Domain Analysis Models and Detailed Clinical Models

A methodological comparison to support a project decision

Outline

- Representing Requirements
- Methodologies for Representing Data Requirements
- Comparison
- Options

REPRESENTING REQUIREMENTS

The Problem

- How do we specify interoperability requirements so that
  - Clinicians can confirm that they are documented <u>correctly</u>
  - Technologists can confirm that they are <u>complete</u> enough to support development
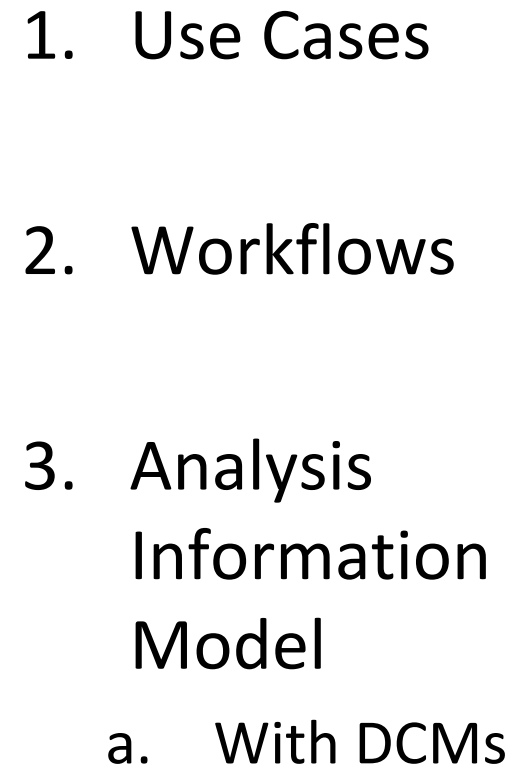
Business Drives Technology

- Start by documenting the process that defines the problem space
  - Process flows
  - Use cases
  - Activity diagrams
- Then derive or enhance whatever else you need
  - Glossary
  - State machines
  - Information model
  - Usability brief

Project Approach: Problem Space
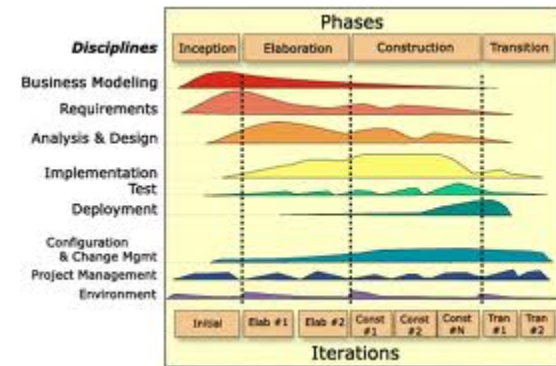
1. Use Cases

2. Workflows

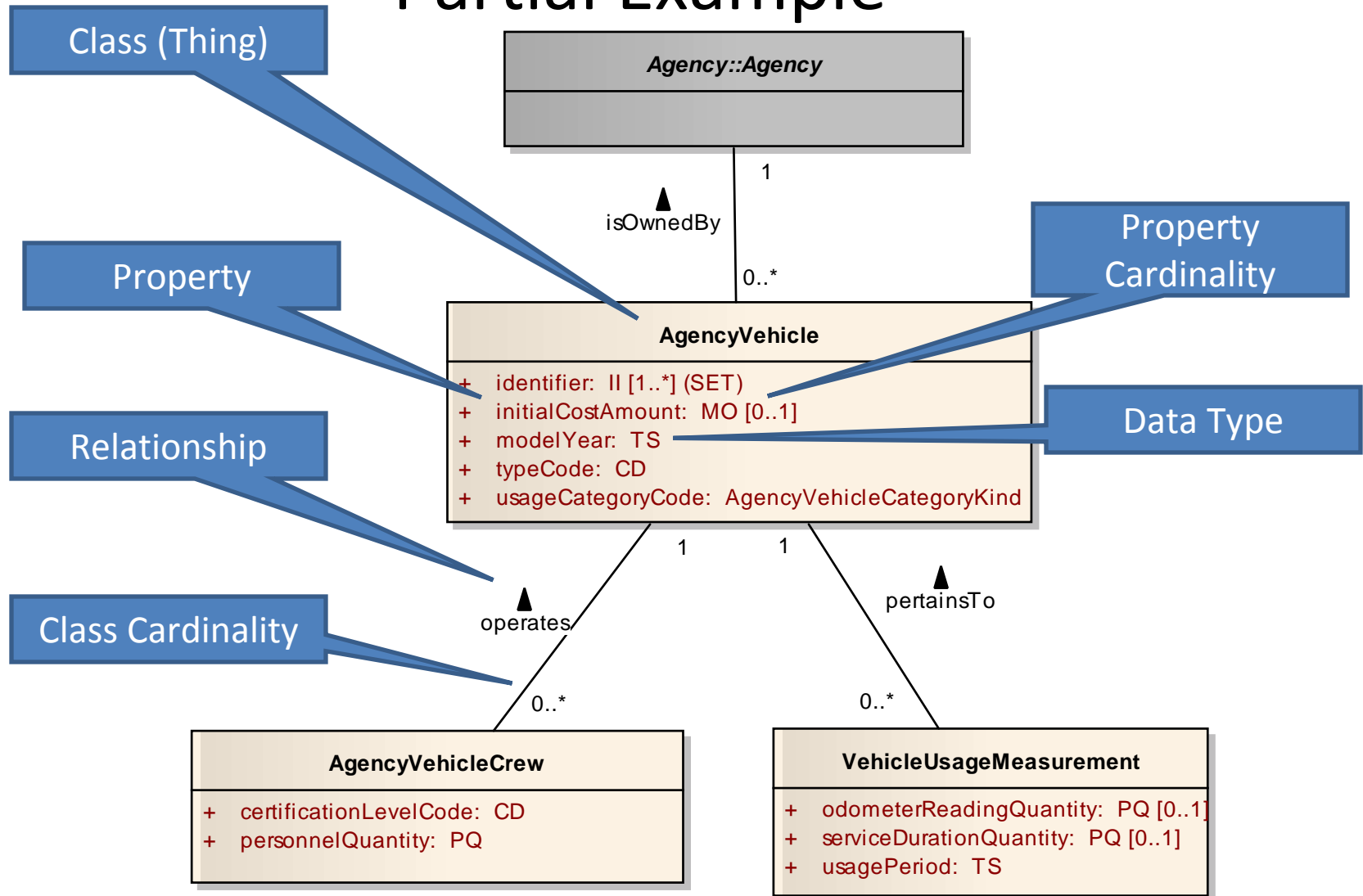3. Analysis Information Model

   a. With DCMs

Information Requirements

- Early efforts: A Glossary
  - Definitions in natural language help, but they leave room for ambiguity
- Recent efforts: An "information model"* at the <u>analysis</u> level
  - Aristotelian, fairly legible; minimal training required
  - Uses natural language definitions but unambiguously clarifies boundary conditions (relationships, cardinalities, properties)
  - Like an entity-relationship diagram
  - Easy to do as a Class Diagram in UML, a commonly understood language

*A.k.a. Conceptual model, domain model, business object model, business viewpoint, information model, etc.

Analysis Information Model Partial Example

Class (Thing)

Property

Relationship

Class Cardinality

Property Cardinality

Data Type

Agency::Agency

1

△ isOwnedBy

0..*

AgencyVehicle

+ identifier: II [1..*] (SET)
+ initialCostAmount: MO [0..1]
+ modelYear: TS
+ typeCode: CD
+ usageCategoryCode: AgencyVehicleCategoryKind

1   1

△ operates   pertainsTo △

0..*   0..*

AgencyVehicleCrew

+ certificationLevelCode: CD
+ personnelQuantity: PQ

VehicleUsageMeasurement

+ odometerReadingQuantity: PQ [0..1]
+ serviceDurationQuantity: PQ [0..1]
+ usagePeriod: TS
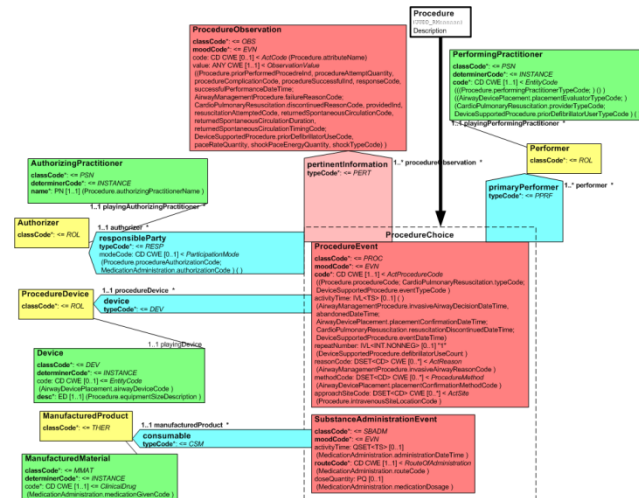
EMS DAM, May 2010 HL7 Ballot

Problem First, Then Solution

- Two sorts of information model:
- An <u>Analysis</u> model represents the <u>problem space</u> in terms the Clinician can confirm.
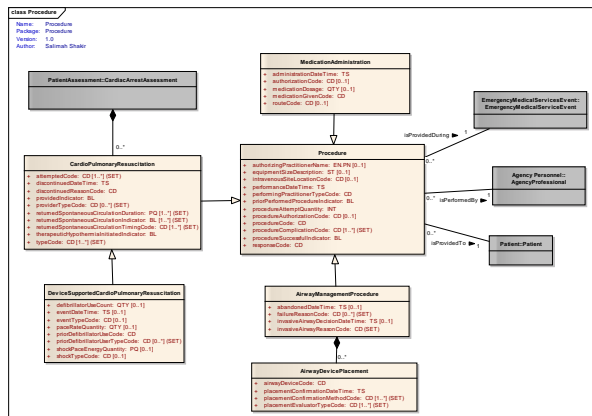

6 Classes

16 Classes

- A <u>Design</u> model represents the <u>solution space</u>; it is derived from the analysis model. It need not be comprehensible to clinicians.

# METHODOLOGIES FOR REPRESENTING DATA REQUIREMENTS

Clarification

- We are using the <u>Domain Analysis Process</u> to model the <u>domain</u> in support of specification development
- We may identify other tools for modeling subsets of detailed clinical information <u>within that domain</u>
- The following comparison addresses modeling at the detail level
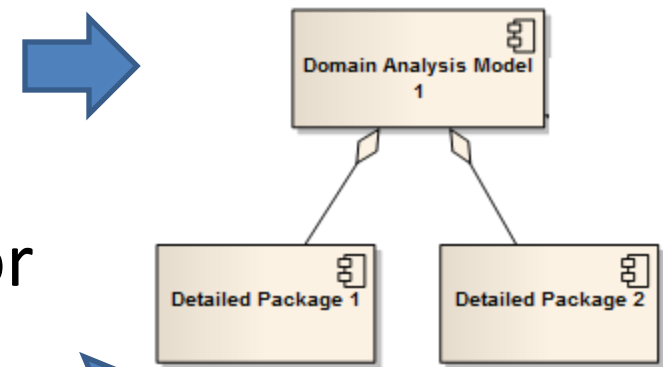
Some Clinical Analysis Modeling Methodologies

- HL7 Domain Analysis Process
- ISO 11973 DCM requirements document
  - Associated with HL7 Patient Care Workgroup, DCM project
- Other modeling efforts
  - Intermountain Healthcare, with GE
  - Kaiser Permanente and VA Nursing Charter Innovation
  - Clinical LOINC Nursing Subcommittee
  - Any other project aiming at modeling clinical information in detail

http://xkcd.com/
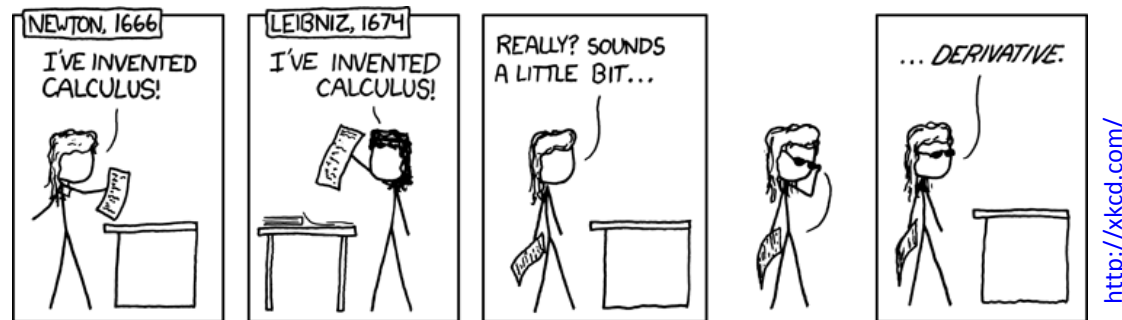
Criteria

- If we're authoring a standard for the domain, we don't need to be inventing new methods: we want an off the shelf methodology, if possible
- It needs to be documented
- It needs to be open

Approaches for Detailed Modeling

Approach	Non-proprietary intellectual property?	Published methodology?	Consider
HL7 Domain Analysis Process	Yes	Yes	✔
ISO 11973 DCM	Planned	Partially	✔
Other	Unknown	Unknown	✘

Domain Analysis Model

- "Domain Analysis produces a set of artifacts that clearly describe the healthcare business in a given domain in terms familiar to the people who work in that business area."
  - HL7 Development Framework
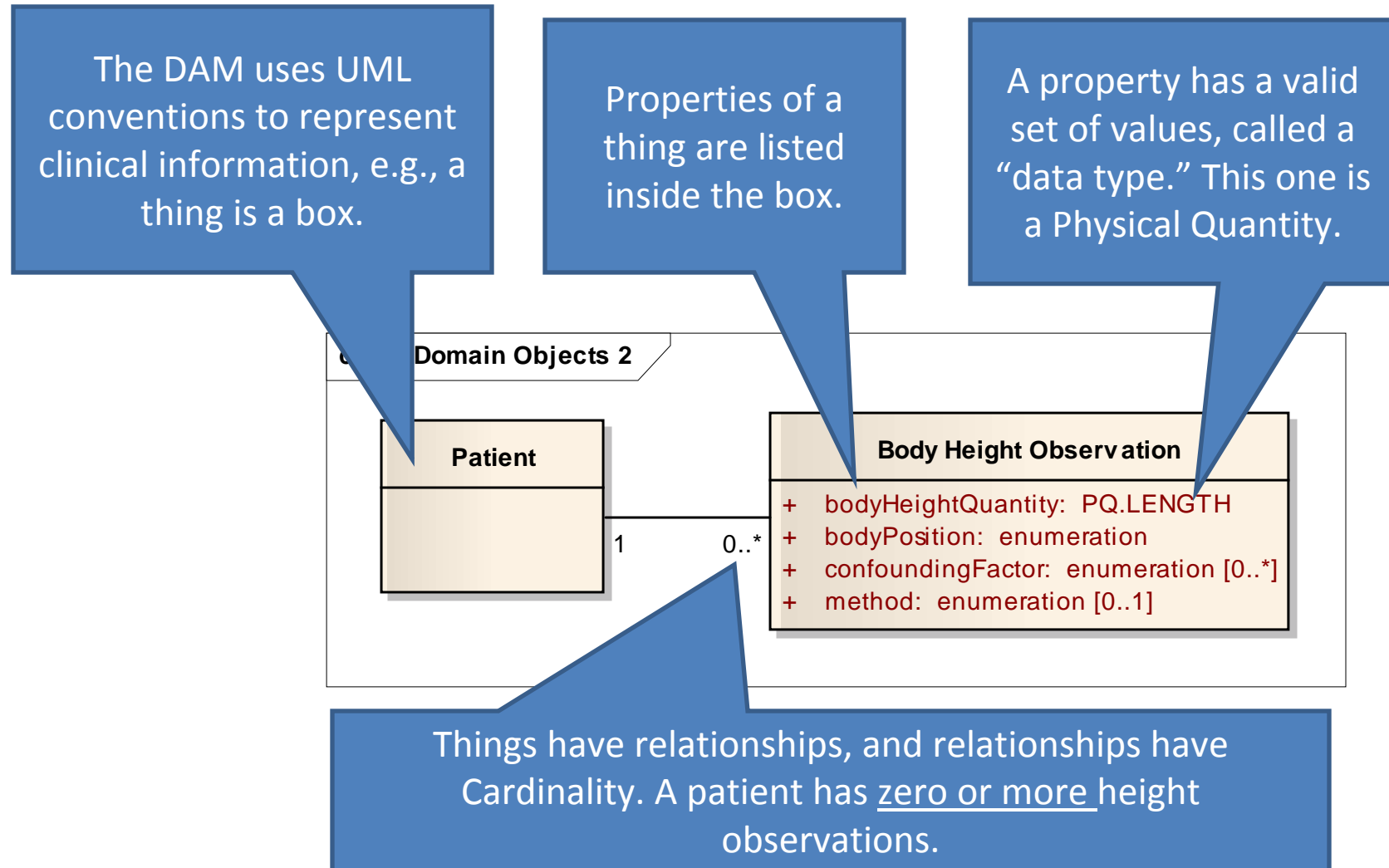- *Clear*
- *Familiar*

Detailed Clinical Model

- At the conceptual level, a Detailed Clinical Model (DCM) is an information model of a discrete set of precise clinical knowledge which can be used in a variety of contexts.

  – ISO NWIP *Detailed Clinical Models* – Draft 01

- *Precise*

- *Reusable*

COMPARING THE EFFORTS

Detailed Clinical Information in a UML Model (DAM-compliant)

The DAM uses UML conventions to represent clinical information, e.g., a thing is a box.

Properties of a thing are listed inside the box.

A property has a valid set of values, called a "data type." This one is a Physical Quantity.

Domain Objects 2

Patient

Body Height Observation

+ bodyHeightQuantity: PQ.LENGTH
+ bodyPosition: enumeration
+ confoundingFactor: enumeration [0..*]
+ method: enumeration [0..1]

1   0..*

Things have relationships, and relationships have Cardinality. A patient has zero or more height observations.

Option for Representing Valid Values

class Domain Objects 2

Patient

1   0..*

Body Height Observation

+   bodyHeightQuantity: PQ.LENGTH
+   bodyPosition: enumeration
+   confoundingFactor: enumeration [0..*]
+   method: enumeration [0..1]

1   1   1

0..1   0..*

«enumeratio...»
Body Position

Supine
Standing

0..1

«enumeration»
Body Height Measurement Method

Ruler
Tape Measure

«enumeration»
Confounding Factor

Amputation
Severe Osteoporosis
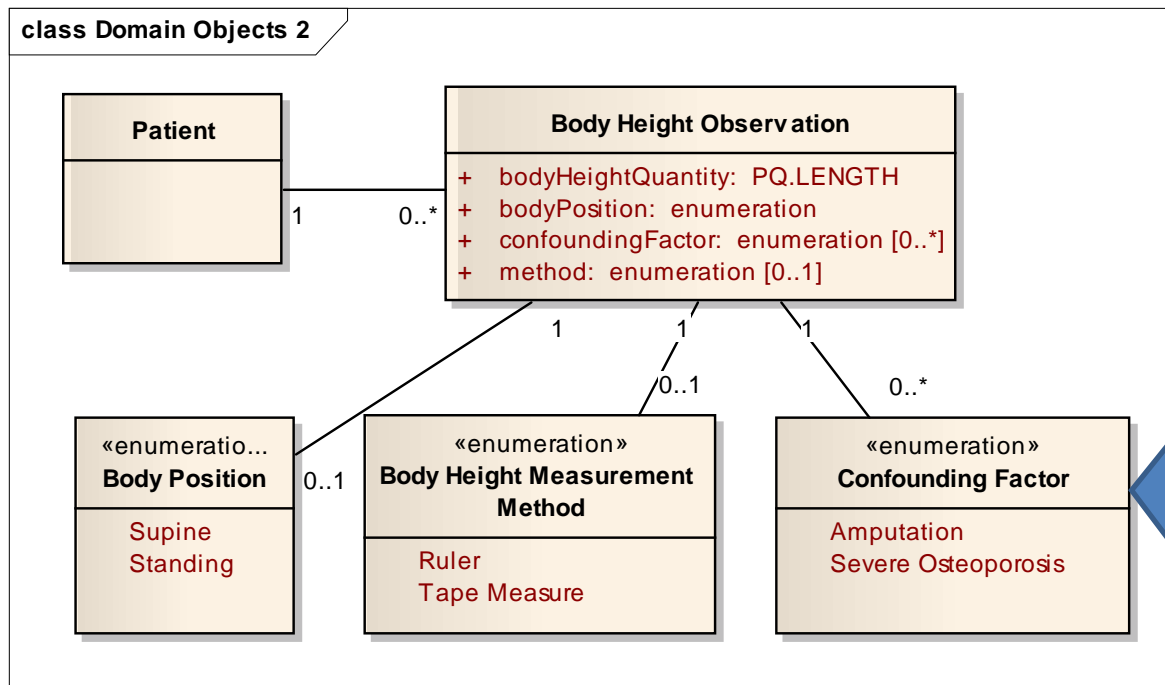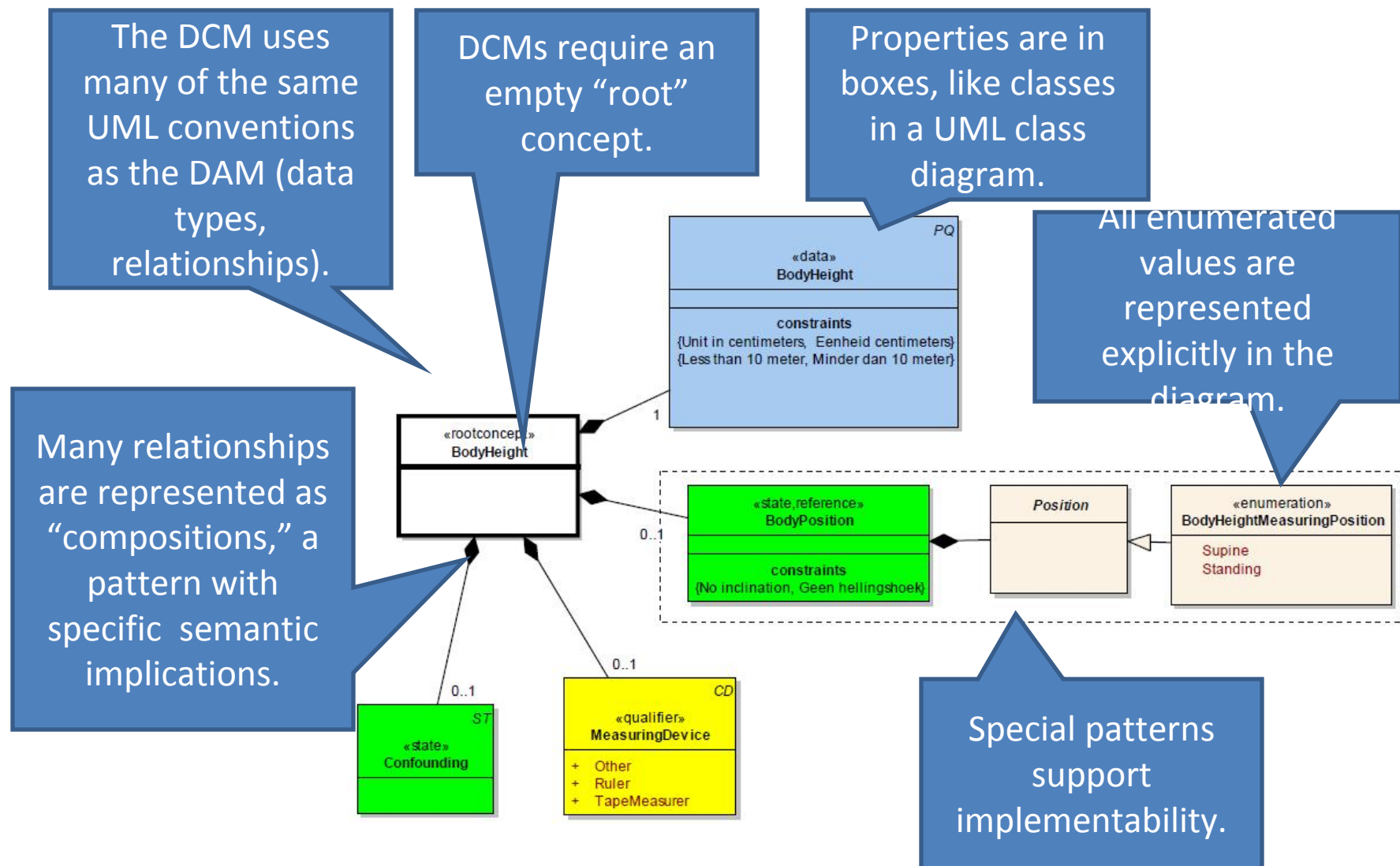
Some properties have enumerated lists of valid values. These may or may not be represented in the picture, depending on size and volatility of the list.

An HL7 Patient Care DCM

The DCM uses many of the same UML conventions as the DAM (data types, relationships).

DCMs require an empty "root" concept.

Properties are in boxes, like classes in a UML class diagram.

All enumerated values are represented explicitly in the diagram.

Many relationships are represented as "compositions," a pattern with specific semantic implications.

Special patterns support implementability.

PQ
«data»
BodyHeight

constraints
{Unit in centimeters, Eenheid centimeters}
{Less than 10 meter, Minder dan 10 meter}

«rootconcept»
BodyHeight

1

0..1

«state,reference»
BodyPosition

constraints
{No inclination, Geen hellingshoek}

Position

«enumeration»
BodyHeightMeasuringPosition

Supine
Standing

0..1

ST
«state»
Confounding

0..1

CD
«qualifier»
MeasuringDevice

+   Other
+   Ruler
+   TapeMeasurer

Comparison

Area	DAM	PC DCM
Maturity	Adolescent	Method not yet documented
Scope	Unrestricted	"Discrete"
Topic	Unrestricted	Clinical information
Detail	Unrestricted	High
Formalism	UML	UML, others
Clinical references	Unrestricted	Required
Discovery	HL7 V3 Edition	Key Goal
Reuse	Unrestricted (conceptual)	Key Goal (concrete)
Automated code generation	Wrong	Key Goal

Key Differences

Area	DAM	PC DCM
1. Separation of problem space from solution space	Separation is fundamental	Separation would prevent code generation
2. Automatic code generation	Code generation would break the requirements model	Code generation is fundamental
3. Clinical workflow orientation	Clinical workflow orientation is fundamental	Clinical workflow orientation might impair reusability
4. Reusability	Reusability is conceptual	Reusability is concrete

DCM Areas of Interest
and Relative Fit with DAM

- Clarity

- Reusability

- Code Generation

Clarity is fundamental to both paradigms

DCM envisions "plug and play" reusability;
DAM standard supports conceptual reuse

Automatic code generation is fundamental
to DCM, but the DAM separates problem
space from solution space.

OPTIONS

Device Project Objectives

- Primary objective: Create device interoperability specifications for selected devices to enhance patient safety

- Secondary objective: develop DCMs as needed in order to promote complete, accurate, and reusable representations of clinical information in diverse contexts

Device Project Current Situation

- The DAM seems to support representation of the information requirements we have been able to identify.

- Can we use the Patient Care formalism to represent selected elements in order to support reuse?

Options for Coordination

A. DAM Component Model: <u>A DCM is a component</u> of other models, including DAMs

B. DAM Enhancement Model: The DCM idea provides a set of <u>enhancements</u> to the DAM

C. Candidate Model: The DAM models the requirements as a <u>candidate DCM</u>; actual DCM(s) may or may not be derived later

A. Component Model Concept
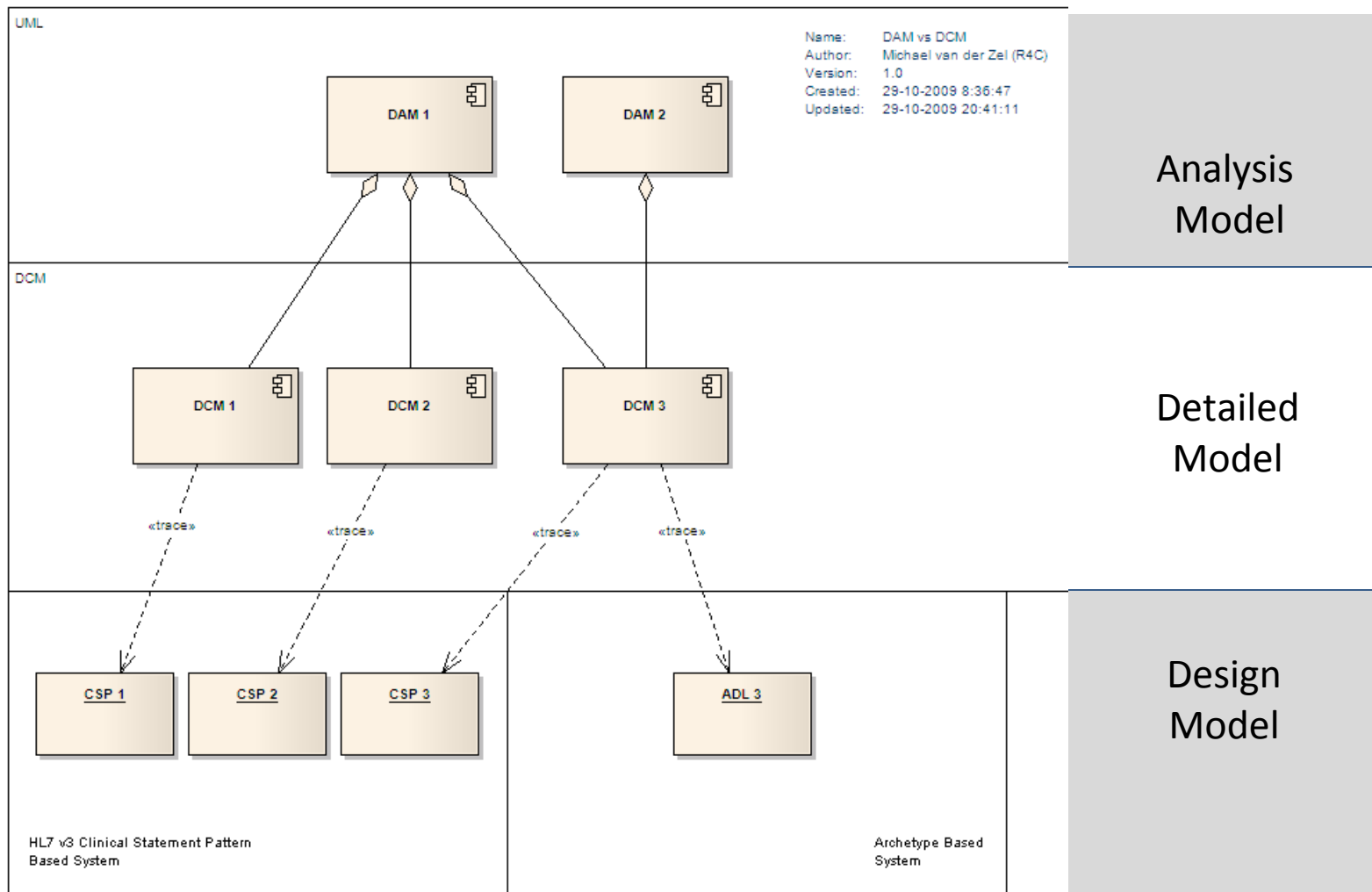
A DCM is a component of other models, including DAMs

A. Component Model
Benefits and Issues

- Benefits
  - As planned by ISO working group & HL7 Patient Care
  - Intended to be reusable
  - May evolve to automated code generation stage
- Issues
  - Divergent DAM and DCM modeling assumptions
  - Coordination of requirements, versions, and usage contexts
  - Specification of model relationships, potential recursion

A. Component Model
General issues found in <u>Device DCM</u> pilot

- We don't have clear direction on what a DCM should look like—the metamodel is not specified

- We don't know where the conceptual boundary of the DCM is— the desire for "reuse" tends to leave that door open

- We don't know how to join the models— either to refer to an existing DCM or package a newly developed one so others can refer to it

A. Component Model
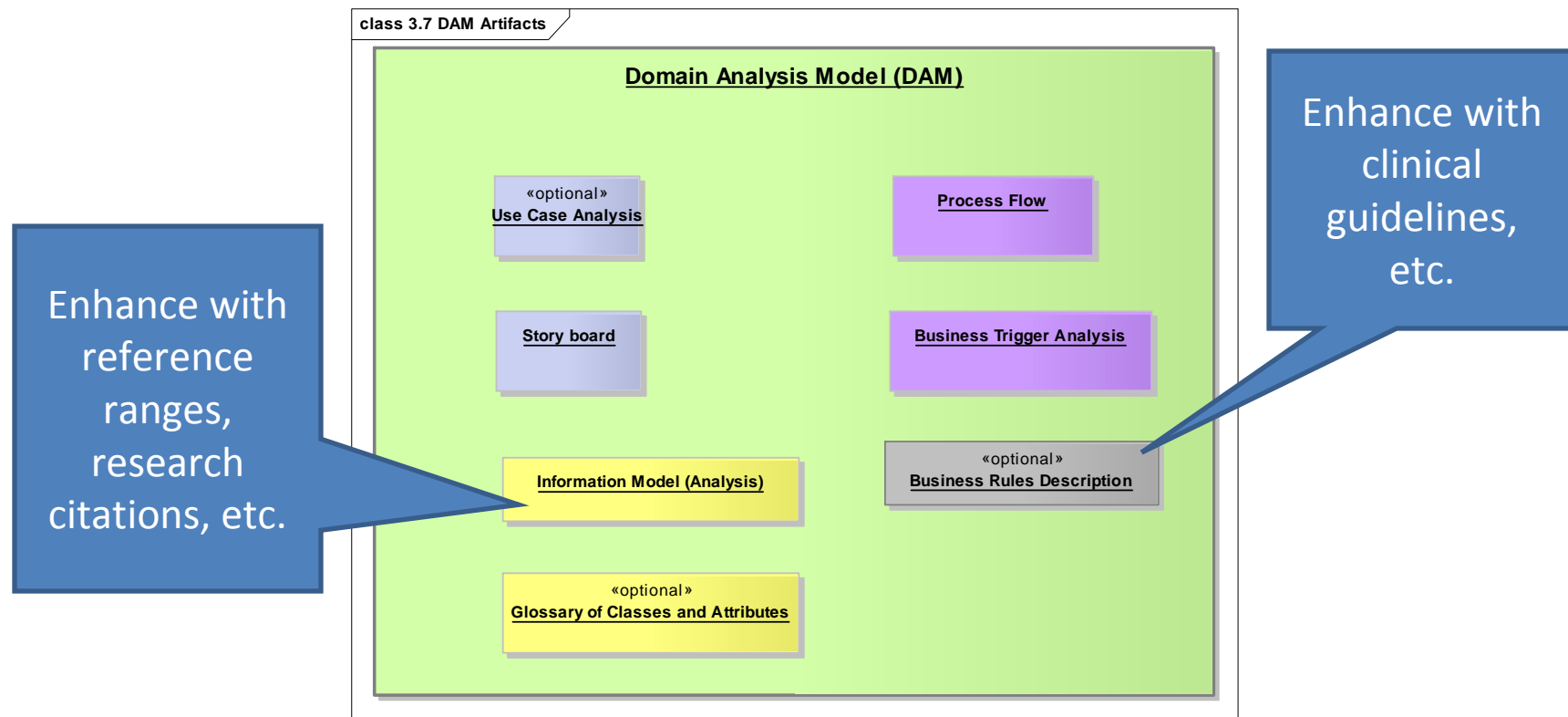## Specific issues found in <u>Device DCM</u> pilot

- Arterial blood gas DCM
  - Should it include peripheral gas measurement?
  - Should it include external factors that may be repeated elsewhere (e.g., patient body temperature, altitude, hemoglobin)?
  - How should it refer to the patient body temperature DCM?
  - Should it model derivation processes or just the semantic content?
  - How should it represent clinical guidelines and other deductive relationships among values?
  - How should it represent clinical citations?

A. Component Model
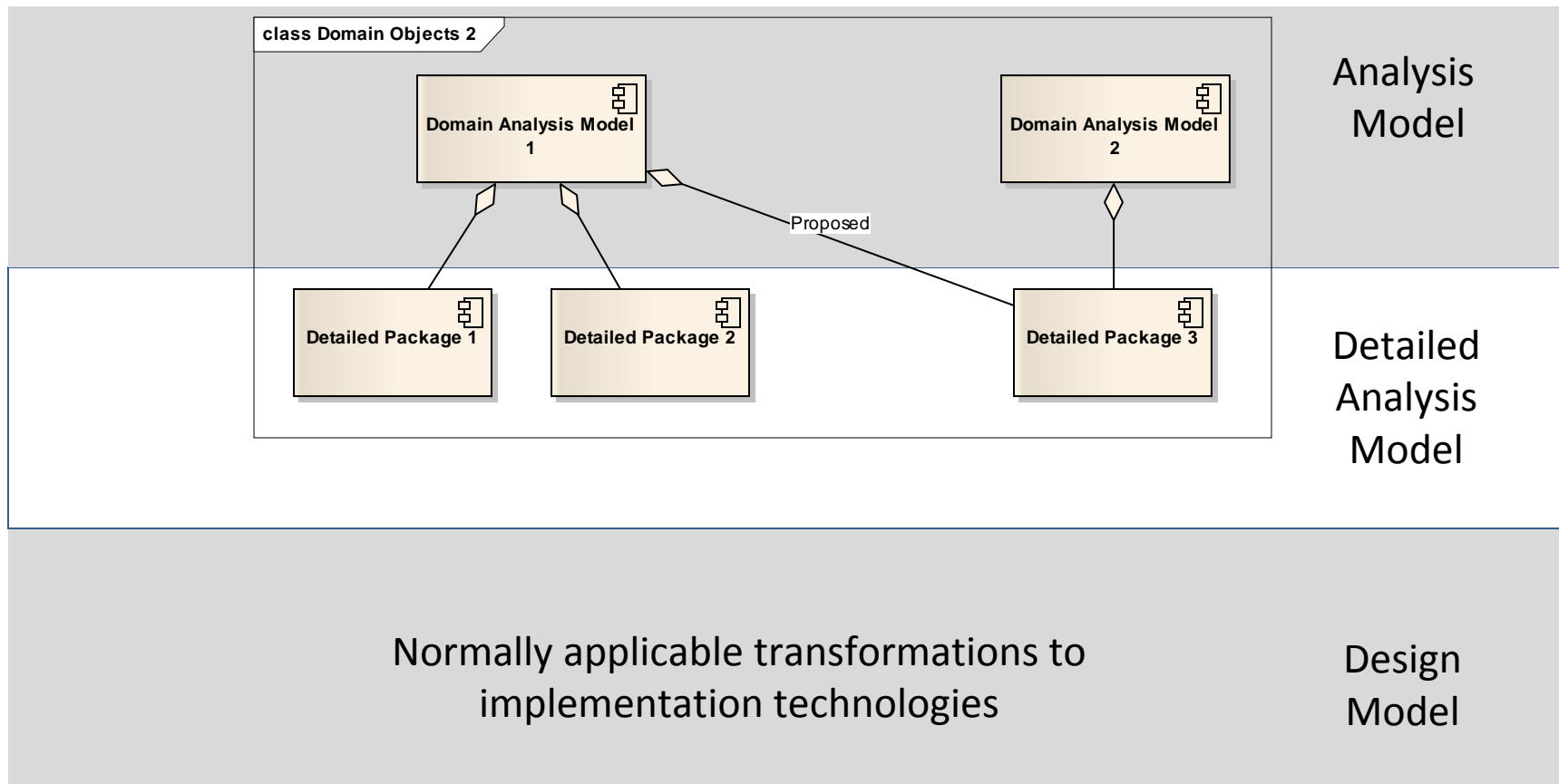## Specific Issues Found in <u>DCM</u> Pilot

- Should modeling patterns necessary for code generation be permitted to affect the representation of clinical information?
  - Root classes
  - Stereotypes
  - UML terms of art—e.g., "collection" vs. "panel"
  - Mediating classes—e.g., three classes to represent the single property of body position

B. Enhancement Model Concept

class 3.7 DAM Artifacts

Domain Analysis Model (DAM)

«optional»
Use Case Analysis

Process Flow

Story board

Business Trigger Analysis

Information Model (Analysis)

«optional»
Business Rules Description

«optional»
Glossary of Classes and Attributes

Enhance with reference ranges, research citations, etc.

Enhance with clinical guidelines, etc.

The DCM idea provides a set of enhancements to the DAM

B. Enhancement Model Concept

B. Enhancement Model Benefits and Issues

- Benefits
  - Single set of modeling assumptions
  - Single effort: no coordination of requirements, versions. Can meet requirements of developing team.
  - Single model; no potential recursion
- Issues
  - Diverges from ISO working group, HL7 Patient Care assumptions
  - No current plans to be reusable outside of domain
  - No intent to develop automated code generation

C. DCM Candidate Concept
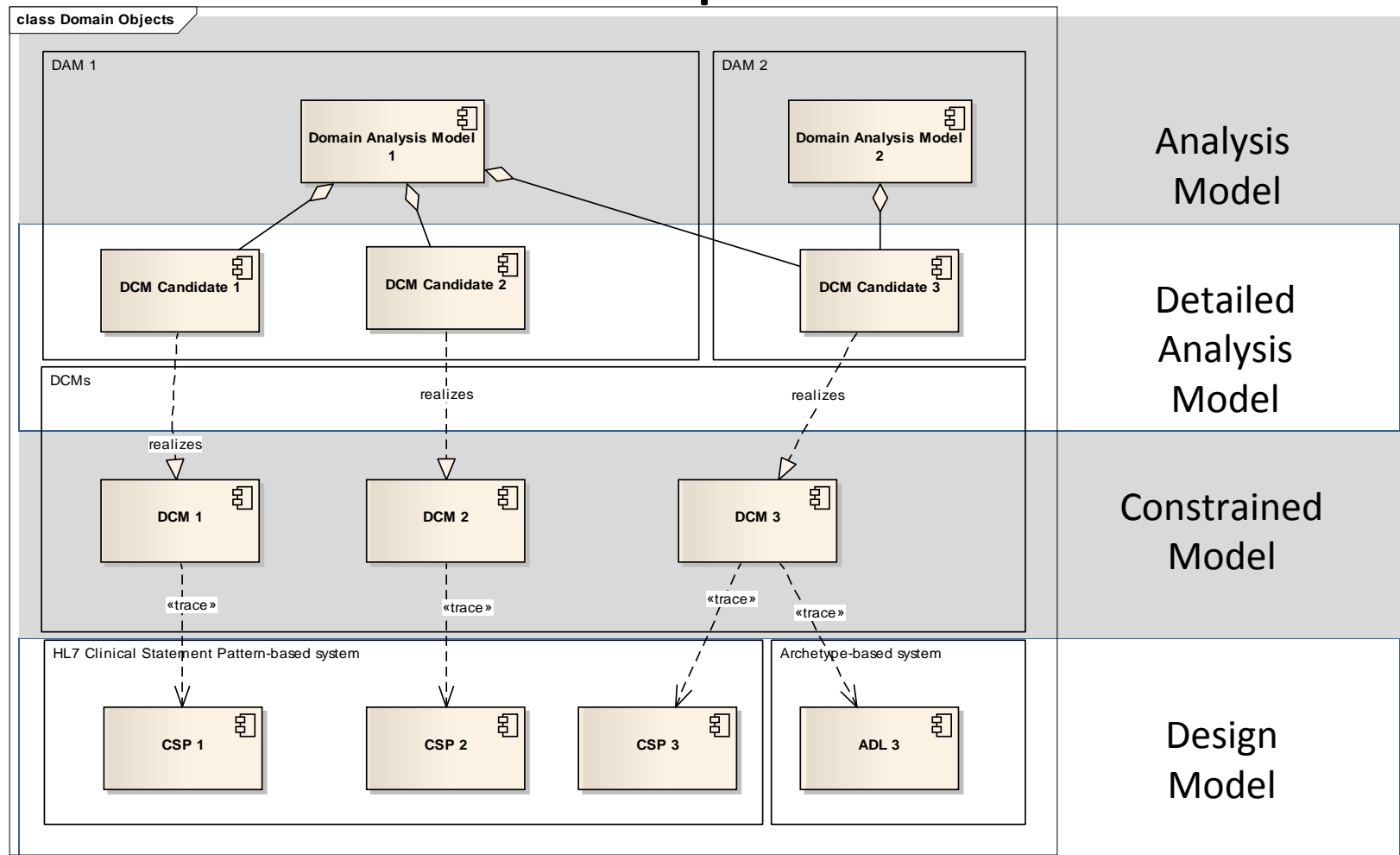
The DAM models the requirements as a candidate DCM;
actual DCM(s) may or may not be derived later

C. DCM Candidate
Benefits and Issues

- Benefits
  - Allows analysis activities to capture requirements without technical constraints
  - DAM modeling assumptions are consistent
  - Supports "downstream" technical efforts
- Issues
  - Does not support "single model" for both analysis and implementation

DECISION CRITERIA

Device DCM Project Decision Criteria

A. Continue to develop DAM with DCMs

    i. If Device project and Patient Care projects can reach agreement that on a DCM meta-model, preferably without design artifacts (or other non-clinical patterning constraints)

    ii. If Patient Care project can collaborate actively with the Device project on DCM boundary definitions and criteria

B. Develop enhanced DAM

    i. If Ai and Aii are not true

C. Develop DAM with candidate DCMs

    i. If Ai is not true but Aii is true