SNOMED CT, FHIR, and more

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IHE International: co-chair of Pathology and Laboratory Medicine (PaLM) committee
Interop'Santé: chair of HL7 France

Where do I speak from?

Two tightly bound organizations

PHAST

- Not-for-profit association
- Members: healthcare IT vendors
- Contributes to healthcare interoperability standards (HL7, IHE, SNOMED CT, LOINC ...)
- Current projects: HL7 IPS, Trillium II, Catalogs on FHIR, ...

PHAST SERVICES

- Company: production structure
- Customers: hospitals & clinics
- Builds and markets services deploying the standards in secondary care settings.
- Current services: terminology services, metathesauri, expertise

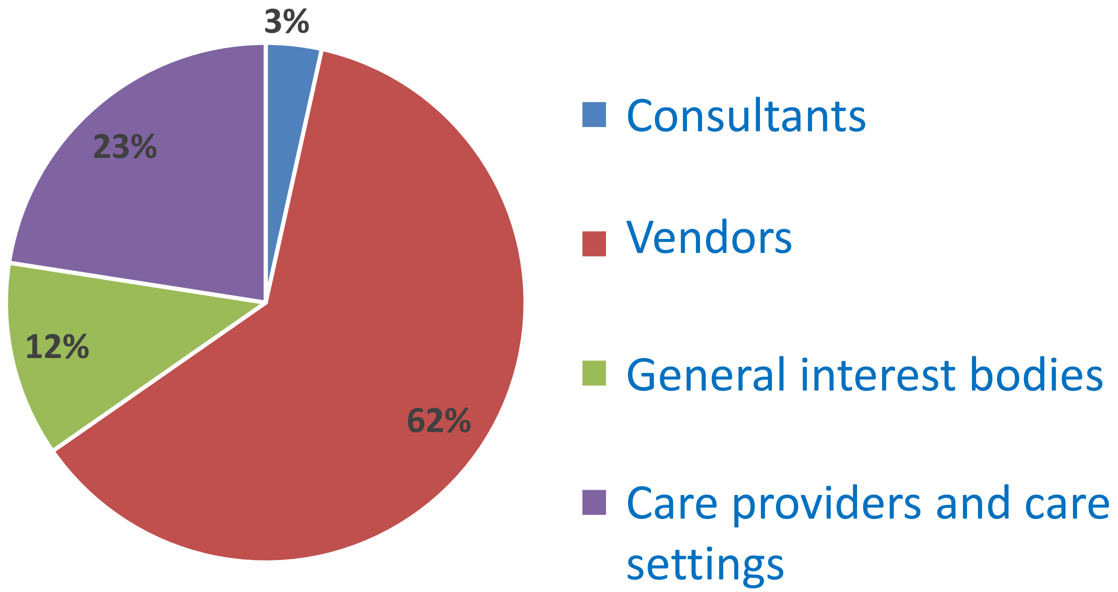
Interop'Santé non-profit association

One goal: build standardized interoperability for health IT systems

1990 + 2004 + 2009 = Interop'Santé

Pour des systèmes d'information communicants

160 members



IHE Integrating the Healthcare Enterprise

International

The *Pathology and Laboratory Medicine* (***PaLM***) domain covers interoperability needs of clinical and pathology laboratory workflows, transfusion medicine workflows and biobanking.

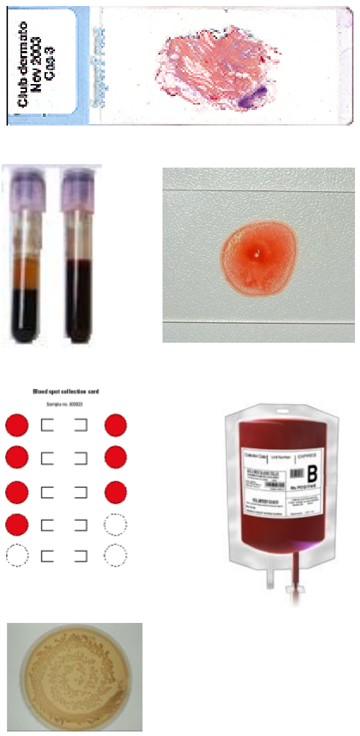
This domain has 3 sponsors :

COLLEGE of AMERICAN PATHOLOGISTS http://www.cap.org

JAHIS 一般社団法人 保健医療福祉情報システム工業会 Japanese Association of Healthcare Information Systems Industry https://www.jahis.jp/

PHAST http://phast.fr/

IHE PaLM domain



Transfusion Medicine
- TMA (P)

Digital Pathology
- … (W)

Internal automation
- LDA (F)
- LAW (F)
- LSH (D)

Blood bank

Clinicians & caregivers

Specimen collection facility

Lab order & report management

Lab operational work area

Subcontracting lab

Biobank

Public health

External workflow
- LTW (F)
- LCC (P)
- LBL (F)
- LPOCT (F)

Subcontracting
- ILW (T)

External reporting
- XD-LAB (F)
- APSR 2 (P)
- ARPH (T)

Transversal services
- LCSD (F)
- SET (D)

W White paper

D Development

P Public comment

T Trial Implementation

F Final Text

Agenda:

1. Meaningful data in health IT systems: why and how?
2. Adoption of SNOMED CT needs to be stepwise
3. Leveraging external FHIR terminology services
4. Leveraging FHIR catalogs

Agenda:

1. Meaningful data in health IT systems: why and how?
2. Adoption of SNOMED CT needs to be stepwise
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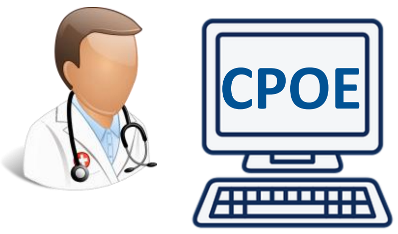
4. Leveraging FHIR catalogs

An example

Laboratory procedure requested:

- Microbiology study on nasal fluid specimen
- Reason for ordering: preoperative diagnosis
- Current medication of the patient: none



Staphylococcus aureus identified.
vancomycin MIC ≥ 32 µg/ml -> Resistant

Laboratory procedure requested:

- Microbiology study of nasal fluid specimen
- Reason for ordering: preoperative diagnosis
- Current medication of the patient: none

The ordering physician and the clinical lab director have a common understanding of this statement because:

a) they speak the same language (syntax),
b) they use a common vocabulary (vernacular + medicine)
c) both of them acquired full knowledge of these concepts by academic education.

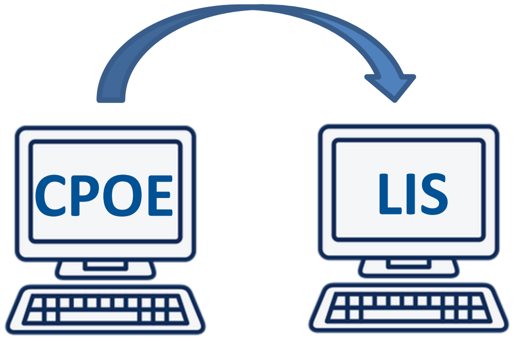
This common understanding enables them to cooperate (interoperate) efficiently on this procedure.

Laboratory procedure requested:

- Microbiology study of nasal fluid specimen
- Reason for ordering: preoperative diagnosis
- Current medication: none

To cooperate even more efficiently, they need their IT systems to interoperate too, and to share this common understanding. This for more than one reason:

1. assist the user at data entry (creation of the procedure request),
2. integrate the request and acknowledge the event,
3. store each data element into the proper place,
4. display meaningfully the content of this request combined with relevant information available locally,
5. trigger actions to automate the process of the request,
6. later on, analyze the activity, or the population of patients based on the outcome of this activity,
7. …



Laboratory procedure requested:

- Microbiology study of nasal fluid specimen
- Reason for ordering: preoperative diagnosis
- Current medication: none

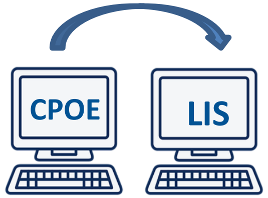
This common understanding between systems is only achieved if:

a) The systems use a common language/syntax (information models + concept binding).

b) The systems use a common vocabulary (reference terminologies).

c) The systems have acquired some level of education (parameterization) about these concepts and models, to be able to operate on them (check consistency, trigger action, …)

d) The systems are able to retrieve knowledge about the concept received or to be keyed in (terminology services).



Common vocabulary:
What terminologies are needed and which concepts from each?

Laboratory procedure requested:

Microbiology study of nasal fluid specimen

Reason for ordering: preoperative diagnosis

Current medication: none

SNOMED CT: |Nasal fluid sample|

SNOMED CT: |Laboratory procedure|

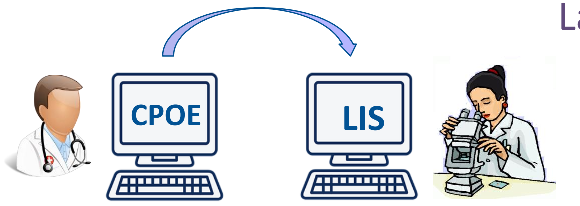
SNOMED CT: |none used|

LOINC: |Current medication|

LOINC: |Reason for test or procedure|

SNOMED CT: |Preoperative diagnosis|

SNOMED CT: |Bacteriology general procedure|



Laboratory procedure requested:

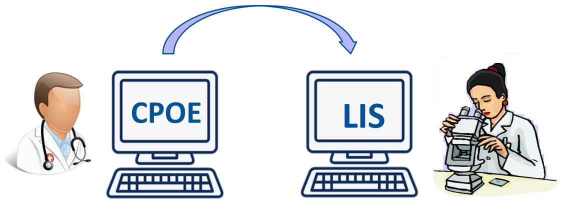
- Microbiology study of nasal fluid specimen
- Reason for ordering: preoperative diagnosis
- Current medication: none

Common language:

Using HL7 v2 language constrained by IHE LTW profile:

Syntax/language
SNOMED CT
LOINC

```
MSH|^~\&| … |OML^O33^OML_O33| … |EN|…
PID| … |EVERYMAN^ADAM^^JR^^^L|19800101|M|…
PV1|…
SPM|1|123^Card||168141000^Nasal fluid sample^SCT|…
ORC|…
TQ1|…
OBR|1|123^Card||275721003^Bacteriology general procedure^SCT|…
OBX|1|CE|67098-4^ Reason for test or procedure^LN||406520001^
Preoperative diagnosis^SCT|…
OBX|2|CE|18606-4^Current medication^LN||""|
```



Laboratory procedure requested:

- Microbiology study of nasal fluid specimen
- Reason for ordering: preoperative diagnosis
- Current medication: none

Another possible common language:

Using HL7 FHIR®© (as in the April R4 ballot):

ServiceRequest

category:
  coding:
    system: http://snomed.info/sct
    code: 108252007
    display: laboratory procedure

orderDetail:
  coding:
    system: http://snomed.info/sct
    code: 275721003
    display: bacteriology general procedure

reasonCode:
  coding:
    system: http://snomed.info/sct
    code: 406520001
    display: preoperative diagnosis

subject → **Patient**

specimen → **Specimen**

Specimen

type:
  coding:
    system: http://snomed.info/sct
    code: 168141000
    display: nasal fluid sample

supportingInfo → **Observation**

Observation

code:
  coding:
    system: http://loinc.org
    code: 18606-4
    display: current medication

valueCodeableConcept:
  coding:
    system: http://snomed.info/sct
    code: 262001002
    display: none used

The selection of concepts depends upon the chosen information model

- In the FHIR standard the concept of "reason for procedure" is built in the information structure:

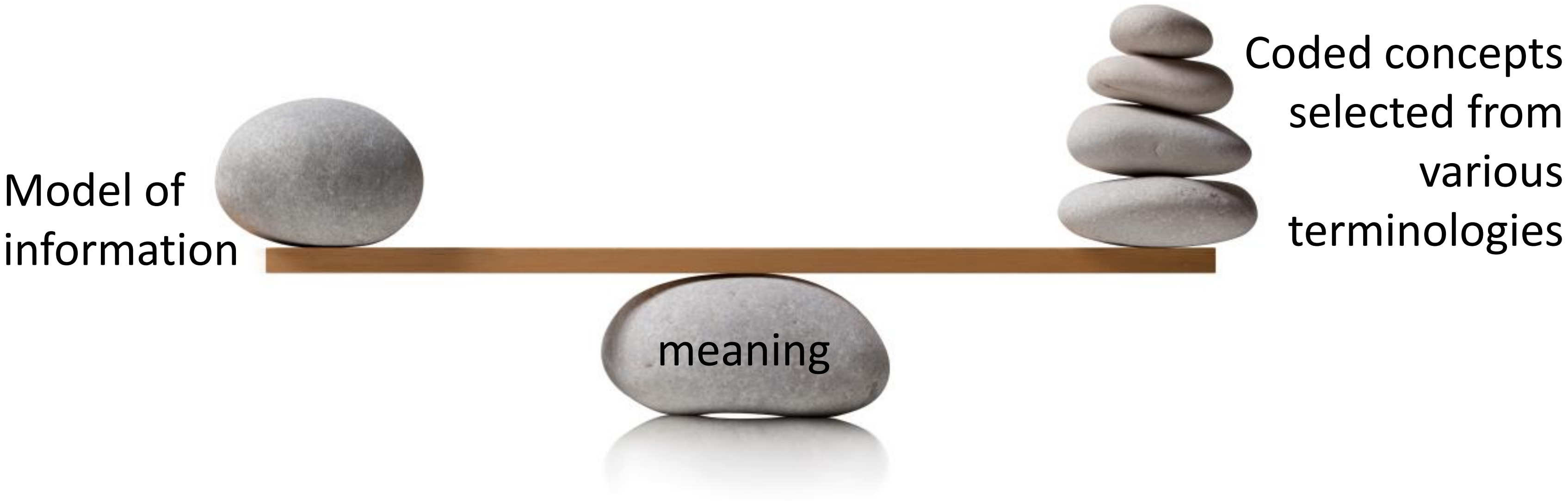
  ServiceRequest.reasonCode: 406520001 |Preoperative diagnosis (qualifier value)|

- In HL7 v2 a multipurpose OBX segment is used instead, therefore an additional concept is needed to specify which kind of observation is that:

  OBX-3: 67098-4^ Reason for test or procedure^LN

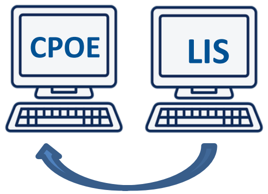
  OBX-5: 406520001^ Preoperative diagnosis^SCT

The information model carries a part of the meaning by itself.



Let’s take a look at the results flow, now.

Staphylococcus aureus identified.
vancomycin MIC ≥ 32 µg/ml -> Resistant



Common vocabulary

What terminologies are needed and which concepts from each?

SNOMED CT: |Staphylococcus aureus|

Bacteria identified: Staphylococcus aureus.

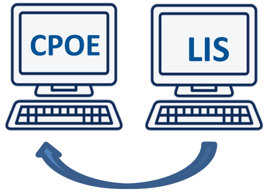
vancomycin MIC ≥ 32 µg/ml -> Resistant

HL7 table 0078: |Resistant|

UCUM: |ug/mL|

LOINC: |Vancomycin [Susceptibility] on isolate|

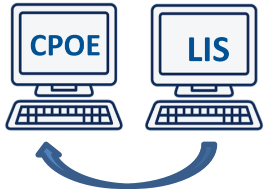
LOINC: |Bacteria identified in Nasopharynx by Culture|



Staphylococcus aureus identified.
vancomycin MIC ≥ 32 µg/ml -> Resistant

Using HL7 v2 language constrained by IHE LTW profile:

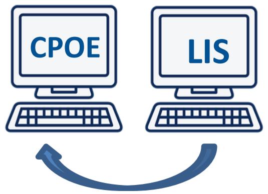
```
MSH|^~\&| … |OUL^R22^OUL_R22| … |EN|…
PID| … |EVERYMAN^ADAM^^JR^^^L|19800101|M|…
⋮
SPM|1|123^Card||168141000^Nasal fluid sample^SCT|…
OBR|1|123^Card||275721003^Bacteriology general procedure^SCT|…
⋮
OBX|n|CE|67098-4^Bacteria identified in Nasopharynx by Culture^LN||3092008^
Staphylococcus aureus^SCT|…                      child order
⋮
OBR|2|123^Card||14788002^Antimicrobial susceptibility test^SCT|…
OBX|1|SN|19000-9^Vancomycin susceptibility on isolate^LN|1|>=^32|ug/mL||R|…
```



Staphylococcus aureus identified.
vancomycin MIC ≥ 32 µg/ml -> Resistant

Other available language: CDA R2 constrained by IHE XD-LAB profile (focusing on the entry)

- entry (act)
  - procedure — Specimen collection, (specimen is a participant with typeCode="PRD" and a role of "SPEC")
  - Organizer (battery) — Culture
    - observation — Bacteria identified
  - Organizer (cluster) — The antibiogram …
    - specimen — … is performed on the isolate represented by the name of the bacteria identified
    - observation — Vancomycin MIC and its clinical interpretation



Staphylococcus aureus identified.
vancomycin MIC ≥ 32 µg/ml -> Resistant

Using CDA R2 constrained by IHE XD-LAB profile

entry (act)

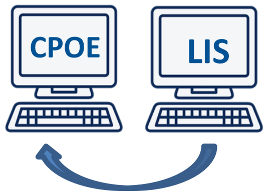
procedure

The entry

```
<entry typeCode="DRIV">
    <templateId root="1.3.6.1.4.1.19376.1.3.1"/>
    <act classCode="ACT" moodCode="EVN">
        <code code="275721003" codeSystem="2.16.840.1.113883.6.96“
              displayName="Bacteriology general procedure"/>
```

The specimen collected

```
      <entryRelationship typeCode="COMP">
        <procedure classCode="PROC" moodCode="EVN">
              <templateId root="1.3.6.1.4.1.19376.1.3.1.2"/>
              :
              <participant typeCode="PRD">
                 <participantRole classCode="SPEC">
                        <playingEntity>
                        <code code="168141000" codeSystem="2.16.840.1.113883.6.96"
                              codeSystemName="SNOMED-CT"displayName="Nasal fluid sample"/>
```



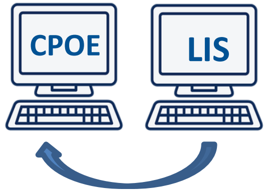
Staphylococcus aureus identified.
vancomycin MIC ≥ 32 µg/ml -> Resistant

Using CDA R2 constrained by IHE XD-LAB profile

entry (act)
- procedure
- ⋮
- Organizer (battery)
  - ⋮
  - observation

The bacteria identified

```xml
<observation classCode="OBS" moodCode="EVN">
    <templateId root="1.3.6.1.4.1.19376.1.3.1.6"/>
    <code code="67098-4" codeSystem="2.16.840.1.113883.6.1" codeSystemName="LOINC"
          displayName="Bacteria identified in Nasopharynx by Culture"/>
    <statusCode code="completed"/>
    <effectiveTime value="20150104131933+0100"/>
    <value xsi:type="CD" code="3092008" displayName="Staphylococcus aureus"
           codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT"/>
```



Staphylococcus aureus identified.
vancomycin MIC ≥ 32 µg/ml -> Resistant

Using CDA R2 constrained by IHE XD-LAB profile

entry (act)

⋮

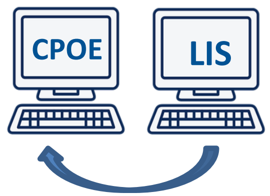
Organizer (cluster)

specimen

The antibiogram …

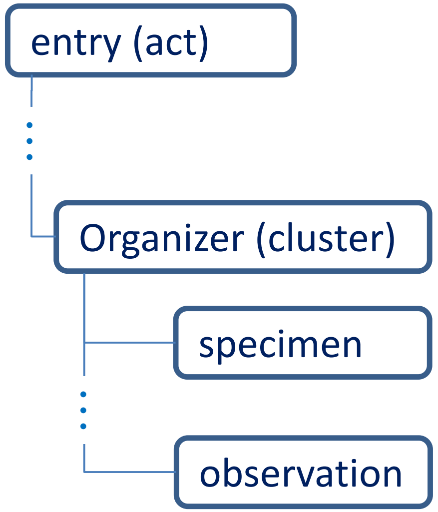
```
<entryRelationship typeCode="COMP">
    <organizer classCode="CLUSTER" moodCode="EVN">
    <templateId root="1.3.6.1.4.1.19376.1.3.1.5"/>
    <statusCode code="completed"/>
    <effectiveTime value="20150104155000+0100"/>

   <specimen typeCode="SPC">
        <specimenRole classCode="SPEC">
              <id extension="55584739" root="1.3.6.1.4.1.19376.1.3.4"/>
              <specimenPlayingEntity classCode="MIC">
              <code code="3092008" displayName="Staphylococcus aureus"
                   codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT"/>
```

… is performed on the isolate represented by the name of the bacteria identified



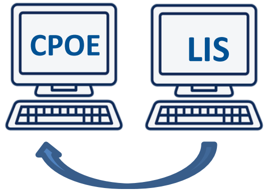
Staphylococcus aureus identified.
vancomycin MIC ≥ 32 µg/ml -> Resistant

Using CDA R2 constrained by IHE XD-LAB profile



The vancomycin MIC

```
<observation classCode="OBS" moodCode="EVN">
     <templateId root="1.3.6.1.4.1.19376.1.3.1.6"/>
     <code code="19000-9" codeSystem="2.16.840.1.113883.6.1"  codeSystemName="LOINC"
            displayName="Vancomycin susceptibility on isolate"/>
    <statusCode code="completed"/>
    <effectiveTime value="20150104155000+0100"/>
    <value xsi:type="IVL_PQ">
           <low value=“32" unit="ug/mL" inclusive="true"/>
    </value>
    <interpretationCode code="R" displayName="Resistant" codeSystem="2.16.840.1.113883.5.83"/>
</observation>
```



Staphylococcus aureus identified.
vancomycin MIC ≥ 32 µg/ml -> Resistant

One more language

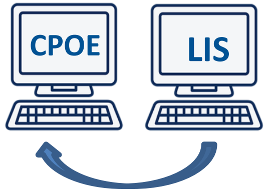
Using HL7 FHIR®© (as in the April R4 ballot):

DiagnosticReport
- **status**: final
- **category**:
  - coding:
    - system: http://hl7.org/fhir/v2/0074
    - code: MCB
    - display: Mycobacteriology
- **code**:
  - coding:
    - system: http://loinc.org
    - code: 67098-4
    - display: bacteria identified in nasopharynx

subject → **Patient**

context → **Encounter**

basedOn → **ServiceRequest**



Staphylococcus aureus identified.
vancomycin MIC ≥ 32 µg/ml -> Resistant

Using HL7 FHIR®©

DiagnosticReport
status: final
…
code:
coding:
system: http://loinc.org
code: 67098-4
display: bacteria

result

Specimen
type:
coding:
system: http://snomed.info/sct
code: 168141000
display: nasal fluid sample

specimen

Observation
code:
coding:
system: http://loinc.org
code: 67098-4
display: bacteria identified in nasopharynx
valueCodeableConcept:
coding:
system: http://snomed.info/sct
code: 3092008
display: Staphylococcus aureus

hasMember

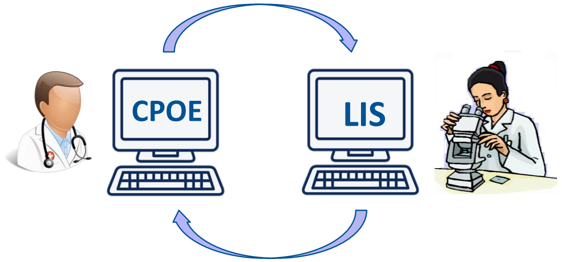
Observation
code:
coding:
system: http://loinc.org
code: 19000-9
display: Vancomycin susceptibility on isolate
valueQuantity:
value: 32
comparator: >=
unit: µg/ml
system: http://unitsofmeasure.org
code: ug/mL
interpretation:
coding:
system: http://hl7.org/fhir/v2/0078
code: R
display: Resistant

Need to alert the clinician about this vancomycin-resistant Staph aureus carrier

1. Use a more specific concept for the observation "Bacteria identified"
   - SNOMED CT: | Vancomycin resistant Staphylococcus aureus (organism) |
2. Provide an additional observation:
   - Observation
     - code: LOINC: | Pathologist interpretation of Unspecified specimen tests |
     - value: SNOMED CT: | Multiple antimicrobial drug resistant bacteria (organism) |
3. In all cases, a conclusion is expected
   - Example with FHIR: DiagnosticReport.conclusion:

     "Nasal carriage of multi-drug resistant Staphylococcus aureus"

One more reference for adopting common reference terminologies



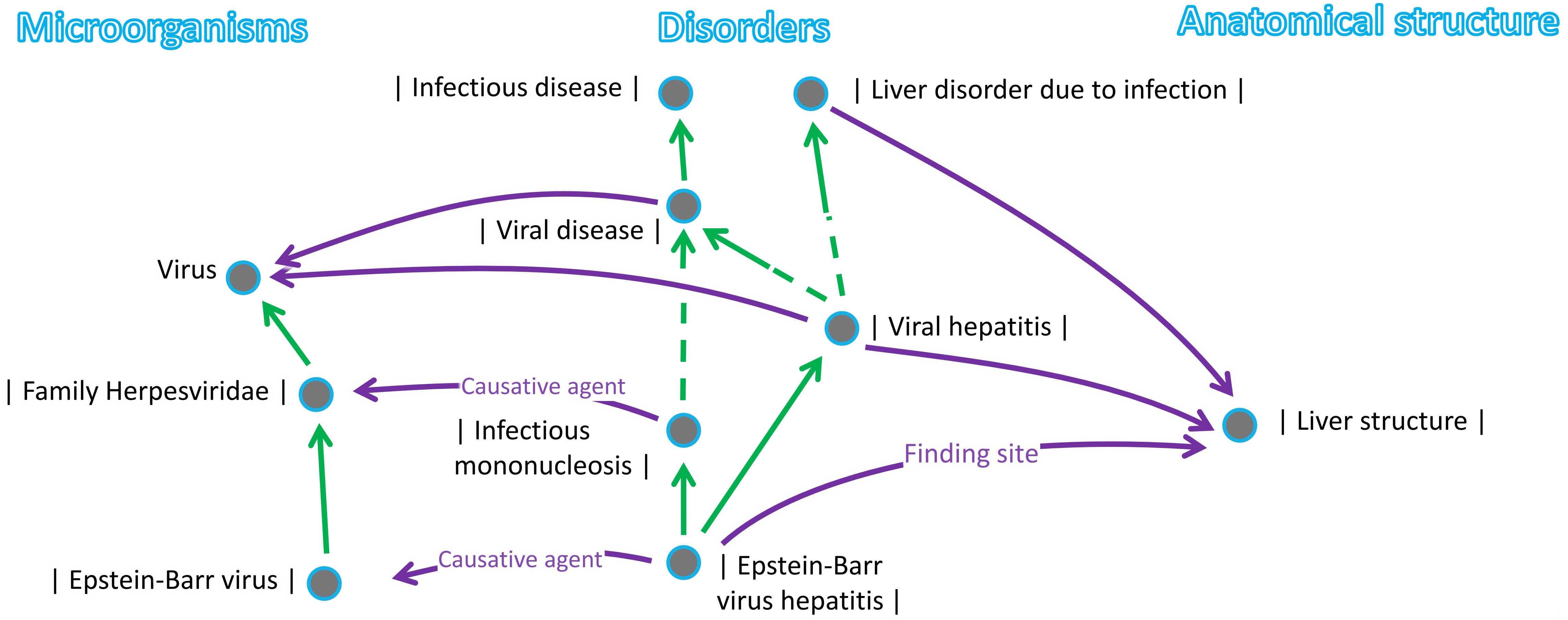
1. assist the user at data entry (creation of the procedure request),
2. integrate the request and acknowledge the event,
3. store each data element into the proper place,
4. display meaningfully the content of this request combined with relevant information available locally,
5. trigger actions to automate the process of the request,
6. later on, analyze the activity, or the population of patients based on the outcome of this activity,
7. Enhance collaborative surveillance of healthcare acquired infections

Agenda:

1. Meaningful data in health IT systems: why and how?
2. Adoption of SNOMED CT needs to be stepwise
3. Leveraging external FHIR terminology services
4. Leveraging FHIR catalogs

SNOMED CT provides not only concepts but also rich relationships

- Polyhierarchical (« *is a* »)
- Multiple attributes ( )

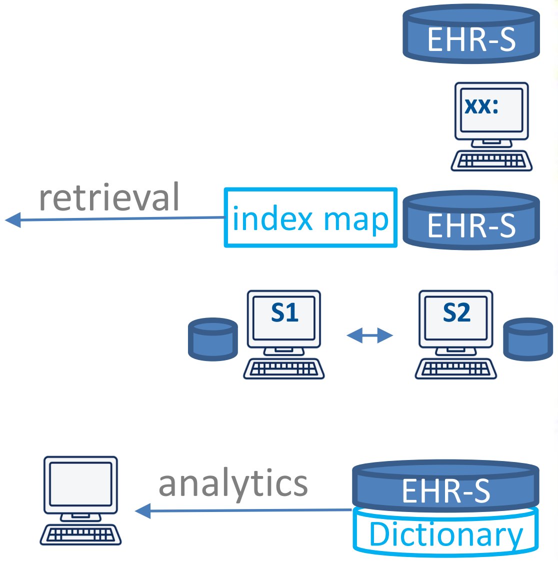


This enables various

Courtesy of
(Implementation course)

Implementation Approaches

SNOMED CT can be used as …



What	Why
A code system	To store clinical information
An interface terminology	To capture and display clinical information
An indexing system	To retrieve clinical information
A common terminology	To communicate in a meaningful way
	To integrate heterogeneous data
A dictionary	To query, analyze and report
	To link health records to knowledge resources
Extensible foundation	To represent new types of clinical data

Use of:
- concept model
- SNOMED CT expressions

Courtesy of (Implementation course)

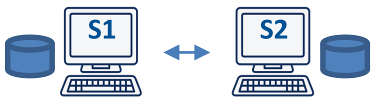
Need to start with the best combination of (high priority need, low hanging fruit, low cost)

My guess for European countries: start using SNOMED CT as a common terminology to improve interoperability

- A small step …
  - IT Systems can rely on simple value sets bound to standardized interoperable information models (FHIR, CDA, HL7 v2, …)
- … which fulfills important needs,
  - National EHR/PHR systems
  - Digitalized CPOE/result reporting in hospitals
  - Cross-border healthcare (eHealth DSI, IPS, Trillium II, …)
- … and is a good priming.
  - IT systems start acquiring SNOMED CT concepts through communication.
  - Once sufficient data is SNOMED CT-encoded in the systems' databases, then other usages become possible (analytics, retrieval, link to knowledge resources …)

Implementation Approaches

Start using SNOMED CT as:



What	Why
A code system	To store the clinical information exchanged
An interface terminology	To capture & display information exchanged
An indexing system	To retrieve clinical information
A common terminology	To communicate in a meaningful way
	To integrate heterogeneous data
A dictionary	To query, analyze and report
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Extensible foundation	To represent new types of clinical data

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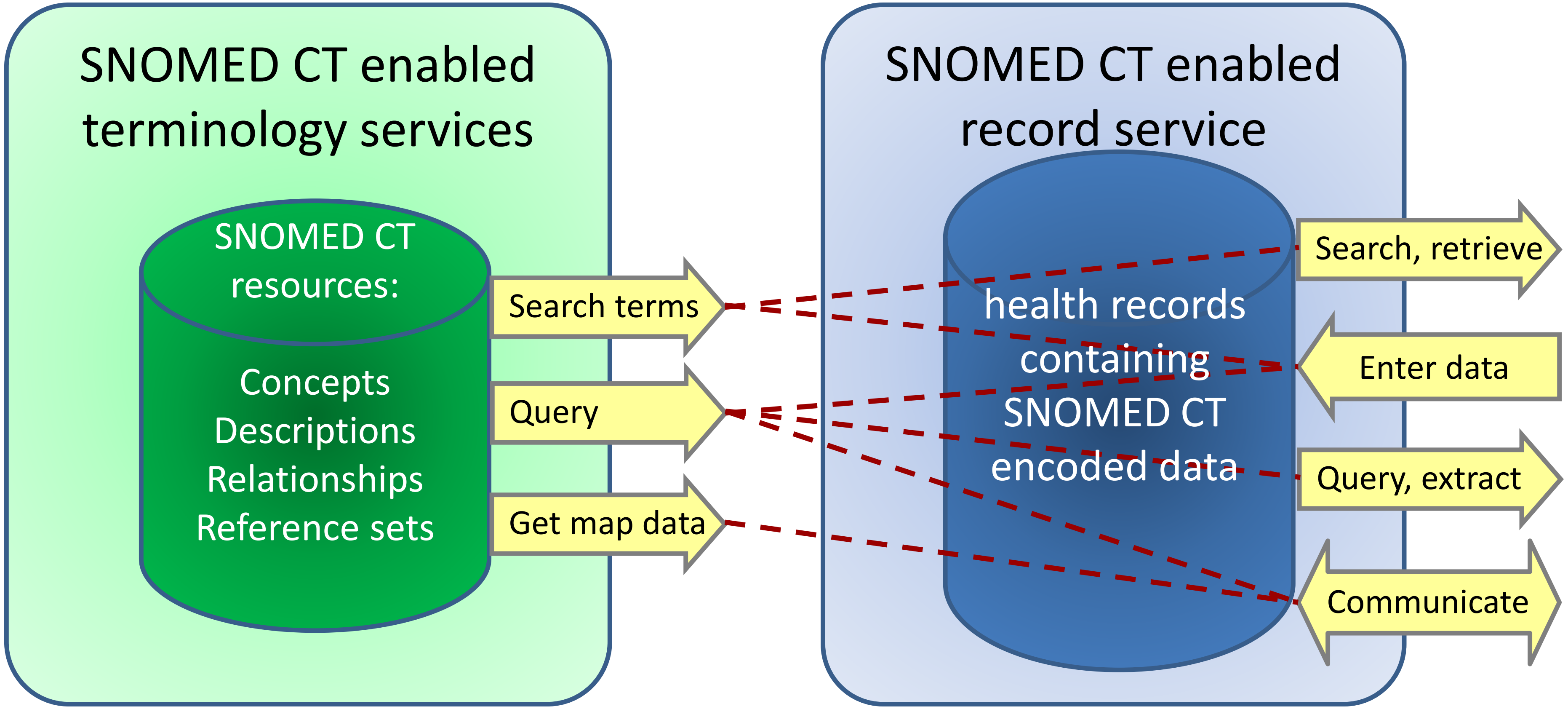
Inspired from
(Implementation course)

Search terms: find a concept based on matching search term

Query:
- Testing membership in reference sets
- Testing concepts for subsumption
- Traversing, navigating hierarchies
- Testing defining relationships against given criteria
- Testing expressions for equivalence and subsumption



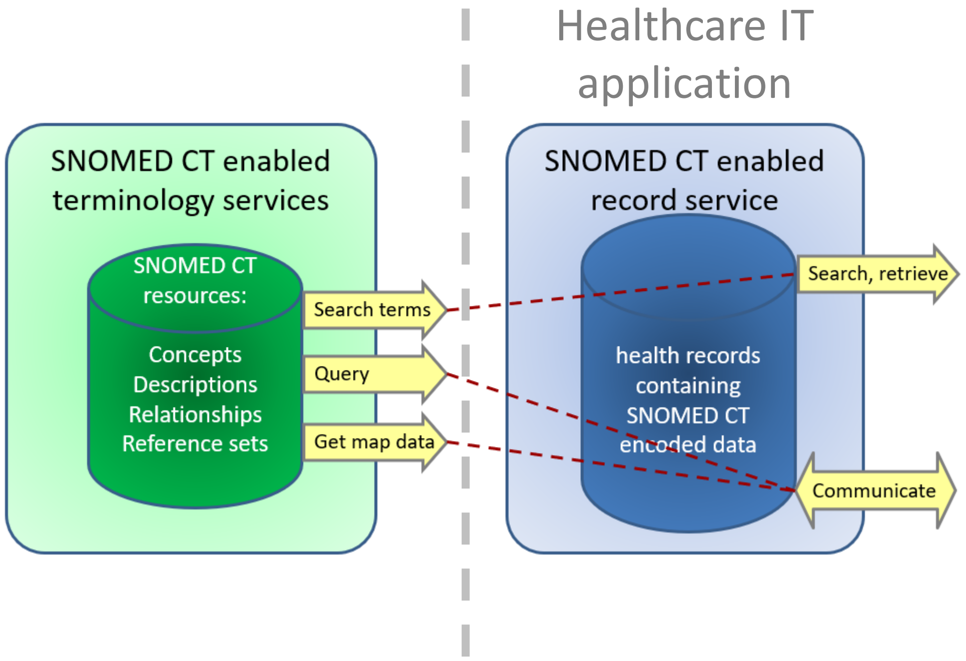
Get map data: Retrieve maps of SNOMED CT to or from other code systems.

An easier first step for health IT solutions using SNOMED CT as a common terminology: Keep the terminology services external

To send meaningful data, the application must have been able to enter coded concepts, therefore **search terms**.

To receive and integrate meaningful data, the application must be able to:

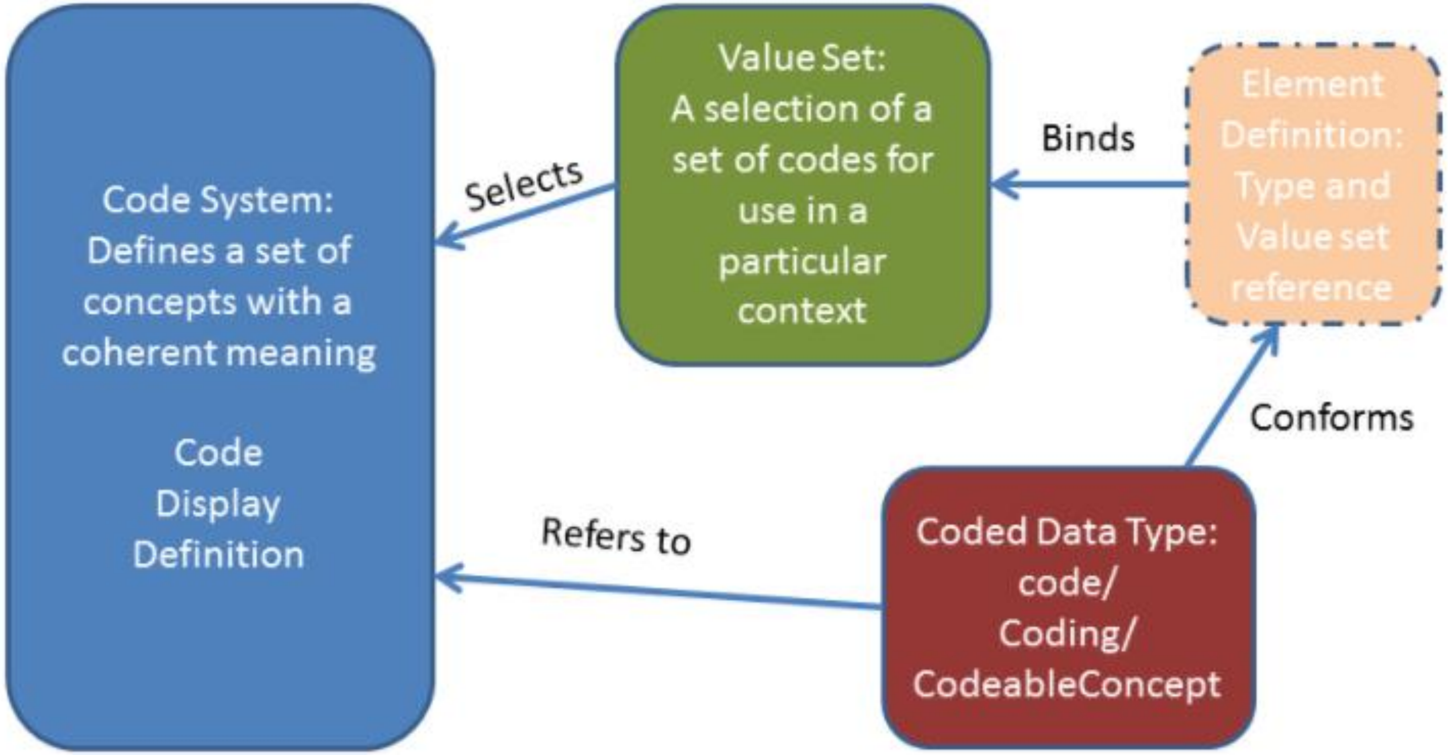
- Check that a received concept belongs to a value set, therefore **test membership in reference sets (reduced Query service)**.
- Map back and forth SNOMED CT concepts to local codes, therefore **Get map data**.



To use SNOMED CT for interoperability, the application needs limited terminology services

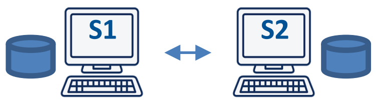
FHIR terminology services fit this first need

The terminology resources and their relationships in FHIR Terminology module



[4.0 Terminology Module]

Terminology services needed by a system, which uses SNOMED CT as a common terminology



Action	Minimal terminology services needed
Communicate in a meaningful way	• **Test membership in reference sets** (to check that a received code is part of the value set) • **Get map data** (to convert back and forth with local code systems)
Capture & display the clinical information that is exchanged	• **Search terms** • **Expand value set** (to obtain a pick list and browse through it to capture the proper concept)
Store the clinical information exchanged	none

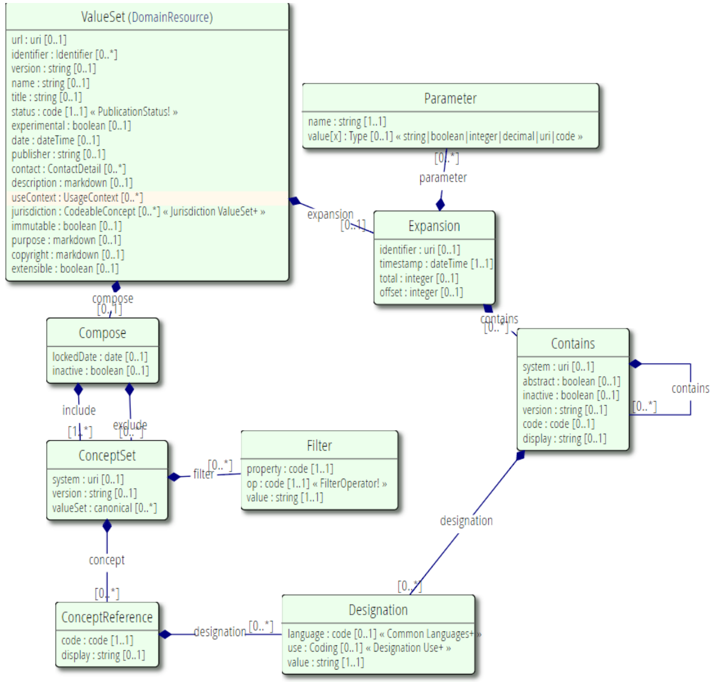
FHIR resources and operations needed

- **Test membership in reference sets** (verify that a code received belongs to the authorized value set)
  - Operation $validate-code on the ValueSet resource, which is candidate normative for R4.

Main parameters:

- the code received
- The value set to look into

See [4.8.1.2 Operation $validate-code on ValueSet]()



FHIR resources and operations needed

- **Expand a value set** (to obtain a pick list and browse through it to capture the proper concept)
  - Operation $expand on the ValueSet resource

Main parameters:

- the value set url
- a context
- a filter may be applied to restrict the subset of codes to be returned

See [4.8.1.1 Operation $expand on ValueSet]

FHIR resources and operations needed

- **Search term** (for user interface: find a concept corresponding to a textual description, to be captured for a field in a form)
  - Operation $expand on the ValueSet resource, using filters

Main parameters:

- the value set url
- a filter on the display term, restricting to the concepts that contain this term.

Example:

GET [base]/ValueSet/23/$expand?filter=urinalysis

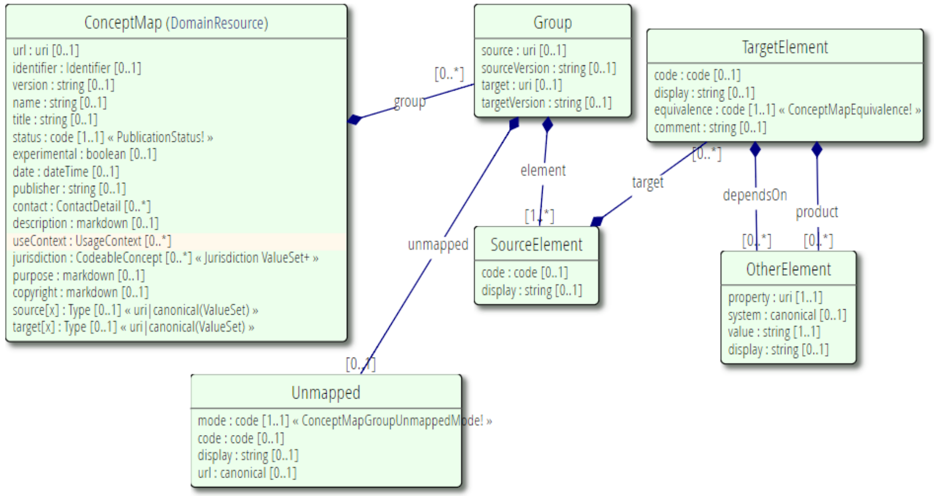
See 4.8.1.1 Operation $expand on ValueSet

FHIR resources and operations needed

- **Get map data** (convert back and forth with local code systems)
  - ➢ Operation $translate on the ConceptMap resource, candidate normative for R4.

The operation translates a code from one value set to another, based on the existing ValueSet and ConceptMap resources, and/or other additional knowledge available to the server.

- Works in both directions, and returns qualified matches for a concept.



See 4.9.1.1 [Operation $translate on ConceptMap]

Conclusion

- A full integration of the terminology SNOMED CT into a healthcare application, based on the RF2 release files represents a significant investment.
- For a first step aiming at using SNOMED CT as a common terminology, leveraging external FHIR terminology services is likely to minimize the adaptation effort.

Agenda:

1. Meaningful data in health IT systems: why and how?
2. Adoption of SNOMED CT needs to be stepwise
3. Leveraging external FHIR terminology services
4. Leveraging FHIR catalogs

Beyond terminology services

- Standardized vocabularies (SNOMED CT, LOINC, EDQM, UCUM, ICD-10, …) are also part of master data sets,
  - like a reference metathesaurus (e.g.; the thesaurus of all medications that can be prescribed in a country)
  - or a catalog reflecting an organization (e.g.; the compendium of in vitro diagnostic services that can be placed to a reference laboratory).
- Other services are needed to share these master data sets.

Catalogs of orderable services/products with FHIR R4

OVERVIEW

SUMMARY OF OUTCOME FROM CONNECTATHON 17

Some examples of catalogs of orderable services/products

- Drug formulary
- Catalog of medical devices
- Laboratory compendium (similar content as eDOS HL7 v2 IG)
- List of tests supported by an IVD device
- Directory of health care services
- …

Overview: Representing a catalog in FHIR R4

http://build.fhir.org/catalog.html
= Profile(Composition)

class = kind of catalog

section
entry Reference(EntryDefinition)
entry Reference(EntryDefinition)
…
entry Reference(EntryDefinition)

A catalog of orderable items is a collection of EntryDefinition resources.

Some of these EntryDefinition represent the orderable items themselves, while others represent resources supporting the orderable items.

EntryDefinition

type	(e.g. drug, service, device)
purpose	(orderable | supporting)
referencedItem	Reference (Medication, Device, Organization, HealthcareService, ActivityDefinition, ObservationDefinition, SpecimenDefinition …)

…
Other metadata for this entry
…

[0..*]
relatedEntry

RelatedEntry

relationType	(e.g. has-input, uses, has-output, …)
item	Reference (EntryDefinition)

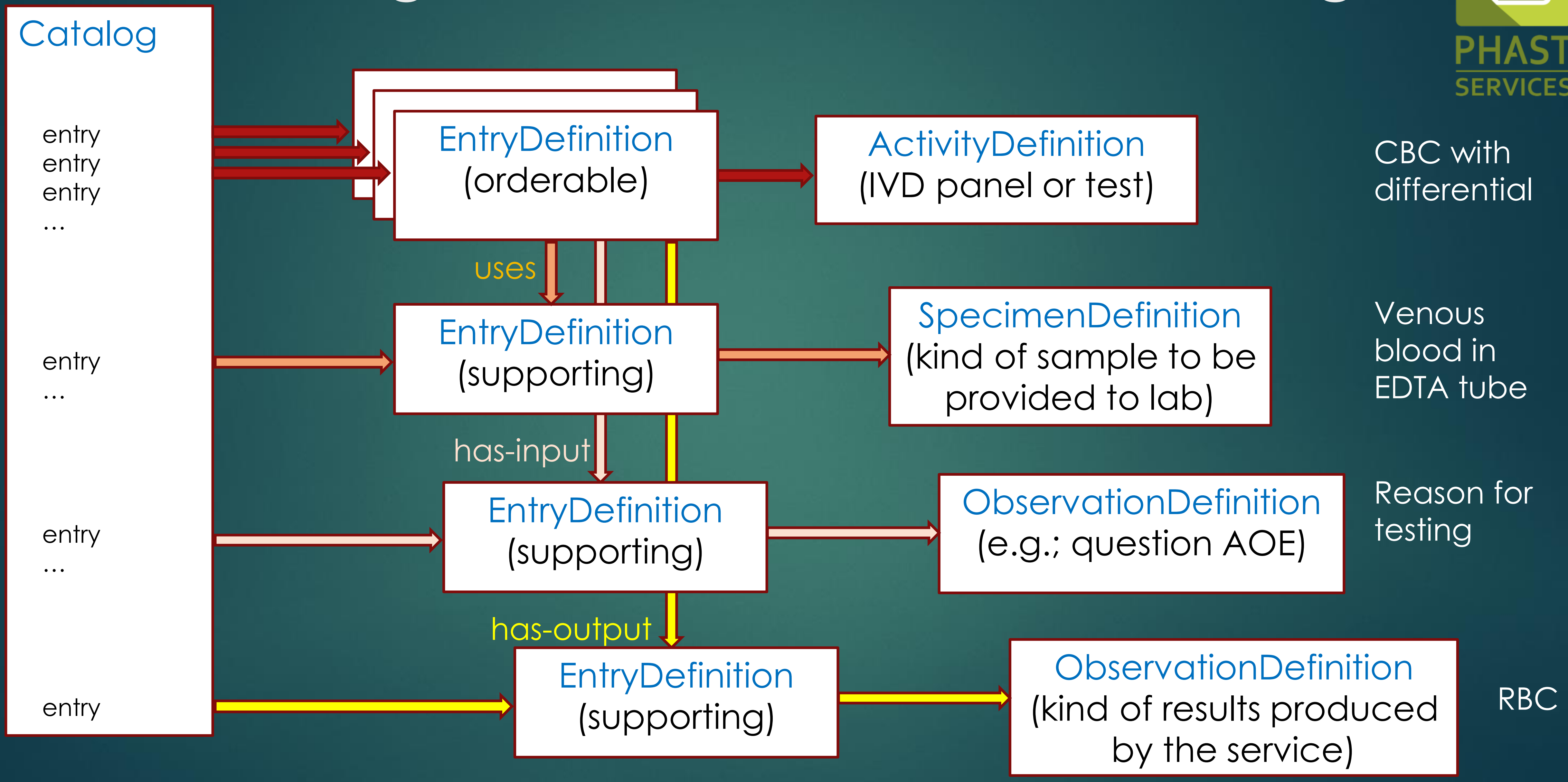
Each orderable item (service/product) is represented by an EntryDefinition resource in the catalog, and is the referencedItem of that resource.

Every resource contributing to the description of an orderable item is the item of a RelatedEntry referenced by the entries it contributes to.

Track “catalog” at connectathon 17

- Catalog: a clinical laboratory compendium
- 1 server (Phast) and 1 client (University of Utah)
- Scenario: Read access to the catalog
  - browse catalogs,
  - query the content of a catalog,
  - retrieve the detail of an orderable lab service (panel/test)
- Goal: verify the appropriateness of the new resources

Organization of the lab catalog



Outcome of connectathon 17

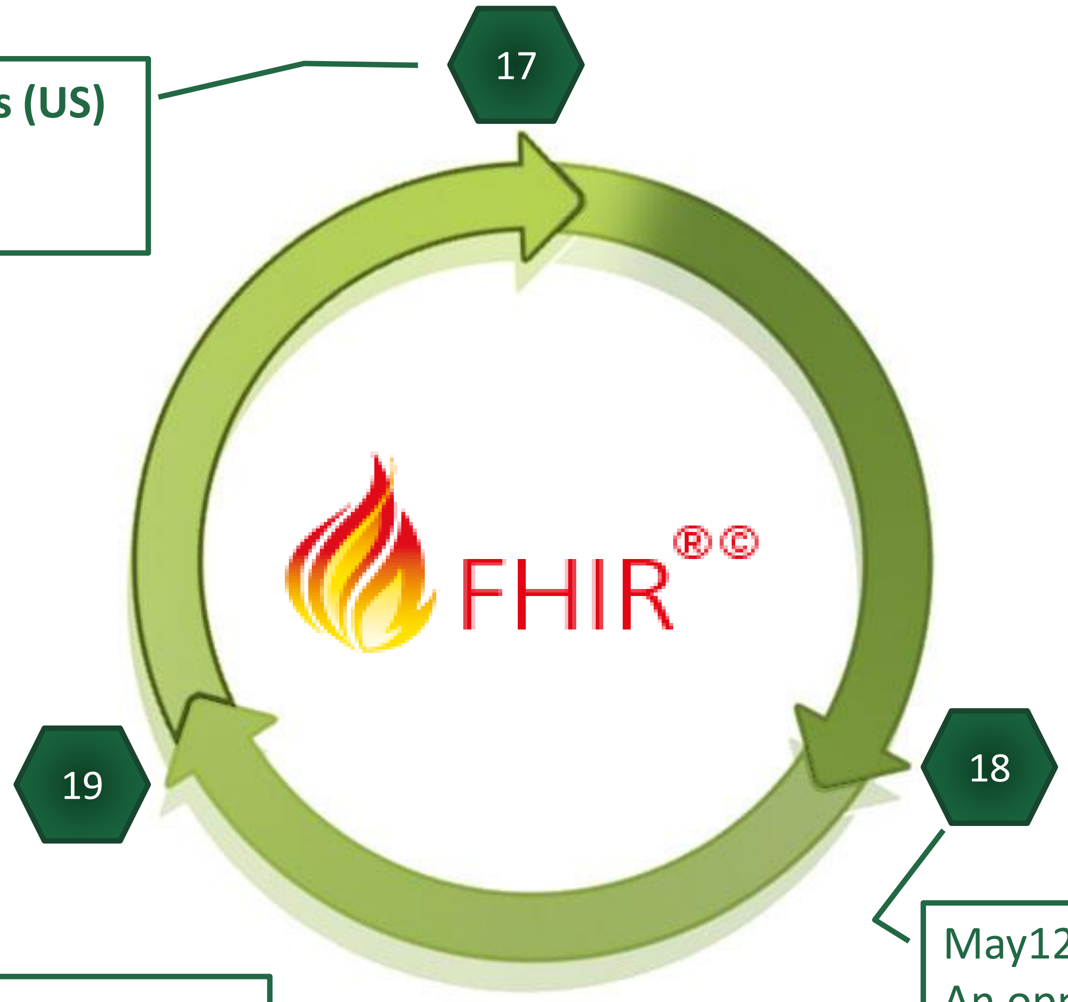
- Catalog Server CIO lab metathesaurus built by Phast-Services
- Catalog client developed by University of Utah
- Scenario: read access to the catalog; successful.
- Brings refinements to value sets, data types and search parameters for catalog resources.
- Catalog weekly calls (Wednesday 7pm, Europe central time). See catalog project wiki page:

  http://wiki.hl7.org/index.php?title=Order_Catalog_Interface

Three connectathons FHIR per year:

PHAST SERVICES

January 27-28, **New Orleans (US)**
265 participants
27 tracks



May12-13, **Cologne (DE)**
An opportunity for European implementers

September **Baltimore (US)**

What's to be gained by attending a FHIR Connectathon?

- Join a community of FHIR users
  - Bring Questions and share your challenges
  - Help others by sharing your knowledge
- Develop and test your system and use the standard
- Demonstrate what's possible
- Refine the FHIR Specification

In summary:

- Health IT systems need international reference terminologies to support efficient coordination of care, locally, nationally, cross-border, cross-continent.
- SNOMED CT is the largest and inescapable one.
- Among the numerous purposes that SNOMED CT can serve, common terminology for meaningful information exchange seems an easy 1st step.
- Particularly for this 1st step, rather than a full integration by applications, it seems wise and affordable to leverage external FHIR terminology services.
- The new FHIR catalog services enable the sharing of large master data sets, making an extensive use of reference terminologies.

Thank you

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