

*open*EHR in real world settings

Dr Ian McNicoll



*open*EHR

Introduction

- Dr Ian McNicoll
 - Family doctor in Glasgow, Scotland for 15 years
 - Independent health informatics consultant
 - NHS
 - openEHR
 - Archetype Editorial Group
 - Ocean Informatics
 - Clinical Analyst



Overview

- Interoperability and the EHR -the Scottish experience
 - What has worked?
 - What has not worked?
- Why is the Scottish NHS seriously considering openEHR?
- What is openEHR?
 - Who is using it?
 - How is it being used?



NHS Scotland

- “Four countries”

- England – 52 million
- Scotland – 5.1 million
- Wales – 3.7 million
- Northern Ireland – 1.7 million



- Health is a devolved responsibility and is increasingly diversely managed including IT strategy, implementation



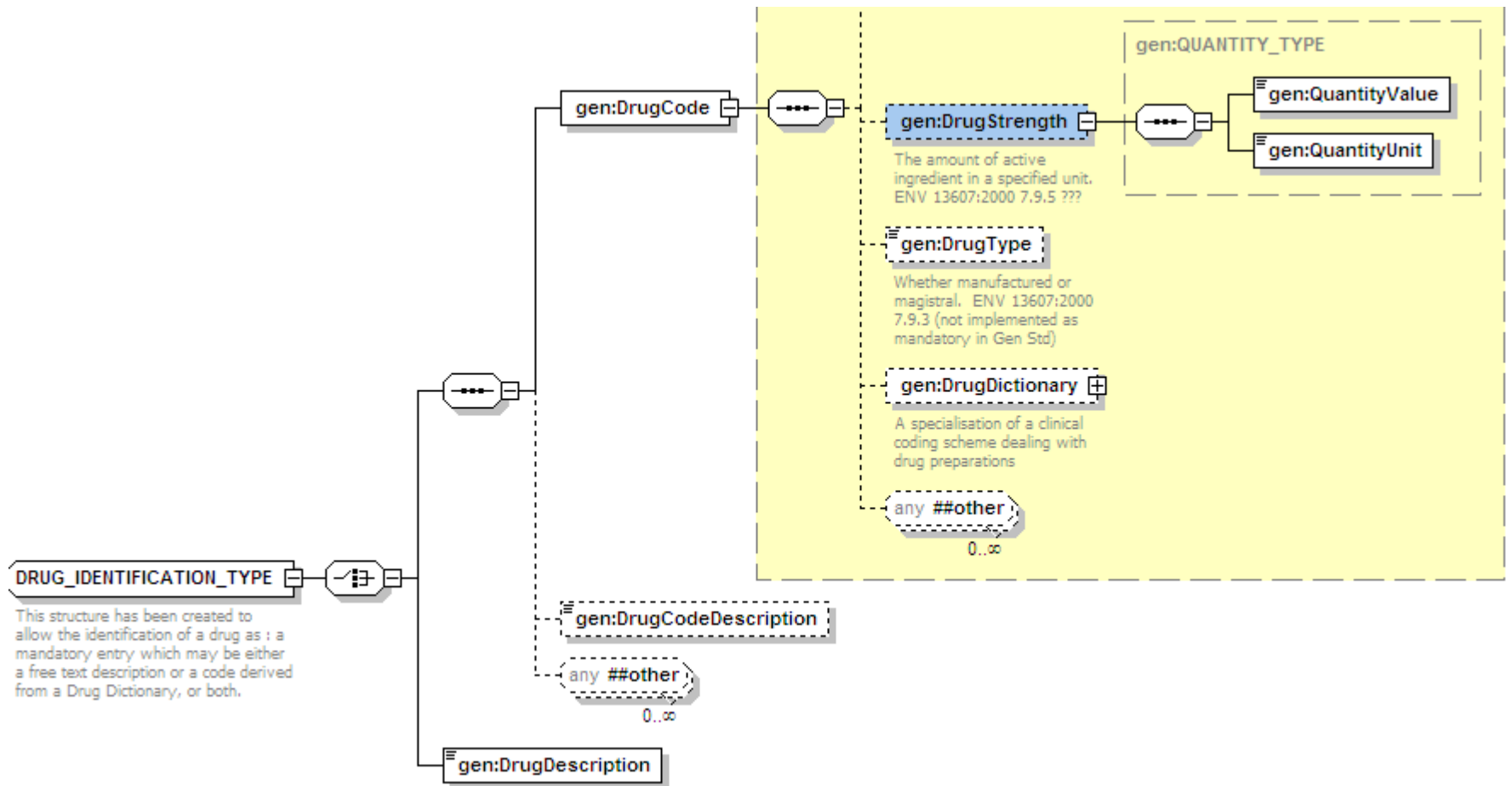
“Scotland has a low population density, mainly due to many parts of Scotland being unsuitable for people to live.”



Scottish eHealth strategy c2001

- “Single Shared Record”
 - SCI-Stores
 - Regional repositories for documents, lab tests
 - Single shared application
- “Ruthless standardisation”
 - National clinical datasets programme
- Clinical communications infrastructure
 - SCI- Gateway message comms.
 - SCI-XML message format (EN13606)
 - No HL7 - felt to be too complex

SCI-XML



Scottish eHealth strategy 2002-2008

~~• “Single Shared Record”~~

- SCI-Stores
 - Regional repositories for documents, lab tests
- ~~• Single shared application~~

• ~~“Ruthless standardisation”~~

- National clinical datasets programme

• Clinical communications infrastructure

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eHealth strategy success

- Easy win projects (relatively)
 - PACS Radiology
 - GP prescription messaging
 - GP Quality and Outcome framework payments
 - Similar to Piedmont GP project
 - Money!!

Communications success

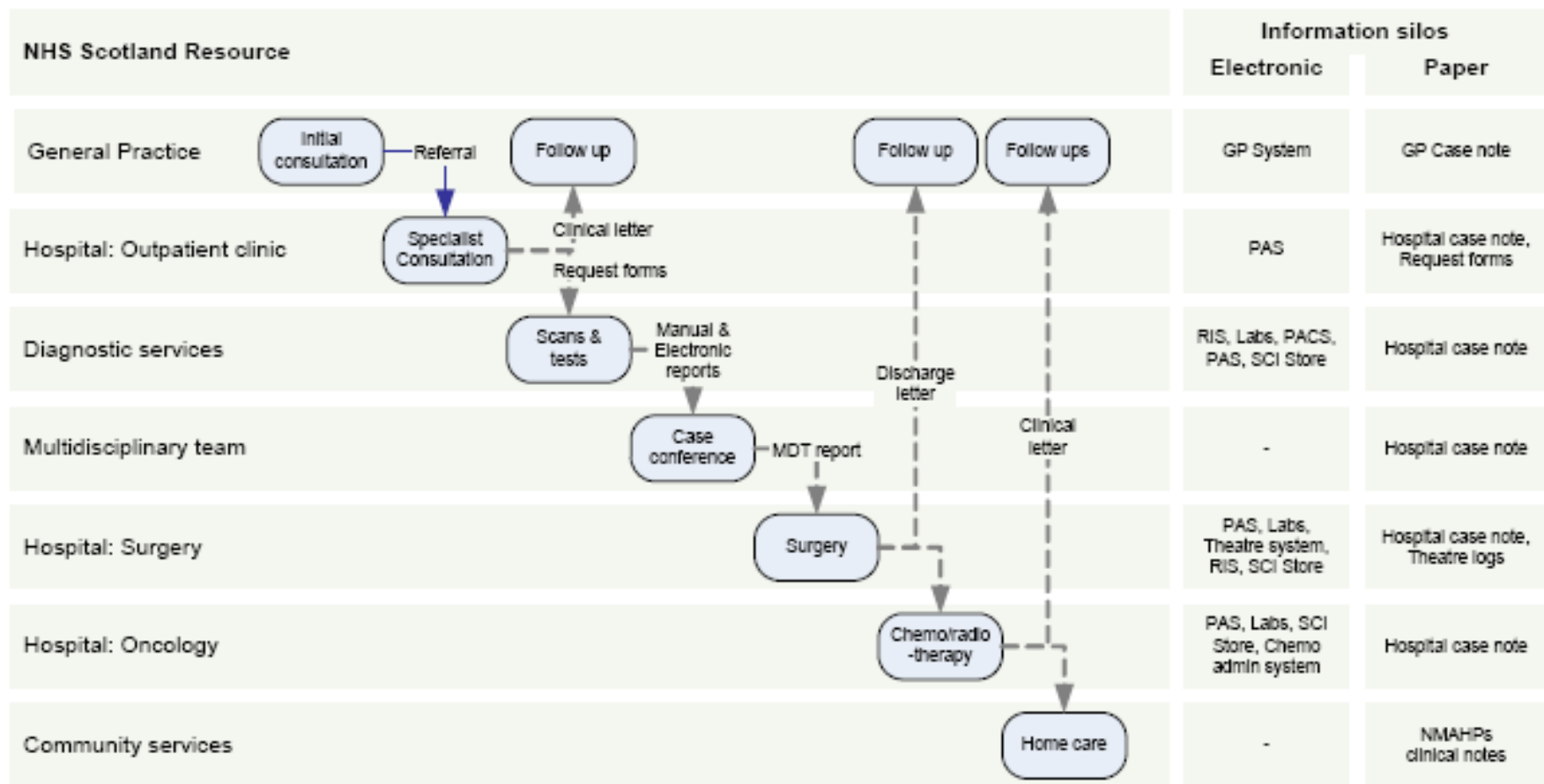
- Clinical communications infrastructure
- SCI- Gateway + SCI-XML
- SCI-XML messages
- Emergency Care Summary
 - Out of Hours centres and hospitals
 - 95% uptake
 - Allergies, current medication from GP systems
 - Extended to support palliative-care data
- SCI-Diabetes
 - Clinical data shared between GP / diabetes specialists
 - Level 2 interoperability “Targetted clinical dataset”

But.....

- There is clearly a move away from semantic interoperability
 - Almost all is Level1-2 communication with limited clinical semantics
 - ECS is stored as an XML-blob
 - No active allergy alerts
- Is this ..
- “Communication not computation” - Coiera
 - Sensible re-evaluation of cost-benefit
 - Or are rich clinical semantics just too difficult?

NHSS eHealth strategy 2008

supporting the patient journey



— Electronic — Paper —

Back to the future?

- Whilst the increased emphasis on document-level information sharing and targeted clinical dataset sharing is sensible and pragmatic...
 - Large tracts of healthcare and patients inhabit Angelo's unstable complex Level 3
 - It may become increasingly difficult to sustain multiple Level 2 clinical datasets for diabetes, cardiology etc given the overlaps in information and patient multi-pathology
 - Proper support for 'the patient journey' and patient safety will require us to re-address the "horrors" of Level 3

Barriers to Level 3 interoperability

- The difficulties of gathering and formalising computable clinical knowledge
 - To inform application design
 - To define message content
 - To enable complex secondary uses analysis
- The difficulties of adapting EHR artefacts to cope with rapid changes in clinical requirements and varied clinical viewpoints
 - Database design
 - Clinical objects
 - Messaging structured clinical content

Clinical Knowledge

Knowledge

- Formally expressed in:
 - Terminology
 - Medication data bases
 - Decision support – guidelines, rules
 - Software
- Informally expressed in:
 - Documents
 - Data dictionaries
- Continually evolving:
 - restructured, new, deprecated

The data dictionary

http://www.datadictionary.scot.nhs.uk/ Go

ISD HOME
COMMENTS

Health and Social Care
Data Dictionary

SCOTTISH EXECUTIVE

NHS
National Services
Scotland

Home Dictionary SMR Datasets Clinical Datasets Social Care Datasets

Search Go Back << >> Print

Introduction to the Dictionary
Definitions by Groups
Definitions A-Z
Appendices

A B C D E F
G
H I J K L M
N
O P Q R S T
U
V W X Y Z

[ISD Data Dictionary](#) > [Definitions & Codes](#) > [Definitions A-Z](#) > D

D

[Date \(Data standards\)](#)

[Date of Birth](#) **Clinical Data**

[Date of Birth](#) **SMR**

[Date of Death](#) **Clinical Data** **Social Care Data**

[Date of Delivery](#) **SMR**

[Date of Inclusion in Last Geriatric Long Stay Census](#) **SMR**

[Date of Main Operation/Treatment/ Investigative Procedure](#) **SMR**

[Date of Other Operation/Treatment/ Investigative Procedures \(2-4\)](#) **SMR**

[Date of referral](#)

[Date referral received](#)

“Ruthless standardisation”

Health and Social Care Data Dictionary			
			SCOTTISH EXECUTIVE
			
Dictionary - A-Z	SMR Datasets	Clinical Datasets	Other Standards
Back	<<	>>	Print

[Clinical Datasets](#) > [Stroke](#) > [Stroke Inpatient Dataset](#) > [Neurological Assessments](#) > Glasgow Coma Scale - Eye Opening

Formal Name:Glasgow Coma Scale - Eye Opening

Common Name(s)

GCS

Definition

A record of the patient's eye response assessed using the Glasgow Coma Scale tool.

Format

Characters

Field Length

2

Codes and Values: (Code order)

01 Spontaneous	Open with blinking at baseline. Score of 4.
02 To speech	Score of 3.
03 To pain	Not applied to face. Score of 2.
04 None	Score of 1.
05 Unassessable	For example, patient does not have eyes

[Sort by Code](#)

[Sort by Value](#)

[Remove Headings](#)

Attributes

Laterality:

Left
Right
Bilateral

Related Data Items

[Conscious Level](#)

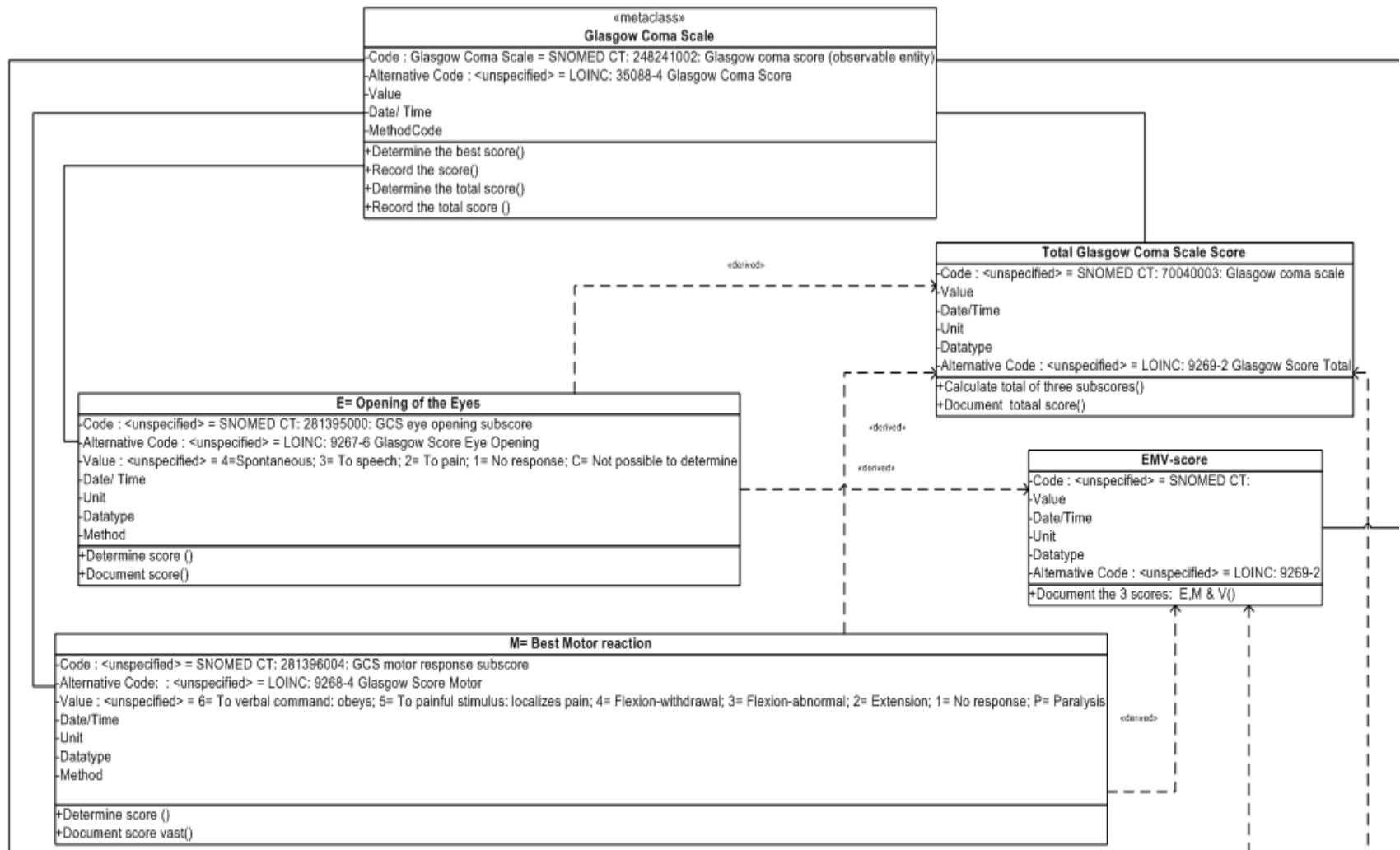
Further Information

The Glasgow Coma Scale provides a framework for describing the state of a patient in terms of three aspects of responsiveness: eye opening, verbal response and best motor response, each stratified according to increasing impairment (Ref SIGN 46).

The data dictionary and minimal dataset approach

- Secondary uses, export requirement
 - service analysis
 - epidemiology
 - Research
- Not fit for detailed data-capture requirements, message content definition
 - To support semantic interoperability
 - Decision / workflow support
 - Detailed operational analysis

Capturing clinical knowledge – UML?



Why is EHR data so difficult?

Clinical domain is extremely complex:

- Information/Knowledge
- Organisational
 - Work flow
 - Fragmentation/specialisation
 - Biological, physiological, psychological, social model
- Expensive
 - Cost and time

Traditional software development
= 'out-of-date' application at launch.

Complexity of Health Knowledge

The total number of concepts and the rate of change is high

- SNOMED medical termset codes some 450,000 atomic concepts and over 1 million relationships

Not only is health care big, it is open-ended:

- *In breadth*, because new information is always being discovered or becoming relevant
- *In depth*, because finer-grained detail is always being discovered or becoming relevant
- *In complexity*, because new relationships are always being discovered or becoming relevant

Diversity

Huge diversity of possible statements

- Heart rate.....72/min
- Microbiology result
- Psychiatric assessment

Structural diversity

State/Context

Certainty

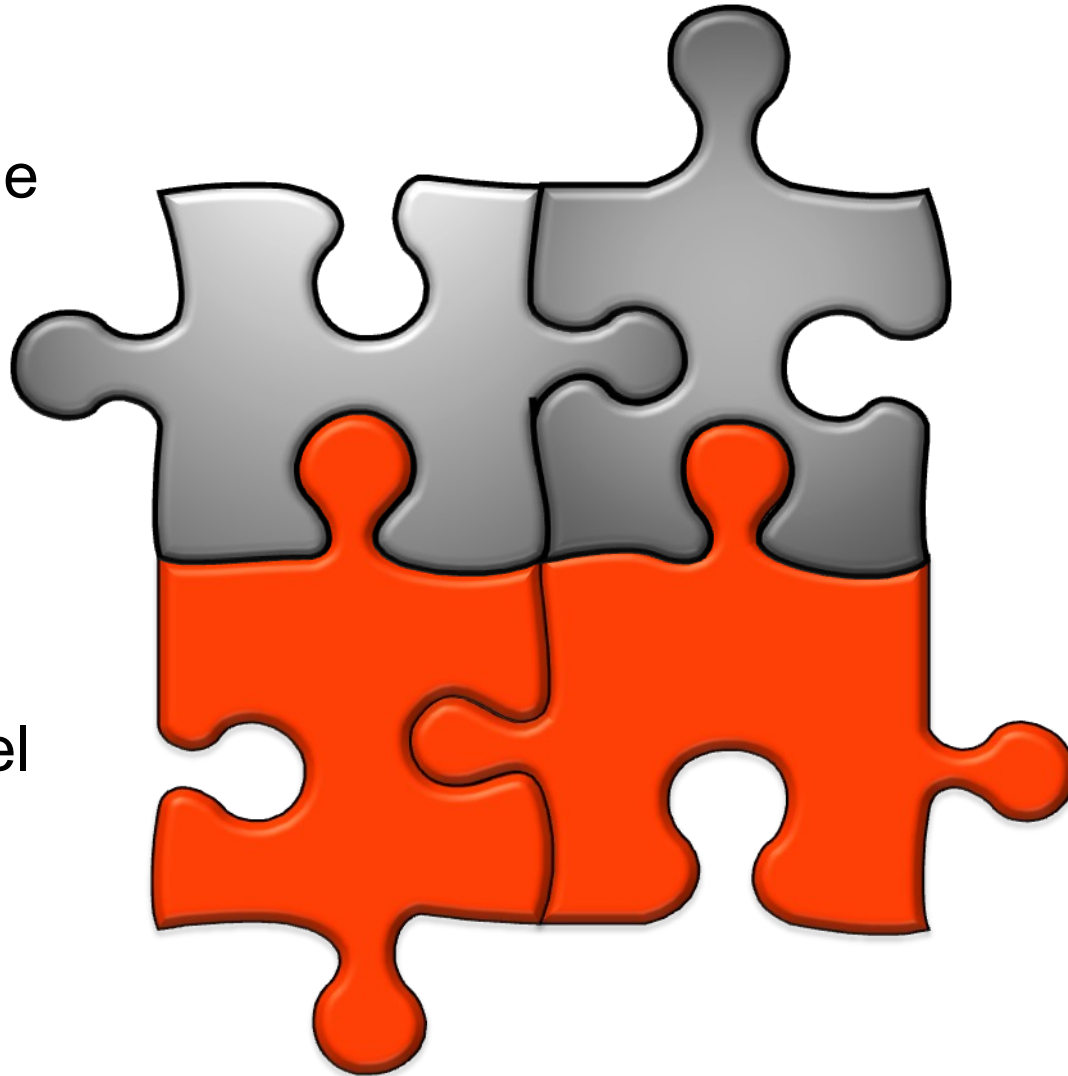
Normal statements

Narrative vs structured

Traditional Application Development

Clinical
Knowledge

Data Model



Scottish eHealth strategy 2008+

- HL7 CDA documents
 - Level 2
 - *Possibly* Level 3 structured content using
 - SCI-XML for legacy content
 - openEHR for new content
 - HL7v3 only where use cases or UK defined content

Scottish eHealth strategy 2008+

Logical Record architecture

- **Computable** Clinical Knowledge
 - Web 2.0 -based clinical engagement
 - openEHR archetypes/templates
 - Derive clinical models as source for
 - Guidance to application developers
 - Define structured content for messages
 - ? Underpin regional repositories

What is *open*EHR?

A specification for a life-long electronic health record:

- **Fundamentally clinical**
 - Supports clinical health care recording
 - Supports this care in a distributed environment
- **Fundamentally international**
 - No language primacy
 - Agnostic about terminologies
 - Community enterprise
- **NOT...**
 - A back-end data store or clinical forms generator
 - An end-user EHR application

Abstract problems addressed...

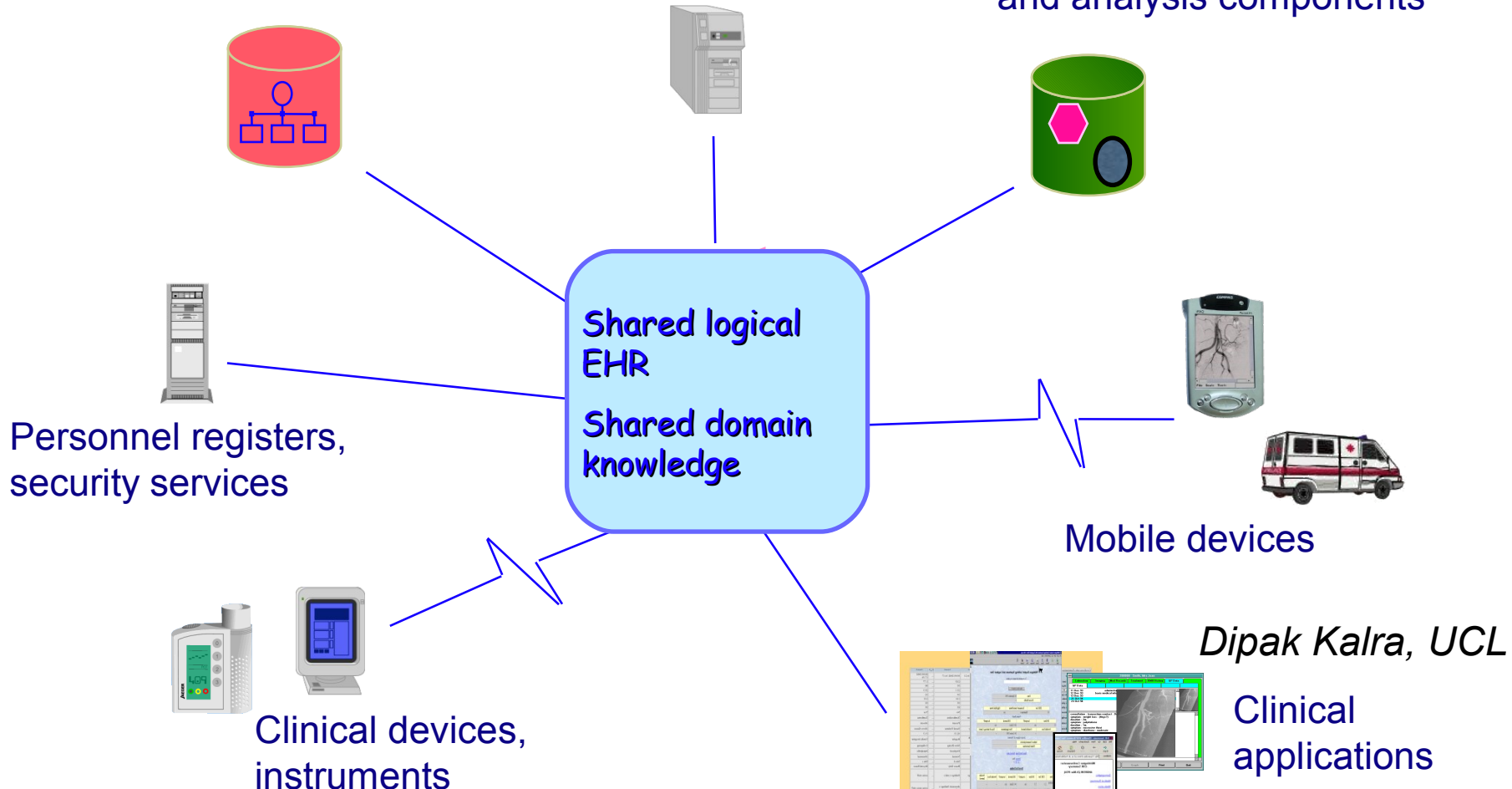
- Semantic interoperability:
 - How do different pieces of software know what the data mean?
- Patient-centric view:
 - How to build a patient-centric longitudinal EHR across enterprises?
 - For decision support, care pathways, health service management, public health, research
- Continual change and complexity:
 - How to build systems that keep up with reality?

The logical EHR

Clinical trials,
functional genomics,
public health databases

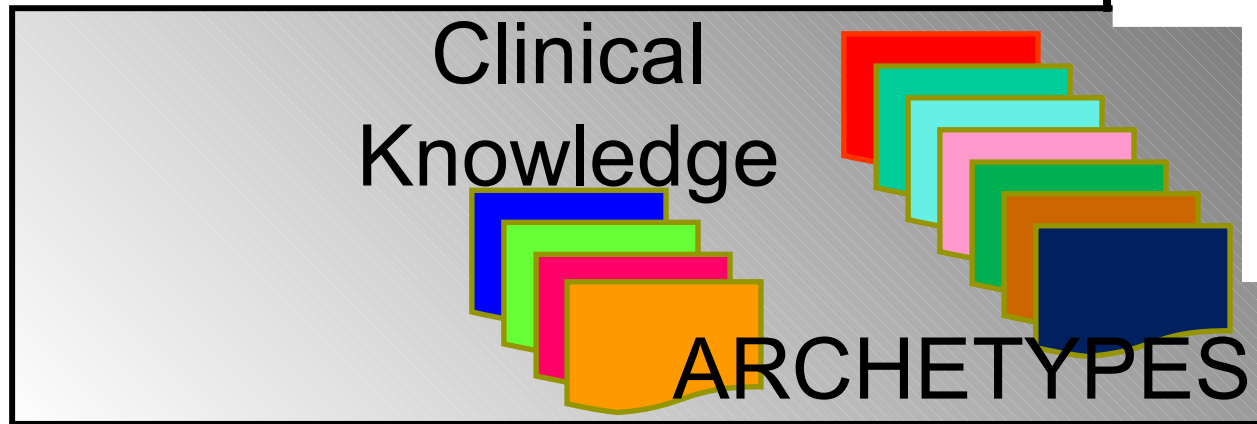
Clinical databases

Decision support,
knowledge management
and analysis components



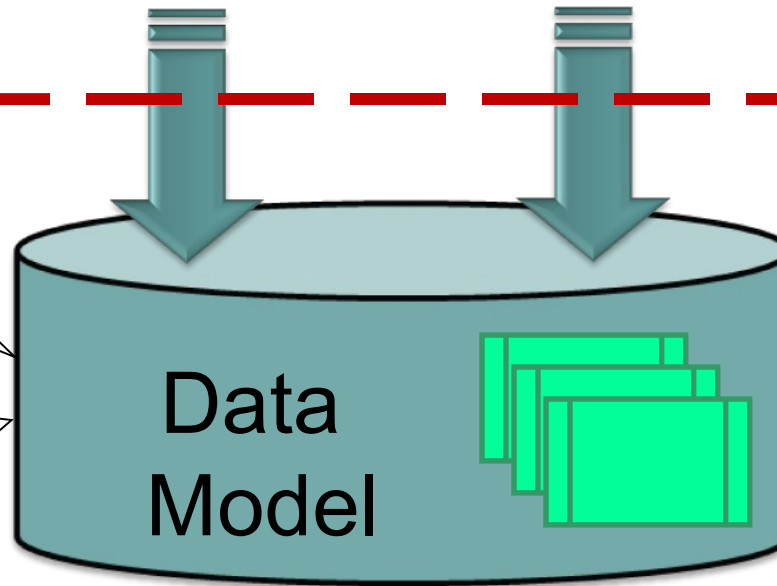
Dipak Kalra, UCL

openEHR 2 level modelling



Easier and cheaper to build and maintain

Contains only generic knowledge and business rules



Much smaller and simpler

Two level modelling

Archetype layer

- Supports computable clinical knowledge models independent of
 - Application form designer
 - Individual users /sites
 - Individual vendors, nations

Reference Layer

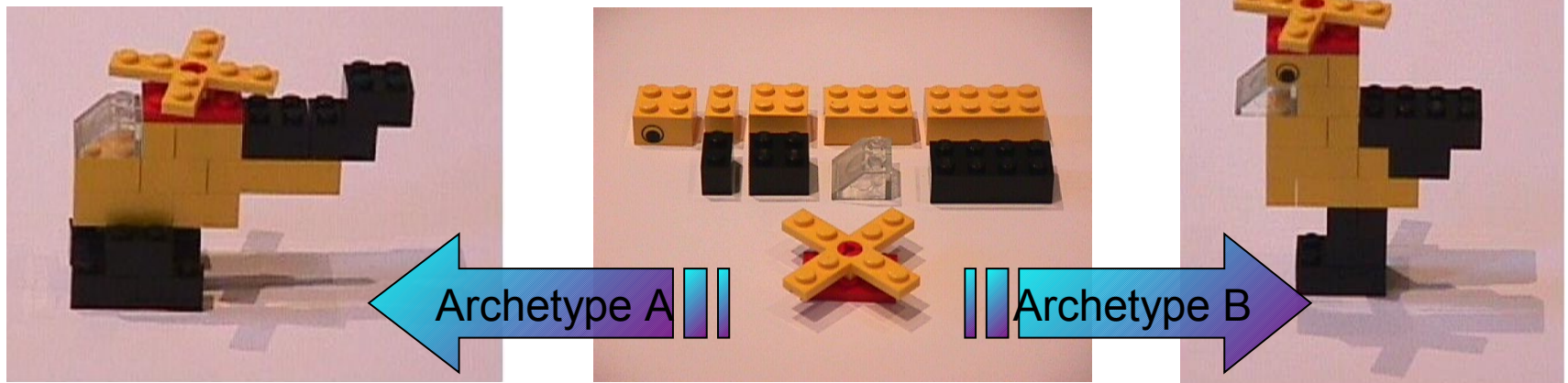
- Releases technical providers from having to continually adjust their data model to match every new or changed clinical idea

Principle

The components of the Reference Model are like
LEGO **brick specifications**

Archetypes = **instructions/designs** constraining the
use of LEGO pieces to create meaningful
structures

Information model
Instances



openEHR

Computable clinical knowledge



openEHR Archetypes








***openEHR* archetypes are models of clinical concepts**

- Keystone of *openEHR* architecture

Model a range of concepts:

- Simple and straightforward concepts
 - ‘blood pressure’
 - ‘weight’
- Complex compound concepts such as
 - ‘medication order’
 - ‘family history’

Clinical Knowledge - Archetype

Archetype: Glasgow Coma Scale (openEHR-EHR-OBSERVATION.glasgow_coma.v1)			
Header		Data	
	Best eye response Ordinal 0..1 (<i>optional</i>)	Best eye response to stimulus	1: No eye opening 2: Eye opening in response to pain 3: Eye opening to speech 4: Eyes opening spontaneously 
	Best verbal response Ordinal 0..1 (<i>optional</i>)	Best verbal response to stimulus	1: None 2: Incomprehensible sounds 3: Inappropriate words 4: Confused 5: Oriented 
	Best motor response Ordinal 0..1 (<i>optional</i>)	Best motor response to stimulus	1: No motor response 2: Abnormal extension to pain 3: Abnormal flexion to pain 4: Flexion withdrawal from pain 5: Localizes to pain 6: Obeys commands 
	Score Count 0..1 (<i>optional</i>)	The final score	

Ocean archetype editor [Peak Expiratory Flow Rate PEFR]

File Edit Publish Language Terminology Tools Help

openEHR-EHR-OBSERVATION.peak_expiratory_flow_rate.v1

Header Definition Terminology Display Interface Description

☒ Protocol ☐ Participation ☐ Person State with EventSeries

Data Protocol

☒ Person State

Tree Events State

☐ Ordered at0005

- Q** Expected peak expiratory flow rate
- 12** Recorded/predicted peak expiratory flow rate ratio
- Q** Single peak expiratory flow rate
- ⌚** Number of consecutive days at less than 80% PEFR
- Q** Best ever peak expiratory flow rate
- T** PEFR Result
- T** Comments

Constraint Details

Occurrences

Min: 0 Max: 1 ☐ Unbounded

Description: *

Runtime name constraint:

Quantity

Property: Flow Rate, Volume

Units: l/m

Count ☐ Limit decimal places

☐ Set min. value

☐ Set max. value

Archetype modelling

Requires:

- ~~Minimum Dataset?~~
- Maximum Dataset?

**Each archetype is inclusive of
ALL
attributes clinicians might want to
capture about a discrete concept**

Computable Clinical Knowledge – ADL/XML

definition

```
OBSERVATION[at0000] matches {          -- Glasgow Coma Scale
  data matches {
    HISTORY[at0001] matches {          -- Event Series
      events cardinality matches {1..*; unordered} matches {
        EVENT[at0002] occurrences matches {0..1} matches {          -- Any event
          data matches {
            ITEM_TREE[at0003] matches {-- Tree
              items cardinality matches {0..*; unordered} matches {

ELEMENT[at0009] occurrences matches {0..1} matches { -- Best eye response
  value matches {
    1|[local::at0010],          -- No eye opening
    2|[local::at0011],          -- Eye opening in response to pain
    3|[local::at0012],          -- Eye opening to speech
    4|[local::at0013]          -- Eyes opening spontaneously
  }
}

ELEMENT[at0007] occurrences matches {0..1} matches { -- Best verbal response
  value matches {
```

openEHR Templates

Templates are formal specifications defining a particular aggregation of archetypes

- Context, purpose, clinical domain or location.
- Constrain the component archetypes to make them 'fit for purpose', including
 - assigning default values,
 - addition of mandatory items
 - Hiding non-mandatory items

In practice...

- combining and further constraining archetypes
 - Define localised data entry requirements
 - Reports
 - Message content

Observations: History

Symptom



Clinical description



BP

systolic mm[Hg]

diastolic mm[Hg]

Weight kg

Examination of the uterus

Normal statements

Clinical description



Size

Fundal height cm

Weeks

Assessment of liquor volume

Number of fetuses

Assessment

Rationale

Urinalysis

Glucose

Bilirubin

Ketones

Specific gravity

Blood

pH

Fetal movements

Presence

FH

Rate

/min

☒ Present

Examination of the fetus

Identifier

Normal statements

Clinical description

Lie of the fetus

Presentation

Position

Engagement

Size relative to gestation

Follow up

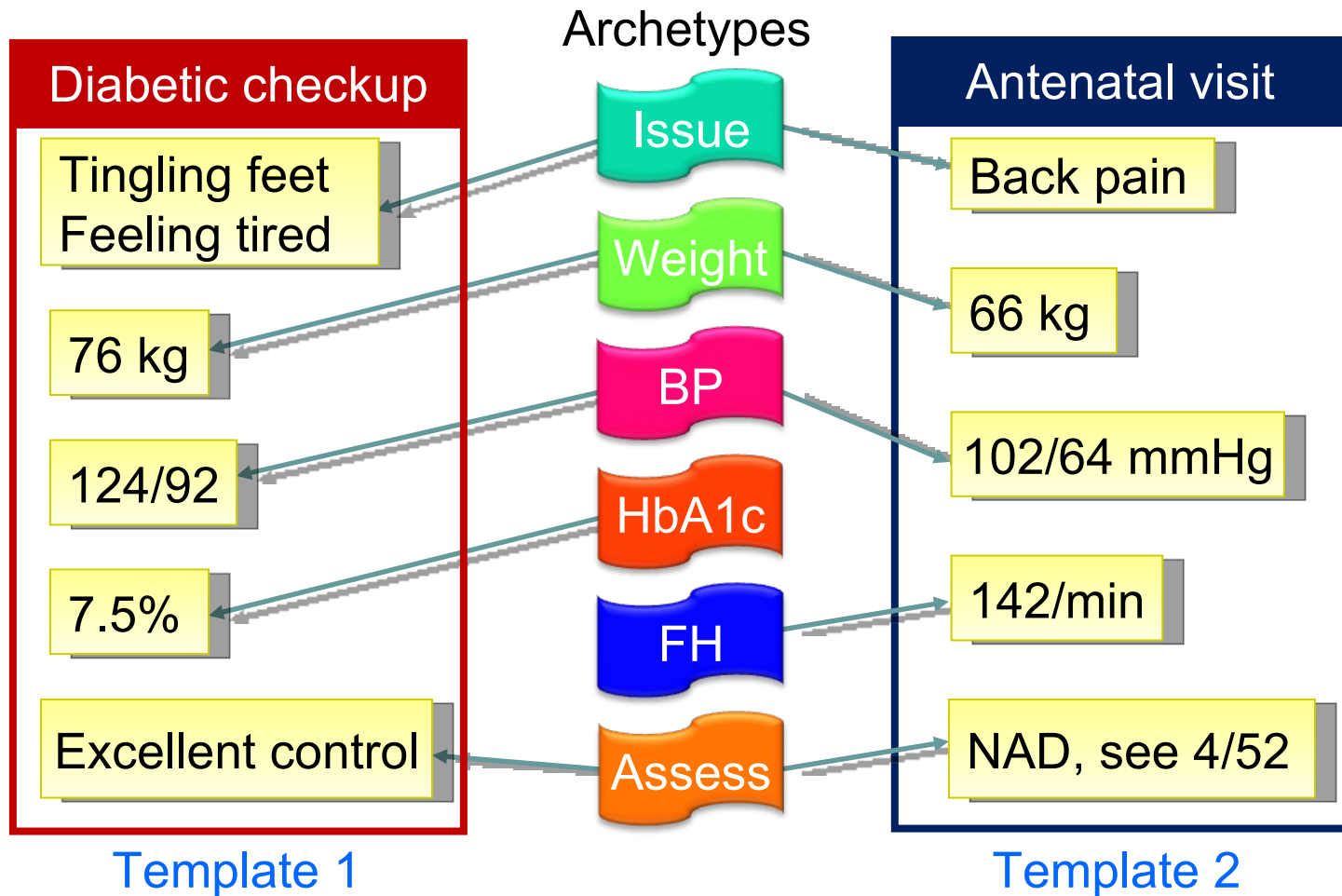
Service

Details

Appointment date and time

Monday .19 March 2007

Archetypes Re-use



Clinical Knowledge Manager

The screenshot displays the openEHR Clinical Knowledge Manager interface. On the left is a navigation pane with a tree view of archetype categories: Archetypes, Cluster, Composition, Demographic, Element, Entry, Action, Admin, Evaluation, and Instruction. The main area on the right shows search results for archetypes. At the top of this area are tabs for 'Find archetypes' and 'Dashboard'. A search bar with a 'Search again' button is present. Below the search bar, a message states 'Found 8 archetypes.' Three results are visible, each with a magnifying glass icon, a title, a 'Details' link, an 'Archetype ID', and a 'Status'.

Archetype ID	Status
openEHR-EHR-OBSERVATION.blood_match.v1	Draft
openEHR-EHR-OBSERVATION.blood_gases.v1	Draft
openEHR-EHR-OBSERVATION.blood_pressure.v1	Teamreview

Diagnosis

Diagnosis

Status

Date of initial onset 28 April 2007

Age at initial onset

Severity

Clinical description

Date clinically recognized 28 April 2007

Location

Body site

Location description

Anatomic site

Agent

☐ Complication of

Description

Occurrences or exacerbations

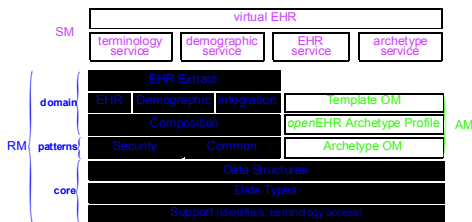
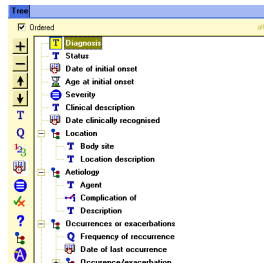
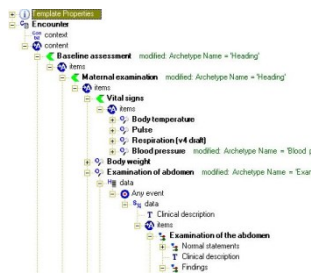
Frequency of recurrence 0.00

Date of last occurrence 28 April 2007

Occurrences or exacerbations

Clinical description

Outcome



1:N

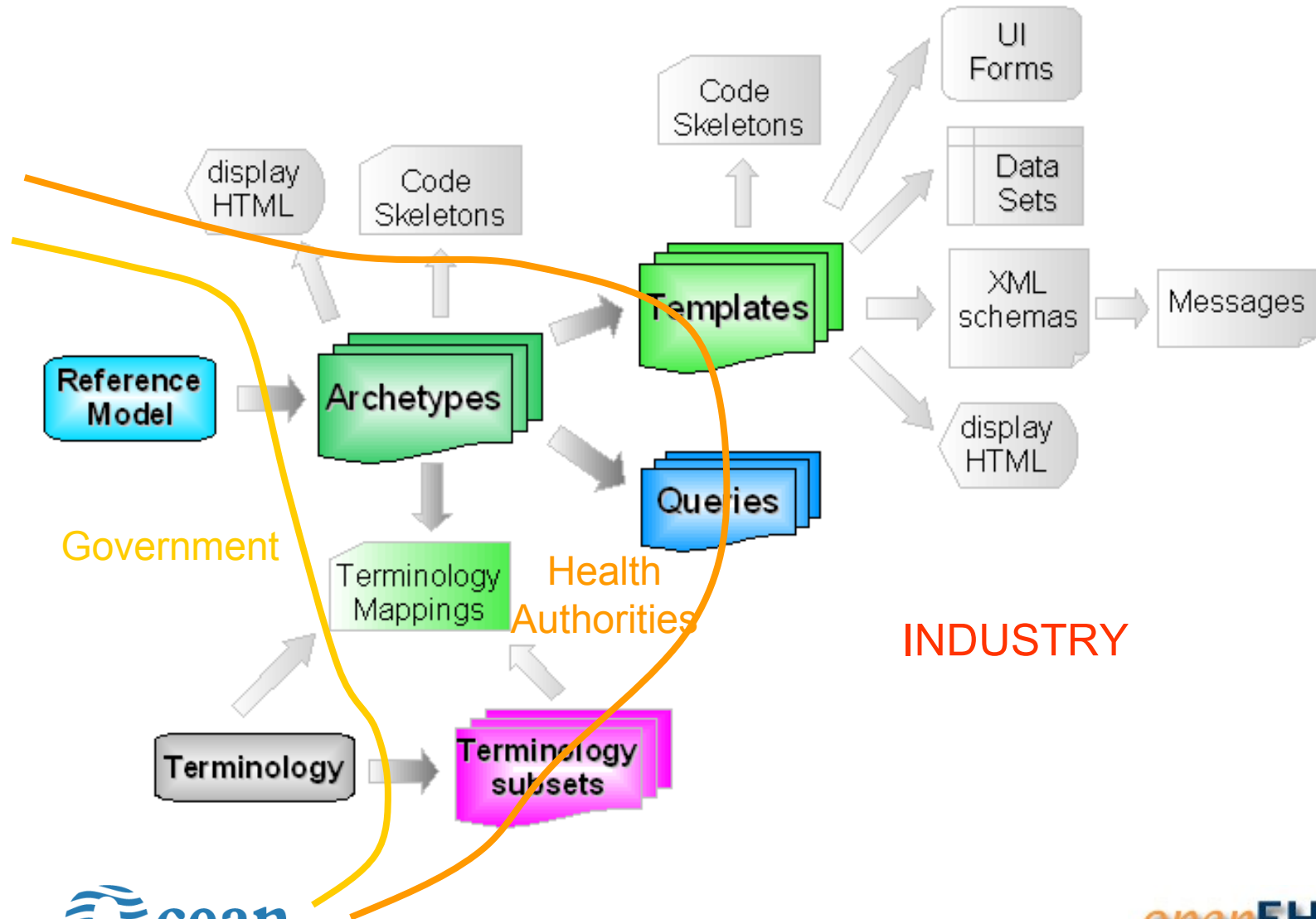
1:N

1:N

Terminology Interface

7 Querying

openEHR artefact ecosystem



Continual change and complexity

“The art of progress is to preserve order amid change and to preserve change amid order.” *Alfred North Whitehead*

“Co-operability”

- Archetype / Template approach allows a ‘**crumple-zone**’ where complete inter-system consensus cannot be achieved
- 30% interoperability is better than 0%

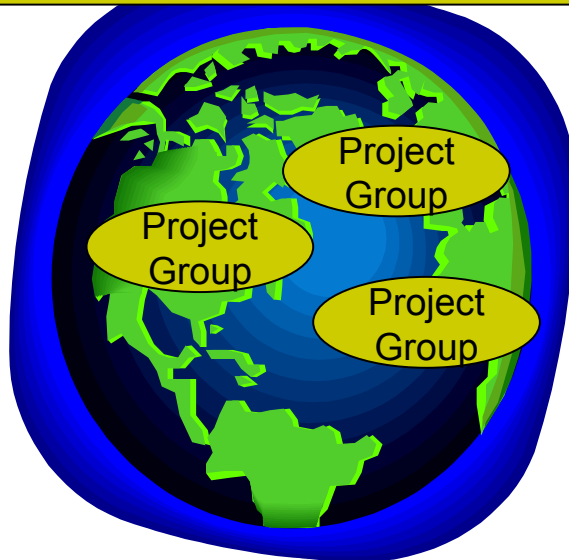
*open*EHR Foundation

- Driven by clinician and patient needs
 - Specifications that compile, not just print.
 - Implementation, not just explanation.
- Open & free specifications and source code
- It's a community

openEHR Governance

openEHR Board

Architecture Review Board



Technical

Clinical Review Board



Clinical

The *open*EHR Community

- Who are its members?
 - 1400 members, 84 countries
- What levels of involvement exist?
 - become a member on the website FREE!!
 - www.openehr.org
 - subscribe to discussion lists
- Technical stream
 - subscribe to implementers' discussion list
 - Use software or specs
 - Join a project: become a developer
 - work with Change Requests & submit changes

*open*EHR OS Products

Modelling and governance tools:

- ADL reference parser (.net, java)
- Ocean archetype editor, LUI archetype editor
- Authoring and release control repository
- Workbench

OS Java EHR system (MySQL)

- EHR service
- Demographics service
- Archetype service
- Terminology access service
- Application component

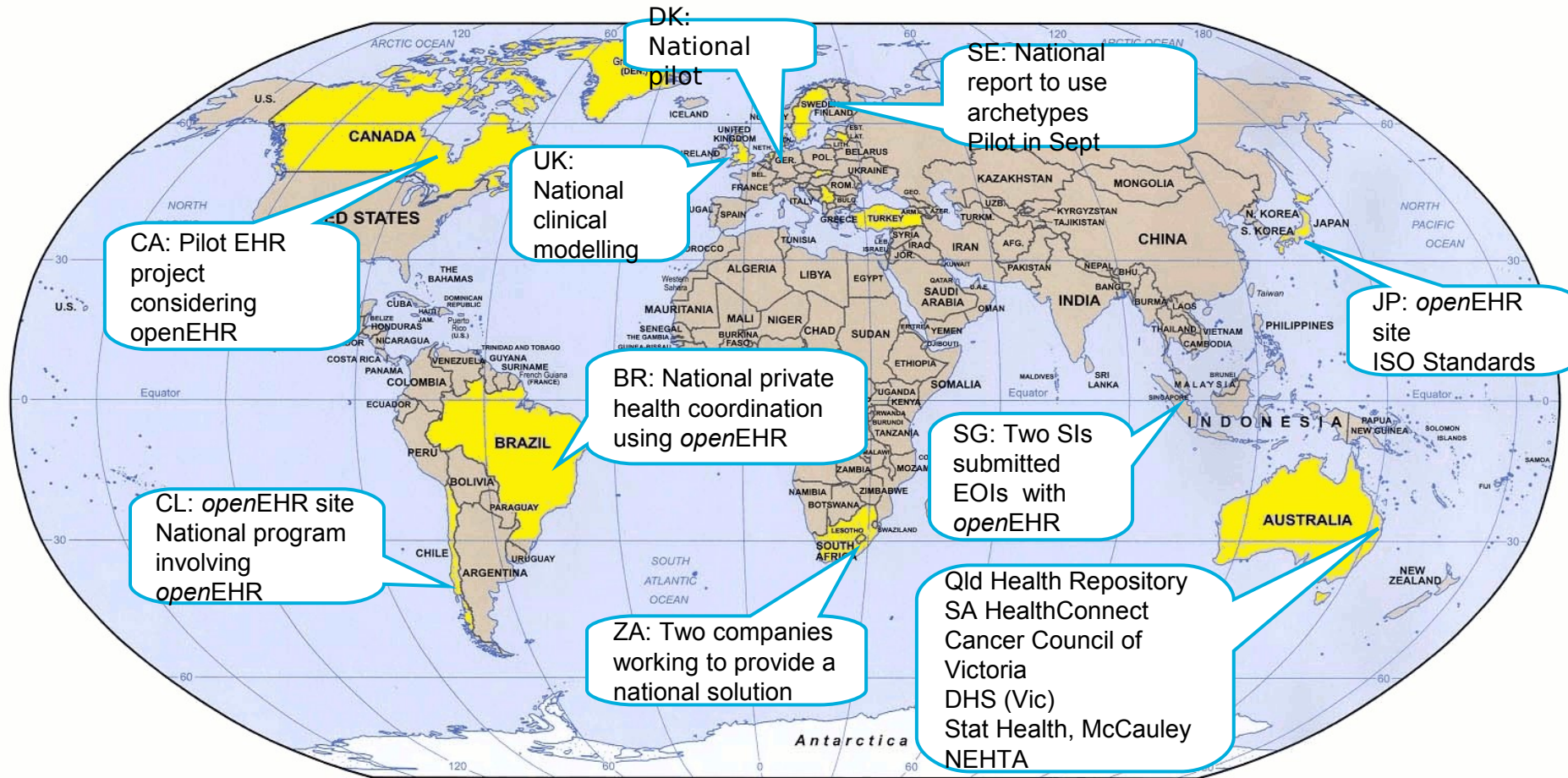
openEHR – How is it being used?

- Design-time..
 - Detailed clinical models definition
 - Increasing regional, national, supranational interest
 - Archetypes, Templates
- Run-time...
 - EHRs built partly or wholly around the openEHR specification
 - Make use of design-time models
 - Ocean Informatics .NET
 - Cambio Sweden JAVA

Who is using *openEHR* runtime?

- Ocean Informatics
 - Internationally
- Extensia
 - Regional repository – Australia
- Vivici
 - Home care – Netherlands
- Currently under development
 - Hospital - Netherlands
 - Primary care, Specialist Care – Australia
 - Hospital - Turkey

Uptake & interest in *openEHR*



Microsoft's internal *openEHR* site went live 2 weeks ago

Growing academic interest around the world

Computing platform for health

- Reference model
 - as the specification of how to represent data at a technical layer
- Archetypes
 - as the specification of how to represent information for a wide clinical community
- Templates
 - as the specification of how to use archetypes in specific clinical settings
- Service specification
 - as how to interact with the EHR Service
- Clinical Knowledge Manager
 - as how to manage archetypes and templates

Fin

