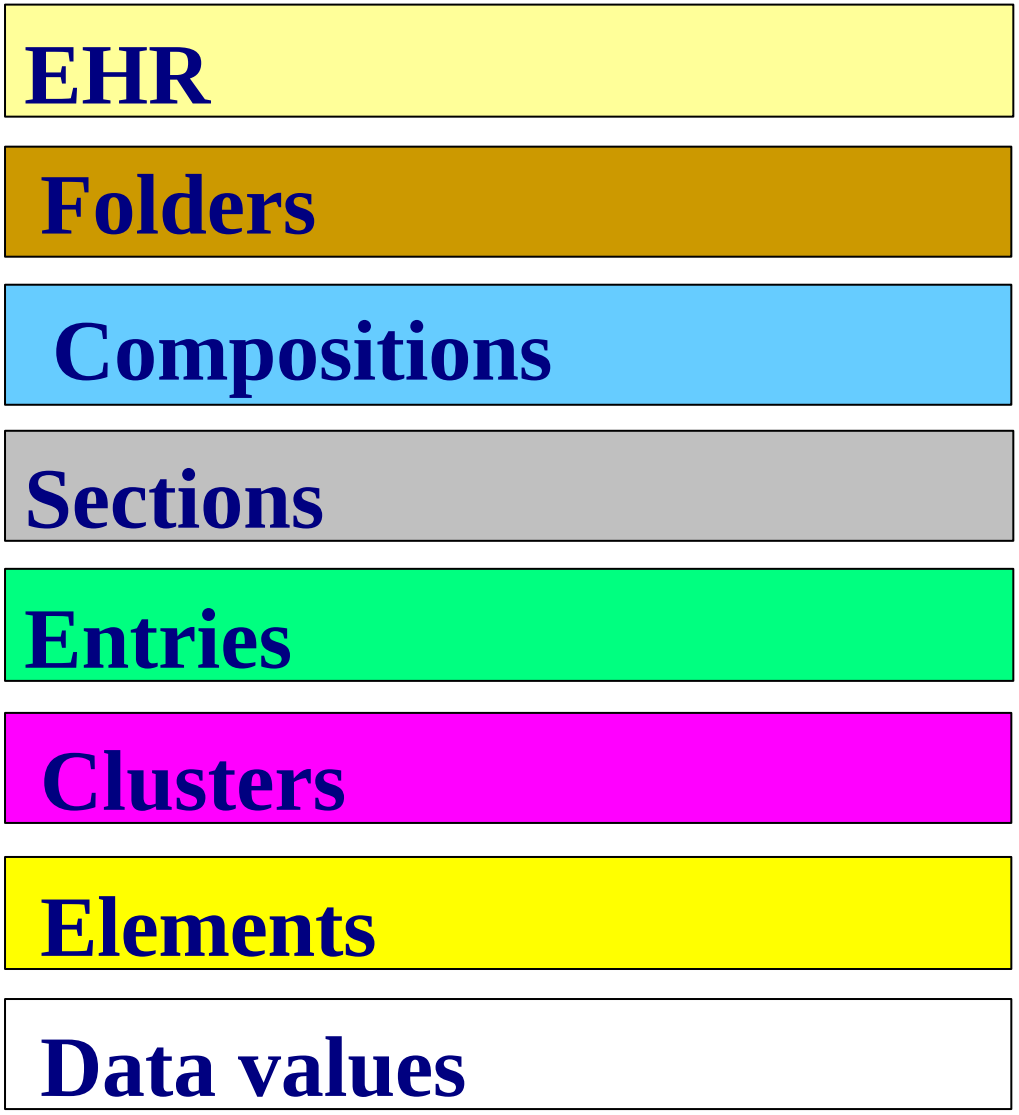
# Health Record Information

- The information in a health record is inherently hierarchical
  - Clinical observations, reasoning and intentions can have a simple or a more complex structure
  - They are generally organised under headings, and contained in “documents” such as consultation notes, letters and reports
  - These documents are usually filed in folders
  - A patient may have more than one folder within a healthcare enterprise (e.g. medical , nursing, obstetric)
- The EHR needs to reflect this hierarchical structure and organisation

# Logical building blocks of the EHR




**The electronic health record for one person**

**High-level organisation of the EHR e.g. per episode, per clinical speciality**

**Set of entries committed at one date/time e.g. progress note, report, letter, test result**

**Clinical headings reflecting the workflow and consultation/reasoning process**

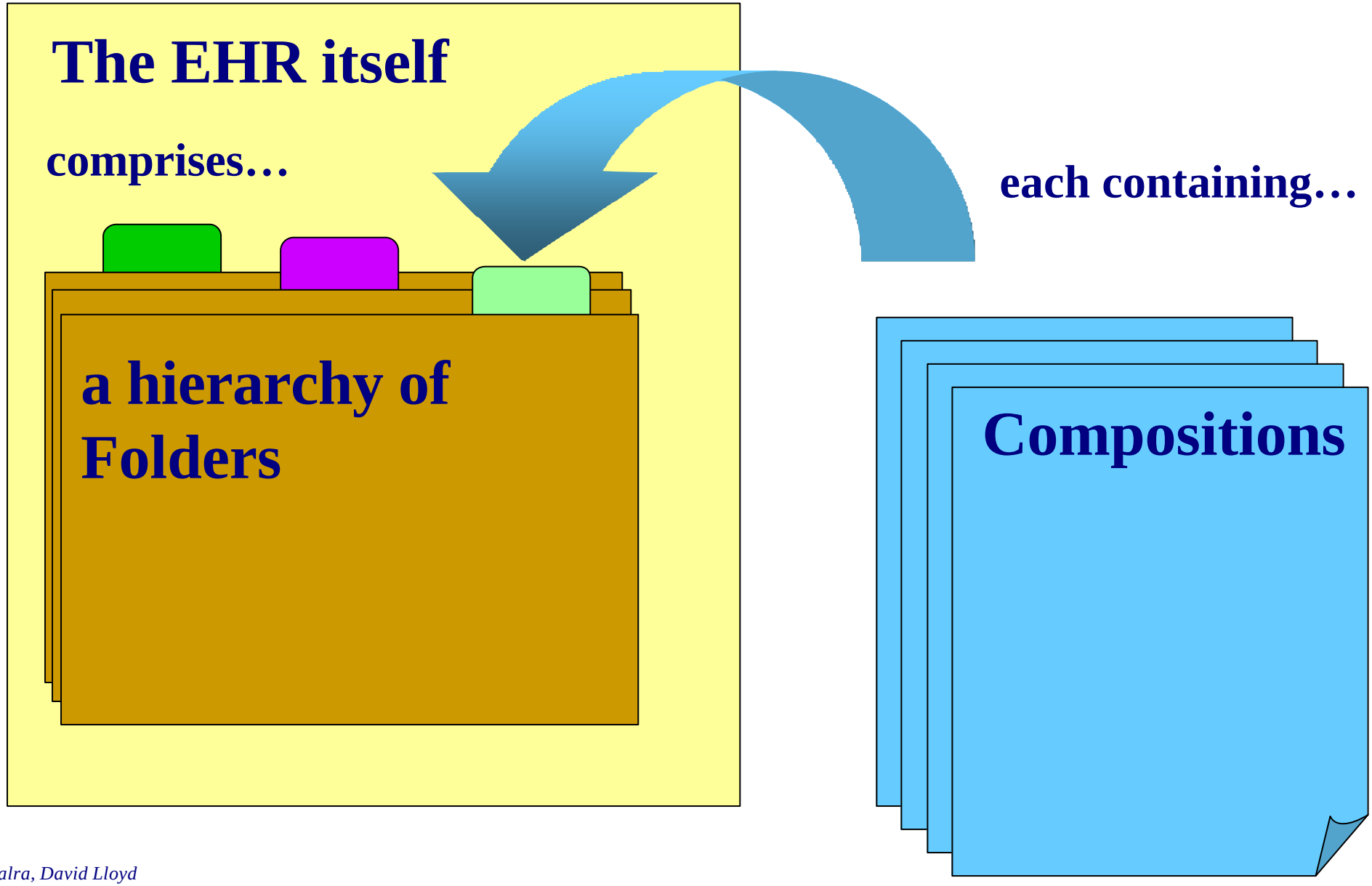
**Clinical "statements" about Observations, Evaluations, and Instructions**

**Compound entries e.g. blood pressure, full blood count**

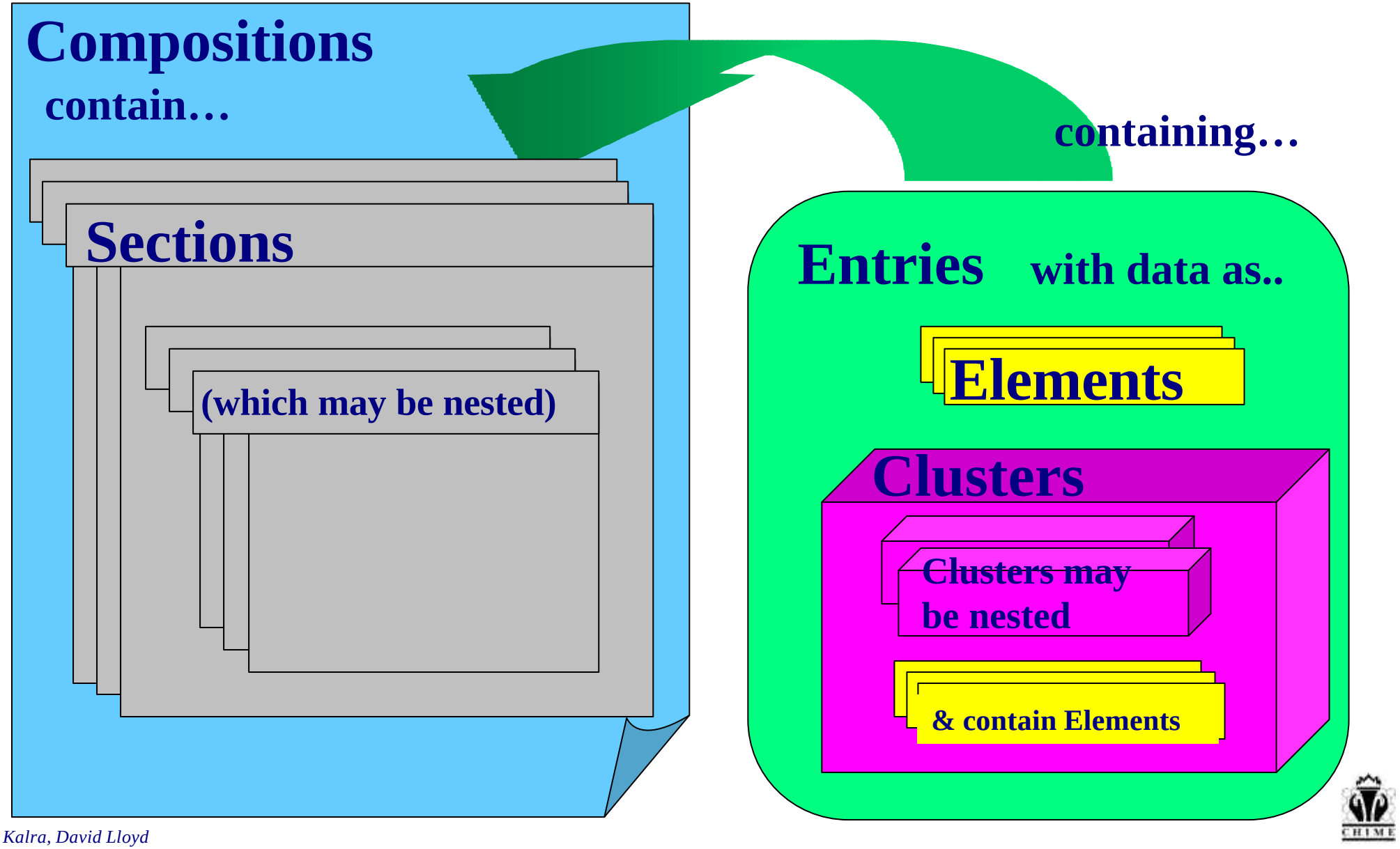
**Element entries e.g. reason for encounter, body weight**

**e.g. Coded terms from term sets, measurements with units**

# Logical building blocks of the EHR



# Logical building blocks of the EHR




*Dipak Kalra, David Lloyd*

# Logical building blocks of the EHR

**Elements**

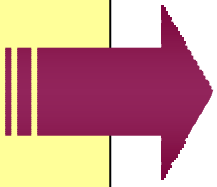
have a single value
of one of a predefined
set of data value types.

# EHR context requirements

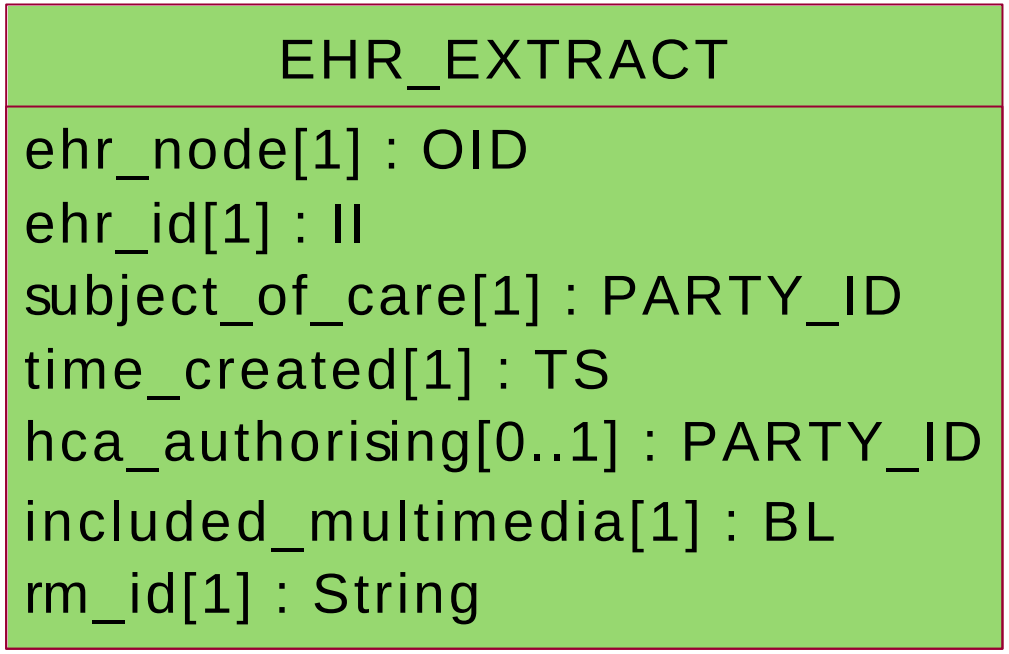
- The EHR Extract reference model needs to meet published requirements to be faithful to the original clinical context and to ensure meaning is preserved when records are communicated
- The following slides show the key EHR contextual requirements, related to the logical building blocks proposed by CEN
- They indicate which attributes are needed at each level in the EHR Extract hierarchy

# EHR context requirements

**The EHR EXTRACT**



- Identity of the subject of care (the patient)
- ID of this electronic record
- ID of the owning organisation (the data controller)
- Who created this Extract and when

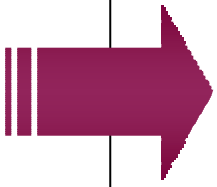



With access to externally-provided Terminologies and Demographic Entities.

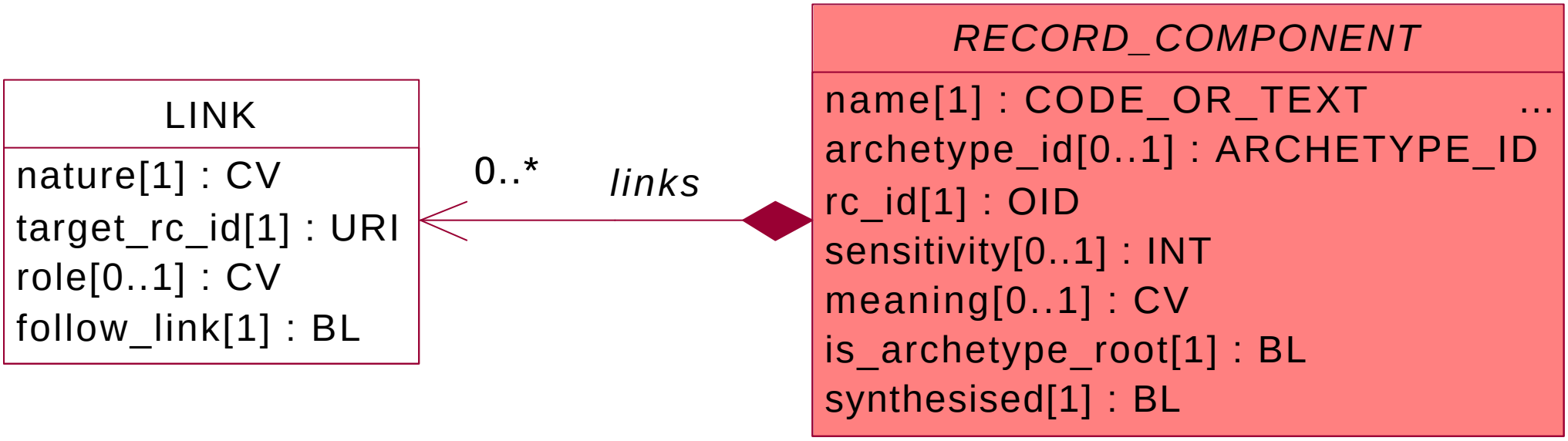
# EHR context requirements

**Any component in the**

**EHR_EXTRACT**

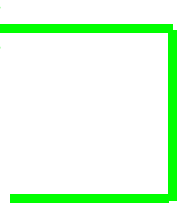


- Component identification
  - UID/OID
- Component clinical meaning
  - Name used by user/application/feeder
  - Archetype ID and normalised name
- Access Control
  - Sensitivity level for any component
  - Support for role-based access
- Support for legacy data
  - Indicator for synthesised
- Support for Revision and Re-use
- Support for Links


LINK
nature[1] : CV
target_rc_id[1] : URI
role[0..1] : CV
follow_link[1] : BL
0..*
links
RECORD_COMPONENT
name[1] : CODE_OR_TEXT ...
archetype_id[0..1] : ARCHETYPE_ID
rc_id[1] : OID
sensitivity[0..1] : INT
meaning[0..1] : CV
is_archetype_root[1] : BL
synthesised[1] : BL

(1 week ago)

C Health check
S Physical exam
S CV Exam
E Blood pressure
E Heart sounds
E Weight Target



(today)

C Diabetic Review
S CV Exam LINK by value
E Blood pressure
E Heart sounds

In an Extract, this would appear as:

(today)

C Diabetic Review
S CV Exam Attributes describing the LINK appear here
E Blood pressure
E Heart sounds
E Weight << logical copy (re-use) of last week's Weight

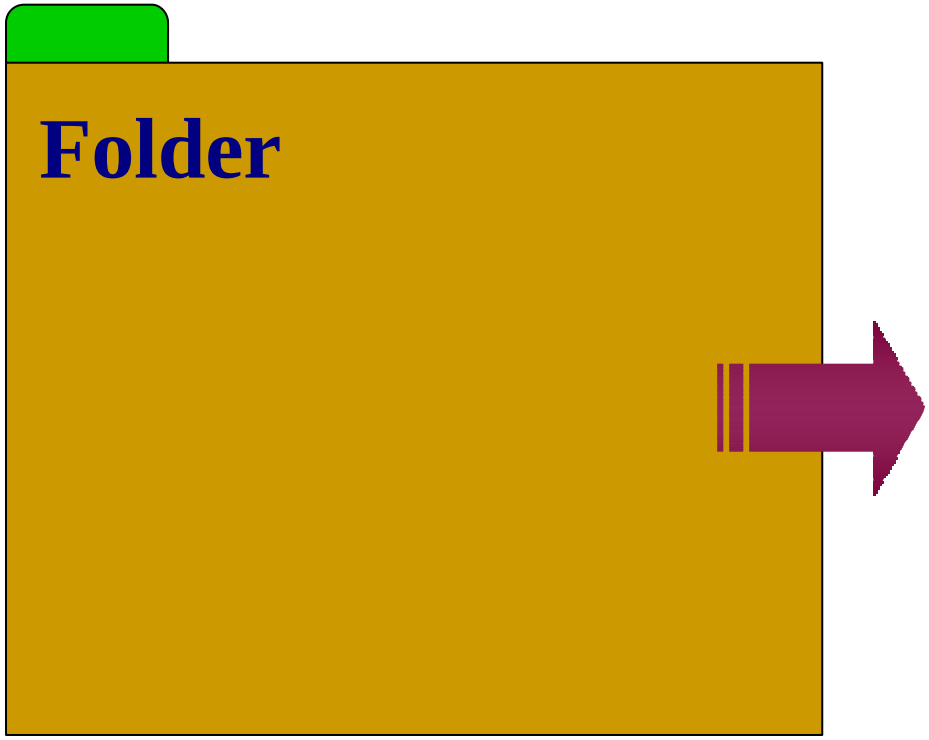
Key:

C Composition
S Section
E Entry
c Cluster
e Element
(indentation implies Containment)

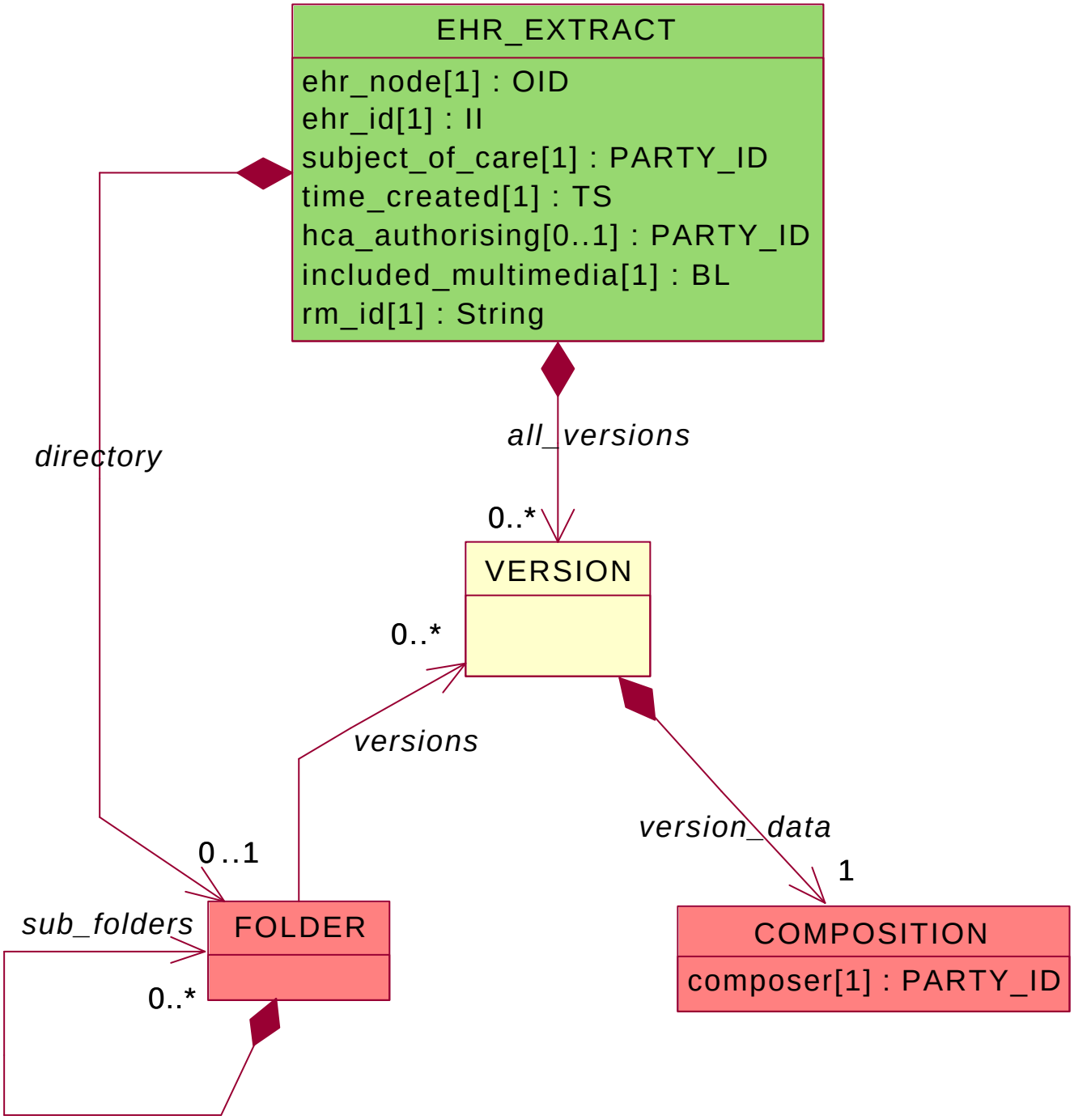
**Archetype CV1 specifies**

| | | | |
|---|---|---|---|
| S | meaning = "CV Exam" | | |
| E | meaning = "Blood Pressure" | data as | Cluster |
| E | meaning = "Heart Sounds" | data as | Cluster |
| E | meaning = "Weight" | data as | Element |

# EHR context requirements




- The high-level organisation of Compositions within an EHR Extract
- An optional hierarchy
  - Folders may contain other Folders
- Permitting many to many containment by reference
  - i.e. each Composition contained once by value, and optionally by reference in other Folders


EHR_EXTRACT
ehr_node[1] : OID
ehr_id[1] : II
subject_of_care[1] : PARTY_ID
time_created[1] : TS
hca_authorising[0..1] : PARTY_ID
included_multimedia[1] : BL
rm_id[1] : String
directory
all_versions
0..*
VERSION
0..*
versions
version_data
1
0..1
sub_folders
FOLDER
0..*
COMPOSITION
composer[1] : PARTY_ID

terminology

demographics

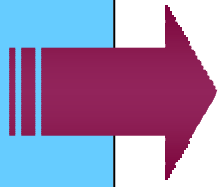
Extract

folder system

versioned data

# EHR context requirements

**Composition**



- Medico-legal unit of committal in the EHR
  - When committed, where, by whom
- The unit of revision in an EHR extract
- Each version states
  - revision status
    - original, correction, for attestation, etc.
  - why revised
  - ID of preceding version

| | | | ac_id | preceding_ac | original_parent_ac | |
|---|---|---|---|---|---|---|
| C | Health Check-up | | 01 | | 00 | <<Original |
| | time_committed | 2002-01-01 | | | | |
| | committer | Dr Jones | | | | |
| S | Physical Exam | | 02 | | 01 | |
| E | Height | | 03 | | 02 | |
| E | Weight | | 10 | | 02 | |
| E | Blood Pressure | | 20 | | 02 | |
| e | Systolic BP | 120 | 21 | | 20 | |
| e | Diastolic BP | 80 | 22 | | 20 | |

# Figure 1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| C | Health Check-up | | | 51 | 01 | 00 | <<First Revision (changed Diastolic BP) |
| | time_committed | 2002-01-03 | | | | | |
| | committer | Dr Jones | | | | | |
| | prev_time_committed | 2002-01-01 | | | | | |
| | prev_committer | Dr Jones | | | | | |
| S | Physical Exam | | | 02 | | 01 | |
| E | Height | | | 03 | | 02 | |
| E | Weight | | | 10 | | 02 | |
| E | Blood Pressure | | | 20 | | 02 | |
| e | Systolic BP | | 120 | 21 | | 20 | |
| e | Diastolic BP | | 90 | 52 | 22 | 20 | |

# Figure 2

| | | | | | | |
|---|---|---|---|---|---|---|
| C | Health Check-up | | 71 | 51 | 00 | << Second Revision (changed Weight) |
| | time_committed | 2002-12-25 | | | | |
| | committer | Dr Smith | | | | |
| | prev_time_committed | 2002-01-03 | | | | |
| | prev_committer | Dr Jones | | | | |
| S | Physical Exam | | 02 | | 01 | |
| E | Height | | 03 | | 02 | |
| E | Weight | | 72 | 10 | 02 | |
| E | Blood Pressure | | 20 | | 02 | |
| e | Systolic BP | 120 | 21 | | 20 | |
| e | Diastolic BP | 90 | 52 | 22 | 20 | |

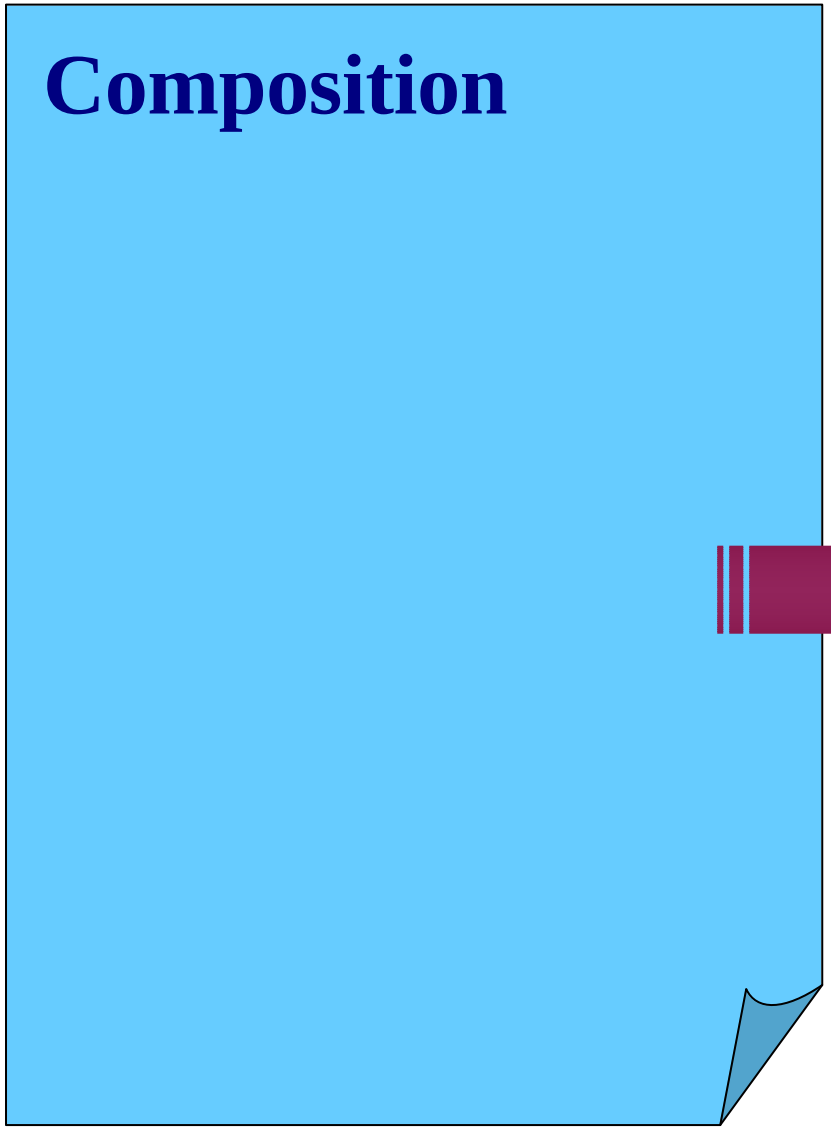
# Figure 3

| | | | | | |
|---|---|---|---|---|---|
| C | Medical Report | | 100 | 51 | 00 |
| | time_committed | 2002-12-31 | | | |
| | committer | Dr Brown | | LINK by Value to AC_ID 72 | |
| S | CV Exam | | 101 | | 100 |
| E | Heart Sounds | | 102 | | 101 |
| E | Weight | | 72 | 10 | 02 |

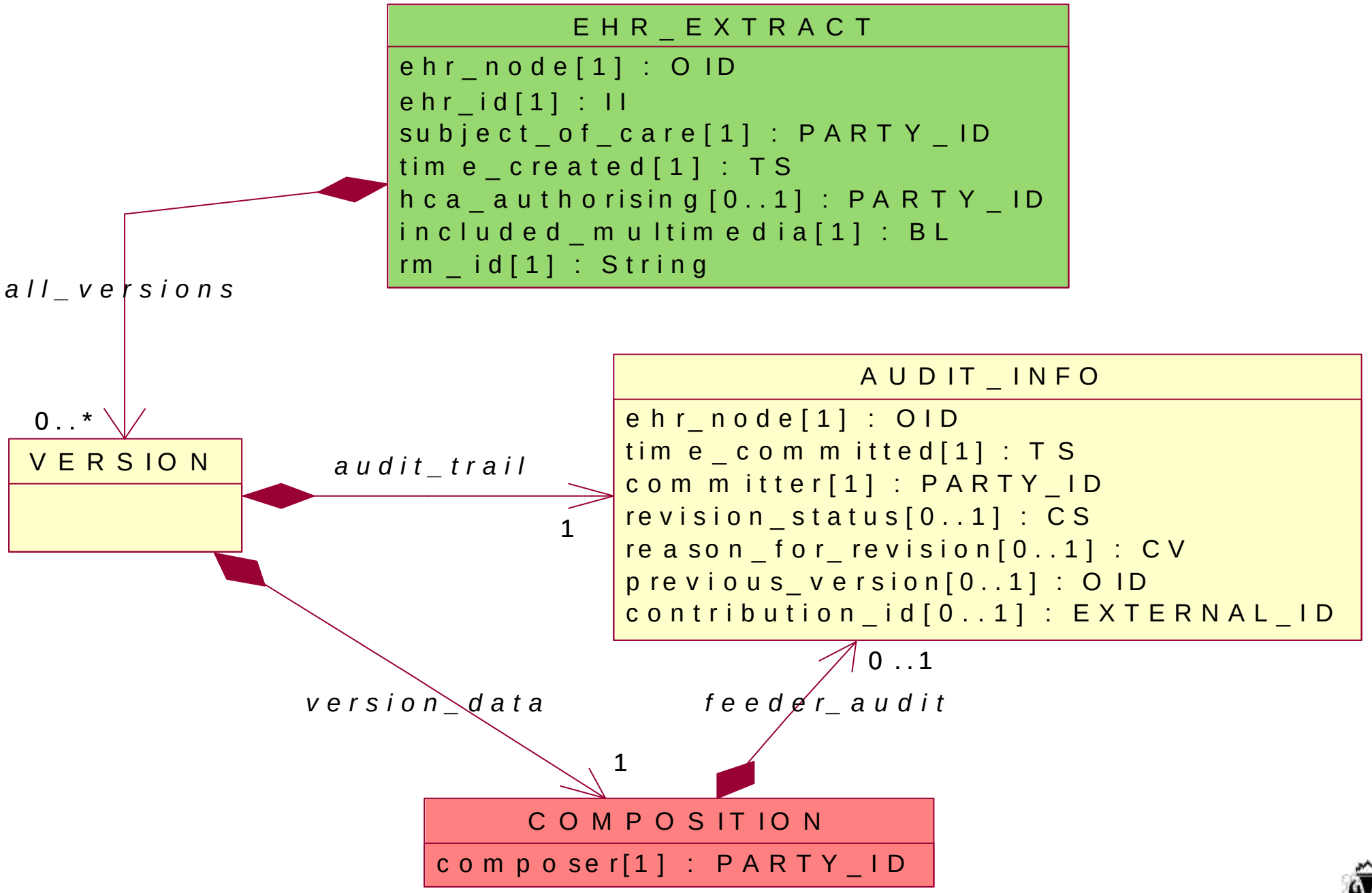
<< note the re-use of a revised component

# Figure 4

# EHR context requirements

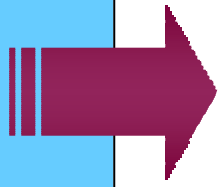



- If acquired from another clinical or EHR system
  - the original version's committal information
  - identity of the originating EHR system
  - details about its acceptance into the receiving record system
    - when, by whom etc.

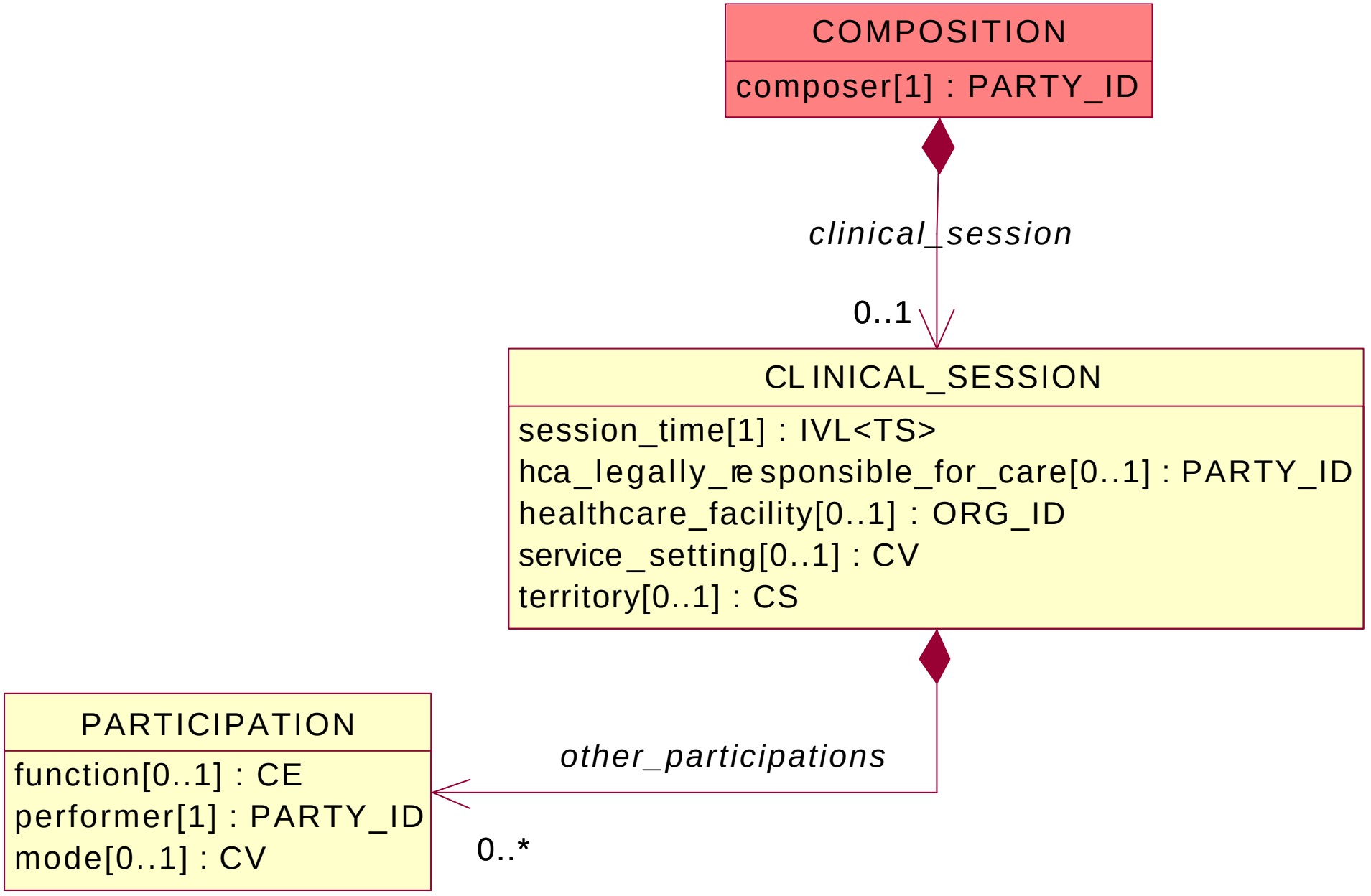

EHR_EXTRACT
ehr_node[1] : OID
ehr_id[1] : II
subject_of_care[1] : PARTY_ID
time_created[1] : TS
hca_authorising[0..1] : PARTY_ID
included_multimedia[1] : BL
rm_id[1] : String
all_versions
0..*
VERSION
audit_trail
1
AUDIT_INFO
ehr_node[1] : OID
time_committed[1] : TS
committer[1] : PARTY_ID
revision_status[0..1] : CS
reason_for_revision[0..1] : CV
previous_version[0..1] : OID
contribution_id[0..1] : EXTERNAL_ID
0..1
version_data
feeder_audit
1
COMPOSITION
composer[1] : PARTY_ID

# EHR context requirements

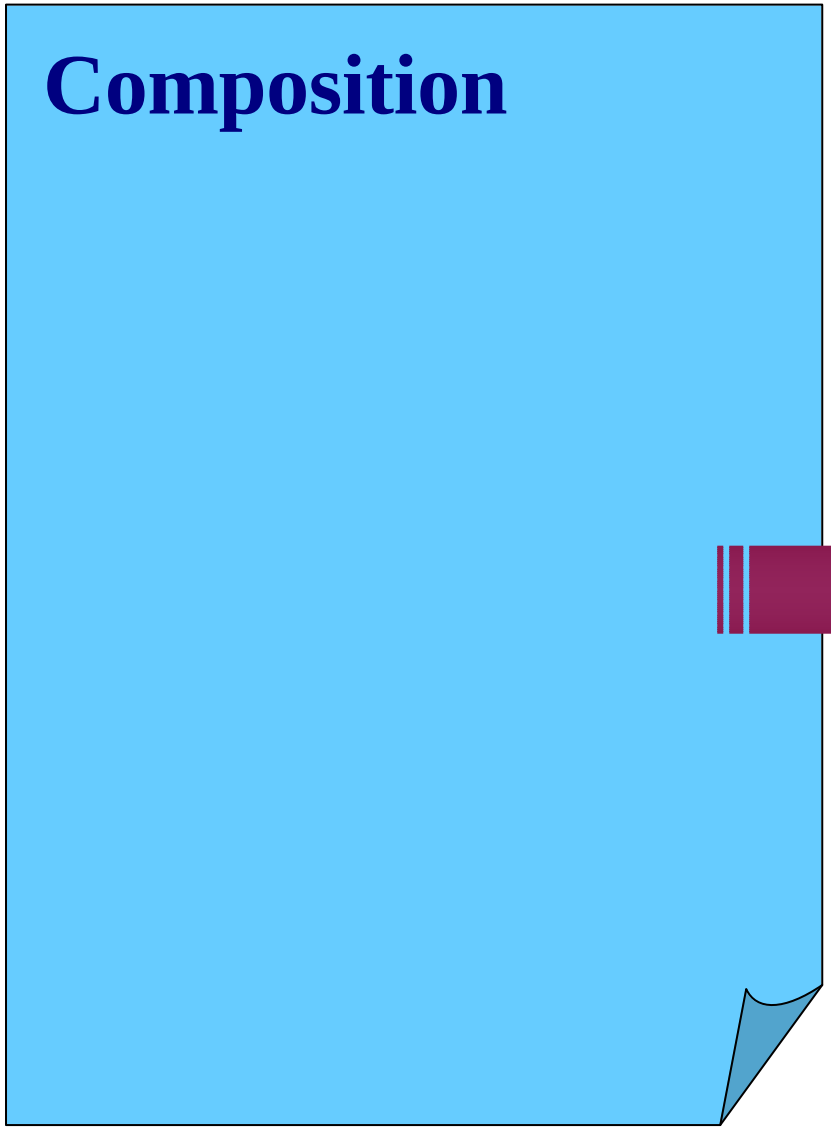
**Composition**



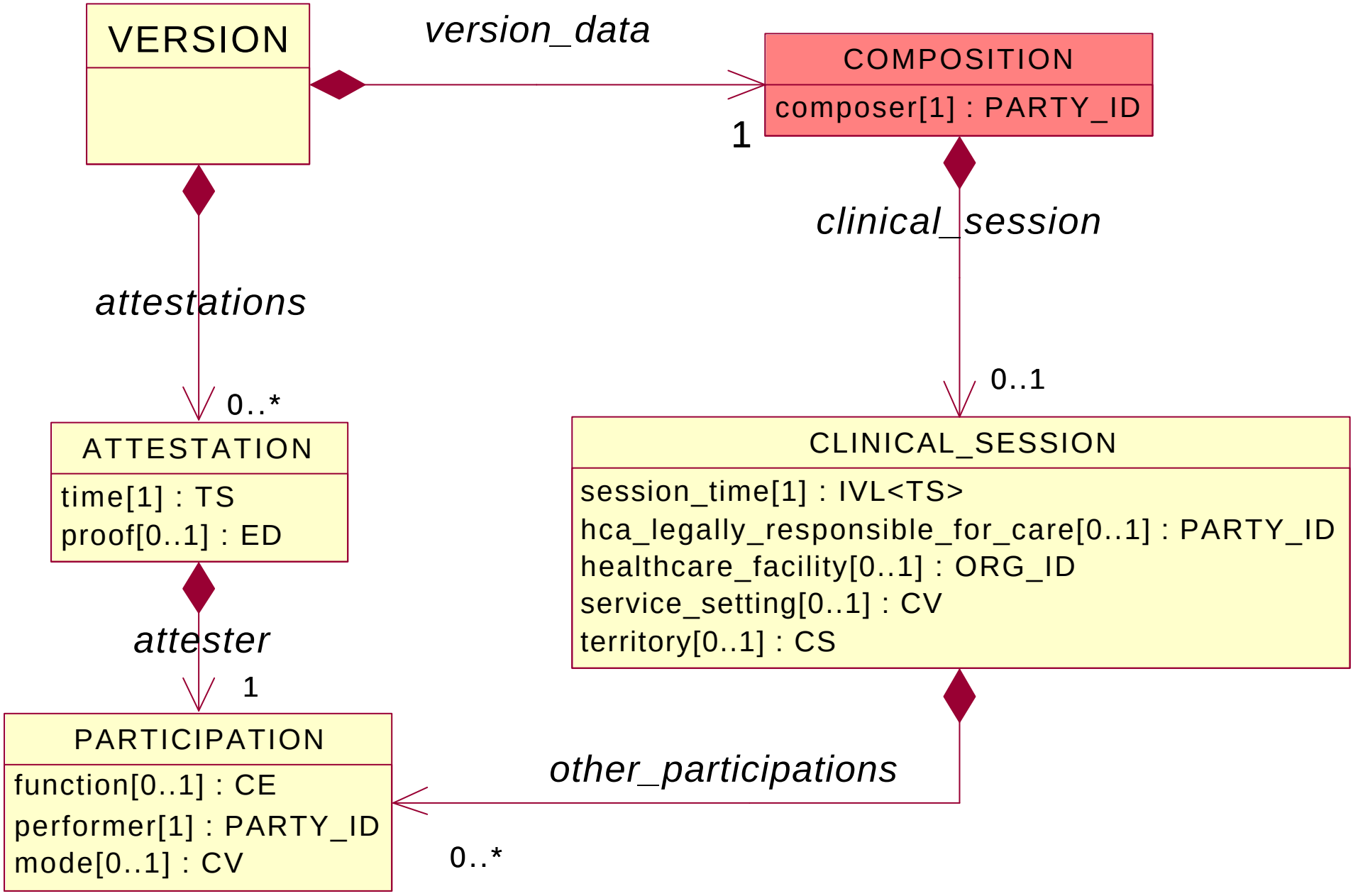
- Clinical session context
  - When and when the care activity took place
  - Which care facility, as part of what service and at which location
  - Which clinician was in charge of the care


COMPOSITION
composer[1] : PARTY_ID
clinical_session
0..1
CLINICAL_SESSION
session_time[1] : IVL<TS>
hca_legally_responsible_for_care[0..1] : PARTY_ID
healthcare_facility[0..1] : ORG_ID
service_setting[0..1] : CV
territory[0..1] : CS
other_participations
0..*
PARTICIPATION
function[0..1] : CE
performer[1] : PARTY_ID
mode[0..1] : CV

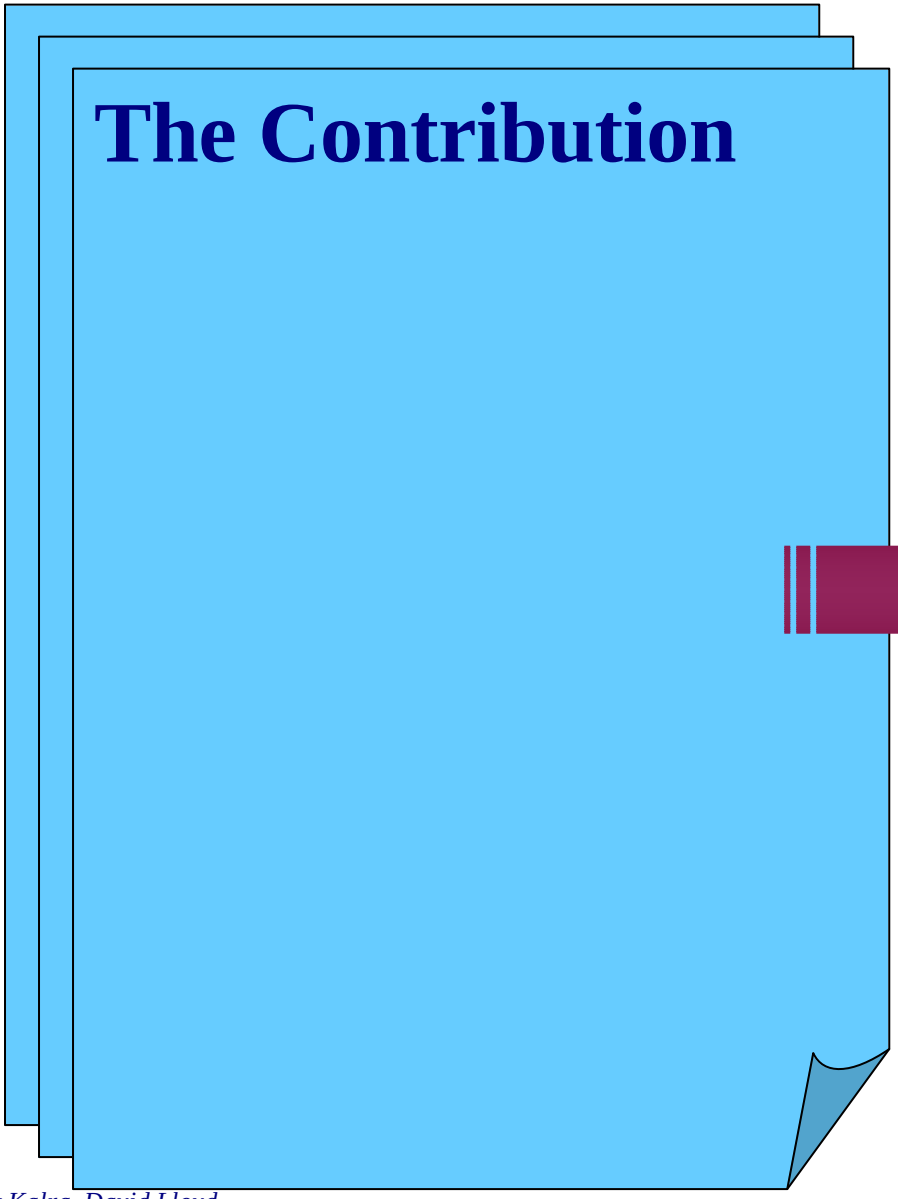
# EHR context requirements



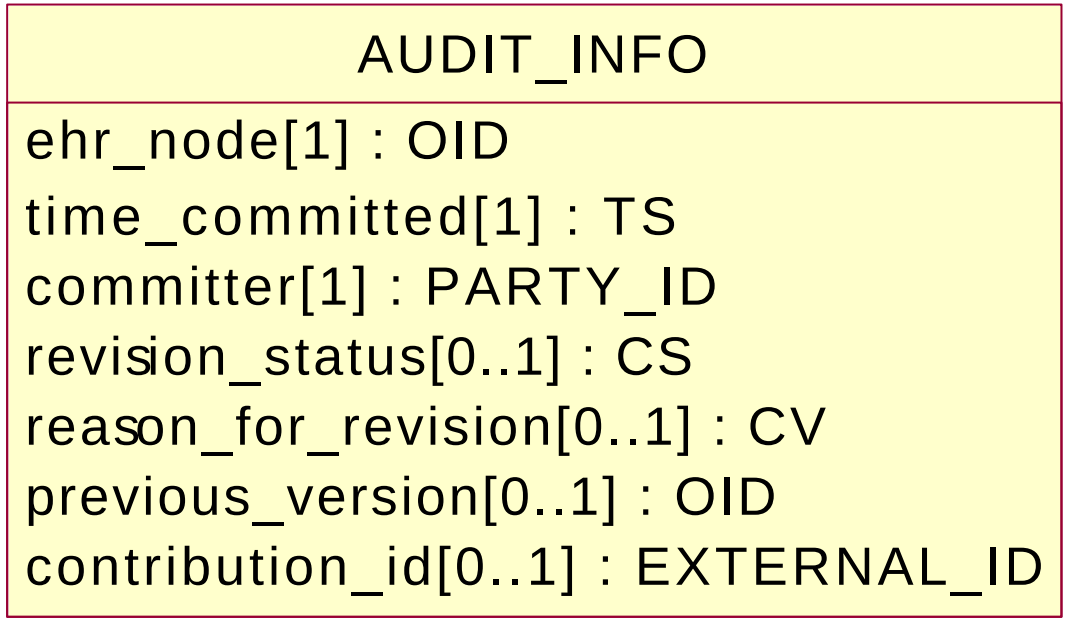

- Attesting the Composition
  - attested by whom, and when
  - optionally include or reference the "signed proof" of attestation
  - optional additional co-attesters
    - e.g. for legal documents
  - attestation status may be required, or not required for some Compositions


VERSION
version_data
COMPOSITION
composer[1] : PARTY_ID
1
clinical_session
attestations
0..*
0..1
ATTESTATION
time[1] : TS
proof[0..1] : ED
CLINICAL_SESSION
session_time[1] : IVL<TS>
hca_legally_responsible_for_care[0..1] : PARTY_ID
healthcare_facility[0..1] : ORG_ID
service_setting[0..1] : CV
territory[0..1] : CS
attester
1
PARTICIPATION
function[0..1] : CE
performer[1] : PARTY_ID
mode[0..1] : CV
other_participations
0..*

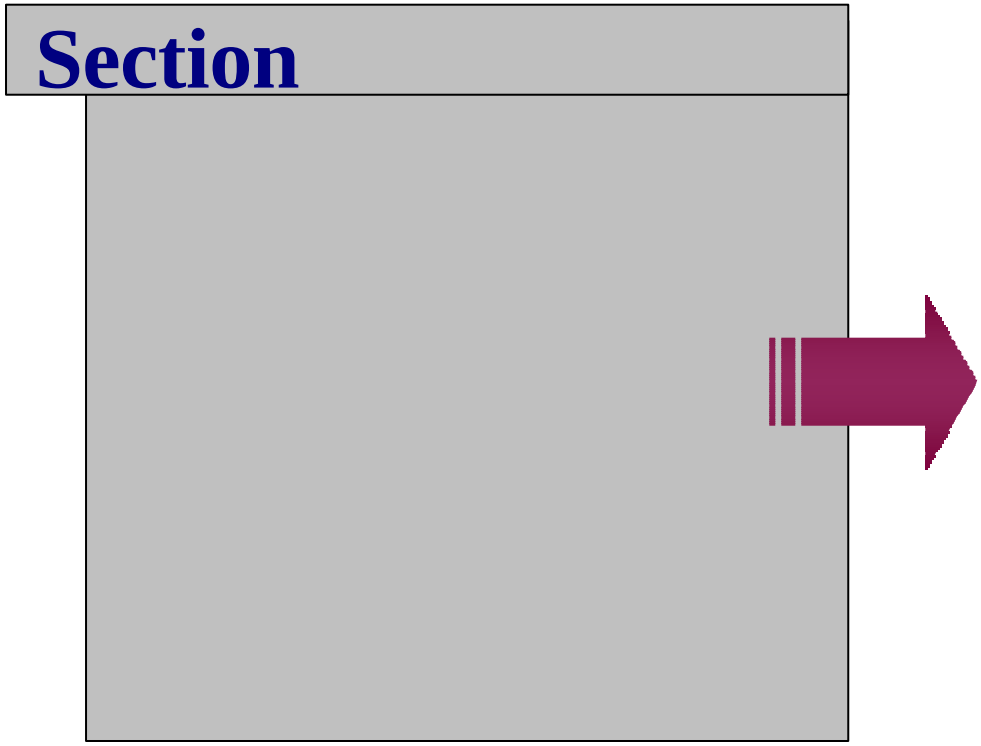
# EHR context requirements



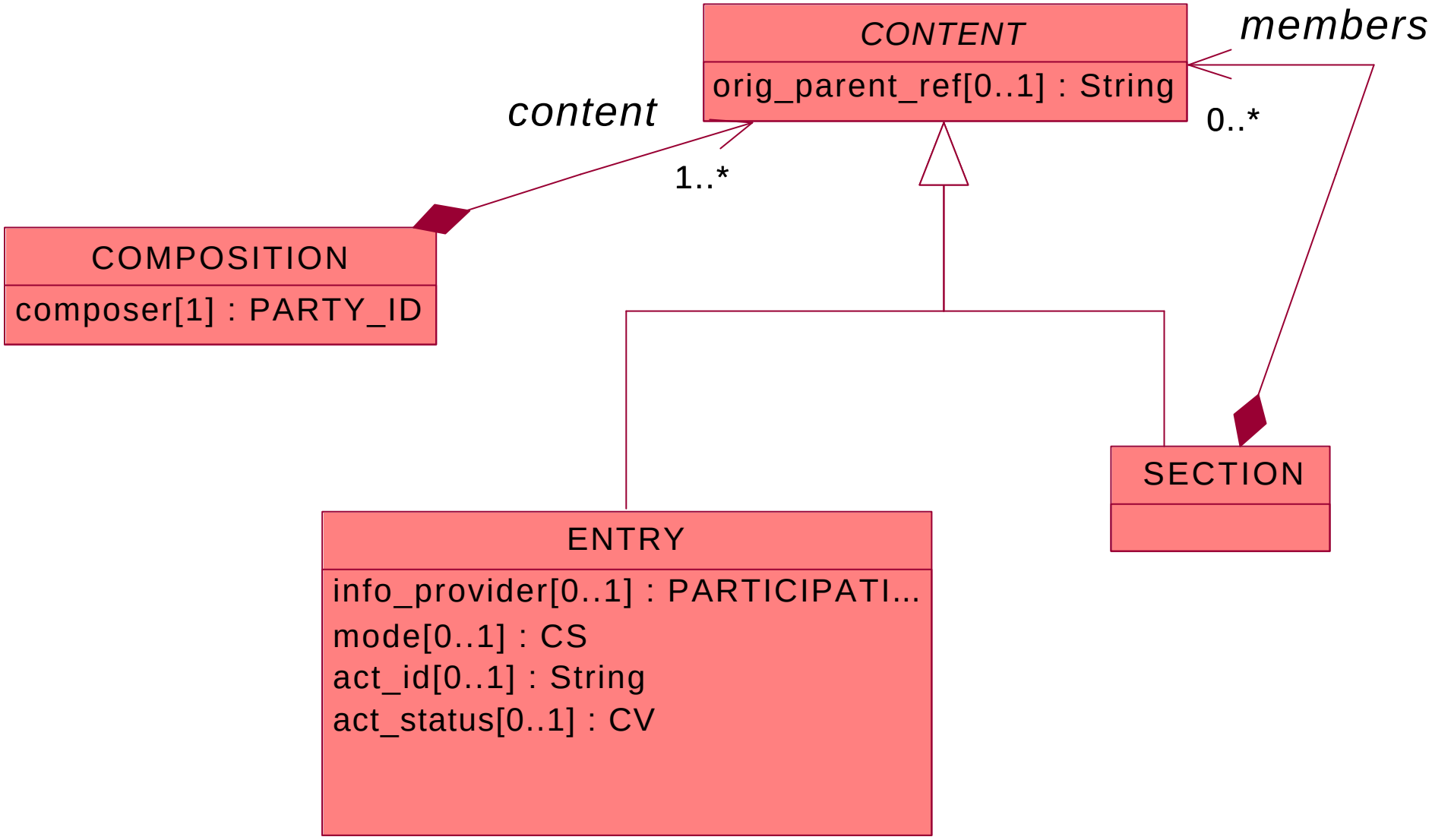

- All of the Compositions created or amended at one record interaction session
- References all changes and updates made in that EHR during that session
  - e.g. addition of a new consultation
  - and update to a repeat medication list elsewhere in the EHR


AUDIT_INFO
ehr_node[1] : OID
time_committed[1] : TS
committer[1] : PARTY_ID
revision_status[0..1] : CS
reason_for_revision[0..1] : CV
previous_version[0..1] : OID
contribution_id[0..1] : EXTERNAL_ID

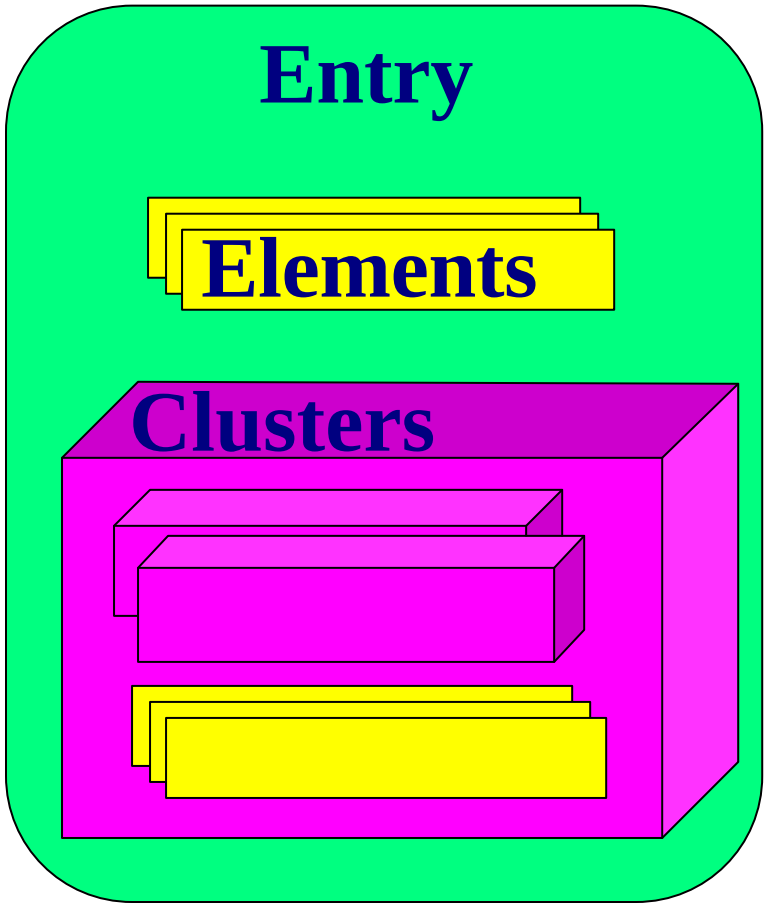
# EHR context requirements




- Optional hierarchy
- Informal containment for human navigation, filtering and readability
- Corresponding to the clinical understanding of headings

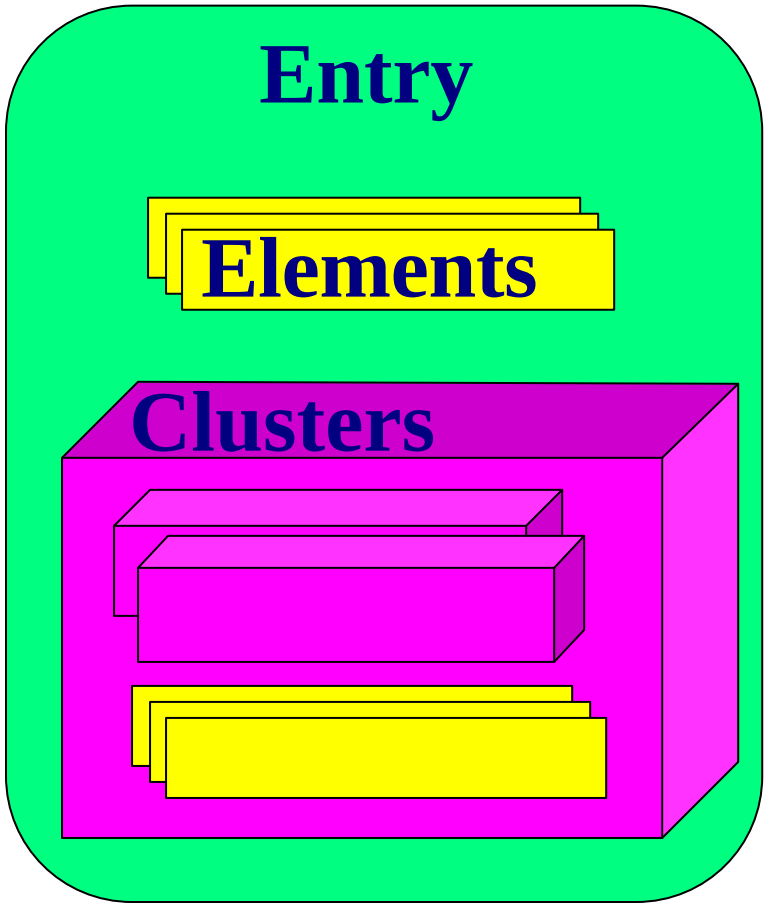

CONTENT
orig_parent_ref[0..1] : String
members
content
0..*
1..*
COMPOSITION
composer[1] : PARTY_ID
SECTION
ENTRY
info_provider[0..1] : PARTICIPATI...
mode[0..1] : CS
act_id[0..1] : String
act_status[0..1] : CV

# EHR context requirements



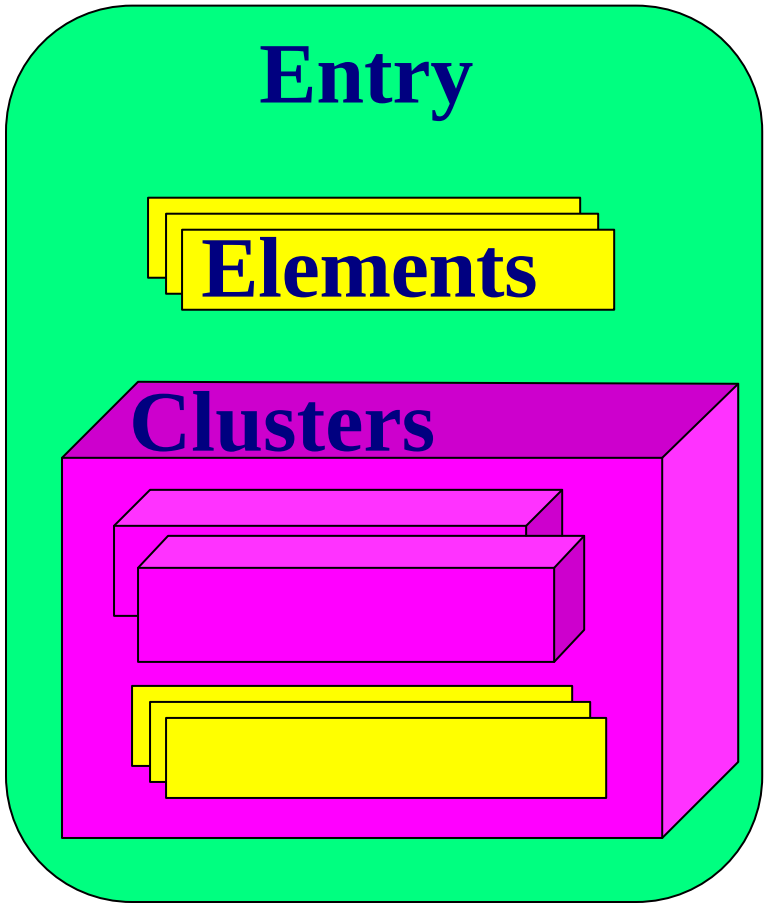

- Corresponds to a single clinical "statement"
- Required to represent the structure of clinical observations, inferences and intended actions
- May contain a simple Element or a more complex Cluster value-set
  - e.g. for device-generated readings

# EHR context requirements

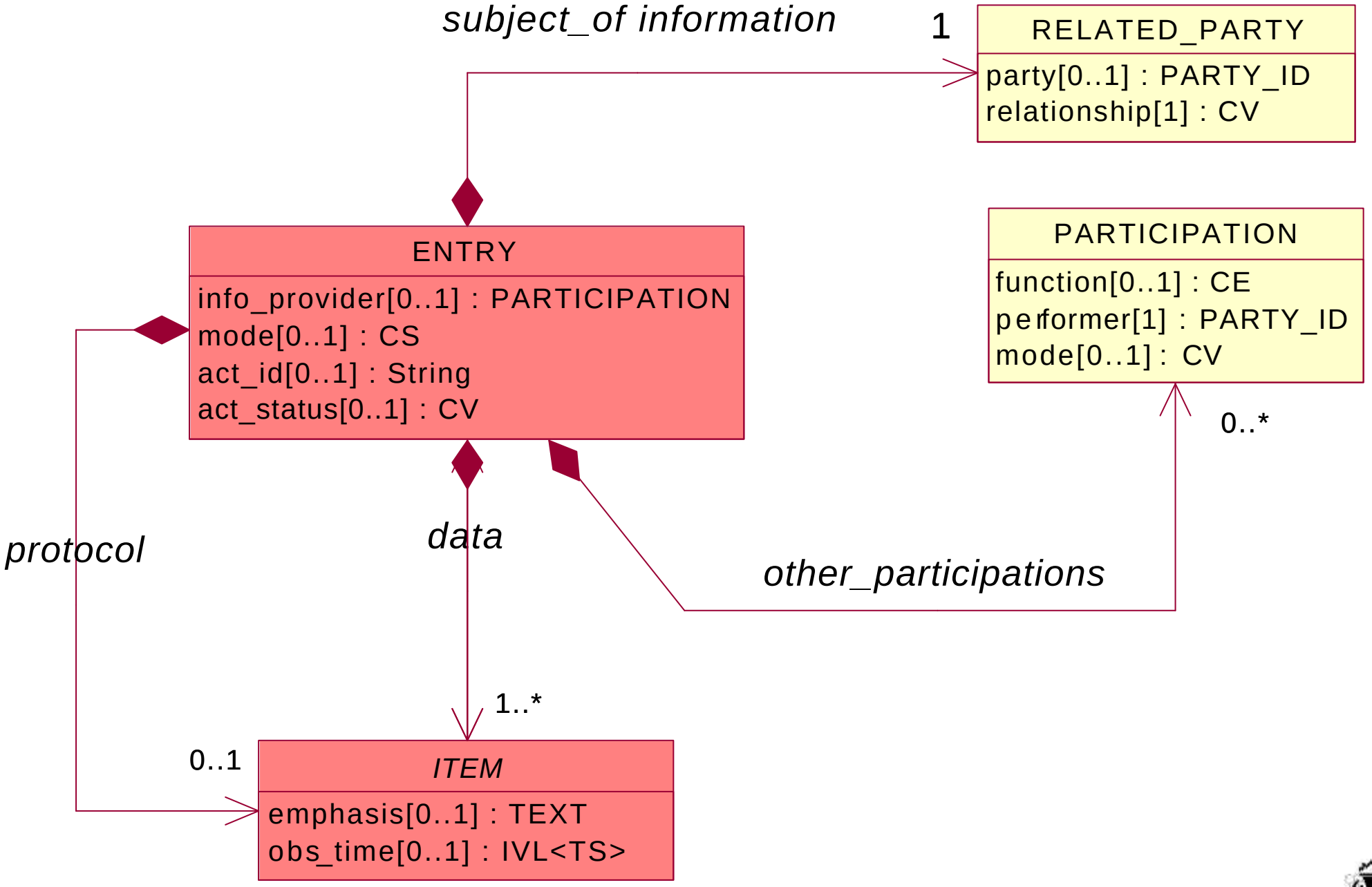



- Information in an entry may be about someone other than the patient (e.g. relative)
- Information in an entry may have been provided by someone else

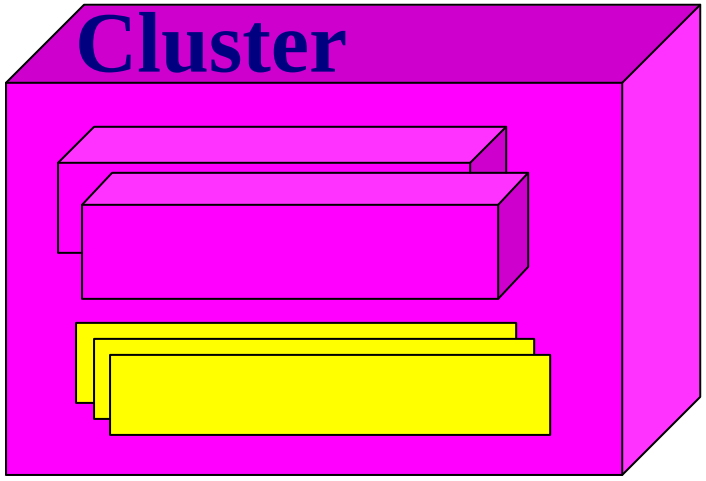
# EHR context requirements




- Representing the clinical reasoning process
  - if an observation or conclusion is uncertain
  - if an observation or conclusion is unusual, abnormal or unexpected
  - if an observation or conclusion is not the actual state of the patient
    - e.g. at risk of, goal, prognosis, negated, excluded
  - Act/process status
    - e.g. requested, performed, reported, cancelled
  - explanation of reasoning/actions
  - guideline reference
  - reference to published knowledge


subject_of information
1
RELATED_PARTY
party[0..1] : PARTY_ID
relationship[1] : CV
ENTRY
info_provider[0..1] : PARTICIPATION
mode[0..1] : CS
act_id[0..1] : String
act_status[0..1] : CV
PARTICIPATION
function[0..1] : CE
performer[1] : PARTY_ID
mode[0..1] : CV
0..*
protocol
data
other_participations
1..*
0..1
ITEM
emphasis[0..1] : TEXT
obs_time[0..1] : IVL<TS>

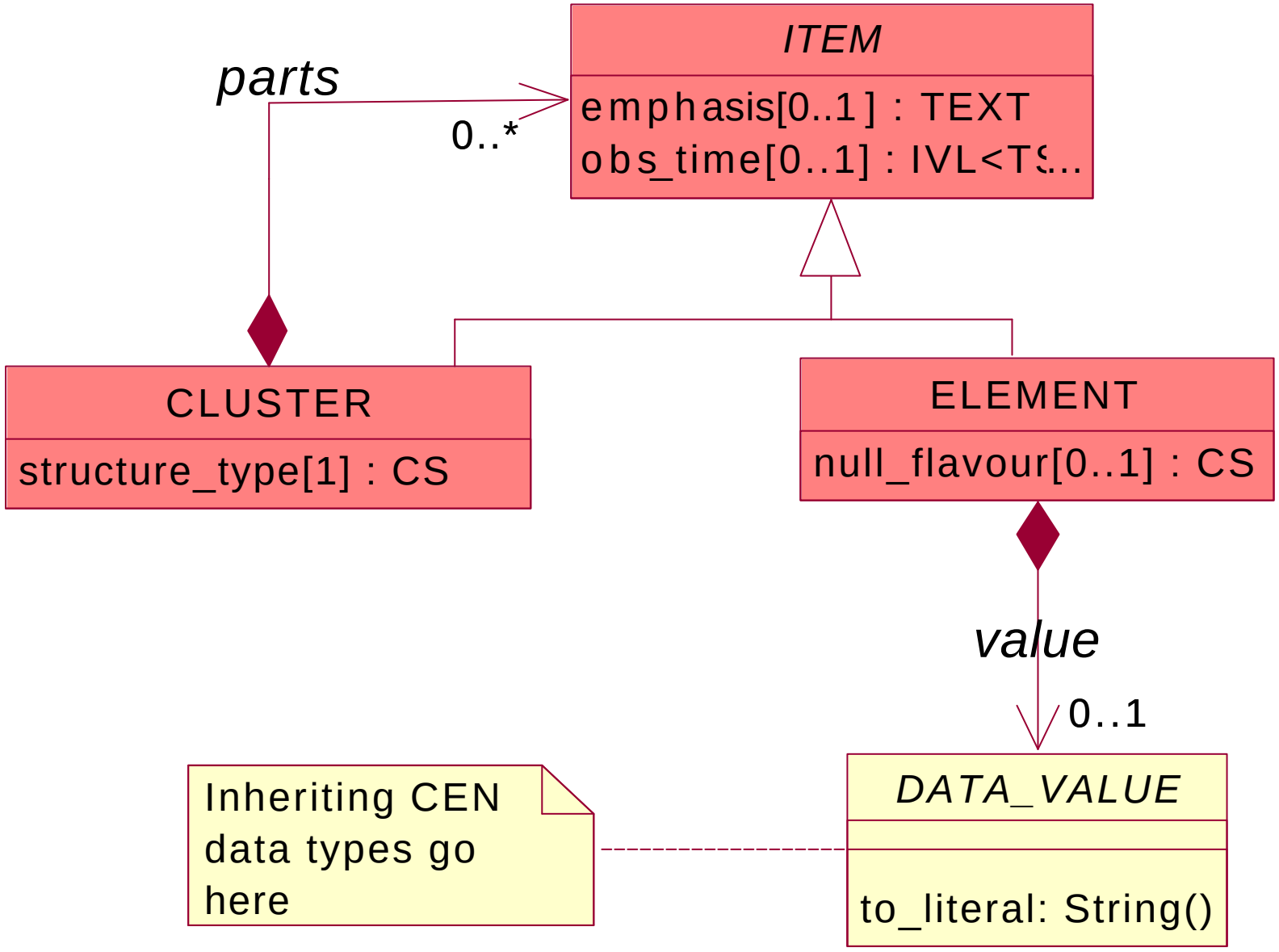
# Structured data




- Complex entries may, for example, be measurements, test results or treatment instructions
- These may need to be represented as a list, table, a tree or a time series
- Time series might be absolute times or relative to an origin
  - the data at each time point might themselves be complex
- Some time series might have regular intervals, or be intermittent 'bursts"

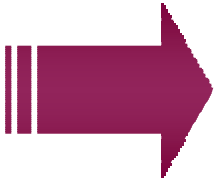
# Representing Structure

- In this model, Lists, Tables, Trees are represented by specific configurations of the Cluster Class. Normative Archetypes will be developed to provide the necessary constraints to ensure interoperability.


ITEM
emphasis[0..1] : TEXT
obs_time[0..1] : IVL<TS...
parts
0..*
CLUSTER
structure_type[1] : CS
ELEMENT
null_flavour[0..1] : CS
value
0..1
DATA_VALUE
to_literal: String()
Inheriting CEN data types go here

# Element

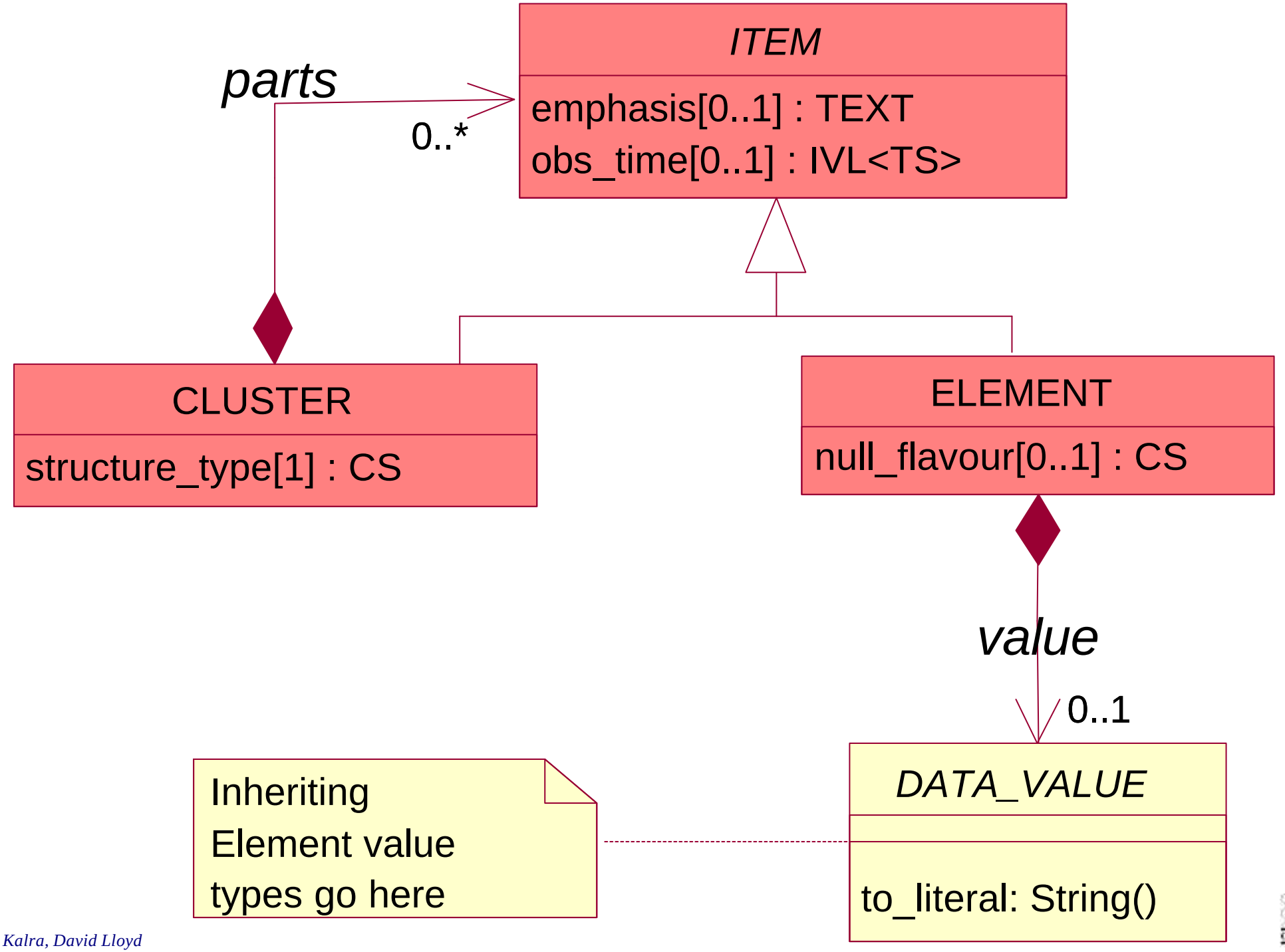
**Element**



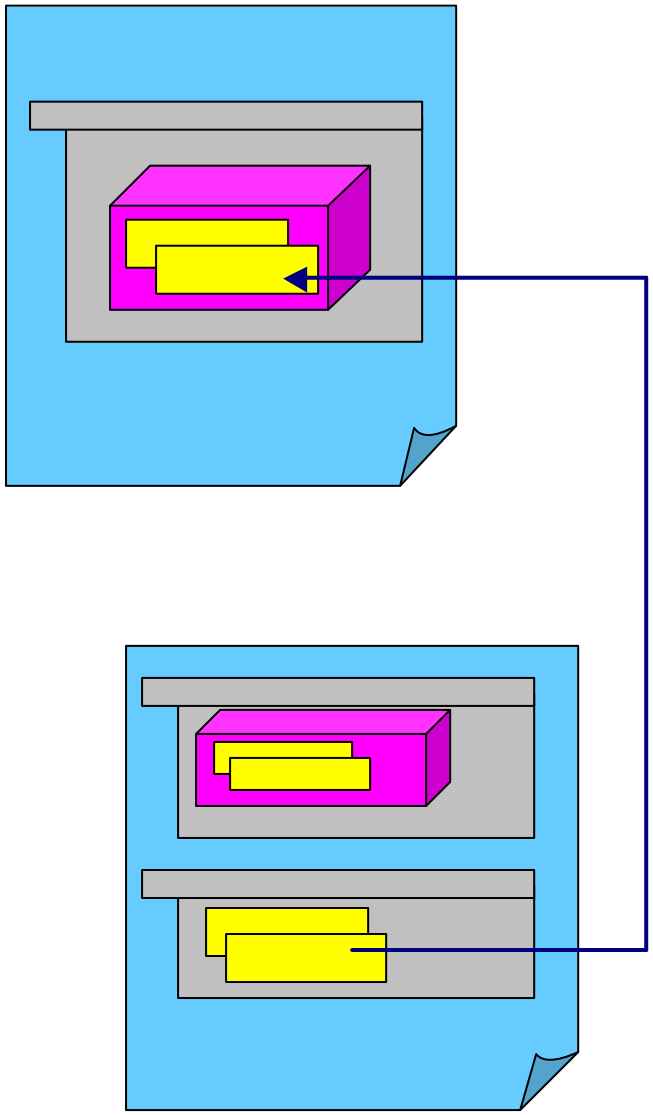
- Information in an Entry may have originated at a date/time different from the care activity or its recording
- An Element may have a data value that has been derived from other components
  - e.g. body mass index
- An Element may have a null data value
  - for example if a value is not known

# Representing Time Series

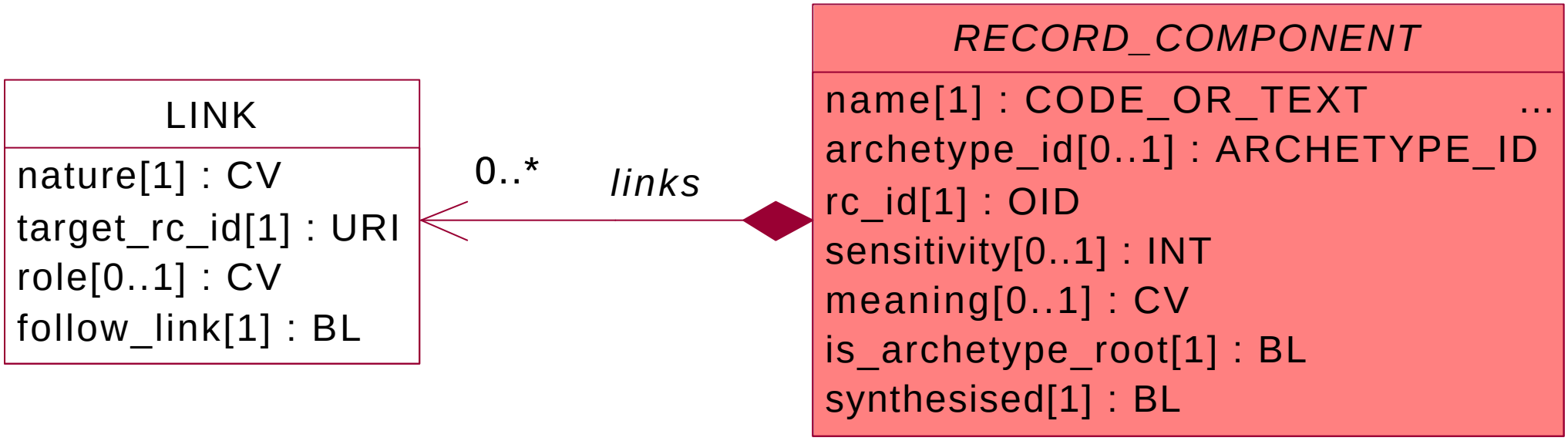
- In principle, any time-related sequence of simple or complex data can be represented by the Cluster, with suitable Elements to represent the time points and data value parts.
- In this model, it is recognised that time-series of simple values will be a common occurrence, so the attribute **obs_time** has been provided. Without this attribute, even a simple time series would require a Cluster of Clusters.
- The attribute **obs_time** also provides a way to meet the requirement for the separate recording of the originating date time of the data.


ITEM
emphasis[0..1] : TEXT
obs_time[0..1] : IVL<TS>
parts
0..*
CLUSTER
structure_type[1] : CS
ELEMENT
null_flavour[0..1] : CS
value
0..1
DATA_VALUE
to_literal: String()
Inheriting
Element value
types go here

# Links between components



- Links may be required between any two record components
  - e.g. to indicate cause and effect
  - e.g. to track the evolution of orders from request to completion
- These might need to form linkage networks
  - e.g. for clinical problems
  - e.g. for clinical or service episodes


LINK
nature[1] : CV
target_rc_id[1] : URI
role[0..1] : CV
follow_link[1] : BL
0..*
links
RECORD_COMPONENT
name[1] : CODE_OR_TEXT
...
archetype_id[0..1] : ARCHETYPE_ID
rc_id[1] : OID
sensitivity[0..1] : INT
meaning[0..1] : CV
is_archetype_root[1] : BL
synthesised[1] : BL

# Linkage nets

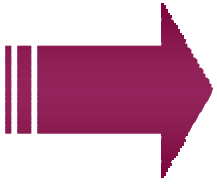
- Networks of links, for example to implement a problem-oriented view of the record, are expected to use an Element to represent the “hub” of the network, with suitable naming and value e.g. **name** = “Problem” and **value** = “dizzy spell”.
- All other components (including future components) that are considered to be related to this problem will have their LINK class instantiated with the **target_ac_id** attribute pointing to the “hub” element, the **nature** attribute set to “problem”, and the **target_role** attribute set e.g.  to “cause” or “contributing factor”.

# Data types


- The Element is the leaf node containing a single data value, which may be
  - text
  - numeric
  - date/time
  - person/software/agent ID
  - graphical
  - other MIME type
    - e.g. image, signal
- Each of these data types has its own context model

# Data types

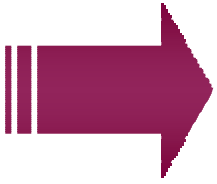
Text
data value



- Narrative
- Coded terms, and the original rubric as seen by the author
- Qualifiers
- Term sets, versions, registering agencies
- Narrative text with "marked up" codes, hyperlinks

# Data types

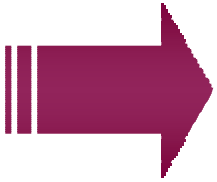
Numeric data value



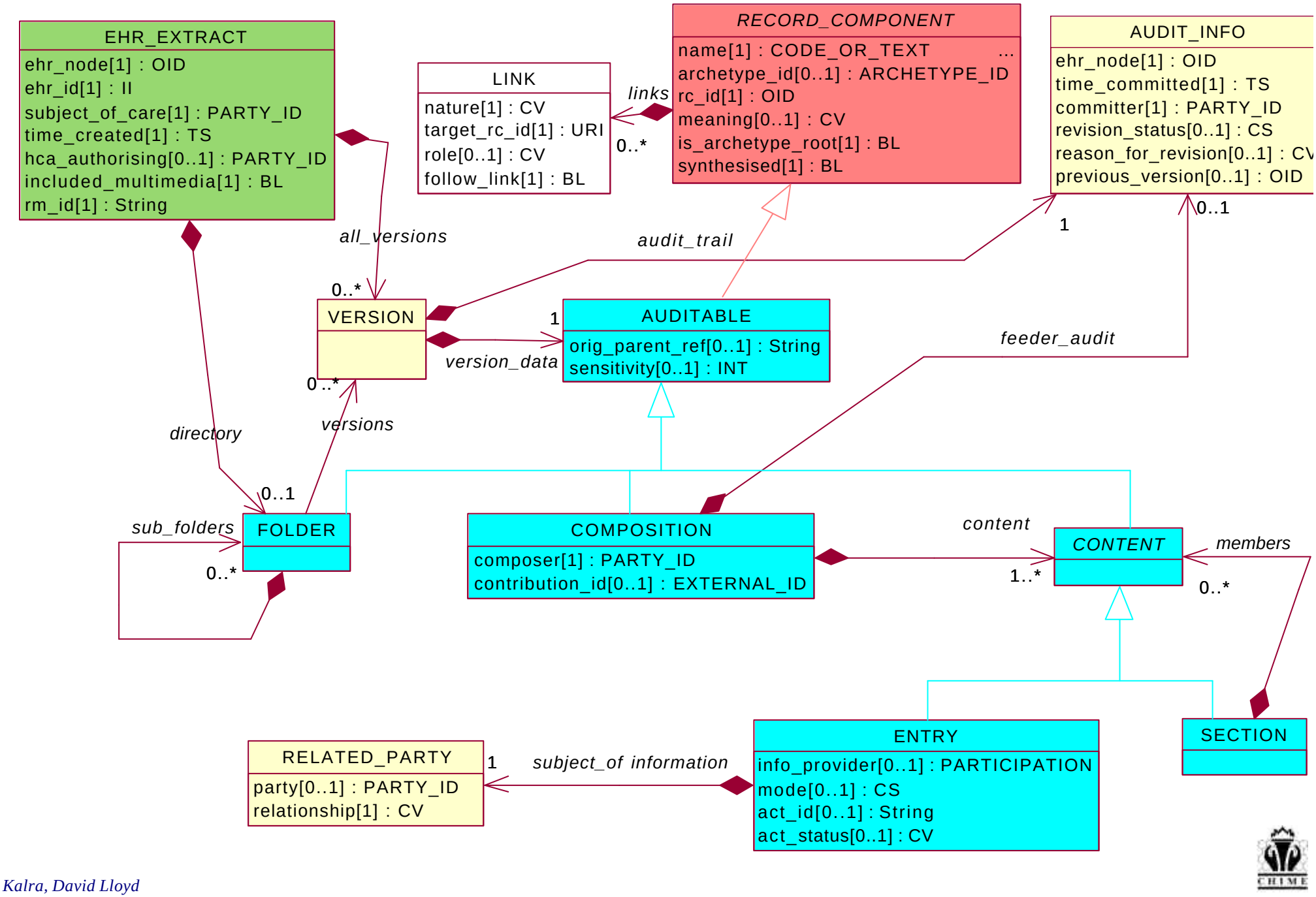
- Quantities, ranges and ratios
- Accuracy and precision
- Units
- Reference ranges

# Data types

Date/time data value



- Date and time intervals
  - including imprecisely specified dates and times
    - e.g. May 1963
  - not the AI equivalent of "fuzzy dates"
    - e.g. a Tuesday in May
    - e.g. three months after the baby is born
    - (these can be represented by free text expressions)


EHR_EXTRACT
ehr_node[1] : OID
ehr_id[1] : II
subject_of_care[1] : PARTY_ID
time_created[1] : TS
hca_authorising[0..1] : PARTY_ID
included_multimedia[1] : BL
rm_id[1] : String
LINK
nature[1] : CV
target_rc_id[1] : URI
role[0..1] : CV
follow_link[1] : BL
links
0..*
RECORD_COMPONENT
name[1] : CODE_OR_TEXT ...
archetype_id[0..1] : ARCHETYPE_ID
rc_id[1] : OID
meaning[0..1] : CV
is_archetype_root[1] : BL
synthesised[1] : BL
AUDIT_INFO
ehr_node[1] : OID
time_committed[1] : TS
committer[1] : PARTY_ID
revision_status[0..1] : CS
reason_for_revision[0..1] : CV
previous_version[0..1] : OID
all_versions
0..*
audit_trail
1
0..1
VERSION
1
AUDITABLE
orig_parent_ref[0..1] : String
sensitivity[0..1] : INT
version_data
feeder_audit
0..*
versions
directory
0..1
sub_folders
FOLDER
0..*
COMPOSITION
composer[1] : PARTY_ID
contribution_id[0..1] : EXTERNAL_ID
content
1..*
CONTENT
members
0..*
RELATED_PARTY
party[0..1] : PARTY_ID
relationship[1] : CV
1
subject_of information
ENTRY
info_provider[0..1] : PARTICIPATION
mode[0..1] : CS
act_id[0..1] : String
act_status[0..1] : CV
SECTION