – clinical data types

HL7v2

EDIFACT

openEHR – ADL

ISO 11404 – general purpose data types

ISO 8601 – date/time

W3C XML-schema

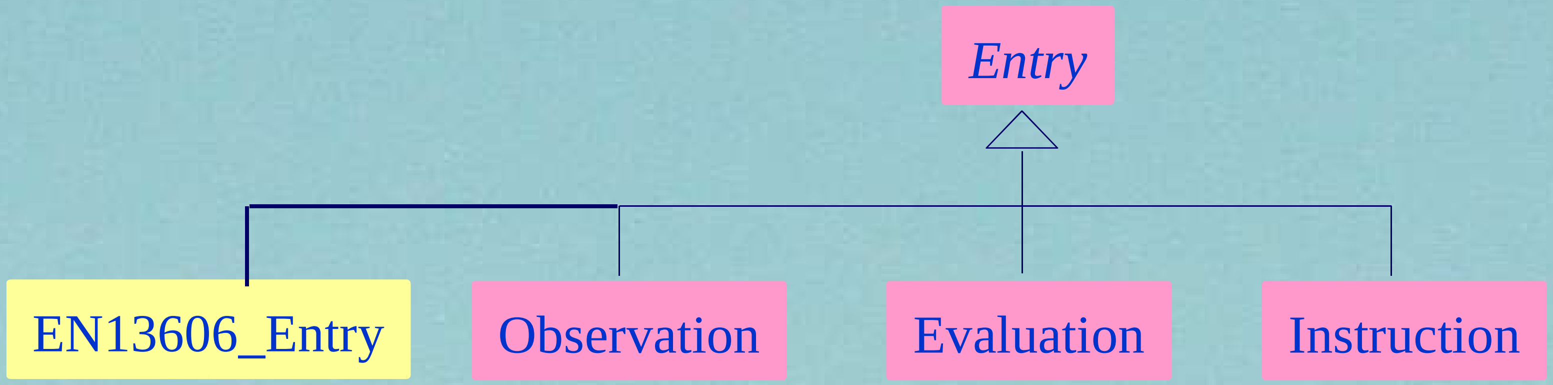
OMG MOF/UML

ISO RM/ODP

Relation to Standards – EN13606

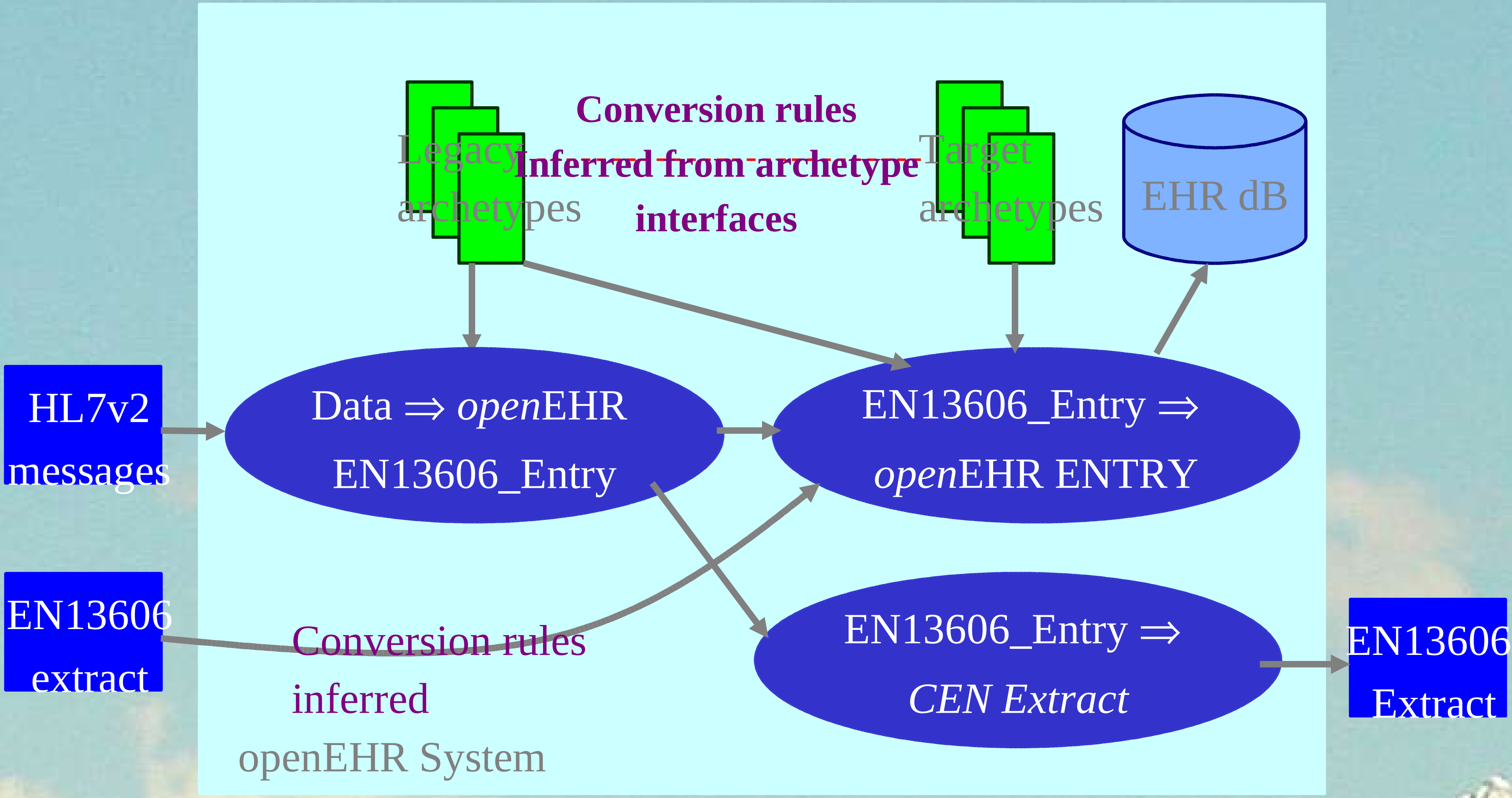
- *open*EHR developers have been active in CEN for 4 years
- 95% compatible with EN13606-1
- *open*EHR archetype model used as EN13606-2
- *open*EHR will implement the specification (using *open*EHR data types)
- => all *open*EHR systems will be EN13606 compliant
- Driving new work item for new CEN standard on archetype tools, environment, and base ontology model

EN13606_Entry proposal



- New EN13606_Entry class models:
  - CEN EN13606 Entry class itself faithfully
  - Using *open*EHR Cluster/Element (same as CEN)
  - And *open*EHR data types
- Conversion rules defined within *open*EHR
- And implemented and tested in real software

Legacy Data Examples



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Relation to Standards – HL7

- HL7v2 bridges are being built in Australia
- *open*EHR developers and community members have been active at HL7 for 5 years
  - Some success in harmonising CDA
- Connection with HL7v3 more difficult:
  - HL7 models don’t obey good ontological principles
  - HL7 methodology breaks some OO rules
  - RIM too small, uses many codes to control instances; most codes not relevant to EHR (or messages?)
  - Poor separation of domain concepts and software models

Other Standards

- ISO TS 18308 EHRRA requirements - ~conformant
- *open*EHR driving new ISO data types work item
- Active in Australian standards development

*open*EHR is dedicated to…

- Being driven by clinician and patient needs
- Specifications that compile, not just print.
- Implementation, not just explanation.
- Being the test bed for health IT standards. If it doesn't work, we'll find out!
- Open & free specifications and source code
- Its community