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Preparing for eHealth collaborative efforts in nursing:

using Health Level 7 version 3 for information exchange

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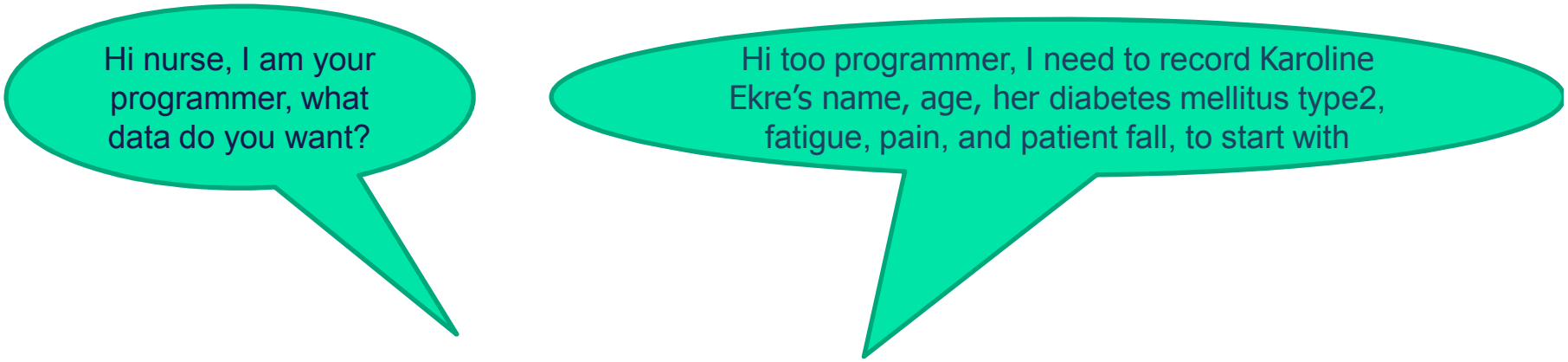
Outline

1. Terminology model versus information model
2. What is an information model?
3. Health Information Standards
4. HL7 v3 RIM and derivations from the RIM
5. HL7 v3 Care Provision message for referral, discharge etc.
6. How to map the nursing content to HL7 v3 Care Provision messages?
7. Dynamic model: how and when to exchange the messages?
8. Conclusion

1. Terminology model and information model

- Nightingale addressed data specification and data collection in nursing (She is often called the first nursing informaticist Betts, 2006).
- Similar work is done with the 'international NMDS'
- Last decades the focus has been on developing nursing terminologies: the meaning of what nurses observe, assess, deliver as care and get as results. This is the terminology development (NANDA, NIC, NOC, Omaha, Perioperative DS, ICF, CCC, ICNP)
- In recent years, standards for data specification have emerged: the information modeling (OO, UML, HL7 v3, OpenEHR, CEN/ISO 13606).
- **We need both** to appropriately document care

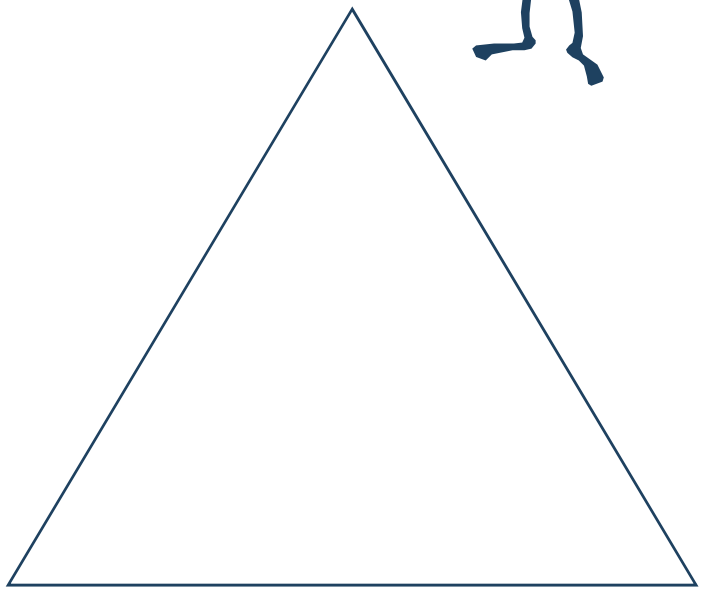
Terminology model & Information model:



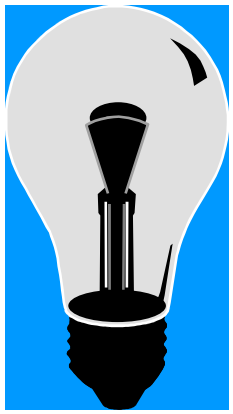
Cartoon is copyrighted

Semiotic triangle

Unit of thought / Concept



Object (in Reality)



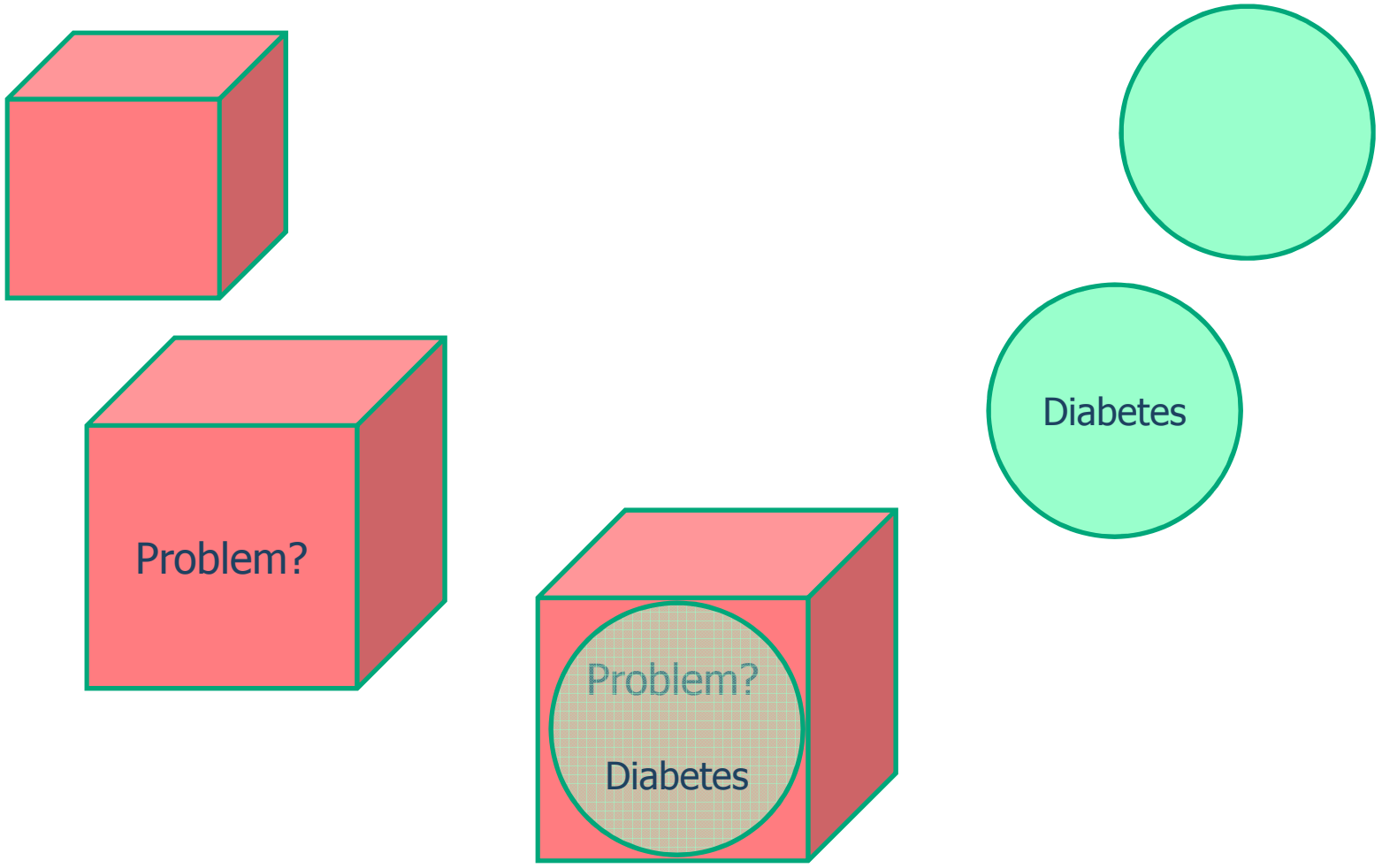
Symbol (Word, Code)

Gloeilamp, Bulb, Birne, Ampoule, Philips Produkt #1022B

Ogden & Richards, 1923

Terminology model & Information model:

2 aspects of object interact: difference in characteristic and instance

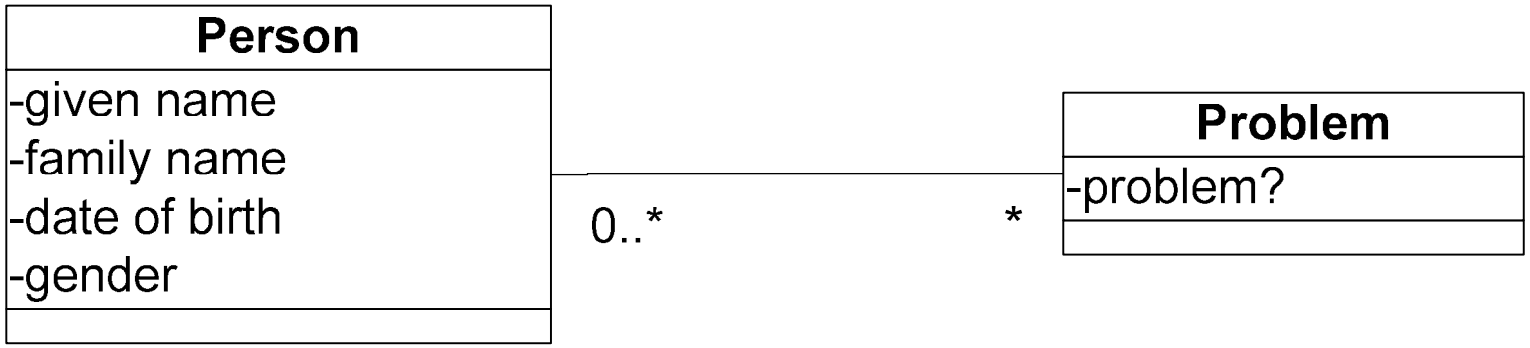


2. Information model

- Model of reality
- Focus on information
- Frequently used nowadays is UML Unified Modeling Language (www.w3c.org)
- Purpose: abstraction from reality to facilitate information system development
- Similar to anatomy models / atoms etc.: focus on understanding a domain

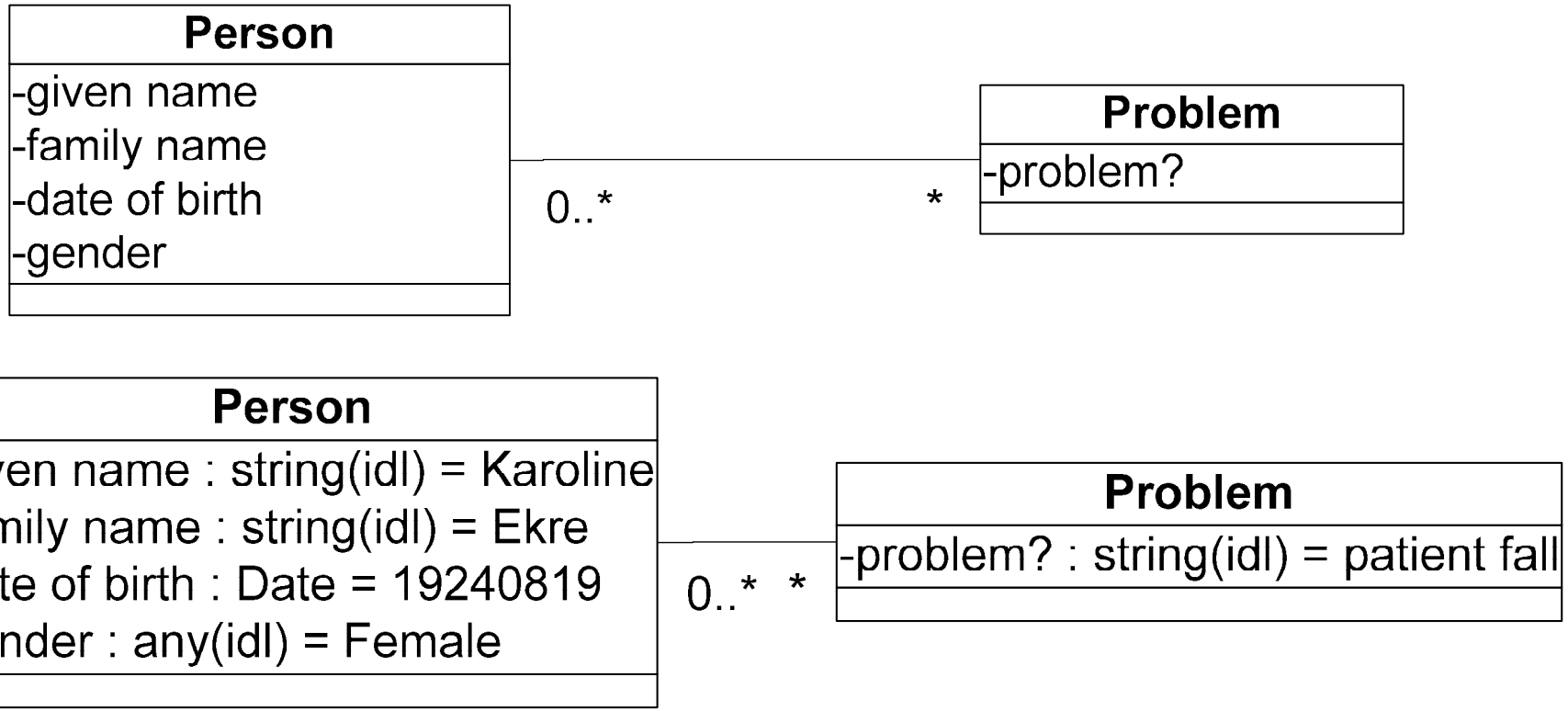
Information model example

UML example: class diagram

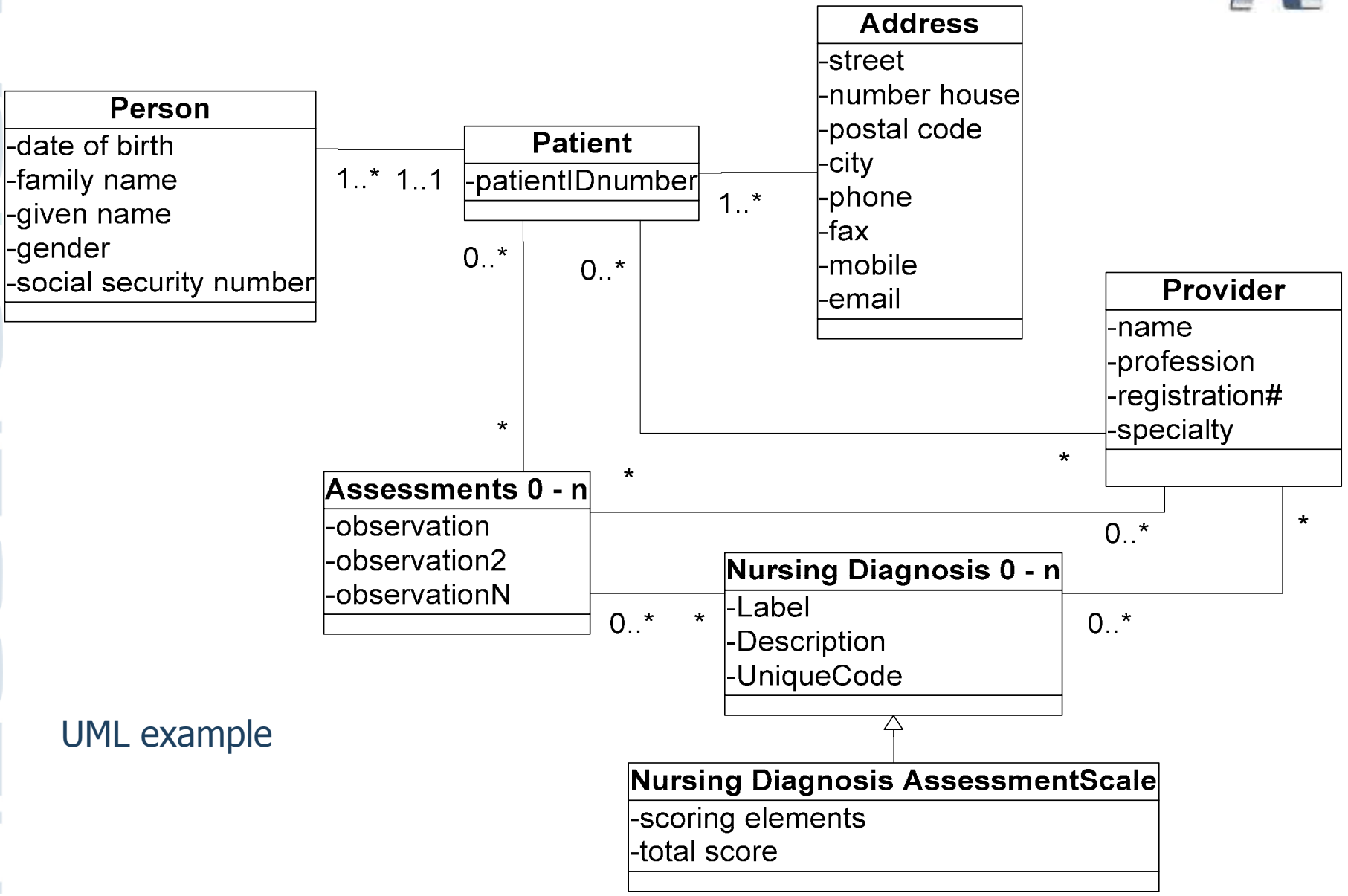


Information model example

UML example: class diagram with instance for Karoline Ekre example case

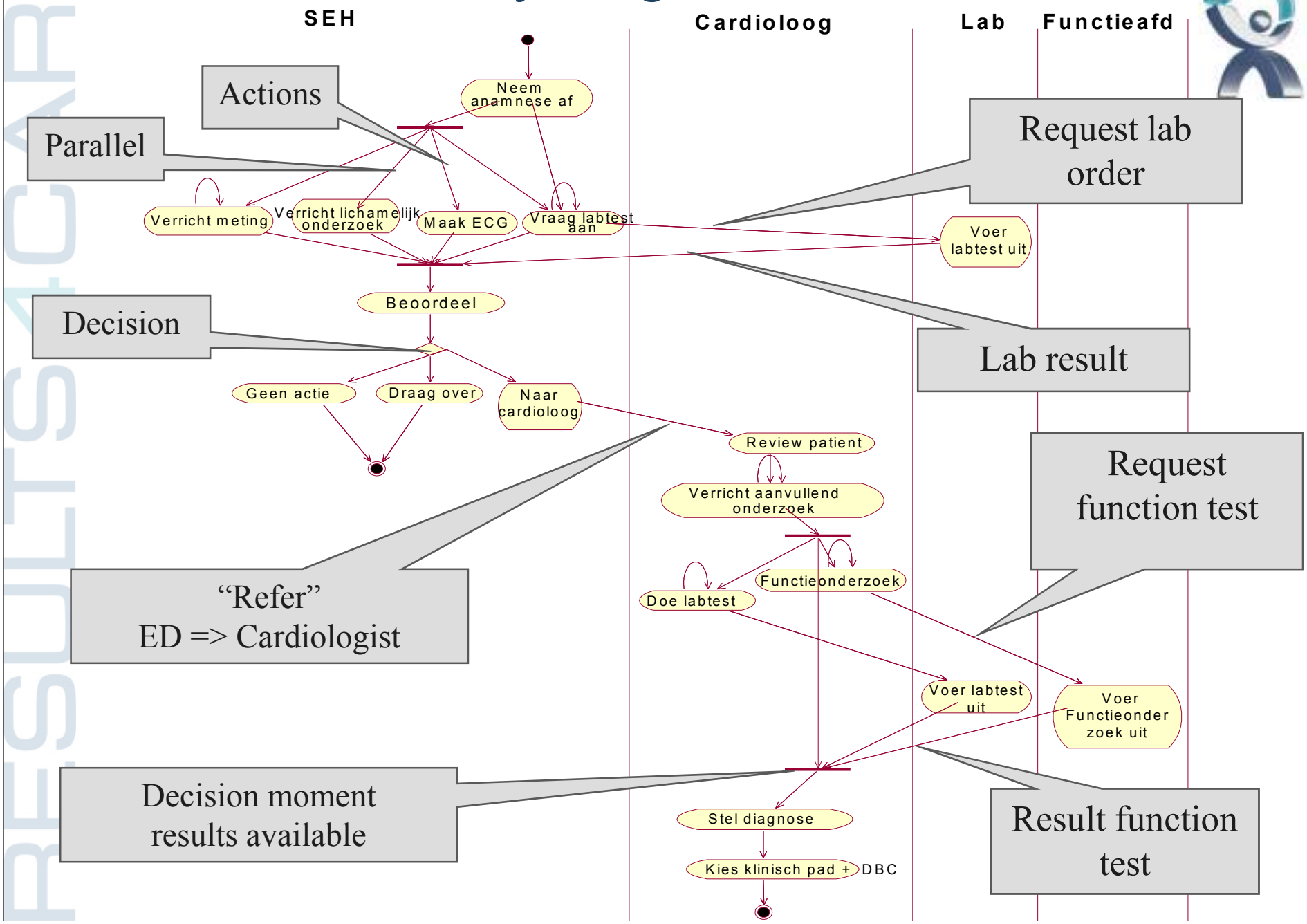


Information model example



UML example

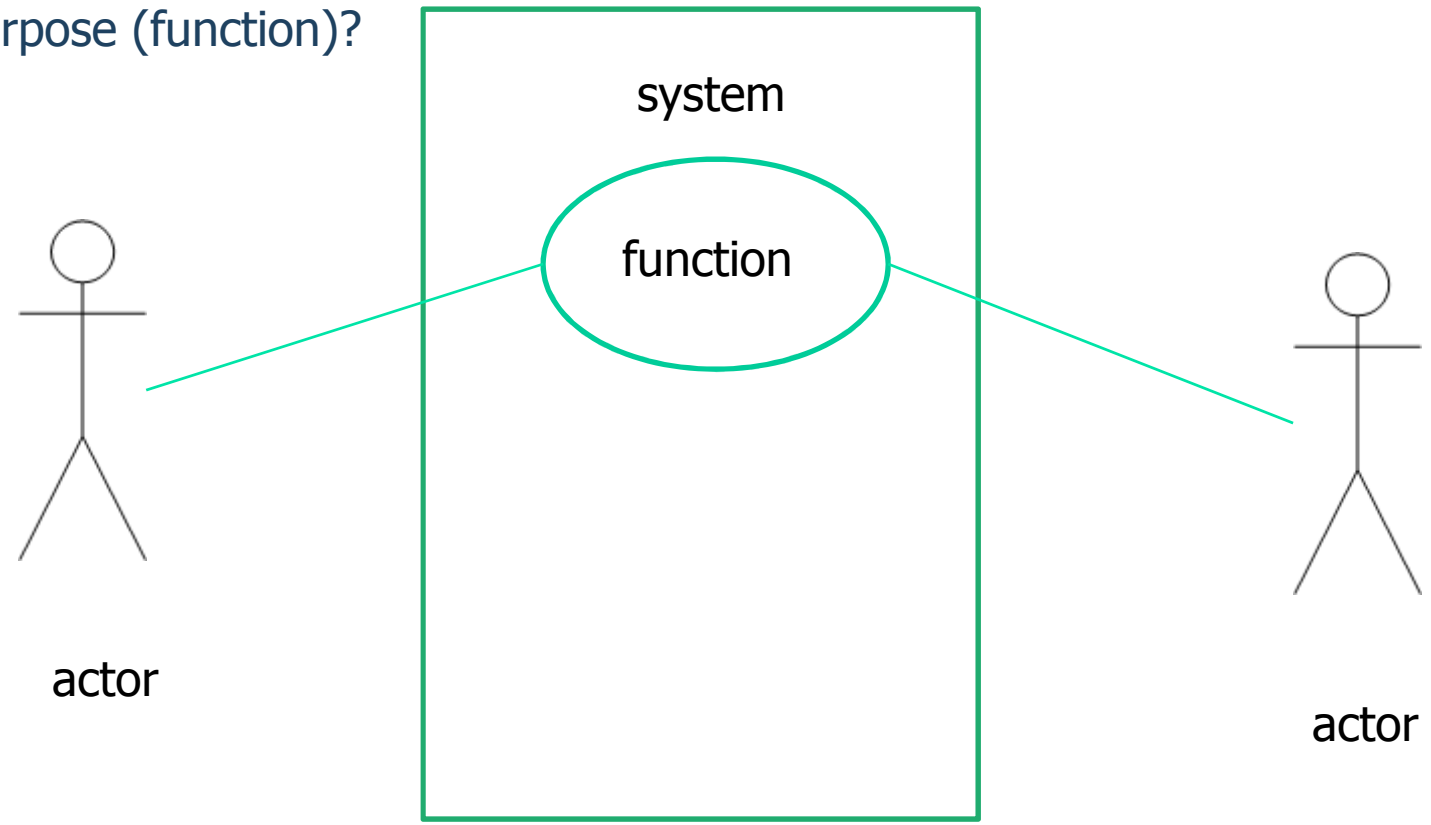
Process: Activity diagram order comm.



Sequence diagram/ interaction diagram

Use Case Diagram

Who will use what system for which purpose (function)?



3. Health Information Standards

- National, European (CEN), International (ISO) bodies
- WWW consortium
- IHTSDO for SNOMED CT and … …
- IEEE, etc. etc. etc. etc. etc.
- Information models for EHR and message exchange between EHR: CEN/ISO 13606, HL7 v3, OpenEHR

Types of standards for healthcare

- **Clinical care**: evidence based practice and guidelines: focus is quality of care
- **Terminology**: focus is quality of documentation and understanding of meaning
- **Information models**: focus is (electronic) management and/or exchange of meaningful information (semantic interoperability)
- **Workflow**: focus is improvement and support of process of care
- **Technical**: focus is quality of technology

Modern approach EHR

- Two level modelling:
- **1. level: basic system functions** (safety, id management, tables for data, webservices, multitier approach)
- **2. level: content**
- For health care examples of such include HL7 templates, clinical templates, archetypes, care information models, and detailed clinical models. On level 2 these are equivalent, level 1 not due to different technical solutions, a computer screen is not a message.

Method in general: 3 steps

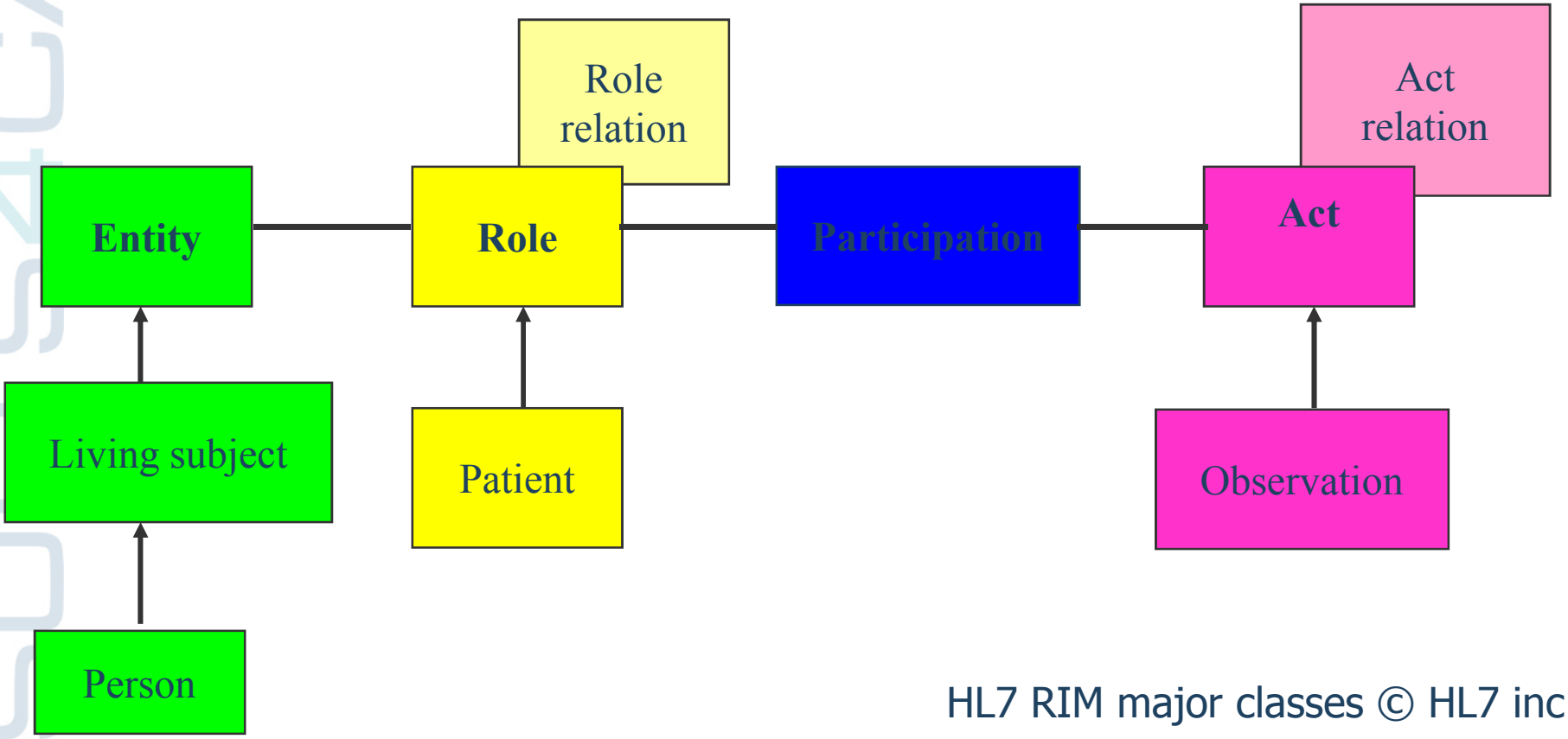
- Sort out the clinical domain (consensus)
- Model the clinical content (information model, terminology <model>, 2 level)
- Apply the models in standard / technology

HL7 v3 2 level modeling

- Message has a generic pattern: choose what you need choice box
- Called Clinical Statement pattern

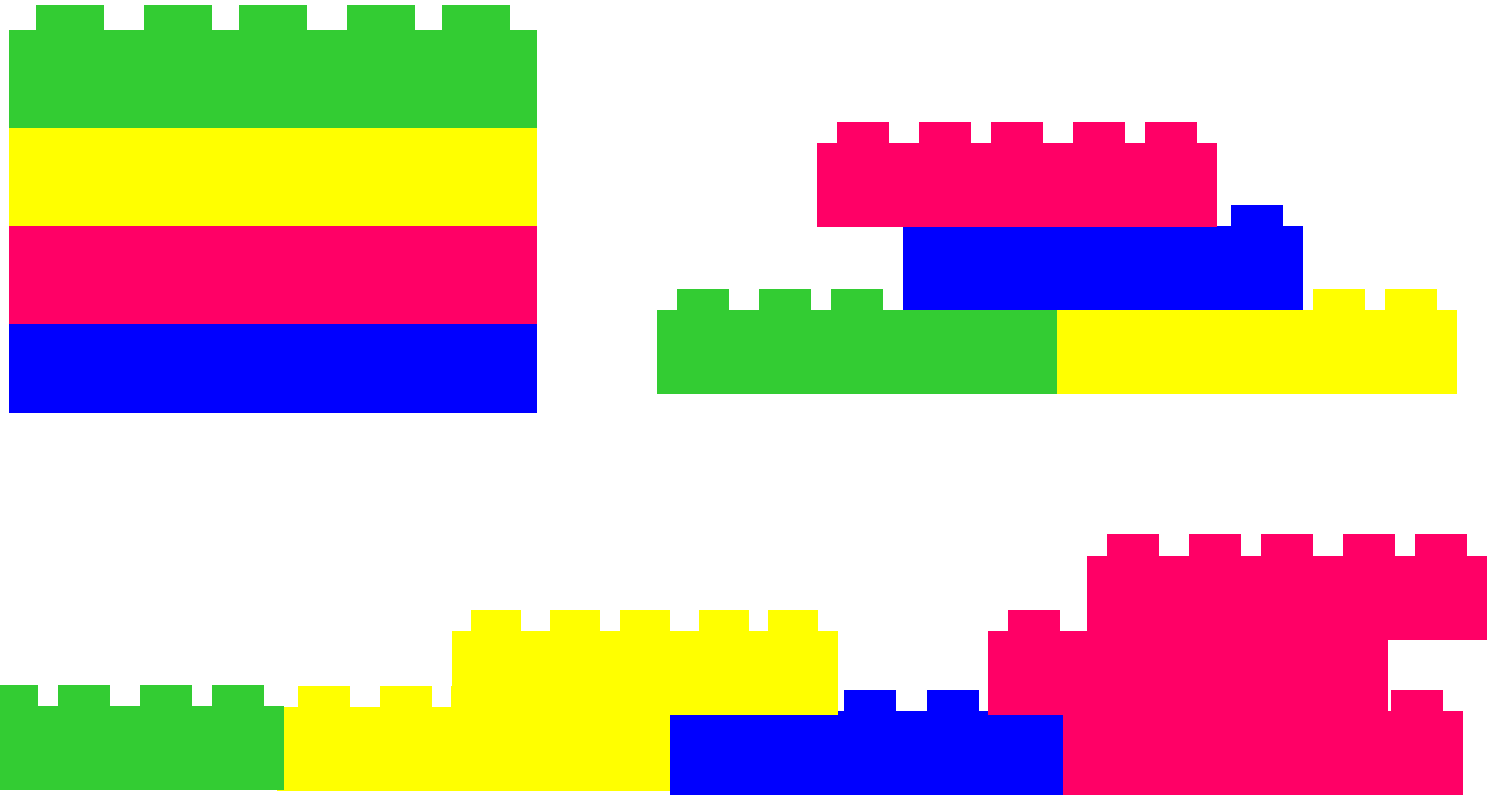
- Can be filled with clinical content that is fully specified (template, archetype, care information model, detailed clinical model)
- Allows sharing and reuse of knowledge
- Repository of Detailed Clinical Models

4. HL7 v3 Standard for clinical data exchange

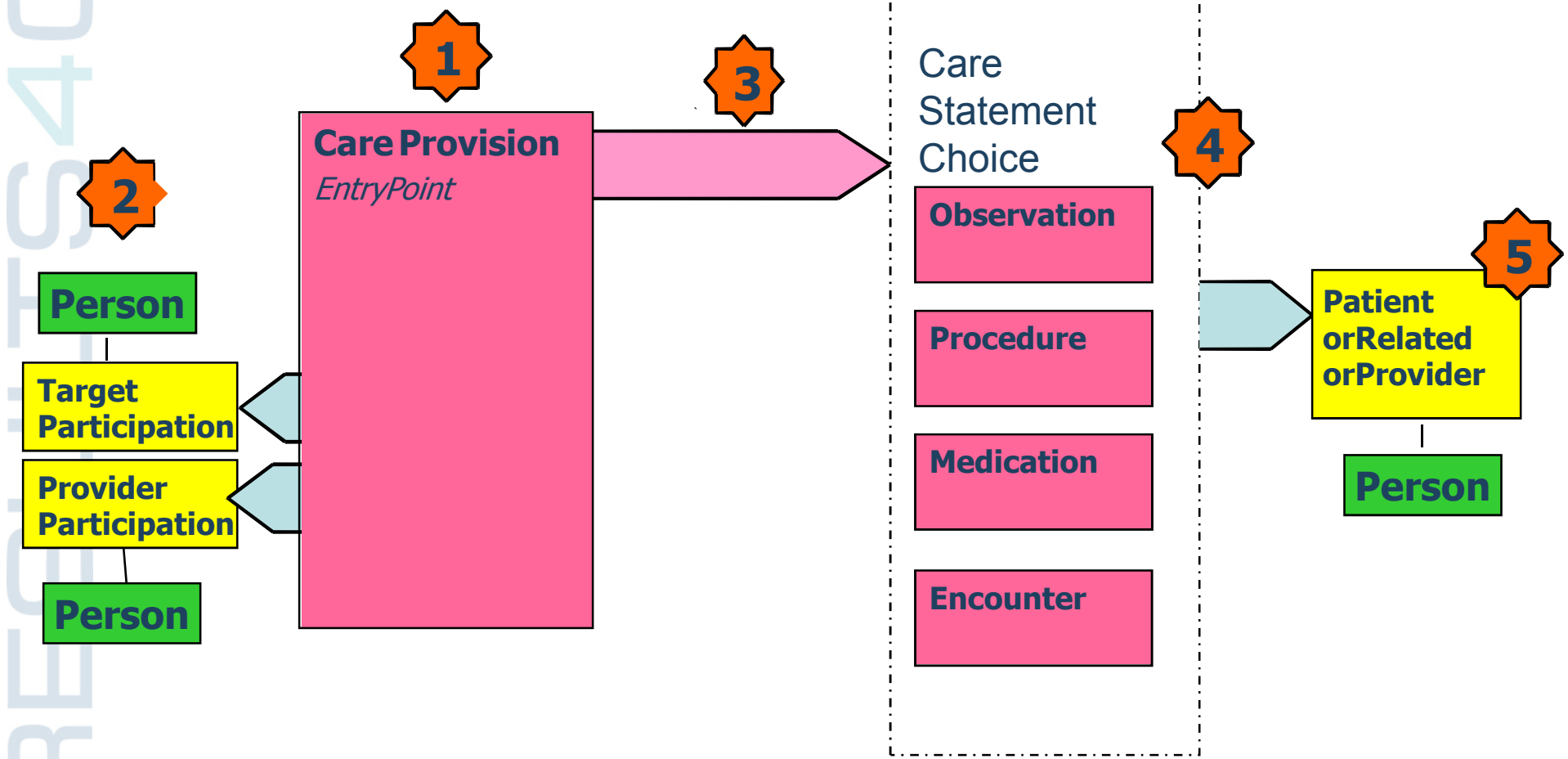


HL7 RIM major classes © HL7 inc.

How to play with LEGO®? For advanced players



5. HL7 v3 Care Provision model summary

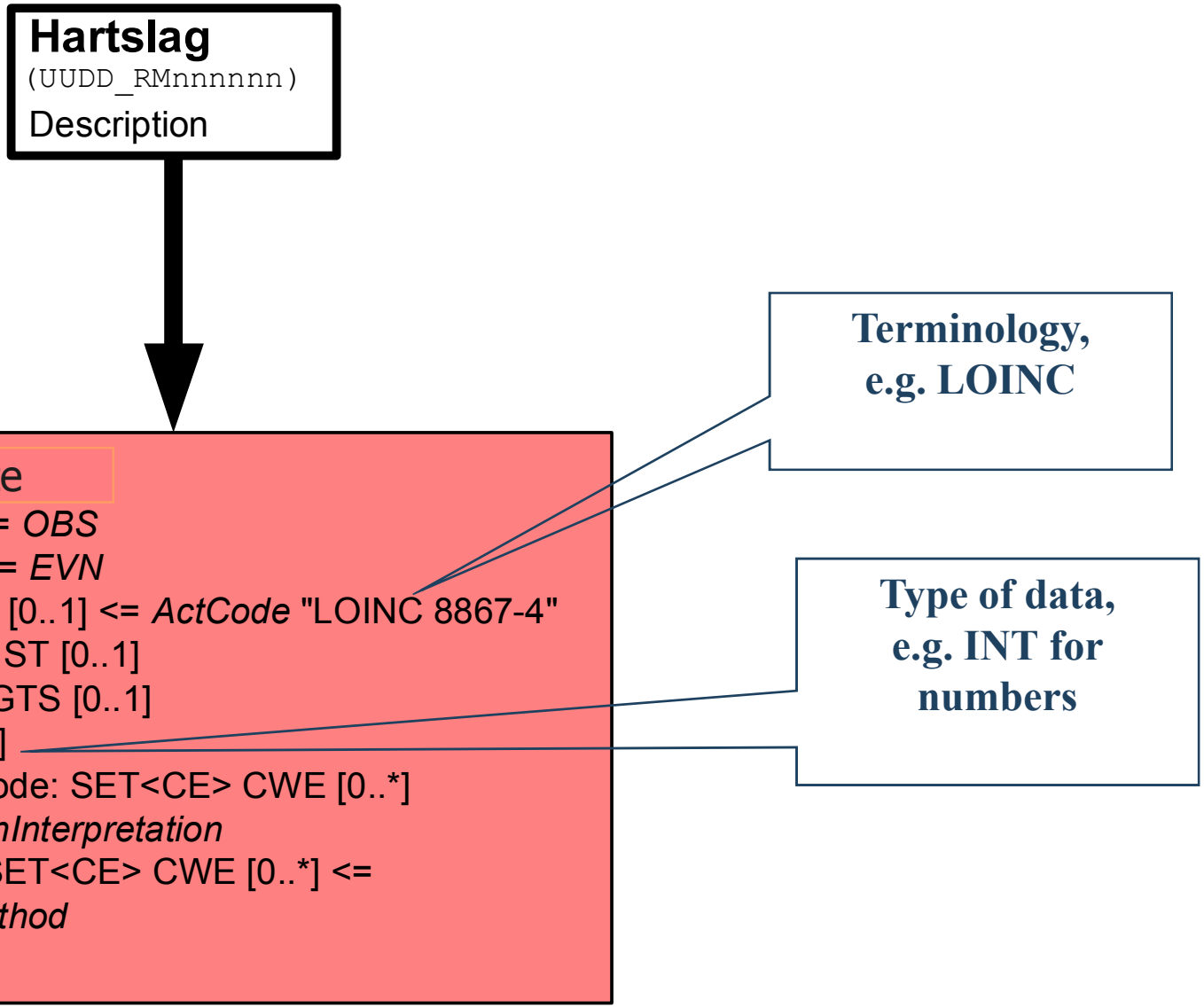


We use the Observation class as example

Any Observation

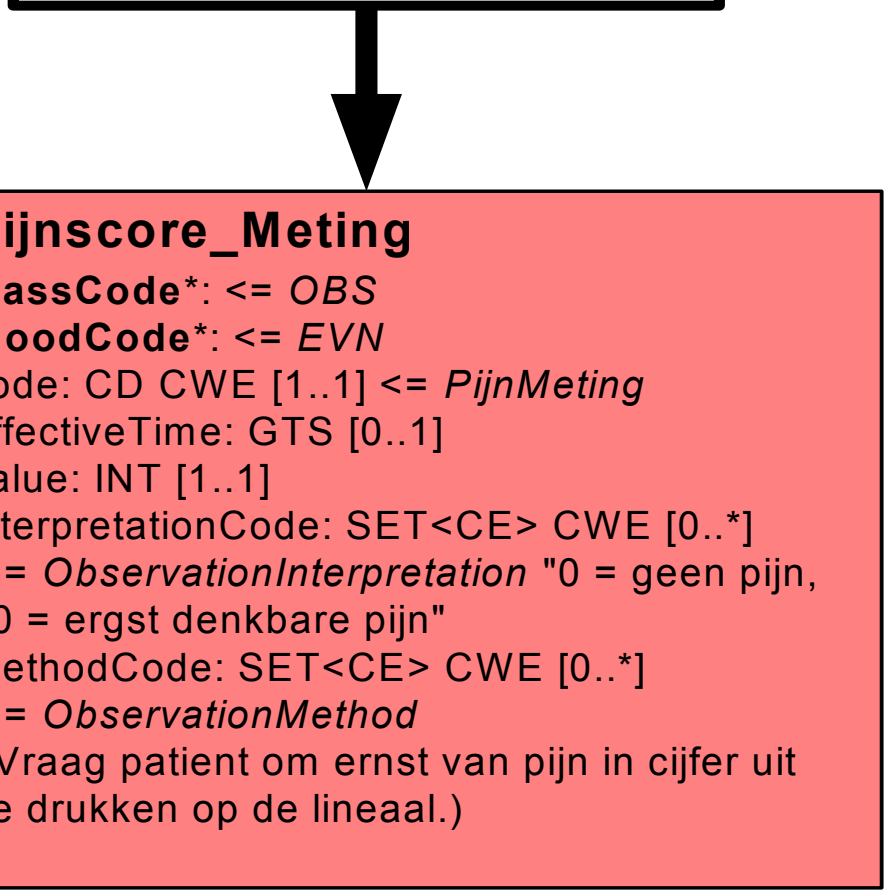
classCode*: <= *OBS*
moodCode*: <= *EVN*
id: SET<II> [0..*]
code: CD CWE [0..1] <= *ActCode*
derivationExpr: ST [0..1]
effectiveTime: GTS [0..1]
value: ANY [0..1]
methodCode: SET<CE> CWE [0..*] <= *ObservationMethod*

Clinical terminology in HL7 v3



Example pain score

Pijnscore_Meting
(Acquest Februari 2005)
Doc_Obs_Pijnscore_Meting_V.0.7



- Moodcode Def = guideline
- Moodcode Int = add to care plan

- Moodcode EVN = measure
- Effective time: 24 November 12.00 hr.
- Value = 8
- Etc.

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Barthel index Care Statement model

Barthel_Index
(BarthelR01V1E)
Barthel Index v1E

Barthel_Index
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "Barthel-index"
derivationExpr*: "Sumscore"
effectiveTime: TS
value*: INT [1..1]
interpretationCode:
<= *ObservationInterpretation* "0-9 seriously limited, 10-19 moderately limited, =>20 independent"

Bathing
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "BrtlD510"
effectiveTime: GTS [0..1]
value*: INT [1..1]
methodCode: <= *ObservationMethod* (0 = dependent; 1 = independent)

1..1 bathing
component10
typeCode*: <= *COMP*

Stairs
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "BrtlD460"
effectiveTime: GTS [0..1]
value*: INT [1..1]
methodCode: , CWE [0..1]
(0 = unable; 1 = needs help (verbal, physical, carrying aid) (□)

1..1 stairs
component9
typeCode*: <= *COMP*

Dressing/Undressing
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "BrtlD540"
effectiveTime: GTS [0..1]
value*: INT [1..1]
methodCode: <= *ObservationMethod*
((0 = dependent; 1 = needs help but can do about 50%
himself; 2 = independent.)

1..1 dressing/Undressing
component8
typeCode*: <= *COMP*

Mobility
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "BrtlD450"
effectiveTime: GTS [0..1]
value*: INT [1..1] (□)
methodCode: <= *ObservationMethod*
(0 = immobile or < 50 yards; 1 = wheelchair independent including corners, > 50 yards; 2 = walks with help of one person (verbal or physical); 3 = independent
(but may use any aid; for example, stick) > 50 yards)

1..1 mobility
component7
typeCode*: <= *COMP*

Transfer
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "BrtlD420"
effectiveTime: GTS [0..1]
value*: INT [1..1]
methodCode: , CWE [0..1] = *independent.□)*
(0 = not able to (not independent) (1-2 people physical)
(physical or with words)

1..1 transfer
component6
typeCode*: <= *COMP*

1..1 continence of Bowels
component1
typeCode*: <= *COMP*

Continence of Bowels
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "BrtlB525"
effectiveTime: GTS [0..1]
value*: INT [1..1]
methodCode: <= *ObservationMethod*
((0 = Incontinent; 1 = Needs help / accidents; 2 = Able to control and no accidents.)

1..1 controlling Bladder
component2
typeCode*: <= *COMP*

Controlling Bladder
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "BrtlB6202"
effectiveTime: GTS [0..1]
value*: INT [1..1]
methodCode: , CWE [0..1] = *continent*
(((0 = incontinent or catheter; 1 = Occasional accidents (max. 1 time per 24 hours)
(for more than 7 days)

1..1 personal Toilet
component3
typeCode*: <= *COMP*

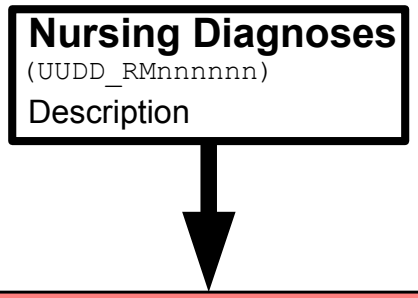
Personal Toilet
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "BrtlD520"
effectiveTime: GTS [0..1]
value*: INT [1..1]
methodCode:) CWE [0..1] <= *ObservationMethod*
(0 = needs help; 1 = independent (face, hair, teeth, shaving)

1..1 toilet
component4
typeCode*: <= *COMP*

Toilet use
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "BrtlD530"
effectiveTime: GTS [0..1]
value*: INT [1..1]
methodCode:) CWE [0..1] <= *ObservationMethod*
((0 = dependent; 1 = needs help but can do some parts on his
own; 2 = independent (can get on and off, dressing and
undressing, wipe)

1..1 feeding
component5
typeCode*: <= *COMP*

Eating
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "BrtlD550"
effectiveTime: GTS [0..1]
value*: INT [1..1]
methodCode: 1 CWE [0..1]
(0 = unable; 1 = needs help cutting, spreading butter, etc., or requires modified diet; 2 = independent□) (□)



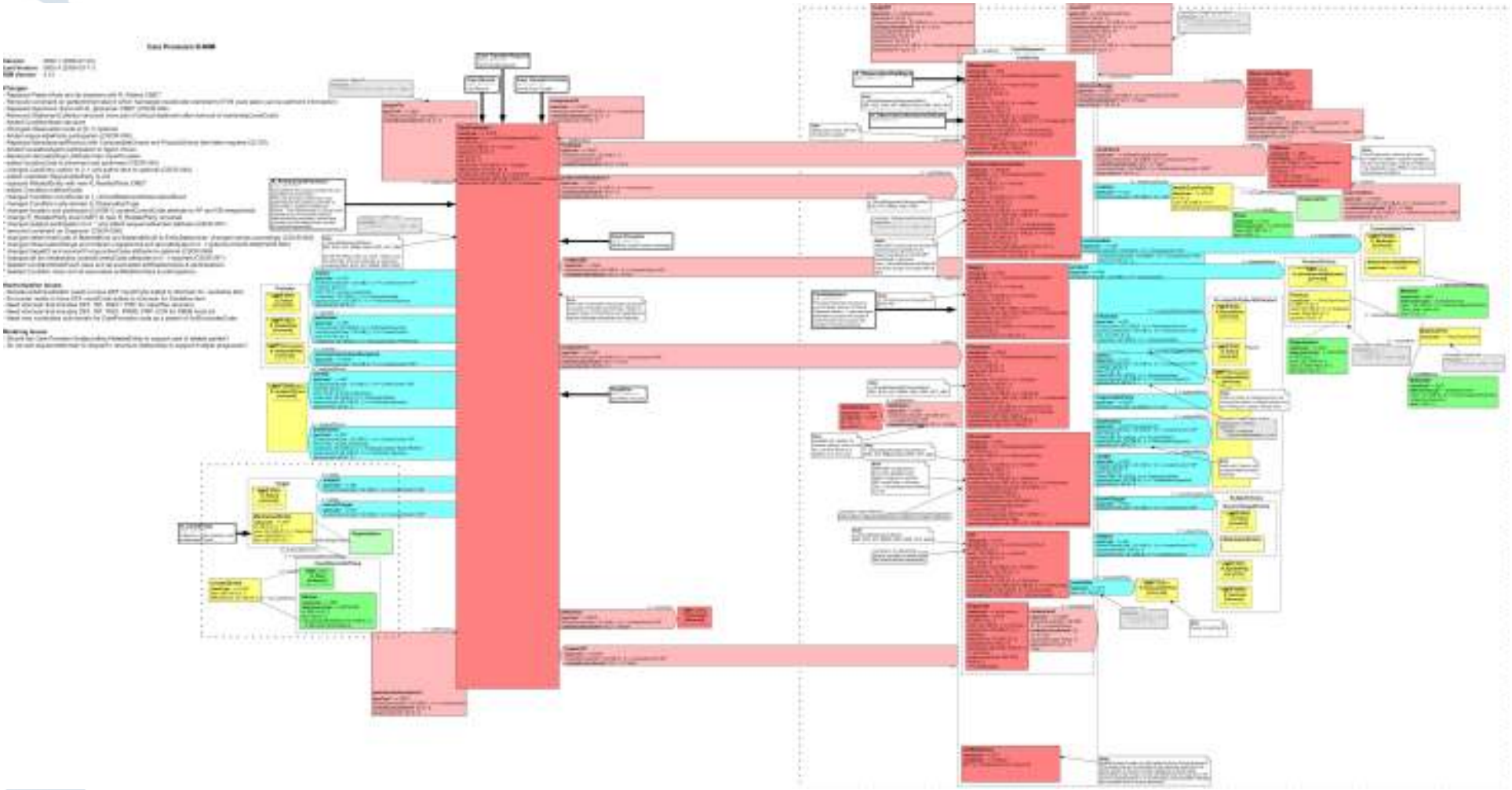
Nursing Diagnoses
classCode*: <= *OBS*
moodCode*: <= *EVN*
code: <= *ActCode* "PROBLIST"
effectiveTime:
value: CE CWE [0..1]
methodCode: <= *ObservationMethod*
(Determine the appropriate nursing diagnoses and use the right description from the problem list)

Example HL7 v3 use for nursing diagnoses in problem list

Mapping Domain Data, Vocabulary and HL7 R-MIM

Variable in domain	DMIM	attribute	Data type HL7	Cardinality	Vocabulary	Code	Example
Nursing diagnosis	OBS	value	CE	0..1	NANDA	***	Acute Pain
Nursing diagnosis	OBS	value	CE	0..1	ICNP beta 2	1A.1.1.1.13.1 & 1D.1	Pain & Acute
Nursing diagnosis	OBS	value	CE	0..1	ICF	d420	Change positions

HL7 v3 Care Provision DSTU



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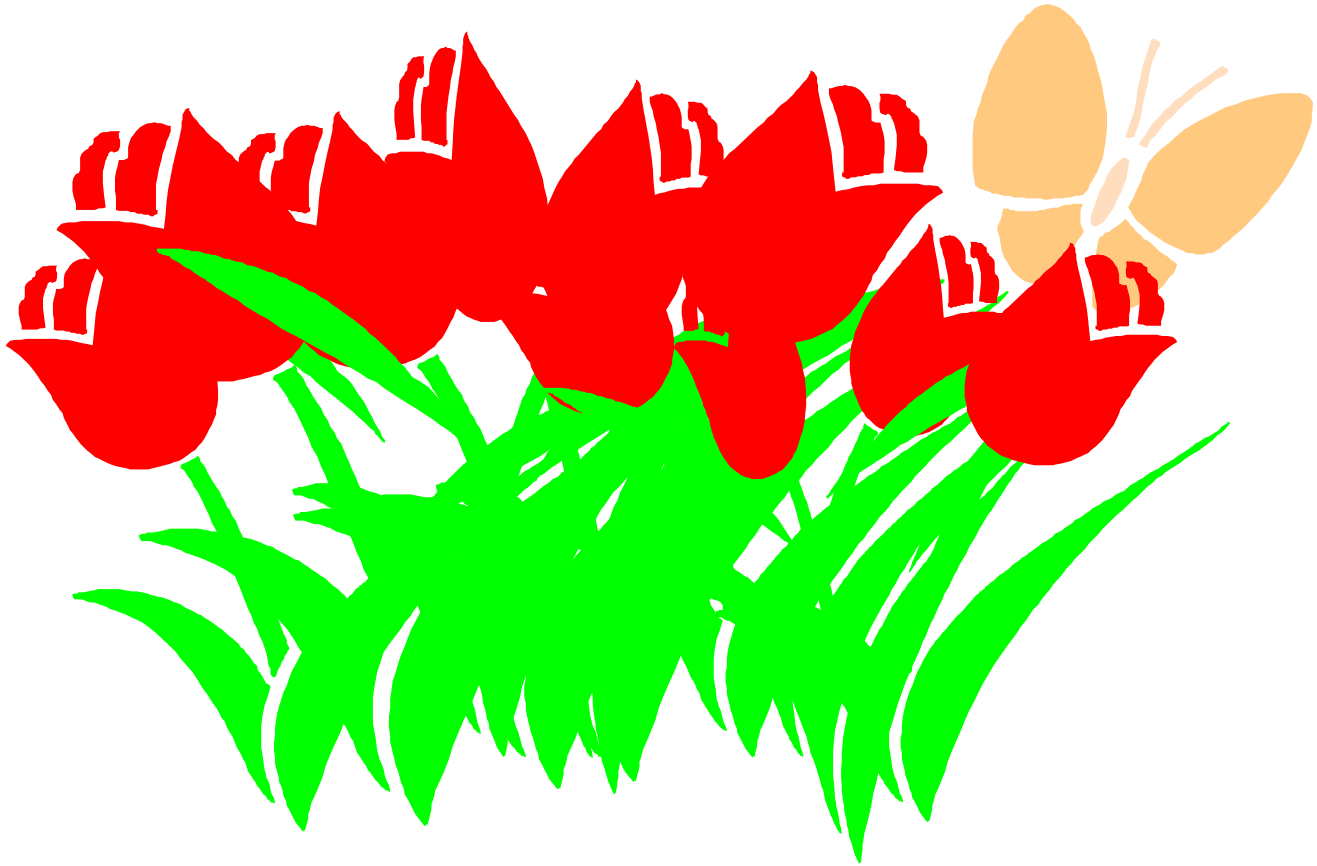
A virtual gift from Amsterdam…



To make it just a little bit easy again ☺

6. Map from domain to HL7 v3

- Data element (question or field)
- Definition: if necessary explain what the data element is
- Code to identify the element (from any vocabulary, criss-cross)
- Data type (text, picture, number, value set)
- If a value set: specify the values (answers)
- Mapping to HL 7 v3 class (where does it fit in message)

Example

- Data element: Gender
- Definition: Sex of a person
- Data type: Coded element
- Code: 11882-8 (LOINC)
- Value set: Not observed, female, male, ambiguous &/or more specific code
- HL7 v3: Person class, in gender attribute

Example Karoline Ekre

- Data element: Gender
- Definition: Sex of a person
- Data type: Coded element
- Code: HL7 internal code
- Value set: Not observed, female, male, ambiguous
- HL7 v3: Person class, in gender attribute
- **Instance: female**

Message content specification perinatology

PRN Label	Definition variabele/ condition	Coding	Path from Care Provision Act (Entry Point) HL7 v3	HL7 Class	Attribute HL7	Datatype HL7
MODULE INTERVENTIONS DELIVERY						
Amniotomy during delivery	Amniotomy during delivery	1=No; 2 = Yes, during dilation <= 3 cm; 3 = Yes, during dilation > 3 cm; 4 = Yes during delivery; 8= not applicable	CareProvision.pertinentInformation1.Procedure	**Procedure**	code negationInd method.Code	CD BL CE
Amniotomy, reason	If amniotomy = yes. Reason / motivation Amniotomy.	1= speed up delivery 2= insert monitoring equipment 3= medical indication other 4= no medical indication	CareProvision.pertinentInformation1.Procedure.targetOf(typeCode=RSON).Observation This item specificies item 5.4.01.01	**Observation**	code value	CD CE
Stimulation during delivery	Stimulation given during delivery	1=No 2=Yes; 9=Unknown	CareProvision.pertinentInformation1.Procedure	**Procedure**	code negationInd method.Code	CD BL CE
Type stimulation during delivery	If stimulation = yes. Stimulation administered during delivery. More answers possible	A = During dilation <= 3 cm; B = During dilation > 3 cm; C = During delivery; D = Desired but unavailable	thit is item above methodCode	see above	see above	see above
Sedation during delivery	Was sedation given during delivery?	1=No 2=Yes; 9=Unknown	CareProvision.pertinentInformation1.Procedure	**Procedure**	code negationInd method.Code	CD BL CE
Specify sedation during delivery	If sedation = yes, specify which type of medication was used	A=Sleep medication; B=Tranquilizers; C=Other.	CareProvision.pertinentInformation1.Procedure.targetOf(typeCode=PERT).SubstanceAdministration. Belongs to item 5.4.03.01 sedation	**Substance Administration**	code negationInd consumable.Medication.Medicine.code	CD CWE BL CE

Data element example Karoline Ekre

0.1	Diagnosis	Categorical examples	Coding
1.1.1	type diabetes	Which type diabetes mellitus does the patient have? 1= type I 2= type II 9=unknown	SNOMED CT: 46635009: diabetes mellitus type 1, 44054006: diabetes mellitus type 2; ICD10: E10: insuline dependent diabetes, E11: non-insuline dependent diabetes, E14: diabetes not specified; ICPC: T89:insuline independent diabetes, T90: not-insuline independent diabetes)
1.1.2	diagnostic methods: what measurement is used for diagnosing diabetes	1= glucose capillair blood after fasting (> 6,0 mmol/l) 2= glucose veneus plasma after fasting (>6,9 mmol/l) 3= glucose capillair blood no fasting (> 11,0 mmol/l) 4= glucose veneus plasma no fasting (>11,0 mmol/l) 5= other 9= unknown	Probably LOINC has these codes: work is ongoing. Example for glucose is 14749-6 Glucose (LOINC), but does not specify method.

Nursing data Karoline Ekre mapped to HL7v3

Data item (Label)	Definition variabele/ condition	Coding value set	Path from HL7 v3 Care Provision Act	HL7 Class	Attribute HL7	Datatype HL7	Code
Able to tell name	Consciousness: knowing their own name	1=No; 2 = Yes 3= not applicable	CareProvision.pertinentInformation1.Observation	Observation	Code value	CD BL	6574-8
Able to tell date / time	Consciousness: time orientation	1=No; 2 = Yes 3= not applicable	CareProvision.pertinentInformation1.Observation	Observation	code value	CD BL	6575-3
X-ray	Rontgen picture	Free text	CareProvision.pertinentInformation1.Observation	Observation	code value	CD ST	87694UYT
Blood test	Blood sample examination	Numeric value and unit	CareProvision.pertinentInformation1.Observation	Observation	code value	CD PQ	32574-4
Surgery for Hip fracture	Surgical procedure to replace hip	N/A	CareProvision.pertinentInformation1.Proc	Procedure	code negationInd	CD	9893471 38

In this column for each data element the codes from (nursing) terminologies are applied: examples are nonsense codes

HL7 v3 XML example: person

```
<REPC_IN004410UV xmlns="urn:hl7-org:v3"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:hl7-org:v3 REPC_IN004410UV.xsd"
ITSVersion="XML_1.0">
<subject typeCode="SBJ">
        <patient classCode="PAT">
          <id extension="58585803" root="2.16.840.1.113883.2.4.6.3"/>
          <statusCode code="active"/>
          <patientPerson>
            <name>
              <given>Karoline</given>
              <family qualifier="BR">Ekre</family>
            </name>
            <administrativeGenderCode code="F"
codeSystem="2.16.840.1.113883.5.1"/>
            <birthTime value="19240819"/>
          </patientPerson>
        </patient>
      </subject>
```

HL7 v3 XML fragment diabetes

```
<!-- Diabetes Mellitus Type 2 as concern -->
    <reason typeCode="RSON">
        <concernTracking moodCode="EVN">
            <id extension="070002" root="2.16.840.1.113883.2.4.4.13"/>
                <statusCode code="completed"/>
    <!-- diagnosis -->
            <observation moodCode="EVN">
                <code code="XYZ" codeSystem="1.99999.1.9.1.1"/>
                <value xsi:type="CE" code="00000"
    codeSystem="1.99999.1.2.1" displayName="diabetes mellitus 2"/>
            </observation>
        </concernTracking>
    </reason>
```

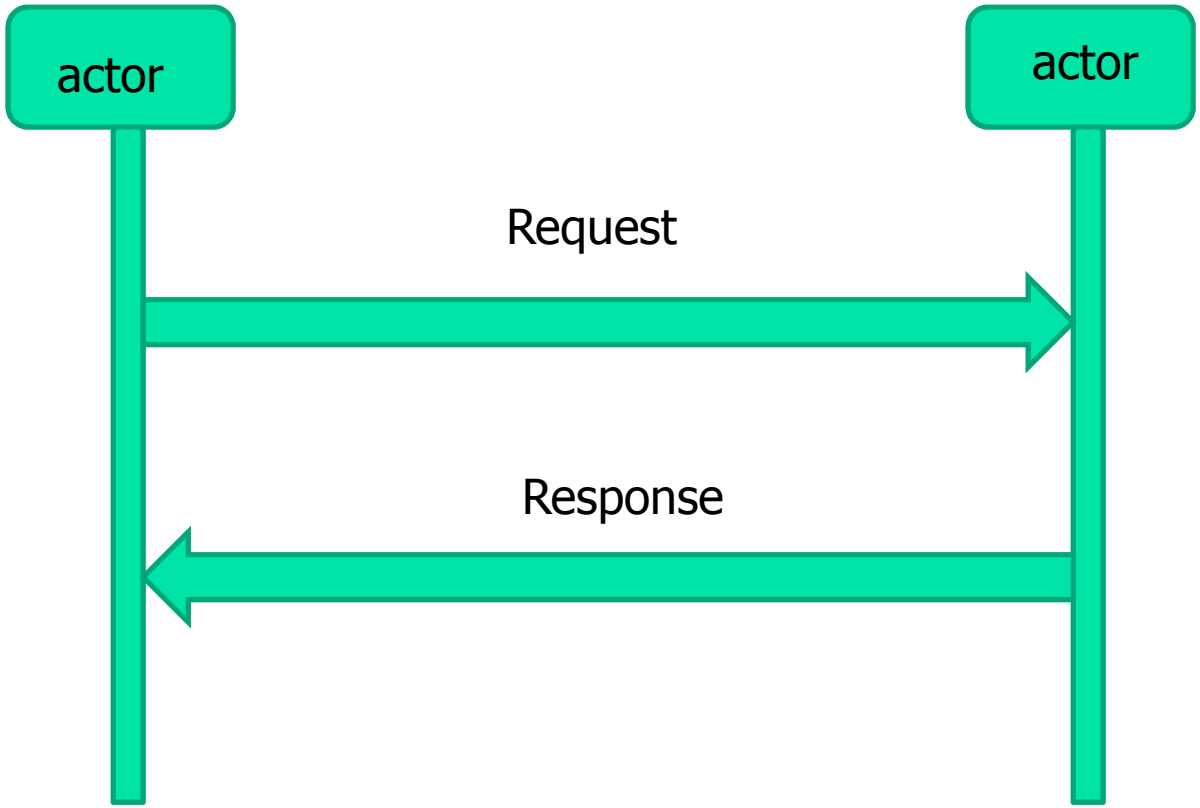
HL7 v3 XML fragment nursing

```
<!-- findings -->
    <pertinentInformation3 typeCode="PERT"
  contextConductionInd="true">
  <!-- Body weight -->
      <observation moodCode="EVN">
        <code code="8348-5" codeSystem="2.16.840.1.113883.6.1"/>
        <value xsi:type="PQ" value="69.3" unit="kg"/>
      </observation>
  <!-- observation fatigue -->
      <observation moodCode="EVN">
        <code code="XYZ - 2" codeSystem="1.99999.1.9.1.1"/>
        <value xsi:type="CE" code="12345" codeSystem="1.99999.1.2.1"
  displayName="Fatigue"/>
      </observation>
    </pertinentInformation3>
```

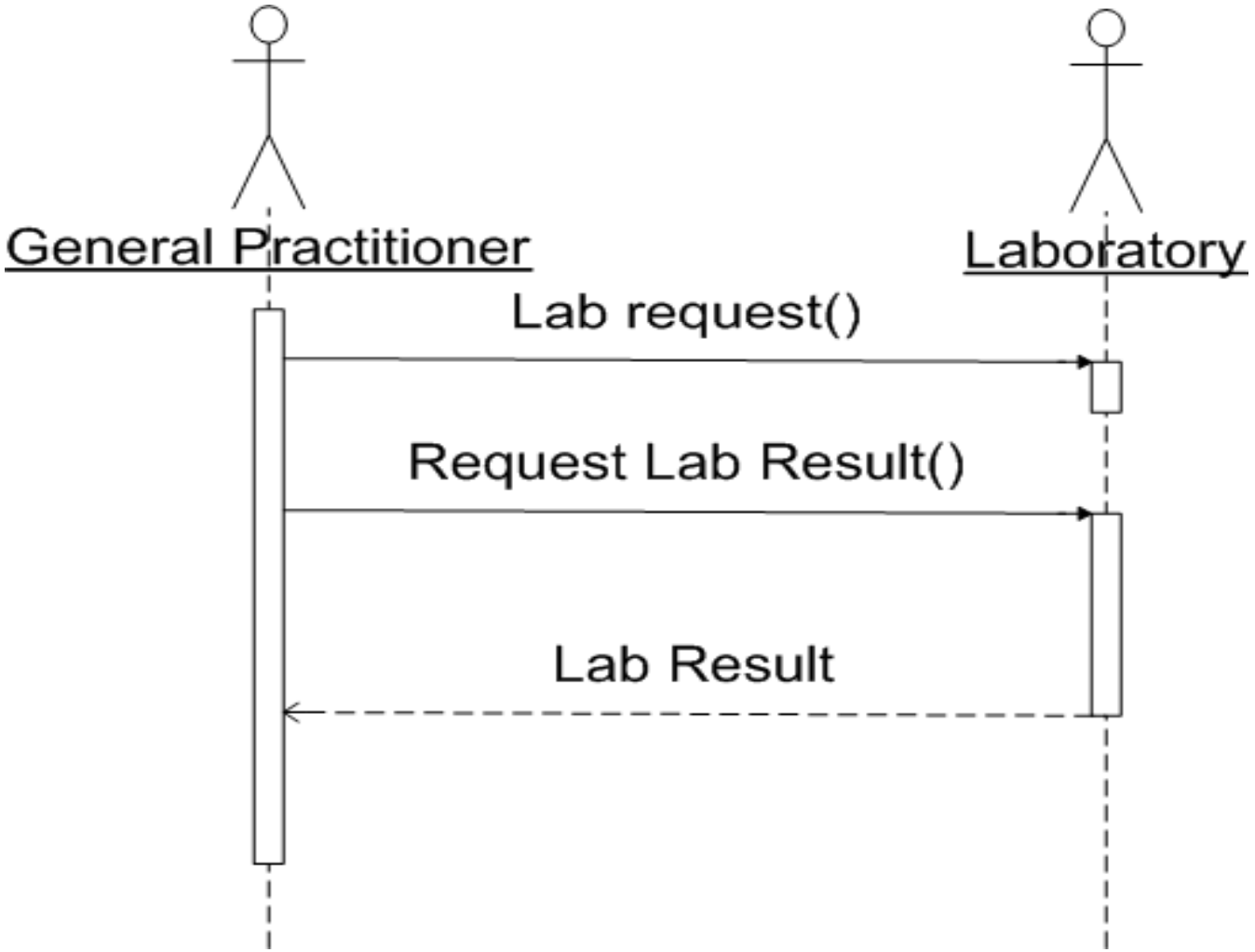
7. Dynamic model

- Once the content is specified and which message to be used is clear, then the interactions apply
- Sequence describes the communications between professionals
- Interaction diagrams specify the electronic messages for this.

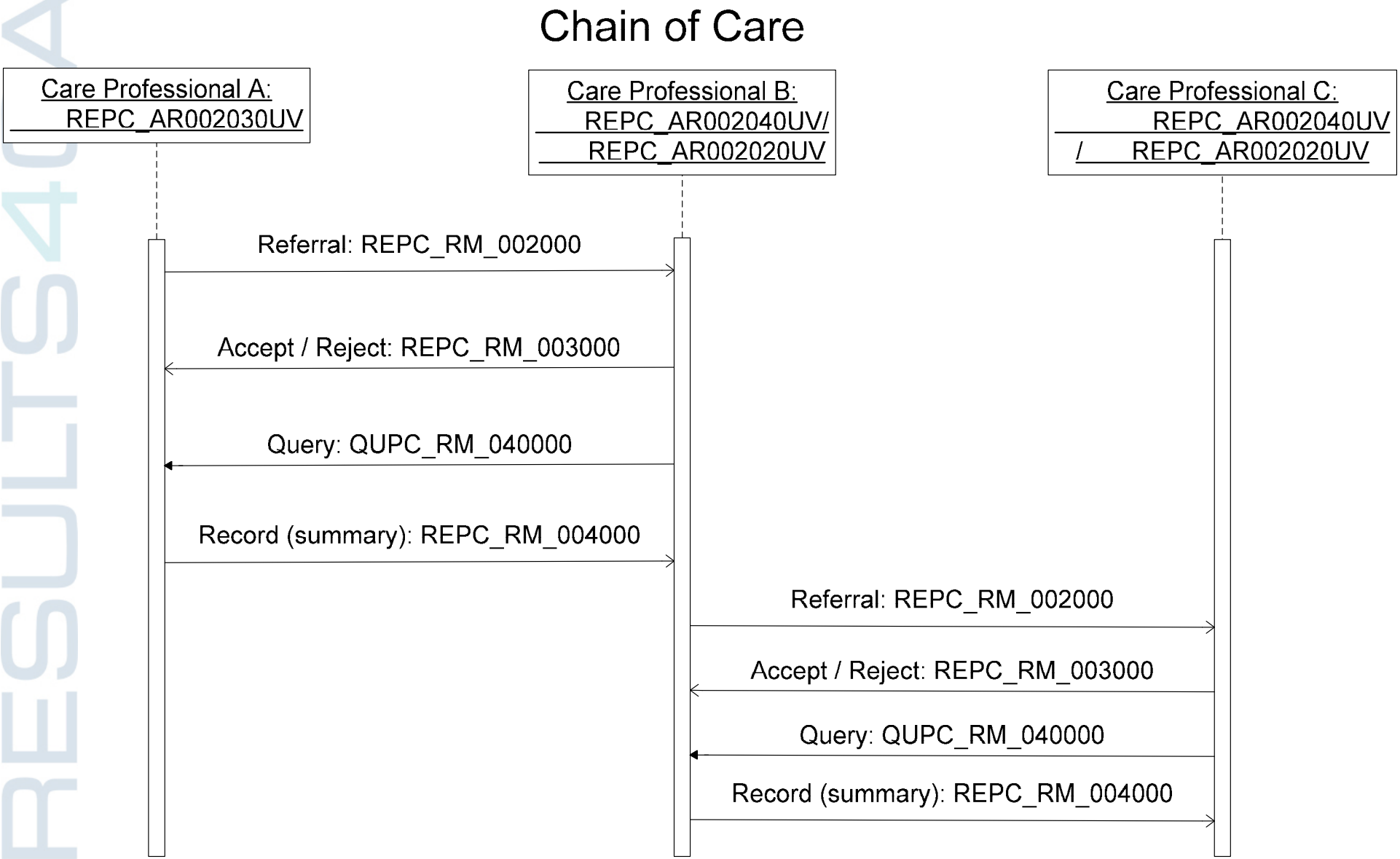
Sequence diagram/ interaction diagram



Interactions diagram for glucose lab request and result reporting

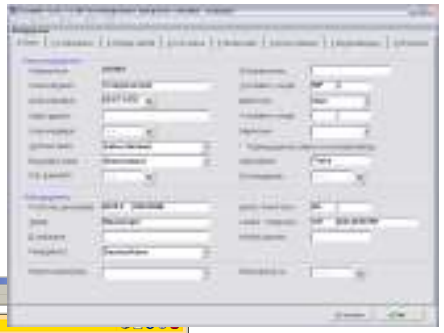


3. Chain of Care Karoline Ekre

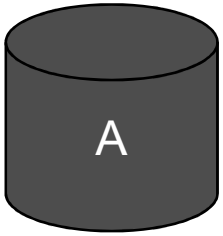


HL7 message in clinical practice

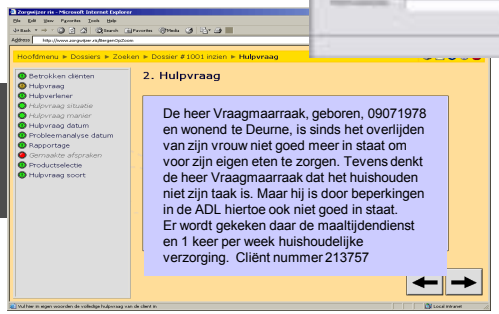
Data entry system A



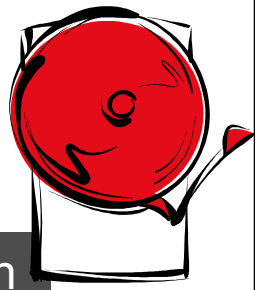
Data use system B

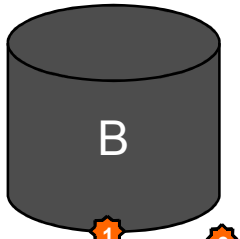


Storage in system A

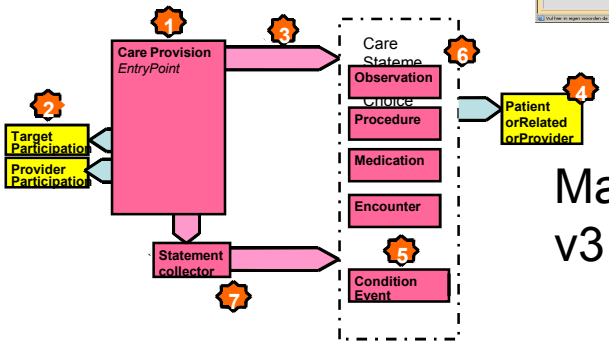


Alert in System B

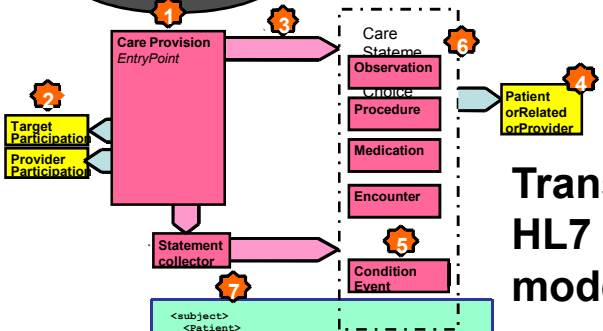




Storage in system B



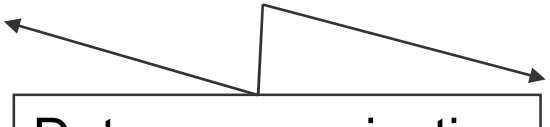
Map to HL7 v3 model



Translate via HL7 v3 model

XML Message Sender

```
<subject>
  <Patient>
    <id extension="213757"
          root="2.16.840.1.113883.2.4.6.2.451.1
          .1"/>
    <addr use="HP">
      <streetName>Maassingel </streetName>
      <houseNumber>82  </houseNumber>
      <postalCode>6678 II</postalCode>
      <city>DEURNE </city>
    </addr>
    <telecom use="HP" value="tel:050-4536758
          "/>
    <statusCode code="active"/>
    <Person>
      <name>
        <given qualifier="CL">M </given>
        <given qualifier="BR">P</given>
        <prefix qualifier="VV">v  </prefix>
        <family qualifier="SP">Vraagmaarraak
          </family>
      </name>
      <administrativeGenderCode code="M"
```




```
<subject>
  <Patient>
    <id extension="213757"
          root="2.16.840.1.113883.2.4.6.2.451.
          1.1"/>
    <addr use="HP">
      <streetName>Maassingel </streetName>
      <houseNumber>82  </houseNumber>
      <postalCode>6678 II</postalCode>
      <city>DEURNE </city>
    </addr>
    <telecom use="HP" value="tel:050-4536758
          "/>
    <statusCode code="active"/>
    <Person>
      <name>
        <given qualifier="CL">M </given>
        <given qualifier="BR">P</given>
        <prefix qualifier="VV">v  </prefix>
        <family qualifier="SP">Vraagmaarraak
          </family>
      </name>
      <administrativeGenderCode code="M"
```

8. Conclusion

- HL7 deals with the information model
- Code attribute holds coding from any vocabulary system: no need to choose one
- Depending on use cases, determine goal and select existing message (or build new)
- Map domain content to message and apply vocabulary and coding that match best (ISO 18104 as gold standard for mapping
- Determine relevant interactions for the electronic communication
- Be patient when learning

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Questions?

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Thank you!

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