HL7 Vocabularies: Bridging Information Models and Vocabulary in HL7

October 26, 2005

Alexandria, Virginia

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http://www.hl7.org

Outline of today’s presentation

- Terminology & Information Models – foundations of HL7 standard information structures
- HL7 Modeling & Methodology Technical Committee
  - Coded terminologies & HL7 Standard Information Structures
- HL7 Vocabulary Technical Committee
  - The HL7 Terminology Model
  - Version 3 coded data types (with XML ITS examples)
  - Vocabulary Binding to Information Models
  - Common Terminology Services (CTS) specification

Why Standard Information Structures

- One of the fundamental goals of computerized medical information is that of precise, accurate and unambiguous communication.

- This communication is required
  - amongst healthcare practitioners,
  - between healthcare practitioners and their patients,
  - between healthcare practitioners and a wide variety of financial, statistical, research and regulatory agencies.

Basis for Communication

Any meaningful exchange of utterances depends upon the prior existence of an agreed upon set of semantic and syntactic rules

ISO TR9007:1987 *Information Processing Systems – Concepts and Technology for the Conceptual Schema and the Information Base*

Basis for Communication (2)

- Information models define the basic relationships between elements of an information structure, whether message or document
- HL7-defined terminologies allow specialization (refinement) of the information models to serve a particular purpose
- Standard HL7-designated terminologies provide the fundamental values to be used with encoded data (over 45% of health care data)
- In HL7, the Reference Information Model and the Vocabulary combine to provide **the rules and semantics** for expressing health care information

The HL7 Modeling & Methodology Technical Committee

Committee Mission

Modeling & Methodology TC:

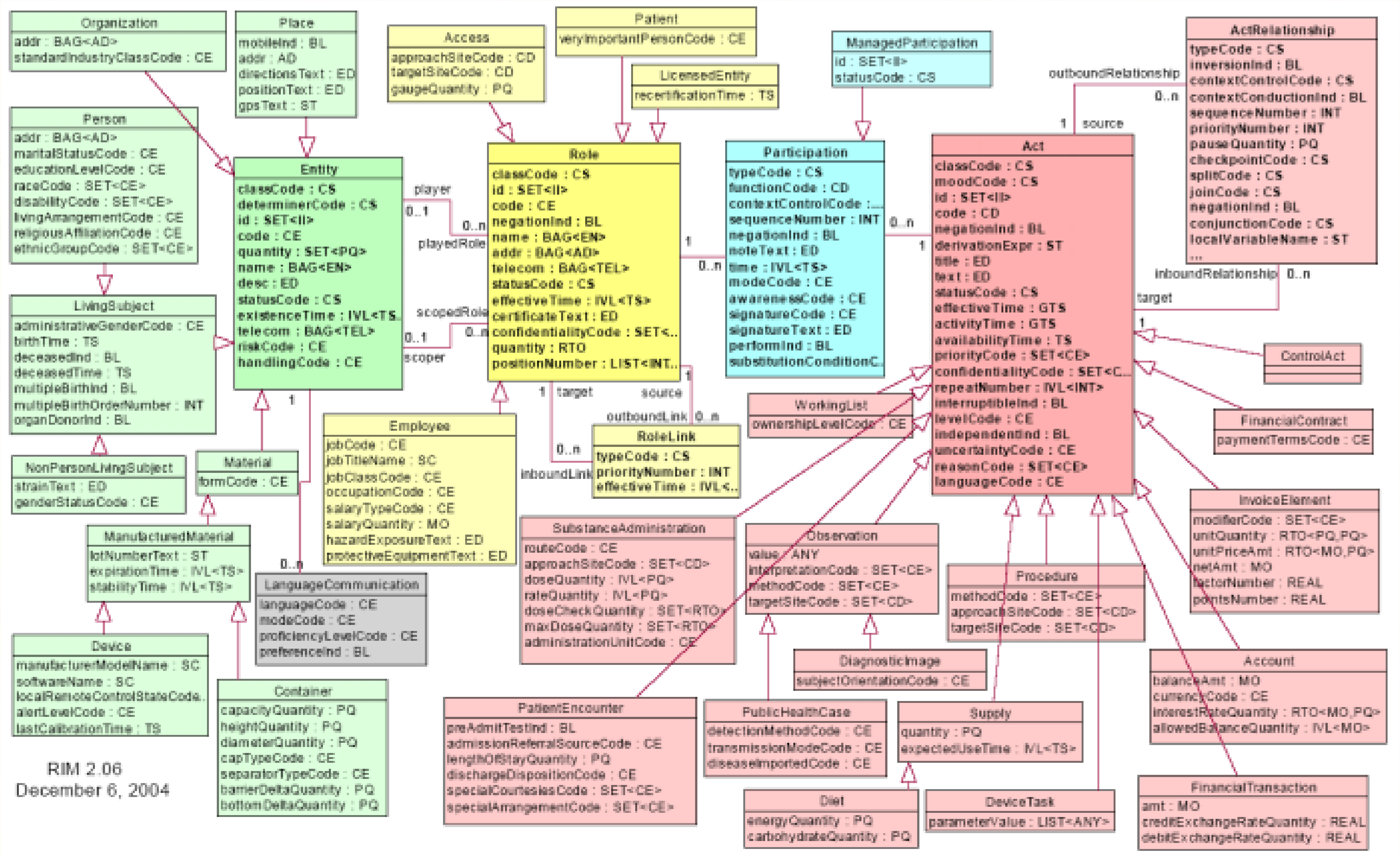
Responsible for creating and maintaining the HL7 development methodology, and maintaining a Reference Model that reflects the shared models that are developed and used by the HL7 Functional Committees.

Modeling & Methodology Activities

- Ongoing projects:
  - Define and Maintain **"HL7 Development Framework" (HDF)** – a development methodology to be used by HL7 in defining messages and other information structures for healthcare systems interoperability
  - Define and Maintain a single **Reference Information Model (RIM)** for use by HL7 developers, based upon an open, consensus-driven harmonization process

Terminology & HL7 Information Structures
-- Definition and Refinement

HL7 Reference Information Model (RIM)



Organization
addr : BAG<AD>
standardIndustryClassCode : CE

Place
mobileInd : BL
addr : AD
directionsText : ED
positionText : ED
gpsText : ST

Person
addr : BAG<AD>
maritalStatusCode : CE
educationLevelCode : CE
raceCode : SET<CE>
disabilityCode : SET<CE>
livingArrangementCode : CE
religiousAffiliationCode : CE
ethnicGroupCode : SET<CE>

LivingSubject
administrativeGenderCode : CE
birthTime : TS
deceasedInd : BL
deceasedTime : TS
multipleBirthInd : BL
multipleBirthOrderNumber : INT
organDonorInd : BL

NonPersonLivingSubject
strainText : ED
genderStatusCode : CE

Entity
classCode : CS
determinerCode : CS
id : SET<II>
code : CE
quantity : SET<PQ>
name : BAG<EN>
desc : ED
statusCode : CS
existenceTime : IVL<TS..
telecom : BAG<TEL>
riskCode : CE
handlingCode : CE

Material
formCode : CE

ManufacturedMaterial
lotNumberText : ST
expirationTime : IVL<TS>
stabilityTime : IVL<TS>

Device
manufacturerModelName : SC
softwareName : SC
localRemoteControlStateCode..
alertLevelCode : CE
lastCalibrationTime : TS

Container
capacityQuantity : PQ
heightQuantity : PQ
diameterQuantity : PQ
capTypeCode : CE
separatorTypeCode : CE
barrierDeltaQuantity : PQ
bottomDeltaQuantity : PQ

LanguageCommunication
languageCode : CE
modeCode : CE
proficiencyLevelCode : CE
preferenceInd : BL

Access
approachSiteCode : CD
targetSiteCode : CD
gaugeQuantity : PQ

Patient
veryImportantPersonCode : CE

LicensedEntity
recertificationTime : TS

Role
classCode : CS
id : SET<II>
code : CE
negationInd : BL
name : BAG<EN>
addr : BAG<AD>
telecom : BAG<TEL>
statusCode : CS
effectiveTime : IVL<TS>
certificateText : ED
confidentialityCode : SET<..
quantity : RTO
positionNumber : LIST<INT..

Employee
jobCode : CE
jobTitleName : SC
jobClassCode : CE
occupationCode : CE
salaryTypeCode : CE
salaryQuantity : MO
hazardExposureText : ED
protectiveEquipmentText : ED

RoleLink
typeCode : CS
priorityNumber : INT
effectiveTime : IVL<..

ManagedParticipation
id : SET<II>
statusCode : CS

Participation
typeCode : CS
functionCode : CD
contextControlCode :...
sequenceNumber : INT
negationInd : BL
noteText : ED
time : IVL<TS>
modeCode : CE
awarenessCode : CE
signatureCode : CE
signatureText : ED
performInd : BL
substitutionConditionC..

Act
classCode : CS
moodCode : CS
id : SET<II>
code : CD
negationInd : BL
derivationExpr : ST
title : ED
text : ED
statusCode : CS
effectiveTime : GTS
activityTime : GTS
availabilityTime : TS
priorityCode : SET<CE>
confidentialityCode : SET<C..
repeatNumber : IVL<INT>
interruptibleInd : BL
levelCode : CE
independentInd : BL
uncertaintyCode : CE
reasonCode : SET<CE>
languageCode : CE

ActRelationship
typeCode : CS
inversionInd : BL
contextControlCode : CS
contextConductionInd : BL
sequenceNumber : INT
priorityNumber : INT
pauseQuantity : PQ
checkpointCode : CS
splitCode : CS
joinCode : CS
negationInd : BL
conjunctionCode : CS
localVariableName : ST
...

ControlAct

FinancialContract
paymentTermsCode : CE

WorkingList
ownershipLevelCode : CE

InvoiceElement
modifierCode : SET<CE>
unitQuantity : RTO<PQ,PQ>
unitPriceAmt : RTO<MO,PQ>
netAmt : MO
factorNumber : REAL
pointsNumber : REAL

SubstanceAdministration
routeCode : CE
approachSiteCode : SET<CD>
doseQuantity : IVL<PQ>
rateQuantity : IVL<PQ>
doseCheckQuantity : SET<RTO>
maxDoseQuantity : SET<RTO>
administrationUnitCode : CE

Observation
value : ANY
interpretationCode : SET<CE>
methodCode : SET<CE>
targetSiteCode : SET<CD>

Procedure
methodCode : SET<CE>
approachSiteCode : SET<CD>
targetSiteCode : SET<CD>

DiagnosticImage
subjectOrientationCode : CE

Account
balanceAmt : MO
currencyCode : CE
interestRateQuantity : RTO<MO,PQ>
allowedBalanceQuantity : IVL<MO>

PatientEncounter
preAdmitTestInd : BL
admissionReferralSourceCode : CE
lengthOfStayQuantity : PQ
dischargeDispositionCode : CE
specialCourtesiesCode : SET<CE>
specialArrangementCode : SET<CE>

PublicHealthCase
detectionMethodCode : CE
transmissionModeCode : CE
diseaseImportedCode : CE

Supply
quantity : PQ
expectedUseTime : IVL<TS>

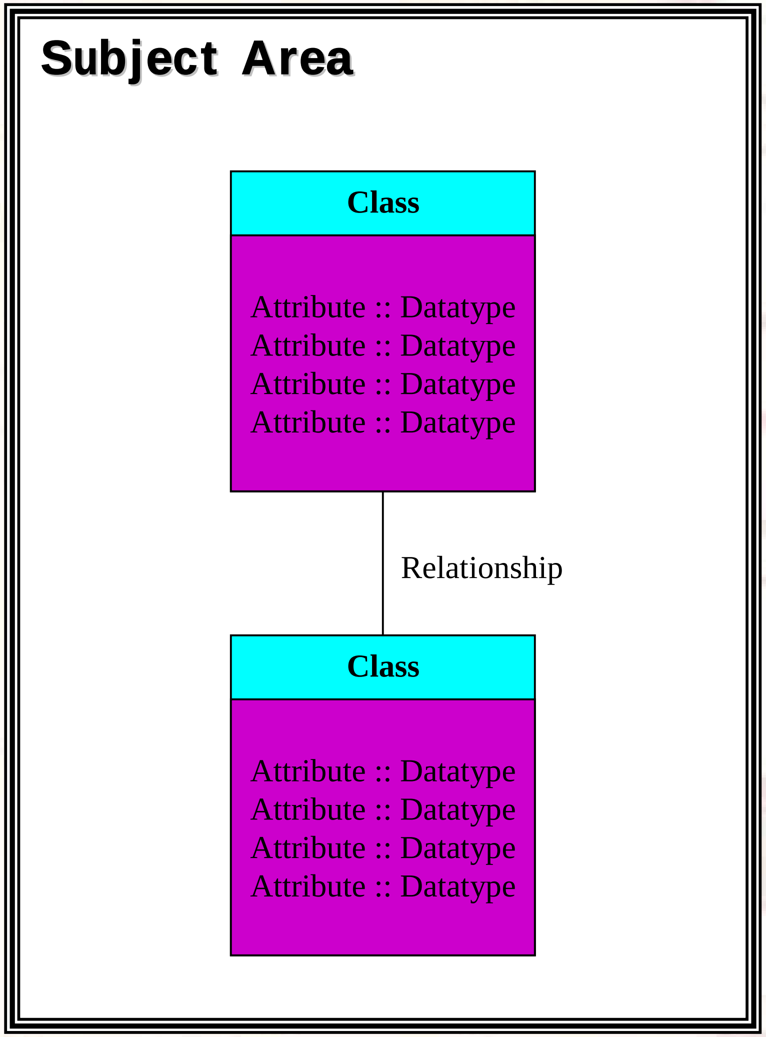
Diet
energyQuantity : PQ
carbohydrateQuantity : PQ

DeviceTask
parameterValue : LIST<ANY>

FinancialTransaction
amt : MO
creditExchangeRateQuantity : REAL
debitExchangeRateQuantity : REAL

RIM 2.06
December 6, 2004

Information Model Components



Subject Area: a major partition of an information model.

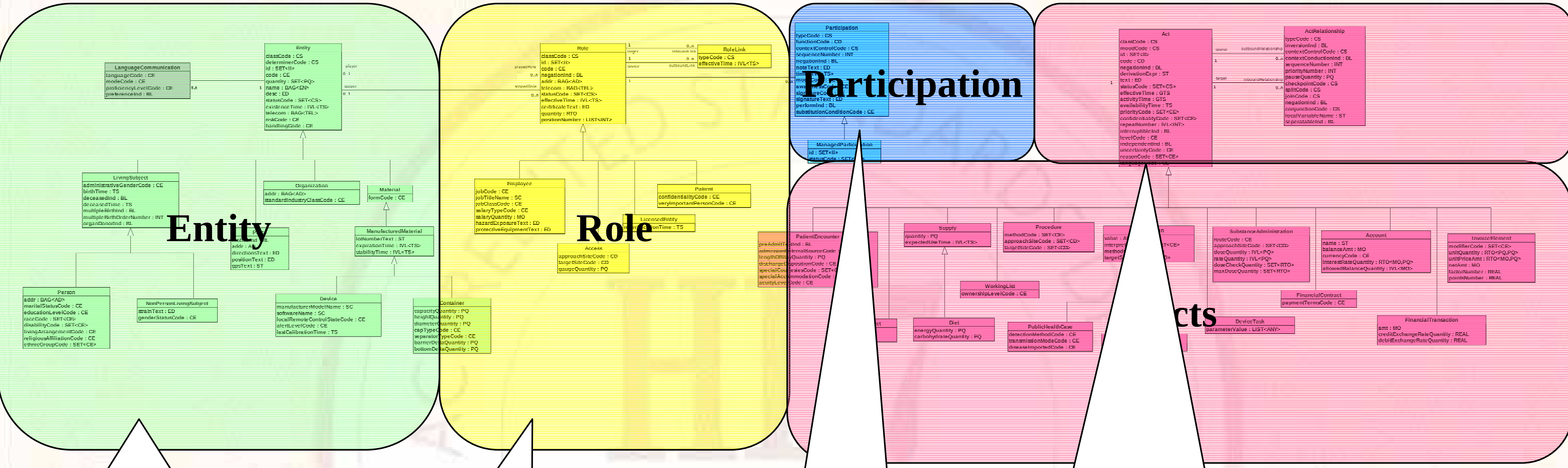
Class: something about which information is collected.

Relationship: an affiliation between two classes.

Attribute: information about a class.

Data Type: a specification of the format of an attribute.

Class Diagram – Normative RIM Release 1



Physical things of interest .

Persons,

Organizations,

Areas

• 28 C

… take on Roles in health care .

Patient, Physici

Employer

Entities in Roles participate as …

Performer, Author, target

… participate in Acts

…

Encounters, Observations, procedures, medications

…

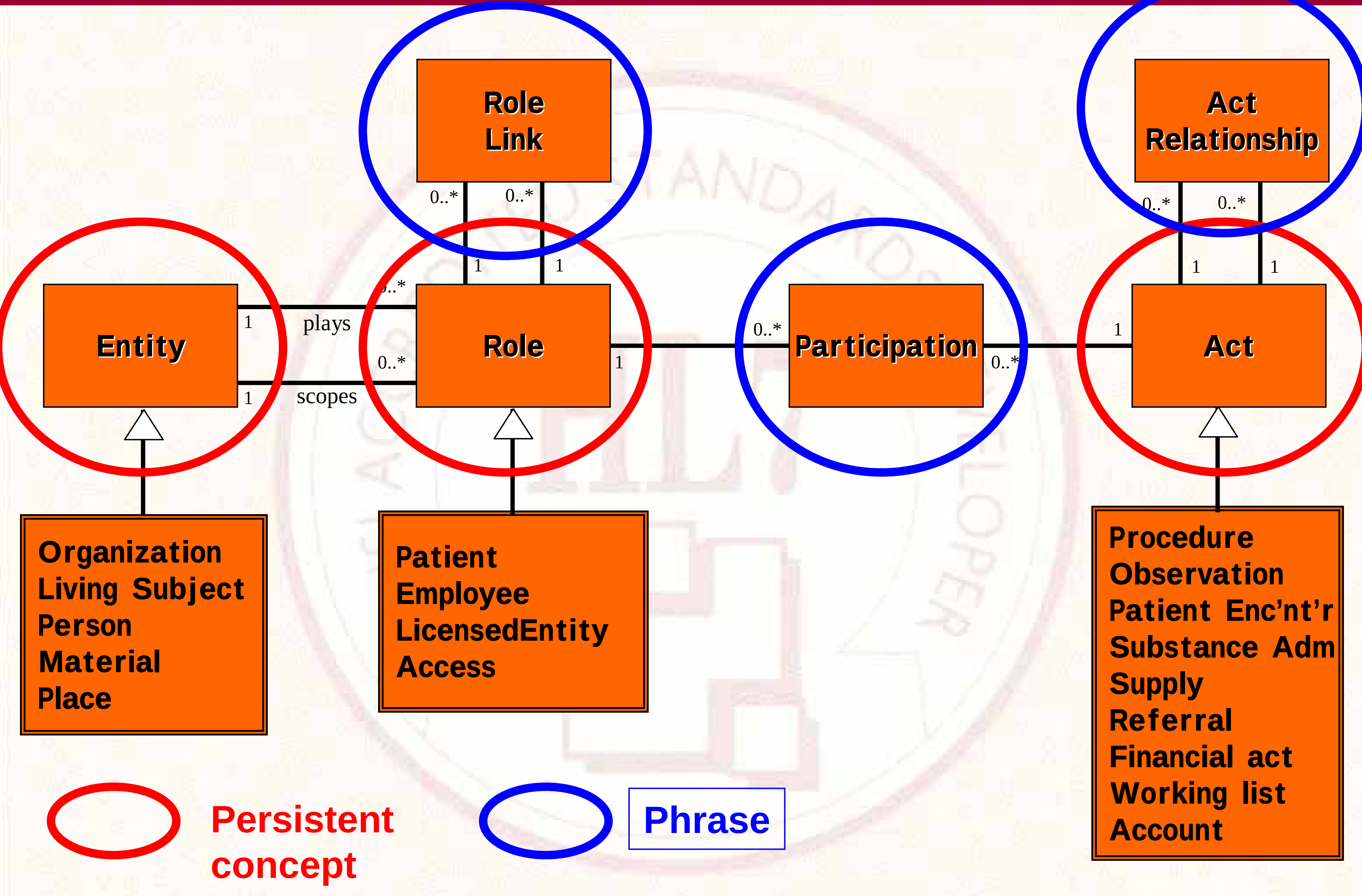
Action – the focus of health care messaging

- The reason we want to automate health care data is to be able to document the actions taken to treat a patient:
  - A request or order for a test is an action
  - The report of the test result is an action
  - Creating a diagnosis based on test results is an action
  - Prescribing treatment based on the diagnosis is an action
- In simple terms, a medical record is a record of each of the individual actions that make up the diagnosis, treatment and care of a patient.

Five core concepts of the RIM

- Every happening is an Act
  - Procedures, observations, medications, supply, registration, etc.
- Acts are related through an ActRelationship
  - composition, preconditions, revisions, support, etc.
- Participation defines the context for an Act
  - author, performer, subject, location, etc.
- The participants are Roles
  - patient, provider, practitioner, specimen, employee etc.
- Roles are played by Entities
  - persons, organizations, material, places, devices, etc.

RIM Core Classes



Role Link

Act Relationship

Entity

Role

Participation

Act

Organization
Living Subject
Person
Material
Place

Patient
Employee
LicensedEntity
Access

Procedure
Observation
Patient Enc'nt'r
Substance Adm
Supply
Referral
Financial act
Working list
Account

Persistent concept

Phrase

Classes may have coded attributes

Class: **Act**

Description: A type of stakeholder. An individual human being.

Associations for: **Act**

target :: (1..1)Act :: inboundRelationship :: (0..*)

source :: (1..1)Act :: outboundRelationship :: (0..*)

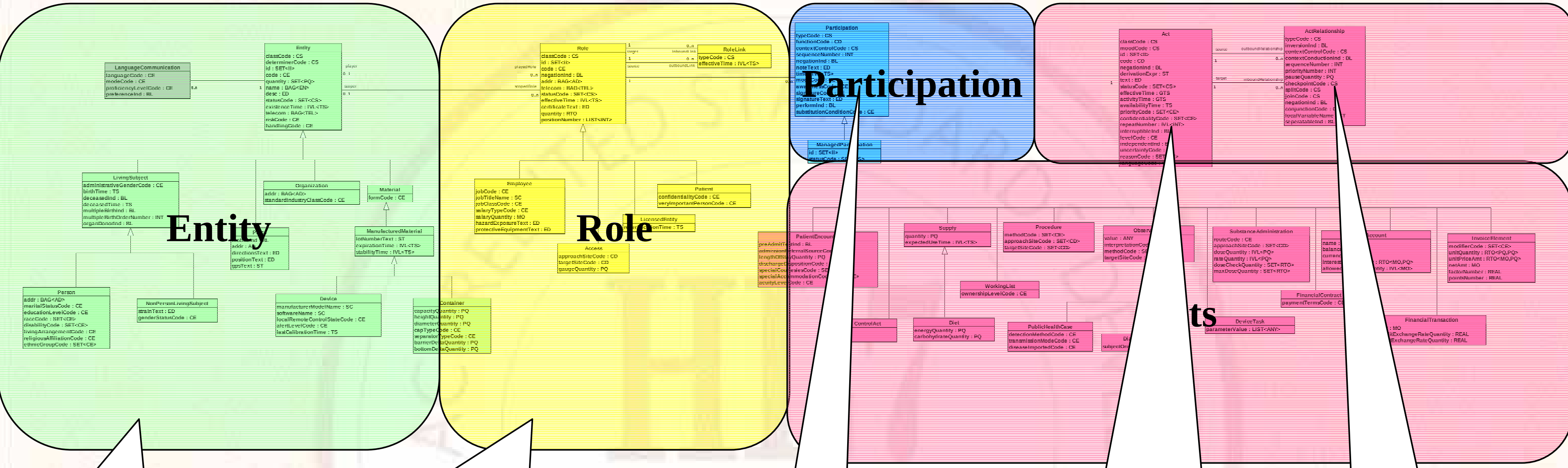
Attributes of: **Act**

classCode : CNE {ActClass}

moodCode : CNE {ActMood}

code : CWE {ActCode}

RIM – Abstract model with encoded detail



9 class-subtypes

27 enumerated subtypes

4 class-subtypes

75 enumerated subtypes

15 class-subtypes

49 enumerated subtypes

1 class-subtype

50 enumerated subtypes

0 class-subtypes

56 enumerated subtypes

35 Classes

181 Attributes

82 “Coded” attributes (45 %)

Is “Act” sufficient?

- How can a single act class represent all of the elements of clinical action – their definition, request, order, report?
- Answer: Terminology (codes) that control
  - the “sub-type” of Act (disjoint, incomplete), and
  - The “mood” of the action, in the sense of the mood of a verb in grammar
    - “A code specifying whether the Act is an activity that has happened, can happen, is happening, is intended to happen, or is requested/demanded to happen. “

“Mood” of a Verb (or action)?

“Yes, verbs have moods, but these ‘moods’ have nothing to do with human emotions such as anger, sadness, or excitement. The ‘mood’ of a verb refers to how the writer presents an idea. The three moods are:

“**Indicative** mood is the one most often used. In general, it is used for situations when *facts and reality, … are the content* of a sentence or clause...

“**Imperative** [mood] forms direct *commands*...

“**Subjunctive** mood generally signals that the action or state specified by *the verb is the object of* a wish, a hope or fear, a request, a conjecture, ...

“[e.g.] Margaret insists that he *take* the dog for a walk. (request)”

from: "*The Basic Elements of English -- An Interactive Guide to Grammar*",
© 1998, English Department, Univ. of Calgary, Calgary, Alberta, Canada

Principle Act ‘moods’

definition (DEF) – Definition of an act, formerly a “master file” *(subjunctive)*

intent (INT) – an intention to plan or perform an act *(imperative)*

- **request** (RQO) – a request or order for a service from a request “placer” to a request “fulfiller” *(imperative)*
- **promise** (PRMS) – intent to perform that has the strength of a commitment *(imperative)*

event (EVN) – an act that actually happens, includes the documentation (report) of the event *(indicative)*

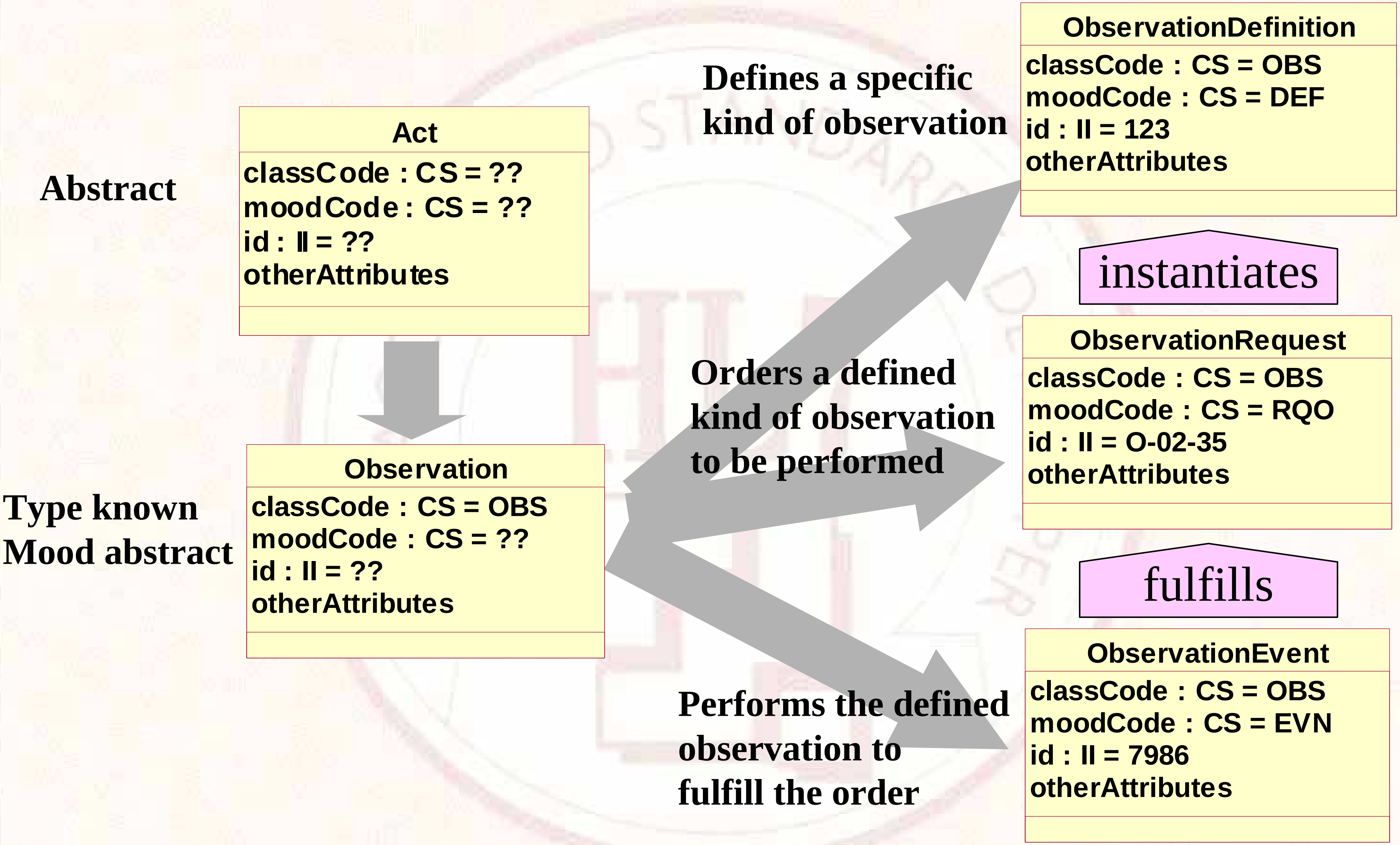
Critical Note –

“Mood” is not a status code.

Each instance of the Act class may have one and only one value for ‘mood.’

Thus, an act in “order” mood that orders an act in definition mood and results in an Act in ‘event’ mood are three different acts, related through the act relationship.

Example of classCode & moodCode attributes



Abstract

Act

classCode : CS = ??
moodCode : CS = ??
id : II = ??
otherAttributes

Type known
Mood abstract

Observation

classCode : CS = OBS
moodCode : CS = ??
id : II = ??
otherAttributes

Defines a specific kind of observation

ObservationDefinition

classCode : CS = OBS
moodCode : CS = DEF
id : II = 123
otherAttributes

instantiates

Orders a defined kind of observation to be performed

ObservationRequest

classCode : CS = OBS
moodCode : CS = RQO
id : II = O-02-35
otherAttributes

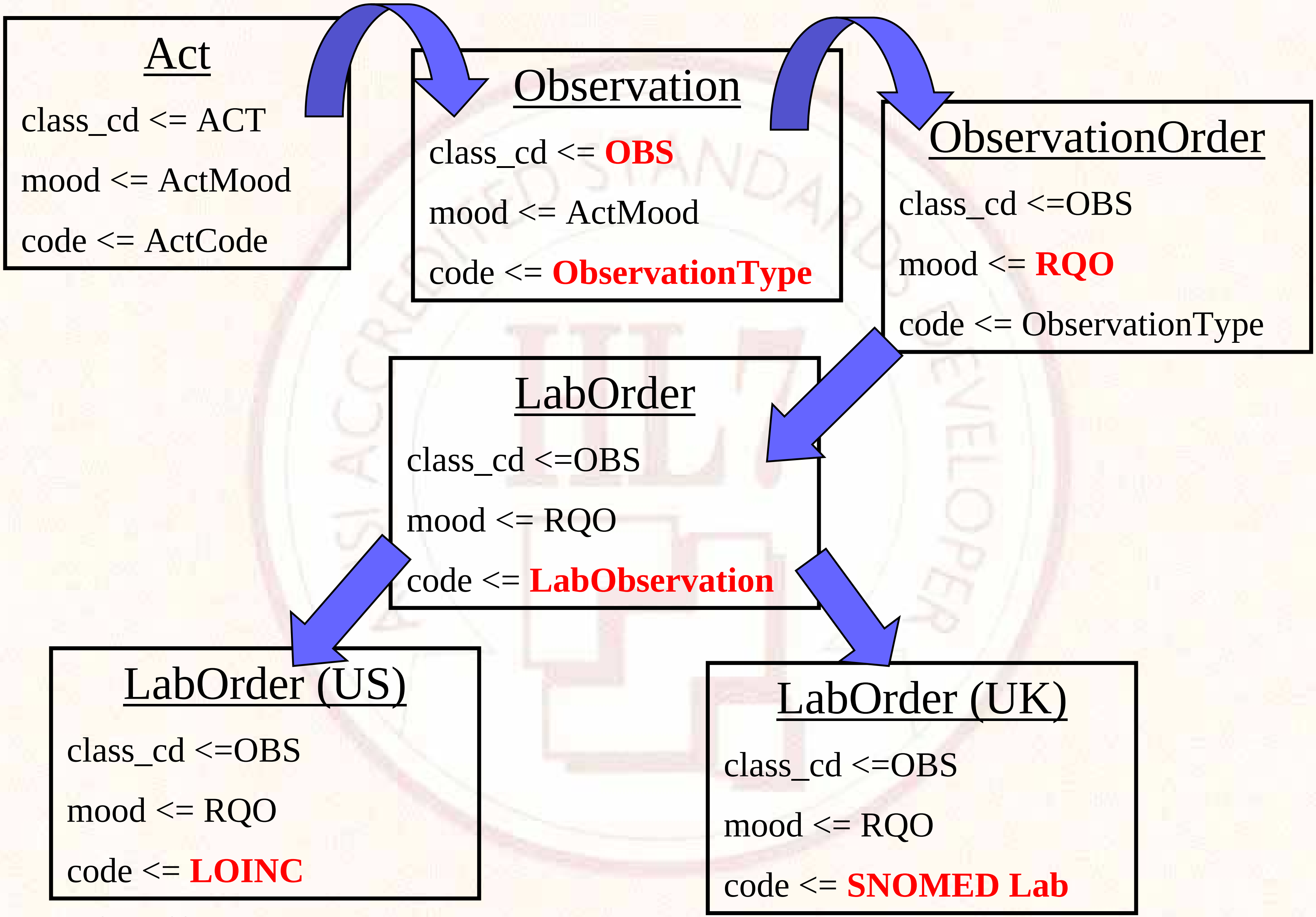
fulfills

Performs the defined observation to fulfill the order

ObservationEvent

classCode : CS = OBS
moodCode : CS = EVN
id : II = 7986
otherAttributes

Specialization by restriction (constraint)



Act

class_cd <= ACT

mood <= ActMood

code <= ActCode

Observation

class_cd <= **OBS**

mood <= ActMood

code <= **ObservationType**

ObservationOrder

class_cd <=OBS

mood <= **RQO**

code <= ObservationType

LabOrder

class_cd <=OBS

mood <= RQO

code <= **LabObservation**

LabOrder (US)

class_cd <=OBS

mood <= RQO

code <= **LOINC**

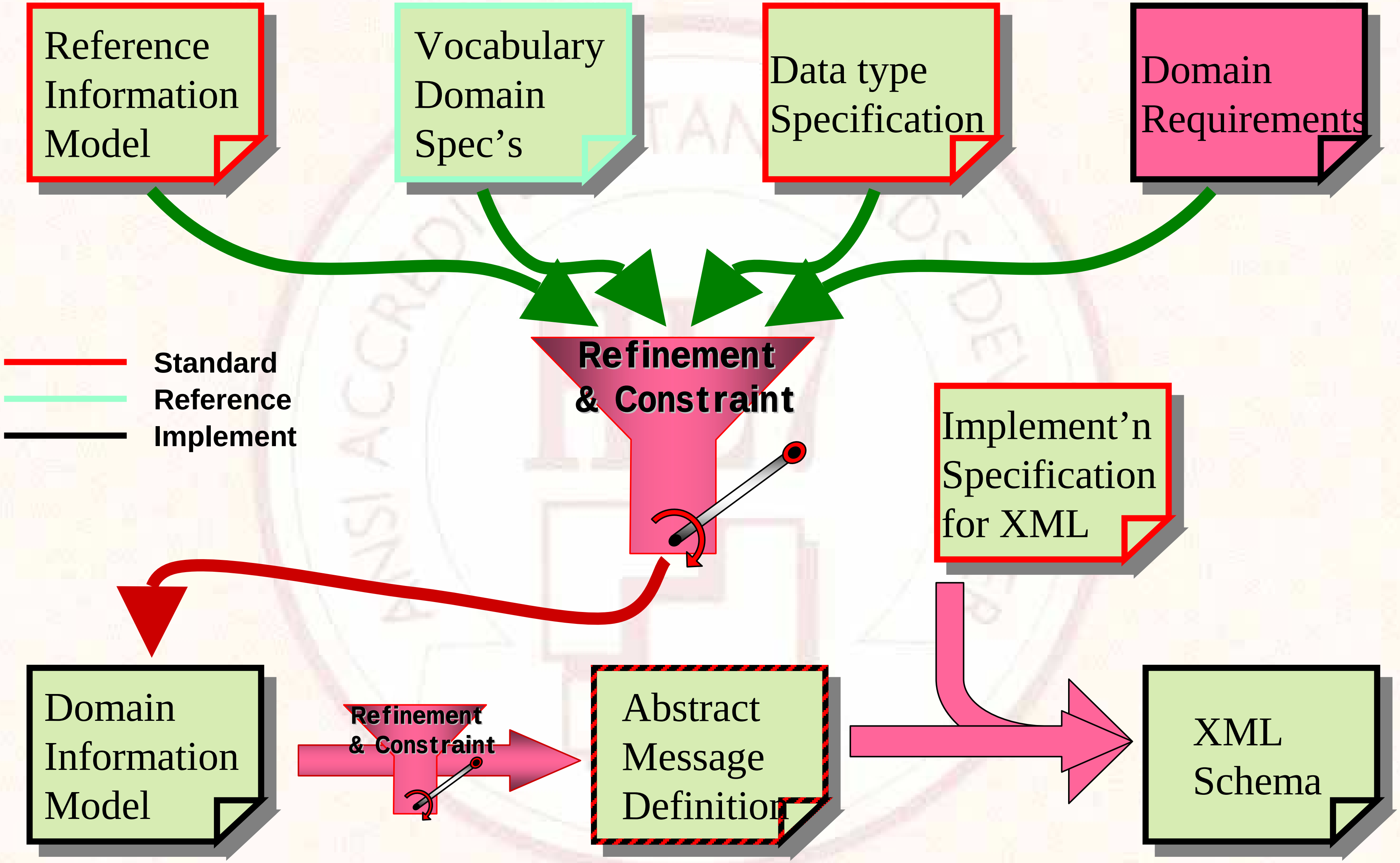
LabOrder (UK)

class_cd <=OBS

mood <= RQO

code <= **SNOMED Lab**

"Turning the Crank"



Reference Information Model

Vocabulary Domain Spec's

Data type Specification

Domain Requirements

Standard

Reference

Implement

Refinement & Constraint

Implement'n Specification for XML

Domain Information Model

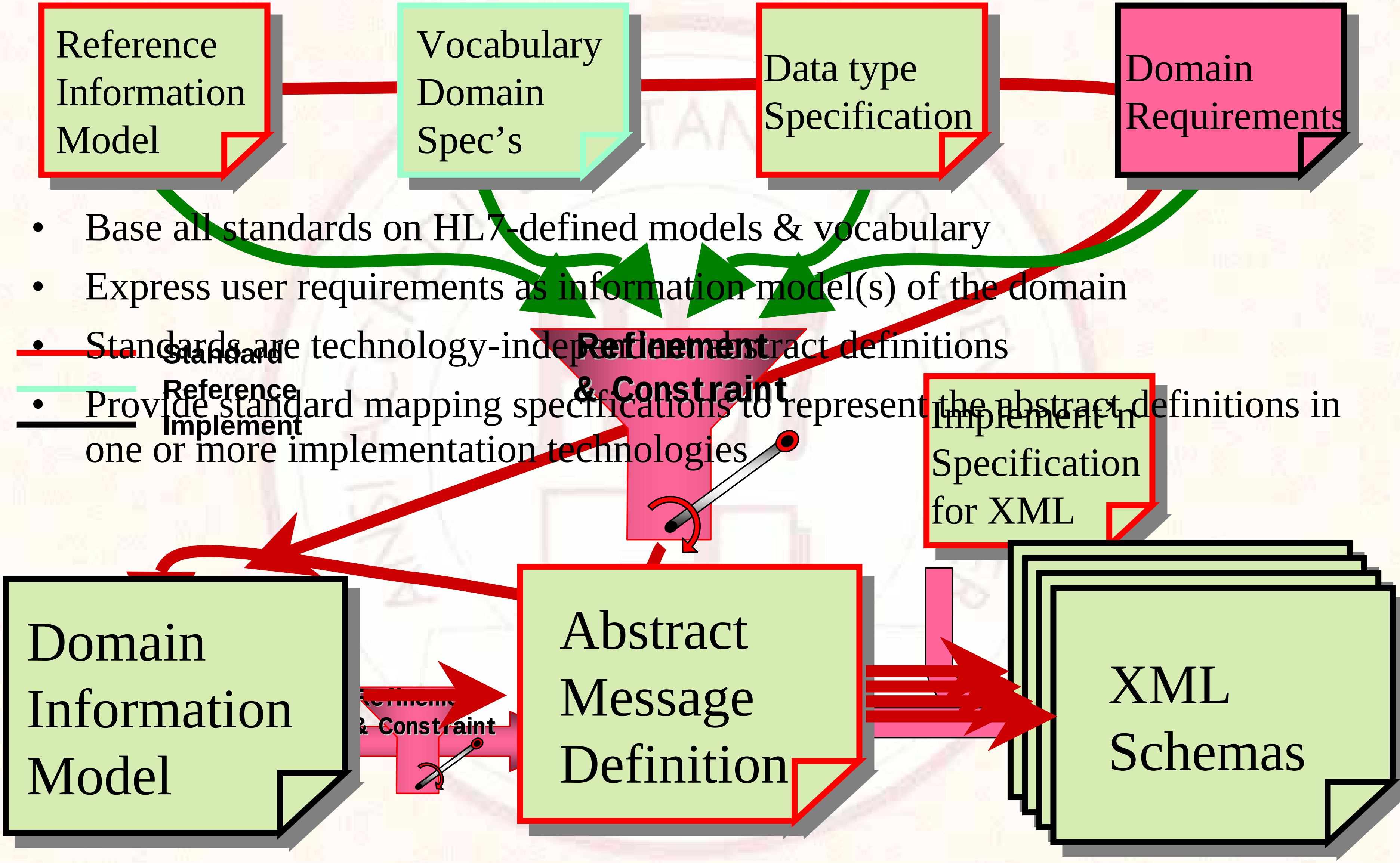
Refinement & Constraint

Abstract Message Definition

XML Schema

Version 3 Principles

- Base all standards on HL7-defined models & vocabulary
- Express user requirements as information model(s) of the domain
- Standards are technology-independent abstract definitions
- Provide standard mapping specifications to represent the abstract definitions in one or more implementation technologies



The “essence” of Version 3

- Apply the ‘best practices’ of software development to developing standards – a model-based methodology
- Predicate all designs on two semantic foundations – a reference information model and a complete, carefully-selected set of terminology domains
- Require all Version 3 standards to draw from these two common resources
- Use software-engineering style tools to support the process.

The problem

Storyboard: A clinician, using a local medical office support system, orders a lab test for one of her patients. The test will be performed on a specimen collected at her office. She will send the specimen by courier, and expects to receive a confirmation that the test will be performed, and a result of the test.

What do we need?

- Act (*order*) – Order
  - Participation – Author
    - Role - Physician
      - Entity - Dr. Smith in the MD office
  - Participation – Performer
    - Role – Laboratory
      - Entity - The lab that will perform the test
  - Participation – Subject
    - Role – Specimen
  - Participation – Record target
    - Role – Patient in whose record the result goes
  - Act relationship – Definition
    - Act (*definition*) – Ordered Test

… of this order.

… was the author …

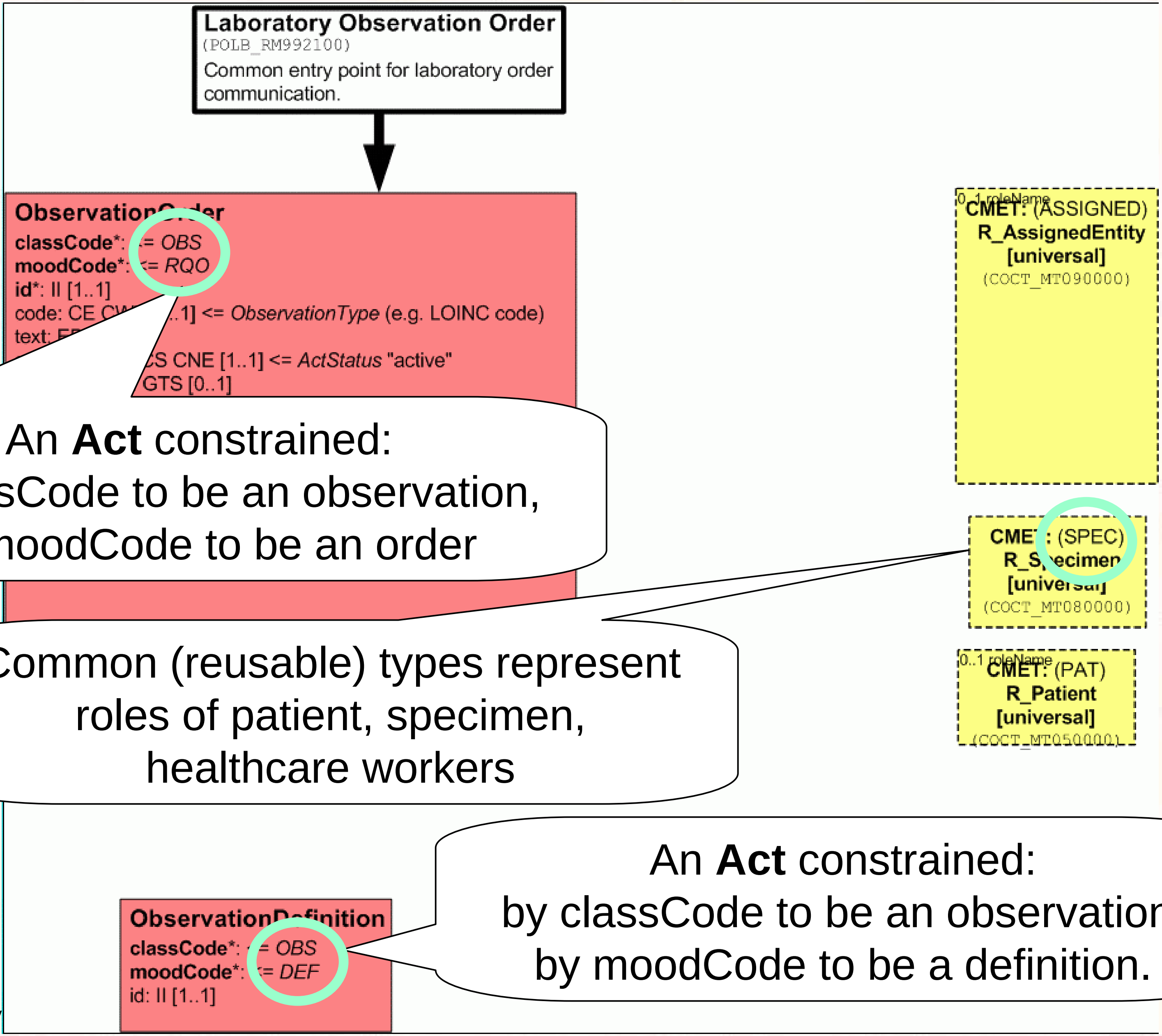
… in her role as a physician …

Suzy Smith …

HL7 Graphic representation

- Foundation of HL7 modeling is defined in a UML profile, but we use an alternate graphic representation that better represents our "messages"
- Persistent elements are in "square boxes"
  - All attributes shown
  - All constraints shown on the diagram
- Phrases are shown as "Arrows" linking elements
  - All attributes shown
  - All constraints shown on the diagram

Building messages – persistent elements



Laboratory Observation Order
(POLB_RM992100)
Common entry point for laboratory order communication.

ObservationOrder
classCode*: <= OBS
moodCode*: <= RQO
id*: II [1..1]
code: CE CW ..1] <= ObservationType (e.g. LOINC code)
text: E
CS CNE [1..1] <= ActStatus "active"
GTS [0..1]

CMET: (ASSIGNED)
R_AssignedEntity
[universal]
(COCT_MT090000)

CMET: (SPEC)
R_Specimen
[universal]
(COCT_MT080000)

CMET: (PAT)
R_Patient
[universal]
(COCT_MT050000)

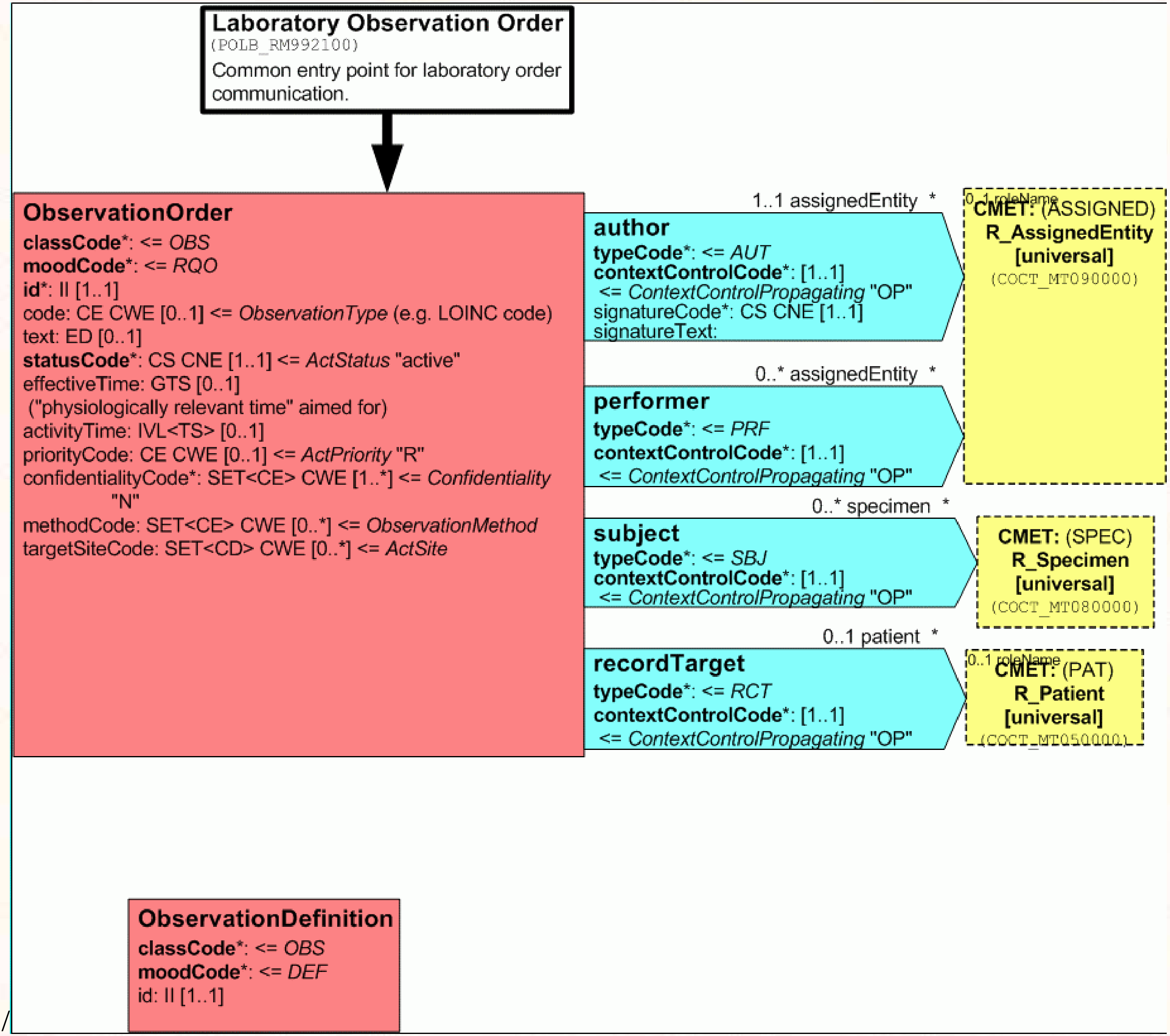
ObservationDefinition
classCode*: <= OBS
moodCode*: <= DEF
id: II [1..1]

An **Act** constrained:
by classCode to be an observation,
by moodCode to be an order

Common (reusable) types represent
roles of patient, specimen,
healthcare workers

An **Act** constrained:
by classCode to be an observation,
by moodCode to be a definition.

Building messages – contextual phrases



Laboratory Observation Order
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Common entry point for laboratory order communication.

ObservationOrder
classCode*: <= *OBS*
moodCode*: <= *RQO*
id*: II [1..1]
code: CE CWE [0..1] <= *ObservationType* (e.g. LOINC code)
text: ED [0..1]
statusCode*: CS CNE [1..1] <= *ActStatus* "active"
effectiveTime: GTS [0..1]
("physiologically relevant time" aimed for)
activityTime: IVL<TS> [0..1]
priorityCode: CE CWE [0..1] <= *ActPriority* "R"
confidentialityCode*: SET<CE> CWE [1..*] <= *Confidentiality* "N"
methodCode: SET<CE> CWE [0..*] <= *ObservationMethod*
targetSiteCode: SET<CD> CWE [0..*] <= *ActSite*

1..1 assignedEntity *

author
typeCode*: <= *AUT*
contextControlCode*: [1..1]
<= *ContextControlPropagating* "OP"
signatureCode*: CS CNE [1..1]
signatureText:

0..* assignedEntity *

performer
typeCode*: <= *PRF*
contextControlCode*: [1..1]
<= *ContextControlPropagating* "OP"

0..1 roleName
CMET: (ASSIGNED)
R_AssignedEntity
[universal]
(COCT_MT090000)

0..* specimen *

subject
typeCode*: <= *SBJ*
contextControlCode*: [1..1]
<= *ContextControlPropagating* "OP"

CMET: (SPEC)
R_Specimen
[universal]
(COCT_MT080000)

0..1 patient *

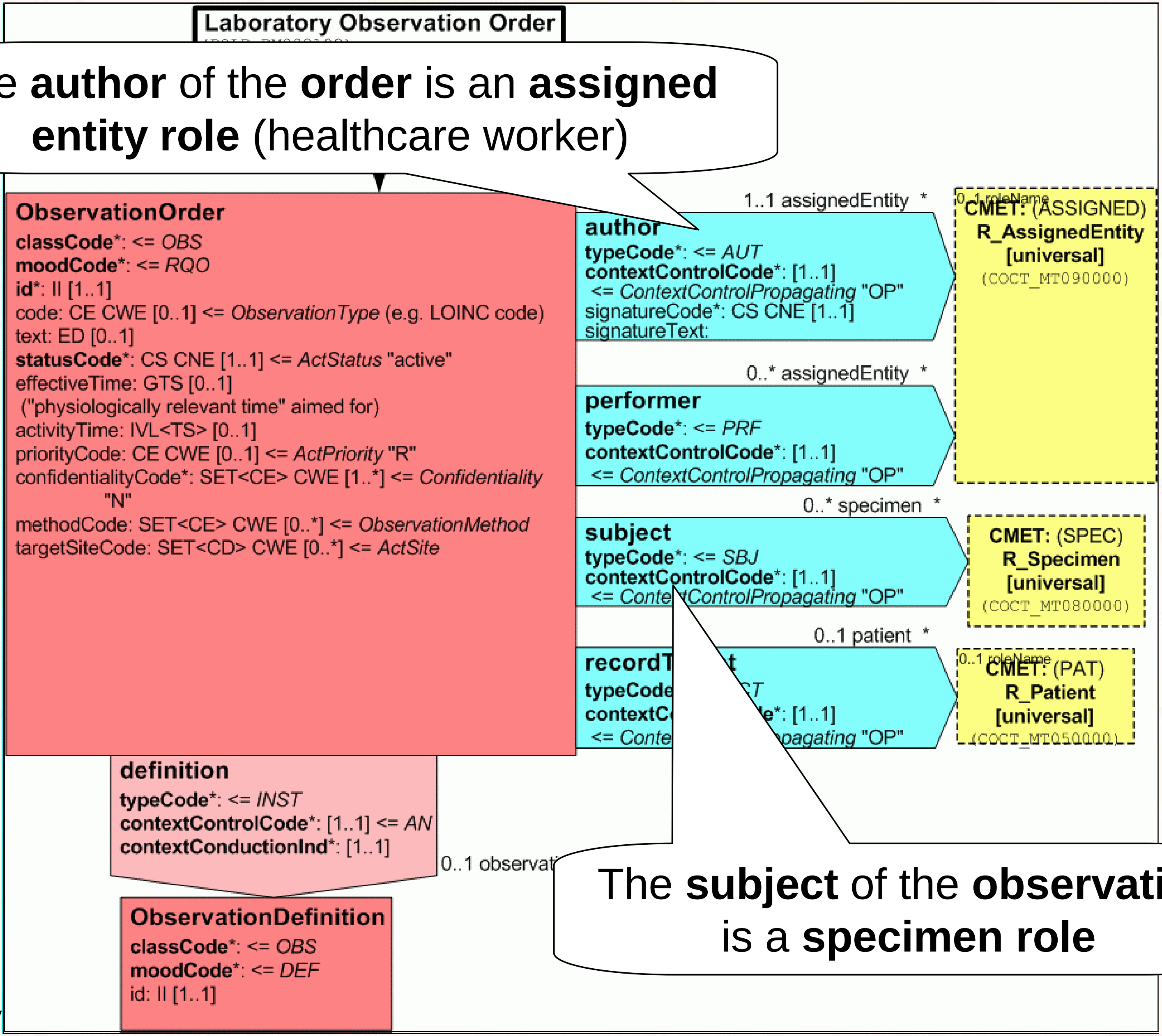
recordTarget
typeCode*: <= *RCT*
contextControlCode*: [1..1]
<= *ContextControlPropagating* "OP"

0..1 roleName
CMET: (PAT)
R_Patient
[universal]
(COCT_MT050000)

ObservationDefinition
classCode*: <= *OBS*
moodCode*: <= *DEF*
id: II [1..1]

Building messages – relational phrase

The **author** of the **order** is an **assigned entity role** (healthcare worker)



Laboratory Observation Order

ObservationOrder

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confidentialityCode*: SET<CE> CWE [1..*] <= *Confidentiality* "N"
methodCode: SET<CE> CWE [0..*] <= *ObservationMethod*
targetSiteCode: SET<CD> CWE [0..*] <= *ActSite*

1..1 assignedEntity *

author
typeCode*: <= *AUT*
contextControlCode*: [1..1]
<= *ContextControlPropagating* "OP"
signatureCode*: CS CNE [1..1]
signatureText:

0..1 roleName
CMET: (ASSIGNED)
R_AssignedEntity
[universal]
(COCT_MT090000)

0..* assignedEntity *

performer
typeCode*: <= *PRF*
contextControlCode*: [1..1]
<= *ContextControlPropagating* "OP"

0..* specimen *

subject
typeCode*: <= *SBJ*
contextControlCode*: [1..1]
<= *ContextControlPropagating* "OP"

CMET: (SPEC)
R_Specimen
[universal]
(COCT_MT080000)

0..1 patient *

recordT t
typeCode *CT*
contextC e*: [1..1]
<= *Conte pagating* "OP"

0..1 roleName
CMET: (PAT)
R_Patient
[universal]
(COCT_MT050000)

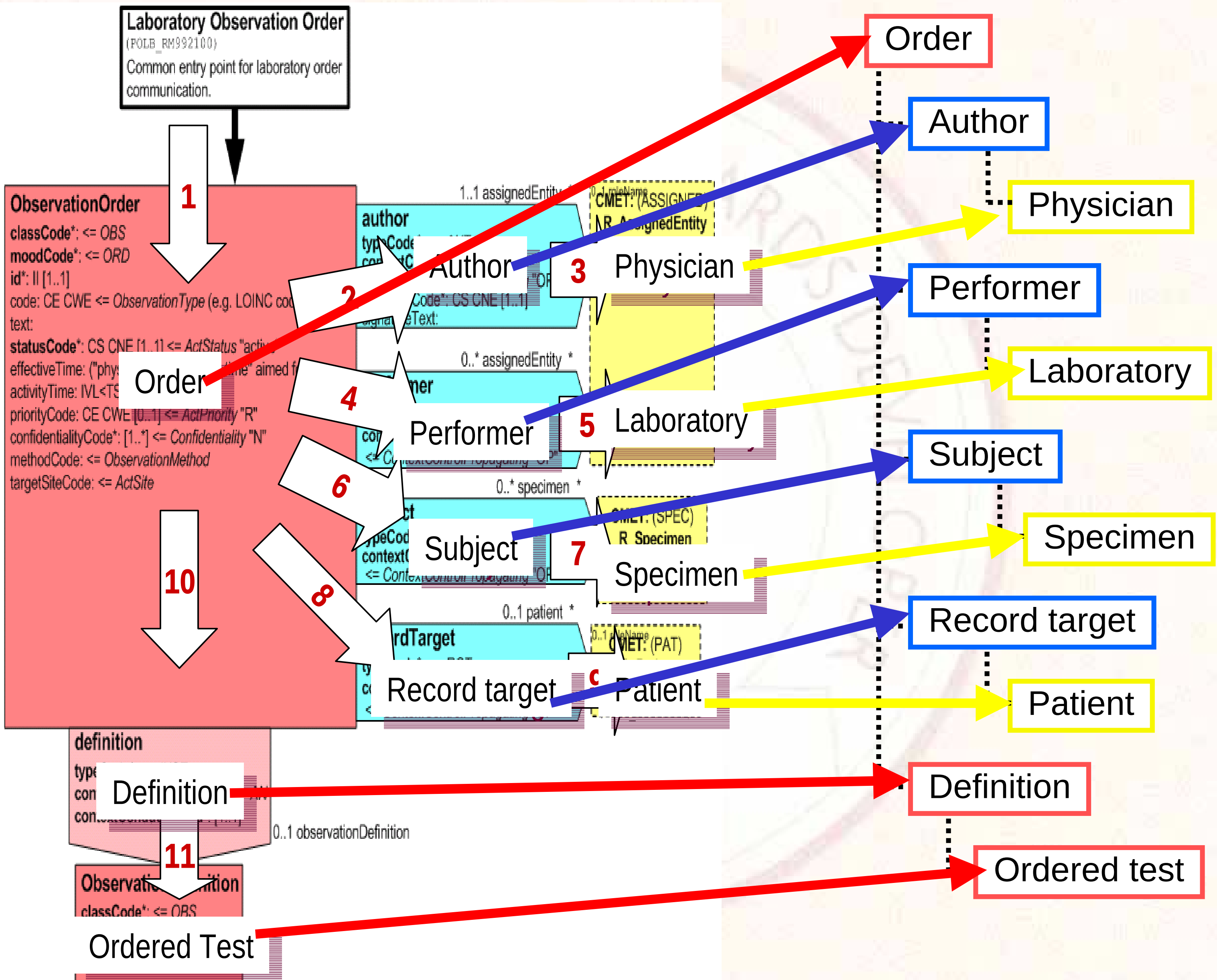
definition
typeCode*: <= *INST*
contextControlCode*: [1..1] <= *AN*
contextConductionInd*: [1..1]

0..1 observat

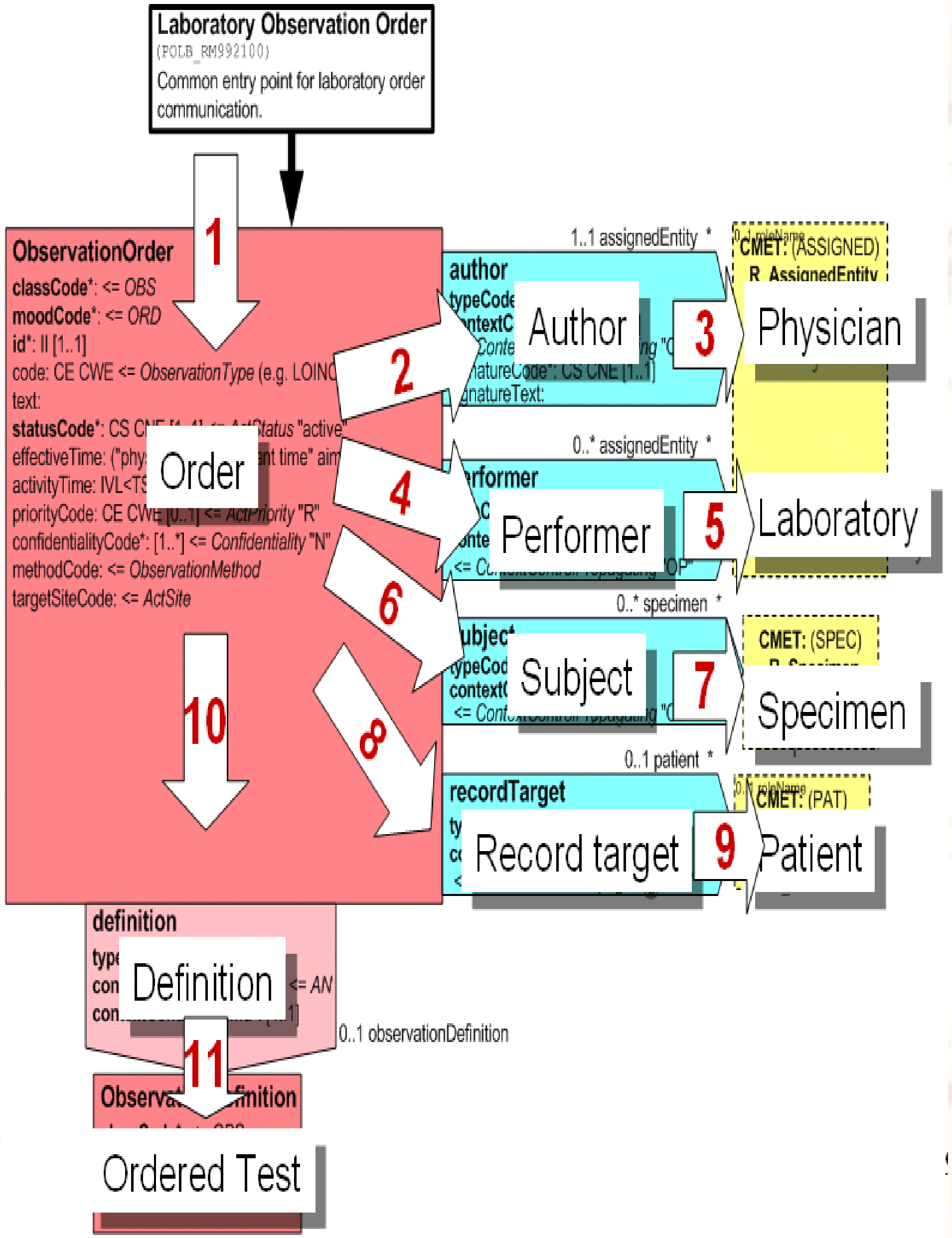
ObservationDefinition
classCode*: <= *OBS*
moodCode*: <= *DEF*
id: II [1..1]

The **subject** of the **observation** is a **specimen role**

Automated serializing of graphic design



Automated serializing of graphic design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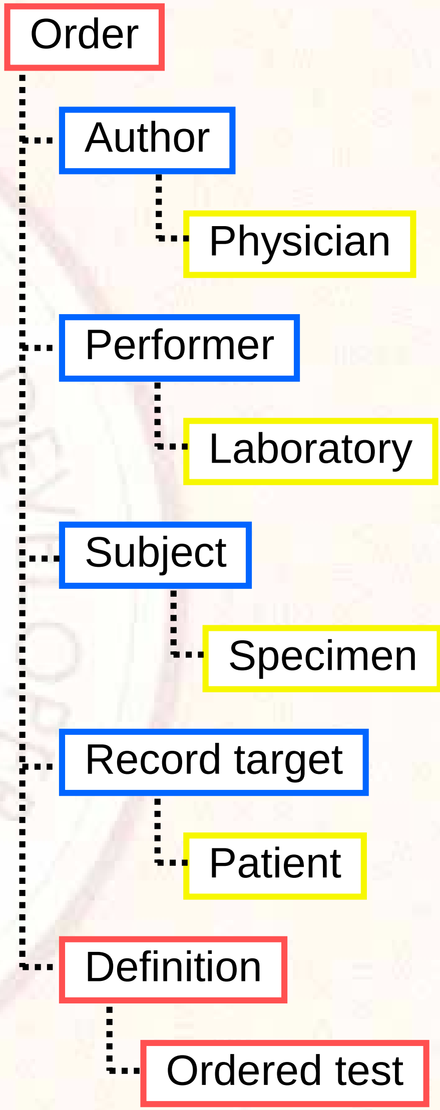
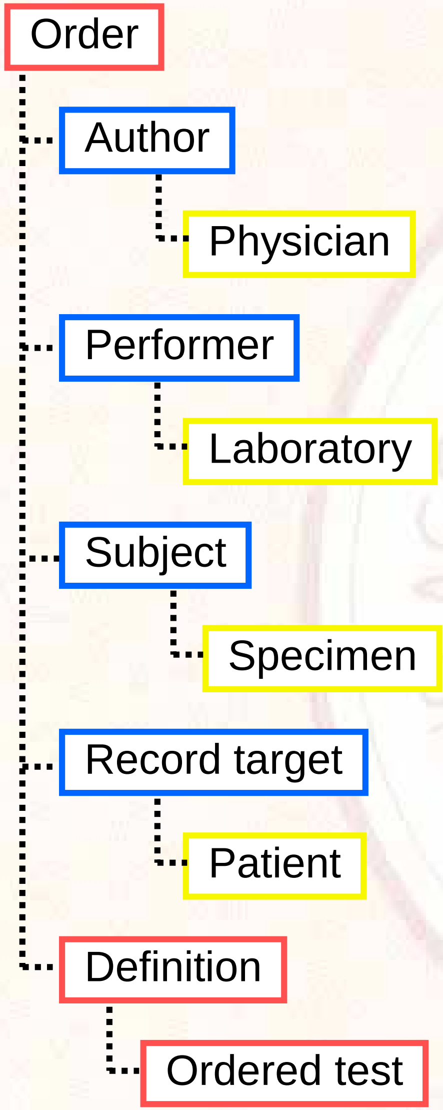
confidentialityCode*: [1..*] <= Confidentiality "N"
methodCode: <= ObservationMethod
targetSiteCode: <= ActSite
1..1 assignedEntity *
CMET: (ASSIGNED)
R_AssignedEntity
author
typeCode
contextC
natureCode*: CS CNE [1..1]
signatureText:
0..* assignedEntity *
performer
<= ContextControlPropagating "OP"
0..* specimen *
CMET: (SPEC)
subject
typeCod
context
0..1 patient *
CMET: (PAT)
recordTarget
definition
0..1 observationDefinition
ObservationDefinition
Order
Author
Physician
Performer
Laboratory
Subject
Specimen
Record target
Patient
Definition
Ordered Test
1
2
3
4
5
6
7
8
9
10
11

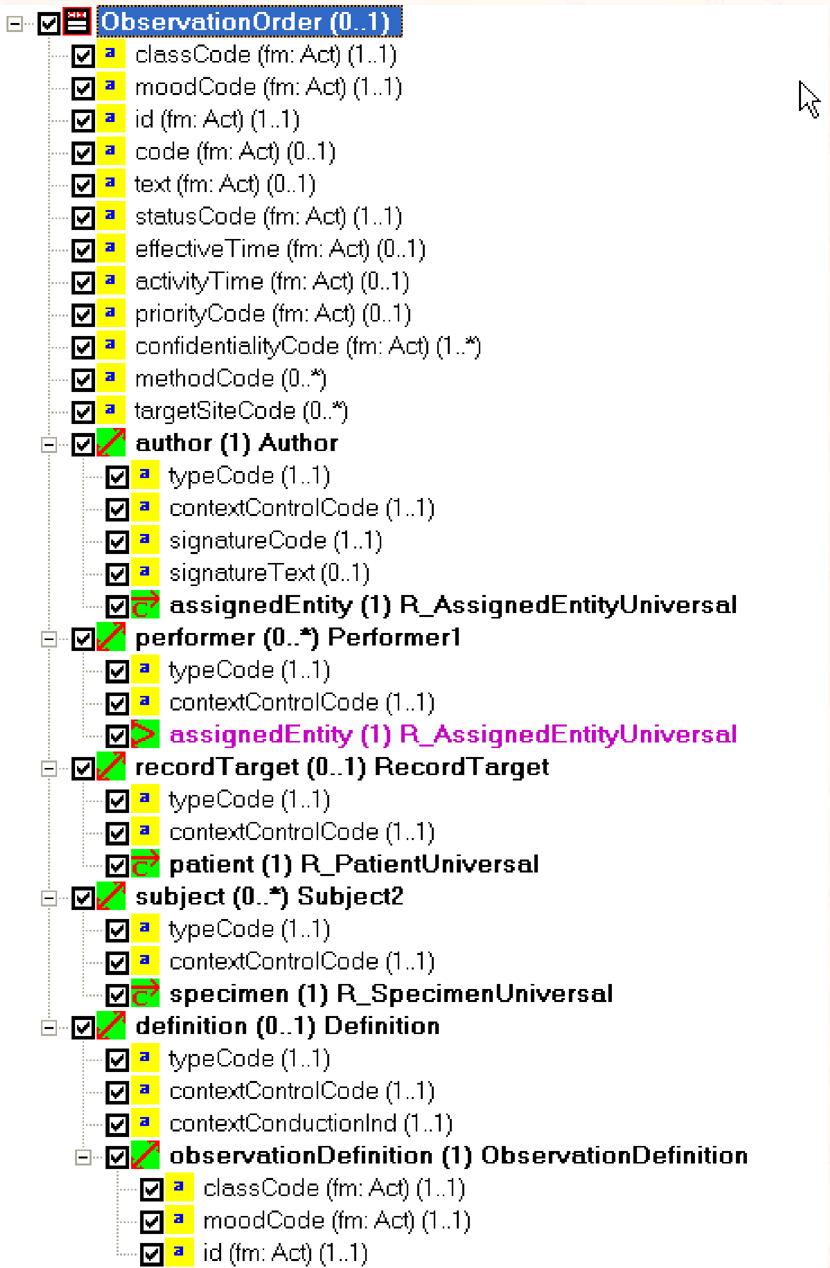

- Order
  - Author
    - Physician
  - Performer
    - Laboratory
  - Subject
    - Specimen
  - Record target
    - Patient
  - Definition
    - Ordered test

Automated serializing of graphic design



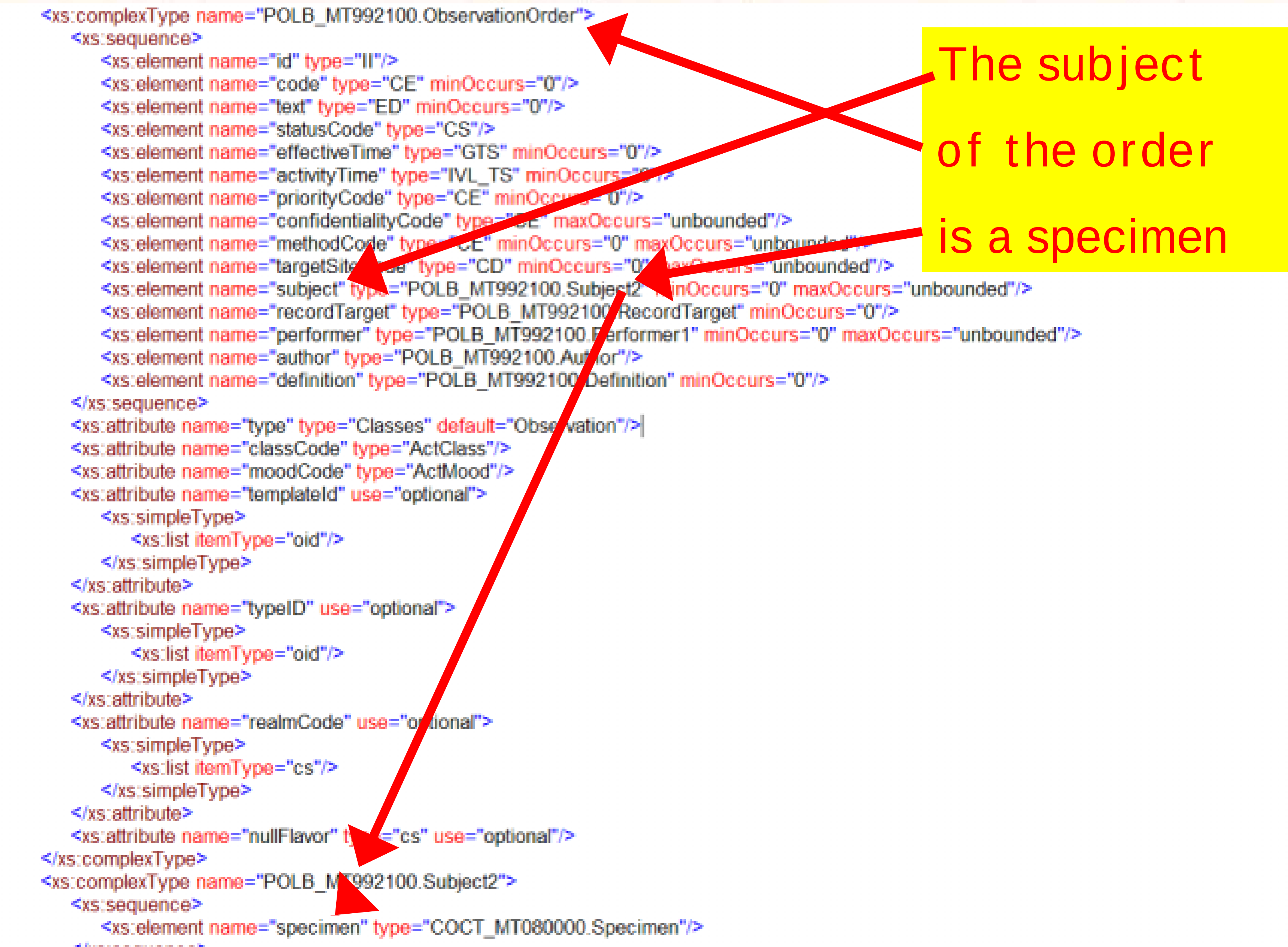
Order

- Author
  - Physician
- Performer
  - Laboratory
- Subject
  - Specimen
- Record target
  - Patient
- Definition
  - Ordered test



```
⊟ ☑ ObservationOrder (0..1)
    ☑ classCode (fm: Act) (1..1)
    ☑ moodCode (fm: Act) (1..1)
    ☑ id (fm: Act) (1..1)
    ☑ code (fm: Act) (0..1)
    ☑ text (fm: Act) (0..1)
    ☑ statusCode (fm: Act) (1..1)
    ☑ effectiveTime (fm: Act) (0..1)
    ☑ activityTime (fm: Act) (0..1)
    ☑ priorityCode (fm: Act) (0..1)
    ☑ confidentialityCode (fm: Act) (1..*)
    ☑ methodCode (0..*)
    ☑ targetSiteCode (0..*)
  ⊟ ☑ author (1) Author
        ☑ typeCode (1..1)
        ☑ contextControlCode (1..1)
        ☑ signatureCode (1..1)
        ☑ signatureText (0..1)
        ☑ assignedEntity (1) R_AssignedEntityUniversal
  ⊟ ☑ performer (0..*) Performer1
        ☑ typeCode (1..1)
        ☑ contextControlCode (1..1)
        ☑ assignedEntity (1) R_AssignedEntityUniversal
  ⊟ ☑ recordTarget (0..1) RecordTarget
        ☑ typeCode (1..1)
        ☑ contextControlCode (1..1)
        ☑ patient (1) R_PatientUniversal
  ⊟ ☑ subject (0..*) Subject2
        ☑ typeCode (1..1)
        ☑ contextControlCode (1..1)
        ☑ specimen (1) R_SpecimenUniversal
  ⊟ ☑ definition (0..1) Definition
        ☑ typeCode (1..1)
        ☑ contextControlCode (1..1)
        ☑ contextConductionInd (1..1)
      ⊟ ☑ observationDefinition (1) ObservationDefinition
            ☑ classCode (fm: Act) (1..1)
            ☑ moodCode (fm: Act) (1..1)
            ☑ id (fm: Act) (1..1)
```

Our example schema



```
<xs:complexType name="POLB_MT992100.ObservationOrder">
    <xs:sequence>
        <xs:element name="id" type="II"/>
        <xs:element name="code" type="CE" minOccurs="0"/>
        <xs:element name="text" type="ED" minOccurs="0"/>
        <xs:element name="statusCode" type="CS"/>
        <xs:element name="effectiveTime" type="GTS" minOccurs="0"/>
        <xs:element name="activityTime" type="IVL_TS" minOccurs="0"/>
        <xs:element name="priorityCode" type="CE" minOccurs="0"/>
        <xs:element name="confidentialityCode" type="CE" maxOccurs="unbounded"/>
        <xs:element name="methodCode" type="CE" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="targetSiteCode" type="CD" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="subject" type="POLB_MT992100.Subject2" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="recordTarget" type="POLB_MT992100.RecordTarget" minOccurs="0"/>
        <xs:element name="performer" type="POLB_MT992100.Performer1" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="author" type="POLB_MT992100.Author"/>
        <xs:element name="definition" type="POLB_MT992100.Definition" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="type" type="Classes" default="Observation"/>
    <xs:attribute name="classCode" type="ActClass"/>
    <xs:attribute name="moodCode" type="ActMood"/>
    <xs:attribute name="templateId" use="optional">
        <xs:simpleType>
            <xs:list itemType="oid"/>
        </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="typeID" use="optional">
        <xs:simpleType>
            <xs:list itemType="oid"/>
        </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="realmCode" use="optional">
        <xs:simpleType>
            <xs:list itemType="cs"/>
        </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="nullFlavor" type="cs" use="optional"/>
</xs:complexType>
<xs:complexType name="POLB_MT992100.Subject2">
    <xs:sequence>
        <xs:element name="specimen" type="COCT_MT080000.Specimen"/>
```

The subject of the order is a specimen

The essence of Version 3

- A family of specifications
- Built upon a single model of
  - How we construct our messages
  - The domain of discourse
  - The attributes used
- Constructed in a fashion to rapidly develop a comprehensive, fully constrained specification in XML

The HL7 Vocabulary Technical Committee

Committee Missions

Vocabulary TC:

To identify, organize and maintain coded vocabulary terms used in HL7 standards.

Modeling & Methodology TC:

Responsible for creating and maintaining the HL7 development methodology, and maintaining a Reference Model that reflects the shared models that are developed and used by the HL7 Functional Committees.

HL7 Vocabulary Development Strategy

- Reference existing vocabularies
  - SNOMED CT, LOINC, RxNorm, FDA identifiers
- Collaborate with other SDO’s
  - NCPDP, DICOM, ASTM, X12, CEN, ISO, OMG
- Collaborate with NCVHS Patient Medical Record Information (PMRI) standards and Consolidated Health Informatics (CHI) standards
- Add value by creating linkage between HL7 messages and existing vocabularies
- Only add items that do not already exist
- Collaborate with vocabulary developers to add needed content to existing vocabularies

Registration of Code Systems

- Code systems used in HL7 standards need to be registered
- Registration process
  - Form for Proposing a Code System
  - Form is received and reviewed in Vocabulary TC
  - If there are no objections, code system becomes official registered during the next meeting
- OID (object identifier) is assigned to the new code system (more about OIDs later)

Coordination with US Standards Adoption

- National Committee on Vital and Health Statistics
  - Makes recommendations to the Secretary of HHS
  - HIPAA legislation – make recommendations on Patient Medical Record Information (PMRI) standards
- Consolidated Health Informatics (CHI)
  - Consortium of US government departments and agencies
- NLM contract with HL7
  - Adoption of CHI terminologies within HL7 messages
  - Exchange of a complete EHR

Vocabulary Recommendations

- Core Terminologies
  - **SNOMED-CT**
  - **LOINC (lab only)**
  - **US National Drug Terminologies**
    - RxNorm – “Clinical Drugs”
    - NDF-RT: Mechanism of action and physiologic effects
    - FDA: Ingredient name, manufactured dosage form and package type

The HL7 Vocabulary Model

HL7 Vocabulary Model

- The underlying model for the HL7 vocabulary is represented in UML in the HL7 CTS specification.
- Describes the relationship between HL7 coded attributes and vocabulary.
- Based on the HL7_V3_Meta-Model Version 1.16
- Primary purpose is to describe the classes and relationships that have a direct bearing on the contents of HL7 coded attributes from the perspective of a meta-model.

HL7 Vocabulary Model

- Divided into:
  - Code Systems
  - Vocabulary Domains
  - Value Sets
  - Coded concepts
  - Concept Designation
  - Concept Property
  - Concept Relationship

HL7 Vocabulary Model - Code System

- A set of unique codes that represent corresponding set of classes in the 'real world'.
- At various times referred to as an *ontology*, *classification*, *terminology*, or *code set*.
- Within the HL7 context, concept codes within a code set must not change 'meaning'.
  - Codes may be added or retired
  - Definitions may be clarified
  - New relationships may be established
  - Codes may not be reused.
- Changing the meaning of concept code(s) results in creation of a new code system.

Code System *(continued)*

Code systems may vary in size and complexity from a simple code/value table…

Code	Value
M	Male
F	Female
U	Undifferentiated

… to a complex reference terminology containing many 100,000’s of concepts, relationships and the like.

Code System Examples

- LOINC
- CPT-4
- NIC
- NOC
- ICD-9-CM
- ICD-10
- SNOMED International
- SNOMED-CT
- ISO 4217 Currency codes
- ISO 3166-2 Country Codes
- IETF Mime Types
- HL7 Version 2 Table 1
- ISO 639 Language Codes
- International Airport Codes
- IANA Character Sets
- HL7 Version 3 Administrative Gender
- HL7 Version 3 Code System Identifiers
- …

Code Systems and HL7

External Code Systems – HL7's policy is to use existing code systems whenever possible. HL7 will not develop their own code system unless all external possibilities have proven unworkable

- **Externally Maintained** - HL7 references the contents of the code system but does not maintain or distribute content. (e.g. LOINC)
- **Internally Maintained** - HL7 maintains an image of the contents for the convenience of its members (e.g. ISO 3166-2 country codes)

Code Systems and HL7

Internal Code Systems – code systems that are developed and maintained within the HL7 organization

- **Structural Codes** - Significant portions of the RIM model are represented as concept codes (e.g. ActClass, ActCode, EntityClass, etc.)
- **Short Code Lists** - Short tables of codes that are tightly coupled with the RIM and have not (as of yet) warranted external references (e.g. AdministrativeGender, ActPriority, etc.)
- **Version 2 Tables** - Already maintained by HL7 and carried in V3 for compatibility.

HL7 Vocabulary Model – Code System

- A **Code System** may define zero or more **Coded Concepts**.
- Every **Coded Concept** must be defined in exactly one **Code System**
- A **Code System** may represent zero or one **CodeSystem Version** at any given point in time.

HL7 Vocabulary Model – Vocabulary Domain

- A vocabulary domain serves as the link between an HL7 coded attribute and the set(s) of valid concept codes for that attribute.
- A vocabulary domain represents an abstract conceptual space such as "countries of the world", "the gender of a person used for administrative purposes", etc.

HL7 Vocabulary Model – Value Set

- A list of valid concept codes is referred to as a **Value Set** that represent a **Vocabulary Domain**.
- A **Vocabulary Domain** may be represented by zero or more **Value Sets**.
- A **Value Set** may include a list of zero or more **Coded Concepts** drawn from a single **Code System**.
- A **Value Set** may include a list of zero or more **Coded Concepts** drawn from a single **Code System**. A **Value Set** can represent:
  - All of the **Coded Concepts** defined in exactly one **Code System**
  - A specified list of **Coded Concepts** that are defined in exactly one **Code System**
  - The set of **Coded Concepts** represented by another **Value Set**.

HL7 Vocabulary Model – Coded Concept

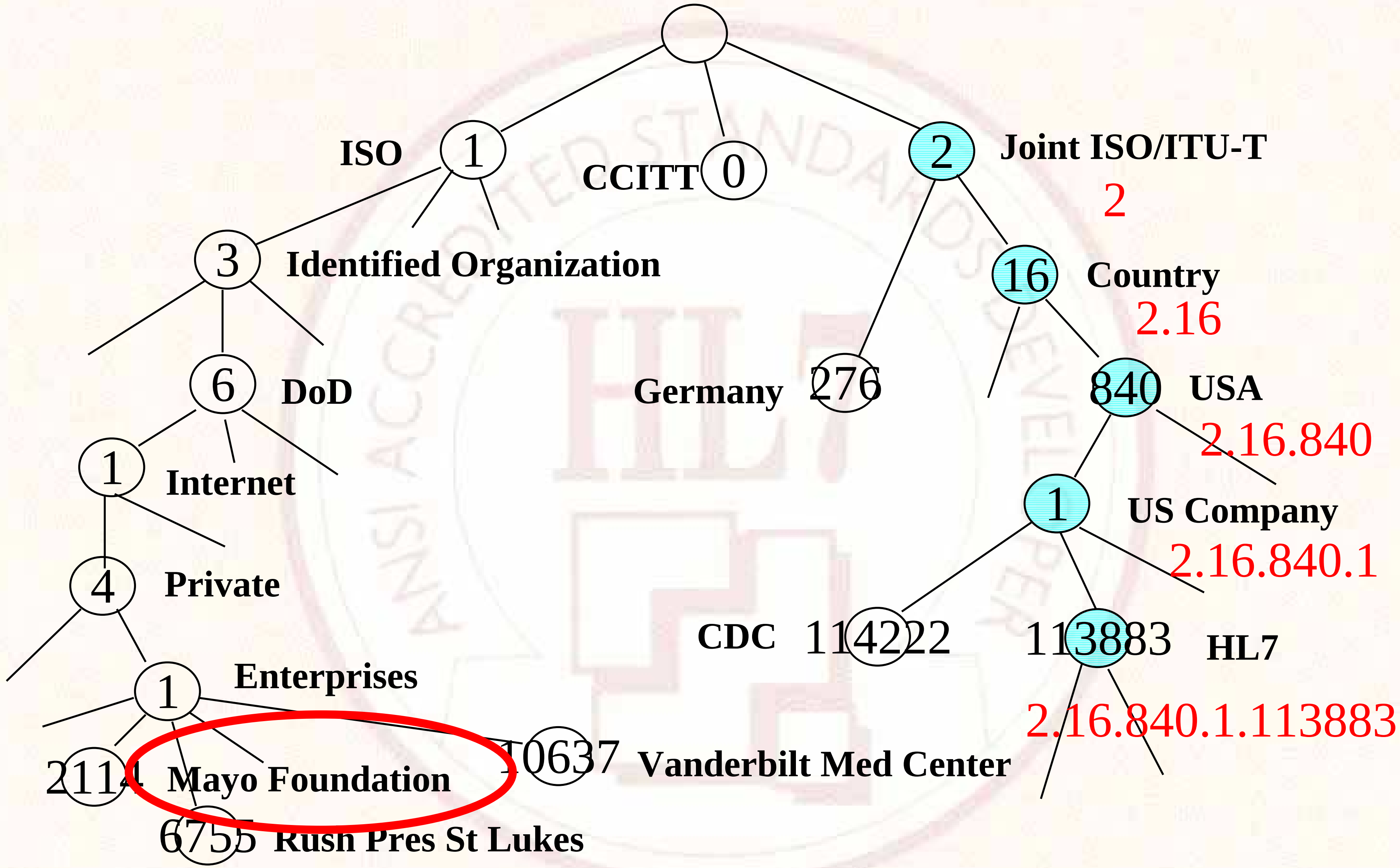
- A **Coded Concept** is unique within the **Code System** that defines it.
- **Coded Concepts** may be characterized by zero or more **Concept Properties**.
- A **Coded Concept** has the following attributes:
  - *code* - an identifier that uniquely names the class or "concept" within the context of the defining **Code System**.
  - *status* - represents the current status of the **Coded Concept** within the **Code System**.

Code System Identifiers (OIDs)

- OID – ISO Object Identifier
- Sequence of integers representing a *Registration Authority* tree
  - "…a convenient mechanism for assigning world-unique identifiers to standard-related objects"[1]
  - Not a directory tree of entities or objects
  - New entries can be registered in a de-centralized fashion
- http://www.alvestrand.no/objectid/top.html
- http://www.iana.org/assignments/enterprise-numbers

[1] *Network and Distributed Systems Management*, Sloman

OID Tree



ISO 1

CCITT 0

2 Joint ISO/ITU-T

2

3 Identified Organization

16 Country

2.16

6 DoD

Germany 276

840 USA

2.16.840

1 Internet

1 US Company

2.16.840.1

4 Private

CDC 114222

113883 HL7

1 Enterprises

2.16.840.1.113883

2114 Mayo Foundation

10637 Vanderbilt Med Center

6755 Rush Pres St Lukes

How to get your own OID

Go to the HL7 home page:

http://www.hl7.org

Click on “OID Registry” under the Resources column

Select “Request an HL7 OID”, and follow out the instructions.

HL7 Vocabulary Model

- More details (including detailed UML representations) can be found in the CTS specification at:

  http://informatics.mayo.edu/LexGrid/downloads/CTS/specification/ctsSpec/cts.htm#CTSCommMsgRTAPI

Coded Data Types for Version 3

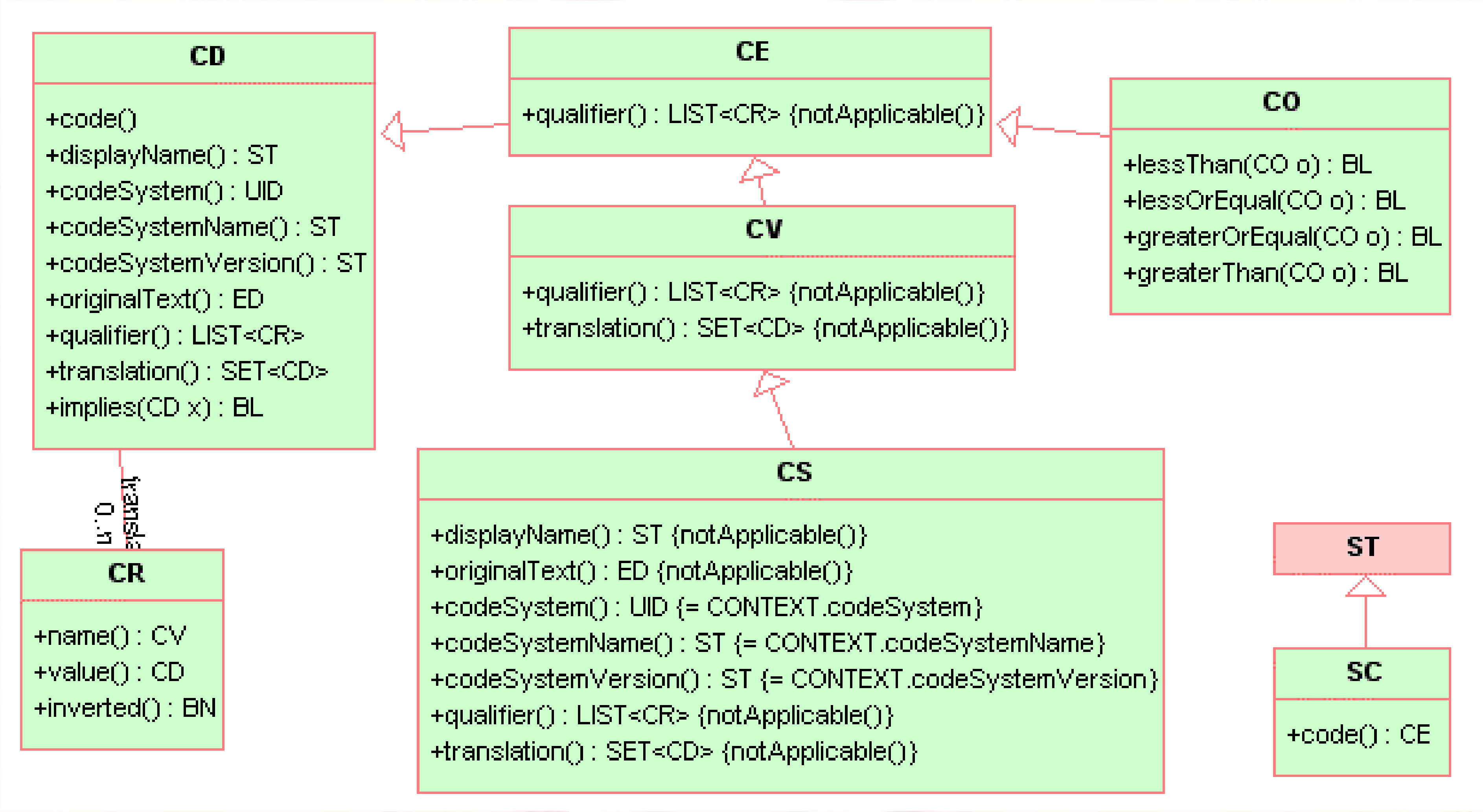
For further details see:

Data Types Abstract Specification

and

V3 XML Data Types Implementation Technology Specification (ITS)

Coded Data Types (Ballot Package Mar ‘04)



CD

+code()
+displayName() : ST
+codeSystem() : UID
+codeSystemName() : ST
+codeSystemVersion() : ST
+originalText() : ED
+qualifier() : LIST<CR>
+translation() : SET<CD>
+implies(CD x) : BL

CE

+qualifier() : LIST<CR> {notApplicable()}

CO

+lessThan(CO o) : BL
+lessOrEqual(CO o) : BL
+greaterOrEqual(CO o) : BL
+greaterThan(CO o) : BL

CV

+qualifier() : LIST<CR> {notApplicable()}
+translation() : SET<CD> {notApplicable()}

CR

+name() : CV
+value() : CD
+inverted() : BN

CS

+displayName() : ST {notApplicable()}
+originalText() : ED {notApplicable()}
+codeSystem() : UID {= CONTEXT.codeSystem}
+codeSystemName() : ST {= CONTEXT.codeSystemName}
+codeSystemVersion() : ST {= CONTEXT.codeSystemVersion}
+qualifier() : LIST<CR> {notApplicable()}
+translation() : SET<CD> {notApplicable()}

ST

SC

+code() : CE

XML Schema for Concept Descriptor

```
<xsd:complexTypename="CD">
  <xsd:complexContent>
    <xsd:extensionbase="ANY">
      <xsd:sequence>
        <xsd:elementname="originalText" type="ED" ... />
        <xsd:elementname="qualifier" type="CR" ... />
        <xsd:elementname="translation" type="CD" ... />
      </xsd:sequence>
      <xsd:attributename="code" type="cs" ... />
      <xsd:attributename="codeSystem" type="uid" ... />
      <xsd:attributename="codeSystemName" type="st" ... />
      <xsd:attributename="codeSystemVersion" type="st" ... />
      <xsd:attributename="displayName" type="st" ... />
    </xsd:extension>
  </xsd:complexContent>
</xsd:complexType>
```

CS – Coded Simple

Name	Type	Description
code	ST	The plain code symbol defined by the code system. For example, "784.0" is the code symbol of the ICD-9 code "784.0" for headache.
original Text	ED	The text or phrase used as the basis for the coding.

```
type CodedSimpleValue alias CS specializes CV {
    ST code;
    literal ST; };
```

```
<mood_cd code=”INT”/>
```

Code **must** come from the specified HL7 domain

CV – Coded Value

Name	Type	Description
code	ST	The plain code symbol defined by the code system. For example, "784.0" is the code symbol of the ICD-9 code "784.0" for headache.
code System	UID	Specifies the code system that defines the code.
codeSystem Name	ST	The common name of the coding system.
codeSystem Version	ST	If applicable, a version descriptor defined specifically for the given code system.
displayName	ST	A name or title for the code, under which the sending system shows the code value to its users.
originalText	ED	The text or phrase used as the basis for the coding.

```
type CodedValue alias CV specializes CE {
    ST code;
    UID codeSystem;
    ST codeSystemName;
    ST codeSystemVersion;
    ST displayName; ED
    originalText; };
```

Example -- Coded Value (HL7 code system)

Patient Gender

XML

```
<administrative_gender_cd
     code=“M”
     displayName=“Male”
     codeSystem=“2.16.840.1.113883.5.1”
     codeSystemName=“Gender:USA:HL7”
     codeSystemVersion=“3.0”/>

<gender_cd code=“M”
     codeSystem=“2.16.840.1.113883.5.1”/>
```

CE – Coded with Equivalents

Name	Type	Description
code	ST	The plain code symbol defined by the code system. For example, "784.0" is the code symbol of the ICD-9 code "784.0" for headache.
codeSystem	UID	Specifies the code system that defines the code.
codeSystem Name	ST	The common name of the coding system.
codeSystem Version	ST	If applicable, a version descriptor defined specifically for the given code system.
displayName	ST	A name or title for the code, under which the sending system shows the code value to its users.
originalText	ED	The text or phrase used as the basis for the coding.
translation	SET< CD>	A set of other concept descriptors that translate this concept descriptor into other code systems.

```
type CodedWithEquivalents alias CE specializes CD {
   ST code;
   UID codeSystem;
   ST codeSystemName;
   ST codeSystemVersion;
   ST displayName;
   ED originalText;
   SET<CV> translation; };
```

CodedWithEquivalents (UMLS and SNOMED)

Patient Blood Type

XML

```
<bloodTypeCode
    code="C0302037"
    displayName="Blood Group Antigen A, NOS"
    codeSystem="2.16.840.1.113883.6.56"
    codeSystemName="UMLS"
    codeSystemVersion="2003AC"
    codingRationale="HL7">
    < translation code="14711003" codeSystem="2.16.840.1.113883.6.5"
    codeSystemName="SCT" codeSystemVersion="January 2004 Release"
     codingRationale="SRC"/>
< /bloodTypeCode>
```

This example assumes that the UMLS Metathesaurus was chosen as the preferred scheme, but the sending system was using SNOMED.

CD – Concept Descriptor

codeSystem	UID	Specifies the code system that defines the code.
codeSystemName	ST	The common name of the coding system.
codeSystemVersion	ST	If applicable, a version descriptor defined specifically for the given code system.
displayName	ST	A name or title for the code, under which the sending system shows the code value to its users.
originalText	ED	The text or phrase used as the basis for the coding.
translation	SET<CD>	A set of other concept descriptors that translate this concept descriptor into other code systems.
qualifier	LIST<CR>	Specifies additional codes that increase the specificity of the the primary code.
codingRationale	CS	Identifies how to interpret the instance of the code.

```
type ConceptDescriptor alias CD specializes ANY {
   ST code;
   ST displayName;
   UID codeSystem;
   ST codeSystemName;
   ST codeSystemVersion;
   ED originalText;
   LIST<CR> qualifier;
   SET<CD> translation;
   CS codingRationale; … };
```

CR – Concept Role, a special kind of CV

Definition: A concept qualifier code with optionally named role. Both qualifier role and value codes must be defined by the coding system of the CD containing the concept qualifier. For example, if SNOMED RT defines a concept "leg", a role relation "has-laterality", and another concept "left", the concept role relation allows to add the qualifier "has-laterality: left" to a primary code "leg" to construct the meaning "left leg".

```
protected type ConceptRole alias CR specializes ANY {
    CV name;
    BN inverted; CD value; };
```

Use for roles like: has laterality, has body location, etc.

Vocabulary Binding

Marrying the Information Models to the Terminologies

Vocabulary Binding

- The point at which vocabulary models and information models meet is referred to as Vocabulary Binding.
- In HL7, the binding of attributes in a RIM-derived, reusable static model to specific vocabularies is the point where these models interact.
- Vocabulary and information model interaction is not a black and white concept.
  - In one case you may need to create a Value Set to constrain the allowable values for a concept, and bind the model to that Value Set.
  - In another, you can use the model constraint rules to enumerate a ‘virtual’ value set.

Vocabulary Binding - Recommendations

- Attributes and Datatype Properties are bound to vocabulary domains in the RIM at the time the RIM is defined whenever the data type of the attribute or property is derived from CD

Vocabulary Binding - Recommendations

- Domains can be associated with Value Sets on a realm-specific basis.
- Some domains are defined as "non-realm-specializable" which means that only one value-set can be bound to that domain and realms are not permitted to define separate bindings.
- All "non-realm-specializable" domains *must* have a value-set binding.

Vocabulary Binding - Recommendations

- In static models (D-MIMs, R-MIMs, HMDs, Message Types, Templates, Static Profiles, etc.) attributes and properties can be either bound to vocabulary domains or value-sets
  - Vocabulary Domains are abstract concepts which can be bound to distinct value-sets by realm (such as Canada, Japan or US)
  - Value-sets are collections of specific codes from one or more code systems where the codes within a value-set each have distinct meaning

Vocabulary Binding - Recommendations

- When constraining models (see static model discussion above) a designer has five options:
  - a) Leave the child element vocabulary domain the same as with the parent model vocabulary domain
  - b) Constrain the 'child' vocabulary domain to a 'child' domain which represents a narrower concept than the parent vocabulary domain
  - c) Constrain the vocabulary domain to a specific value-set d) Leave the 'child' value-set the same as the parent value-set
  - e) Constrain the 'child' value-set to a narrower value-set than parent value-set

Vocabulary Binding - Recommendations

- In some circumstances, domains and/or Value Sets may be asserted as 'free-hand constraints' rather than a direct binding of a single domain to the attribute or property.
- If so, each domain and/or Value Set that is asserted by the constraint must follow the rules defined by 4.

Vocabulary Binding - Recommendations

- Constraining to Value Sets should happen as late in the constraint process as possible to encourage the general application/use of the artifacts so constrained.

Vocabulary Binding - Recommendations

- There are constraints on when a vocabulary domain can be constrained to a Value Set
  - a) A non-realm-specializable domain can always be constrained to a Value Set (on the grounds that a domain always has a 1..1 relationship to a Value Set)
  - b) A non-universal domain can only be constrained to a Value Set if the model is itself bound to a single realm **and** that realm has bound the parent domain to a Value Set.
  - c) The Value Set bound to a child whose parent is a domain must either be the same as the Value Set tied to the parent based on realm, or a subset thereof.

Vocabulary Binding - Recommendations

- When validating an instance, the Value Set to be bound against should be determined as follows:
  - a) The allowed Value Set is the intersection of the Value Sets of the balloted static model for the interaction transmitted as well as any profiles and templates which apply to the scope of the element being validated
  - b) Where the balloted static model or templates/profiles bind to a domain, the value-set is determined by the realm that is effective at that point in the instance

Common Terminology Services

Common Terminology Services (CTS)

- An HL7 ANSI approved standard Terminology Service
- Purpose is to specify a common Application Programming Interface (API) to access terminological content.
- Developed as an alternative to a common data structure.
- Identifies the common functional characteristics that an external terminology must be able to provide.
- Client software doesn’t have to know about specific terminology data structures and/or how to access them.
- Server software can plug and play with many clients.

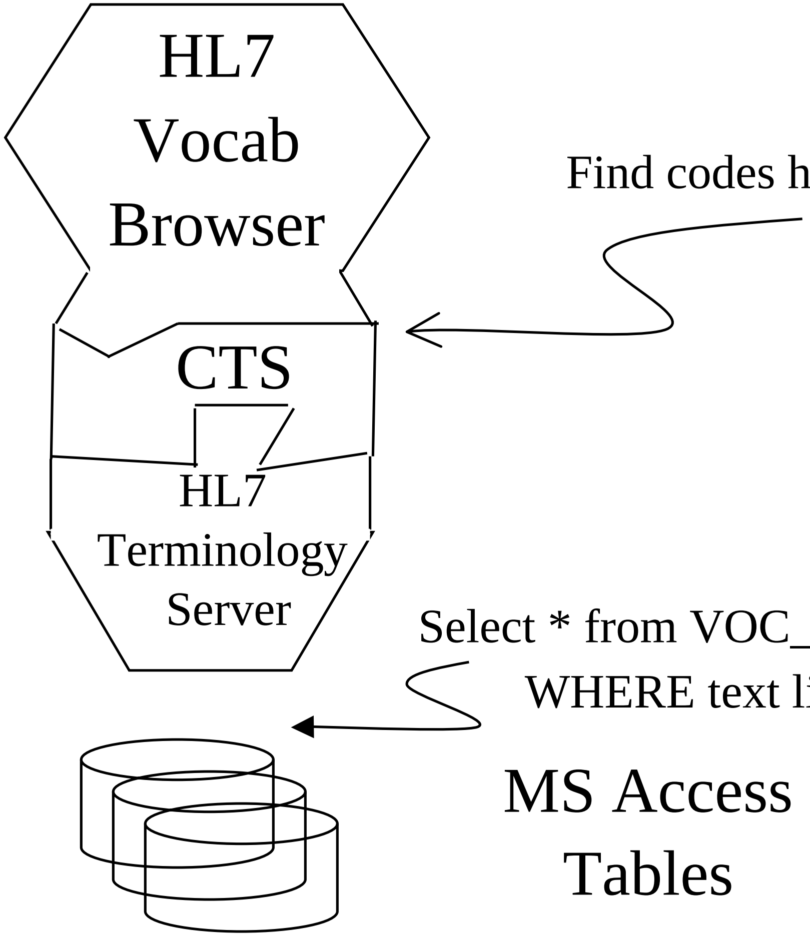
CTS API

Application

Interface

Service

Data



HL7 Vocab Browser

CTS

HL7 Terminology Server

Find codes having “*myelitis”

Select * from VOC_concept_designation WHERE text like ‘%myelitis’

MS Access Tables

Common Terminology Services API

- Allows Client Software to be Developed Independently from Service Server Software
- Allows Terminology Plug-and-Play
- Allows Client Plug-and-Play
- Defines a “Functional Contract”

Additional CTS API's

- CTS Message Browsing API
  - Used by HL7 Modelers
- CTS Vocabulary Browsing API
  - Used by HL7 Terminology Authors and Value Set Building
- CTS Mapping API
  - Used to translate concept codes from one system to another

Details can be found on HL7 Ballot spec

Common Terminology Services

- Interface specification
  - Different message processing applications, same functions
  - Different terminology structures, philosophy – same behavior
- Language Bindings
  - (Currently) specified in OMG IDL
  - Java interface binding
  - Java bean binding
  - WSDL/SOAP binding
- Version 1.0 Finalized Spring 2004

Common Terminology Services

Resources:

- Specification: http://informatics.mayo.edu/informatics_pages/standards/cts/specification/ctsSpec/cts.htm
- Implementations:
  - http://informatics.mayo.edu/
    - Tools / CTS Demos - open source SOAP, Java and JSP implementations of CTS
- CTS Implementer's Mail Server
  - **cts-impl@kestral.com.au**
  - To get someone added to the list, send an email to either **grahame@kestral.com.au** or **jamies@kestral.com.au**
- CTS Implementer's WIKI
  - http://informatics.mayo.edu/wiki/index.php/CTS_Implementation

Common Terminology Services – Future Work

- Mayo Clinic reference implementation proposed for use by:
  - The NHS from the UK
  - Eclipse OHF,
    - Users are looking to OHF to provide a CTS implementation under EPL.
- CTS II
  - New project within the Vocab TC
  - *Additional* CTS functionality
    - Import
    - Edit/Update
    - OWL
    - Extended H7 Functionality – value set constraints, etc.

Thank You!